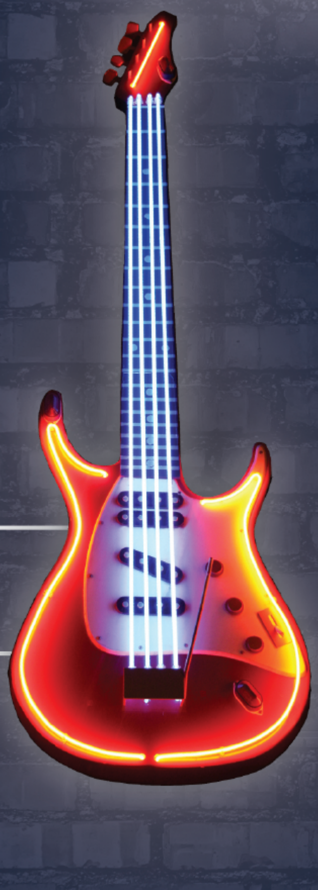
INFORMS ANNUAL MEETING

November 13–16

informs Nashville 2016

Fine Tuning Decisions in Music City



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110 8th Street, Troy, NY 12180, U.S.A.

Dear INFORMS Friends and Colleagues,

Welcome to the 2016 INFORMS Annual Meeting in Nashville, the capital city of the state of Tennessee and the second most populated. In addition to being a major music production center, Nashville's economy is powered by the healthcare industry along with other important industries such as automotive, financial, insurance and publishing industries. The conference theme, "Fine-Tuning Decisions in the Music City," reflects the broad scope of what will be covered in the conference, from applications in industries such as healthcare, finance and risk, entertainment, and supply chains to methodologies and analysis in advanced computing, big data, and new challenges in the optimization of systems.

An intriguing blend of topics from academics and practitioners fill the plenary and semi-plenary presentations. Guruduth Banavar, VP and Chief Science Officer at IBM, is the distinguished speaker for the opening plenary on Sunday, presenting an overview of cognitive computing, the technology breakthroughs, and the practical applications that are transforming every industry.

Margaret L. Brandeau, Professor of Engineering and Professor of Medicine at Stanford University, delivers a Monday plenary on effective public health preparedness and national security implications with a view to answering very complex questions using operations research. A Tuesday plenary is offered jointly by Professors Suvrajeet Sen and Gareth James, University of Southern California, on big data and big decisions.

Omega Rho's 40th Year Anniversary is celebrated with a Monday plenary lecture given by an expert panel consisting of Professors Alfred Blumstein (Carnegie Mellon University), John Birge (University of Chicago), Ralph Keeney (Duke University), and John Little (MIT). Moreover, the IFORS Distinguished Lecture is given by Professor Rolf H. Möhring, Beijing Institute for Scientific and Engineering Computing. The winners of the Franz Edelman, UPS George D. Smith, and Daniel H. Wagner Prizes will present their accomplishments in separate keynote presentations.

The lineup of keynote lectures also includes: Jeff Nichols, Director, Oak Ridge National Laboratory, on creating the Exascale ecosystem for science; Jason Murray, Vice President of World wide Retail Systems, Amazon, on optimizing supply chains; Edmund Jackson, Chief Data Scientist, Hospital Corporation of America, on analytics in healthcare; Stephen Prather, on sports analytics and the pursuit of usefulness; and Gerald Brown, Naval Postgraduate School, on what the goals of analysis should be.

Please take advantage of the many opportunities to network, including the Welcome Reception on Sunday evening, the General Reception on Tuesday evening, and the gathering areas at the conference exhibits and the Career Center. Also, do not forget to indulge yourself in the "The Coolest, Tastiest City in the South" food offerings from southern fare to haute cuisine to quite literally everything in between.

I am grateful to the INFORMS Meetings Committee for their support, and to the highly professional and efficient INFORMS staff members for their dedication to success. I am indebted to the organizing committee members for their unwavering support and hard work to put together a high quality program. The Program Chair, Bogdan Bichescu, University of Tennessee, has been my right-hand person persevering for success for over two long years, along with James Primbs, California State University, who served as Plenary and Keynote chair. Tutorial co-chairs, Aparna Gupta and Agostino Capponi; Invited sessions chair, Shabbir Ahmed; Poster sessions co-chairs, Melissa Bowers and Oleg Shylo; Contributed sessions co-chairs, Scott Mason and Justin Yates; Sponsored sessions chair, James Ostrowski; Practice program co-chairs, Mingzhou Jin and Sean Willems; and Arrangements co-chairs, Christine Vossler and Anahita Khojandi, all contributed immensely to the meeting's success. Organizing this event would not have been possible without their creative spirit and steadfast support.

I would also like to thankfully acknowledge the generous support received from our sponsors for the success of this conference. My special thanks go to the Platinum sponsor, Haslam College of Business, University of Tennessee; Gold sponsors, AIMMS, Caterpillar, IBM, and Industrial and Systems Engineering, University of Tennessee; Bronze sponsors, The Hong Kong Polytechnic University and SAS; and various Contributor sponsors, a long list that includes Rensselaer-Lally School, UT Dallas-Jindal School, Georgia Tech-ISyE, Lehigh-Engineering, PennState, Northwestern-Engineering, SUTD-Singapore, UTenn-Business Analytics, UT Austin-Engineering, GAMS, AMPL, and LINDO Systems.

It is my great pleasure and privilege to welcome you to INFORMS 2016! I hope you will enjoy the conference.

Chanaka Edirisinghe, General Chair
Professor, Lally School of Management,
Rensselaer Polytechnic Institute

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FRIDAY, NOVEMBER 11

Combined Colloquia		
Registration	Omni - Legends D, 2nd Floor	5:30–6:30pm
Dinner	Omni - Legends ABC, 2nd Floor	6–8pm

SATURDAY, NOVEMBER 12

Combined Colloquia	Omni - Cumberland 1-6	7am–6pm
CIST	Omni - Legends B,C,D	7:30am–6pm
ISR Editors Meeting	Omni - Music Row 2	8am–2pm
Organization Science Dissertation Competition	Omni - Legends A, 2nd Floor	8am–5pm
Data Mining & Analytics Workshop	Omni - Music Row 3,4,5	8am–7pm
Visit Music City	MCC - Exhibit Hall A, Level 3	9am–5pm
INFORMS Registration	MCC - Exhibit Hall A, Level 3	7am–5:30pm
Executive Committee Meeting	Omni - Gibson Boardroom, 3rd Floor	10am–12noon
INFORMS Board Meeting	Omni - Legends EF, 2nd Floor	12noon–4:30pm
Technology Workshops		
SAS - GAP/EDU	MCC - 201A, Level 2	9–11:30am
Optimization Direct	MCC - 201B, Level 2	9–11:30am
AIMMS	MCC - 201A, Level 2	12noon–2:30pm
FICO	MCC - 201B, Level 2	12noon–2:30pm
SAS - JMP	MCC - 202A, Level 2	12noon–2:30pm
Bayesia	MCC - 202B, Level 2	12noon–2:30pm
SAS Institute	MCC - 201A, Level 2	3–5:30pm
GAMS	MCC - 201B, Level 2	3–5:30pm
GUROBI	MCC - 202B, Level 2	3–5:30pm
IBM Analytics	MCC - 205A, Level 2	3–5:30pm
SIMIO	MCC - 202C, Level 2	3–5:30pm
MathWorks	MCC - 202A, Level 2	3–5:30pm
Neusrel	MCC - 208B, Level 2	3–5:30pm
LINDO Systems	MCC - 208A, Level 2	3–5:30pm
Frontline Systems	MCC - 205B, Level 2	3–5:30pm
INFORMS Member Meeting	Omni - Broadway GHJK, 2nd Floor	5–6:30pm
Roundtable Reception	Omni - Acoustic, 4th Floor	5–6pm
Roundtable Dinner	Omni - Electric, 4th Floor	6–7pm
ISS Awards & *ISR* Editors Reception	Omni - Legends G, 2nd Floor	6:30–8pm

SUNDAY, NOVEMBER 13

INFORMS Registration	MCC - Exhibit Hall A, Level 3	7am–5pm
New Member Breakfast (invite only)	Omni - Broadway F, 2nd Floor	7–8am
MNSC Editorial Board Meeting (invite only)	Omni - Broadway K, 2nd Floor	7:30–9am
ITED Editorial Board Meeting (invite only)	Omni - Broadway H, 2nd Floor	7:30–9am
Career Center Breakfast & Meeting	Omni - Broadway E, 2nd Floor	7:30–9am
Technical Sessions (SA)	**Music City Center & Omni**	**8–9:30am**
INFORMS Board	Omni - Legends EF, 2nd Floor	8am–5pm
CIST	Omni - Legends B,C,D	8am–5:15pm
Visit Music City	MCC - Exhibit Hall A, Level 3	9am–5pm
Coffee Break	MCC - Level 2 / Omni - 2nd Floor	9:30–10am
Welcome & Plenary: Guru Banavar	**MCC - Davidson Ballroom, Level 1M**	**10–10:50am**
Technical Sessions (SB)	**Music City Center & Omni**	**11am–12:30pm**
QSR Student Intro. & Interactive	Omni - Mockingbird 2	11am–12:30pm
Exhibits, Career Center, Technology Center	MCC - Exhibit Hall A, Level 3	12noon–5pm
INFORMS Center, Networking Lounge	MCC - Exhibit Hall A, Level 3	12noon–5pm
CIEADH	Omni - Legends A, 2nd Floor	12noon–6pm
Junior Faculty Interest Group Lunch (ticketed event)	Omni - Broadway E, 2nd Floor	12:30–1:30pm
Lunch Break (on your own)		12:30–1:30pm
M&SOM Associate Editors Lunch (invite only)	Omni - Broadway A, 2nd Floor	12:30–2:30pm
Technical Sessions (SC)	**Music City Center & Omni**	**1:30–3pm**
Keynote: UPS George D. Smith Reprise	**MCC - Davidson Ballroom A, Level 1M**	**3:10–4pm**
Keynote: Jeff Nichols, ORNL	**MCC - Davidson Ballroom B, Level 1M**	**3:10–4pm**
Keynote: IFORS Distinguished Lecture	**MCC - Davidson Ballroom C, Level 1M**	**3:10–4pm**
Coffee Break	MCC - Exhibit Hall A, Level 3 / Omni - 2nd Floor	4–4:30pm
Technical Sessions (SD)	**Music City Center & Omni**	**4:30–6pm**
INFORMS Community Meetings	See p. 6	
INFORMS Connect & Social Networking Reception	Omni - Broadway AB, 2nd Floor	6:30–7:30pm
Welcome Reception - Exhibits Open	MCC - Exhibit Hall A, Level 3	7:30–9pm
Minority Issues Forum Reception	Omni - Broadway K, 2nd Floor	7:30–9pm
Awards Ceremony & Dessert	Omni - Broadway EF, 2nd Floor	8:30–9:45pm

MONDAY, NOVEMBER 14

INFORMS Registration	MCC - Exhibit Hall A, Level 3	7am–5pm
ACORD Breakfast & Meeting	Omni - Broadway H, 2nd Floor	7:30–9am
Engagement with Organization Committee Meeting	Omni - Broadway B, 2nd Floor	8–9am
Technical Sessions (MA)	**Music City Center & Omni**	**8–9:30am**
Service Science Editorial Board Meeting (invite only)	Omni - Broadway D, 2nd Floor	8–10am

Interfaces, EIC Orientation	Omni - Broadway A, 2nd Floor	8am–12noon
Chapters/Fora Committee	Omni - Broadway J, 2nd Floor	8:30–9:30am
Exhibits, Career Center, Technology Center	MCC - Exhibit Hall A, Level 3	9am–5pm
INFORMS Center, Networking Lounge	MCC - Exhibit Hall A, Level 3	9am–5pm
Visit Music City	MCC - Exhibit Hall A, Level 3	9am–5pm
Section/Societies Committee	Omni - Broadway J, 2nd Floor	9:30–10:30am
Coffee Break	MCC - Exhibit Hall A, Level 3 / Omni - 2nd Floor	9:30–10am
Amazon Fulfillment Center Plant Tour	MCC – 6th Ave Exit, Near Rooms 210-214	9:30–12:30pm
Plenary: Philip McCord Morse Lecture	**MCC - Davidson Ballroom, Level 1M**	**10–10:50am**
Technical Sessions (MB)	**Music City Center & Omni**	**11am–12:30pm**
Education Committee Meeting	Omni - Broadway D, 2nd Floor	11am–12noon
Lunch Break (on your own)		12noon–1:30pm
Sections/Societies Officers Lunch (invite only)	Omni - Broadway J, 2nd Floor	12noon–1:30pm
Bonder Scholarship Lunch	Omni - Broadway A, 2nd Floor	12:30–1:30pm
COIN-OR Members & Users	Omni - Broadway H, 2nd Floor	12:30–1:30pm
PSOR Business Meeting	Omni - Legends E, 2nd Floor	12:30–1:30pm
MOOR Editorial Board Meeting (invite only)	Omni - Broadway K, 2nd Floor	12:30–2pm
Poster Session & Competition	MCC - Exhibit Hall A, Level 3	12:30–2:30pm
Publications/Editors-in-Chief Meeting	Omni - Broadway C, 2nd Floor	12:30–3:30pm
Fellows Lunch (invite only)	Omni - Legends D, 2nd Floor	12:45–2:30pm
Technical Sessions (MC)	**Music City Center & Omni**	**1:30–3pm**
Subdivisions Council	Omni - Broadway D, 2nd Floor	2:30–4:30pm
Analytics Program Director Meeting	MCC - Executive Boardroom, Level 3	3–4pm
Plenary: Omega Rho – 40th Year Anniversary Panel	**MCC - Davidson Ballroom, Level 1M**	**3:10–4pm**
Coffee Break	MCC - Exhibit Hall A, Level 3	4–4:30pm
Omega Rho Reception (invite only)	MCC - Davidson Ballroom A, Level 1M	4:30–6pm
Technical Sessions (MD)	**Music City Center & Omni**	**4:30–6pm**
INFORMS Community Meetings	See p. 6	
Interfaces Editorial Board Meeting (invite only)	Omni - Broadway B, 2nd Floor	6:15–7:15pm
International Activities Reception	Omni - Broadway G, 2nd Floor	7:30–9pm
Student Awards Reception	Omni - Broadway EF, 2nd Floor	7:30–9:30pm
WORMS Networking/Dessert Reception	Frothy Monkey (off-site)	8–10pm

TUESDAY, NOVEMBER 15

INFORMS Registration	MCC - Exhibit Hall A, Level 3	7am–5pm
Chapters/Fora Officers Breakfast	Omni - Broadway F, 2nd Floor	7–8am
IFORS Members Societies Representatives Breakfast	Omni - Broadway J, 2nd Floor	7–8am
Transportation Science Associate Editors (invite only)	Omni - Broadway K, 2nd Floor	7:30–9am
Student Chapter Officers Meeting	Omni - Broadway F, 2nd Floor	8–8:45am
Technical Sessions (TA)	**Music City Center & Omni**	**8–9:30am**
Exhibits, Career Center, Technology Center	MCC - Exhibit Hall A, Level 3	9am–5pm
INFORMS Center, Networking Lounge	MCC - Exhibit Hall A, Level 3	9am–5pm
Visit Music City	MCC - Exhibit Hall A, Level 3	9am–5pm
Coffee Break	MCC - Exhibit Hall A, Level 3 / Omni - 2nd Floor	9:30–10am
Smyrna Vehicle Assembly Plant Tour (ticketed event)	MCC - 6th Ave Exit, Near Rooms 210-214	9:30–11:30am
Plenary: Suvrajeet Sen & Gareth James, Univ. of Southern Calif.	**MCC - Davidson Ballroom, Level 1M**	**10–10:50am**
Technical Sessions (TB)	**Music City Center & Omni**	**11am–12:30pm**
Lunch Break (on your own)		12noon–1:30pm
IJOC Editorial Board Meeting (invite only)	Omni - Broadway G, 2nd Floor	12:30–1:30pm
Women in OR/MS Lunch (ticketed event)	Omni - Broadway F, 2nd Floor	12:30–1:30pm
Poster Session & Competition	MCC - Exhibit Hall A, Level 3	12:30–2:30pm
Technical Sessions (TC)	**Music City Center & Omni**	**1:30–3pm**
Keynote: Wagner Prize Winner Reprise	**MCC - Davidson Ballroom A, Level 1M**	**3:10–4pm**
Keynote: Jason Murray, Amazon	**MCC - Davidson Ballroom B, Level 1M**	**3:10–4pm**
Keynote: Edelman Reprise: UPS	**MCC - Davidson Ballroom C, Level 1M**	**3:10–4pm**
Coffee Break	MCC - Exhibit Hall A, Level 3 / Omni - 2nd Floor	4–4:30pm
Technical Sessions (TD)	**Music City Center & Omni**	**4:30–6pm**
Exhibitor & Organizing Committee Reception	Omni - Broadway JK, 2nd Floor	5–6pm
INFORMS Community Meetings	See p. 6	
General Reception	MCC - Grand Ballroom, Level 4	7:30–9:30pm

WEDNESDAY, NOVEMBER 16

INFORMS Registration	MCC - Exhibit Hall A, Level 3	7am–4:30pm
Technical Sessions (WA)	**Music City Center & Omni**	**8–9:30am**
Exhibits, Career Center, Technology Center	MCC - Exhibit Hall A, Level 3	9am–3pm
INFORMS Center, Networking Lounge	MCC - Exhibit Hall A, Level 3	9am–3pm
Coffee Break	MCC - Exhibit Hall A, Level 3 / Omni - 2nd Floor	9:30–10am
Keynote: Edmund Jackson, HCA	**MCC - Davidson Ballroom A, Level 1M**	**10–10:50am**
Keynote: Gerald Brown, Naval Postgraduate School	**MCC - Davidson Ballroom B , Level 1M**	**10–10:50am**
Keynote: Stephen Prather, SportSource Analytics	**MCC - Davidson Ballroom C, Level 1M**	**10–10:50am**
Technical Sessions (WB)	**Music City Center & Omni**	**11am–12:30pm**
Technical Sessions (WC)	**Music City Center & Omni**	**12:45–2:15pm**
Coffee Break	MCC - Exhibit Hall A, Level 3 / Omni - 2nd Floor	2:15–2:45pm
Technical Sessions (WD)	**Music City Center & Omni**	**2:45–4:15pm**
Technical Sessions (WE)	**Music City Center & Omni**	**4:30–6pm**

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SUNDAY, NOVEMBER 13

Information Systems	Omni - Legends D, 2nd Floor	5:15–6:15pm
Aviation Applications	MCC - 107A, Level 1	6:15–7:15pm
Decision Analysis Society Council	Off-Site	6:15–7:15pm
ENRE Section	MCC - 101D, Level 1	6:15–7:15pm
Forum on Education (INFORM-ED)	MCC - 211, Level 2	6:15–7:15pm
Location Analysis Section	MCC - 107B, Level 1	6:15–7:15pm
Manufacturing & Service Operations Society	MCC - Davidson B, Level 1M	6:15–7:15pm
Minority Issues Forum	MCC - 105A, Level 1	6:15–7:15pm
Military Applications Society Board	MCC - 108, Level 1	6:15–7:15pm
Multiple Criteria Decision Making	MCC - 105B, Level 1	6:15–7:15pm
Optimization	MCC - Davidson A, Level 1M	6:15–7:15pm
Railway Applications	Off-Site	6:15–7:15pm
Revenue Management & Pricing	MCC - 207D, Level 1	6:15–7:15pm
Telecommunications Section	MCC - 110A, Level 1	6:15–7:15pm
Transportation Science & Logistics Society Board	MCC - 110B, Level 1	6:15–7:15pm
Simulation	MCC - 209A, Level 2	6:15–7:15pm
Women in OR/MS	MCC - 212, Level 2	6:15–7:15pm
Revenue Management & Pricing Board Meeting	MCC - 207D, Level 2	7:15–8:15pm

MONDAY, NOVEMBER 14

PSOR	Omni - Legends E, 2nd Floor	12:30–1:30pm
DM, QSR, & Artificial Intelligence	MCC - Davidson B, Level 1M	6–8pm
Analytics	MCC - 104D, Level 1	6:15–7:15pm
Applied Probability	MCC - 207A, Level 2	6:15–7:15pm
Computing	MCC - 106B, Level 1	6:15–7:15pm
CPMS Isolated Practitioners Workshop	MCC - 109, Level 1	6:15–7:15pm
Decision Analysis	MCC - 208A, Level 2	6:15–7:15pm
e-Business	MCC - 107A, Level 1	6:15–7:15pm
Financial Services	MCC - 207C, Level 2	6:15–7:15pm
Health Applications	MCC - Davidson C, Level 1M	6:15–7:15pm
Military Applications Society	MCC - 108, Level 1	6:15–7:15pm
Social Media Analytics	MCC - 210, Level 2	6:15–7:15pm
Tech., Innovation Mgmt., & Entrepreneurship	MCC - 107B, Level 1	6:15–7:15pm
TSL	MCC - Davidson A, Level 1M	6:15–7:15pm
Behavioral Operations Management	MCC - 109, Level 1	7:15–8:15pm
Military Applications Reception	MCC - 108, Level 1	7:15–10:15pm

TUESDAY, NOVEMBER 15

SpORts	Baileys Sports Grille (off-site)	6:00–7:00pm
CPMS Section Membership Reception	Palm Restaurant (off-site)	6:15–7:15 pm
Service Science	MCC - 107A, Level 1	6:45–7:30pm

UNIVERSITY RECEPTIONS

MONDAY, NOVEMBER 14

Texas A&M University	Omni - Legends A, 2nd Floor	5:30–7:30pm
Princeton University	Omni - Broadway H, 2nd Floor	TBA
Tepper School of Business - Carnegie Mellon University	Omni - Legends E, 2nd Floor	6–8pm
University of Florida	Omni - Legends F, 2nd Floor	6–7:30pm
University of Texas at Austin (Sponsored by: IROM & ORIE)	Omni - Broadway D, 2nd Floor	7–9pm
University of Notre Dame	Omni - Broadway A, 2nd Floor	7–9pm
Cornell University	Omni - Legends C, 2nd Floor	7:15–8:15pm
Northwestern University	Omni - Broadway C, 2nd Floor	7:30–9:30pm

All Technology Tutorials will take place in the Music City Center, 5th Avenue Lobby.

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Monday, November 14, 5:15–6pm

***Technology Tutorial:** AMPL in the Cloud: Using Online Services to Develop and Deploy Optimization Applications through Algebraic Modeling Robert Fourer, President AMPL Optimization Inc., 4er@ampl.com. Optimization modeling systems first appeared online almost 20 years ago, not long after web browsers came into widespread use. This presentation describes the evolution of optimization alternatives in what has come to be known as cloud computing, with emphasis on the role of the AMPL modeling language in making models easy to develop and deploy. We start with the pioneering free NEOS Server, and then compare more recent commercial offerings such as Gurobi Instant Cloud; the benefits of these solver services are readily leveraged through their use with the AMPL modeling tools. We conclude by introducing QuanDec, which creates web-based collaborative applications from AMPL models. Robert Fourer, an authority on the design and implementation of computer software to support large-scale optimization, studied at MIT and Stanford and was a professor of Industrial Engineering and Management Sciences for over 30 years. He is a founder and is currently President of AMPL Optimization Inc. and is co-author of a popular book on modeling in the AMPL language.*

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Monday, November 14, 8:45–9:30am

***Technology Tutorial:** Solving Large Least-Squares Models with the Artelys Knitro Nonlinear Optimization Solver. Presenting Author: Richard Waltz, Senior Scientist, Artelys Corp, richard.waltz@artelys.com. Artelys Knitro is the premier solver for nonlinear optimization problems. This software demonstration will highlight the latest Knitro developments, including a new specialized API, as well as enhanced algorithms, for large-scale nonlinear least-squares models. We will demonstrate how to solve least-squares models using Knitro through a variety of interfaces such as R, MATLAB and C/C++, and also provide some benchmarking results. In addition, we will summarize some of the other recent developments in Knitro.*

Bayesia, USA 33
www.bayesialab.com

Bayesian Networks & BayesiaLab: Artificial Intelligence for Research, Analytics, and Reasoning. The objective of this workshop is to show that "Artificial Intelligence" should not be perceived as a quasi-magic technology that is mostly incomprehensible to normal mortals. We want to illustrate how scientists in any field of study—rather than only computer scientists—can employ AI to explore complex problems. For this purpose, we present Bayesian networks as the framework and BayesiaLab as the software platform. In this context, we demonstrate BayesiaLab's supervised and unsupervised machine learning algorithms for knowledge discovery in high-

All Technology Tutorials will take place in the Music City Center, 5th Avenue Lobby.

dimensional, unknown domains. Also, while AI is commonly associated with another buzzword, "Big Data", we wish to prove that AI can be useful for dealing with problems for which we possess little or no data. Here, expert knowledge modeling is critical, and we describe how even a minimal amount of expertise can serve as a basis for sound reasoning aided by AI.

Sunday, November 13, 11:45am–12:30pm

Technology Tutorial: *AArtificial Intelligence in Marketing Science: Marketing Mix Modeling and Optimization with Bayesian Networks & BayesiaLab , "Half the money I spend on advertising is wasted; the trouble is I don't know which half." Various versions of this quote have been attributed to John Wanamaker, Henry Ford, and Henry Procter, yet 100 years after these marketing pioneers, in this day and age of big data and advanced analytics, the quote still rings true. The current practice is often "more art than science." The lack of a well-established marketing mix methodology has little to do with the domain itself. Rather, it reflects the fact that marketing is yet another domain that typically has to rely on nonexperimental data for decision support. Marketing mix modeling is a causal problem, which means we are not looking for a prediction of an outcome based on the observation of marketing variables, but attempting to manipulate the marketing variables to optimize the outcome. Thus, we must simulate interventions, not observations, and switch from observational to causal inference. This brings us to deriving causal inference from observational data. We introduce the fundamental concepts of graphical models and how they can help us perform causal identification, i.e., determine whether it is possible to estimate causal effects from observational data, which requires causal assumptions about the domain plus a decision criterion, e.g., the Adjustment Criterion. However, the complexity of the marketing domain limits the practical application of this criterion. We introduce the Disjunctive Cause Criterion, which reduces the number of assumptions required for causal identification and, thus, confounder selection. Proceeding from causal identification to estimation requires an "inference engine." In the simplest case, we could use a regression, but with dozens of interacting variables, that is not practical. Instead we use Artificial Intelligence by employing BayesiaLab's machine-learning algorithms, which builds a high-dimensional Bayesian network model that represents the joint probability distribution of all variables. This causal inference engine plus BayesiaLab's Target Optimization algorithm enable us to search efficiently for the ideal marketing mix.*

Cambridge University Press 34
www.cambridge.org/academic

Cambridge University Press' publishing in books and journals combines state-of-the-art content with the highest standards of scholarship, writing and production. Visit our stand to browse new titles, available at 20% discount, and to pick up sample copies of our journals. Visit our website to find out more about what we do.

Clemson University/COIN-OR Foundation 23
www.coin-or.org

The Computational Infrastructure for Operations Research publishes high quality, free, open-source tools for OR professionals and students, suitable for commercial, educational, and personal use. COIN-OR is the place to go when you need a "white box" for algorithm research and development. COIN-OR is a strategic partner of the INFORMS Computing Society.

Cornell Tech 7
http://tech.cornell.edu

At Cornell Tech, students across programs learn and work side-by-side, spending one-third of their experience together working on a studio-based core curriculum. They collaborate with the tech industry and postdoc-level researchers to build start-up companies and new products. By bringing these talents together at the start, there is enormous potential for better, more impactful and ultimately more successful companies and products. Programs offered: Master of Engineering in Computer Science, Master of Engineering in Electrical and Computer Engineering, Master of Engineering in Operations Research and Information Engineering, Technion-Cornell Dual Degree in Connective Media, Technion-Cornell Dual Degree in Health Tech, Johnson Cornell Tech MBA, and Master of Laws in Law, Technology and Entrepreneurship.

Darden Business Publishing 16
http://store.darden.virginia.edu

Darden Business Publishing markets case-based educational materials written by the renowned faculty at the University of Virginia Darden School of Business. Darden maintains a catalogue of student-centered learning materials that energize classrooms around the world with dynamic interactive simulations and thought-provoking paper cases.

Dynamic Ideas, LLC 49
www.dynamic-ideas.com

Dynamic Ideas, LLC is a publisher of scientific books that have quality and originality in the areas of Operations Research and Applied Mathematics. The key objective of our titles is to "educate the next generation." Many of our books are currently being used as the main textbook in academic courses in some of the finest universities and research institutions in the world.

Elsevier 26
www.elsevier.com/decisionsciences

Elsevier publishes leading journals in OR/MS and Decision Sciences, including *European Journal of Operational Research*, *Computers & Operations Research*, and *Omega-International Journal of Management Science*. Elsevier journals occupy 7 of the Top 10 Impact Factor positions in the Thomson Reuters 'Operations Research & Management Science' category. Come to the booth to find out more, including how to use Elsevier's researcher centric tools to develop your research.

FDA/Center for Drug Evaluation and Research 38
www.fda.gov/drugs

The Center for Drug Evaluation and Research (CDER) performs an essential public health task by making sure that safe and effective drugs are available to improve the health of people in the United States.

All Technology Tutorials will take place in the Music City Center, 5th Avenue Lobby.

FICO 5

www.fico.com

FICO is a leading analytics software company, helping businesses in 90+ countries make better decisions that drive higher levels of growth, profitability and customer satisfaction. The company's groundbreaking use of Big Data and mathematical algorithms to predict consumer behavior has transformed entire industries. FICO provides analytics software and tools used across multiple industries to manage risk, fight fraud, build more profitable customer relationships, optimize operations and meet strict government regulations. Many of our products reach industry-wide adoption. These include the FICO® Score, the standard measure of consumer credit risk in the United States. FICO solutions leverage open-source standards and cloud computing to maximize flexibility, speed deployment and reduce costs. The company also helps millions of people manage their personal credit health.

Tuesday, November 15, 4:30–5:15pm

Technology Tutorial: *How to deploy your analytic models to empower non-technical business users. You have a team with great analytics background. They have developed advanced analytical tools using SAS, Python, R, or with your current traditional optimization solver. They have derived crucial insights from your data, and figured out how your decisions shape your customers' behaviors. Now it's time to put these critical analytical insights in the hands of your non-technical business users. In this tutorial, we will cover how FICO's Optimization Suite (including Xpress and Optimization Modeler) make it possible to embed your analytic models in user-friendly business-user facing applications. Learn how you can supercharge your analytic models with simulation, optimization, reporting, what-if analysis and agile extensibility.*

Frontline Systems, Inc. 39

www.solver.com

Frontline Systems is democratizing analytics, enabling business analysts and developers to get results quickly with just a browser, spreadsheet, or programming language, instead of expensive enterprise software with steep learning curves. See how easily you can solve optimization, simulation/risk analysis, forecasting and data mining problems–starting for free, and scaling up easily to the largest models, using AnalyticSolver.com, Analytic Solver® for desktop Excel, and our RASON® modeling language and REST API. Use our Solver and XLMiner® SDKs for C#, Java, C++, R and Python to create your own analytics applications. Find your fastest path to real analytics results.

Tuesday, November 15, 8–8:45am

Technology Tutorial: *AnalyticSolver.com: Data Mining, Simulation and Optimization in Your Web Browser. AnalyticSolver.com is the new, simple, point-and-click way to create and run analytic models using only your web browser – that also works interchangeably with your spreadsheet. Whether you need forecasting, data mining and text mining, Monte Carlo simulation and risk analysis, and conventional and stochastic optimization, you can "do it all" in the cloud. We'll show how you can upload and download Excel workbooks, pull data from SQL Server databases and Apache Spark Big Data clusters, solve large-scale models, and visualize results – without leaving your browser. If you're more comfortable working on your own laptop or server, we'll show how you can do that, too.*

GAMS Development Corp 4

www.gams.com

The General Algebraic Modeling System (GAMS) is a high-level modeling system for mathematical programming and optimization. It consists of a language compiler and a stable of integrated high-performance solvers. GAMS is tailored for complex, large-scale modeling applications, and allows you to build large maintainable models that can be adapted to new situations. Come to our booth to learn more about GAMS or ask for an evaluation license. Visit our technology workshop or software demo.

Monday, November 14, 1:30–2:15pm

Technology Tutorial: *We demonstrate many of the capabilities of the GAMS software as we start with a simple optimization model and build it out by adding nonlinear and integer variables to the model and connecting it with a GUI in a sample application.*

Gurobi Optimization 21

www.gurobi.com

Gurobi Optimization is dedicated to helping our users succeed with optimization. We provide the leading math programming solvers, offering best-in-class performance as well as a broad array of tools for developing and deploying optimization applications on top of these solvers. We support all of the most popular programming languages, as well as client-server architectures, cloud computing, and distributed optimization. We also provide outstanding, easy-to-reach support and transparent, no-surprises pricing.

Monday, November 14, 4:30–5:15pm

Technology Tutorial: *Advanced Python Modeling with Gurobi. Are you looking for an environment that combines the expressiveness of a modeling language with the power and flexibility of a programming language? The Gurobi Python interface allows you to build concise and efficient optimization model, using high-level modeling constructs. This tutorial will provide an overview of these capabilities, including an introduction to new modeling features that significantly enhance the expressiveness of our environment.*

IBM 35

www.ibm.com

Critical business decisions can be made with ease when you know what is likely to happen in the future and how you should respond. IBM is paving the way to the next generation of analytics solutions and platforms by combining descriptive, predictive and prescriptive analytics with the power of cloud and cognitive insights. These advanced analytics capabilities provide robust; user friendly platforms aimed at helping you solve even the most complex business and research problems. Visit the IBM Advanced Analytics booth to learn more

Monday, November 14, 11:45am–12:30pm

Technology Tutorial: *IBM Decision Optimization: Performance gains and New features in CPLEX and CP Optimizers. In this tutorial, you will learn about the new CPLEX and CP Optimizer engine features in the upcoming IBM CPLEX Optimization Studio release, including how to use the new features, how they can help you during the development of your model, and how they can speed up the resolution of your models.*

All Technology Tutorials will take place in the Music City Center, 5th Avenue Lobby.

IFORS 11
www.IFORS.org

The International Federation of Operational Research Societies (IFORS) is an umbrella organization comprising the national Operations Research societies of over 45 countries from four geographical regions: Asia Pacific, Europe, North America, South America. Total membership is over 30,000 persons. IFORS' mission is to promote Operations Research as an academic discipline and a profession.

Ivey Publishing 9
www.iveycases.com

Ivey Publishing is the leader in providing business case studies with a global perspective. With over 35,000 products in our library, Ivey Publishing adds more than 350 classroom-tested case studies each year. Virtually all Ivey cases have teaching notes. Clear, concise, and current, Ivey cases are lauded by the academic community as meeting the rigorous demands of management education by responding to the ever changing needs of business and society. Meet with one of our case experts on how to publish with us and how you can integrate world-class cases into your curriculum.

LINDO Systems, Inc. 29
www.lindo.com

Operations Research professionals across nearly every industry for over 30 years. LINDO offers a full range of solvers to cover all your optimization needs. The Linear Programming solvers handle million variable/constraint problems fast and reliably. The Quadratic/SOCP/Barrier solver efficiently handles quadratically constrained problems. The Integer solver works fast and reliably with LP, QP and NLP models. The Global NLP solver finds the guaranteed global optimum of non-convex models. The Stochastic Programming solver has a full range of capabilities for planning under uncertainty.

Get all the tools you need to get up and running quickly. LINDO provides a set of versatile intuitive interfaces to suit your modeling preference. What's best is an add-in to Excel that you can use to quickly build spreadsheet models that managers can use and understand. LINDO has a full featured modeling language for expressing complex models clearly and concisely, and it has links to Excel and databases that make data handling easy. LINDO API is a callable library that allows you to seamlessly embed the solvers into your own applications. You can pick the best tool for the job based upon who will build the application, who will use it, and where the data reside. Technical support at LINDO is responsive and thorough - whether you have questions about the software or need some guidance on handling a particular application.

Monday, November 14, 2:15–3pm

Technology Tutorial: *Optimization Modeling Made Easy. Presenter: Mark Wiley, VP Marketing, mwiley@lindo.com. Come and learn how easy it is to: quickly build linear, nonlinear, quadratic, conic and integer optimization models; incorporate uncertainty into optimization models; easily access data from Excel and databases; seamlessly embed a solver into your own application. Come and see a demonstration of the power and flexibility of the new releases of: LINDO API – a callable solver engine, LINGO – an integrated modeling language and solvers, for Excel.*

MathWorks 8
www.mathworks.com

The MATLAB and Simulink product families are fundamental applied math and computational tools at the world's educational institutions. Adopted by more than 5,000 universities and colleges, MathWorks products accelerate the pace of learning, teaching, and research in engineering and science. MathWorks products also help prepare students for careers in industry worldwide, where the tools are widely used for data analysis, mathematical modeling, and algorithm development in collaborative research and new product development. Application areas include data analytics, mechatronics, communication systems, image processing, computational finance, and computational biology.

Monday, November 14, 8–8:45am

Technology Tutorial: *Data Analytics with MATLAB. Mary Fenelon, Product Manager, MathWorks, mary.fenelon@mathworks.com. Using data analytics to turn large volumes of complex data into actionable information can help you improve engineering design and decision-making processes. However, developing effective analytics and integrating them into business systems can be challenging. In this session you will learn approaches and techniques available in MATLAB to tackle these challenges through an example showing steps of data access, exploration, predictive and prescriptive model development, and deployment.*

Military Operations Research Society 10
www.mors.org

MORS is a professional society of nearly 1,000 operations researchers and national security analysts. Since 1966 MORS' mission has been to enhance the quality of analysis to address real world national security interests through the advancement of the operations research profession. Today MORS services include the Annual MORS Symposium with 500+ classified and unclassified sessions, year-round communities of practice, geographic chapters, an annual Education and Professional Development Colloquium for students and young analysts, classified and unclassified special meetings/workshops, tutorials and CEU Courses, *Phalanx* the magazine of national security analysis and a catalog of original books, reports and republished historical manuals.

MIT Sloan 52
www.mitsloan.mit.eduu

MIT Sloan is a mission-driven organization. We develop principled, innovative leaders who improve the world and generate ideas that advance management practice. Our diversified, specialized, and action-oriented curriculum exemplifies our commitment to balancing innovative ideas and theories with hands-on, real-world application. The coursework at MIT Sloan is markedly rigorous and further distinguished by emphasis on real-world engagement that turns innovative ideas into practical solutions to the world's problems. MIT Sloan School offers a variety of degree programs to help you advance your career. The two-year full time MBA program allows you to customize your curriculum to focus on specific areas of interest. Optional tracks and certificates in Enterprise Management, Entrepreneurship & Innovation, Finance, Healthcare, and

Sustainability help you dive more deeply into your career interests. For students interested in careers in finance or data analytics, MIT Sloan has innovative programs to help them succeed. The new one-year Master of Business Analytics (MBAn) program is tailored for graduating college seniors and early-stage professionals. This innovative program features Action Learning labs, collaboration with other MIT Sloan programs, a Summer Capstone project, career support, and tailored electives in statistics, finance, economics, and operations research. The program answers the industry's demand for a skilled pool of graduates who can apply data science to solve business challenges. The 12-month and 18-month Master of Finance (MFin) program is designed for students who want to become leaders in the field of finance. The MFin program combines in-depth study of quantitative techniques with practical problem solving and the 18-month pilot allows time for a summer internship. MIT Sloan is about invention. It's about ideas that are made to matter. At MIT Sloan, we discover tomorrow's interesting and important challenges and opportunities. We go where we want to have impact. And then, we invent the future.

MOSEK ApS 46

https://mosek.com

MOSEK ApS provides optimization software to help clients making better decisions. It specializes in creating advanced software for solution of mathematical optimization problems. In particular, the company focuses on solution of large-scale linear, quadratic, and conic optimization problems. MOSEK ApS was established in 1997 by Erling D. Andersen and Knud D. Andersen. Our customer base consists of financial institutions and companies, engineering and software vendors, among others.

Neusrel/Success Drivers 19

www.neusrel.com

NEUSREL is the leading software for exploring cause-effect networks using the Universal Structure Modeling approach. Because it leverages machine learning techniques it is a self-learning system and the only methodology to explore previously not hypnotized nonlinearities (of any form) or interactions (of any type). It is the first system meeting the need of researcher to explore success factors instead of just falsifying a given set of hypothesis. It bridges the largely relevant gap between qualitative exploration and statistical testing/modeling. NEUSREL Causal Analytics is dedicated to provide software as well as training and statistical consulting to the academic community.

Tuesday, November 15, 2:15–3pm

Technology Tutorial: NEUSREL is a self-learning causal analysis software and leverages Advanced Machine Learning techniques. It builds cause-effect networks (path models) in order to understand the impact and role of success factors. The software is the only solution worldwide that is able to explore unexpected nonlinearities and unexpected interactions – a capability that not only led to largely increased explanation power but turned out to be crucial when understanding true key drivers of outcomes. The software is applied in all fields where many factors drive a particular outcome and therefore it is not clear how important those are and how they interact.

North Carolina State University 51

www.ise.ncsu.edu

Within NC State's renowned College of Engineering, the Edward P. Fitts Department of Industrial and Systems Engineering (ISE) is among the top ranked programs in the country by *US News & World Report*. The department has created a legacy of success by partnering with industry, government and universities while producing engineers with cutting edge ingenuity, interpersonal skills and business acumen. The College ranks ISE #1 in student satisfaction, job placement and job placement in their field of study. Currently, there are more companies looking to hire our students than there are candidates to fill those positions.

Now Publishers 30

www.nowpublishers.com

Now Publishers publishes a suite of reference journals called *Foundations and Trends* including *Information Systems, Machine Learning, Operations Management, Optimization*, and *Systems and Control*, academic journals including the *DEA Journal* and *Review of Behavioral Economics*, and scholarly books in the fields of business and technology. We will also represent World Scientific who publishes about 600 new titles a year and 130 journals in various fields. Started in 1981, it has established itself as one of the leading scientific publishers in the world, and the largest international scientific publisher in the Asia-Pacific region.

Optimization Direct Inc. 24

www.optimizationdirect.com

Optimization Direct Inc., markets IBM® ILOG® CPLEX Optimization Studio®, the world's leading software product for modeling and optimization. CPLEX Optimization Studio solves large-scale optimization problems and enables better business decisions and resulting financial benefits in areas such as supply chain management, operations, healthcare, retail, transportation, logistics and asset management. It has been applied in sectors as diverse as manufacturing, processing, distribution, retailing, transport, finance and investment.

Monday November 14, 11–11:45am

Technology Tutorial: *Recent advancements in Linear and Mixed Programing give us the capability to solve larger Optimization Problems. CPLEX Optimization Studio solves large-scale optimization problems and enables better business decisions and resulting financial benefits in areas such as supply chain management, operations, healthcare, retail, transportation, logistics and asset management. In this tutorial using CPLEX Optimization Studio, we will discuss modeling practices, case studies and demonstrate good practices for solving Hard Optimization Problems. We will also discuss recent CPLEX performance improvements and recently added features.*

All Technology Tutorials will take place in the Music City Center, 5th Avenue Lobby.

Palgrave Macmillan — 6

www.palgrave.com

Palgrave Macmillan is proud to publish a unique cross-section of high-quality research work fundamental to understanding contemporary issues and developments in operations research and information technology. Our growing portfolio in this area includes the journals of the OR Society and the OR Essentials series. With offices in London and New York, and sales teams across 50 countries, we have a global reach, and as part of Springer Nature, are proud to uphold an unbroken tradition of over 170 years of academic publishing.

Palisade Corporation — 53

www.palisade.com

Palisade Corporation is the maker of the market leading risk and decision analysis software @RISK and the DecisionTools® Suite. Virtually all Palisade software adds in to Microsoft Excel, ensuring flexibility, ease-of-use, and broad appeal across a wide range of industry sectors. Free trial downloads at www.palisade.com.

Sunday, November 13, 11–11:45am

Technology Tutorial: *Introduction to Risk and Decision Analysis using @RISK and The DecisionTools Suite. This software presentation is designed to provide an entry-level introduction into probabilistic analysis and will show how Monte Carlo simulation and other techniques can be applied to your everyday business analyses. Using Monte Carlo simulation, @RISK will analyze many different scenarios all at once, giving you more insight into what could happen. We'll look at example models including a basic revenues/cost/profits model, an NPV model, and a Cost Estimation model, to give you an idea of how quickly you can get started in probabilistic modeling in Excel. If you build models in Excel then Palisade solutions can almost certainly help you to make more informed decisions, right from your desktop. For more than 30 years, Palisade software and solutions have been used to make better decisions. Cost estimation, NPV analysis, operational risk registers, portfolio analysis, insurance loss modeling, reserves estimation, schedule risk analysis, budgeting, sales forecasting, and demand forecasting are just some of the ways in which the tools are applied. This presentation will demonstrate how easy – and necessary – it is to implement quantitative risk analysis in any business.*

Princeton Consultants — 20

www.princeton.com

Founded in 1980, Princeton Consultants blends advanced analytics, data science, software development and management consulting to help industry leaders and fast-growing innovators transform performance. Based on our track record of developing and implementing critical operational systems, we review and improve optimization and predictive analytics models through our quality assurance service. We are a member of the INFORMS Roundtable.

Provalis Research — 28

www.provalisresearch.com

Provalis Research is a leading developer of text analytics software with groundbreaking qualitative and quantitative analysis programs, such as QDA Miner, an innovative mixed-methods qualitative data analysis software; WordStat, a powerful add-on module for computer assisted content analysis and text mining; and Simstat, an easy yet powerful statistical software. One of the most distinctive features of these tools is their interoperability, allowing researchers to integrate numerical and textual data into a single project file and to seamlessly move back and forth between quantitative and qualitative data analysis, as well as to easily explore relationships between numerical and textual data.

Sunday, November 13, 1:30–2:15pm

Technology Tutorial: *Provalis Research will showcase its integrated collection of text analytics software.*
QDA Miner is an easy-to-use qualitative and mixed methods software that meets the needs of researchers performing qualitative data analysis and would like to code more quickly and more consistently larger amounts of documents. It offers high level computer assistance for qualitative coding with innovative text search tools that help users speed up the coding process as well as advanced statistical and visualization tools. Users with even bigger text data can also take advantage of WordStat. This add-on module to QDA Miner can be used to analyze huge amounts of unstructured information, quickly extract themes, find trends over time, and automatically identify patterns and references to specific concepts using categorization dictionaries.

Responsive Learning Technologies — 18

www.responsive.net

Responsive Learning Technologies provides compelling business simulations to teach Operations Management and Supply Chain Management in a dynamic context and adaptive self-study software to help students prepare for beginning a degree program. Our software has enriched courses at the undergraduate, graduate, and executive levels for thousands of students at hundreds of institutions in dozens of countries. Our products are developed with leading scholars, to achieve well-defined learning objectives.

RPI, Lally School of Business — 45

https://lallyschool.rpi.edu

At the Lally School of Management at Rensselaer Polytechnic Institute in Troy, NY, we develop aspiring business leaders who have a passion for innovation with the ability to work across business functions. Our programs are built around innovation, technology, and entrepreneurship in the global economy. The Lally School offers eight undergraduate concentrations including: Accounting, Business Analytics, Entrepreneurship, Finance, International Management, Management Information Systems, Marketing, and Supply Chain Management. It also offers an MBA; MS degrees in business analytics, supply chain management, technology commercialization and entrepreneurship, quantitative finance and risk analytics, or management; and a PhD in management.

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SAS - GAP/EDU 2

www.sas.com

SAS is the leader in analytics. Through innovative analytics, business intelligence and data management software and services, SAS helps customers at more than 80,000 sites make better decisions faster. Since 1976, SAS has been giving customers around the world THE POWER TO KNOW®.

Tuesday, November 15, 8:30–9:30am

Technology Tutorial: *Analysis of a Presidential Debate Using SAS Text Analytics. Presenter: Andre de Waal. During the last year of a presidential term in the United States of America, the race to the White House has everybody excited. News channels and newspapers provide "expert" analysis of day to day events. However, many of the expert opinions are biased and reflect a commentator's political viewpoint or affiliation. Can text mining be used to look at the data objectively and cut through the political rhetoric? In this talk, a script of one of the 2016 presidential debates is analyzed with SAS Text Miner. An attempt is made to look at the data "objectively" and to let the data speak. Words are counted and stemmed, documents are grouped into clusters, topics are identified and candidates are analyzed while trying to determine what separates one candidate from the rest of the field. Although it is impossible to predict using text mining alone who will win the presidential election, text mining could provide some insight into the election process (of which the debates are an integral part) that is not generally available to the general populace and might influence their choice of presidential candidate.*

SAS Institute Inc. 1

www.sas.com

The effective use of analytics is more important than ever for today's organizations. The most effective analytics are coordinated, and the best and most complete set of coordinated analytic capabilities comes from SAS. Data integration, statistics, data and text mining, econometrics, and forecasting integrate deeply with operations research features like optimization, simulation, and scheduling. SAS helps organizations around the world build analytic models, populate them with relevant data and insights, communicate recommended decisions effectively, and surface these capabilities within accessible, business-oriented interfaces. See how SAS can help you understand the past and present, anticipate the future, and make better decisions.

Tuesday, November 15, 11–11:45am

Technology Tutorial: *"Solving Business Problems with SAS Analytics and OPTMODEL." Abstract: SAS provides a diverse array of analytics, including data integration, statistical analysis, data/text mining, forecasting, and reporting, all integrated with operations research capabilities in optimization, discrete-event simulation, and scheduling. The most prominent SAS optimization component is the OPTMODEL procedure. OPTMODEL incorporates an algebraic optimization modeling language that provides unified support for LP, MILP, QP, NLP, CLP, and network-oriented models and methods, including an expanding suite of standard solvers and support for customized algorithms. We'll demonstrate OPTMODEL's power and versatility in building and solving optimization models, noting the significant improvements resulting from recently added features. We'll emphasize integration with SAS data, analytic, and reporting capabilities, focusing primarily on case studies drawn from our successful work with customers across a broad range of industries.*

SAS JMP Division 3

www.jmp.com

JMP® statistical discovery software from SAS is the tool of choice for scientists, engineers and other data explorers worldwide. JMP links dynamic data visualization with powerful statistics, in memory and on the desktop. Interactive and visual, JMP reveals insights that raw tables of numbers or static graphs tend to hide. JMP simplifies data access, cleanup and processing, and makes it easy to share results. It includes comprehensive capabilities for: Statistical analysis, design of experiments, multivariate analysis, quality and reliability analysis, scripting, graphing and charting, and more.

Tuesday, November 15, 11:45am–12:30pm

Technology Tutorial: *SAS Institute, JMP Division: Interactive Data Analysis and Modeling with JMP 13 Pro Mia Stephens, JMP Academic Ambassador JMP® Statistical Discovery Software is dynamic and interactive desktop software for data exploration, visualization, analysis, and modeling. In this workshop we'll use case studies to illustrate how to interactively build, compare and deploy predictive models using the newly release JMP 13 Pro. We use the Graph Builder®, data filter and other tools to get to know and prepare our data. Then, we explore a variety of predictive models (decision trees, regression, neural networks, and penalized regression), and use the Prediction Profiler and the Solution Path to interactively explore parameters and select potential models. Finally, we compare a variety of competing models using Model Comparison, and use the Model Depot to easily deploy these models.*

SIAM 44

www.siam.org

Visit the Society for Industrial and Applied Mathematics booth to check out our new publications, including recent titles in the MOS-SIAM Series on Optimization such as *Minimum-Volume Ellipsoids: Theory and Algorithms* (Todd) and *Electrical Transmission System Cascades and Vulnerability: An Operations Research Viewpoint* (Bienstock), plus other bestselling SIAM books, all available at a conference discount. You'll also find sample issues of SIAM's renowned journals, including SIOPT, along with information and applications for anyone interested in becoming a SIAM member. And don't forget to pick up a copy of SIAM News for the road.

SIMIO LLC 41

www.simio.com

Simio Simulation and Scheduling Software is the most advanced solution on the market. With simulation, it is the only software that is fully object oriented with process and objects being defined graphically with no programming. Unlike other scheduling software, Simio allows you to introduce risk into your production schedule with its patented Risk Based Planning and Scheduling. This dual function in Simio not only helps you improve your business performance from a facility design perspective, but also helps you maximize business results by optimizing the use of critical resources and assessing the risk associated with operational decisions.

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Tuesday, November 15, 1:30–2:15pm

Technology Tutorial: *Simio now leverages the cloud computing power of Microsoft Azure to support your most demanding applications; compatibility with Schneider Electric's Wonderware to allow detailed production scheduling with real-time data and risk analysis; and healthcare and other capabilities in the services field. Outside our immense technology partner advances, we have great new features, application areas and capabilities! Come explore an overview of the new Simio experience and see why we are always "Forward Thinking."*

SIMUL8 17
www.SIMUL8.com

For over 20 years SIMUL8 Corporation has been producing powerful simulation software. SIMUL8's Educational Software is used in universities worldwide and gives tutors the ability to teach simulation, not software thanks to its intuitive interface. When teaching simulation, the purpose is not for students to learn software; it's to get them understanding the benefits that simulation can bring to decision making. SIMUL8 was created with this in mind and as a result our software allows students to build and run their first simulation in less than an hour and see the results.

Springer 42 & 43
www.springer.com

Looking to publish your research? Discover Springer's print and electronic publication services, including open access! Get high-quality review, maximum readership and rapid distribution. Visit our booth or springer.com/authors. You can also browse key titles in your field and buy ebooks at discount prices. With Springer you are in good company.

Taylor & Francis Group 25
http://taylorandfrancis.com

Taylor & Francis boasts a first-class journal portfolio publishing Manufacturing and Operational Engineering articles as well as a wide range of scholarship from related disciplines. Our journals are edited by some of the most prominent academics in the world and offer a variety of accommodating options for our authors. Our prominent journals include *International Journal of Production Research*, *Production & Manufacturing Research: An Open Access Journal* and *INFOR: Information Systems and Operational Research*.

University of Illinois at Urbana-Champaign 50
www.ise.illinois.edu

The Department of Industrial and Enterprise Systems Engineering at the University of Illinois at Urbana-Champaign, innovates the engineering discipline with leading-edge research and scientific discoveries; educates a new generation of leaders in systems, industrial and financial engineering; and serves education, industry, & society.

University of TN, College of Engineering 22
www.ise.utk.edu

Department of Industrial & Systems Engineering (ISE) at UTK offers graduates and scientific professionals a Master of Science (MS) degree, a MS in Reliability and Maintainability Engineering, a dual-degree option (MS and MBA), a PhD with a major in IE, and a concentration in Engineering Management. Located in the recently dedicated John D. Tickle Building, the ISE Department has about 163 undergraduate and 130 graduate students enrolled. The ISE department has been active in the research areas of Operations Research, Management Systems, Lean, Statistics, and Human Factors with applications in manufacturing, healthcare, service, transportation, energy, finance, entertainment, and logistics.

University of TN, Haslam College of Business 31
http://haslam.utk.edu

The Haslam College of Business at the University of Tennessee, Knoxville, was founded in 1914 and consists of approximately 5,500 undergraduate and graduate students, 130 faculty and 125 staff members. Our departments, centers, institutes, forums and graduate and executive education programs reach across the profit, not-for-profit and governmental sectors of business, with a heavy emphasis on practical research. From our top-notch supply chain management and highly regarded accounting programs to our renowned business analytics and Physician EMBA programs, Haslam students and faculty create the change that changes our world for the better."

Wiley 40
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Wiley is a global provider of knowledge and knowledge-enabled services that improve outcomes in areas of research, professional practice, and education.

Sunday, November 13, 2:15–3pm

Technology Tutorial: *Interested in publishing for the Wiley Series in Operations Research and Management Science? The Wiley Series in Operations Research and Management Science is a broad collection of books that meet the varied needs of researchers, practitioners, policy makers, and students who use or need to improve their use of analytics. The workshop will include presentations on the following: The Mission of the Series for the Betterment of the Community, The Proposal Process: Maximizing your Success, What's Next: The Writing, Review, and Publishing Process, Q&A. In addition to the presentation, you will be able to meet with Founding Series Editor James J. Cochran and Wiley Editor Susanne Steitz-Filler to discuss any further questions or potential book ideas you may have."*

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infORmational SESSIONS

INFORMS CENTER is located in Exhibit Hall A in the Music City Center. InfORmational Q&A sessions with INFORMS members are listed below.

SUNDAY, NOVEMBER 13

CAP/aCAP 3:30–5pm
Ever wonder what this thing called CAP is? And now there's an aCAP to boot. Find out what they are, why they're important to you and get answers to any other questions about the certification program.

2017 Houston 3:30–5pm
Learn about many exciting things to see and do next year at the INFORMS Annual Meeting in Houston. Stop by for info and a giveaway while supplies last.

Service Science 3:30–5pm
Service Science publishes articles about various aspects of service and service systems. Come chat with the Editor-in-Chief and Area Editors to learn more about the journal and the service science community at INFORMS.

Transactions on Education 3:30–5pm
The Editor-in-Chief and Area Editor for classroom games will provide suggestions to authors who wish to submit their work to *ITE*. What material should be included in a case study or classroom game? To what extent should my approach be classroom tested? What are the main criteria to accept or reject a paper for *ITE*?

Meet the Board 7:30–8:30pm

MONDAY, NOVEMBER 14

CAP/aCAP 9–10:30am

2017 Houston 9–10:30am

Volunteering Opportunities 9–10:30am
No matter how much (or little) time you have to give, INFORMS offers opportunities to get involved, make a difference, and build your network. Come chat with staff about current volunteer opportunities.

Management Science 9–10:30am
Management Science is ranked among the top journals in the area of O.R. The journal's submission rate has grown steadily over the years. In 2015, the journal received 150% more original articles as compared to 2011. Teck Ho, editor-in-chief, will be present to share the journal's selection criteria.

CAP/aCAP 3:30–5pm

2017 Houston 3:30–5pm

Editor's Cut 3:30–5pm
Come learn about multimedia collections, INFORMS *Editor's Cut*, speak with series editor Anne Robinson, and volume editors. See what INFORMS is publishing on hot topics like Big Data Analytics and Elections, and learn how you can use *Editor's Cut* in your research or classroom. There is also a unique giveway!

SpORts 3:30–5pm
The mission of the Section on OR in Sports is to promote and disseminate research and applications among professionals interested in theory, methodologies, and applications of ORMS to sports problems. Basically have fun with sports analytics.

TUESDAY, NOVEMBER 15

Volunteering Opportunities 9–10:30am

2017 Houston 9–10:30am

ProBono Analytics 9–10:30am
Interested in volunteering your analytical skills to help underserved communities? Come learn about recent projects we have undertaken, and discover how you can join your colleagues who have already signed up to be a Pro Bono Analytics volunteer!

CAP/aCAP 3:30–5pm

What's New @ INFORMS 3:30–4:30pm
Stop by and visit with Executive Director Melissa Moore to learn more about what we are doing to promote the OR & Analytics professions, our members, and more.

WEDNESDAY, NOVEMBER 16

CAP/aCAP 9–10:30am

Initiative Proposals 9–10:30am
Do you have an idea for a special project for INFORMS? Attend this special discussion about the initiatve proposal process to learn how to get visibility, support, and funding to bring your idea to fruition.

MICRO-VOLUNTEERING OPPORTUNITY

INFORMS Pro Bono Analytics has paired with Safe Haven of Nashville to help measure the impact of the organization's education support program for school-age children. It involves assessing the social and cognitive levels of children before and after enrolling in the program by assisting with the design and implementation of a survey, and conducting analysis of the survey data.

As a special aside, we invite all Annual Meeting attendees to visit the INFORMS Center to create cards of encouragement or to wish happy holidays for program families who have recently moved from the shelter to housing. It's just one more way for us to give back, and we hope you'll take a moment to stop by the INFORMS Center to help us make a difference. And be sure to keep an eye out in INFORMS Connect and in the Center for more ways to help.

How to Navigate the Technical Sessions

There are four primary resources to help you understand and navigate the Technical Sessions:

- This Technical Session listing, which provides the most detailed information. The listing is presented chronologically by day/time, showing each session and the papers/abstracts/authors within each session.
- The Author and Session indices provide cross-reference assistance (pages 518-560).

Quickest Way to Find Your Own Session

Use the Author Index (page 518) — the session code for your presentation will be shown along with the room location. You can also refer to the full session listing for the room location of your session.

The Session Codes

TA01

Room number. Room locations are also indicated in the listing for each session.

The day of the week

Time Block. Matches the time blocks shown in the Program Schedule.

Time Blocks

Sunday - Tuesday

8:00am -9:30am

11:00am – 12:30pm

1:30pm – 3:00pm

4:30pm – 6:00pm

Wednesday

8:00am -9:30am

11:00am – 12:30pm

12:45pm -2:15pm

2:45pm – 4:15pm

4:30pm- 6:00pm

Rooms and Locations /Tracks

All tracks / technical sessions will be held in the Music City Center and Omni Hotel. Room numbers are shown on the Quick Reference and in the Technical session listing.

Sunday, 8:00AM - 9:30AM

■ SA01

101A-MCC

Temporal Data Mining and Pattern Discovery

Sponsored: Data Mining

Sponsored Session

Chair: Mustafa Gokce Baydogan, Bogazici University, Bebek, Istanbul, 34342, Turkey, baydoganmustafa@gmail.com

1 - Discovering Distinct Features Using Deep Learning For Arrhythmia Detection

Seho Kee, Arizona State University, Tempe, AZ, United States, skee4@asu.edu, Phillip Howard, George Runger

Although domain knowledge-based features have been widely adopted in anomaly detection studies, they still suffer from the limitations of the insufficient known features or unavailability in practice. To address these problems, we propose an autoencoder model that is able to discover useful features that identify anomaly patterns in temporal heartbeat data without assuming any prior knowledge. The results show that the discovered features obtained from just a two-dimensional projection layer can effectively distinguish abnormal beats from normal beats without training on pre-labeled data.

2 - Process Control For Time-varying Situations

Seoung Bum Kim, Korea University, sbkim1@korea.ac.kr, Seulki Lee

In modern manufacturing systems containing the complexity and variability of processes, appropriate control chart techniques that can efficiently handle the nonnormal and nonlinear processes are required. In this talk, I will present some recently developed multivariate control charts to handle both nonnormal and time-varying process situations.

3 - On The Use Of Support Vectors For Time Series Pattern Discovery

Mustafa Gokce Baydogan, Bogazici University, Istanbul, Turkey, mustafa.baydogan@boun.edu.tr, Mehmet R Kamber, Erhun Kundakcioglu

Similarity search and classification on time series (TS) databases has received great interest over the past decade. The definition of similarity between TS is a major problem in this context. Nearest-neighbor (NN) classifers are widely used for TS classification but these approaches compute the similarity over the whole TS which might be problematic with the long TS and relatively short features of interest. Moreover, these classifiers are not directly interpretable as they do not describe why a TS is assigned to a certain class. This study utilizes margin maximization to discover the regions of the time series that have potentially representative patterns related to the classification task.

4 - Machine Learning For Predicting Heart Failure Readmission

Wei Jiang, Research Assistant, Johns Hopkins University, 3400 N Charles St, Baltimore, MD, 21218, United States, wjiang1990@gmail.com, Scott R Levin, Lili Barouch, Frederick Korley, Sauleh Ahmad Siddiqui, Diego A. Martinez, Matthew Toerper, Sean Barnes, Eric Hamrock

Predicting risk of heart failure (HF) readmission has gained increasing attention, with existing studies mainly using administrative data. We will focus on using clinical data from EMR for predicting HF readmission by doing pattern recognition with time series clinical data. We will then use classification models for predicting the drivers of readmission.

■ SA02

101B-MCC

Healthcare Analytics and Medical Decision Making

Sponsored: Data Mining

Sponsored Session

Chair: Hasan Kartal, University of Massachusetts Lowell, One University Avenue, Lowell, MA, 01854, United States, Hasan_Kartal@uml.edu

1 - PPMF: A Patient-based Predictive Modeling Framework For Early ICU Mortality Prediction

Mohammad Amin Morid, The David Eccles School of Business, University of Utah, 130 University Village, Salt Lake City, UT, United States, amin.morid@business.utah.edu, Olivia R. Liu Sheng, Samir Abdelrahman

This paper presents a patient based predictive modeling framework (PPMF) to improve the performance of early ICU mortality prediction. PPMF consists of three main components. The first component captures dynamic changes of patients' status in the ICU using their time series data. The second component is a local approximation algorithm that classifies patients based on their similarities. The third component is a Gradient Decent wrapper that updates feature weights according to the classification feedback. Experiments show that PPMF significantly outperforms: (1) the severity score systems, (2) the aggregation based classifiers, and (3) baseline feature selection methods.

2 - The Emergency Response Community Effectiveness Modeler: A Simulation Modeling Tool To Analyze EMS vs. Smartphone-based Samaritan Response

Michael Khalemsky, Graduate School of Business Administration, Bar Ilan University, Ramat Gan, Israel, khalemsky@gmail.com, David G. Schwartz

Smartphones and location-based social networking technologies present an opportunity to re-engineer certain aspects of emergency medical response by establishing Emergency Response Communities (ERC). The ERC Effectiveness Modeler (ERCEM) estimates the efficacy of smartphone-based Samaritan response for given medical condition and geographic region. The ERCEM uses parameters such as population density, prescription adherence, smartphones penetration etc. and performs Monte Carlo simulation to compare potential ERC response to traditional EMS response. We present the modeler and show how it assessed effectiveness of ERC for anaphylaxis in the USA based on data from the NEMSIS project.

3 - Public Health Data Sharing With Privacy Protection

Hasan Kartal, Manning School of Business, University of Massachusetts Lowell, Lowell, MA, 01850, United States, hasan_kartal@uml.edu

This study examines privacy disclosure risks in health data when patients have multiple records in a dataset. Existing data privacy approaches typically assume that each individual in a dataset corresponds to a single record, which tends to underestimate the disclosure risks in the multiple-record problems. We propose a new privacy measure, called g-balance, and develop an efficient algorithm based on the g-balance measure to protect against the multiple-record linkage attacks. The effectiveness of the proposed approach is demonstrated in an experimental study using real-world data.

■ SA03

101C-MCC

Nicholson Student Paper Prize I

Invited: Nicholson Student Paper Prize

Invited Session

Chair: Maria Esther Mayorga, North Carolina State University, 400 Daniels Hall, Raleigh, NC, 27695, United States, memayorg@ncsu.edu

1 - Nicholson Student Paper Prize

Maria Esther Mayorga, North Carolina State University, Dept. of Industrial & Systems Engineering, Raleigh, NC, 27695, United States, memayorg@ncsu.edu

This session highlights the finalists for the 2016 George Nicholson Student Paper Competition.

2 - A Necessary and Su cient Condition for Throughput Scalability of Fork and Join Networks with Blocking

Yun Zeng, Ohio State University, Columbus, OH, United States, zeng.153@buckeyemail.osu.edu, Augustin Chaintreau, Don Towsley, Cathy Xia

3. Household-level Economics Of Scale In Transportation

Mehdi Behroozi, Northeastern University, Boston, MA, 02115, United States, behro040@umn.edu

4. Online Decision-Making With High-Dimensional Covariates

Hamsa Bastani, Stanford University, Stanford, United States, bayati@stanford.edu

Big data has enabled decision-makers to tailor choices at the individual-level in a variety of domains such as personalized medicine and online advertising. This involves learning a model of decision rewards conditional on individual-specific covariates. In many practical settings, these covariates are high-dimensional; however, typically only a small subset of the observed features are predictive of a decision's success. We formulate this problem as a multi-armed bandit with high-dimensional covariates, and present a new efficient bandit algorithm based on the LASSO estimator. Our regret analysis establishes that our algorithm achieves near- optimal performance in comparison to an oracle that knows all the problem parameters. The key step in our analysis is proving a new oracle inequality that guarantees the convergence of the LASSO estimator despite the non-i.i.d. data induced by the bandit policy. Furthermore, we illustrate the practical relevance of our algorithm by evaluating it on a real-world clinical problem of warfarin dosing.

5 - Distributionally Robust Stochastic Optimization With Wasserstein Distance

Rui Gao, Georgia Institute of Technology, Atlanta, GA, United States, rgao32@gmail.com

■ SA04

101D-MCC

Electricity Markets and Contract Design

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Edward James Anderson, University of Sydney, H70 - Abercrombie Building, Sydney, NSW 2006, Australia, edward.anderson@sydney.edu.au

1 - Retail Equilibrium With Switching Consumers In Electricity Markets

Carlos Ruiz Mora, Universidad Carlos III de Madrid, Madrid, Spain, caruizm@est-econ.uc3m.es, F. Javier Nogales, F. Javier Prieto

We consider a game theoretical model where asymmetric retailers compete in prices to increase their profits by accounting for the utility function of switching consumers. Consumer preferences for retailers are uncertain and distributed within a Hotelling line. We analytically characterize the equilibrium of a retailer duopoly, establishing its existence and uniqueness conditions for a wide class of utility functions. The duopoly model is extended to a multiple retailer case.

2 - Flow-based Market Coupling In The European Electricity Market

Mette Bjørndal, Professor, NHH Norwegian School of Economics, Bergen, Norway, Mette.Bjorndal@nhh.no

From May 2015, the Flow-Based Market Coupling (FBMC) model replaced the Available Transfer Capacity (ATC) model in parts of the European power market. The FBMC model aims to enhance market integration and to better monitor the physical power flow, and it is expected to lead to increased social welfare in the day-ahead market and more frequent price convergence between different market zones. This paper gives a discussion on mathematical formulations of the FBMC model and the procedures of market clearing. We examine the FBMC model in two test systems and show the difficulties of implementing the model in practice.

3 - Negotiating Forward Contracts With Private Information

Edward James Anderson, University of Sydney, edward.anderson@sydney.edu.au

We consider the use of forward contracts to reduce risk for firms operating in a spot market. Firms have private information on the distribution of prices in the spot market. We discuss different ways in which firms may agree on a forward contract (offers to a broker and direct bargaining). We also discuss an equilibrium in which two firms each offer a supply function and the clearing price and quantity for the forward contracts are determined from the intersection. In this context a firm can use the offer of the other player to augment its own information about the future price. It is interesting that these sophisticated strategies are likely to produce worse outcomes for both firms.

SA05

101E-MCC

Power System Resilient Design and Optimization

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Seyedamirabbas Mousavian, Clarkson University, 8 Clarkson Avenue, Potsdam, NY, 13699-5790, amir@clarkson.edu

1 - Self-healing Attack-resilient PMU Network For Power System Operation

Chen Chen, Argonne National Laboratory, Lemont, IL, United States, morningchen@anl.gov, Hui Lin, Jianhui Wang, Junjian Qi, Dong Jin

We propose a self-healing PMU network by exploiting the features of programmable configuration in a software-defined networking (SDN) to achieve resiliency against cyber-attacks. After a cyber-attack, by changing the configuration of the network switches, the disconnected yet uncompromised PMUs will be reconnected to the network to "self-heal" and thus restore the observability of the power system. Specifically, we formulate an integer linear programming (ILP) model to minimize the overhead of the self-healing process, while considering the constraints of power system observability, hardware resources, and network topology.

2 - Minimum Risk-maximum Availability Response To Electric Vehicle-initiated Smart Grid Attacks

Seyedamirabbas Mousavian, Clarkson University, amir@clarkson.edu, Melilke Erol-Kantarci, Thomas Ortmeyer

Malware pose a significant threat to the power grid and the connected electric vehicle infrastructure. Penetration and propagation of cyber attacks including worms and viruses vary depending on the nature of the connected systems. Electric vehicles (EVs) being the mobile portion of the smart grid may easily spread worms and viruses in a large geographic area. We propose a probabilistic model for the worm propagation in EV to Electric Vehicle Supply Equipment (EVSE) networks, formulate threat levels and then, we propose a Mixed Integer Linear Programming (MILP) model as a protection scheme that relies on isolating infected nodes.

3 - Storage And Generation Expansion Problem Considering Primary Response

Hrvoje Pandzic, University of Zagreb, Zagreb, Croatia, hrvoje.pandzic@fer.hr, Yury Dvorkin, Miguel Carrion

A sustainable and efficient generation and storage expansion program needs to consider both the capacity needs and short-term operational requirements of a power system. A generation expansion formulation considering frequency regulation using both generators and storage units will be presented.

4 - Optimal Resilient Grid Design Distribution And Transmission Systems

Russell Bent, Los Alamos National Laboratory, rbent@lanl.gov Emre Yamangil, Harsha Nagarajan, Pascal Van Hentenryck

Modern society is critically dependent on the services provided by engineered infrastructure networks, particularly distribution and transmission grids. When natural disasters (e.g. Hurricane Sandy) occur, the ability of these networks to provide service is often degraded. However, well-placed upgrades to these grids can greatly improve post-event network performance. Hence, we pose the optimal electrical grid resilient design problem as a two-stage, stochastic mixed-integer program with damage scenarios and propose decomposition-based algorithms to solve and analyze medium-sized networks.

SA06

102A-MCC

Joint Session DM/Optimization: Discrete Optimization and Machine Learning

Sponsored: Data Mining

Sponsored Session

Chair: Berk Ustun, Massachusetts Institute of Technology, Cambridge, MA, United States, ustunb@mit.edu

1 - A Multi-group Discrete Support Vector Machine – Theory And Computation

Eva Lee, Georgia Tech, evakylee@isye.gatech.edu

We describe a general-purpose machine learning framework, DAMIP, for discovering gene signatures that can predict vaccine immunity and efficacy. DAMIP is a multi-group 'concurrent' classifier that offers unique features not present in other models: a nonlinear data transformation to manage the curse of dimensionality and noise; a reserved-judgment region that handles fuzzy entities; and constraints on the allowed percentage of misclassifications.Computational results for biological and medicine problems will be discussed.

2 - Optimized Risk Scores

Berk Ustun, MIT, Massachusetts Institute of Technology, Sloan School of Management, Cambridge, MA, 02142, United States, ustunb@mit.edu, Cynthia Rudin

Risk scores are simple models that let users quickly assess risk by adding, subtracting, and multiplying a few small numbers. These models are widely used in healthcare and criminology, but difficult to create because they need to be risk-calibrated, use small integer coefficients, and obey operational constraints. We present a new approach to learn risk scores from data by solving a discrete optimization problem. We formulate the risk score problem as a MINLP, and present a cutting-plane algorithm to efficiently recover the optimal solution by solving a MIP. We demonstrate the benefits of our approach by creating risk scores for real world problems.

3 - Supersparse Integer Regression Model For Nonparametric Failure Time Analysis

Keivan Sadeghzadeh, MIT Sloan School of Management, Cambridge, MA, United States, keivan@mit.edu, Cynthia Rudin

Analysis of failure time data has an inevitable role in predicting events occurrence. We develop an integer-based predictive model that is accurate and also interpretable, in order to determine effective features and predict potential failures. The strategy is to select appropriate covariates for censored large-scale and high-dimensional failure time data in a regression model. Our approach is to design robust algorithm to find the optimal integer solution for supersparse linear model. This optimal solution is reached by using machine learning techniques over a high-dimensional closed quadric hypersurface.

4 - Nested Clustering On A Graph

Gokce Kahvecioglu, Northwestern University, 2145 Sheridan Road Room C210, Evanston, IL, 60208, United States, gokcekahvecioglu2014@u.northwestern.edu David P. Morton

We study a clustering problem defined on an undirected graph with weight function defined on the edges, which denotes the importance of the connection between vertices. We remove a set of edges in order to maximize the number of clusters in the residual graph while minimizing the weight of deleting edges. Solving this graph clustering problem parametrically identifies the solutions that lie on the concave envelope of efficient frontier and the breakpoints on this envelope have a nested structure. We propose to solve this parametric model in polynomial time by solving a sequence of parametric maximum flow problems, which yields the family of nested clusters on the efficient frontier.

SA07

102B-MCC

Undergraduate OR Prize – I

Invited: Undergraduate Operations Research Prize

Invited Session

Chair: Pavithra Harsha, IBM Research, 1101 Kitchawan Road, Room 34-225, Yorktown Heights, NY, 10598, United States, pharsha@us.ibm.com

1 - Car Sharing Fleet Location Design With Mixed Vehicle Types For CO2 Emission Reduction

Joy Chang, University of Michigan, Ann Arbor, MI, United States, joychang@umich.edu. Siqian Shen, Ming Xu

As carsharing companies integrate electric vehicles to reduce CO_2 emissions, we optimize a mixed-integer linear program to study a carsharing fleet location design problem with mixed vehicle types. We create a minimum cost flow formulation on a spatial-temporal network to model round-trip and one-way vehicle flows. We test different one-way trip demands, and provide a model that ensures the first-come first-serve principle while satisfying CO_2 restrictions. Via testing instances from the Boston Zipcar fleet, we provide insights on carsharing fleet location and vehicle-type composition.

2 - Collaborative Decision Making For Air Traffic Management

Hale Erkan, Bilkent University, Ankara, Turkey, hale.erkan@bilkent.edu.tr, Nesim K. Erkip, Ozge Safak

We propose a model which can be utilized within a collaborative decision making (CDM) framework for rescheduling of flights. The proposed mathematical program is expected to be utilized by major stakeholders, airlines and air navigation service providers. After providing the constraints, we list possible equity and efficiency performance measures that will make-up the objective function to be used by a stakeholder. We suggest guidelines to utilize the model for any stakeholder within CDM. Finally, a case study is prepared using publicly available data to demonstrate possible benefits.

3 - A Reformulation Of The Appointment Scheduling Problem With Customer Choice Behavior And Multiple Customer Types

Cem Aydin, Koc University, Dept of Industrial Engineering, Istanbul, Turkey, cemaydin@ku.edu.tr, Alp Aribal, Cansu Erol, Begum Tuglu

In this paper, we propose a new formulation to the appointment scheduling problem with customer choice behavior and multiple customer classes. Using this new formulation and an approximation of the state space, we find an upper bound to the total expected revenue. We exploit the special structure created by our new formulation to present an efficient algorithm that can find this upper bound. We test methods commonly used in practice using our upper bound to rate their performance and show that performances of traditional methods decay as problem size increases.

■ SA09

103B-MCC

Balancing Water Use for Food and Energy

Sponsored: Energy, Natural Res & the Environment I Environment & Sustainability

Sponsored Session

Chair: Hayri Onal, University of Illinois, 305 Mumford Hall, 1301 W. Gregory Dr., Urbana, IL, 61801, United States, h-onal@illinois.edu

1 - A Robust Planning Decision Model For Smart Water System

Mengqi Hu, University of Illinois at Chicago, 842 W. Taylor St., 3023 ERF, Chicago, IL, 60607, United States, mhu@uic.edu, Afshin Ghassemi

Water is a critical resource for different sections and people's everyday life. In this research, we propose a robust planning decision model for smart water system including sources, water plants, end users and waste water systems. In the smart water system, the concepts of dynamic pricing and onsite inventory and 3rd-party water plant are explored. Various levels of uncertainties from both water demand and pipeline efficiencies are considered. Three sets of experiments are developed to test the effectiveness of the proposed decision model. It is concluded that our proposed model provides a platform to transform novel smart grid concepts to renovate the existing water infrastructure.

2 - Assessment Of Ecosystem Services In A Semi-arid Agriculture-dominant Area: Framework And Case Study

Yihsu Chen, University of California, Santa Cruz, Yihsu Chen, Ramesh Dhungel, Rudy Maltos, Kumar Sivakumaran, Andres Aguilar, Thomas Harmon

Evaluating ecosystem services is difficult as the services are not traded at an open market. In this study, we developed a framework that allows for assessing the effectiveness and implied costs of ecosystem services provided by a restored SJR (San Joaquin River) in a semi-arid agriculture-dominant area. This is done by explicitly linking economics-based farmers' model with a reduced-form hydrological model that is loosely coupled to a physical-based stream-temperature model. We quantify the lower bound of the short-run economic costs and show that current mandated flows are unlikely to have a meaningful impact on restoring fish population.

3 - Predictive Analytics For Sustainable Water Consumption

Ellen Wongso, Student, Purdue University, West Lafayette, IN, 47906, United States, ewongso@purdue.edu, Zijian He, Roshanak Nateghi

According to a recent report by the EPA, 40 states will experience water shortages in the coming decade. Climate change and increased consumption trends will likely exacerbate the current water scarcity issues. Access to clean water is a basic human right and is an essential element is ensuring energy and food security. There is therefore a critical need to identify the main drivers of consumption to promote sustainable use. Previous research on water sustainably has been local in scope and mostly from a management science perspective. In this research we will leverage advanced statistical learning methods to identify the main drivers of water usage in the US.

4 - Scheduling Water Reuse In The Food Industry: Theory And Application

Renzo Akkerman, Technical University of Munich, Munich, 80333, Germany, renzo.akkerman@tum.de
Sai Jishna Pulluru

Water considerations are increasingly relevant in the planning and scheduling of production activities in the food industry. This includes the reuse of various water streams and their possible treatment or regeneration. We develop a model for production scheduling that integrates water flows and their possible treatment for reuse. We perform a numerical study to analyze the performance of the modelling approach, and also apply the model in a case application from the dairy industry. Overall, the results demonstrate the relevance of the modelling approach and its computational performance. Furthermore, the work provides managerial insights for increased water efficiency in the food industry.

■ SA10

103C-MCC

Optimizing Distributed Energy Generation I

Sponsored: Energy, Natural Res & the Environment, Energy II Other

Sponsored Session

Chair: Alexandra M Newman, Colorado School of Mines, 1, Golden, CO, 1, United States, anewman@mines.edu

1 - Hybrid Energy System Dispatch Strategy For A Forward Operating Base

Mark Husted, Colorado School of Mines, mhusted@mines.edu

Given a set of systems (i.e., batteries, diesel generators, and photovoltaics), we determine a dispatch strategy for a forward operating base, isolated from the grid. This cost-minimizing strategy subscribes to minute-level fidelity over a 24-hour time horizon given the expected demand profile and the anticipated solar generation. Operational constraints include (i) ramp-up and ramp-down and minimum up and down times of the generators, (ii) spinning reserve levels, and (iii)other interoperability requirements among the systems. We show how our model results improve over traditional rules of thumb used for real-time dispatch.

2 - A Capacity Expansion Model For Energy Planning For Turkey

Muhammed Sutcu, Assistant Professor, Abdullah Gul University, Sumer Campus, Erkilet Bulvari, Kayseri, 38060, Turkey, muhammed.sutcu@agu.edu.tr, Tugba Degirmenci

There has been a considerable effort to raise the share of their renewable energy (RE) sources in the total sum to reach an environmental sustainability. This study addresses the question of what level of each type of RE should actually be provided year by year to maximize the total productions by minimizing the associated costs for RE policies of Turkey. With this goal on mind, a multistage optimization model for years 2016-2023 is constructed and solved with the interpretation of the results throughout the study.

3 - Integrated Model For Power Interruption Contracts

Lakshmi Palaparambil Dinesh, University of Cincinnati, 601 Mc Alpin Avenue, Apartment 5, Cincinnati, OH, 45220, United States, lakshmi603@gmail.com, Uday S Rao, Jeffrey D. Camm, Kenneth Skinner

Demand response is changing electricity usage based on a change in price of electric power. We study a demand response program where residential customers participate. Each customer has to sign up for a contract to enroll in the program. We develop a model that helps to decide which power unit to turn on or off, which customers to cut power during peak demand hours, and what contract parameters to use while designing contracts between the supplier and residential customers. The proposed model leads to higher overall costs savings for the power supplier compared to the current model used in practice.

4 - Optimal Sizing Of An EV Parking Facility Within A Microgrid

Ebrahim Mortaz, Auburn University, 115 N. Debardeleben St. Apt 29, Auburn, AL, 36830, United States, emortaz@auburn.edu
Jorge F Valenzuela

Integrating the provided energy and storage capacity by the electric vehicles into the microgrid reduces the cost of electricity supply. In this talk, we assume that a grid-connected microgrid is set to transform an EV parking facility into a large energy storage resource by investing on the V2G technology. We propose a mathematical model that aims to determine the optimal number of V2G stations in the parking facility by minimizing the total cost of the microgrid. The results show that the investment in the V2G technology is an enhancement to the long-term economics of microgrids.

■ SA11

104A-MCC

Cliques and Clique Relaxations

Sponsored: Optimization, Network Optimization

Sponsored Session

Chair: Eugene Lykhovyd, Texas A&M University, College Station, TX, United States, lykhovyd@tamu.edu

1 - Exact Algorithms For The Minimum S-Club Partitioning Problem

Oleksandra Yezerska, Texas A&M Univeristy, Fort Worth, TX, United States, yaleksa@tamu.edu

Graph clustering (partitioning) is a helpful tool in understanding complex systems and analyzing their structure and internal properties. An s-club is a distance-based relaxation of a clique and is formally defined as a subset of vertices inducing a subgraph with a diameter of at most s. We study the minimum s-club partitioning problem, which is to partition the graph into a minimum number of s-club clusters. Integer programming techniques and combinatorial branch-and-bound framework are employed to develop exact algorithms to solve this problem. We also compare the computational performance of the proposed algorithms for the special case of $s=2$ on a test-bed of real-life graphs.

2 - High Communication Efficiency Subgraphs

Vladimir Stozhkov, University of Florida, Gainesville, FL, United States, vstozhkov@ufl.edu, Alexander Veremyev, Oleg A Prokopyev

We introduce a new clique relaxation model which is based on the notion of communication efficiency. The communication efficiency is assumed to be a non-increasing function of pair-wise distances in a graph. We prove that the corresponding maximization problem is NP-hard and present effective exact algorithms to solve it.

3 - Approximating The Maximum Edge Weight Clique Problem Using A Continuous Formulation

Seyedmohammadhossein Hosseinian, Texas A&M University, 2027 Emerging Technologies Building, Mail stop 3131, College Station, TX, United States, hosseinian@tamu.edu, Dalila B M M Fontes, Sergiy Butenko

The Maximum Edge Weight Clique (MEWC) problem, defined on an undirected and weighted graph, is to find a clique whose sum of edge weights is maximized. This work presents a continuous formulation for the MEWC problem, along with a heuristic based on solving the continuous form over a n dimensional hypersphere, where n is the number of vertices of the graph. Results of the algorithm on some benchmark instances are also presented.

■ SA12

104B-MCC

Algorithms, Polyhedra and Games

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Swati Gupta, Massachusetts Institute of Technology, Cambridge, MA, United States, swatig@mit.edu

1 - Algorithms For Stable Matching With Imperfect Transfer Of Utility (ITU)

Rajan Harish Udwani, Massachusetts Institute of Technology, rudwani@mit.edu, James B Orlin

The classical stable matching and utility transfer problems (also the dual of the assignment problem), are two extreme cases of the imperfect utility transfer problem, where we wish to find a stable matching in a bipartite graph, while allowing imperfect/lossy transfer of utility across matched pairs. In case of complete loss (or no transfer), we recover the former and in absence of loss we get the latter. We develop a novel combinatorial algorithm for this generalized stable matching problem under imperfect transfer of utility, when the loss function is linear. The model was inspired by a recent paper of Galichon et al. (2016).

2 - Polyhedral Study Of A Generalization Of The Continuous Mixing Set

Haochen Luo, Texas A&M University, College Station, TX, United States, hcluo@tamu.edu, Kiavash Kianfar

We report our progress on polyhedral study of a generalization of the continuous mixing set. We provide facet-defining valid inequalities and discuss how they can be used to generate cuts for well-known problems such as lot-sizing.

3 - Learning Combinatorial Structures

Swati Gupta, Massachusetts Institute of Technology, Cambridge, MA, United States, swatig@mit.edu, Michel X Goemans, Patrick Jaillet

To find optimal strategies for dueling algorithms, we consider two online learning methods: multiplicative weights update (MWU) and online mirror descent (OMD). We first show how to simulate MWU over vertices of polytopes in R^m (e.g. spanning trees, bipartite matchings), in time poly(m) under fast generalized counting oracles (even if approximate). Next, we solve a well-known computational bottleneck of computing projections for the OMD by giving novel algorithms for separable convex minimization over base polymatroids (e.g. for spanning trees, truncated permutations, subset of experts). These results extend to applications in stochastic optimization, game theory and machine learning.

■ SA13

104C-MCC

Global Optimization: Algorithms and Applications

Sponsored: Optimization, Global Optimization

Sponsored Session

Chair: Emily Speakman, University of Michigan, MI, United States, eespeakm@umich.edu

1 - Strong Relaxations For Optimal Power Flows

Pascal Van Hentenryck, University of Michigan, pvanhent@umich.edu, Carleton Coffrin, Hassan Hijazi

This talk reviews recent progress in convex relaxations of the power flow equations, which combines the SDP relaxation, the QC relaxations, bound tightening, and valid inequalities. Computational results on state-of-the-art benchmarks are presented.

2 - Branching Point Selection For Trilinear Terms

Emily Speakman, University of Michigan, 2222 Fuller Court, Apt 702A, Ann Arbor, MI, 48105, United States, eespeakm@umich.edu, Jon Lee

The case of having three or more expressions multiplied together (each expression being possibly complex itself) occurs frequently in global-optimization models. For these “trilinear terms,” we present some analytic results regarding the choice of branching point and branching variable in the context of spatial branch-and-bound, and we compare our results to common practice in software. In obtaining the “best” branching point or variable we use n-dimensional volume as a comparison measure. Using volume as a measure gives a way to analytically compare formulations and corresponds to a uniform distribution of the optimal solution across a relaxation.

3 - Virtuous Smoothing For Global Optimization.

Daphne Skipper, US Naval Academy, daphne.skipper@gmail.com, Jon Lee

Virtually all exact solvers for global-optimization (GO) rely on NLP solvers, both to generate good feasible solutions and to solve relaxations. Convergence of most NLP solvers requires that functions be twice continuously differentiable. Yet many models naturally utilize functions with some limited non-differentiability. One approach to handle limited non-differentiability is via smoothing. We propose a method, mostly aimed at (concave) root functions ($f(x)=x^p$, with $0<p<1$) that provides a tighter lower bound than the obvious shift ($g(x)=(x+\epsilon)^p-\epsilon^p$), and is smooth and globally concave, so it works well with local and global solvers.

■ SA14

104D-MCC

Operations Research Approaches to Plant Breeding

Invited: Agricultural Analytics

Invited Session

Chair: Lizhi Wang, Iowa State University, Ames, IA, United States, lzwang@iastate.edu

1 - Resource Allocation In Trait Introgression – A Markov Decision Process Approach

Ye Han, Iowa State University, yeh@iastate.edu
Lizhi Wang, William D Beavis, John N Cameron

Plant breeding companies continuously improve their cultivars through trait introgression projects, which are usually constrained with budgets and deadlines. In this presentation, we formulate the optimal allocation of money and time resources as a Markov decision process, in which the breeder incurs a cost for each progeny produced and receives a reward for producing an ideal progeny by the deadline. We will share preliminary results on a hypothetical trait introgression project and discuss future research opportunities.

2 - Maximizing Quantitative Traits In The Mating Design Problem

Susan R Hunter, Purdue University, West Lafayette, IN, United States, susanhunter@purdue.edu, Benjamin McClosky

We consider a version of the mating design problem in which breeders allocate a breeding budget to a set of parent pairs to maximize the expected maximum trait observed in the progeny population. In this context, the only parent pairs that receive nonzero breeding budget at optimality in the mating design problem lie on a Pareto set. Since the performance of each parent pair is assessed through Monte Carlo simulation, identifying the Pareto set is a bi-objective simulation optimization problem. We derive an asymptotically optimal simulation budget allocation to estimate the Pareto set of parent pairs. This estimated Pareto set is used as an input to the mating design problem, which is an integer program.

3 - Response Surface Methodology In Plant Breeding

Reka Howard, University of Nebraska – Lincoln, NE, rekahoward@gmail.com, William Beavis, Alicia Carriquiry

We introduce Response Surface Methodology (RSM) as a strategy to find the combination of attribute levels that results in accurate predictions for a given genomic prediction (GP) method, and compare GP methods. We illustrate RSM with a simulated example where the response we optimize is the difference between prediction accuracy using the parametric best linear unbiased prediction (BLUP) and the nonparametric support vector machine (SVM). The greatest impact on the response is due to the genetic architecture of the population and the heritability. When epistasis and heritability are highest, the advantage of using the SVM versus the BLUP is greatest.

4 - A New Genomic Selection Approach

Lizhi Wang, Iowa State University, lzwang@iastate.edu, Matthew Goiffon, Guiping Hu, Aaron Kusmec, Patrick Schnable

Conventionally, plant breeders make selection decisions based on phenotype observations and intuitive judgement. The advent of genotyping techniques provides breeders with much more informative genomic data. However, the enormous volume and complexity of the genomic data also present great challenges in extracting the useful information deeply buried in the mountains of data. We present a new approach for genomic selection and demonstrate its improvement over previous methods using computer simulation with realistic genomic data.

■ SA15

104E-MCC

Big Data in the E-Commerce Deliveries

Invited: Modeling and Methodologies in Big Data

Invited Session

Chair: Chung-Yee Lee, HKUST, IELM Dept. HKUST, Clear Water Bay, Hong Kong, 0000, Hong Kong, cylee@ust.hk

1 - The Benefits Of Randomization In Warehousing And Logistics

John Carlsson, University of Southern California, jcarlsso@usc.edu

A recent innovation in warehousing and logistics has been the use of randomization, such as Amazon's random stow, in which warehouse items are scattered throughout the floor map as opposed to being concentrated in one area. We use a continuous approximation model to describe how such a policy is beneficial in the long run.

2 - Resource Allocation With Unmanned Aerial Vehicle

Siyuan Song, University of Southern California, siyuanso@usc.edu, John Gunnar Carlsson

Unmanned aerial vehicles, commonly known as drones, have become more widely utilized in delivery nowadays. We study the efficiency of a so-called 'horsefly' delivery system, in which drones are used in conjunction with truck. We propose a mathematical formulation of a 'horsefly' problem followed by some general properties of optimal solutions. Then some approximation results, including an approximation algorithm, are given to illustrate the benefit of horsefly system on a large scale. Lastly, we compare some practical heuristic algorithms in different scenarios for best choice in each case.

3 - The Last Mile Rush

Song Zheng, Cainiao Network, Hang Zhou, China, zhengsong.zs@alibaba-inc.com, Lijun Zhu

As e-commerce keeps its impressive growth, a large percentage of express orders are generated by e-commerce. In China, for example, it is over 60 percent. Increasing investments rush into China's express delivery industry, which now has thousands of delivery companies and millions of delivery workers. Alibaba group and Cainiao Network are building China Smart Logistics Network and developing a huge ecosystem with all major logistics companies in China. We will present an optimal solution to the last mile delivery, more specifically, arranging thousands of courier to delivery all kinds of packages in cities including online e-commerce packages and offline O2O packages.

■ SA16

105A-MCC

Inverse Optimization: Theory

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Taewoo Lee, Rice University, #217, 7010 Staffordshire Street, Houston, TX, 77030, United States, taewoo.lee@utoronto.ca

Co-Chair: Timothy C.Y. Chan, University of Toronto, Toronto, ON, Canada, tcychan@mie.utoronto.ca

1 - Goodness-of-fit In Multi-point Inverse Optimization Optimization

Rafid Mahmood, University of Toronto, Toronto, ON, Canada, rafid.mahmood@mail.utoronto.ca, Timothy Chan, Taewoo Lee, Daria Terekhov

Inverse optimization is a model fitting technique that uses observed points to impute the cost function of an unknown optimization problem. Applications of inverse optimization often rely on ad-hoc or informal methods to evaluate the fit quality of the inverse solution to the data. A previous work introduced a general formulation for inverse optimization with a single observation and a measure for the goodness-of-fit. We extend both of these results to the case of multiple observed points. Our techniques are capable of comparing different models and identifying outliers that do not fit well with the remaining points.

2 - Inverse Optimization For Determining Constraint Parameters

Neal Kaw, University of Toronto, Toronto, ON, Canada, neal.kaw@mail.utoronto.ca, Timothy Chan

Most inverse optimization literature has focused on determining the objective function of an optimization problem, given an observed solution. In this work, we develop inverse optimization models that additionally determine unspecified parameters of the feasible set. First, we propose an inverse linear programming model to determine all problem data. Second, we propose inverse robust linear programming models to determine a cost vector and unspecified parameters of the uncertainty set, for two types of uncertainty: interval uncertainty and cardinality constrained uncertainty.

3 - Robust Inverse Optimization

Kimia Ghobadi, MIT, Cambridge, MA, United States, kimiag@mit.edu, Daria Terekhov, Houra Mahmoudzadeh, Taewoo Lee

In this talk, we explore the robustification of inverse optimization. Our work is motivated by problems in which the observation of the solution is partial, noisy, or uncertain. We build an uncertainty set around the observation and derive an inverse model that finds a cost vector that protects against the worst case scenario in the given uncertainty set. Our model generalizes previous work on single-observation inverse models. It can also be seen as more general than inverse optimization with multiple points, since the points can be thought of as a sample from the uncertainty set.

■ SA17

105B-MCC

Optimal Statistical Learning

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Nana Kwabena Aboagye, Princeton University (ORFE), 1 Nassau Hall, Princeton, NJ, 08544, United States, aboagye@princeton.edu

1 - Uncertain Date Envelopement Analysis

Allen Holder, Rose-Hulman Institute of Technology, holder@rose-hulman.edu

We motivate an inverse optimization problem that calculates a decision making unit's maximum efficiency within the context of uncertain data envelope analysis. One of the sub-problems is a robust linear program, but unlike a traditional robust model that sacrifices the objective to hedge against uncertainty, the data envelope model leverages uncertainty to promote efficiency. We apply the method to a set of prostate radiotherapy treatments to help discern appropriate treatments.

2 - Optimal Learning Of Expensive Quadratic Functions

Nana Kwabena Aboagye, Princeton University, aboagye@princeton.edu

We study the problem of learning the unknown parameters of an expensive function where the true underlying surface can be described by a quadratic polynomial. We present a previously studied Bayesian optimization algorithm known as the knowledge gradient for the parametric belief model. Originally established in the limited context of drug discovery (see Negoescu et al. (2011), the knowledge gradient for the parametric belief model remains under-studied with regards to its behavior. We seek to understand the behavior of this algorithm and exploit this understanding to derive a simple heuristic that performs just as well as the knowledge gradient for the parametric belief model.

3 - Dueling Bandits With Dependent Arms

Bangrui Chen, Cornell University, bc496@cornell.edu

We consider online content recommendation with implicit feedback through pairwise comparisons. We study a new formulation of the dueling bandit problems in which arms are dependent and regret occurs when neither pulled arm is optimal. We propose a new algorithm, Comparing The Best (CTB), appropriate for problems with few arms, and a variation of this algorithm for problems with many arms. We show both algorithms have constant expected cumulative regret. We demonstrate through numerical experiments on simulated and real dataset that these algorithms improve significantly over existing algorithms in the setting we study.

4 - Asymptotic Optimality In Finite Horizon Multi-armed Bandits With Multiple Pulls Per Period

Weici Hu, Cornell University (ORIE), wh343@cornell.edu

We view the finite horizon multi-arm bandit problem with multiple pulls per period (MABMP) as a special case of a weakly coupled dynamic program (WCDP). A WCDP is a class of optimal control problems for which the complexity can be reduced by Lagrangian Relaxation. We propose an index-based policy that utilizes the Lagrange multiplier in the relaxed problem, and give a proof that this index-based policy is asymptotically close to the optimal policy as the problem size gets larger. We also use simulation to show that this index policy performs better than state-of-art heuristics in various problem sizes.

■ SA18

106A-MCC

High-Performance Computing for Stochastic Optimization

Invited: High Performance Computing

Invited Session

Chair: Jean-Paul Watson, Sandia National Laboratories, P.O. Box 5800, MS 1326, Albuquerque, NM, 87185, United States, jwatson@sandia.gov

1 - Parallel Branch-and-bound Based On PH For Stochastic MIPS

David Woodruff, University of California Davis, dlwoodruff@ucdavis.edu, Jason Barnett

Progressive hedging (PH), though an effective heuristic for stochastic mixed integer programs (MIPs), is not guaranteed convergence in the integer case. Here, we describe BBPH, a branch and bound algorithm that uses PH within each node that, given enough time, will always converge to the optimal solution. In addition to providing a theoretically convergent wrapper for PH applied to MIPs, computational results are given that demonstrate that for some difficult problem instances branch and bound can find improved solutions within a few branches.

2 - Schuripopt: A Parallel Optimization Package For Structured Nonlinear-programming Problems

Gabriel Hackebeil, University of Michigan, Ann Arbor, MI, United States, hackebeg@umich.edu, Jose Santiago Rodriguez, Jean-Paul Watson, Carl Laird

In this work, we develop SchurIpopt, a parallel extension to Ipopt that solves structured NLP problems efficiently on shared memory and distributed memory parallel architectures. Our implementation uses a Schur-complement decomposition strategy to exploit the structure of NLP problems arising in multi-scenario and dynamic optimization applications. The implementation achieves high parallel efficiency by parallelizing the solution of the KKT system and related vector-vector and matrix-vector operations. We interface SchurIpopt with PySP — a Python-based software package for modeling stochastic programming problems, which is an extension of the open-source AML Pyomo (pyomo.org).

3 - Parallel Solution Of Large-scale Stochastic Economic Dispatch And Unit Commitment Problems

Jean-Paul Watson, Sandia National Laboratories, jwatson@sandia.gov

We consider the solution of large-scale, industrially relevant economic dispatch and unit commitment problems, for systems with large renewables penetration levels, using parallel scenario-based decomposition methods. We discuss both lower and upper bounding performance, in the context of CAISO and other realistic data sets. We will detail tuning and implementation issues that impact and in some cases limit scalability of scenario-based decomposition (in particular, progressive hedging) on these problems.

■ SA19

106B-MCC

Computing

Sponsored: Computing

Sponsored Session

Chair: Guzin Bayraksan, The Ohio State University, The Ohio State University, Columbus, OH, United States, bayraksan.1@osu.edu

1 - Reconfigurable Optimization

Prateek Raj Srivastava, Graduate Research Assistant, The University of Texas at Austin, 204 East Dean Keeton Street, Engineering Training Center II (ETC), Austin, TX, 78712, United States, prateekrs@utexas.edu, Nedialko Dimitrov, David L. Alderson

We develop a modeling framework for a class of optimization problems in which operational decisions need to be altered as a system transitions stochastically between states of the world. Our framework addresses the multi-objective problem of minimizing reconfiguration costs associated with changing the operational decisions and ensuring good quality solutions in each individual state. We compare and contrast our model solutions with those obtained from other modeling frameworks like Stochastic and Robust Optimization.

2 - Variance Reduction For Sequential Sampling In Stochastic Optimization

Jangho Park, The Ohio State University, Columbus, OH, United States, park.1814@osu.edu, Rebecca Stockbridge, Güzin Bayraksan

We investigate Antithetic Variates (AV) and Latin Hypercube Sampling (LHS) for sequential sampling in stochastic optimization. We assume a sequence of solutions is given and employ AV or LHS to assess the quality of these solutions in a sequential sampling framework. The sequence of solutions can be given by any method satisfying some convergence properties. Therefore, the sequential framework can be used by a variety of methods to find high-quality solutions with a desired probability. We present theoretical justification and update the theory especially for LHS. Computational results indicate that the use of AV and LHS can lead to tighter confidence intervals on the quality of solutions obtained.

3 - A Tractable Stochastic Program For The Operation Of A Hydroelectrical Complex With Uncertain Inflows

Charles Gauvin, École Polytechnique de Montréal, 2900 Boul. Édouard-Montpetit, Montréal, QC, H3T 1J4, Canada, charles.gauvin@polymtl.ca, Erick Delage, Michel Gendreau

This talk considers the operation of a real multireservoir hydroelectrical complex. We focus on the uncertainty surrounding inflows and explicitly capture the serial correlation though well-known time series. We then consider affine decision rules to quickly obtain solutions to this multistage stochastic program. Finally, we evaluate the quality of these policies by embedding our approach into a rolling horizon simulation.

4 - Distributionally Robust Newsvendor Problem With Variation Distance

Hamed Rahimian, PhD Candidate, The Ohio State University, 1971 Neil Ave., Columbus, OH, 43215, United States, rahimian.1@osu.edu, Guzin Bayraksan, Tito Homem-de-Mello

We study a general class of newsvendor models where the underlying demand distribution is unknown. An ambiguity set of distributions is formed by the variation distance centered around a nominal continuous distribution. We characterize the optimal solution to the resulting distributionally robust problem. Then, we examine which demand levels are more critical to the optimal cost than others. Finally, we show the sets of critical demands are decreasing and converge to a set of measure zero as the level of robustness increases. Numerical results show that the optimal decision to the risk-neutral model plays an important role to characterize the most critical demands.

■ SA20

106C-MCC

Storage and Read-Optimized Data Placement Structures for High Performance Analysis

Invited: Tutorial

Invited Session

Chair: Edmon Begoli, University of Tennessee-Knoxville, Joint Institute for Computational Sciences (JICS),, Knoxville, TN, 37831, United States, ebegoli@utk.edu

1 - Storage And Read-Optimized Data PlacementStructures For High Performance Analysis

Edmon Begoli, University of Tennessee-Knoxville, Joint Institute for Computational Sciences (JICS), Knoxville, TN, 37831, United States, ebegoli@utk.edu, Pragnesh Patel, J. Blair Christian

We present state-of-art structures and methods for efficient data preparation, and representation for analysis. Our intent is to introduce the data science and analytics communities to open source data placements, structures, and methods. These practices can make the foundational processes of data preparation and access dramatically more efficient than typical raw file or database representations and use more conservative storage. To illustrate this, we introduce two highly efficient data placement structures. We then present a tutorial, supported by step-by-step examples, of how to create, use and access data, structured by Parquet or ORC, using Apache Spark. Finally, we illustrate the benefits of using these structures with computational and storage volume benchmarks.

■ SA21

107A-MCC

Healthcare Operations Research in Practice

Sponsored: Health Applications

Sponsored Session

Chair: Sandra Potthoff, University of Minnesota, 420 Delaware Street SE, D362 Mayo MMC 729, Minneapolis, MN, 55455, United States, potth001@umn.edu

Co-Chair: David J. Cook, Mayo Clinic, 200 1st St SW, Rochester, MN, 55902, United States, cook.david@mayo.edu

1 - Optimization-based Scheduling Tools For Hospital Staff

Fei Li, Hennepin County Medical Center, Fei.Li@hcmed.org

Clinics and hospital units hope to staff more accurately to demand patterns, but many have trouble doing so, because of multiple difficulties. We try to understand the difficulties in real practice and offer optimization-based solutions.We propose a solution that is both easier to use and more personalized. Our solution includes a one-stop web-based access to our CPLEX server for any model, and a customized user-friendly tool for each team. They gain users' acceptance, and we reach better schedules that both the department and staff are happy with.Continued effort cannot be saved in making the tool fit the team's need. Including modeling skill in supporting staff is recommended.

2 - A Target Discharge Strategy For Inpatient Discharge Planning

Nicholas Ballester, PhD Candidate, Wright State University, 1555-A Sudbury Lane, Faiborn, OH, 45324, United States, ballester.2@wright.edu, Pratik Parikh, Nan Kong

Ineffective inpatient discharge planning may cause discharge lateness and upstream patient boarding. Working with a local hospital, we propose a novel target discharge strategy, the n-by-T strategy. We demonstrate the effectiveness of this strategy via a simulation study, which suggests nearly 2 hr of advancement in the mean discharge time and nearly 15% reduction in upstream boarding. The sensitivity of this strategy for varying unit's occupancy rates and findings from a trial implementation at this hospital unit will also be discussed.

3 - Enhancement and Validation Of Outpatient Blood And Marrow Transplant Practice Using Time Driven Activity Based Costing (TDABC)

William J Hogan, Mayo Clinic-Rochester, NY, United States, hogan.william@mayo.edu

Mayo Clinic has developed an infrastructure to permit the performance of a complex procedure, Blood and Marrow Transplant (BMT), as an outpatient. Using a combination of Standardize to Value (STV) and Time Driven Activity Based Costing (TDABC) approach a number of strategies were developed to converge the practice across multiple sites resulting in greater standardization, consistency, quality of care and cost containment. The value of performing BMT as an outpatient was interrogated using TDABC, which effectively demonstrated enhanced resource utilization and cost containment while maintaining excellent clinical outcomes. These principles are generalizable to other practices involving complex care.

4 - Anesthesiology Practice Redesign

Michael J Brown, Mayo Clinic-Rochester, NY, United States, Brown.Michael3@mayo.edu

The Department of Anesthesiology led perioperative practice redesign initiative improved the quality and increased the value of perioperative care. Utilizing an analytical approach to identify, prioritize, assimilate, and interpret impactful information, multiple high-value strategies were implemented that optimized Mayo Clinic's perioperative facilities, human resources, workflows and clinical outcomes. The majority of interventions were perioperative specialty specific, however others were generalizable to the entire practice. "

■ SA22

107B-MCC

Incentives and Resource Allocation in Healthcare Settings

Invited: ORinformed Healthcare Policies

Invited Session

Chair: Karthik Natarajan, University of Minnesota, Edina, MN, United States, knataraj@umn.edu

1 - Optimal Patient And Provider Incentives In Funding-constrained Humanitarian Healthcare Service Settings

Karthik Natarajan, University of Minnesota, Minneapolis, MN, United States, knataraj@umn.edu, Mili Mehrotra

We analyze how a budget-constrained humanitarian organization managing a healthcare service program should design incentives to the provider and patients to maximize program coverage. We explore how the incentives change with the service offered and operating environment. We also compare the optimal incentive scheme to incentive schemes used in practice.

2 - Competing For Donations In The NPO Sector

Milind Sohoni, Indian School of Business, milind_sohoni@isb.edu, Sripad K Devalkar, Neha Sharma

We study the impact of competition under two fund-raising models, commonly observed in the non-profit sector, when donors and non-profit organizations face challenges due to information asymmetry and outcome (benefit) uncertainty. We also analyze implications on benefits delivered from a social planner's perspective.

3 - Discharge Decision In Emergency Departments: Impact Of Operational Measures And Pay-for-performance Incentives

Eric Park, University of Hong Kong, 1, Hong Kong, ericpark@hku.hk

We study how operational measures in the emergency department such as number of patients waiting to be seen and physician's patient load affect patient discharge decisions. We also analyze the impact of a provincial government level pay-for-performance incentive scheme on discharge decisions. We empirically study several major hospitals in the metro Vancouver, Canada area.

■ SA23

108-MCC

Evaluating Health Policy Decisions

Sponsored: Health Applications

Sponsored Session

Chair: Zhaowei She, Georgia Institute of Technology, 755 Ferst Drive, NW, Atlanta, GA, 30332, United States, zhaowei@gatech.edu

1 - Positive Externalities In Disease Intervention: A Study Of Mosquito Borne Viruses

Anneke Claypool, Stanford University, annekecl@stanford.edu Jeremy Goldhaber-Fiebert

Health interventions often result in positive externalities that are not captured in traditional cost-effectiveness analysis. This study uses a dynamic transmission model to analyze the cost-effectiveness of Chikungunya prevention measures. We compare a potential Chikungunya vaccine to vector control methods that result in fewer Chikungunya, Zika and Dengue cases. By using this model, the additional health benefits of interventions that impact multiple diseases can be captured.

2 - Modeling Health Insurance Marketplaces

Zhaowei She, Georgia Institute of Technology, zhaowei@gatech.edu

As part of the Affordable Care Act, Health Insurance Marketplaces (HIX) has significantly reduced the number of uninsured in the United States. However, concerns exist about quality and accessibility of services in HIX. Motivated by these concerns, we propose a theoretical framework to understand the current state of HIX, and make projections about its future and sustainability. Our analysis shows that the current design of HIX may unintentionally incentivize health plans to ration services to attract low risk enrollees, leading to adverse selection and narrow-network phenomena in HIX. Moreover, HIX's limitations in addressing upcoding behavior can lead to an unraveling of the market.

3 - Balancing Functional And Technical Quality In Health Services Under Provider Consolidation And Shifts In Payment Structure

Aaron H Ratcliffe, University of North Carolina at Greensboro, 438 Bryan Building, University of North Carolina at Greensboro, Greensboro, NC, 27402-6165, United States, aaron.ratcliffe@uncg.edu, Ann Marucheck, Wendell G Gilland

We develop a competitive queueing model to study how health service providers balance investments in functional quality (experiential elements of service) against investments in technical service quality (positive service outcomes). Our analytical derivations measure the impact of provider consolidation and alternative payment structures on the equilibrium technical quality and functional quality efforts and equilibrium wait times for health service.

■ SA24

109-MCC

Dynamics of Scope and Innovation

Invited: Strategy Science

Invited Session

Chair: Brian Wu, University of Michigan, Tappan Street, Ann Arbor, MI, 48109, United States, wux@umich.edu

1 - Adaptation On Multiple Landscapes: Relatedness, Complexity And Dynamic Coordination Costs

Aseem Kaul, University of Minnesota, Minneapolis, MN, United States, akaul@umn.edu, Mo Chen, Xun Wu

We introduce and explore the concept of dynamic coordination costs, i.e. the reduction in a diversified firm's ability to adapt within its businesses resulting from the coordination of activities across them. Using a modified NK simulation, we show that a combination of rigidity and learning means that these costs are highest at moderate levels of relatedness across business, with the level of interdependency within businesses moderating this effect. We also show that diversifying entrants in new markets experience a short-term learning advantage, but a long-term rigidity disadvantage. Our study speaks to work on organizational adaptation and strategic renewal in multi-business firms.

2 - Innovation In Ecosystems

Gwendolyn K Lee, University of Florida, 2822 SW 94th Drive, Gainesville, FL, 32608, United States, gwendolyn.lee@cba.ufl.edu, Martin Ganco, Rahul Kapoor

We consider the context for innovation to comprise of interdependent industries within an ecosystem. Using a simulation model, we explore how the structure of interdependencies shapes the pattern of innovation across industries. The notion is that an industry's close proximity to end-use provides firms with a larger pool of components to combine but also more complex objective function to solve. A larger pool presents more choices and covers a wider variety of choices. However, certain architectural configurations impose heavy constraints on downstream firms. We show innovation outcomes depend on the architecture of interdependencies across and within the different industries in an ecosystem.

3 - Effect Of Competitor Investments On Established Firms' Redeployment Entry Into Nascent Markets: Evidence From The U.S. Electric Utilities' Adoption Of Solar Energy

Shaohua Lu, Tulane University, Freeman School of Business, New Orleans, LA, 70118, United States, slu4@tulane.edu
Jay Anand

This paper examines the effect of competitor investments on established firms' entry into an emerging, uncertain market. To understand information effect, we shift attention to the "flow" of recent competitor investments rather than analyzing the "stock" of cumulative investments. We further postulate that this information effect interacts with a competition effect in oligopolistic market competition. We construct formal models and predict a U-shaped relationship. We further examine how competitor similarity and existing capacity affect this U-shaped relationship. Using data on investor-owned utilities' entry into the solar market, we find supporting evidence for our predictions.

4 - Stock Market Undervaluation Of Resource Redeployability

Arkadiy Sakhartov, University of Pennsylvania, Wharton School of Business, 3620 Locust Walk, Philadelphia, PA, 19104, United States, arkadiys@wharton.upenn.edu

The study uses three steps to establish the applicability of the strategic factor market theory to acquisitions of firms in stock markets. First, the study reviews literature on resource valuation and finds a likely source of the undervaluation, ambiguity about redeployability of resources to a new business. Second, the study compiles a case of Apple Inc., revealing a prolonged undervaluation of redeployability of the firm's resources to the smartphone business. Third, the study builds a valuation model deriving the undervaluation as a function of observable resource properties.

■ SA25

110A-MCC

Capacity Allocation and Scheduling Issues

Invited: Project Management and Scheduling

Invited Session

Chair: Zhixin Liu, University of Michigan-Dearborn, 19000 Hubbard Dr, Dearborn, MI, 48126, United States, zhixin@umich.edu

1 - Coordination Mechanisms For Several Scheduling Game Problems

Guo-Qiang Fan, Northwestern Polytechnical University, Xi'an, China, pacpos.gqfan@gmail.com, Jun-Qiang Wang

We consider two scheduling problems in the non-cooperative game setting. Each job is owned by a selfish agent whose strategy is to minimize its completion time. (P1) For the scheduling game problem Q||max wjCj, we design the Greatest-Weight-First Coordination Mechanism and show that the price of anarchy is equal to 2-1/m for identical parallel machines and is not greater than 1+(m-1)smax/ms for uniform parallel machines. (P2) For the scheduling game problem Q|p-batch,b<n|Cmax, we design the FBLPT coordination mechanism and show that the price of anarchy is not greater than 2-2/(3b)-1/(3max{m,b}) for identical parallel-batching machines and 1+smax(1-1/max(m,b)) for uniform parallel machines.

2 - Disruption Recovery For Berth Allocation

Li Chen, Assistant Professor, Tianjin University, College of Management and Economics, Tianjin University, Tianjin, China, cliad@connect.ust.hk, Xiangtong Qi

A major disruption to a container terminal may cause a substantial delay to the vessels waiting for services. When the terminal makes the berth allocation decision after the hit of a major disruption, the possibility of missing container transshipment becomes a new issue that does not exist in conventional berth allocation models. We study the berth allocation problem under such a scenario to balance the operational efficiency of the terminal and lose of misconnected containers.

3 - Fixed Factor Allocation For Capacity Allocation With Demand Competition

Zhixin Liu, University of Michigan-Dearborn, Dearborn, MI, United States, zhixin@umich.edu, Jianbin Li, Xueyuan Cai

We consider a supply chain consisting of a supplier and two retailers. The supplier sells a single product to the retailers, who in turn retail the product to customers. The supplier has limited production capacity, and the retailers compete for the supplier's capacity and are duopolists engaged in Cournot competition for their customers. We propose a new capacity allocation rule, fixed factor allocation, which incorporates the ideas of proportional and lexicographic allocations: it prioritizes retailers as in lexicographic allocation, but guarantees only a fixed proportion of the total available capacity to the prioritized retailer. We show desirable properties of the fixed factor allocation.

■ SA26

110B-MCC

Procurement Auctions and Bidding

Invited: Auctions

Invited Session

Chair: Kartikeya Puranam, La Salle University, 1900 West Olney Ave, Philadephia, PA, 19141, United States, puranam@lasalle.edu

1 - Behavioral Analysis Of A + B Sealed Bid Procurement Auctions

Bernardo F. Quiroga, Assistant Professor, Clemson University, Clemson, SC, 29634, United States, bquirog@g.clemson.edu
Brent Moritz, Xiaosong Wu

Using a laboratory experiment, we study the effect of complexity in multidimensional bidding in A+B governmental procurement auctions. Varying the number of bidders and the dimensionality of the bid, we offer an explanation for over/underbidding, and suggest potential solutions to the welfare implications of the observed biases. In our analyses, we evaluate several different explanations to rationalize this behavior, including risk attitudes, bounded rationality, loss aversion, quantile response equilibria measures, and structural estimation of the implied private value of the contracts.

2 - Score Auction Bidding Under Quality Uncertainty: Effort, Risk And Agency Considerations

Daniel Nielubowicz, Clemson University, dnielub@g.clemson.edu
Bernardo F. Quiroga

In a price-and-quality score procurement auction setting, we model the effect of quality uncertainty on bidding behavior under the presence of moral hazard, using a sealed-bid-first-score mechanism. In our scenario, bidders submit prices and target quality levels, and are subject to a failure-to-deliver penalty from deviations below said target. We present our analytical model and offer policy implications in presence and absence of default risk/renegotiation, and offer light to a dynamic extension of this model (in which credibility plays a fundamental role).

3 - Bidding With Learning In Repeated Auctions

Kartikeya Puranam, La Salle University, puranam@lasalle.edu,
Michael N Katehakis

We consider the problem of a firm that procures items in a sequence of auctions by bidding against the “market.” The firm has two bid levels available (High and Low). The firm and the “market” learn from each winning bid. We study bidding strategies for the firm when the objective of the firm is to minimize the expected total cost of acquiring items to meet demand.

■ SA27

201A-MCC

Behavioral Operations

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Javad Nasiry, Hong Kong University of Science and Technology-HKUST, Hong Kong, nasiry@ust.hk

Co-Chair: Xiaoyang Long, Hong Kong University of Science and Technology, Hong Kong, xlongaa@connect.ust.hk

1 - Trust, Social Networks, And Information Sharing Among Executives

Ozalp Ozer, The University of Texas at Dallas, Richardson, TX, 75080, United States, oozer@utdallas.edu, Emily Choi,
Yanchong Zheng

We experimentally study how trust and social networks influence forecast information sharing behavior among executives with an average 17 years of professional experience. We demonstrate how trust preconditioned by prior experiences and trust measured from social network jointly influence information sharing behavior and the resulting supply chain efficiency.

2 - A Behavioral Study On Abandonment Decisions In Multi-stage Projects

Xiaoyang Long, Hong Kong University of Science and Technology, Hong Kong, Hong Kong, xlongaa@connect.ust.hk
Javad Nasiry, Yaozhong Wu

We experimentally investigate continuation/abandonment decisions in a multi-stage project under two conditions: when the project is reviewed at every stage and when review opportunities are limited. We find systematic deviations from the optimal solution: subjects may wrongly continue or abandon the project, and their decisions are path dependent. We propose a behavioral model which explains the behavioral regularities.

3 - Newsvendor Problem In The Presence Of Strategic Customers: Theory And Laboratory Evidence

Yang Zhang, Tsinghua University,
yangzhanguser@mail.tsinghua.edu.cn, Benny Mantin,
Yaozhong Wu

How would a newsvendor react to strategic customers who may delay their purchase until a price discount to take place? In theory, the newsvendor should optimally order less than the conventional critical fractile, in order to signal a shortage of products so that strategic customers herd into purchases at full price. In the laboratory however, retailers tend to psychologically overreact to the strategic customer behavior, which produces the so-called pull-below-center bias. We develop a behavioral model based on reference dependence to explain the observed ordering patterns, comparative statics, and the presence and asymmetry of pull-below-center bias across treatments.

4 - Competitive Dynamic Pricing Under Capacity Constraints: An Experimental Study

Bahriye Cesaret, Ozyegin University, Istanbul, Turkey,
bahriye.cesaret@ozyegin.edu.tr, Elena Katok

We present an experimental study of a stylized competitive dynamic pricing model for a duopoly. We designed a set laboratory experiments to investigate how human decision makers price their fixed units of capacity over a multiple-period selling season when they face a competition in the market. We report on the results of four experiments. The results show that our laboratory participant tends to underprice (i.e., price over-competitively) at the beginning of a selling season, and as the selling deadline gets closer she tends to overprice (i.e., price not competitive enough) her units.

■ SA28

201B-MCC

MSOM Student Paper Competition Finalists – I

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Sameer Hasija, Insead, 1 Ayer Rajah Avenue, Singapore, 138676, Singapore, sameer.hasija@insead.edu

Co-Chair: Tolga Tezcan, London Business School, Regent’s Park, London, IL, NW1 4SA, United Kingdom, ttezcan@london.edu

Co-Chair: Nicos Savva, London Business School, Regent’s Park, London, NW1 4SA, United Kingdom, nsavva@london.edu

The MSOM Student Paper Competition is awarded annually by the Manufacturing & Service Operations Management Society at the INFORMS Annual Meeting for papers judged to be the best in the field of operations management.

1 - Buyer Intermediation in Supplier Finance

Weiming Zhu, Smith School of Business, College Park, MD, United States, zhuwm923@gmail.com

Abstract to come

2 - Using Patient-Centric Quality Information to Unlock Hidden Health Care Capabilities

Guihua Wang, University of Michigan, Ann Arbor, MI, United States, guihuaw@umich.edu

Abstract to come

3 - Strategic Open Routing in Service Networks

Andrew Frazelle, Duke University, Durham, NC, United States, andrew.frazelle@duke.edu

Abstract to come

■ SA29

202A-MCC

Dynamic Mechanism Design

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Peng Sun, Duke University, Durham, NC, United States, peng.sun@duke.edu

1 - Dynamic Mechanism Design With Budget Constrained Buyers Under Limited Commitment

Omar Besbes, Columbia University, ob2105@columbia.edu, Santiago Balseiro, Gabriel Weintraub

We study the dynamic mechanism design problem of a firm repeatedly selling items to budget-constrained buyers when the seller has limited commitment power. We argue that this problem is generally intractable. Thus motivated we introduce a fluid model that allows for a tractable characterization of the optimal mechanism. We leverage our characterization to provide insights into the dynamic structure of the optimal mechanism and show that the proposed mechanism is a good approximation in large markets.

2 - Dynamic Short-term Contracts Under Hidden Inventory And Backlog

Hao Zhang, University of British Columbia, Vancouver, BC, Canada, hzhang01@sauder.ubc.ca
Lifei Sheng, Mahesh Nagarajan

We study a supply chain consisting of a supplier and a retailer faced with random demand over multiple periods. At the beginning of each period, the supplier offers a one-period contract and the retailer chooses order quantity before the demand is realized. The retailer carries leftover inventory or backlogs unmet demand, which is unobservable by the supplier. We find that in the infinite-horizon setting with exponentially distributed demand, for a large parameter set, the optimal sequence of short-term contracts is a generalized base-stock policy, where the base-stock level weakly increases with the beginning inventory.

3 - Dynamic Mechanism Design Without Money

Huseyin Gurkan, Duke University, Duke University, Durham, NC, 27707, United States, huseyin.gurkan@duke.edu, Santiago Balseiro, Peng Sun

We consider a principal repeatedly allocating a single resource in each period to one of multiple agents without relying on monetary payments over an infinite horizon. Agents' private valuations are independent and identically distributed. We show that as the discount factor approaches 1, the optimal dynamic mechanism without money achieves the first-best allocation (the welfare maximizing allocation when valuations are public). As part of the proof, we provide an incentive compatible dynamic mechanism that asymptotically achieves the first-best.

4 - Optimal Contract To Induce Continued Effort

Peng Sun, Duke University, Durham, NC, psun@duke.edu, Feng Tian

We consider a principal incentivizing an agent to exert effort in order to raise the arrival rate of a Poisson process. The effort is costly to the agent, unobservable to the principal, and affects the instantaneous arrival rate. Each arrival yields a constant revenue to the principal. A contract involves payments and a potential stopping time in order to motivate the agent to always exert effort. Although payments can take general forms contingent upon past arrival times, the optimal contract has a simple and intuitive structure, which depends on whether the agent is less patient than the principal.

■ SA30

202B-MCC

Revenue Management: Algorithms and Applications

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Retsef Levi, MIT, Cambridge, MA, United States, retsef@mit.edu

1 - Assortment Optimization Under A Mallows Distribution Over Permutations

Antoine Desir, Columbia University, 601 W 113th Street, Apt 3J, New York, NY, 10025, United States, ad2918@columbia.edu, Vineet Goyal, Srikanth Jagabathula, Danny Segev

We study assortment optimization under Mallows distribution over permutations model that is specified by a central permutation and a decay parameter. The probability of any permutation decays exponentially in the (Kendall-Tau) distance from the central permutation. We present an efficient procedure to compute exact choice probabilities for any assortment even with exponential size distribution. Our procedure crucially exploits the symmetries of the Mallows model and leads to a compact IP formulation for assortment optimization. We also give an efficient near-optimal approximation for the IP.

2 - Auctions In The Online Display Advertising Chain: A Case For Transparency

Amine Allouah, Columbia University, 520 W 122nd Street Apt 24, New York, NY, 10027, United States, mallouah19@gsb.columbia.edu
Omar Besbes

In the online display advertising market in which auctions are run to sell impressions in real time, advertisers most often bid for impressions through intermediaries. We investigate the impact of the active role such intermediaries take on the selling mechanism that sellers should use and on the performance metrics of the different agents in the advertising chain.

3 - Fast Provably Near-optimal Algorithms For Dynamic Assortment Optimization

Ali Aouad, Massachusetts Institute of Technology, aaouad@mit.edu
Retsef Levi, Danny Segev

We study the dynamic assortment planning problem, where the demand is stochastic, and retailers' decisions need to be robust (revenue-wise) to stock-out events, elicited by the inventory limitations. While being key to revenue management, particularly in retailing and airlines, the computational aspects of such problems are still wide open. We devise the first efficient algorithms with provable performance guarantees, under several common modeling primitives, including the widespread Multinomial Logit choice model. In practical comparisons against incumbent heuristics, our algorithms improve the revenue by 9% to 35%, with better computational efficiency and robustness in most cases.

■ SA31

202C-MCC

Derivatives in the Operations/Finance Interface Area

Sponsored: Manufacturing & Service Oper Mgmt, iFORM

Sponsored Session

Chair: Arun Chockalingam, Eindhoven University of Technology, Den Dolech 2, Eindhoven, 5612 AZ, Netherlands, a.chockalingam@tue.nl

1 - The Optimal Hedging Strategy In A Competitive Supply Chain With Substitutable Commodities

Ehsan Bolandifar, Chinese University of Hong Kong, ehsan@baf.cuhk.edu.hk, Zhong Chen

This paper studies two risk-neutral processors procure two substitutable commodities from spot markets to process and sell through a retailer. First, we characterize the optimal index-based contracts for processors that indicates the processor's optimal contract consists of a processing margin which is independent of its financial hedging decisions and a hedge ratio which is a function of commodity price volatility. Next, we characterize conditions under which, the retailer prefers to be exposed to commodity price risks. We show that processors can benefit from market pricing, when these prices are linked to input commodity prices and index-based contracts are a means to achieve it.

2 - Integrated Risk Management In Commodity Markets

Fehmi Tanrisever, Bilkent University, tanrisever@bilkent.edu.tr

In this paper, we examine the integrated operating and financial hedging decisions of a value maximizing firm, in the presence of capital market imperfections. Our results show that the working capital and the hedging polices of the firm interact with each other in a multi-period dynamic inventory model. In particular, looser working capital policies lead the managers to take relatively more speculative positions in the market to maximize firm value.

3 - Production Planning With Shortfall Hedging Under Partial Information And Budget Constraint

Liao Wang, Columbia University, lw2489@columbia.edu, David D Yao

We study production planning integrated with risk hedging by considering shortfall (from a pre-specified target) as the risk measure. The optimal hedging strategy is identified via a dual lower-bound problem, and takes the form of a digital option combined with a put option; and optimizing the production quantity, given the optimal hedging, is shown to be a convex minimization problem. With both production and hedging optimized, we provide a complete characterization of the efficient frontier, and an explicit quantification of the shortfall reduction achieved by hedging.

4 - Dual Sourcing: Optimal Procurement Policy With Option Hedging Against Freight Rate Risk

Arun Chockalingam, Eindhoven University of Technology, Hoog Gagel 62, Eindhoven, 5611BG, Netherlands, a.chockalingam@tue.nl, Taimaz Soltani, Jan C Fransoo, Chung-Yee Lee

Raw materials cost less to procure on offshore markets as opposed to domestic markets. However, offshore procurement requires ocean shipping, the price of which is highly volatile, and firms usually have to charter ships, even if they do not use the whole capacity of ships. We consider a commodity processor with two sourcing choices and develop models to determine the firm's optimal sourcing policy. The models allow for three sources of uncertainty: demand, commodity spot price and freight rate. Using option contracts as hedging tools against freight rate risk, we develop a model that integrates a firm's optimal sourcing decision with the integer constraint on hiring ships.

■ SA32

203A-MCC

Scheduling I

Contributed Session

Chair: Neil Desnoyers, Saint Joseph's University, 133 Green Valley Rd, Upper Darby, PA, 19082, United States, ndesnoye@sju.edu

1 - A Bicriteria Scheduling Problem With Two Competing Agents

Shudong Sun, Northwestern Polytechnical University, 127 Youyi West Road, PO Box 554, Xi'an, 710072, China, sdsun@nwpu.edu.cn

Single machine scheduling with two competing agents is studied. Cost function of the machine and agent 1 must be minimized simultaneously, while cost function of agent 2 is keeped below a determined value Q. Total completion time and maximum lateness of the machine, and most regular cost functions of the agents are consided. The model of multiagent scheduling has been enlarged to including the goal of both machine and agents. Some polynomial and pseudo-polynomial algorithms are presented.

2 - Scheduling Student Volunteers For The Informs Annual Meeting

Neil Desnoyers, Adjunct Instructor, Saint Joseph's University, 5600 City Avenue, Philadelphia, PA, 19131, United States, ndesnoye@sju.edu

The 2015 INFORMS Annual Meeting in Philadelphia required the assistance of 59 student volunteers. Each student volunteer was required to serve two half-day shifts out of the eight shifts available over four days (AM and PM shift each day). Via a web survey, student volunteers indicated five of eight shifts they were available to work. Between 12 and 14 student volunteers were required for each shift, and student volunteers were assigned to 9 or 10 locations/roles each shift. The problem was set up and solved as a binary integer programming problem. The problem provides lessons for volunteer scheduling in general.

■ SA33

203B-MCC

Simulation and Optimization I

Contributed Session

Chair: Tomas Ignacio Lagos, Masters Degree Student, University of Chile, 2017 - Pozuelo, Santiago, 7640031, Chile, tomas.lagos.gonzalez@gmail.com

1 - An Integrated Multi-criteria Decision Making And Simulation-optimization Framework For Supplier Selection

Mohammad Dehghanimohammadabadi, Teaching Assistant Professor, Northeastern University, 360 Huntington Ave, MIE Department, Boston, MA, 02115, United States, mdehghani@neu.edu, Emanuel Melachrinoudis

A wide spectrum of criteria have been introduced by researchers to evaluate the suppliers' performance; however, measuring and employment of all of these criteria is impractical. In this study, a two-fold integration of MCDM and Simulation-Optimization is developed to select the most effective criteria for the supplier selection process. In this framework, the MCDM module incorporates a combination of criteria to select the suppliers. Then, the simulation model evaluates the performance of the Supply Chain (SC) considering the selected suppliers. Based on the simulation results, a metaheuristic algorithm finds the best/good combination of the criteria that maximizes the SC performance.

2 - Cloud-based Collaborative Application Development

Susanne Heipcke, Principal Engineer, FICO, FICO House, Starley Way, Birmingham, B37 7GN, United Kingdom, susanneheipcke@fico.com, Oliver Bastert

Integrated development environments are critical for efficient development but tooling for algebraic modeling languages has been lacking adoption of the latest technologies, no single tool covering the whole application development process so far. FICO Optimization Designer provides a novel approach for collaborative web-based development of optimization solutions. It supports model development in Xpress-Mosel, add-in predictive models implemented in R, deployment as on premises or cloud applications, and debugging of models run from a FICO Optimization Modeler application GUI.

3 - Adaptive Sampling Trust-region Optimization For Derivative-based And Derivative-free Simulation Optimization Problems

Sara Shashaani, PhD, Purdue University, Lafayette, IN, 47901, United States, sshashaa@purdue.edu, Raghu Pasupathy

We present ASTRO and ASTRO-DF – adaptive sampling trust-region optimization algorithms – or solving derivative-based and derivative-free continuous simulation optimization problems. Sampling in ASTRO and ASTRO-DF is done adaptively in an attempt to keep stochastic and structural errors in lock-step as the algorithm iterates evolve through the search space. We show consistency and discuss finite-time performance for a set of low to moderate dimensional optimization problems.

4 - Designing Resilient Electric Networks Under Natural Hazards

Tomas Ignacio Lagos, Masters Degree Student, University of Chile, 2017 - Pozuelo, Santiago, 7640031, Chile, tomas.lagos.gonzalez@gmail.com

We present an optimization framework for the problem of designing a resilient electric grid under high impact and low probability events, such as earthquakes. We use an Optimization via Simulation approach to solve this discrete decision problem, where the measure of resilience is the expected Energy Not Supplied and its evaluation uses an existing simulator with historical earthquake data, information of fragility curves of the components provided by FEMA, and an Optimal Power Flow model. We use this framework to evaluate the effect of different resilience measures and algorithms.

■ SA34

204-MCC

Hospital Operations

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Carolyn Queenan, University of South Carolina, 1014 Greene St, Columbia, SC, 29208, United States, carrie.queenan@moore.sc.edu

1 - The Impact Of Call Rotations And Geographic Localization Of Patients On Hospital Performance

Douglas Morrice, University of Texas-Austin, Austin, TX, United States, douglas.morrice@mccombs.utexas.edu, Ying Chen, Jonathan F Bard, Luci Leykum

We study the impact of an on-call rotation of teaching teams for admissions and geographic localization of patients on hospital performance using patient-level data from a Texas teaching hospital and simulation. Performance is measured by length of stay in the Emergency Department, patient hand-offs, and bed availability. The results of this study inform admission decision-making including patient allocation to medical teams and admission capacity planning.

2 - Complementarities Or Substitutes Of Physician Employment For Managing Patient Care: Effects Of Focus, Experience, And Technology

David Zepeda, Northeastern University, Boston, MA, 02115, United States, d.zepeda@neu.edu, Gilbert N. Nyaga, Gary J. Young

A dramatic change in the health care industry is the increasing emphasis on linking provider payment to clinical quality performance metrics. This is one of several considerations leading hospitals to vertically integrate by acquiring physician practices and employing physicians directly. Yet, there is little evidence regarding whether this form of vertical integration leads to better performance on clinical quality performance metrics. We empirically evaluate the relationship between hospital employment of physicians and hospital performance on clinical quality performance metrics. We also consider several hospital operational considerations as potential moderators.

3 - Analyzing The Impact Of Surgical Process Changes On Patient Flow

Justin Kistler, University of South Carolina, Columbia, SC, United States, justin.kistler@grad.moore.sc.edu
Ramkumar Janakiraman, Vikram Tiwari, Subodha Kumar

Leveraging unique patient level encounter data through econometric techniques, we examine the impact of two process changes on surgical operations at a medical center. Building on management and operations literature, we posit that a process change, and a subsequent intra-operative IT enabled process change, will significantly improve surgical operations flow time. Given the high opportunity cost of resources associated with surgical procedures, this finding has important implications for surgical process owners and participants.

■ SA35

205A-MCC

Adversiting, Trade-ins, and Distribution Channels

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Shuya Yin, University of California-Irvine, Merage School of Business, Irvine, CA, 92697, United States, shuya.yin@uci.edu

Co-Chair: Rachel Rong Chen, University of California-Davis, Graduate School of Management, Davis, CA, 95616, United States, rachen@ucdavis.edu

1 - Exploring The Rational Behind Outlet Stores

Jiaru Bai, University of California, Irvine, jiarub@uci.edu, Haresh Gurnani, Shuya Yin

Outlet stores have been both complementary to and competing with the main stores. In this project, our goal is to understand the tradeoffs involved in offering outlet stores. In particular, we study how much differentiation should be kept between the main and outlet stores from three perspectives: price, product and location.

2 - Fit-revelation Sampling And Advertising: Complementary Or Substitutable?

Rachel Rong Chen, University of California-Davis, Davis, CA, United States, rachen@ucdavis.edu, Shiming Deng, Lingli Wu

Buyers are often uncertain about how a product fits their individual preferences. In such situations, fit-revelation sampling can be offered to allow consumers to resolve such uncertainties before purchase. When advertising is jointly offered, fit-revelation sampling may have a correction effect that could enhance or weaken the valuation added by advertisements. This paper studies the profit implications of the interactions between advertising and fit-revelation sampling.

3 - Replenishment Strategies For Micro-retailers In Developing Countries

Sean Zhou, Chinese University of Hong Kong, Hong Kong, Hong Kong, zhoux@baf.cuhk.edu.hk, Christopher S. Tang, Kairen Zhang

When formal distribution channels are absent in developing countries, micro-retailers travel long distances to replenish their stocks directly from key suppliers. We examine a model where multiple competing retailers collectively determine the replenishment strategy among three possible strategies: informal, formal, and hybrid. We show that when the stores engage in quantity competition, the hybrid strategy maximizes the retailers' total welfare when either the travel cost is sufficiently high or the fixed operating costs are sufficiently low.

■ SA36

205B-MCC

Data-driven Operations Management Research

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: Fuqiang Zhang, Washington University in St. Louis, St. Louis, MO, United States, zhang@olin.wustl.edu

Co-Chair: Tianjun Feng, Fudan University, Shanghai, China, tfeng@fudan.edu.cn

1 - An Empirical Investigation Of Network Effect In Automobile Sales

Tianjun Feng, Fudan University, tfeng@fudan.edu.cn, Fuqiang Zhang, Peiwen Yu

This paper investigates the network effect in automobile sales by using a unique dataset from a large city in China. We demonstrate the existence of a positive but diminishing marginal effect of the local owner base on the sales of automobiles.

2 - The Operational Value Of Social Media Information

Dennis Zhang, Northwestern University, 1500 Chicago Avenue, Apt.712, Evanston, IL, 60201, United States, j-zhang@kellogg.northwestern.edu, Antonio Moreno-Garcia, Ruomeng Cui, Santiago Gallino

This paper empirically studies whether using publicly available social media information can improve the accuracy of daily sales forecasts. We collaborated with an online apparel retailer to implement a variety of machine learning methods to create daily sales forecasts. We find that using social media information results in statistically significant improvements in the out-of-sample accuracy of the forecasts, with relative improvements ranging from 12.85 percent to 23.23 percent over different forecast horizons.

3 - When You Work With A Super Man, Will You Also Fly? An Empirical Study Of The Impact Of Coworkers On Performance

Serguei Netessine, INSEAD, serguei.netessine@insead.edu
Fangyun Tan

We examine a large operational data set in a casual restaurant setting to study how coworkers' sales ability (measured as servers' sales premium) affects workers' performance in terms of service speed and service quality. We find that servers react non-linearly to their coworkers' ability. In particular, when coworkers' overall sales ability is low, increasing this ability may trigger servers to redouble both upselling and cross-selling efforts at the expense of slower service speed. Our empirical findings imply that managers should mix servers having heterogeneous ability levels during the same shift.

4 - Ceo Overconfidence And Inventory Management

Fuqiang Zhang, Washington University in St. Louis, zhang@olin.wustl.edu, Tianjun Feng, Qing Zhang

Using the data of the US-listed companies in the manufacturing industry during 1999-2011, this study empirically investigates the relationship between CEO overconfidence and firms' operations efficiency. Specifically, we focus on inventory turnover, a widely used operations efficiency measure for inventory management. We find that firms with overconfident CEOs are associated with higher inventory turnover.

■ SA37

205C-MCC

Operations in an Omnichannel World

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session"

Chair: Santiago Gallino, Dartmouth College, Tuck School of Business, Dartmouth College, Hanover, NH, 03755, United States, santiago.gallino@tuck.dartmouth.edu

Co-Chair: Antonio Moreno-Garcia, Northwestern University, Kellogg School of Management, Evanston, IL, 60208, United States, a-morenogarcia@kellogg.northwestern.edu

1 - Impact Of Physical Retail Channel On Customers' Online Purchase Behavior

Anuj Kumar, University of Florida, akumar1@ufl.edu
Amit Mehra, Subodha Kumar

We use customer-level data of a large apparel retailer to estimate the treatment effect of store openings on the online purchase behavior of its existing customers. The retailer's store openings resulted in a 29 percent increase in annual online purchase revenue of the existing customers. The increase in online purchases of existing customers after store opening could be attributed to: (1) higher engagement with the retailer from their higher store interactions and (2) availability of a low cost option of returning their online purchases in store if it does not fit their needs. The effect of store opening was found to be higher for customers who experience higher reduction in their store distances.

2 - When The Bank Comes To You: Branch Network And Custsomer Multi-channel Banking Behavior

Vibhanshu Abhishek, Carnegie Mellon University, vibs@cmu.edu
Beibei Li, Dan Geng

Customers today increasingly interact with their banks using digital channels, lifting the necessity for banks to rethink the distribution of physical branches and customer behavior in a multi-channel environment. Using approximately 1.2M anonymized individual-level data from a large commercial bank in US over 6 years, our paper investigates the traditional channel - bank branches - and the impact of its network change (branch opening or closure) on customer multi-channel preferences and other banking behavior. Our results show that both branch opening and closure are associated with decreasing transactions through offline channels and increasing transactions in online banking.

3 - Inventory Management In An Omnichannel Environment

Yong-Pin Zhou, Professor, Foster School of Business, University of Washington, Seattle, Seattle, WA, 98195-3226, United States, yongpin@uw.edu, Elnaz Jalilipour Alishah

We consider a single newsvendor-type product that is sold both online and offline. We present two models where each channel is used as a backup for the other channel, and derive structural and qualitative results on effective inventory management policies. Specifically, we consider inventory positioning, inventory level, and real-time inventory rationing decisions. When it is possible to shift some customer demand using discounts, we also investigate the level of discount and customer reaction.

4 - The Omni-channel Fulfillment Dilemma

Santiago Gallino, Dartmouth College, Dartmouth, NH, United States, santiago.gallino@tuck.dartmouth.edu, Antonio Moreno-Garcia, Robert P. Rooderkerk

Using transaction level data from a multi-channel retailer we explore how customer interact with the retailer over time. We study the underlying patters of customer's interactions and discuss the implications for retailers that have both an online and a brick and mortar presence.

■ SA38

206A-MCC

Product Development and Competition

Invited: New Product Development

Invited Session

Chair: Morvarid Rahmani, Georgia Institute of Technology, Atlanta, Atlanta, GA, 30308, United States, morvarid.rahmani@scheller.gatech.edu

Co-Chair: Karthik Ramachandran, Georgia Institute of Technology, Atlanta, GA, 30308, United States, karthik.ramachandran@scheller.gatech.edu

1 - Knowledge Search In Mobile App Development

Nilam Kaushik, PhD Candidate, UCL School of Management, London, United Kingdom, uceikau@ucl.ac.uk, Bilal Gokpinar

The process of search, identification, and acquisition of new knowledge is essential for the success of new products. We explore how firms search for ideas in sequential product development through the highly competitive and dynamic setting of mobile application development. Using novel text-mining techniques, we derive measures of similarity between a focal app's update and updates made by competitor apps and study performance implications thereof. We also explore the performance implications of the distance of an app's update with respect to its past updates.

2 - Decision Options At Project Gate Reviews: Beyond The Go/ Kill Model

Alison Olechowski, Massachusetts Institute of Technology, Cambridge, MA, United States, alisono@mit.edu Steven D Eppinger, Nitin Joglekar

Most current academic models of project gate reviews represent the gate decision as a simple choice between go and kill. In reality, product developers often reach the gate with incomplete or unacceptable deliverables, and managers consider more than just the kill option if a go is not appropriate. We have created a simple model which adds options of: waiver, waiver with re-review, delay and switch to back-up plan. This decision tree model compares the value of this more realistic set of options based on costs, payoffs and confidences. We demonstrate the application of this model to complex product development gate decisions via multiple case examples from industry.

3 - Capacity Investment For Product Upgrades Under Competition

Ram Bala, Santa Clara University, ram.bala@gmail.com, Milind Sohoni, Sumit Kunnumkal

Firms often introduce a vertical line extension of an existing product to consolidate their market position after loss of monopoly status. However, introducing a line extension is fraught with uncertainty as it may fail to be technically feasible as originally intended. We analyze a two stage competitive game between an incumbent and an entrant where the firms make capacity investment decisions before uncertainty resolution and then set production quantities. We uncover conditions on innovation level which determine whether the incumbent will continue to offer the existing product once the new product succeeds. We also determine the innovation level beyond which competitive entry is deterred.

4 - Institutional Design And The Creative Process: An Experimental Study

Lakshminarayana Nittala, University of California San Diego, La Jolla, CA, 92037, United States, lnittala@ucsd.edu Sanjiv Erat, Viswanathan Krishnan

The process of Innovation often takes the form of problem solving and requires creative insights for achieving success. In an experimental setting we use tasks that are representative of such problems and study the role of institutional design on the creative output and the underlying search process.

■ SA39

207A-MCC

A/B Testing, Experiments, and Learning

Sponsored: Applied Probability

Sponsored Session

Chair: Ramesh Johari, Stanford University, Stanford, CA, United States, ramesh.johari@stanford.edu

Co-Chair: David Walsh, Stanford University, Department of Statistics, Stanford, CA, 94305, United States, dwalsh@stanford.edu

1 - Using Simulation To Improve Statistical Power In Switchback Experiments At Uber

Peter Frazier, Cornell University, Ithaca, NY, 14850, United States, pf98@cornell.edu

We consider A/B testing of systemic changes with time-varying effects, such as changes to the algorithm used to dispatch cars at Uber. Testing such changes is made difficult by correlations in outcomes across dispatches, and by seasonal and autocorrelated random variation in riders' demand for trips. One standard A/B testing method is a switchback experiment, which applies the treatment and control on alternating days over two weeks. We show how to combine simulation-based predictions of a change's effects with data from a switchback experiment to improve statistical power, and make analysis robust to missing data.

2 - A/B Testing In A Changing World

David Walsh, Stanford University, dwalsh@stanford.edu

The purpose of A/B testing is to let any technology company iterate on its products quickly and stay ahead of a rapidly changing market. Given this dynamic context, it is odd that the existing statistical approaches to A/B testing view the environment as static. The outcome: inferences that do not generalize beyond the life of the experiment, which then lead to actions that perform substantially worse than expected. I present new methodology that anticipates temporal variation, generating the right inferences to support dynamic product optimization.

3 - Simple Bayesian Algorithms For Identifying The Best Arm In A Multi-armed Bandit

Daniel Russo, Northwestern University, Evanston, IL, United States, Dan.Joseph.Russo@gmail.com

This talk considers the optimal adaptive allocation of measurement effort for identifying the best among a finite set of options or designs. An experimenter sequentially chooses designs to measure and observes noisy signals of their quality with the goal of confidently identifying the best design after a small number of measurements. I propose three simple Bayesian algorithms for adaptively allocating measurement effort. Each is shown to have strong performance in numerical experiments, and a unified analysis establishes each satisfies a strong asymptotic optimality property.

4 - Sequential A-B Testing With Constraints

Vivek Farias, Massachusetts Institute of Technology, Cambridge, MA, United States, vivekf@mit.edu, Ciamac Cyrus Moallemi

We consider the problem of sequential A-B testing when the impact of a treatment is marred by a large number of covariates. Our main contribution is a tractable algorithm for the online allocation of test subjects to either treatment with the goal of maximizing the efficiency of the estimates treatment effect under a linear model, which due to a surprising state space collapse, reduces to solving a low dimensional dynamic program. Our approach is robust and covers many variations of the problem, including cases where there are budget constraints on individual treatments, where the number of trials is to be endogenously decided, and where the objective is to balance a tradeoff between efficiency and bias.

■ SA40

207B-MCC

Applications in Efficiency Analysis

Invited: Data Envelopment Analysis

Invited Session

Chair: Kankana Mukherjee, Babson University, 231 Forest Street, Babson Park, MA, 02457, United States, kmukherjee@babson.edu

1 - Malmquist Productivity Analysis With The Stoned Method

Endre Bjørndal, Norwegian School of Economics, Endre.Bjorndal@nhh.no, Xiaomei Cheng, Mette Bjorndal

We construct a Malmquist productivity index based on the Stochastic Non-parametric Envelopment of Data (StoNED) method, and we discuss how the distributional assumptions in the second StoNED stage affect estimates of productivity change and its decompositions. Our results are also valid for similar methods, such as COLS and MOLS, where a best-practice frontier is obtained from an average-practice frontier. Data on Norwegian electricity distribution companies is used to illustrate our discussion.

2 - Determinants Of Energy Efficiency In Indian Manufacturing

Kankana Mukherjee, Babson University, kmukherjee@babson.edu

This paper takes a production perspective and utilizes Data Envelopment Analysis to examine the major determinants of the traditional index of energy efficiency in the Indian manufacturing industry. The roles of technical efficiency of production, capacity utilization, and the adoption of energy efficient technology in determining energy efficiency is specifically addressed.

3 - Implicit Estimation For Stochastic Frontier Model

Mohamed Nejib Ouertani, Sfax University, n_ouertani@yahoo.fr

In this paper, a novel approach has been proposed to estimate stochastic frontier models; namely the Implicit approach. As we reckon, to our limited knowledge this method steel has not been applied to the stochastic frontier approach. For this purpose, the Markov Chain Monte Carlo (MCMC) techniques are used and implemented for both approaches subject of our study. As matter of fact, our new approach has been illustrated by means of a data pertaining to a sample of Saudian insurers.

4 - Inward Internationalization And Performance: An Application Of The Bootstrapped Truncated Regression Model

Yi-Chun Liu, National Taiwan University, Taipei, Taiwan, d02724003@ntu.edu.tw, Yang Li, Homin Chen

This study is the first to study the influence of the breadth of inward internationalization (BII) on the performance of internationalization of international tourists (ITHs). We employ the bootstrapped truncated regression model and takes into account the property of quasi-fixed inputs to analyze how BII influences the operational performance of Taiwan's ITHs. The data set consists of 70 Taiwanese ITHs and 208 observations for the period 2011-2013. The empirical results show that the BII contributes positively to ITHs' efficiency, benefits independent ITHs greater than it does for chain ones, and moderates the relationship between core revenue and operational performance.

■ SA41

207C-MCC

Control and Optimization in Finance

Sponsored: Financial Services

Sponsored Session

Chair: James Primbs, Cal State Fullerton, Fullerton, CA, United States, jprimbs@fullerton.edu

1 - Order Book Dynamics And Price Sensitivity At Nasdaq: Part 1

James Primbs, California State University Fullerton, Fullerton, CA, 92831, United States, japrimbs@live.com
Scott Condie, Sean Warnick

The order book is a rich source of information detailing trading dynamics in equity markets. Recent concerns with algorithmic trading activities suggest that high frequency traders have unfair advantages compared with nominal traders. The first part of this talk will introduce the order book and explore the data set used in the analysis. Public concerns related to high frequency trading and Siren orders will also be discussed.

2 - Order Book Dynamics And Price Sensitivity At Nasdaq: Part 2

James Primbs, California State University Fullerton, 925 Berenice Dr, Brea, CA, 92821, United States, japrimbs@live.com
Scott Condie, Sean Warnick

The order book is a rich source of information detailing trading dynamics in equity markets. Recent concerns with algorithmic trading activities suggest that high frequency traders have unfair advantages compared with nominal traders. The second part of the talk will explore differences in market dynamics over different time scales and price sensitivity to the shape of the order book. Efforts to find evidence for the concerns detailed in Part I will be explained.

3 - On A New Class Of Pairs-trading Strategies

Atul Deshpande, University of Wisconsin, Madison, WI, United States, adeshpande4@wisc.edu, B. Ross Barmish

The starting point for this paper is a new class of pairs-trading strategies which have rather weak requirements on the underlying stocks. We allow the user to define a rather arbitrary spread function to relate the two stock prices under consideration. Moreover, when this function, in conjunction with the price processes, satisfies a certain mean-reversion condition, we deem the stocks to be a tradeable pair. For such a case, we prove that our trading strategy results in positive expected growth in the account value. For a limited number of backtests using popular spread functions from literature, we see robust growth while avoiding huge drawdowns.

4 - Robust Empirical Optimization Is Almost The Same As Mean-variance Optimization

Jun-ya Gotoh, Chuo University, jgoto@indsys.chuo-u.ac.jp

We consider a robust optimization problem. Our main finding is that a large class of robust empirical optimization problems are essentially equivalent to an in-sample mean-variance. With this insight, we suggest a robust version of cross-validation which can be beneficial to high-dimensional-small-data situation such as portfolio optimization.

■ SA42

207D-MCC

Quantitative Methods in Finance

Sponsored: Financial Services

Sponsored Session

Chair: Richard Sowers, University of Illinois, Champaign, Urbana, IL, 61801, United States, r-sowers@illinois.edu

1 - Measures Of Financial Network Complexity: A Topological Approach

Mark Flood, Office of Financial Research, Mark.Flood@ofr.treasury.gov

We present a general definition of complexity appropriate for financial counterparty networks, and derive several topologically based implementations. These range from simple and obvious metrics to others that are more mathematically subtle. It is important to tailor a complexity measure to the specific context in which it is used. This paper introduces measures of the complexity of search and netting in dealer markets. We define measures of line graph homology and collateral line graph homology that are sensitive to network interactions, such as collateral commingling and interdependent chains of obligations, that can be difficult or intractable to unwind.

■ SA43

208A-MCC

Military Applications of Decision Analysis

Sponsored: Decision Analysis

Sponsored Session

Chair: Gregory S Parnell, University of Arkansas, University of Arkansas, Fayetteville, AR, 72701, United States, gparnell@uark.edu

1 - Stakeholder Requirements For Engineered Resilient Systems Decision Support Tools

Christina Rinaudo, Operations Research Analyst, USACE Engineer Research and Development Center (ERDC), Vicksburg, MS, 39180, United States, christina.h.rinaudo@usace.army.mil,
Randy Buchanan

Engineered Resilient Systems (ERS) seeks to improve engineering and design development to generate adaptive, effective, and trusted systems in a physics model-based environment. The ERS program strives to incorporate decision analysis tools that enable customization of analytical tools. Through a collaborative workshop held with ERS stakeholders, researchers gained an understanding of multiple perspectives for decision analysis methods in a physics model-based environment. This presentation explores the stakeholder requirements identified by the workshop and proposes next steps to incorporate decision analysis into the ERS tradespace analytical tool suite.

2 - Tradespace Tools For Engineering Resilient Systems

Valerie B. Sitterle, Senior Research Engineer, Georgia Tech Research Institute, Atlanta, GA, United States, valerie.sitterle@gtri.gatech.edu, Santiago Balestrini-Robinson, Dane F. Freeman, James Arruda, Simon R. Goerger, Tommer R. Ender

Engineered Resilient Systems (ERS) is a U.S. Department of Defense (DoD) program focusing on effective, efficient development of complex engineered systems across their lifecycle and different future operational needs and mission contexts. This presentation will describe the ERS TRADESPACE toolset being collaboratively developed for the DoD Acquisitions community to support the end-to-end set of integrated processes necessary to specify stakeholder needs and create tradespaces for exploration in synergy with decision analysis methods. We will also discuss how traditional decision analysis may be a foundation from which to explore additional questions relevant to key decision makers.

3 - Decision Analysis In The Engineering Body Of Knowledge

Gregory S Parnell, University of Arkansas, gparnell@uark.edu

We review the definitions of decision analysis and list the decision analysis articles in the body of knowledge for the following professional societies: INFORMS, the Society for Decision Professionals, the Military Operations Research Society (MORS), The International Council on Systems Engineering (INCOSE), and the American Society for Engineering Management (ASEM).

4 - Evaluating Stakeholder Requirements To Assess Resiliency For Engineered Resilient Systems

Christina Rinaudo, USACE Engineer Research and Development Center (ERDC), Vicksburg, MS, United States, Christina.H.Rinaudo@usace.army.mil, Randy K Buchanan

Engineered Resilient Systems (ERS) research focuses on identifying methods and incorporating processes to enable model-based systems engineering analysis early in the acquisition life cycle. ERS research efforts include defining, quantifying, and developing a methodology to analyze system resiliency. Previous research described an aspect of resilience as robustness and proposed a workflow to quantify robustness using Multi-Attribute Utility Theory (MAUT). This presentation describes the application of the robustness workflow to evaluate design alternatives using the system requirements generated during the development of the Mine Resistant Ambush Protected (MRAP) vehicle.

■ SA44

208B-MCC

Applications of Decision Analysis to Natural Resource Management

Sponsored: Decision Analysis

Sponsored Session

Chair: Karen Jenni, US Geological Survey, DFC, MS 939, Denver, CO, 80225, United States, kjenni@usgs.gov

Co-Chair: Michael Runge, US Geological Survey, Patuxant Wildlife Research Center, Laural, MD, 20708, United States, mrunge@usgs.gov

1 - Optimal Design Of Protection Zones For Wildlife.

Julien Martin, US Geological Survey, julienmartin@usgs.gov

The establishment of protection areas to reduce mortality risk of wildlife is a common management action, yet implementation of these zones can be contentious. We apply optimization approaches to determine optimal configuration of protection zones that meet management objectives under various costs and constraints scenarios. One key management objective is to minimize risk of deadly collisions. We apply encounter rate theory to quantify the relative risk of lethal collisions between marine mammals and watercraft.

2 - Managing A Long-term Tidal Estuary Restoration: An Adaptive Framework For Decisions Under Uncertainty And Risk

David R Smith, Researcj Statistician, US Geological Survey, Leetown, WV, 25430, United States, drsmith@usgs.gov
Jill Gannon, Mitchell J Eaton

In collaboration with NPS, we developed a decision framework to help guide restoration of an ecologically degraded estuary, restricted from tidal influence for 100+ years. Decisions involve the timeframe under which restored tidal exchange will occur via modified water control structures, and implementation of secondary actions to address specific concerns. Decision complexity is magnified by multiple objectives, a long restoration horizon, high uncertainty about ecosystem response to hydrologic changes and low risk tolerance by numerous stakeholders. Although leaning is anticipated to occur rapidly, problem complexity limits the application of formal adaptive management principles.

3 - Models And Tools To Support Decision Making On Multiple, Future, As-yet Unclear Management Issues

Karen Jenni, US Geological Survey, kjenni@usgs.gov

The USGS is developing a set of approaches and tools for conducting multi-resource analyses. These tools are intended to support decision making on a variety of future issues related to landscape-scale resource management. The tools can be used to consider multiple natural resources and sources of change and to address the relationships among resources and the social and economic impacts of resource change over time. We will discuss some of the unique challenges in scoping, defining, and building such models, focusing on the benefits a decision analysis approach brings even to problems without a clearly defined issue or specifically identified decision-makers.

4 - Casting Endangered Species Recovery As A Budget Allocation Problem

Michael C Runge, USGS Patuxent Wildlife Research Center, Laurel, MD, 20708, United States, mrunge@usgs.gov, Leah R. Gerber, Jeff Newman, Lynn A. Maguire, Richard F. Maloney, Deborah T. Crouse

The U.S. Fish and Wildlife Service (FWS) is charged with managing recovery programs for species listed under the Endangered Species Act. At an agency level, this can be seen as the allocation of scarce resources to a portfolio of individual recovery efforts, taking into account the potential synergies among programs, as well as the opportunity to motivate additional funding from external partners. We are working with FWS to frame such decisions, using combinatorial optimization to explore solutions. Initial results suggest recovery outcomes could be improved with strategic budget allocation. Further, this framework provides a way to clearly articulate the benefits of increased funding.

■ SA45

209A-MCC

Financial Network Structure and Systemic Risk

Invited: Risk and Compliance

Invited Session

Chair: Rafael Mendoza, McCombs School of Business, University of Texas, Austin, TX, 78712, United States, rafael.mendoza-arriaga@mccombs.utexas.edu

Co-Chair: John R Birge, University of Chicago, 5807 S Woodlawn Ave, Chicago, IL, 60637, United States, John.Birge@ChicagoBooth.edu

1 - Financial Network Structure And Systemic Risk

John R Birge, University of Chicago, John.Birge@ChicagoBooth.edu

This talk will present a tutorial on financial network structure and systemic risk, the impact of the structure on the propagation of shocks and the potential for failure cascades. The tutorial will describe basic models and their implications and an examination of the inclusion of endogenous decisions on inter-relationships.

■ SA46

209B-MCC

Pricing and New Product Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Nur Sunar, UNC, Chapel Hill, NC, United States, nur_sunar@kenan-flagler.unc.edu

1 - Optimal Subscription Pricing For Free Delivery Services

Chinmoy Mohapatra, PhD Student, The University of Texas at Austin, McCombs School of Business, Austin, TX, 78712, United States, chinmoym@utexas.edu, Anant Balakrishnan, Shankar Sundaresan

We study the subscription pricing problem of a retailer that offers its consumers two delivery choices: a pay-per-delivery option and a subscription option with free delivery. The retailer balances the “loss” incurred in covering the shipping costs of subscribers against the increase in revenue from the “lift” in their purchase quantity. We develop a model based on a novel utility-based framework that captures consumer heterogeneity, both in terms of their utility and preference across different firms, characterize the retailer’s optimal subscription pricing policy, and develop interesting insights.

2 - Optimal Dynamic Product Development And Launch For A Network Of Customers

Nur Sunar, UNC, nur_sunar@kenan-flagler.unc.edu
John Birge, Sinit Vitavasiri

We consider a firm that dynamically chooses its effort to develop a product for a network of customers represented by a general connected graph. In addition to dynamically choosing its development effort, the firm chooses when to launch or abandon the product. If the firm launches the product, the firm also chooses a selling price, a promotional price and a target customer to offer promotion. Once the target customer adopts the product, the product dynamically diffuses over the customer network based on the topology of the graph and the selling price. In a continuous-time setting, we explicitly solve the firm's jointly-optimal development, launch and post-launch strategies for any connected network.

3 - Quantity Pre-commitment And Cournot Equivalence

Amr Farahat, Washington University-St. Louis, Campus Box 1133, 1 Brookings Drive, St. Louis, MO, 63130, United States, farahat@wustl.edu, Woonghee Tim Huh, Hongmin Li

We study a two-stage oligopolistic competition game, called the Quantity Pre-Commitment game, in which firms compete on quantity in the first stage and then compete on price in the second stage. This game is compared to a single-stage Cournot game, in which firms compete on the quantity only and the prices are set to clear the market. We show an equivalence result that an equilibrium of the Quantity Pre-Commitment game coincides with an equilibrium of the Cournot game, under certain conditions. The conditions that we identify are more general than those of specific models used in the seminal papers in the literature.

4 - A Stochastic Model For Pricing In Reverse Supply Chains

Elif Akcali, University of Florida, Dept of Industrial and Systems Engineering, 303 Weil Hall PO Box 116595, Gainesville, FL, 32611-6595, United States, akcali@ise.ufl.edu, Sila Cetinkaya, Yi Zhang

We address channel coordination issues in a two-echelon reverse supply chain that consists of a collector and a manufacturer. We develop stochastic models to maximize the manufacturer's and collector's profits in a game-theoretic framework. We develop an effective mechanism to coordinate manufacturer's and collector's decisions.

■ SA47

209C-MCC

Topics in Assortment Planning and Consumer Choice

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Kris Johnson Ferreira, Harvard Business School, Boston, MA, United States, kferreira@hbs.edu

1 - A Data-driven Approach To Customer Segmentation

Ashwin Venkataraman, New York University, 719 Broadway, 7th Floor, New York, NY, 10003, United States, ashwin@cs.nyu.edu
Srikanth Jagabathula, Lakshminarayanan Subramanian

We propose a new "model-based" projection technique for segmenting customers based on partial observations for each customer. We suppose that data are available in the form of categorial responses for on a collection of n variables for each customer. This unified representation allows one to combine diverse signals (clicks, demographics, purchases, etc.) to obtain accurate segmentation. Our method relies on a combination of model-based projections and matrix completion techniques to obtain the clusters. We theoretically and empirically show how our method is superior to existing benchmarks.

2 - Analysis Of Choice Models: A Welfare-based Framework

Xiaobo Li, University of Minnesota, Minneapolis, MN, 55414, United States, lixx3195@umn.edu, Guiyun Feng, Zizhuo Wang

We propose a framework for discrete choice models through a welfare function. The framework provides a new way of constructing choice models. It also provides great analysis convenience for establishing connections among existing choice models. We define a new property in choice models: substitutability/complementarity and study conditions for a choice model to be substitutable. We show that our framework is flexible in this property, which is desirable in capturing practical choice patterns.

3 - A Dynamic Clustering Approach To Data-driven Assortment Personalization

Fernando Bernstein, Duke University, fernando@duke.edu
Sajad Modaresi, Denis R. Saure

A retailer faces heterogeneous customers with initially unknown preferences. The retailer can personalize assortment offerings based on available profile information; however, users with different profiles may have similar preferences, suggesting that the retailer can benefit from pooling information among customers with similar preferences. We propose a dynamic clustering approach that adaptively adjusts customer segments and personalizes the assortment offerings to maximize cumulative profit.

4 - Assortment Rotation And The Value Of Concealment

Kris Johnson Ferreira, Harvard Business School, kferreira@hbs.edu, Joel Goh

The frequency at which retailers change their assortment varies widely across fashion retailers. Some retailers choose to sell products simultaneously throughout the season, whereas others choose to sell products sequentially, requiring that the consumer make a purchase decision before seeing the subsequent products for sale. By offering products sequentially, retailers can introduce uncertainty in consumer choice that affects purchase decisions. We develop a consumer choice model and finite-horizon stochastic dynamic program to study when this uncertainty is advantageous for a retailer: a phenomenon we refer to as the retailer's value of concealment.

■ SA48

210-MCC

Social Media Analysis I

Invited: Social Media Analytics

Invited Session

Chair: Chris Smith, Air Force Institute of Technology, 2950 Hobson Way, 2950 Hobson Way, Wright-Patterson AFB, OH, 45433, United States, cms3am@virginia.edu

1 - User Reward Programs In Online Social Media

Fouad H Mirzaei, Santa Clara University, Unit 3, 559 Alviso St, Santa Clara, CA, 95050, United States, fhm.phd@ivey.ca, Fredrik Odegaard, Xinghao Yan

Online social media (OSMs) have become a popular and growing Internet phenomenon, as exemplified by the millions of followers of websites like YouTube, Twitter, and Facebook. Given the Internet's ease of access and the high degree of competition to attract users to these sites, a question arises as to whether OSMs should develop revenue-sharing programs as a way to reward their contributing users. We present an ex ante asymmetric duopoly OSM game, where heterogeneous users are either active or passive with respect to each OSM. In this study, we explore how online users' actions and perspectives impact the outcome of the competition among OSMs.

2 - Research On The Influence Of Microblog Advertising Of Theatre Chain On Its First Week Box Office Revenue

Jiayin Qi, Shanghai University of International Business and Economics, Shanghai, 100876, China, qijiayin@139.com, Jiaqi Liu

With the participation of enterprise in social network, a question arises of how enterprise can gain more real profit from social network advertising. This article analyzes the relationships among contents of enterprise's online post, consumer's participation on microblog, and short-term product sales. Taking movie market as research set, this research finds that short-term product sales is positively influenced by the information quantity of enterprise's post, and the influence is mediated by the "repost" of other users of Sina microblog. The mechanism examined in this research on the influence of microblog advertising on short-term sales can be guidelines of social network advertising.

3 - Social Media Use And New Product Development Performance

Debasish N Mallick, Associate Professor, University of St. Thomas, Opus College of Business, 1000 La Salle Avenue # TMH 443, Minneapolis, MN, 55403, United States, dnmallick@stthomas.edu

Use of social media is becoming increasingly popular in new product development (NPD). Yet, the performance impact of social media use in NPD remains inconclusive. Using a cross industry survey of new product development projects, we explore the factors affecting the relationship between social media use and NPD performance.

■ SA49

211-MCC

Case Competition I

Sponsored: Education (INFORMED)

Sponsored Session

Chair: Palaniappa Krishnan, University of Delaware, Newark, DE, United States, baba@udel.edu

1 - Wine Of Kings, King Of Wines

David Kopcso, Babson College, Wellesley, MA, United States, kopcso@babson.edu

It is a cool October morning and Borbála Bodnar is faced with a dilemma. The harvest at her northeast Hungary vineyard is finishing. Her hopes for a harvest of botrytis-affected, aszu (dried) grapes is waning. The seasonally rainy days are approaching. Bodnar must decide if she should harvest the grapes immediately for a modest profit or wait with the hope of a Botrytis infection. A heavy downpour would swell the already ripe grapes with water producing an inferior wine with little profit while a shower or even just a high humidity day followed a day later by a drop in humidity would be ideal for the development of the Botrytis cinerea fungus needed to produce the very profitable, complex, sweet Tokaji wine.

2 - Risks and Rewards in Professional Tennis

Fredrik Odegaard, Western University, London, ON, Canada. fodegaard@ivey.uwo.ca

The case centers on the professional tennis tour ATP, and the world-famous and prestigious Grand Slam tournament Wimbledon.Depending on the instructor's use of the case, the case is suitable in both an introductory and as well as intermediate/advanced management science/analytics course. Although the main target audience is under-graduate business and engineering students, the case is also suitable for Masters students (including MBA). The case has been used both as a casebased final exam and as material for in-class case discussion.

3 - Optimizing Promotions For Supermarkets Using Data Analytics

Maxime Cohen, New York University, Stern School of Business, New York, NY, United States, maxcohen@nyu.edu, Georgia Perakis

In this case, we expose the students to the issues faced by a supermarket manager seeking to optimize price promotions for a category of products. The students will learn: how to handle data, demand modeling and forecasting, business rules and mathematical modeling, optimization formulation, solving linear programs, and how to measure the practical impact of the approach. The case includes data sets so that the students can experience handling data. The approach encompasses the entire process behind promotion planning, from data collection to optimizing promotion decisions.

4 - Ingenuity Technology-From Chaos To Structured Data

William Schmidt, Cornell University, Ithaca, NY, United States, wschmidt@cornell.edu

This case will familiarize students with the process of merging together and analyzing data from multiple files. Students will (1) conduct a data integration effort similar to what they may encounter it in a practical setting and (2) perform an analysis on the combined data set. The case is designed such that the tasks can be conducted using a variety of platforms. The setting is a recently founded technology firm that has experienced rapid growth in its first 2 years of operations. The protagonist must decide whether a new sales process has improved the performance of the sales organization.

■ SA50

212-MCC

Gender and Diversity-based Research

Sponsored: Women in OR, MS

Sponsored Session

Chair: Sarah G Nurre, University of Arkansas, 4207 Bell Engineering, Fayetteville, AR, 72701, United States, snurre@uark.edu

1 - Evaluations At Every Corner A Discussion Of Bias In The Evaluation Process

Tristan Botelho, MIT Sloan School of Management, Cambridge, MA, United States, tbotelho@mit.edu

Evaluations were traditionally handled by experts (e.g., critics, experts, judges), however, over the past 10-15 years, platforms have emerged to facilitate the evaluation process in nearly every domain. Now, any individual or firm has an outlet that they can use to evaluate a candidate, good, or service with a click of a button. Further, the prevalence of these evaluation processes has led to organizations utilizing similar rating systems to evaluate workers, ideas, and strategy. In this talk I review some work on how biases can enter into different stages of the evaluation process affecting evaluation outcomes. I will specifically focus on issues related to social influence, gender, and expertise.

2 - It's A Man's Job: Income And The Gender Gap In Industrial Research

Myriam Mariani, University, 1, Bocconi, Italy, myriam.mariani@unibocconi.it

This study examines differences in income and job performance between women and men in creative jobs tasked with achieving technological inventions. By building on data pertaining to 9,692 inventors from 23 countries, this study shows that female inventors represent only 4.2% of total inventors, and they earn 14% less than their male peers. The gap persists after controlling for sources of heterogeneity, the selection of inventors into types of jobs and tasks, and potential parenthood, instrumented by exploiting religious practices. The income gap is not associated with differences in the quality of the inventions.

3 - An Agenda For Diversity And Inclusion-related Research within OR/MS/Analytics

Michael P Johnson, University of Massachusetts Boston, 100 Morrissey Blvd, M-3-428A, Department of Public Policy and Public Affairs, Boston, MA, 02124, United States, michael.johnson@umb.edu

Diversity and inclusion have been widely studied and debated, most often within the social sciences. What contributions can operations research, management science and analytics make to this domain of inquiry? This talk will critically examine assumptions and practices within the decision sciences that may support as well impede diversity- and inclusion-related research, and propose a research agenda that can challenge yet enrich our profession.

4 - Bridging The Gap: Optimal Responses To Equal Pay Legislation

Margret Bjarnadottir, University of Maryland, R H Smith School, College Park, MD, 20, United States, margret@rhsmith.umd.edu, David Anderson

We study how firms can reduce any measured demographic based pay-gap (such as the gender pay gap), in the most cost efficient way possible. We show that by prioritizing wage increases and targeting workers that will have the greatest impact, a manager can meet the Equal Pay for Equal Work standard for less than half the cost of the naive methods. We further formulate a trade-off optimization model that balances the need to close a pay gap with employee fairness, given a fixed budget during the annual review cycle.

■ SA51

213-MCC

Applied Humanitarian Operations Management

Sponsored: Public Sector OR

Sponsored Session

Chair: Alfonso J Pedraza-Martinez, Indiana University, 1309 E. 10th Street, Room HH 4100, Bloomington, IN, 47405, United States, alpedraz@indiana.edu

1 - Dynamic Allocation Of NGO Funds Among Program, Fundraising, And Administration

Telesilla Kotsi, Indiana university, Bloomington, IN, United States, tkotsi@umail.iu.edu, Goker Aydin, Alfonso Pedraza Martinez

NGOs report three types of spending: program spending to deliver services directly to beneficiaries; fundraising spending; and administrative spending. Watchdog organizations give higher ratings to NGOs that allocate more of their budget to the program. However, fundraising and administrative spending are also necessary. Fundraising helps to increase the NGO's future budget, while administrative spending helps to make future program spending more impactful. We model this trade-off in a dynamic program. One of our results is that NGOs with tight budgets should prioritize fundraising and administration now, so that they are in a better position to make impactful program spending in the future.

2 - Supporting Hurricane Inventory Management Decisions With Consumer Demand Estimates

Douglas Morrice, University of Texas Ausitn, Douglas.Morrice@mccombs.utexas.edu, Paul Cronin, Fehmi Tanrisever, John Butler

We consider inventory allocation issues faced by a retailer during a hurricane event and provide insights that can be applied to humanitarian operations during slow-onset events. We start with an empirical analysis using regression that triangulates three sources of information: a large point-of-sales data set from a Texas Gulf Coast retailer, the retailer's operational and logistical constraints, and hurricane forecast data from the National Hurricane Center (NHC). Using the results of the empirical analysis and the NHC forecast data, we construct a demand model and develop an inventory management model to satisfy consumer demand prior to a hurricane making landfall.

3 - Information Dissemination Through Social Media In Humanitarian Operations

Eunae Yoo, Arizona State University, Tempe, AZ, United States, eunae.yoo@asu.edu, Elliot Rabinovich, Bin Gu, William Rand, Mahyar Eftekhar

For humanitarian operations, the distribution of information is critical to support the effective and efficient delivery of goods and services. Since social media facilitates real-time information sharing, humanitarian organizations have started leveraging these platforms to communicate with their stakeholders. Our research examines information diffusion patterns on social media during disasters, taking into account the underlying social network among users. From our results, we identify how humanitarian organizations can improve information propagation on social media in emergencies.

4 - Disaster Cycle Management: Matching Supply And Demand Of Social Support Through Social Media.

Alfonso Pedraza-Martinez, Indiana University, alpedraz@indiana.edu, Lucy Yan

We study information management during the disaster cycle. This research investigates the match of social support supply provided by organizations and social support demand from social media users during the stages of preparedness, response and early recovery. Using the case of Hurricane Sandy, 2012 we find a mismatch between supply and demand for social support and provide discussions on alleviating the mismatch. Moreover, we study how actionable operations management content posted by organizations affects their interaction with users through social media.

■ SA52

214-MCC

Prevailing Issues in Public Sector OR

Sponsored: Public Sector OR

Sponsored Session

Chair: Ebru Bish, Virginia Tech, Dept of Industrial and Systems Engineering, Blacksburg, VA, 24061, United States, ebru@vt.edu

1 - The Probabilistic Independence Of Mass Killings In The United States

Douglas M King, Lecturer, University of Illinois at Urbana-Champaign, 117 Transportation Building, 104 S Mathews Avenue, Urbana, IL, 61801, United States, dmking@illinois.edu, Sheldon Jacobson

As mass killings are increasingly visible in media coverage, understanding patterns in their occurrence becomes increasingly important. This talk finds that the 300 mass killings taking place in the United States from 2006 to 2016, as documented by USA Today, have a temporal distribution indistinguishable from a homogeneous Poisson process. This result suggests that these events are independent in that the occurrence of one mass killing does not indicate whether another is imminent.

2 - Adaptive Array-based Screening For Heterogeneous Populations

Hrayer Aprahamian, Virginia Tech, 250 Durham, Blacksburg, VA, 24061, United States, ahrayer@vt.edu, Ebru Korular Bish, Douglas R Bish

Group (pooled) testing has seen many applications, especially in the context of public health, blood screening, and genetics. We consider a special form of group testing called “array-based testing,” which takes advantage of overlapping pools. We model an adaptive and informative testing scheme that considers important test and population characteristics, including imperfect tests, dilution effect, and heterogeneity in the population, and determine the structure of the optimal testing design and optimal assignment of the heterogeneous subjects to the pools. Our case study indicates that the proposed optimization-based model leads to a substantial improvement over current practices.

3 - Prevalence Estimation Through Pooled Testing

Ngoc Nguyen, Virginia Tech, ntn@vt.edu, Ebru Korular Bish, Douglas R Bish

Surveillance studies often rely on pooled testing in order to estimate the unknown prevalence rate of an infection or a genetic disorder. Utilizing larger pools reduces testing costs, but also leads to a loss of accuracy due to dilution effects. We develop a mathematical model that considers this trade-off and determines the optimal pool size as well as the optimal number of pools under resource constraints. Our case study shows that this optimization-based approach improves upon the accuracy of the prevalence rate estimate over current approaches.

4 - Production And Distribution Capacity Planning For Mitigating Urban Delivery Risk Of E-commerce

Mu Du, Dalian University of Technology, 509 School of Management, No.2 Linggong Road, Dalian, 116023, China, dumu.dlut@gmail.com, Nan Kong

The integrated production and distribution capacity planning is vital to the supply chains of perishable commodity B2C e-commerce, which are keen on reducing production makespan and delivery lateness. However, significant challenge lies in the uncertain delivery workload caused by traffic control and adverse weather (e.g., smog) in Chinese urban areas. We formulate a two-stage stochastic programming model and propose a stochastic branch and bound algorithm. We report the impact of traffic control and adverse weather on the capacity planning decisions, confounded by other factors.

■ SA53

Music Row 1- Omni

Topics in Revenue Generation from Innovation

Sponsored: Technology, Innovation Management & Entrepreneurship

Sponsored Session

Chair: Pascale Crama, Singapore Management University, 50 Stamford Road, Singapore, 178899, Singapore, pcrama@smu.edu.sg

1 - Retaining Capable New Employees: Role Of Strategic Interaction And The Learning Rate

Onesun Steve Yoo, University College London, London, United Kingdom, onesun.yoo@ucl.ac.uk, Dharma Kwon

We study a two-sided game involving a firm and a newly hired employee whose capability is not initially known to either party. As the employee performs, both players learn and are presented with an option: the firm can terminate an incapable employee, and a capable employee can leave the firm for greater financial remuneration elsewhere. We examine the Markov perfect equilibrium (MPE) termination strategies and payoffs that unfold. We report a counterintuitive result: slower learning can increase the equilibrium payoff for both parties. Our result identifies a nonfinancial way for firms to improve retention of highly capable employees and create a win-win situation for both parties.

2 - The Impact Of Valuation Heterogeneity And Network Structure On Equilibrium Prices In Supply Networks

Alper Nakkas, Nova School of Business and Economics, Campus de Campolide, VAT - 506030636, Lisbon, 1099-032, Portugal, alper.nakkas@novasbe.pt, Yi Xu

We study how valuation heterogeneity and network structure on equilibrium prices in supply networks by identifying the main factors that influence the equilibrium prices, trading pattern and surplus allocation in such networks. We also show what types of links can be added into a supply network to improve its competitiveness and/or efficiency.

3 - Signaling Product Quality Through A Trial Period

Gulru Ozkan-Seely, University of Washington – Bothell, Bothell, WA, 98033, United States, gulru@uw.edu, Shouqiang Wang

We evaluate a firm’s pricing and timing strategies when launching via a time-locked trial period a new product that has privately observable product quality. While the trial period allows consumers to learn about the product quality (a phenomenon we term a learning effect), a longer trial period increases the heterogeneity of consumers’ willingness-to-pay for the firm (a phenomenon we term a dispersion effect). The dispersion effect exacerbates the firm’s pricing difficulty and generates an informational cost, warranting a longer trial period as a credible signal of the firm’s superior product quality. In a key finding, we show that a firm can use the price and the trial length as dual signals.

4 - An Experimental Study Of Idea Evaluation Process

Zhijian Cui, IE Business School, Zhijian.cui@ie.edu

With an online experiment, this study compares the efficacy of two idea evaluation processes commonly observed in practice: ranking and scoring. We find that the scoring process has a higher evaluation accuracy than the ranking process. In addition, providing more information and domain-specific expertise could improve the evaluation accuracy of scoring process, but not the ranking process.

■ SA54

Music Row 2- Omni

Smart Service Systems and Modeling

Sponsored: Service Science

Sponsored Session

Chair: Robin Qiu, Penn State University, 30 E. Swedesford Road, Malvern, PA, 19355, United States, robinqiu@psu.edu

1 - Analytics Framework For Higher Education

Roger Gung, University of Phoenix, Phoenix, AZ, United States, roger.gung@phoenix.edu

We present an end-to-end anlytics framework for adult learning/higher education industry that covers solution methods with using big data analytics for the management of marketing, enrollment service, learning platform, academic performance and institutional finance.

2 - Big Data And FinTech Programs at Asia University

Grace Lin, Institute for Information Industry, 1F, No. 133, Sec. 4, Minsheng E. Rd., Taipei, Taiwan, gracelin.ny@gmail.com

Asia University in WuFeng, Tahchung, Taiwan recently established a Big Data Research Center and a FinTech and Blockchain Research Center. We will present an overview of our research projects including precision medicine, IOT-enabled healthcare, and FinTech Innovation. ORMS opportunities related to these projects will also be discussed.

3 - Integrating Physical And Social Sensing To Enable Smart Services

Robin Qiu, Penn State, robinqiu@psu.edu, Youakim Badr, Lawrence Qiu

The Internet of Things (IoT) allows objects to be sensed and managed over the networks, which creates opportunities for more direct integration between the physical world and computer-based systems. People-centric sensing or social sensing transforms how we sense the world. Today, social sensing (e.g., mobile apps) complements physical sensing (e.g., IoT) by substantially extending the horizon we know about the world in real time. This talk mainly discusses how we can integrate physical and social sensing to enable better and smarter services. An example will be provided.

■ SA55

Music Row 3- Omni

Service Science: Operationalize Data Analytics for Better Service

Sponsored: Service Science

Sponsored Session

Chair: Jie Zhang, The University of Vermont, The University of Vermont, Burlington, VT, 05405, United States, jz@bu.edu

1 - Hotel Performance Impact Of Socially Engaging With Consumers

Saram Han, Cornell University, Ithaca, NY, United States, sh2322@cornell.edu, Chris K Anderson

This study examines three aspects of the online interaction based on customer reviews using TripAdvisor data. First, the study found that simply encouraging reviews was associated with an increase in a hotel's ratings. Second, the fact that management responds to reviews leads to improved sales and revenue. Finally, the study found that revenue improvements based on review responses are limited in two ways. First, revenue levels increase as the number responses increases, but only to a point. Second, consumers seem to be most appreciative of responses to negative reviews, rather than positive reviews.

2 - The Impact Of Marketing Expenditures On Outlet Performance In Franchised Channels

Ben Lawrence, Cornell University, benlawrence@cornell.edu

This study contributes to a greater understanding of marketing expenditures in the context of franchising by empirically examining the effects of different types of advertising expenditures including loyalty programs, local sales force, and e-commerce on unit level profitability. Examining the profit and loss statements of over 4,500 franchised hotel properties in the U.S between 2007 to 2013 we find a direct positive effect of advertising on unit level performance. We also find differential effects of advertising for units with varying levels of dependence on the franchisor.

3 - Introduction To Wellness-inspired Service Operations Strategies

Min Lee, Clemson University, minl@g.clemson.edu
Aleda Roth, Rohit Verma

The design and the specific features of buildings can have a meaningful impact on building occupants health, productivity, and mental state as well. This research focuses on the unstudied area of human sustainability in terms of their health and wellness. This research presents a conceptual framework and research agenda that explores wellness-inspired service operations strategies.

4 - Exploring The Synergy Between Online Reviews And Structured Surveys

Jie Zhang, University of Victoria, jz@bu.edu

Service organizations have relied on guest surveys to assess satisfaction and identify opportunities for operational improvement. Increasingly, online reviews presents opportunities to collect real-time feedback. In this study, we describe a study that explores how to use the insights from online reviews to adapt survey questions for more focused performance evaluation.

■ SA56

Music Row 4- Omni

Analytics in Social Media and Sharing Economy

Sponsored: EBusiness

Sponsored Session

Chair: Young Jin Lee, Assistant Professor, University of Denver, 2101 S. University Blvd., Denver, CO, 80208, United States, YoungJin.Lee@du.edu

1 - Visualizing The Dynamics Of Multivariate Time-series Data From Social Media During Emergency Management And Disaster Response

Dave Yates, Assistant Professor, University of Denver, Denver, CO, 80208, United States, dave.yates@du.edu, Joe Ryan

This project develops visualization approaches for dynamic multivariate time-series data shared via social media during emergency and disaster response, a focus area in which decision making is of paramount importance. The data is similar to that shared on social media such as blogs or social networks for entertainment, personal connections, and many other purposes. In this research we discuss the nature of social media data and the particular challenges of visualizing it in ways that make sense for decision makers. Synergizing social theory with visualization techniques we present best practices, lessons learned, and a research agenda.

2 - Using Social Capital Theory In Social Network Sites To Improve Innovative Performance

Valerie Bartelt, Texas A&M University - Kingsville, TX, vbartelt@gmail.com, Murad Moqbel

Innovative performance has become increasingly essential for business success. This research compares how social capital through social network site (SNS) affects innovative performance. Survey research from 276 professionals found that work SNS use significantly increased innovative performance while social SNS use significantly decreased innovative performance. Structural capital significantly moderated the relational capital on innovative performance. These findings open new avenues for further research by identifying the type of SNS use that will cultivate innovation in businesses.

3 - Are Multi-listing Hosts Better Off? How Host Attributes Affect The Performance Of Airbnb Listings

Karen Xie, University of Denver, Karen.Xie@du.edu

This study investigates the relationship between Airbnb hosts' attributes, in terms of both the quality of host services and the quantity of host listings. Our unique sample included 5,805 active listings of 4,608 hosts in Austin, of which 12.26% or 565 hosts had more than one listing. We found that the host may make a tradeoff between quantity and quality as he/she manages more listings. Such research into Airbnb hosts will unveil important business and policy strategies for Airbnb to improve and grow its business more strategically.

4 - User Engagement In Social Media: Evidence From A Field Experiment

Jane Tan, University of Washington, xuetan@uw.edu
Yingda Lu, Yong Tan

User engagement in charitable campaigns over social media environment is critical for raising awareness, which is key to the success of fundraising. In this study, we analyze the impacts of different solicitation approaches. Specifically, we evaluate the effect of adding compassionate followers to prospective users and the effect of adding prospective users into a charitable list. Using a randomized field experiment at Twitter, we find that adding compassionate followers positively affect users' propensity of engagement, while adding them to a charitable list has negative effect.

■ SA57

Music Row 5- Omni

Topics in Behavioral Operations Management

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Ruth Beer, Indiana University, Kelley School of Business, Bloomington, IN, United States, ruthbeer@indiana.edu

1 - An Experimental Investigation Of Managing Quality Through Monetary And Relational Incentives

Andrew M. Davis, Cornell University, adavis@cornell.edu, Kyle Hyndman

We investigate indirect and direct incentives for managing the quality of a product in a two-tier supply chain. In our study, a retailer pays a supplier for a product, where the supplier can choose to exert high effort, which is costly but guarantees high quality, or low effort, which does not assure high quality. We consider scenarios where the retailer pays the supplier a fixed fee, or a combination of a fixed fee and conditional bonus, which is only paid to the supplier when high quality is received. We evaluate these scenarios in both one-shot and repeated environments and find that different incentives can significantly influence the quality of a product.

2 - The Supplier's Dilemma: Buyback Contracts In A Competitive Setting

Anna Devlin, University of Alabama in Huntsville, agd0008@uah.edu

This research studies the performance of buyback (BB) and wholesale price (WP) contracts when a single newsvendor retailer purchases products from two suppliers competing for retailer effort. We determine that a profit-maximizing retailer's effort allocation differs by contract pair offered by the suppliers, impacting supplier profits and equilibrium decisions. If demand uncertainty is low the difference in retailer effort across contract pairs minimally impacts profits and both suppliers offer BB contracts in equilibrium. However if demand uncertainty is high this effort allocation disparity creates a "prisoner's dilemma" for the suppliers and both will offer WP contracts in equilibrium.

3 - Stagnant Leader Or Fast Improver? The Impact Of Transparency On Consumers' Purchase Behavior

Yanchong Zheng, Massachusetts Institute of Technology, yanchong@mit.edu
Ryan Buell, Shwetha Mariadassou

We study how consumers' purchase behavior may be influenced by a company's information transparency in its sustainability performance. We consider interaction between transparency and two types of information: current performance level and changes in performance. Our results yield important insights about a company's transparency strategy in the marketplace.

4 - How Negotiatons Improve Performance In The Buyback Contract

Elena Katok, University of Texas at Dallas, 800 W. Campbell Rd., Jindal School of Management (SM30), Richardson, TX, 75080, United States, ekatok@utdallas.edu, Michael Becker-Peth, Ulrich Thonemann

We conduct a lab experiment to analyze how negotiations affect performance of a buyback contract. We show that adding a negotiation phase in a human-human setting improves performance significantly if negotiation agreements are reached. These Agreements result in almost full SC efficiency (0.97) and the profit split is fairly equal (0.54 to 0.46). We analyze the underlying drivers of successful negotiations which are both, personal and procedural.

■ SA58

Music Row 6- Omni

Energy I

Contributed Session

Chair: Arnab Roy, PhD Student, University of Louisville, 2719 South 4th Street, Apt. #2, Louisville, KY, 40208, United States, arnab.roy@louisville.edu

1 - Modeling The North American NGL Market In A Low Oil And Gas Price Environment

Robert Brooks, Founder, RBAC Inc, 14930 Ventura Boulevard, Suite 210, Sherman Oaks, CA, 91403, United States, rebrooks@rbac.com

The last decade's "shale gas revolution" recreated the US natural gas and oil industry. It also revitalized the natural gas liquids business and promised to do the same for petrochemicals. But runaway production combined with slowed demand growth has resulted in a collapse of prices for all of these commodities world-wide. How can one make rational predictions about the future of the North American NGL market under these conditions? NGL-NA is a model of the North American market for natural gas liquids. The presentation will describe the model and results from recently run scenarios.

2 - Fuel Procurement Strategy With Inventory Consideration For Electric Power Utilities

Chung-Hsiao Wang, LG&E and KU, 102 Spruce Lane, Louisville, KY, 40207-1701, United States, chunghsiao@hotmail.com, K Jo Min

In recent years, natural gas combined cycle power plants have started to replace aging and less efficient coal power plants. Furthermore, due to cheap natural gas prices, economic dispatching has resulted in high coal inventory levels. Under these circumstances, in this paper, we develop mathematical models for structured and analytical guidelines on fuel procurement strategies for a utility owning both natural gas and coal generation units.

3 - Modeling And Analysis Of Remote, Off-grid Microgrids

Sreenath Chalil Madathil, Doctoral Candidate, Clemson University, 110 Freeman Hall, Clemson, SC, 29634, United States, schalil@g.clemson.edu, Emre Yamangil, Harsha Nagarajan, Arthur K Barnes, Russell Bent, Scott Backhaus, Scott J. Mason, Salman Mashayekh, Michael Stadler

We develop a mixed-integer, quadratically-constrained quadratic program for minimizing total installation and operation costs of remote off-grid microgrids with renewable and non-renewable energy sources under N-1 contingencies and one day time horizon. We compare various relaxations for this NP-Hard problem and present efficient decomposition algorithms for our problem. We model the nonlinear efficiency curves associated with these devices using a piecewise linear approximations and demonstrate the efficiency of proposed relaxation and decomposition methods using benchmark test problems.

4 - An Empirical Study On A Demand Response Program With Battery Storage Systems

Arnab Roy, PhD Student, University of Louisville, 2719 South 4th Street, Apt. #2, Louisville, KY, 40208, United States, arnab.roy@louisville.edu, Prajwal Khadgi, Lihui Bai

Demand response (DR) in smart grid aims to reduce peak load, thus the needs for ancillary services in generation. On the other hand, any DR programs must be implemented with incentives to ensure consumers' active engagement. In this paper, we investigate the effects of the DR implementation measures by one utility company on the load consumption of approximately 300 homes. The DR measures include the introduction of an innovative residential rate structure, direct load control, installation of efficient heat pump water heaters, and reliable utility-grade power storage systems.

■ SA59

Cumberland 1- Omni

Electrification in Transportation

Sponsored: Transportation Science & Logistics

Sponsored Session

Chair: Mohammad Esmaeil Khodayar, Southern Methodist University, 6425 Boaz Lane, Dallas, TX, 75205, United States, mkhodayar@smu.edu

1 - Network Design For In-motion Wireless Charging Of Electric Vehicles In Urban Areas

Mamdouh Mubarak, Southern Methodist University, mmubarak@smu.edu, Halit Uster, Khaled Abdelghany, Mohammad Esmaeil Khodayar

We present a model to optimize the location and power capacity of in-motion electric charging stations. We formulate the problem as a MIP and we propose a Benders-decomposition-based algorithm to solve it efficiently. We present the computational results of testing the algorithm on large-scale grid networks.

2 - Deployment Of Stationary And Dynamic Charging Infrastructure For Electric Vehicles Along Traffic Corridors

Zhibin Chen, University of Florida, Gainesville, FL, United States, zhibinchen@ufl.edu, Yafeng Yin, Wei Liu

This paper optimizes a deployment plan of dynamic and stationary charging facilities along a traffic corridor to serve the charging need of electric vehicles with the minimum social cost. The deployment plan will specify the number of charging stations, the number of chargers installed at each station, the lengths of dynamic charging lanes, and charging prices of charging stations and lanes.

3 - Modeling Plug-in Electric Vehicles Driving And Charging Behavior Using Real-world Connected Vehicles Data

Kuilin Zhang, Assistant Professor, Michigan Technological University, Houghton, MI, 49931, United States, klzhang@mtu.edu
Shuaidong Zhao

We propose to investigate driving and charging behavior of Plug-in Electric Vehicles using real-world connected vehicles data. We use a data-driven approach to estimating 24-hour activity-travel dynamics of individual drivers from connected vehicles data collected in real-world. Based on this real-world driver's activity and mobility pattern, we formulate an optimization model to address driving and charging behavior of Plug-in Electric Vehicles to better understand the battery performance of electric vehicles under real-world conditions.

4 - Operation Of Electricity And Transportation Networks With Ev Wireless Charging

Mohammad Khodayar, Southern Methodist University, mkhodayar@smu.edu, Saeed D Manshadi, Khaled Abdelghany, Halit Uster

This research presents the coordinated operation of wireless electric vehicle charging stations (WECS) in electricity and transportation networks. The traffic flow pattern in transportation network is assumed to follow the user equilibrium (UE) traffic assignment, where the cost of utilized electricity is incorporated in the total traveling cost. The presented formulation leverages consensus optimization to address the unit commitment in the electricity network as well as user equilibrium traffic assignment in the transportation network.

■ SA60

Cumberland 2- Omni

Topics on Shared Public Transportation Systems

Sponsored: TSL, Urban Transportation

Sponsored Session

Chair: Hai Wang, Singapore Management University, Singapore Management University, Singapore, Singapore, Singapore, haiwang@smu.edu.sg

1 - Matching Problem For A Stochastic And Dynamic Online Vehicle Sharing System

Hai Wang, Singapore Management University, haiwang@smu.edu.sg, Chiwei Yan

We study a stochastic and dynamic matching problem for online vehicle sharing platform: match the spatial and temporal changing demand (ride request) with supply (vehicle). We propose an algorithm to determine the pairings of drivers to riders' requests. At any decision epoch, we consider the set of known available drivers and potential available drivers, as well as the set of known existing passengers and potential passengers. We use an iterative procedure which calls a static and deterministic matching problem as a sub-routine. The objective is to minimize the average waiting time until picked-up for ride requests. We demonstrate the advantages of our algorithm by testing in real world data sets.

2 - Estimating Primary Demand In One-way Vehicle Sharing Systems

Chiwei Yan, Massachusetts Institute of Technology, Cambridge, MA, United States, chiwei@mit.edu, Chong Yang Goh

Observed trip data for one-way vehicle sharing systems do not always correspond to true demands for the service due to varying vehicle and parking availability. For example, in bike sharing systems, passengers arriving at an empty pickup station may either leave the system or spill over to nearby stations. We propose efficient methods to estimate the true origin-destination demands in a one-way vehicle sharing system using observed trip data. Our approach models a customer's station substitution behavior based on a ranking-based choice model. We demonstrate the effectiveness of our approach using data from a bike-sharing system in Boston.

3 - The Learning Curve Of Taxi Drivers In an Urban Area: An Empirical Analysis

Youngsoo Kim, Singapore Management University, Singapore, Singapore, yskim@smu.edu.sg

This study aims to better understand the dynamic change of individual taxi drivers' performance on both an aggregated output level (e.g., revenue and trips) and process level (e.g., occupancy rate and zone selection decision). We also conduct counterfactual policy experiments that capture the change derived through knowledge sharing of demanding zone on both individual and company levels. The implications of our findings for both theory and practice are discussed.

4 - Stochastic Ride-matching In Peer-to-peer Ridesharing Systems

Neda Masoud, University of Michigan, 2350 Hayward St., 2124 GG Brown Bldg., Ann Arbor, MI, 48109, United States, nmasoud@umich.edu, R. Jayakrishnan

We formulate the multi-hop peer-to-peer stochastic ride-matching problem as a binary program, and propose an efficient algorithm to solve the problem. We use a forecast of passenger arrivals, and take into consideration the possible future states of the ridesharing system when routing drivers. The multi-hop property of the system allows passengers to transfer between different vehicles/modes of transportation.systems.

■ SA61

Cumberland 3- Omni

RAS Student Paper Award

Sponsored Session

Chair: Steven Harrod, Technical University of Denmark, KGS. Lyngby, Denmark, stehar@transport.dtu.dk

Rail Applications Section (RAS) sponsored a student research paper contest on analytics and decision making in railway applications. Papers must advance the application or theory of OR/MS for improvement of freight or passenger railway transportation, and it must represent original research that has not been published elsewhere by the time it is submitted. Authors of the First, Second and Third Place award winning papers will present their papers in this session.

■ SA62

Cumberland 4- Omni

Aviation Applications Section: Best Student Presentation Competition

Sponsored: Aviation Applications

Sponsored Session

Chair: Lavanya Marla, University of Illinois, lavanyam@illinois.edu

■ SA63

Cumberland 5- Omni

Facility Logistics

Sponsored: TSL, Facility Logistics

Sponsored Session

Chair: Jennifer A Pazour, Rensselaer Polytechnic Institute, 110 8th street, CII 5217, Troy, NY, 12180, United States, pazouj@rpi.edu

1 - Facility-level Item Allocation Problem In Ship-from-Store Environment

Seyed Shahab Mofidi, Rensselaer Polytechnic Institute, 110 8th Street, RPI ISE Department, CII 5015, Troy, NY, 12180, United States, mofids@rpi.edu, Jennifer A Pazour

Leading retailers are using their brick-and-mortar stores to fulfill online order requests, which results in ambidextrous stores that use inventory to serve both in-store and on-line shoppers. We develop a novel multi-product optimization model that captures the tradeoff between applying resources in advance when the demand is unknown or applying resources after the demand realizes. A case study illustrates how our model can be used to recommend item allocation policies for omni-channel supply chains.

2 - Parallel Algorithms For Large Assignment Problems On Graphics Processing Unit Clusters

Rakesh Nagi, University of Illinois, Urbana-Champai, 117 Transportation Building, MC-238, 104 South Mathews Avenue, Urbana, IL, 61801, United States, nagi@illinois.edu, Ketan Date

We discuss efficient parallel algorithms for solving large instances of the Linear Assignment Problem (LAP) and the Quadratic Assignment Problem (QAP). Our parallel architecture is comprised of CUDA enabled NVIDIA Graphics Processing Units (GPUs) on a computational cluster. We propose novel parallelization of the Hungarian algorithm on the GPUs, which shows excellent parallel speedup for large LAPs. We also propose a novel parallel Dual Ascent algorithm on the GPUs, which is used for solving the RLT2 linearization of the QAP, which also utilizes our parallel Hungarian algorithm. We show that this GPU-accelerated approach is extremely valuable in a branch-and-bound scheme.

■ SA64

Cumberland 6- Omni

Spatial Multicriteria Decision Making: Challenges and Current Developments

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Valentina Ferretti, London School of Economics and Political Science, Houghton Street, London, WC2A 2AE, United Kingdom, V.Ferretti@lse.ac.uk

1 - Geographically Weighted Multi-attribute Decision Making For Taxi Assignment

Ali Esmaeeli, University of California, Irvine, Irvine, CA, United States, esmaeeli@uci.edu, L Robin Keller

Taxi assignment problem is usually considered as one part of the more general vehicle routing problem (VRP) with a known value function. In this work, we extend this viewpoint to match the problem more with the real world conditions. We consider a map with weighted regions and propose a method to find the best option for each taxi request based on two different attributes. These attributes are the average response time for each region and the rate of accepted requests for each region. We show how to combine these attributes and how to include the region weights into the main value function. Moreover, we present a method for finding the best assignment option based on our defined value function.

2 - Spatial Multi Criteria Decision Analysis In The Energy Sector: A Preliminary Application To Deep Geothermal Energy Systems

Matteo Spada, Risk Analyst, Paul Scherrer Institut, OHSA/D19, Villigen PSI, 5232, Switzerland, matteo.spada@psi.ch Peter Burgherr

This study presents the preliminary application of a spatial MCDA to the energy sector. In particular, Deep Geothermal Energy (DGE) systems are considered in the analysis. DGE is gaining quite some interest as new renewable energy system, since it offers the prospect of supplying base-load power in a decentralize fashion and a theoretically large resource potential. The proposed approach will combine spatial information from both explicit data (e.g., heat flow) and calculated ones (e.g., risk indicators, environmental impact indicators, etc.) for specific a priori defined capacity plants. The results will be presented for different hypothetical stakeholders for the case study of Switzerland.

3 - Case Studies With Gear, A New Tool For Geospatial Multi-Criteria Decision Analysis

Matthew Bates, Research Engineer, US Army Corps of Engineers, Concord, MA, United States, matthew.e.bates@usace.army.mil Michelle Hamilton, Jeffrey Cegan, Cate Fox-Lent, John Nedza

GEAR (the Geospatial Environment for Analysis and Reasoning) is a new, state-of-the-art geospatial multi-criteria decision analysis (GIS-MCDA) tool developed by the Engineer Research & Development Center of the US Army Corps of Engineers. GEAR has a friendly and intuitive user interface, accepts diverse web-service and file data inputs, and guides users through data exploration, criteria development, value function and weight specification, and running the analysis. It is designed for both practiced analysts and non-expert users. In this presentation, we introduce the GEAR functionality through a series of spatial decision case studies.

4 - Behavioural Issues In Spatial Decision-making Processes

Valentina Ferretti, London School of Economics and Political Science, V.Ferretti@lse.ac.uk

Behavioral decision research has demonstrated that judgments and decisions of ordinary people and experts are subject to numerous biases. While these biases have already been extensively discussed in several disciplines, e.g. economics, game theory, finance, and risk analysis, to name the most relevant, there is now a need to pay more attention to behavioral and cognitive effects in spatial environmental decision-making processes. Within this context, this talk explores which biases are relevant in the field and proposes a first behavioral experiment focusing on the weights elicitation step

5 - Landscape Multi-methodological Evaluations: Approaches For Collaborative Spatial Decision-making Processes

Maria Cerreta, University of Naples,, cerreta@unina.it

The paper, starting from the evolution of the landscape's concept and related evaluative approaches, focuses on the management of its complexity in transformation processes included in the dynamic context of landscape's values and in its local development strategies. A multi-methodological synergistic evaluations framework for a Collaborative Spatial Decision-Making Process has been tested in some case-studies for context-aware planning strategies and scenarios of local sustainable policies, combining Multi-Criteria Analysis (MCA), Multi-Group Analysis (MGA) and Geographic Information Systems (GIS).

■ SA65

Mockingbird 1- Omni

Economics of Information Systems

Sponsored: Information Systems

Sponsored Session

Chair: Marius Florin Niculescu, Georgia Institute of Technology, Georgia Institute of Technology, Atlanta, GA, 30332, United States, marius.niculescu@scheller.gatech.edu

1 - E-commerce In The Manufacturing Supply Chain: An Empirical Analysis

Patricia Angle, Georgia Institute of Technology, Patricia.Angle@scheller.gatech.edu, Christopher M Forman, Kristina Steffenson McElheran

In this paper, we explore the value of e-commerce technologies on the total factor productivity (TFP) of manufacturing plants. We find that, on average, e-selling adoption is associated with a 1.4% increase in TFP. However, these returns differ significantly between small and large plants. For large plants, those above the 25th percentile in number of employees, the increase in TFP is 2%. For plants below that size threshold, the returns to e-selling are statistically indistinguishable from zero. We further find that plants with prior experience with enterprise IT realize greater productivity gains from their e-selling investments.

2 - Piracy-induced Competition In Information-good Supply Chains

Antino Kim, Indiana University, Bloomington, IN, United States, antino@iu.edu, Debabrata Dey, Atanu Lahiri

In an otherwise monopolistic information goods market, piracy presents itself as a "shadow competition" to the legal product by providing consumers with other means to use the product, albeit at a lower quality. In this work, we analyze the effect of this shadow competition by comparing it to competition in a manufacturer-retailer setting.

3 - Impact Of Promoting Free Wi-fi On Mobile Data Usage: Evidence From A Field Experiment

Karthik Babu Nattamai Kannan, Georgia Institute of Technology, KarthikBabu.NK@scheller.gatech.edu, Jeffrey Hu, Sridhar Narasimhan

With the rapid proliferation of free Wi-Fi hotspots in public locations such as restaurants, shopping malls, airports etc., mobile users have the choice of accessing Internet either via paid mobile data plans or through the free Wi-Fi hotspots. We conduct a field experiment in July 2015 to study the impact of promoting free Wi-Fi service on mobile data usage. We work with a leading national mobile carrier in the USA to randomly choose 500,000 subscribers who receive a promotional text message about the availability of free Wi-Fi hotspots and compare them with a control group made of 500,000 customers who do not receive any promotional message.

4 - Strategic Intellectual Property Sharing: Competition on an OpenTechnology Platform Under Network Effects

Marius Niculescu, Georgia Institute of Technology, marius.niculescu@scheller.gatech.edu, D. j. Wu, Lizhen Xu

This study explores when an incumbent software developer might find it optimal to utilize the open business model to share its intellectual property with entrants in markets for software products with network effects.

■ SA66

Mockingbird 2- Omni

High-Dimensional Functional Data Analysis

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Hao Yan, Georgia Institute of Technology, yanhao@gatech.edu

Co-Chair: Kamran Paynabar, kpaynabar3@gatech.edu

1 - Difference Detection Between Two Images For Image Monitoring

Peihua Qiu, University of Florida, pqiu@ufl.edu

Comparison of images is a fundamental task in image-based quality control. This problem, however, is complicated because 1) observed images often contain noise, and 2) the related images need to be geometrically matched up first because images of different products could be geometrically mismatched. In this paper, we propose effective methods for detecting difference between two images of products, and our proposed methods can accommodate both noise and geometric mismatch mentioned above.

2 - Online Adaptive Sampling And Estimation For Clustered Anomaly Detection

Hao Yan, Georgia Institute of Technology, yanhaopku@gmail.com

In point-based sampling and sensing system, adaptive exploration in complex sampling space can dramatically reduce the sampling time. Most of the existing techniques focus on reducing the overall fitting error for the entire sampling space. However, in many application, such as anomaly detection, only sparse clustered anomalous regions are important. In this paper we develop two adaptive sampling strategies together with estimation methods to recover the clustered region and discuss their properties to balance the space filling property and focus sampling near the anomalous region. Finally, the proposed methodology is validated by simulation study and real datasets in Guided Wave Experiment.

3 - A Penalized (log)-Location-Scale Tensor Regression Model For Residual Useful Lifetime Prediction

Xiaolei Fang, Georgia Institute of Technology, xfang33@gatech.edu
Kamran Paynabar, Nagi Gebraeel

We develop a penalized prognostic model whose covariates are tensor-based degradation signals. To address the ultrahigh dimensionality challenge, the coefficient tensor is decomposed as a product of some basis matrices (CP decomposition) or a product of a core tensor and some factor matrices (Tucker decomposition) . Instead of estimating the coefficient tensor itself, we estimate these basis matrices or core tensor and factor matrices, which have far much smaller dimensionalities. Two algorithms with global convergence property are developed for model estimation. The effectiveness of our models is validated using a simulation study and an infrared image-based degradation signal dataset.

4 - Multivariate Profile Monitoring Based On Sparse Multichannel Functional Principle Component Analysis

Chen Zhang, National University of Singapore, zhangchen@u.nus.edu, Hao Yan, Jianjun Shi

This paper presents a new monitoring framework for multi-channel profile data. In particular, we first propose a sparse multichannel functional principle component analysis (SMFPCA) to model multiple profiles, SMFPCA on one hand can capture the auto-correlation structure of profile data well, and on the other can allow flexible cross-correlations of multiple or even high-dimensional profiles with different features. Then using SMFPCA scores, we further propose a monitoring scheme that can detect sparse out-of-control changes efficiently. Numerical studies together with a real example in the semiconductor manufacturing demonstrate the application and effectiveness of our methods.

■ SA67

Mockingbird 3- Omni

Journal of Quality Technology Invited Session

Sponsored: Quality, Statistics and Reliability
Sponsored Session

Chair: Fugee Tsung, HKUST, Hong Kong, season@ust.hk

1 - Bayesian Life Test Planning For Log-Location-Scale Family Of Distributions

Yili Hong, Virginia Polytechnic Institute, yilihong@vt.edu

This paper describes Bayesian methods for life test planning with censored data from a log-location-scale distribution. We use a Bayesian criterion based on the estimation precision of a distribution quantile. A large-sample normal approximation gives a simplified, easy-to-interpret, yet valid approach to this planning problem, where in general no closed-form solutions are available. We present numerical investigations using the Weibull distribution with type II censoring. We also assess the effects of prior distribution. A simulation approach of the same Bayesian problem is also presented.

2 - Multivariate Exponentially Weighted Moving-average Chart For Monitoring Poisson Observations

Nan Chen, National University of Singapore, isecn@nus.edu.sg

In this talk, we develop a feasible multivariate monitoring procedure based on the general multivariate exponentially weighted moving average (MEWMA) to monitor the multivariate count data. The multivariate count data is modeled using Poisson log-normal distribution to characterize their interrelations. We systematically investigate the effects of different charting parameters and propose an optimization procedure to identify the optimal charting parameters. To further improve the efficiency, we integrate the variable sampling intervals (VSI) in the monitoring scheme. We use simulation studies and an example to elicit the application of the proposed scheme.

■ SA68

Mockingbird 4- Omni

QSR Refereed Research Session

Sponsored: Quality, Statistics and Reliability
Sponsored Session

Chair: Hui Yang, Pennsylvania State University, University Park, PA, United States, huy25@psu.edu

1 - An Optimum Design Of Laser-based Additive Manufacturing Experiments by Leveraging Analogous Prior Data

Amir Massoud Aboutaleb, Mississippi State University, 139 A, Park Circle, Starkville, MS, 39759, United States, aa1869@msstate.edu
Linkan Bian

Most of Lase-Based Additive Manufacturing studies do not use a systematic approach for optimizing process parameters for desired part properties. Existing design-of-experiment methods require two stages of experiments: a large batch of initial experiments and multiple smaller batches of sequential experiments. Our method directly utilizes experimental data from previous studies to guide the sequential optimization experiments of the current study.

2 - Model Transfer via Equivalent Effects Of Lurking Variables

Arman Sabbaghi, Purdue University, West Lafayette, IN, 47907, United States, sabbaghi@purdue.edu
Qiang Huang

The transfer of a model across different settings of lurking variables is addressed with a novel framework that fuses the Rubin causal model with the effect equivalence concept. A Bayesian methodology for model transfer is developed and applied to transfer deformation models across additive manufacturing environments

3 - Residual Useful Lifetime Prediction Using a Degradation Image Stream

Xiaolei Fang, Georgia Institute of Technology, 1546 Woodlake Dr NE, Apt F, Atlanta, GA, 30329, United States, xfang33@gatech.edu, Kamran Paynabar, Nagi Gebraeel

This paper proposes a new methodology for RUL prediction of a system using a sequence of degradation images. The methodology integrates tensor linear algebra with traditional location-scale regression widely used in reliability and prognosis. Two optimization algorithms with a global convergence property are developed for model estimation.

4 - Statistical Modeling For Spatio-Temporal Degradation Data

Xiao Liu, IBM, 1101 Kitchwan Road, Room 29-252, Yorktown Heights, NY, 10598, United States, liuxiao@us.ibm.com
Kyongmin Yeo, Jayant Kalagnanam

This paper investigates the modeling of an important class of degradation data, which are collected not only over time but also from a spatial domain. Like many traditional degradation models which rely on stochastic processes, a space-time random field is constructed, through a novel approach, for modeling the spatio-temporal degradation process.

■ SA69

Old Hickory- Omni

2016 Edelman Finalists Reprise – I

Sponsored: CPMS, The Practice Section
Sponsored Session

Chair: Michael A Trick, Carnegie Mellon University, Pittsburgh, PA, United States, trick@cmu.edu

1 - Operations Research Transforms The Scheduling Of Chilean Soccer Leagues And South American World Cup Qualifiers

Andres P Weintraub, Universidad de Chile, Dept De Ingenieria Industrial, Republica 701 Casilla 86-D, Santiago, Chile, aweintra@dii.uchile.cl, Fernando Alarcon, Guillermo Duran, Luis Ramirez, Hugo Munoz, Mario Ramirez, Denis R. Saure, Sebastian Souyris, Rodrigo Wolf-Yadlin, Gonzalo Zamorano, Matias Siebert, Jaime Miranda, Mario Guajardo

For the past 12 years, we have applied OR techniques to schedule soccer leagues in Chile. Using integer programming-based methods, it is decided which matches are played in each round, taking into account various objectives. We have scheduled more than 50 tournaments using this approach, resulting in an estimated economic impact of about $59 million. Because of the high portability of these techniques, we have used them successfully to schedule sports leagues in other countries and the South American qualifiers for the 2018 Soccer World Cup. Furthermore, the methods used in this application have been disseminated widely, helping to promote OR as an effective tool for addressing practical problems.

■ SA70

Acoustic- Omni

Transportation, Freight I

Contributed Session

Chair: Mohammad Torkjazi, University of South Carolina, 620 Heidt Street, Apt 1, Columbia, SC, 29205, United States, torkjazi@email.sc.edu

1 - Stacking Containers In An Automated Terminal

Amir Hossein Gharehgozli, Texas A&M University at Galveston, P.O. Box 1675, Galveston, TX, 77553, United States, gharehga@tamug.edu

We study temporary stacking of containers in an automated terminal. In such terminals, containers to be transported the hinterland or other terminals are stacked in compact stacks with multiple piles of containers. Transfer zones located at both ends of each stack are used to stack and retrieve containers. We propose a mathematical model to stack containers.

2 - An Economical, Reliable And Sustainable Transport Strategy: Synchromodality From Shipper's Perspective

Chuanwen Dong, Kuehne Logistics University, Grosser Grasbrook 17, Hamburg, 20457, Germany, chuanwen.dong@the-klu.org Robert Boute, Alan Mckinnon, Marc Verelst

In order to cut the GHG emission by 60-80% by 2050, innovation is needed to shift more volume from trucks to trains. We argue that the current standstill of modal split is due to a lack of holistic understanding of the supply chain changes driven by modal split. Building on a literature review, we broaden the conventional focus of multimodal transport to a supply chain viewpoint and propose a new concept: synchromodality from shipper's perspective. We apply our approach to a case of an FMCG firm and quantitatively demonstrate that the shipper can significantly reduce its emission without sacrificing cost or service level.

3 - Design Of Truck Appointment System

Mohammad Torkjazi, University of South Carolina, Columbia, SC, 29205, United States, torkjazi@email.sc.edu, Nathan Huynh

The truck appointment system can adjust the length of queue at the gate of the marine container terminals. This adjustment affects the terminal operations as well as trucking companies' schedule. This study proposes a new mathematical formulation for the truck appointment system which optimizes terminal operations as well as trucking companies' schedule.

■ SA71

Electric- Omni

Transportation, Public I

Contributed Session

Chair: Betty Love, University of Nebraska - Omaha, Mathematics Department, Omaha, NE, 68182, United States, blove@unomaha.edu

1 - Bus Service Design Under Demand Diversion And Dynamic Roadway Congestion Based On Aggregated Network Models

Antoine Petit, Research Assistant, U of Illinois at Urbana-Champaign, 205 N Mathews Avenue, # B156, Urbana, IL, 61801, United States, apetit@illinois.edu, Mehmet Yildirimoglu, Nikolas Geroliminis, Yanfeng Ouyang

This paper proposes an integrated methodological framework to design a spatial-dependent bus route network and time-dependent headways to serve travel demand that varies over time and space. Travelers choose transit or driving mode (as well as travel paths) that minimizes its equilibrium travel cost in the multi-modal network. Numerical experiments are used to demonstrate the applicability of the proposed modeling framework and provide managerial insights on the influence of the demand pattern, transit network design, and roadway congestion on the system performance.

2 - Evaluating Impacts Of Rainfall On Subway Ridership In Manhattan By Utilizing Bayesian Hierarchical Poisson Regression Model

Shirin Najafabadi, PhD Candidate, CCNY, 650 West 42nd Street, Apt 3014, New York, NY, 10036, United States, shirin.najaf@gmail.com, Ali Hamidi, Mahdieh Allahviranloo, Naresh Devineni

Impacts of rainfall on subway ridership in Manhattan was studied by using ridership and hydrology data for the year 2010-2011. Using Bootstrap technique, several hypothesis on ridership for different days of the week were constructed and tested. We present Bayesian Hierarchical Poisson Regression Model and incorporate Land-use characteristics as the influential factor in the estimation of ridership, as well as in estimating the sensitivity of the ridership to rainfall. A preliminary comparison between the Bayesian model and simple Poisson regression model supports the use of the former model.

3 - A Mixed Integer Programming Model For Dynamic Taxi Sharing Considering Provider Revenue

Yeming Hao, Research Assistant, University of Maryland-College Park, 8136 Paint Branch Dr., 0147C Engineering Laboratory, College Park, MD, 20742, United States, yhao@umd.edu, Ali Haghani

This paper proposed an optimization model for Dynamic Taxi Sharing(DTS), which allows two groups of taxi users to ride on the same taxi together. The significance of the taxi-sharing service was evaluated. A customized matching algorithm for taxi drivers and user pairs was developed to maximize taxi providers' revenue. We also designed a DTS fare calculation scheme which can automatically calculate the fare for each DTS user and self-adjust to balance the taxi occupancy rate in real time. A real world case was studied to demonstrate the DTS system is beneficial to taxi users, drivers and providers.

4 - Bike System Rebalancing In Omaha Nebraska

Betty Love, University of Nebraska - Omaha, Mathematics Department, Omaha, NE, 68182, United States, blove@unomaha.edu, Livvia Bechtold

Heartland B-cycle in Omaha, Nebraska is a bike sharing system that operates over 70 stations and 150 bikes. Rebalancing is done daily using one truck. We present the results of our work on the rebalancing problem using both integer programming and heuristic approaches.

■ SA72

Bass- Omni

Supply Chain Mgt I

Contributed Session

Chair: Qiaohai (Joice) Hu, City University of Hong Kong, AC-1, Room 7605, Dept of management Science, Kowloon, Hong Kong, joice.hu@gmail.com

1 - Modeling And Analysis Of Supply Chain Coordination Under The Crowd-funding Financing

Kuan Zeng, Dr, Huazhong University of Science and Technology, Wuhan, China, zk00315@126.com, Xianhao Xu

In this paper, we consider a supply chain which consists of a single manufacture and a single retailer with a single new product. The retailer designs a new product and posts it on the crowd-funding platform for financing. If the financing target is reached, the retailer will initiate cooperation with manufacture and decide the quantity of the mass production and the manufacture will decide the price accordingly. The target of the manufacture and retailer is to maximize their own profit. We also consider and analyze the situation in which manufacture will provide the retailer a quantity related trade credit.

2 - Swapping Inventory Between Competing Firms

Seung Jae Park, Assistant Professor, Ewha Womans University, Seoul, Korea, Republic of, park.s@ewha.ac.kr

We investigate how competing firms swap inventory. We first show that the firms would not swap inventory without a sophisticated method. However, under our proposed inventory swapping method, competing firms swap a positive amount of inventory. We also find that the swapped quantity increases as transportation costs decrease, and swapping inventory may not be beneficial if the transportation cost is either too low or too high. In addition, we show that firms may prefer to return the physical products to pay the value difference, especially if they are risk-averse.

3 - Manufacturers' Strategic Responses To Power Imbalance In Supply Chains

Zhexiong Tao, McGill University, 1001 Rue Sherbrooke O, Montreal, QC, H3A1G5, Canada, zhexiong.tao@mail.mcgill.ca Shanling Li, Saibal Ray

Our research presents a model of the manufacturer's strategic responses to the imbalance of power in supply chain relationships and empirically tests it using plant-level data. Analysis results show that in different contexts, the manufacturer will adopt different strategies and integration mechanisms to counteract the dominance of the strong actors.

4 - Debt Finanacing And Specific Capacity Investment

Qiaohai (Joice) Hu, City University of Hong Kong, AC-1, Room 7605, Dept of Management Science, Kowloon, Hong Kong, joice.hu@gmail.com

The supplier has to commit to building specific capacity for the buyer before demand uncertainty has been resolved. After uncertainty has been resolves, the parties engage in a bargaining game to decide whether or not to trade and at what price. We show that debt financing can improve supplier's bargaining position. However, this expanded capacity is still below the channel-efficient level because debt financing reduces the probability of trade. Surprisingly, the supplier's debt financing may also benefit the buyer and encourage the buyer to invest in value enhancement. Actually, the supplier's debt may result in Pareto improvement.

■ SA86

Gibson Board Room-Omni

Manufacturing I

Contributed Session

Chair: Mohsen Moghaddam, Postdoctoral Researcher, Purdue University, Grissom Hall, 315 N. Grant Street, West Lafayette, IN, 47907, United States, mmoghadd@purdue.edu

1 - Identifying Shifting Production Bottlenecks Using Clearing Functions

Reha Uzsoy, Professor, North Carolina State University, Dept. of Industrial & Systems Engg, 300 Daniels Hall Camps Box 7906, Raleigh, NC, 27695-7906, United States, ruzsoy@ncsu.edu, Baris Kacar, Lars Moench

Production planning models using clearing functions can provide meaningful dual prices for resources that are not fully utilized. We present a case study of the analysis of a semiconductor wafer fabrication system using this approach, and demonstrate the rapidly shifting nature of production bottlenecks even under stable demand.

2 - Determinants Of Commercial Exploitation For European Funded Technological R&D In Manufacturing

Vasco Figueiredo Teles, Researcher, MIT Portugal Program, Porto, Portugal, vbteles@inesctec.pt, Abilio P. Pacheco, Abilio P. Pacheco, Joao Claro, Joao Claro

A significant number of technologies resulting from R&D funded by the European Commission and aiming at commercial exploitation, do not achieve success in the marketplace, or in fact even reach it. We use regression analysis and a data set describing 60 technologies from European R&D projects in manufacturing, to identify potential determinants of exploitation. The technologies are classified in a 4-stage exploitation scale, and their characteristics (type, sector, geography, technology readiness level, or platform potential, among others) are compared among stages. Based on the identified determinants, we offer a set of suggestions on how to improve exploitation support in these contexts.

Sunday, 10:00AM - 10:50AM

■ Sunday Plenary

Davidson Ballroom-MCC

Cognitive Computing: From Breakthroughs in the Lab to Applications on the Field

Plenary Session

Chairs: Chanaka Edirisnghe, Rensselaer Polytechnic Institute, & Ed H. Kaplan, Yale University and INFORMS 2016 President

1 - Cognitive Computing: From Breakthroughs In The Lab To Applications on The Field

Guru Banavar, Vice President, IBM Research, Watson Research Center, Yorktown Heights, NY, United States, banavar@us.ibm.com

In the last decade, the availability of massive amounts of new data, the development of new machine learning technologies, and the availability of scalable computing infrastructure, have given rise to a new class of computing systems. These “Cognitive Systems” learn from data, reason from models, and interact naturally with us, to perform complex tasks better than either humans or machines can do by themselves. These tasks range from answering questions conversationally to extracting knowledge for discovering insights to evaluating options for difficult decisions. These cognitive systems are designed to create new partnerships between people and machines to augment and scale human expertise in every industry, from healthcare to financial services to education. This talk will provide an overview of cognitive computing, the technology breakthroughs that are enabling this trend, and the practical applications of this technology that are transforming every industry.

Sunday, 11:00AM - 12:30PM

■ SB01

101A-MCC

Machine Learning

Sponsored: Data Mining

Sponsored Session

Chair: Cynthia Rudin, MIT, 100 Main Street, Cambridge, MA, 02142, United States, rudin@mit.edu

1 - Generalized Inverse Classification

Michael Lash, University of Iowa, Iowa City, IA, United States, michael-lash@uiowa.edu, Qihang Lin, Nick Street, Jennifer Robinson, Jeffrey W Ohlmann

Inverse classification (IC) is the process of perturbing a test point such that the predicted probability of a specific class is minimized. In previous work, we outlined an IC framework that incorporated a linear cost function and solved the problem by assuming the classifier was differentiable. In this talk we extend the framework to non-linear costs and relax our assumptions. We demonstrate that, using heuristic-based methods, the IC problem can be solved using arbitrary classifiers, about which only basic assumptions are made.

2 - On Difference Of Convex Optimization To Visualize a Word Storm

Dolores Romero Morales, Copenhagen Business School, drm.eco@cbs.dk, Emilio Carrizosa, Vanesa Guerrero

In this talk we address the problem of visualizing in a bounded region a set of individuals, which has attached a dissimilarity measure and a statistical value. This problem, which extends the standard Multidimensional Scaling Analysis, is written as a global optimization problem whose objective is the difference of two convex functions (DC). Suitable DC decompositions allow us to use the DCA algorithm in a very efficient way. Our algorithmic approach is used to visualize a dynamic linguistic real-world dataset.

3 - Consensus Based Modeling Using Distributed Feature Construction

Haimonti Dutta, University at Buffalo, haimonti@buffalo.edu

Inductive Logic Programming can be used as a tool for discovering relational features for subsequent use in a predictive model. However, such models often do not scale. In this paper, we address this computational difficulty by allowing features and models to be constructed in a distributed manner. There is a network of computational units, each of which employs an ILP engine to construct a small number of features and build a (local) model. Then a consensus-based algorithm is learnt, in which neighboring nodes share information to update local models. For a category of models (those with convex loss functions), it can be shown that the algorithm will result in all nodes converging to a consensus model.

4 - Regulating Greed In Multi-Armed Contextual Bandits

Stefano Traca, MIT, stet@mit.edu

Abstract to come

■ SB02

101B-MCC

Data Mining in Medical and Sociological Decision Making

Sponsored: Data Mining

Sponsored Session

Chair: Kamran Paynabar, Georgia Institute of Technology, Atlanta, GA, United States, kamip@umich.edu

1 - Single Stage Prediction With Text Data Using Dimension Reduction Techniques

Shawn Mankad, Cornell, spm263@cornell.edu

Text data is playing an increasingly important role within the business world for economic analyses and operations management. There are many ways to summarize and transform unstructured data into actionable insights. We compare several modern text analysis methods for prediction of economic outcomes to derive guidelines for researchers and practitioners.

2 - A Multi-response Multilevel Model With Application In Nurse Care Coordination

Bing Si, Arizona State University, Tempe, AZ, United States, bingsi@asu.edu, Jing Li

Nurse care coordination plays a vital role in promoting patient outcomes. The recently developed Nurse Care Coordination Instrument (NCCI) enables quantitative data to be collected on nurses' coordination activities, demographics, workload and practice environment. Driven by this, we propose a novel multi-response multilevel model with joint fixed/random effect selection across multiple responses and apply it to a dataset collected across four U.S. hospitals using the NCCI. Our study conducts the first quantitative analysis linking multiple care coordination metrics with multilevel predictors and thus provides important insight into how care coordination might be impacted or improved.

3 - Optimal Expert Knowledge Elicitation For Bayesian Network Structure Identification

Yan Jin, University of Washington, Seattle, WA, United States, yanjin@uw.edu, Cao Xiao

This talk is about a systematic approach that combines observational data and expert knowledge to better learn the influential relationships between variables for networked systems, as well as automates the expert elicitation process and collect the most informative expert knowledge, optimally matched to the observational data, to improve the learning of the BN structure.
Applications include event cascade modeling of Alzheimer's disease and human resource management key performance indicator measurement.

4 - Temporal Monitoring Of Dynamic Attributed Networks

Mostafa Reisi, Georgia Tech, mostafa.reisi@gmail.com

We consider the problem of change detection in dynamic attributed networks. First, networks are modeled through a generalized linear model (GLM). Then, a state-space model is built by considering a linear state model over the parameters of the GLM. Extended Kalman filter is used for estimating and predicting the parameters of the state-space model. For each upcoming network, a Pearson residual based on the actual network and its prediction is calculated. The Pearson residuals are monitored through an EWMA control chart. Comparison of this method with its static counterparts shows significant improvement in detecting changes.

■ SB03

101C-MCC

Nicholson Student Paper Prize II

Invited: Nicholson Student Paper Prize

Invited Session

Chair: Maria Esther Mayorga, North Carolina State University, 400 Daniels Hall, Dept. of Industrial & Systems Engineering, Raleigh, NC, 27695, United States, memayorg@ncsu.edu

1 - Nicholson Student Paper Prize

Maria Esther Mayorga, North Carolina State University, Dept. of Industrial & Systems Engineering, Raleigh, NC, 27695, United States, memayorg@ncsu.edu

This session highlights the finalists for the 2016 George Nicholson Student Paper Competition.

2 - Robust Monotone Submodular Function Maximization

Rajan Harish Udwani, James B. Orlin, Andreas S. Schulz, Massachusetts Institute of Technology, Cambridge, MA, rudwani@mit.edu

We consider a robust formulation, introduced by Krause et al. (2008), of the classical cardinality constrained monotone submodular function maximization problem, and give the first constant factor approximation results. The robustness considered is w.r.t. adversarial removal of up to \tau elements from the chosen set. We give both, fast and practical approximation algorithms with sub-optimal guarantees as well as more theoretical ones achieving the best possible guarantee. Finally, we also give a black box result for the more general setting of robust maximization of monotone submodular functions subject to an independence system.

3 - A Constant-Factor Approximation For Dynamic Assortment Planning Under The Multinomial Logit Model

Ali Aouad, Massachusetts Institute of Technology, Cambridge, MA, aaouad@mit.edu

Abstract to come

4 - Delay, Memory, and Messaging Tradeoffs in Distributed Service Systems

Martin Zubeldia, Massachusetts Institute of Technology, Cambridge, MA, Contact: zubeldia@mit.edu

Abstract to come

■ SB04

101D-MCC

Energy Storage and Virtual Trading in the Smart Grid

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Miguel F Anjos, Polytechnique Montreal, C.P. 6079, Succ. Centre-ville, Montreal, QC, H3C 3A7, Canada, anjos@stanfordalumni.org

1 - Optimizing Energy Flows For A Grid Connected Smart House Producing Renewable Energy

Luce Brotcorne, INRIA, luce.brotcorne@inria.fr
Ekaterina Alekseeva, Michel Gendreau, Mohammed Skiredj

We focus on optimizing energy flows for demand management of a grid connected smart house equiped with a system combining photovoltaic electricity and battery . The smartly scheduled way of using, storing, generating, buying and selling energy allows customers to reduce electricity payments, to be less dependent on the grid and avoid creating peak power demand in the grid. We propose a stochastic mathematical linear program to make an optimal decision with the lack of perfect information related to purchasing electricity prices and energy produced by PV generator.

2 - Capacity Expansion Modeling For Storage Technologies

Elaine Thompson Hale, Senior Engineer, National Renewable Energy Laboratory, Golden, CO, United States, elaine.hale@nrel.gov, Brady Stoll, Trieu Mai

The Resource Planning Model (RPM) is a capacity expansion model designed for regional power systems and high levels of renewable generation. Recent extensions capture value-stacking for storage technologies, including batteries and concentrating solar power with storage. After estimating per-unit capacity value and curtailment reduction potential, RPM co-optimizes investment decisions and reduced-form dispatch, accounting for planning reserves; energy value, including arbitrage and curtailment reduction; and three types of operating reserves. Multiple technology cost scenarios are analyzed to determine level of deployment in the Western Interconnection under various conditions.

3 - Optimizing Storage Operations In Transmission-constrained Networks For Medium And Long-term Operation

Diego Alejandro Tejada Arango, Universidad Pontificia Comillas, IIT, Madrid, Spain, Diego.Tejada@iit.comillas.edu
Sonja Wogrin, Efraim Centeno

The main objective is to present a new approach to model the storage operation in the context of Medium- and Long-Term Operational Planning (MLTOP). This approach is based on the system-state framework but including transmission constraints. A DC power flow approach is used to represent the transmission network. The methodology is related to clustering techniques using information such as demand and wind generation per node. Case studies are presented in order to compare the newly proposed methodology and the hourly approach. The results illustrate the computational time reduction without loss of accuracy in the solution.

4 - A Model Of Virtual Trading And The Forward Day Ahead Market

Gauthier De Maere D'Aertrycke, GDF Suez, Boulevard Simon Bolivar 34, Brussels, Belgium, gauthier.demaeredaertrycke@gdfsuez.com, Yves Smeers, Andreas Ehrenmann

The day ahead market plays an ambiguous role in restructured electricity markets. It is meant to help physical transactions such as the starting of machines in the unit commitment but is also intended to be a forward market capable of transferring the vagaries of real time prices into forward prices. Virtual trading was introduced for that purpose. We provide a model of virtual trading and give conditions for achieving the objective. We discuss what those conditions would imply in case of important penetration of decentralised energy. We also show some numerical experiment.

■ SB05

101E-MCC

Real Options in the Energy Sector

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Stein-Erik Fleten, Norwegian University of Science & Technology, NO-7491 Trondheim, Trondheim, NO-7491, Norway, stein-erik.fleten@iot.ntnu.no

1 - Switching From Oil To Gas Production – Decisions In A Field's Tail Production Phase

Kristian Støre, Norwegian University of Science and Technology, Bodø, Norway, krm@uin.no, Verena Hagspiel, Stein-Erik Fleten, Claudia Nunes

We derive an optimal decision rule with regards to making an irreversible switch from oil to gas production. Assuming that both the oil and gas prices follow a geometric Brownian motion we derive a quasi-analytical solution for the exercise threshold. We also derive the related abandonment option.
When comparing the use of a static decision rule to the proposed option approach we show that the value loss can be substantial for the abandonment option. For the switching option we find that with low gas prices the value loss can be more substantial than for the abandonment option, while for high gas prices it may be optimal to switch even as oil production is still generating positive cash flows.

2 - Resilience And Investment Valuation Of A Microgrid: A Real Options Approach

Reinhard Madlener, Full Professor of Energy Economics and Management, RWTH Aachen University, E.ON Energy Research Center, FCN, Mathieustrasse 10, Aachen, Germany, RMadlener@eonerc.rwth-aachen.de, Lisa Goebbels

In this study, microgrids are discussed as a possible decentralized system approach to stabilize local power supply. Microgrids are a way to achieve a higher resilience for a whole energy supply system. We introduce and empirically apply a definition and quantification method for the resilience of a microgrid. Investment feasibility of the installation of different combinations of components is evaluated by adopting a real options approach for the optimal time to invest that takes the uncertainty about future developments into account.

3 - Real Options In Renewable Portfolio Standards

Ryuta Takashima, Tokyo University of Science, takashima@rs.tus.ac.jp, Makoto Goto

In order to promote renewable energy generation, the schemes as renewable portfolio standards have been introduced in various countries. Thus the power generators make investment decisions allowing not only for uncertain demands and competitors' strategies but also for the schemes. In this work we model an equilibrium investment strategy of generators to analyze an effect of the schemes on the investment in competitive electricity market. The market is composed of non-renewable and renewable sectors. We show how the uncertainty affects the investment timing for both generators with the scheme.

4 - Structural Empirical Analysis Of Hydropower Scheduling

Stein-Erik Fleten, Norwegian University of Science & Technology, stein-erik.fleten@iot.ntnu.no, Maren Boger, Jussi Keppo, Alois Pichler, Einar M Vestbøstad

Our goal is to study how price expectations are formed in an electricity market. In the context of a single hydropower producer in the Nordic market, we expect the forward curve to have a strong influence. The alternative we allow for is a seasonal autoregressive joint inflow and spot price model that takes dry- and wet year dynamics into account. Using observed time series of generation, reservoir trajectories and technical plant data, and a structural model of optimal releases, our initial findings indicate that forward prices have influence on price expectations. An important byproduct of the proposed procedure is estimates of marginal water values.

■ SB06

102A-MCC

Panel: What Industry Wants Analytics Graduates to Know

Sponsored: Data Mining

Sponsored Session

Moderator: Thomas Tiahrt, The University of South Dakota, Beacom School of Business, Rm 229, Vermillion, SD, 57069, United States, Thomas.Tiahrt@usd.edu

A panel discussion on What Industry Wants Analytics Graduates to Know

1 - What Industry Wants Analytics Graduates To Know

Panelist: Eric B Stephens, Vanderbilt University Medical Center, eric.b.stephens@vanderbilt.edu

2 - What Industry Wants Analytics Graduates To Know

Panelist: Sean T MacDermant, International Paper, yorrie@macdart.com

3 - What Industry Wants Analytics Graduates To Know

Panelist: Alkis Vazacopoulos, Optimization Direct, Inc., alkis@optimizationdirect.com

■ SB07

102B-MCC

Data Mining in Decision Analytics: Predictive Modeling in Theory and Applications

Sponsored: Data Mining

Sponsored Session

Chair: Ali Dag, Auburn University, Auburn, AL, United States, azd0033@auburn.edu

1 - A Novel Sentiment Analytic Methodology For Multinomial Classification Of Product And Service Reviews

Ali Dag, Auburn University, azd0033@auburn.edu

The objective of this study is to classify the customer reviews (on a five-star scale) that were collected for 3 different product/service. To achieve this goal, a novel classification framework is built by constructing a unique predictor, which includes rich information gathered by using all of the extracted features. The results indicate that the proposed method outperforms the alternatives.

2 - Probabilistic Decision Analytic Risk Level Prediction Model For Kidney Transplants

Kazim Topuz, Wichita State University, Wichita, KS, United States, mktopuz@gmail.com, Mehmet B Yildirim, Ferhat Zengul, Ali Dag

The objective of this study is to define risk levels and offer additional insights into the factors affecting the short, medium and long-term success/failure of a kidney transplant from deceased donor by using machine learning techniques. We utilized an exhaustive variable selection algorithm to eliminate improper/noisy variables by combining medical knowledge and mathematical models on large pool of variables. Then we employed BBN to extract the hidden patterns and relations between predictor variables as well as multi-class response variable.

3 - Ensemble Model With Cluster Analysis For Short-term Stock Prediction

Bin Weng, Auburn University, Auburn, AL, 36849, United States, bzw0018@auburn.edu, Fadel Mounir Megahed, Chen Li

The stock market is one of the most important ways for companies and individuals to raise money due to the feature of publicity and high liquidity. Accurately predicting stock market is extremely difficult due to the non-linear, volatile and complex of the market. The purpose of this study is to develop a model to predict stock's short-term returns using disparate data sources from online data, economic data, technical indicators, and traditional history data. This study uses cluster analysis to cluster the trading days into different time periods and ensemble machine learning methods to develop the models for each period. As a result, the overall prediction performance has been increased.

■ SB08

103A-MCC

Health Care, Modeling II

Contributed Session

Chair: Shenghai Zhou, Shanghai Jiao Tong University, 1954 Hua Shan Road, Shanghai, 200030, China, zshsjtu2014@sjtu.edu.cn

1 - Planning And Scheduling Of Operating Rooms And Personnel Under Uncertainty

Dominic Johannes Breuer, PhD Candidate, Northeastern University, 360 Huntington Ave, Boston, MA, 02115, United States, dbreuer@coe.neu.edu, Nadia Lahrichi, James C Benneyan

De-centralized decision-making in complex operating room (OR) environments leads to sub-optimal resource allocations. In this study, we consider operating room planning and patient sequencing as well as clinician scheduling to minimize the number of open rooms, overtime, and patient wait while maximizing shift preferences, urgent case accommodation, and OR utilization. Uncertainties such as case duration, surgeon lateness, and staff availability by specialty are incorporated in realistic-sized scenarios through robust optimization.

2 - Second-order Conic Robust Optimization With Radiation Therapy Treatment Planning Of Breast Cancer

Zengbo Zhang, Beijing Institute of Technology, 5 South Zhongguancun Street, Beijing, 10081, China, zhangzengbo_1999@163.com

We incorporate robust optimization into CVaR to formulate a loss distribution under uncertainty. We demonstrate an application of our model to the radiation therapy treatment planning problem of breast cancer. In this therapy process, the dose distribution dependented on each state is uncertain. Our framework generalize and develop this type of uncertainty and that the uncertainty set is ellipsoidal, then the formulation can be re-written as second-order conic programs. Monte Carlo simulation example are presented to illustrate the proposed approach. Our results increased dosimetric performance for former treatment planning methods and improved cardiac sparing.

3 - Patient Assignment And Operation Room Scheduling Under Uncertainty Of Patient Cancellation And Operation Duration

Bowen Pang, Tsinghua univ., Beijing, China, pzkaixin@foxmail.com, Xiaolei Xie, Li Luo, Yongjia Song

Considering the multistage decisions faced by hospital practitioners under the uncertainties of operation duration and patient no-show in multiple operation rooms, we develop a Stochastic Integer Programming (SIP) model, in which all the objectives from different stakeholders are unified into costs. Bender's Decomposition is applied to enhance the performance for solving the SIP. A case study of West China Hospital, SCU is presented.

4 - Using A Slotted Queuing Model To Predict Collaborative Emergency Center Operational Performance

Peter Vanberkel, Dahousie University, PO Box 1000, Halifax, NS, B3H 4R2, Canada, peter.vanberkel@dal.ca, Alix Carter, Ben Wedge

Nova Scotia has developed a novel way to manage Emergency Department (ED) patients in small communities. Staffed by a paramedic and a RN, and overseen by physician via telephone, Collaborative Emergency Centres (CECs) and able to manage the few patients who seek emergency care overnight in a cost effective manner. This work models the performance of CECs using a slotted queuing model in a number of different communities. Using the model, it is found that a CEC's success is related to the proportion of demand for primary care appointments compared with the supply of primary care appointments.

■ SB09

103B-MCC

Renewable Energy Policies

Sponsored: Energy, Natural Res & the Environment I Environment & Sustainability

Sponsored Session

Chair: Sandra D. Eksioglu, Clemson University, Clemson, SC, United States, seksiog@clemson.edu

1 - Biomass Supply Contract Pricing And Environmental Policy Analysis: An Agent-based Modeling Approach

Shiyang Huang, Iowa State University, Ames, IA, United States, shuang@iastate.edu, Guiping Hu

This paper proposes an agent-based simulation model to study the biomass supply contract pricing and policy making in biofuel industry. Farmers' decision making is assumed to be profit driven and the biofuel producer's pricing decision is represented with a linear equation with an objective to maximize profits. A case based on Iowa has been developed to analyze the interactions between stakeholders. The impact of government environmental regulations on farmers' decision making and biomass supply has also been analyzed, and managerial insights have been derived.

2 - On The Effectiveness Of Tax Incentives To Support Biomass Co-firing

Hadi Karimi, Clemson University, hkarimi@clemson.edu, Sandra D. Eksioglu

We present models which capture the efficiency of renewable energy policies (such as, the production tax credit (PTC)) on biomass co-firing in coal-fired power plants. The efficiency measure assumed here is the sum of utilities (profits) obtained when power plants adopt biomass co-firing. The utilitarian approach identifies a PTC which maximizes this summation. We use the utilitarian solution as a basis for comparison with other PTC schemes, such as, flat tax rate and capacity based rate.

3 - A Game Theoretic Model Of Biomass Co-firing Policies

Sandra Eksioglu, Clemson University, seksiog@clemson.edu, Amin Khademi

We propose a bilevel optimization model for the optimal design of a production tax credit that optimizes renewable electricity production via biomass co-firing in coal-fired power plants. The policy maker identifies a tax credit scheme which minimizes the total tax credit necessary to meet GHG emission reduction standards at power plants. Power plants decide on biomass utilization in order to maximize their profits. We propose a solution algorithm and evaluate its performance on a case study.

4 - Evaluation Of A Wind Farm Project

Metin Cakanyildirim, The University of Texas at Dallas, metin@utdallas.edu

We discuss the evaluation of profit, revenues and costs of a wind farm. The revenue requires both wind energy generated and the sales price per unit of this energy. Generated energy is based on the wind speed and so is random. The price can also be random. Appropriate random variables for wind speed are introduced and their moments are evaluated. Costs are more predictable but government tax incentives can drastically affect profitability.

■ SB10

103C-MCC

Optimal Surveillance and Control of Bio-Invasions

Sponsored: Energy, Natural Res & the Environment I Environment & Sustainability

Sponsored Session

Chair: Esra Buyuktahtakin, Wichita State University, 1845 N Fairmount, Wichita, KS, Wichita, KS, 67260, United States, esra.b@wichita.edu

1 - Cooperative Management Of Invasive Species: A Dynamic Nash Bargaining Approach

Robert G Haight, USDA Forest Service Northern Research Station, St. Paul, MN, 55108, United States, rhaight@fs.fed.us Kelly Cobourn, Gregory Amacher

We use a Nash bargaining framework to examine scope for bargaining in invasive species problems where spread depends on the employment of costly controls. Municipalities bargain over a transfer payment that slows spread but requires an infested municipality to forgo nonmarket benefits from the host species. We find that when the uninfested municipality has a relative bargaining power advantage, bargaining may attain the first-best solution. However, in many cases a short-term bargaining agreement is unlikely to succeed, which suggests a role for higher levels of government to facilitate long-term agreements even when the details are left to municipalities to negotiate.

2 - Stochastic Programming Approaches To Surveillance And Control Planning For Emerald Ash Borer Infestations In Cities

Eyyub Yunus Kibis, Wichita State University, eykibis@wichita.edu, Esra Buyuktahtakin, Robert Haight

In this study, our objective is to maximize the net benefits of the ash trees on a landscape by applying surveillance to the ash population, followed by treatment or removal of trees based on the emerald ash borer (EAB) infestation level. Specifically, we propose a new multistage stochastic programming model which allows us to consider all possible scenarios for surveillance, treatment, and removal decisions over a planning horizon to control the invasion. Due to the model complexity, we use a decomposition technique to reach to optimal solutions for various initial scenarios. Results provide insights into surveillance and control policies, and provide an optimal strategy to reduce EAB infestation.

3 - Optimal Design Of A Nation-wide Surveillance System For Early Detection Of An Invasive Bark Beetle

Rebecca Epanchin-Niell, Resources for the Future, Epanchin-Niell@rff.org

Surveillance programs for early detection of new invaders can reduce long term costs by increasing the likelihood of successful eradication and reducing control and damage costs. We develop a model for allocating surveillance resources based on expected return on investment, in which resources are targeted first in areas with the highest expected benefits relative to costs. We define trapping benefits as the expected reduction in costs from active surveillance (i.e. trapping) relative to passive surveillance alone. We apply the approach to bark beetle detection programs in the U.S.

4 - Optimal Control Of Bio-invasions With Eradication Success Benchmarks And Management Of High Program Costs

Denys Yemshanov, Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Cente, Sault Ste. Marie, ON, P6A2E5, Canada, denys.yemshanov@canada.ca
Robert G Haight, Frank H. Koch, Robert Venette, Kala Studens, Ronald Fournier, Jean J Turgeon

We present a scenario-based model that incorporates uncertainty about the spread of an invasive pest and optimizes the deployment of survey and control measures to eradicate the outbreak. The model accounts for program success aspirations and controls the risk of high program costs. We apply the model to allocate surveys outside the quarantine area established following the discovery of Asian longhorned beetle in the Greater Toronto Area, Canada. Our approach is generalizable and helps support decisions on surveys and control of invasive pests when knowledge about a pest's spread is uncertain.

■ SB11

104A-MCC

Clusters, Routes and Flows in Network Systems

Sponsored: Optimization, Network Optimization

Sponsored Session

Chair: Foad Mahdavi Pajouh, University of Massachusetts Boston, 100 Morrissey Boulevard, Boston, MA, 02125, United States, foad.mahdavi@umb.edu

1 - Extreme-point Search Heuristics For Generalized Interval-flow Network Problems

Angelika Leskovskaya, Southern Methodist University, Dallas, TX, United States, aleskovs@lyle.smu.edu, Richard Barr

Generalized interval-flow networks are a new extension of the classic generalized network formulation that adds a conditional lower bound constraint on the arcs. An interval-pivoting heuristic that exploits the quasi-tree-forest basis structure to explore extreme points is developed and computational testing is presented.

2 - Detecting Central Clusters In Networks

Maciej Rysz, NRC, mwrysz@ufl.edu, Foad Mahdavi Pajouh

We propose a solution algorithm for identifying the most central clusters in graphs and examine its effectiveness when the centrality measure is defined by betweenness and the clusters represent cliques. Numerical experiments demonstrating the computational performance of the proposed method are conducted and compared with results obtained from solving an equivalent mixed integer programming representation.

3 - An Integrated Assignment Routing Network Representation For Solving The Multi Vehicle Routing Problem With Pickup And Delivery With Time Windows

Monireh Mahmoudi, Arizona State University, Tempe, AZ, 85283, United States, mmahmoudi@asu.edu, Chen Junhua, Xuesong Zhou

Generally, in the most commonly used exact approaches for solving the m-VRPPDTW, i.e., column generation and branch-and-cut, generating additional columns and cuts is an exhausting and time-consuming task. In this research, we intend to reach optimality for local clusters derived from a reasonably large set of passengers on real world transportation networks. In our proposed multi-vehicle state-space-time network, in order to keep only the non-dominated paths, we introduce the assignment-based hyper paths which embed passengers' cumulative service states. In addition, by the aid of our passengers' cumulative service patterns, we are able to take control of the symmetry issue.

■ SB12

104B-MCC

Approximation Algorithms in Networks and Scheduling

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Viswanath Nagarajan, University of Michigan, 1205 Beal Ave, Ann Arbor, MI, 48105, United States, viswa@umich.edu

1 - Approximating Min-cost Chain-constrained Spanning Trees: A Reduction From Weighted To Unweighted Problems

Chaitanya Swamy, Combinatorics & Optimization, University of Waterloo, 200 University Avenue West, Waterloo, ON, Canada, cswamy@uwaterloo.ca
Andre Linhares

We consider the problem of finding a min-cost spanning tree satisfying degree bounds for node-sets that form a chain. We give the first approximation algorithm for this problem that approximates both the cost and degree bounds by a constant factor. Our algorithm is based on a novel use of Lagrangian duality to simplify the cost structure of the underlying problem to obtain a decomposition into uniform-cost subproblems, and then using a known algorithm for the unweighted problem. We show that this Lagrangian-relaxation based idea is in fact applicable more generally and, for any cost-minimization problem with packing side-constraints, yields a reduction from the weighted to the unweighted problem.

2 - K-trails: Recognition, Complexity, And Approximations

Mohit Singh, Microsoft Research, mohitsinghr@gmail.com

Degree-constrained spanning hierarchies, also called k-trail, have been introduced to model network routing problems. Formally, they describe graphs that are homomorphic images of connected graphs of degree at most k. In this work, we show that computational aspects of k-trails can be analyzed using techniques from algorithmic matroid theory. Exploiting this connection, we resolve several open questions about k-trails raised by Molnar, Newman, and Sebo. The problems include the recognition of a k-trail and approximating the minimum weight k-trail in a graph.

3 - Stabilizing Unstable Graphs Through Minimum Modification

Karthik Chandrasekaran, UIUC, karthe@illinois.edu

An undirected graph G is stable if the max-fractional-matching LP (with degree and non-negativity constraints) has no integrality gap. Motivated by applications in cooperative game theory, we consider the optimization problem of achieving stability by modifying the graph to the smallest possible extent. We consider two modifications: min edge-deletion and min edge-weight-addition. We show that both these problems are NP-hard and develop approximation algorithms in certain families of graphs.

4 - Adaptive Submodular Ranking

Fatemeh Navidi, University of Michigan, navidi@umich.edu

We study a general adaptive ranking problem where we need to perform a sequence of actions on a random user, drawn from a known distribution, so as to satisfy the user as soon as possible. The user is said to be satisfied when its individual submodular function value goes above some threshold. We obtain a logarithmic factor approximation algorithm for this problem, which is the best possible. The adaptive ranking problem has many applications in active learning and ranking: it generalizes previously-studied problems such as optimal decision trees, equivalence class determination, decision region determination and submodular cover, for which our result matches the best known approximation ratio.

■ SB13

104C-MCC

Advances in Structured Nonconvex Optimization

Sponsored: Optimization, Global Optimization

Sponsored Session

Chair: Fatma Kilinc Karzan, Assistant Professor, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA, 15213, United States, fkilinc@andrew.cmu.edu

1 - Solving Standard Quadratic Programming By Cutting Planes

Andrea T. Lodi, École Polytechnique de Montréal, andrea.lodi@polymtl.ca

Standard quadratic programs are non-convex quadratic programs with the only constraint that variables must belong to a simplex. By a famous result of Motzkin and Straus, those problems are connected to the clique number of a graph. We propose cutting planes to obtain strong bounds: our cuts are derived in the context of Spatial Branch & Bound, where linearization variables represent products. Their validity is based on Motzkin-Straus result. We study the relation between these cuts and the ones obtained by the first RLT level. We present extensive computational results using the cuts in the context of the Spatial Branch & Bound implemented by the commercial solver CPLEX.

2 - Some Cut-generating Functions For Second-order Conic Sets

Asteroide Santana, Georgia Institute of Technology, Atlanta, GA, 30308, United States, asteroidemtm@gmail.com
Santanu Subhas Dey

In this paper, we study cut generating functions for conic sets. Our first main result shows that if the conic set is bounded, then cut generating functions for integer linear programs can easily be adapted to give the integer hull of the conic integer program. Then we introduce a new class of cut generating functions which are non-decreasing with respect to second-order cone. We show that, under some minor technical conditions, these functions together with integer linear programming-based functions are sufficient to yield the integer hull of intersections of conic sections in R2.

3 - Polynomial Dc Decompositions And Applications

Georgina Hall, Princeton University, Princeton, NJ, United States, gh4@princeton.edu, Amir Ali Ahmadi

Difference of Convex (DC) programming is a class of optimization problems where the objective and constraints are given as the difference of convex functions. Although several important problems (e.g., in machine learning) already appear in DC form, such a decomposition is not always available. We consider this decomposition question for polynomial optimization and present some new applications, primarily to distance geometry problems.

4 - A Second-order Cone Based Approach For Solving The Trust Region Subproblem And Its Variants

Nam Ho-Nguyen, Carnegie Mellon University, Pittsburgh, PA, United States, hnh@andrew.cmu.edu, Fatma Kilinc-Karzan

We study the trust region subproblem (TRS) of minimizing a nonconvex quadratic function over the unit ball with additional conic constraints. We follow a second-order cone based approach to derive an exact convex formulation of the TRS, and under slightly stronger conditions, give a low-complexity characterization of the convex hull of its epigraph without any additional variables. Our study highlights an explicit connection between the nonconvex TRS and smooth convex quadratic minimization, which allows for the application of cheap iterative methods to the TRS.

■ SB14

104D-MCC

OR In Agriculture

Invited: Agricultural Analytics

Invited Session

Chair: Margarit Khachatryan, Monsanto, United States, margarit.khachatryan@monsanto.com

1 - Government Interventions In Promoting Sustainable Practices In Agriculture

Duygu Akkaya, Stanford Graduate School of Business, Stanford, CA, United States, duygug@stanford.edu, Hau Lee, Kostas Bimpikis

Sustainable practices in agriculture such as organic farming have attracted immense attention lately due to the increase in environmental and health concerns. Government support is often used to incentivize producers to convert to sustainable practices. We investigate the effectiveness of government interventions including tax, subsidy and hybrid policies in terms of their impact on sustainable practice adoption, producers' profits, consumer welfare, and return on government spending using a setting in which producers with traditional and sustainable production options serve consumers that have a high valuation for sustainable production.

2 - Accelerating Digital Agriculture Through Automated R&D Trial Placement Into Field Zones

Qinglin Duan, Monsanto, St. Louis, MO, United States, qinglin.duan@monsanto.com, David Ciemnoczolowski

The trend towards Digital Agriculture requires increasing information on conditions within fields and corresponding decisions about product selection and management. To provide placement and management prescriptions, products must be tested across differing conditions within fields. We formulate the zone mapping problem as a 2D bin-packing model with trials of known dimensions and operational constraints. The model is integrated into Monsanto's geospatial field platform with analytics relating climate, soils, and topography to crop performance. Optimized placement has enabled representative testing across environments and set the foundation for advancements in digital agriculture.

3 - Combining Expert Estimates With Data To Obtain Hybrid Yield Distributions

Saurabh Bansal, Penn State University, sub32@psu.edu, Genaro J Gutierrez

We discuss a Copula based approach to combine expert judgments for yield distributions with data, and illustrate its application for the seed corn business.

4 - A Mathematical Model For Farm Scale Land Management Considering Uncertainty

Qi Li, Iowa State University, qili@iastate.edu, Guiping Hu

Farmers make decisions on types of crops to plant and irrigation frequency and pattern on an annual basis. This is often done under various uncertainties, such as precipitation amount, crop prices, and soil profile. In the study, a farm level precision farmland management model based on stochastic programming is proposed. The model focuses on the uncertainties in weather, yield and market prices. Advanced statistical methods such as time series analysis and spatial analysis are also investigated to generate representative realizations for the uncertainties.

■ SB15

104E-MCC

Building Better Models: Innovations in Predictive Analytics

Invited: Modeling and Methodologies in Big Data

Invited Session

Chair: CP Teo, NUS, 1 Business Link, Singapore, 598727, Singapore, bizteocp@nus.edu.sg

1 - Multi-product Pricing Problem Using Experiments

Zhenzhen Yan`, National University of Singapore, Singapore, Singapore, a0109727@u.nus.edu, Cong Cheng, Karthik Natarajan, Chung-Piaw Teo

We study the multi-product pricing problem using pricing experiments. In particular, we develop a data driven approach to this problem using the theory of marginal distribution. We show that the pricing problem is convex for a large class of discrete choice models, including the classical logit and nested logit model. Our model remains convex as long as the marginal distribution is log-concave. More importantly, by fitting data to optimize the selection of choice model, we develop an LP based approach to the semi-parametric version of the pricing problem. Preliminary tests using a set of automobile data show that this approach provides near optimal solution, even with random coefficient logit model.

2 - Disruption Risk Mitigation In Supply Chains – The Risk Exposure Index Revisited

Sarah Yini Gao, NUS, 1, Singapore, Singapore, yini.gao@nus.edu.sg, Chung-Piaw Teo, David Simchi-Levi

We proposed a new method to integrate probabilistic assessment of disruption risks into the REI approach, and measure supply chain resiliency by analyzing the Worst-case CVaR of total lost sales under disruptions. We show that the optimal emergency inventory positioning strategy in this model can be fully characterized by a conic program. Moreover, the optimal primal and dual solutions to the conic program can be used to shed light on comparative statics in the supply chain risk mitigation problem.

3 - Provably Data-Driven Approximation Schemes For Joint Pricing And Inventory Control Models

Hanzhang Qin, Massachusetts Institute of Technology, Cambridge, MA, United States, hqin@mit.edu, Davis Simchi-Levi, Li Wang

We propose a data-driven algorithm to solve the joint inventory and pricing problem for a single-product, multi-period model under independent demand. Our algorithm provides a near-optimal solution under any degree of accuracy and pre-specified confidence probability and requires polynomial number of sample data and is polynomial in the number of time periods. This algorithm differs from other online data-driven counterparts in the sense that we make all decisions based on past data only.

4 - Lockers Network: A Solution To Last Mile Delivery Problem

Guodong Lyu, National University of Singapore Business School, #B1-01, BIZ2 Building, 1 Business Link, Singapore, 117592, Singapre, 117592, Singapore, guodong.lyu@u.nus.edu
Chung-Piaw Teo

Lockers (Parcel Collection Point) are convenient for parcels collection. To maximize the coverage of failed delivery by using lockers, a novel locker location model is introduced and customer choice is considered as an input. We provide the mobile flow from stations to residence blocks, and use the mobility data to locate lockers. The mobile delivery flow is calculated based on the transportation data and failed delivery data. Customers' parcel collection behavior is estimated from locker usage data. Furthermore, lockers location data from an Express are provided to validate our model. We demonstrate that the value of using mobility date for failed delivery coverage maximization is significant.

■ SB16

105A-MCC

Algorithms for Stochastic Programming

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Natashia L Boland, Georgia Institute of Technology, 755 Ferst Drive, NW, Atlanta, GA, 30332, United States, natashia.boland@isye.gatech.edu

1 - Scenario Set Partition Dual Bounds For Multi-stage Stochastic Programming

Ilke Bakir, PhD Candidate, Georgia Institute of Technology, Atlanta, GA, 30309, United States, ilkebakir@gatech.edu
Natashia Boland, Brian Dandurand, Alan Erera

We propose expected partition (EP) bounds, a hierarchy of bounds based on partitions of the scenario set into subsets of (nearly) equal cardinality. Additionally, using the fact that solution of group subproblems for all subsets in a single partition also yields a dual bound, we establish that the best of even a very small number of such single partition bounds is likely to be better than the corresponding EP bound. By sampling partitions of the scenario set, we obtain an algorithm that computes confidence intervals for an EP bound, while also providing exact dual bounds. The practical value of these ideas is illustrated on benchmark problems, and the approach is compared to Sample Average Approximation.

2 - AMPL Representation And Solution Of Multiple Stochastic Programming And Robust Optimization Formulations

Christian Valente, OptiRisk Systems, One Oxford Road, Uxbridge, UB9 4DA, United Kingdom, christian@optirisk-systems.com,
Gautam Mitra, Christiano Arbex Valle, Robert Fourer

Paradigms of 'Uncertainty Models', namely, recourse, chance constrained, integrated chance constrained, and robust optimization models, are introduced and represented through use case exemplars. Through our continued research and close collaboration with AMPL Optimization we have now developed AMPL templates and frameworks which can describe these classes of models and connect them to respective solvers, making them readily available to industry-based analysts and to the academic research community. We also describe an E-book (in preparation) which captures the use cases that underpin our goal to make these modelling and solving capabilities widely available to the OR community.

3 - Combining Progressive Hedging And Frank-Wolfe To Solve The Lagrangian Dual Of a Multistage Stochastic Integer Program

Natashia Boland, Georgia Institute of Technology, natashia.boland@isye.gatech.edu, Jeffrey Christiansen, Brian Dandurand, Andrew Eberhard, James Luedtke, Jeffrey Linderoth, Fabricio Oliveira

We present a new primal-dual algorithm for computing the value of the Lagrangian dual of a stochastic mixed-integer program (SMIP) formed by relaxing its nonanticipativity constraints. The algorithm relies on the progressive hedging method, but unlike previous progressive hedging approaches for SMIP, it converges to the optimal Lagrangian dual value. The key improvement is an inner loop of optimized linearization steps, as in the classical Frank-Wolfe method. Numerical results show that the new algorithm outperforms the standard progressive hedging approach.

4 - First Order Approximation Methods For Estimating Decision Covariance In Stochastic Optimization

Sriram Sankaranarayanan, Johns Hopkins University, 3400, N. Charles St, Baltimore, MD, 21218, United States, ssankar5@jhu.edu, Felipe A Feijoo, Sauleh Ahmad Siddiqui

We use first order methods to efficiently approximate the covariance matrix of the optimal solution vector. The idea is extended for the covariance of the solution to a complementarity problem by posing the complementarity problem as an unconstrained minimization problem using the Fischer Burmeister merit function. Having done this, we estimate the variability in the estimated Market equilibrium of a Natural gas model, owing to uncertainty in the parameters of the demand function.

■ SB17

105B-MCC

Optimization Challenges in Modeling

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Leobardo Valera, University of Texas El Paso, 500 W. University Ave, El Paso, TX, 79968, United States, lvalera@miners.utep.edu

1 - Problem Of Moments Over Log-concave Measures

Christopher Thomas Ryan, The University of Chicago, Chicago, IL, United States, chris.ryan@chicagobooth.edu, Simai He, Bo Jiang, Teng Zhang

We explore the classical discrete problem of moments in a setting where the underlying distribution are discrete log-concave. This situation arises in applied problems such as reliabilit The challenge is that with log-concavity constraints, the problem of moments becomes a non-convex optimization problem. Nonetheless, we are able to characterize optimal extreme point solutions to such problems. Our approach gives rise to improved bounds over the existing literature, as well as analytical insight into the structure of extreme point optimal solutions as geometric distributions.

2 - Interval Constraint Solving Techniques And Model Order Reduction To Enhance The Solution Of Dynamic Systems

Leobardo Valera, The University of Texas at El Paso, lvalera@utep.edu, Martine Ceberio

Many natural phenomena are dynamic systems, which can often be modeled as nonlinear systems of equations. Major issues with solving such nonlinear systems are that their dimension can be very large and that uncertainty, often present, is tricky to handle. Reduced-Order Modeling (ROM) can address dimension issues, via Proper Orthogonal Decomposition (POD) in particular. On the other hand, interval constraint-solving techniques (ICST) allow to handle uncertainty and ensure reliable results. In this presentation, we show how ICST can be embedded into POD to address dimension and uncertainty.

■ SB18

106A-MCC

HPC in Optimization 1

Invited: High Performance Computing

Invited Session

Chair: Kibaek Kim, Argonne National Laboratory, 9700 South Cass Avenue, Building 240, Lemont, IL, 60439, United States, kimk@anl.gov

Co-Chair: Geoffrey Malcolm Oxberry, Lawrence Livermore National Laboratory, P. O. Box 808, Livermore, CA, 94551, United States, goxberry@gmail.com

1 - Asynchronous Parallelization Of Decomposition Methods

Kibaek Kim, Argonne National Laboratory, kimk@anl.gov

We present an approximate and incremental bundle method based on dual decomposition for stochastic mixed-integer programming (SMIP), where the Lagrangian dual function is incrementally updated by approximate subgradients as well as exact ones. We implemented the method in an open source parallel solver DSP, taking advantage of asynchronous communications on HPC cluster using MPI library. We present our computational results on several SMIP problem instances.

2 - Parallel Branch And Bound Revisited

Lluis-Miquel Munguia, Georgia Institute of Technology, lluis.munguia@gatech.edu, Geoffrey Malcolm Oxberry, Deepak Rajan

Branch and Bound (B&B) is a widely used algorithm for solving Mixed Integer Programs (MIPs). Despite its straightforward parallelization, current B&B implementations have shown to scale inconsistently. In this talk, we propose a new decentralized and lightweight implementation of parallel Branch & Bound for PIPS-SBB, a distributed-memory parallel stochastic MIP solver. In this work, we exploit parallelism at two levels of the optimization process with the objective of increasing parallel efficiency. We present computational results to evaluate the effectiveness of our approach.

3 - Scalable Strategies Exploited by Parallel Nonlinear Solver PIPS-NLP

Nai-Yuan Chiang, United Technology Research Center, chiangn@utrc.utc.com

We present PIPS-NLP, a software library for the solution of large-scale structured nonconvex optimization problems on high-performance computers. We focus on linear algebra parallelization strategies and discuss how such strategies influence the choice of algorithmic frameworks, while all the proposed approaches guarantee global convergence. Small examples about using parallel solver PIPS-NLP via AMPL or StructureJuMP are given, to illustrate how to exploit the problem structures. Numerical studies from large-scale security-constrained ACOPF and line-pack dispatch in natural gas networks also demonstrate the robustness and efficiency of PIPS-NLP.

■ SB19

106B-MCC

Bilevel Programming: Methodology and Applications

Sponsored: Computing

Sponsored Session

Chair: Juan S. Borrero, University of Pittsburgh, 1012 Benedum Hall, Pittsburgh, PA, 15261, United States, jsb81@pitt.edu

Co-Chair: M. Hosein Zare, University of Pittsburgh, 1012 Benedum Hall, Pittsburgh, PA, 15260, United States, moz3@pitt.edu

1 - A Sampling-based Exact Approach For The Bilevel Mixed Integer Programming Problem

Leonardo Lozano, Clemson University, llozano@g.clemson.edu Cole Smith

We examine bilevel mixed integer programs which are difficult to solve because the leader feasible region is defined in part by optimality conditions governing the follower variables, which are difficult to characterize because of the nonconvexity of the follower problem. We propose an exact finite algorithm for these problems based on an adaptive sampling scheme, and demonstrate how this algorithm can be tailored to accommodate either optimistic or pessimistic assumptions on the follower behavior. Computational experiments demonstrate that our approach outperforms existing algorithms that are tailored to problems in which all functions are assumed to be linear.

2 - On Bilevel Progams With Inexact Follower

M. Hosein Zare, University of Pittsburgh, moz3@pitt.edu

We consider classes of bilevel programs, where the upper-level decision-maker (i.e., the leader) needs to consider the uncertain behavior of the lower-level decision maker (i.e., the follower). We derive some theoretical properties of the proposed models, and illustrate our results with numerical illustrations.

3 - Reliable Vehicle Sharing Program Network Design

Ran Zhang, University of South Florida, ranzhang@mail.usf.edu, Bo Zeng

This talk develops a bi-level optimization model to achieve a reliable vehicle sharing program network design. A set of numerical study will be presented to demonstrate our design model.

4 - Sequential Max-min Bilevel Programming With Incomplete Information And Learning

Juan S. Borrero, University of Pittsburgh, jsb81@pitt.edu Oleg A Prokopyev, Denis R. Saure

We consider an adversarial bilevel problem where the leader and follower interact repeatedly. At each period the leader implements an upper-level solution after which the follower reacts by solving the lower-level problem. The leader has incomplete information about the variables, constraints, and data of the follower's problem, and learns about them from observing his reaction to her actions. Given that the leader's objective is to maximize the costs the follower incurs across all periods, we study a set of greedy and robust decision policies that are able to find an optimal solution to the full-information bilevel problem in finite time periods, and moreover, are worse-case optimal.

■ SB20

106C-MCC

Methods and Applications of Network Sampling

Invited: Tutorial

Invited Session

Chair: Mohammad Al Hasan, Indiana University/Purdue University, Department of Computer Science, Indianapolis, IN, 46202, United States, alhasan@iupui.edu

1 - Methods And Applications Of Network Sampling

Mohammad Al Hasan, Indiana University/Purdue University, Indianapolis, IN, 46202, United States, alhasan@iupui.edu

Network data appears in various domains, including social, communication, and information sciences. Analysis of such data is crucial for making inferences and predictions about these networks, and moreover, for understanding the different processes that drive their evolution. However, a major bottleneck to perform such an analysis is the massive size of real-life networks, which makes modeling and analyzing these networks simply infeasible. Further, many networks, specifically, those that belong to social and communication domains are not visible to the public due to privacy concerns, and other networks, such as the Web, are only accessible via crawling. Therefore, to overcome the above challenges, researchers use network sampling overwhelmingly as a key statistical approach to select a sub-population of interest that can be studied thoroughly. In this tutorial, we aim to cover a diverse collection of methodologies and applications of network sampling. We will base the discussion of network sampling in terms of population of interest (vertices, edges, motifs), and sampling methodologies (such as Metropolis-Hastings, random walk, and importance sampling). We will also present a number of applications of these methods.

■ SB21

107A-MCC

Applications in Healthcare

Sponsored: Health Applications

Sponsored Session

Chair: Sarah Kadish, Dana-Farber Cancer Instititue, 450 Brookline Ave, Boston, MA, 02215, United States, sarah_kadish@dfci.harvard.edu

1 - Determining The Optimal Schedule For Premixing Chemotherapy Drugs

Donald Richardson, University of Michigan, 2753 IOE Building, 1205 Beal, Ann Arbor, MI, 48109-2117, United States, donalric@umich.edu, Amy Cohn

In collaboration with the University of Michigan Comprehensive Cancer Center, we have developed an optimization-based approach to improve make-ahead policies for chemotherapy drugs for infusion patients. We first present our optimization model. Then we present our proposed user interface to aid our collaborators with interpreting the solutions.

2 - Operations Research Applications At A Comprehesive Cancer Center

Victoria Jordan, University of Texas MD, vsjordan@mdanderson.org

Industrial and Systems Engineering is an emerging field in healthcare. The University of Texas MD Anderson Cancer Center has Healthcare Systems Engineers working in the Office of Performance Improvement. This session will provide a high level overview of OR applications to improve patient flow and the patient experience, reduce costs, and improve safety. Also presented will be more clinical applications to improve delivery of care and the care itself.

3 - Factors That Predict Discharge Disposition At Admission For Veterans

Nicholas Ballester, Wright State University, 207 Russ Center, 3640 Col Glenn Hwy, Dayton, OH, 45435, United States, ballester.2@wright.edu, Pratik J Parikh

Discharge delays reduce inpatient quality of care and reverberate back through the health care system, tying up valuable resources needed by incoming patients. Discharge disposition, in particular, has a significant effect as different dispositions require vastly different procedures for insurance and transportation coordination. We have developed model to predict discharge disposition upon admission for veterans admitted to a general internal medicine unit. This model considers patient factors known at admission such as demographics, medical history, and living status. Preliminary findings from a trial implementation will also be discussed.

4 - Applications Of Real Time Locating Systems In Ambulatory Oncology

Sarah Kadish, Dana-Farber Cancer Instititue, Boston, MA, United States, sarah_kadish@dfci.harvard.edu, Constance Barysauskas, Ryan Leib, Avishai Mandelbaum, Petar Momcilovic, Arik Senderovich, Nikolaos Trichakis, Craig Bunnell

Real Time Locating Systems (RTLS) implementations have increased in the healthcare industry despite few studies supporting efficacy. In addition, the potential applications of RTLS as a tool for improving hospital operations management remains relatively unexplored. We sought to measure the improvement in quality of care and patient experience immediately after RTLS implementation. Furthermore, we explored the utility of RTLS in providing unbiased data to improve accuracy for chemotherapy scheduling. Finally, we demonstrate the ability for RTLS to assess impacts of large organizational changes such as the implementation of an Electronic Health Record on patient time in clinic.

■ SB22

107B-MCC

Panel: Challenges of Implementing OR in the Healthcare Industry

Invited: ORinformed Healthcare Policies

Invited Session

Moderator: Michael W Carter, University of Toronto, Toronto, ON, Canada, carter@mie.utoronto.ca

Implementing OR/MS in healthcare poses major challengers to practical researchers. The problems and the corresponding solutions are similar to those in industry and other service industries. So why is it so difficult? This panel brings together a group of researchers who have been successful in overcoming the challenges.

1 - The Challenge Of Lean; Working With Health Professionals Who Think O.R. Means Operating Room

Panelist: Martin L Puterman, University of British Columbia, martin.puterman@sauder.ubc.ca

2 - Developing Good Collaborations And Avoiding Bad Ones

Panelist: Brian T Denton, University Of Michigan, btdenton@umich.edu

3 - The Good, The Bad, And The Ugly Of Publishing Operations Research Work In Medical Journals

Panelist: Sheldon H Jacobson, University Of Illinois, shj@illinois.edu

4 - Struggles In Getting Data For Healthcare Research

Panelist: Amy Cohn, University Of Michigan, amycohn@umich.edu

5 - Moving The Needle In Public Health Decision Making

Panelist: Margaret L Brandeau, Stanford University, brandeau@stanford.edu

■ SB23

108-MCC

Joint Session MIF/HAS: Modeling and Optimization for Advanced Stage Liver and Kidney Disease Patients

Sponsored: Health Applications

Sponsored Session

Chair: Anahita Khojandi, University of Tennessee Knoxville, 521 John D. Tickle Building, 851 Neyland Drive, Knoxville, TN, 37996, United States, khojandi@utk.edu

Co-Chair: Murat Kurt, Merck Research Labs, 351 N. Sumneytown Pike, North Wales, PA, 19454, United States, murat.kurt7@gmail.com

1 - Optimal Liver Cancer Surveillance In Hepatitis C Infected Population

Qiushi Chen, Georgia Institute of Technology, Atlanta, GA, United States, chenqiushi0812@gatech.edu, Turgay Ayer, Jagpreet Chhatwal

Liver cancer is the fastest growing cause of cancer deaths in the United States. Although early diagnosis through can improve survival, the optimal surveillance policy remains unknown. We develop a mixed-integer programming-based framework to identify the most cost-effective surveillance policy. Our framework allows a formulation of practical policy structures. Our numerical results find that (1) the optimal surveillance interval should depend on patient's stage of hepatitis C and age, and (2) expanding surveillance to earlier stage of hepatitis C improves the cost-effectiveness of HCC surveillance.

2 - The Changing Etiology Of End Stage Liver Disease And The Implicationsfor The Liver Transplant Waitlist

Maria Mayorga, North Carolina State University, memayorg@ncsu.edu
Zinan Yu, Stephanie B Wheeler

Changes in the epidemiology of end stage liver disease will impact future liver transplant (LT) waitlist. We performed a discrete event simulation model to forecast both regional and national LT waitlist size, number of transplants, and hazard of waitlist drop out, while considering patient arrivals, demographic and clinical attributes, waiting time and liver availability.

3 - Investigating Steroid Withdrawal Strategies For Kidney Transplant Recipients

Yann B. Ferrand, Clemson University, Clemson, SC, United States, yferran@clemson.edu, Vibha Desai, Christina M. Kelton, Teresa M. Cavanaugh, Jaime Caro, Jens W. Goebel, Pamela C. Heaton

We evaluate various steroid withdrawal strategies for kidney transplant recipients. The goal is to minimize major complications resulting from these complex drug regimens over the long term. We develop a model calibrated with an econometric study of patient data from a national registry to simulate the long-term course of these patients. We report on the frequency and timing of adverse events and identify trade-offs in the steroid withdrawal strategies.

4 - Eliciting Patients' Revealed Risk Perceptions Of Dialysis And Death In Preemptive Living-donor Kidney Transplantation

Masoud Barah, University of Tennessee, Knoxville, TN, United States, mbarah@vols.utk.edu, Anahita Khojandi, Murat Kurt

When kidneys can no longer function at the level needed, patients must undergo either dialysis or transplantation to survive. Given empirical patterns in timing of pre-dialysis living donor transplantation, we investigate the behavioral dynamics behind patients' risk-averse behavior. We develop an inverse MDP model to elicit the perceived life-year loss associated with kidney failure or death due to delaying transplantation. We calibrate the model using clinical literature and publicly available datasets and provide insights on patients' perceptions of kidney failure and risk of death.

■ SB24

109-MCC

Ecology of Innovation: Sources of Knowledge and Complements

Invited: Strategy Science

Invited Session

Chair: Daniel Levinthal, University of Pennsylvania, Wharton School, Philadelphia, PA, 189, United States, levinthal@wharton.upenn.edu

1 - Intra-firm Spillovers? The Stock And Flow Effects Of Collocation

Evan Rawley, Columbia Business School, New York, NY, United States, erawley@columbia.edu, Robert Seamans

We study how intra-firm collocation—geographic clustering of establishments owned by the same parent company—influences performance, decomposing collocation effects to learn about the mechanisms behind intra-firm agglomeration. Using Census micro data on the population of U.S. hotels and restaurants 1977-2007, we find that doubling the intensity of intra-firm collocation is associated with a productivity increase of about 2%. Further analyses reveal that a significant component of the productivity gains persist after an establishment ceases to be collocated, suggesting that proximity to other establishments owned by the same parent firm facilitates the transfer of knowledge.

2 - Waste Reduction Strategies: Less Is More

Luca Berchicci, Erasmus University, Rotterdam School of Business, Rotterdam, Netherlands, Berchicci @erasmus.edu
Nilanjana Dutt, Will G Mitchell

Manufacturing firms seek to develop and implement techniques to improve production efficiency by obtaining information from various knowledge sources. Examining a greater number of knowledge sources should help firms find a viable solution to improve production efficiency, but it also raises the costs of collecting and using new information, which may ultimately hinder performance. Due to these tradeoffs, a key initial choice is how many knowledge sources to search. Based on U.S. manufacturing facilities that seek to improve production efficiency by reducing their annual toxic waste output, our results indicate that examining one knowledge source is the best approach.

3 - Reload And Relaunch: Strategic Governance Of Platform Ecosystems

Joost Rietveld, Erasmus University, Burgemeester Oudlaan 50, Mandeville (T) Building, Room 7-41, Rotterdam, 3072AP, Netherlands, rietveld@rsm.nl, Melissa A Schilling, Christiano Bellavitis

Platforms have a number of levers for managing their ecosystems. However, they must use them carefully: how and by whom value is captured is shaped by the dynamics between complementors and the platform itself. We develop a framework of value creation and value capture yielding implications for whether and when platforms should selectively promote complements. We analyze data from seventh generation video games, assessing both how games are selected for promotion, and how promotion affects sales. Platform owners do not promote best in class complements; they invest in underappreciated ones where there is more marginal value to be unlocked, and with whom the platform has greater bargaining power.

4 - Value-Based Outsourcing

Joaquín Poblete, Pontificia Universidad Catolica de Chile, s, s, Chile, joaco.poblete@gmail.com, Jorge Martabit

Using a value-based approach we analyze make-or-buy choices in settings in which value created by activities depend on the set of activities being performed. We show that when activities are complements, optimal make or buy choices tend to follow a common pattern, i.e., they are all insourced or outsourced, whereas firms tend to choose different governance modes when activities are substitutes. We also found that coordination advantages of insourcing are more important when activities are complements, while cost advantages of outsourcing are more important when activities are substitutes.

■ SB25

110A-MCC

Improving Efficiency of Supply Chains through Scheduling

Invited: Project Management and Scheduling

Invited Session

Chair: Chelliah Sriskandarajah, Texas A&M University, College Station, TX, United States, chelliah@mays.tamu.edu

Co-Chair: Yunxia Peter Zhu, Assistant Professor, Rider University, Sweigart Hall 358, 2083 Lawrenceville Road, Lawrenceville, NJ, 08648, United States, yuzhu@rider.edu

1 - Provider Selection Framework For Bundled Payments In Healthcare

Seokjun Youn, Texas A&M University, College Station, TX, United States, syoun@mays.tamu.edu, Anupam Agrawal, Subodha Kumar, Chelliah Sriskandarajah

Well-designed incentive system can lead to the successful operation of bundled payment program. Focusing on provider selection and evaluation problems, we develop a framework that aims to select better providers than existing method while balancing cost reduction, quality of care, and efficiency measures.

2 - A Framework For Analyzing The U. S. Coin Supply Chain

Yiwei Huang, Visiting Assistant Professor, The Pennsylvania State University, State College, PA, United States, yuh201@psu.edu

This is the first study that addresses operational issues within a Coin Supply Chain (CSC) and presents a framework, an optimal/near-optimal operating policy, and a robust planning system for the Federal Reserve System and Depository Institutions to increase their efficiency and effectiveness of coin ordering, producing, packaging, distribution, and inventory management by treating the U.S. CSC as a closed-loop supply chain from both supply and demand-side perspectives.

3 - Recent Results In Scheduling Dual Gripper Robotics Cells

Kyung Sung Jung, University of Florida, ksjung@ufl.edu, Harry Neil Geismar, Michael L Pinedo, Chelliah Sriskandarajah

We focus on the problem of finding 1-unit cyclic sequence of robot movements in dual-gripper buffer-less robotic cells designed to produce identical parts under the free-pickup criterion. We establish conditions where the problem of finding an optimal cycle is NP-hard. The remaining cases can be shown to be polynomial solvable.

4 - Cross-dock Terminal Scheduling

Yunxia Zhu, Rider University, yuzhu@rider.edu
Harry Neil Geismar, Chelliah Sriskandarajah, Inna Drobouchevitch

We study various scheduling problems encountered in cross-dock terminals. In a general cross-dock scheduling problem, a set of inbound trucks are assigned to a fixed number of unload docks. Items are first unloaded from these trucks then are transferred to outbound trucks to be dispatched to customers. The typical objective is to minimize the total time spent to perform such unloading and loading operations for a planning horizon. We also study other objective functions under various cross-dock terminal environments (e.g., with no-wait processing and with the presence of temporary storage).

■ SB26

110B-MCC

Procurement Auctions

Invited: Auctions

Invited Session

Chair: Martin Bichler, Technische Universitat Munchen, Munich, Germany, bichler@in.tum.de

1 - Trust In Procurement Interactions

Nicolas Fugger, ZEW Mannheim, L7, 1, Mannheim, 68161, Germany, nicolas.fugger@zew.de, Elena Katok

We investigate the observation that auctions in procurement can be detrimental to the buyer-seller relationship. Poor relationship can result in a decrease in trust by the buyer during the sourcing and an increase in opportunistic behavior by the supplier after the sourcing. We consider a setting in which the winning supplier decides on the level of costly quality to provide to the buyer, and compare a standard reverse auction and a buyer-determined reverse auction in the laboratory. We find that buyer-determined auctions result in higher prices but also improve cooperation between the buyer and the selected supplier.

2 - An Optimal Procurement Mechanism With Post-auction Cost-reduction Investigations

Qi (George) Chen, University of Michigan, Ann Arbor, MI, United States, georgeqc@umich.edu, Damian Beil, Izak Duenyas

This paper studies the optimal mechanism design problem of a buyer who needs to procure from a pool of qualified suppliers in a setting where she can choose to investigate the suppliers to identify cost-reduction opportunities which reduce their costs after the bids are collected, and then awards the contract. We fully characterize the optimal mechanisms and show that for symmetric suppliers, our mechanisms create ex ante win-win situations for everyone compared to the optimal mechanism without investigations. The win-win situation may break down when suppliers are sufficiently asymmetric, but no supplier has the incentive to unilaterally block investigation.

3 - Linear Pricing In Large-scale Combinatorial Exchanges

Vladimir Fux, Technical University of Munich, vladimir.fux@tum.de, Martin Bichler

Linear and anonymous competitive equilibrium prices are desirable in multi-object auctions, but unfortunately such prices typically do not exist in combinatorial exchanges. We discuss the market design of a large-scale combinatorial exchange for fishery access rights where linear and anonymous prices is a requirement and minor efficiency loss can be tolerated. We analyze the trade-offs of different payment rules relevant for an auction designer, in particular with respect to the welfare loss they incur. Via analytical models and numerical simulations, we show that these losses can be up to 100% in worst-case scenarios, but that these losses are small on average in larger markets.

4 - Equilibrium Bidding Strategies In Ex-post Split-award Auctions With Diseconomies Of Scale

Gian-Marco Kokott, Technical University of Munich, Munich, Germany, gian.marco@dss.in.tum.de, Martin Bichler, Per Paulsen

Ex-post split-award auctions are a wide-spread form of combinatorial procurement auctions. We focus on markets with diseconomies of scale, which is practically relevant and strategically challenging, since bidders have to coordinate on the efficient outcome. We show that the first-price sealed-bid and the Dutch ex-post split-award auction are not strategically equivalent. The first-price sealed-bid format exhibits a coordination problem for bidders, whereas the Dutch has a unique and efficient equilibrium. We also analyze a combination of both formats and compare all three auctions with respect to efficiency and costs. In lab experiments, we find support for the theoretical results.

■ SB27

201A-MCC

Diagnosis Under Uncertainty

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Sarang Deo, Indian School of Business, Hyderabad, India, sarang_deo@isb.edu

Co-Chair: Tinglong Dai, Johns Hopkins University, Baltimore, MD, United States, dai@jhu.edu

1 - False Diagnosis And Overtreatment In Services

Senthil Veeraraghavan, University of Pennsylvania, senthilv@wharton.upenn.edu

In many services, consumers must rely on experts to identify the type of service they need. In such service, diagnosis is a crucial step in which the expert identifies the problem and provides the corresponding treatment. The information asymmetry leads to inefficiencies in the form of overtreatment. Overtreatments are expensive but also require more service capacity and time, and thus result in longer delays and higher waiting costs for services. However, we find that such delays act as a natural "fraud cost" and mitigates expert cheating and induce honesty. Experts high capacity utilization are less prone to overtreat.

2 - Conspicuous By Its Absence: Diagnostic Expert Testing Under Uncertainty

Tinglong Dai, Assistant Professor, Johns Hopkins University, 100 International Drive, Baltimore, MD, 21202, United States, dai@jhu.edu, Shubhranshu Singh

Diagnostic experts, such as medical doctors, are crucial for evaluating the state of the world. All diagnostic experts are not equally competent, and even the best experts are imperfect. We model the decision-making process of a diagnostic expert, who is altruistic but concerned about reputation. Our paper presents interesting insights about the expert's test-ordering behavior primarily driven by reputation concerns.

3 - Incentizing Less-than-Fully-Qualified Providers For Early Diagnosis Of Tuberculosis In India

Sarang Deo, Indian School of Business, sarang_deo@isb.edu
Milind Sohoni, Neha Jha

A major driver of TB epidemic in India is delay in diagnosis by less-than-fully-qualified providers (LTFQs), who are typically the first point of contact for patients. This work is motivated by pilots funded by international donors to provide monetary incentives to LTFQs to induce earlier referral and diagnosis. Using a game-theoretic model, we show that the optimal structure of the incentive referral contract (whether to pay for all referrals or only for confirmed referrals) depends on the quality of diagnosis of the provider. We calibrate our model results using realistic parameter estimates obtained from primary and secondary data sources.

4 - Medical Guideline Making When Litigation Is A Concern: The Role Of Ubiquitous Health Information

Mehmet U Ayvaci, University of Texas-Dallas, 800 W. Campbell Rd. SM33, Richardson, TX, 75080, United States, Mehmet.Ayvaci@utdallas.edu, Yeong In Kim, Srinivasan Raghunathan, Turgay Ayer

We examine the optimal formulation of guidelines in a generic health screening with consideration for the physician's increased liability risk under ubiquitous health information and information technologies. We find that under the litigation concern, the social planner strategically provides imprecise guidelines with vague recommendations regarding which patients should undergo the test while providing precise guidelines regarding the physician's decisions based on test results. Strategic vagueness in guidelines balances the trade-off between the reduction of defensive medicine and supply of the health service.

■ SB28

201B-MCC

MSOM Student Paper Competition Finalists – II

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Sameer Hasija, Insead, 1 Ayer Rajah Avenue, Singapore, 138676, Singapore, sameer.hasija@insead.edu

Co-Chair: Tolga Tezcan, London Business School, Regent's Park, London, NW1 4SA, United Kingdom, ttezcan@london.edu

Co-Chair: Nicos Savva, London Business School, Regent's Park, London, NW1 4SA, United Kingdom, nsavva@london.edu

2 - Economies of Scale and Scope in Hospitals

Michael Freeman, University of Cambridge, Cambridge, United Kingdom. mef35@cam.ac.uk

Abstract to come

3 - Online Decision-Making with High-Dimensional Covariates

Hamsa Bastani, Stanford University, Stanford, CA, bayati@stanford.edu

Big data has enabled decision-makers to tailor decisions at the individual-level in a variety of domains such as personalized medicine and online advertising. This involves learning a model of decision rewards conditional on individual-specific covariates. In many practical settings, these covariates are high-dimensional; typically only a small subset of the observed features are predictive of a decision's success. We formulate this problem as a multi-armed bandit with high-dimensional covariates, and present a new efficient bandit algorithm based on the LASSO estimator. Our regret analysis establishes that our algorithm achieves near-optimal performance in comparison to an oracle that knows all the problem parameters. The key step in our analysis is proving a new oracle inequality that guarantees the convergence of the LASSO estimator despite the non-i.i.d. data induced by the bandit policy. Furthermore, we illustrate the practical relevance of our algorithm by evaluating it on a real-world clinical problem of warfarin dosing.

4 - Real-time Optimization of Personalized Assortments

Negin Golrezaei, USC Marshall School of Business, Los Angeles, CA, golrezae@usc.edu

Abstract to come

■ SB29

202A-MCC

Innovations in the Operations-Marketing Interface

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Jose A Guajardo, University of California-Berkeley, Berkeley, CA, United States, jguajardo@berkeley.edu

1 - Does Online Learning Work In Retail?

Serguei Netessine, INSEAD, serguei.netessine@insead.edu
Marshall L Fisher, Santiago Gallino

We partnered with Experticity, a firm that provides online training modules for retail Store Associates, and Dillard's, a leading department store chain whose more than 50,000 Store Associates had access to the Experticity product training modules. We found that as Store Associates engaged in training over time, their sales rate increased by 1.8 percent for every module taken. We also found that willingness to engage in voluntary training was an indicator of raw talent; those Store Associates who engaged in training were 20 percent more productive prior to any training, and 46 percent more productive after training, than those who took no training.

2 - Business Models In The Sharing Economy: Manufacturing Durable Goods In The Presence Of Peer-to-peer Rental Markets

Zhe Zhang, Carnegie Mellon University, 4800 Forbes Avenue, Pittsburgh, PA, 15213, United States, zhezhang@cmu.edu
Vibhanshu Abhishek, Jose A Guajardo

Business models focusing on providing access to assets rather than on transferring ownership of goods have become an important recent industry trend. Motivated by this trend, this research analyzes the interaction between a manufacturer of durable goods and a peer-to-peer marketplace, characterizing market outcomes under alternative market structures.

3 - When The Bank Comes To You: Branch Network And Custsomer Multi-channel Banking Behavior

Vibhanshu Abhishek, CMU, vibs@andrew.cmu.edu
Beibei Li, Dan Geng

Customers today increasingly interact with their banks using digital channels, lifting the necessity for banks to rethink the distribution of physical branches and customer behavior in a multi-channel environment. Using approximately 1.2M anonymized individual-level data from a large commercial bank in US over 6 years, our paper investigates the traditional channel - bank branches - and the impact of its network change (branch opening or closure) on customer multi-channel preferences and other banking behavior.

■ SB30

202B-MCC

Social and Environmental Considerations in Retailing

Sponsored: Manufacturing & Service Oper Mgmt
Sponsored Session

Chair: Xiajun Amy Pan, University of Florida, Gainesville, FL, United States, amy.pan@warrington.ufl.edu

Co-Chair: Dorothee Honhon, University of Texas at Dallas, Richardson, TX, United States, dorothee.honhon@utdallas.edu

1 - Social Labeling: Leaderboard Or Threshold Policy?

Xiajun Amy Pan, University of Florida, amy.pan@warrington.ufl.edu, Quan Zheng, Asoo Vakharia

Labeling, as a way to certify corporate social performance, is widely adopted in practice. However, little attention has been paid to the endogenous choice of a labeling policy. Should the label be awarded to manufacturers based on absolute performance (threshold policy) or relative performance (leaderboard policy)? We address this question through a mechanism design perspective. Our findings are that an impact-motivated third-party organization should confer the label on the best manufacturer provided it meets a threshold. On the other hand, a profit-maximizing retailer should select a certain number of manufacturers who outperform the others in the set without setting a threshold.

2 - The Impact Of Supply Chain Contracts On Inventory Shrinkage: Inference From Packaged Food Products

Min Choi, Arizona State University, mchoi9@asu.edu
Elliot Rabinovich, Timothy Richards

This paper examines the effect of supply chain contracts on inventory shrinkage using a data set from a packaged bakery manufacturer in the U.S. We find that the amount of inventory shrinkage tends to be higher under scan-based (SBT) contracts compared to vendor-managed inventory (VMI) contracts when measured in terms of both explicit and non-explicit shrink. We attribute this effect to retailers' moral hazard under SBT contracts. Our findings highlight a potential loss in efficiency in food supply chains reflected in higher inventory shrinkage under SBT contracts. Our study calls for a careful reexamination of emerging contractual forms in light of their potential impact on inventory waste.

3 - Online Grocery Retail: Revenue Models And Environmental Impact

Elena Belavina, The University of Chicago, ?, chicago, IN, 6, United States, elena.belavina@chicagobooth.edu

We compare the financial and environmental performance of two revenue models for the online retailing of groceries: the per-order and the subscription model. We find that subscription incentivizes smaller and more frequent orders, which reduces food waste and results in higher retailer revenues. These advantages are countered by greater delivery-related travel and expenses. Subscription leads to lower food waste-related emissions but to higher delivery-related emissions. Geographic and demographic data indicate that the subscription model is almost always environmentally preferable because lower food waste emissions dominate higher delivery emissions.

4 - Incorporating Consumer Attitudes To Minimise Waste And Out-of-stock Situations In Food Retail

Emel Aktas, Senior Lecturer, Cranfield University, Cranfield, United Kingdom, emel.aktas@cranfield.ac.uk
Soroosh Saghiri, Zeynep Topaloglu, Tamara van 't Wout, Akunna Oledinma, Zahir Irani, Amir Sharif, A. K. Samsul Huda

Inventory management of perishable food products is not straightforward since the demand volatility for these products is usually high. Consumer behavior is influenced by many factors, particularly the product availability and the expiry date of the product. Product inventory is to meet the customer demand and due to short shelf life it cannot act as a buffer against demand fluctuations. We study the optimal inventory policies to minimize food waste and stock-out situations based on the expiry dates and consumer preferences. Implications for the environment follow from reduced food waste.

■ SB31

202C-MCC

Empirical Research in Supply Networks

Sponsored: Manufacturing & Service Oper Mgmt, iFORM
Sponsored Session

Chair: Vishal Gaur, Cornell University, 321 Sage Hall, Ithaca, NY, 14850, United States, vg77@cornell.edu

Co-Chair: Yasin Alan, Vanderbilt University - Owen Graduate School of Management, 401 21st Avenue South, Nashville, TN, 37203, United States, yasin.alan@owen.vanderbilt.edu

1 - Evolution Of Supply Networks

Nikolay Osadchiy, Emory University, nikolay.osadchiy@emory.edu, Vishal Gaur, Maximiliano Udenio

Using a large panel of firm-level buyer-supplier relationships, we study evolution of supply networks over time.

2 - Inaccurate Durations And Supply Chain Disruptions

William Schmidt, Cornell University, wschmidt@cornell.edu, Mili Mehrotra

We use supply chain and production data from a division of a Fortune 500 multinational manufacturer to examine the operational performance impact of inaccurate supply chain disruption duration estimates. We find that such inaccuracies can materially increase the cost of the disruption. This effect (1) persists after controlling for the actual length of a disruption and (2) can occur regardless of whether the disruption duration is initially over-estimated or under-estimated. We identify several factors that contribute to the impact of inaccurate estimates.

3 - Using Delay Forecasting To Correct Airline Turn Time Misallocation

Yannis Stamatopoulos, McCombs School of Business, Austin, TX, United States, yannis.stamos@mccombs.utexas.edu, Jun Li, Carlos Carvalho

Achieving good on time performance (OTP) is a challenging task for airlines. At the center of this challenge is the tradeoff between utilization and resilience. For example, longer turn times increase network resilience by reducing propagated flight delay, but at the same time keep airplanes away from flying and generating revenues. In this work, using proprietary data from a large US airline, we examine how an airline can manage turn times smartly from a network perspective. We find evidence for a potential significant improvement in OTP without hurting revenues.

4 - Shock Propagation In Supply Chain Networks

Jing Wu, University of Chicago, jwu7@chicagobooth.edu

Firms do not exist in isolation but are linked to each other through supply chain relationships. How do firm-level information transmits in the supply chain networks empirically? In this talk, we show both average shock propagation as reflected in stock returns, and extreme shock propagation as reflected in credit default swaps. The results are supported by supply chain theory and also have practical value in investment.

■ SB32

203A-MCC

Scheduling II

Contributed Session

Chair: Mauricio G. C. Resende, Amazon.com, Inc., 2483 Birch Ave N, #512, Seattle, WA, 98109, United States, resendem@amazon.com

1 - Online Lazy Bureaucrat Scheduling With A Machine Deadline

Ling Gai, Shanghai University, Shanghai, 201444, China, lgai@shu.edu.cn

The lazy bureaucrat scheduling problem was first introduced by Arkin et al. in 1999. Since then, a number of variants have been addressed. However, very little is known on the online version. In this note we focus on the scenario of online scheduling, in which the jobs arrive over time. The bureaucrat (machine) has a working time interval. Namely, he has a deadline by which all scheduled jobs must be completed. A decision is only based on released jobs without any information on the future. We consider two objective functions of [min-makespan] and [min-time-spent]. Both admit best possible online algorithms with competitive ratio of 1.618.

2 - A Model For Scheduling Practical Lessons And Selecting Teaching Assistants At Universities

Cristian D Palma, Assistant Professor, Universidad del Desarrollo, Avda. Sanhueza 1750, Pedro de Valdivia, Concepcion, 4040418, Chile, cristianpalma@ingenieros.udd.cl, Pablo Gonzalez, Pamela Riffo

Most of the courses at universities includes practical sessions taught by teaching assistants (TA), which are also students. These sessions are usually scheduled as part of the courses, so the day and time when they are taught are known when students register their courses. Since TAs have to attend their own courses, they apply for teaching only in courses that match their own schedules rather than courses they are good at. We propose a framework in which practical sessions are scheduled after course registration, and show a model that schedules practical sessions and simultaneously selects the TAs for each course. We discuss the advantages of using this approach and present results of its application.

3 - Scheduling Virtual Network Embeddings

Frank Fischer, University of Kassel, Heinrich-Plett-Str. 40, Kassel, 34132, Germany, frank.fischer@mathematik.uni-kassel.de, Andreas Bley

The virtual network embedding problem aims to embed several virtual network (VN) requests, each consisting of several node and connection services that require certain CPU, memory and bandwidth resources, into a shared physical substrate network in such a way that the resources available in the substrate network are not exceeded.

We consider the dynamic version of this problem, where VN requests have time windows and durations specifying when and how long they should be embedded. We discuss several mixed integer and constraint programming approaches for this combined embedding and scheduling problem. Our computational results show that a combination of both techniques performs best.

4 - An Improved Genetic Algorithm For Job-shop Scheduling

Mauricio G. C. Resende, Principal Research Scientist, Amazon.com, Inc., 333 Boren Ave N, Seattle, WA, 98109, United States, resendem@amazon.com
José F. Gonçalves

We present a local search, based on a new neighborhood for the job-shop scheduling problem, and its application within a biased random-key genetic algorithm. Schedules are constructed by decoding the chromosome supplied by the genetic algorithm with a procedure that generates active schedules. After an initial schedule is obtained, a local search heuristic, based on an extension of the 1956 graphical method of Akers, is applied to improve the solution. The new heuristic is tested on a set of 205 standard instances taken from the job-shop scheduling literature and compared with results obtained by other approaches. The new algorithm improved the best-known solution values for 57 instances.

■ SB33

203B-MCC

Simulation and Optimization II

Contributed Session

Chair: Ryan Lawhead, Research Assistant to Dr. Gosavi, Missouri University of Science and Technology, 223 Engineering Management Building, Rolla, MO, 65409, United States, rjlm97@mst.edu

1 - A Study on The Operations Analysis Using Big Data Developed by Simulations

Hongseon Park, University of Central Florida, Orlando, FL, United States, gauss1211@naver.com, Won Il Jung, Yong Bok Lee, Gakgyu Kim, Gene Lee, Rabelo Luis

The operations analysis is analyzed under simulation circumstances. A lot of assumptions and limited environments are included and, thus, the results have a bias. To overcome this problem, we proposed a new methodology for the operations analysis using Big Data developed by Virtual and Constructive (VC) simulations. The VC simulations can produce a large volume and variety of data since many variables are used for analyzing the operations close to reality by using 6 Degrees of Freedom models. More than terabytes of data including structured and unstructured types are applied to the current techniques of Big Data. Then we will build the probability map and index to help the commanders make decisions.

2 - Cloud Based Collaborative Information Sharing In Supply Chains

Cigdem Kochan, Assistant Professor, Ohio Northern University, Dicke College of Business Administration, 525 S Main St, Ada, OH, 45810, United States, cigdem.kochan@gmail.com, David R. Nowicki

This research develops system dynamics models to simulate the effect of cloud based collaborative information sharing in a supply chain. The results suggest that the use of the cloud based information sharing in supply chain reduces inventory levels, reduces actual lead time through demand and inventory visibility, and reduces delivery delays while increasing overall performance of the supply chain.

3 - A Fully Exploratory Reinforcement Learning Algorithm For Solving Semi-Markov Decision Processes

Angelo Encapera, Research Assistant, Missouri University of Science & Technology, Rolla, MO, 65409, United States, amet3b@mst.edu, Abhijit Gosavi

We study the development of a fully exploratory Reinforcement Learning (RL) algorithm for solving Semi-Markov Decision Processes (SMDPs). Existing RL algorithms, such as R-SMART, for solving SMDPs require gradual decay of exploration. The latter adds a tuning parameter to the algorithm, and indeed its success depends on how the exploration-decay parameter is tuned. Our algorithm uses a "reflective" update that accompanies the main update, based on relative Q-Learning, to estimate the average reward without decaying the exploration. Our algorithm delivers encouraging empirical behavior.

4 - A Bounded Actor Critic Algorithm For Reinforcement Learning

Ryan Lawhead, Research Assistant to Dr. Gosavi, Missouri University of Science and Technology, 223 Engineering Management Building, Rolla, MO, 65409, United States, rjlm97@mst.edu, Abhijit Gosavi, Susan Murray

Actor-critic algorithms are amongst the oldest reinforcement learning algorithms that can be used to solve Markov decision processes (MDPs) via simulation. Unfortunately, the values of the "actor" in the classical version of this algorithm get unbounded in practice. In practice, the actor's values are artificially constrained to obtain solutions. Boltzmann action selection is used for this algorithm in which a temperature is used, but the convergence of the algorithm is guaranteed only when the temperature equals 1. We propose a new actor-critic algorithm in which the actor's values are bounded even when the temperature is set to 1. Our algorithm delivers encouraging numerical behavior.

■ SB34

204-MCC

Data-Driven Decisions in Healthcare

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Vishal Ahuja, Southern Methodist University, Dallas, TX, United States, vahuja@smu.edu

1 - Optimizing Cancer Prevention Strategies For BRCA1/2 Mutation Carriers

Elisa Frances Long, Assistant Professor, UCLA Anderson School of Management, Los Angeles, CA, United States, elisa.long@anderson.ucla.edu, Eike Nohdurft, Stefan Spinler

BRCA1/2 mutation carriers face significantly elevated lifetime risks for breast and ovarian cancer. Prophylactic surgery (bilateral mastectomy, oophorectomy, or both) can reduce the risk of cancer but may impact health utility. We developed a Markov decision process model to determine the optimal age to undergo surgery to maximize quality-adjusted life years or survival. Key state variables include age, mutation type, breast cancer stage and sub-type, ovarian cancer stage, and preventive surgery status. We solve the model with linear programming and compute the optimal policy for different parameter settings reflecting varying mutation carrier's preferences.

2 - Predictive Models For Making Patient Screening Decisions

Michael Hahsler, Southern Methodist University, Dallas, TX, United States, mhahsler@lyle.smu.edu, Vishal Ahuja, Michael Bowen

A critical dilemma that clinicians face is when and how often to screen patients who may suffer from a disease. The stakes are heightened in the case of chronic diseases that impose a substantial cost burden. We investigate the use of predictive modeling to develop optimal screening conditions and assist with clinical decision-making. We use electronic health data from a major U.S. Hospital and apply our models in the context of screening patients for type-2 diabetes, one of the most prevalent diseases in the U.S. and worldwide.

3 - Belief Perseverance And Experience

Bradley R Staats, University of North Carolina at Chapel Hill, bstaats@unc.edu, Diwas S KC, Francesca Gino

Many models in operations management involve dynamic decision making that assumes optimal updating in response to information revelation. However, behavioral theory suggests that rather than updating their beliefs, individuals may persevere in their prior beliefs. We examine how individuals' prior experiences and the experiences of those around them alter their belief perseverance in operational decisions after the revelation of negative news using a field experiment and two lab experiments.

4 - Being On The Productivity Frontier: Identifying “Triple Aim Performance” Hospitals

Sriram Venkataraman, University of South Carolina, sriram.venkataraman@moore.sc.edu
Aleda Roth, Anita L Tucker, Jon A Chilingerian

Hospital decision makers may face tradeoffs that make it difficult to achieve relatively high performance simultaneously on cost, clinical quality and patient experience. We empirically examine the association between having high performance on any of the three criteria on the probability of being a U.S. News & World Report honor roll hospital. Surprisingly, we find a significant negative relationship exits between being an honor roll hospital and achieving high performance outcomes on any of the three TAP criteria. Furthermore, we find that the percent of physicians employed by the hospital has a positive and significant effect on being a TAP hospital.

■ SB35

205A-MCC

Behavioral Models in Service Operations

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Guillaume Roels, UCLA, Anderson School of Management, Los Angeles, CA, 90095, United States, groels@anderson.ucla.edu

1 - Pricing With Consumer Optimism And Quality Perception: From Experiment To Theory

Rim Hariss, Massachusetts Institute of Technology, 254Windsor Street, Apt 2L, Cambridge, MA, 02139, United States, rhariss@mit.edu, Georgia Perakis, Wichinpong Sinchaisri, Yanchong Zheng

We study how consumers’ optimism about future markdowns and their quality perceptions influence a firm’s optimal markdown pricing strategy. We experimentally elicit the relationship between consumers’ perceived quality of a product and the product’s price information (e.g., initial price, discount, final selling price). We estimate a functional relationship from the data and incorporate this relationship into consumers’ purchase behavior. We then characterize the firm’s optimal policy given that consumers form price-based quality perceptions and may hold inaccurate expectation of the level of future markdown.

2 - Impact Of Server Behavior On The Performance Of Queueing Systems

Masha Shunko, University of Washington, mshunko@gmail.com

Multi-server single-queue (SQ) systems may outperform multi-server parallel-queue (PQ) systems due to the pooling effect. We model and analyze the impact of human server behaviors (namely, slowdown due to free riding and workload-dependent service rate) on the performance of SQ and PQ systems and derive how large the behavioral impacts should be to outweigh the benefits of pooling.

3 - Pooling Queues With Work Averse Servers

Guillaume Roels, UCLA, groels@anderson.ucla.edu, Mor Armony, Hummy Song

Contrary to the classical theory of operations management, recent case studies in retail, call centers, and healthcare indicate that pooling queues may not necessarily result in less expected work in process. In this paper, we propose that this phenomenon may arise when servers are work averse and have some discretion over their choice of service capacity. We distinguish two types of work aversion, namely workload aversion and busyness aversion, and show that dedicated configurations yield less expected work in process than pooled configurations when servers exhibit high degrees of workload aversion or low degrees of busyness aversion.

■ SB36

205B-MCC

Incentives and Risk in Supply Chains

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: Karan Girotra, INSEAD, Fontainebleau, France, karan.girotra@insead.edu

Co-Chair: Simone Marinesi, Wharton, Philadelphia, PA, United States, marinesi@wharton.upenn.edu

1 - Fleet Management For Healthcare Delivery In Africa: Vehicle Ownership And Contracting Models

Sang-Hyun Kim, Associate Professor, Yale University, New Haven, CT, United States, sang.kim@yale.edu, Li Chen, Hau Leung Lee

In this paper we study an innovative healthcare product delivery system that Riders for Health, a nonprofit organization based in UK, has implemented in a number of African nations. Health products are delivered to rural areas via motorcycles in difficult transportation conditions, and therefore it is critical to run an effective vehicle maintenance program. Riders for Health experimented with different contractual agreements with government agencies. We build a model based on reliability theory and contract theory that captures the essence of the problem that Riders faced, and discuss managerial insights that the model predicts.

2 - Learning (or Not) From Precursors To Disasters

Heikki Peura, Imperial College, London, United Kingdom, hpeura@london.edu, Nitin Bakshi

Disasters are invariably preceded by more frequent precursor events. These events embed valuable information about the likelihood of the root cause of a disaster, and thereby facilitate risk assessment. But to learn from precursors, a managing firm typically relies on the reports of a contractor, who is often also responsible for mitigating the occurrence of these incidents. We show how firms may fail to learn from precursor events due to the resulting intertwined problems of moral hazard (on risk mitigation) and hidden information (on reporting precursors).

3 - Supply Disruptions And Optimal Network Structures

Kostas Bimpikis, Stanford, kostasb@stanford.edu, Ozan Candogan, Shayan Ehsani

We study multi-tier supply chain networks in the presence of disruption risk. Firms compete in one of K production stages and prices of intermediate goods are set so that markets clear. We characterize equilibrium prices, profits, and sourcing decisions and explore how they are affected by the network structure. Also, we identify the network structures that maximize aggregate profits, welfare, and consumer surplus. Interestingly, these networks can be ranked in terms of how “balanced” the supply chain is. Finally, we consider endogenous chain formation and argue that it leads to inefficiencies both in terms of the number of firms that enter and in terms of the structure of the resulting networks.

■ SB37

205C-MCC

Supply Chain Topics

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: Robert Bray, Kellogg School of Management, 830 Hinman Ave. Apt. 2S, Evanston, IL, 60202, United States, robertlbray@gmail.com

1 - Buyer Intermediation In Supplier Finance

Tunay Tunca, Professor, Unversity of Maryland, College Park, MD, 20910, United States, ttunca@rhsmith.umd.edu, Weiming Zhu

We analyze the role and the efficiency of buyer intermediation in supplier financing (BIF). We theoretically demonstrate that BIF can significantly improve the supply chain surplus over traditional financing. Using data from a large Chinese online retailer, we estimate model parameters, empirically verify the theory, and predict efficiency gains.

2 - Shock Spillover And Financial Response In Supply Chain Networks: Evidence From Firm-Level Data

Andrew Wu, Assistant Professor of Tech, Operations, Finance, Ross School of Business, University of Michigan, Ann Arbor, MI, United States, andydiwu@umich.edu, Jun Li

Using machine learning methods on firm-level textual disclosures, this research studies the propagation of firm-specific production shocks through supply chain relationships, and the stock market reactions to such propagated shocks.

3 - Unbundling Of Ancillary Service: How Does Price Discrimination Of Main Product Matter?

Yao Cui, Cornell University, Ithaca, NY, United States, yao.cui@cornell.edu, Izak Duenyas, Ozge Sahin

We consider a setting where the firm sells a main service and an ancillary service. We study how the firm's ability to charge discriminatory main service prices affects the decision of whether to separately charge for the ancillary service, both for the firm and for the industry.

4 - Centralized Vs. Decentralized Platform Markets

Daniela Saban, Stanford GSB, dhs2131@columbia.edu, Yash Kanoria

We consider a two-sided matching market with search frictions, and study the impact of the matching technology and platform design on the efficacy of the marketplace in serving its users. We find that a few different designs may be optimal in different settings, with the best choice of design depending crucially on the agents' selectivity — likelihood that a potential match on the opposite side of the market will be acceptable— and their cost of search —cost of discovering the value of a potential match.

■ SB38

206A-MCC

Innovation: Choices and Constraints

Invited: New Product Development

Invited Session

Chair: Pascale Crama, Singapore Management University, Singapore, Singapore, pcrama@smu.edu.sg

1 - The Role Of Form In Product Evolution: An Analysis Of Styles

Tian Chan, Emory University, Atlanta, GA, 3, United States, tianheong.chan@insead.edu, Jurgen Mihm, Manuel Sosa

Styles are groupings of product designs of similar form. We leverage on a recently introduced database of styles among the more than 350,000 US design patents granted from 1977 through 2010 to study how styles evolve over time. We study and theorize how the interactions between design, technology, and organizations lead to the emergence, growth, and decline of styles. We discuss the implications of our results in furthering the understanding of how products evolve.

2 - Implementing Corporate Entrepreneurship With Contests

Lakshminarayana Nittala, University of California San Diego, La Jolla, CA, 92037, United States, lnittala@ucsd.edu, Sanjiv Erat, Viswanathan Krishnan

We analyze the use of Innovation contests by firms as processes to implement corporate entrepreneurship. The cost benefit analysis of such internal contests brings forth interesting insights on the relation between the institutional features and profitability of such contests.

3 - Contracts With Reciprocal Buyout Options

Pascale Crama, Singapore Management University, pcrama@smu.edu.sg, Niyazi Taneri

Joint research and development (R&D) allows firms to combine complementary capabilities, but is difficult to organize in the face of uncertainties surrounding the future product and skills needed to bring it to market. We analyze how contracts with reciprocal buyout options can help to organize joint R&D to mutual advantage when the parties to the contract can invest in capability-building.

■ SB39

207A-MCC

Mean Field Models and Economic Applications

Sponsored: Applied Probability

Sponsored Session

Chair: Ramesh Johari, Stanford University, Stanford, CA, United States, ramesh.johari@stanford.edu

1 - Mean Field Models For Economic Applications

Ramesh Johari, Stanford University, ramesh.johari@stanford.edu

This session will survey the use of mean field methods for analysis of strategic interactions in dynamic markets. Dynamic markets can be viewed as a significant special class of dynamic stochastic games; these are generally difficult to analyze, and these difficulties are only exacerbated when the number of players is large. We will discuss the use of large system asymptotics to simplify equilibrium characterization and market design. A significant emphasis will be on discussion of open applied directions for such methods. It will not be assumed that attendees are experts in dynamic games or economic modeling; the goal is to introduce applied probabilists to an exciting area of application.

■ SB40

207B-MCC

Applications of Data Envelopment Analysis

Invited: Data Envelopment Analysis

Invited Session

Chair: Daiki Wakayama, Komazawa University, 1-23-1-2409 komazawa, Setagaya-ku, Tokyo, 154-8525, Japan, dwakayam@komazawa-u.ac.jp

1 - Transmission Congestion And Eco-technology Innovation In U.S. Electric Power Industry Measured by DEA Environmental Assessment

Daiki Wakayama, Komazawa University, Tokyo, 3510021, Japan, dwakayam@komazawa-u.ac.jp, Mika Goto, Toshiyuki Sueyoshi

This study discusses a new use of DEA environmental assessment to measure a possible occurrence of congestion in U.S. coal-fired power plants. The congestion is classified into two categories: Undesirable Congestion (UC: indicating a transmission limit) and Desirable Congestion (DC: indicating eco-technology innovation). The identification of UC is important to avoid a cost increase and a shortage of electricity, while investigating of DC can be effectively used to reduce the amount of air pollution. This study finds that UC may occur on most of power plants. In contract, DC may occur on a limited number of power plants.

2 - Study Of Capital Requirement And Bank Operating Efficiency

Yang Li, National University of Kaohsiung Kaohsiung, yangli@nuk.edu.tw

Following the 2008 financial tsunami, the Bank of International Settlements proposed Basel III in 2010, in which banks need to raise their capital adequacy ratio in order to make them sound and safe. This study employs the two-stage bootstrapped truncated regression model, proposed by Simar and Wilson (2007), and takes into account undesirable outputs to investigate how the increases in core, tier I, and total capital adequacy ratios influence the efficiency of Chinese commercial banks. The data set is obtained from Bankscope for the period 2012-2014. Empirical results are consistent with the schedule and intention set by Basel III.

3 - Statistical Measure Of Goodness On Quantitative Models Of Efficiency And Effectiveness

Abbas Attarwala, University of Waterloo, Waterloo, ON, Canada, aattarwa@uwaterloo.ca, Stanko Dimitrov, Amer Obeidi

We propose a statistical measure of goodness on quantitative models of efficiency and effectiveness. Our measure is used in a financial setting based on the Efficient Market Hypothesis. Using information criterion we find the best fit model in a family of functions. The goodness of fit of a model is traded against the number of parameters required to achieve this approximation. We apply the developed statistical measure on four models using two case studies of U.S and Indian bank data.

4 - The Group And Individual Evaluation Using Fuzzy Dea

Hiroshi Morita, Osaka University, Suita, Japan, morita@ist.osaka-u.ac.jp, Rui Dai, Minghao Chen

We use the fuzzy DEA to evaluate the performance based on the evaluators' scores, which come from the evaluation questionnaire and considered as fuzzy DMUs. We suppose the situation of teachers' evaluation by students' score. The fuzzy DEA model is used to analyze the group evaluation of the performance effectiveness. The DEA model is firstly used to analyze the scores for every DMU, where the evaluators' ambiguity or bias may bring the fuzziness of DMU. It also compares the group evaluation and individual evaluation on efficiencies. This approach is more objective and fair by avoiding the effect of the directly counting scores which is easily affected by negative or positive attitude of evaluators.

■ SB41

207C-MCC

Spectral Methods in Finance: Option Pricing and Econometrics

Sponsored: Financial Services

Sponsored Session

Chair: Lingfei Li, Assistant Professor, The Chinese University of Hong Kong, 608 William M.W.Mong Engineerng Building, Shatin, N.T., none, Hong Kong, lfli@se.cuhk.edu.hk

1 - Error Analysis Of Finite Difference And Markov Chain Approximations For Option Pricing With Non-smooth Payoffs

Gongqiu Zhang, PhD Candidate, The Chinese University of Hong Kong, ERB 802, Hong Kong, gqzhang@se.cuhk.edu.hk, Lingfei Li

We provide error analysis for finite difference and Markov Chain approximations in option pricing when the payoff function is non-smooth. We assume the asset price is a one-dimensional diffusion or a jump process constructed from a diffusion by subordination. We show that the spatial discretization error is second order for call and put-type payoffs and first order for digital-type payoffs. Furthermore, averaging discontinuous payoffs can restore second order convergence.

2 - Long Forward Probabilities, Recovery And The Term Structure Of Bond Risk Premiums

Likuan Qin, Northwestern University, Evanston, IL, 60016, United States, likuan.qin@gmail.com, Vadim Linetsky

We show that the martingale component in the long-term factorization of the stochastic discount factor due to Alvarez and Jermann (2005) and Hansen and Scheinkman (2009) is highly volatile, produces a downward-sloping term structure of bond Sharpe ratios, and implies that the long bond is far from growth optimality. In contrast, the long forward probabilities forecast an upward sloping term structure of bond Sharpe ratios and implies that the long bond is growth optimal. Thus, transition independence and degeneracy of the martingale component are implausible assumptions in the bond market.

3 - Parametric Inference Of Discretely Observed Subordinate Diffusions

Weiwei Guo, The Chinese University of Hong Kong, wwguo@se.cuhk.edu.hk

We develop a two-step procedure to estimate a class of jump processes known as subordinate diffusions from discrete-time data. The first step identifies the diffusion parameters using estimating functions only involve diffusion parameters and the second step identifies the subordinator parameters using martingale estimating functions based on eigenfunctions. Under regularity conditions, our estimators are consistent and asymptotically normal. Numerical examples show that our method is statistically and computationally efficient. Analysis of VIX index indicates that a pure jump subordinate diffusion model significantly outperforms diffusion models in modeling the VIX index.

■ SB42

207D-MCC

Quantitative Methods in Finance XIII

Sponsored: Financial Services

Sponsored Session

Chair: Changle Lin, Princeton University, Jersey City, NJ, United States, changlel@princeton.edu

Co-Chair: Woo Chang Kim, Associate Professor, KAIST, KAIST 291, Daehak-ro, Yuseong-gu, Daejeon, 34141, Korea, Republic of, wkim@kaist.ac.kr

1 - Goal-based Investment Via Multi-stage Stochastic Programming For Robo Advisor Service

Woo Chang Kim, KAIST, wkim@kaist.ac.kr

Robo-advisors aim to attract non high-net-worth individual investors by significantly lowering the entry barrier to professional wealth management industry. Unfortunately, existing schemes of robo-advisors have not been sophisticated enough to provide fully personalized investment advices. However, it surely is challenging to ask clients, who might lack financial literacy, to provide their detailed financial situation through online platform. Therefore, we propose a goal-based investment model that only requires the input of wealth, income, and consumption goals with priorities via multi-stage stochastic programming approach.

2 - How to Train Your Lawyer

Ephrat Bitton, Future Advisor, ephratb@gmail.com

For better or worse, Robo Advisors operate in a highly regulated industry. Folks may roll their eyes at the mention of compliance, but it is a crucial process for ensuring that we protect the end client. As a mathematician at FutureAdvisor, one of my greater challenges is adequately describing to our compliance officer how we manage portfolios using optimization. MILP can be immensely powerful for solving complex decision problems, but it is notoriously difficult to pinpoint the reasons for different outcomes. This talk follows my story on automating portfolio management, ensuring the quality of our results, and finally, explaining how it all works to someone who reads legal settlements for fun.

3 - Pricing And Hedging Guaranteed Minimum Withdrawal Benefit With High Water Mark Benefit Base

Peiqi Wang, Princeton University, Princeton, NJ, United States, peiqiw@princeton.edu, Patrick Cheridito

We consider pricing and hedging of Guaranteed Minimum Withdrawal Benefit (GMWB) rider on a variable annuity (VA) contract. We price the VA+GMWB contract by considering the optimal withdrawal strategy of the policyholder. We show that policyholder's payoff resulting from the optimal withdrawal strategy corresponds to the super-replication cost of the contract and we provide a hedging strategy. Our numerical results show that it is sometimes optimal for the policyholder to aggressively withdraw and ruin the account. Further analysis on the numerical results suggests how the insurer should determine the fee structure and minimal deposit requirement.

4 - About Holistic Robo-advice Engine

Dan Dibartolomeo, Northfield Information, dan@northinfo.com

Robo-advisors aim to attract non high-net-worth individual investors by significantly lowering the entry barrier to professional wealth management industry. Unfortunately, existing schemes of robo-advisors have not been sophisticated enough to provide fully personalized investment advices. However, it surely is challenging to ask clients, who might lack financial literacy, to provide their detailed financial situation through online platform. Therefore, we propose a goal-based investment model that only requires the input of wealth, income, and consumption goals with priorities via multi-stage stochastic programming approach.

■ SB43

208A-MCC

Systems Engineering and Decision Analysis

Sponsored: Decision Analysis

Sponsored Session

Chair: Robert F Bordley, PMP, MBA, Booz Allen Hamilton, Troy, MI, United States, bordley_robert@bah.com

1 - Value-focused Thinking For Engineering Resilient Systems

Greg Parnell, University of Arkansas, gparnell@uark.edu

DoD's requirements analysis identifies Key Performance Parameters to meet the system goals. The acquisition documents identify the thresholds and objectives for each parameter that are supported by mission analysis that considers mission needs, technical maturity, affordability, and schedule. Multiple objective decision analysis and Value-Focused Thinking can provide a mathematical framework for evaluating the resilience of systems in mission scenarios under uncertainty and the adaptability of the platform to future missions.

2 - The Systems Engineering Approach To Setting Design Targets

Robert Bordley, Booz Allen Hamilton, bordley_robert@bah.com

Systems engineering is a value-focused process aimed at defining feasible component-level design targets for a system which, when designed and assembled, will best meet the needs of system stakeholders. To reach this goal, systems engineering first defines targets at the system level, then at the subsystem level, the assembly level etc down to the component level. At each level, informed trade-offs are made about what is most appealing to stakeholders given beliefs about what is technically possible. Making these tradeoffs involves specifying alternative solutions, investigating each solution and constructing an optimal hybrid of the solutions.

3 - A Bayesian Method For Selecting Elite Varieties Of Soybean

Jack Kloeber, Kromite, LLC, 82 Nelson Drive, Churchville, PA, 18966, United States, jkloeber@kromite.com, Joseph Byrum, Tracy Doubler, Greg Doonan, Craig Davis, Peiran Zhao

In agriculture R&D, a new variety's genetic contribution to higher yield is difficult to separate from factors of soil, insects, weather, or agronomic practices. Varieties are grown at multiple locations, downselecting over 4 years. Syngenta developed a generalizable method which helps soy breeders find the genetic winner using Bayesian Updating. The increased accuracy leads to better decision-making and higher yield.

■ SB44

208B-MCC

Decision Analysis, Game Theory, and Homeland Security

Sponsored: Decision Analysis

Sponsored Session"

Chair: Jun Zhuang, University at Buffalo, SUNY, Buffalo, NY, United States, jzhuang@buffalo.edu

Co-Chair: Jing Zhang, University at Buffalo, SUNY, University at Buffalo, SUNY, Buffalo, NY, 14228, United States, jzhang42@buffalo.edu

1 - Defensibility - A New Concept In Risk Analysis

Vicki Bier, University of Wisconsin-Madison, vicki.bier@wisc.edu
Alexander Gutfraind, Ziyang Lu

We define a system as defensible if modest investment of resources can significantly improve the outcome to the defender. After quantifying defensibility, we use empirical examples and stylized examples to show that some systems that appear highly vulnerable are actually highly defensible.

2 - Using The Concept Of Multidimensional System Resilience In Decision And Risk Analysis

Dante Gama Dessavre, Stevens Institute of Technology, dgamades@stevens.edu, Jose Emmanuel Ramirez-Marquez

Resilience is generally understood as the ability of an entity to recover from an external disruptive event. Systems such as cities, face the challenge of each of their subsystems being vulnerable to multiple threats. This work analyzes the compilation of subsystem and multiple measurements in order to have more accurate description of system resilience. The object of this work is to introduce the use of this multidimensional system resilience model in the disciplines of decision and risk analysis, showing how it allows creating more comprehensive and intuitive tools for decision makers.

3 - Behavioral Experiments On Deterrence

Richard John, USC, richardj@usc.edu

When evaluating potential countermeasures, emphasis is often placed on interdiction over deterrence because the impact of interdiction focused countermeasures are easier to identify and quantify compared to the impact of countermeasures designed to deter. Resource allocation decision often focus on measures of interdiction enhancement only, even though the involve countermeasures are expected to improve both interdiction and deterrence. I will focus on innovative methods to characterize and quantify the deterrent effects of countermeasures. I will also include methods and findings drawn from decision and risk analysis, game theory, and behavioral research on deterrence.

4 - A Robust Optimization Approach For Electric Power Grid Protection

Alberto Costa, NUS, Singapore, Singapore, isealc@nus.edu.sg
Alberto Costa, Future Resilient Systems (FRS) - ETH Zurich, Singapore, Singapore, isealc@nus.edu.sg

We study the problem of the optimal allocation of protection resources in an electric power grid with the aim of maximizing its robustness against attacks to the lines. This problem can be seen as a game between two players, i.e., the system operator and the attacker. Given a budget for protecting the lines and a performance threshold, i.e., the maximum value of load shed tolerated by the system operator, the attacker wins the game if the load shed after the attack is above the threshold. We propose an algorithm to find the allocation of the system operator's budget to the lines of the grid which maximizes the amount of budget needed by the attacker to win the game.

■ SB45

209A-MCC

Model Uncertainty, Risk, & Compliance

Invited: Risk and Compliance

Invited Session

Chair: Ricky Rambharat, Lead Statistician, Office of the Comptroller of the Currency, 400 7th SW, Mail-stop 6E-2, Washington, DC, 20219, United States, ricky.rambharat@occ.treas.gov

1 - Missing Data Inference With Application To The Home Mortgage Disclosure Act

Andrew Porter, Office of the Comptroller of the Currency, Washington, DC, United States, andrew.porter@occ.treas.gov
Tong-yob Nam

The Home Mortgage Disclosure Act (HMDA) mandates financial institutions to report protected class information such as race and ethnicity for each mortgage applicant when available. However, a significant proportion of these data is missing which impairs regulatory ability to determine whether a financial institution provided fair access to its mortgage products. We use a multinomial logit with spatial data analysis coupled with a multiple imputation methodology to infer the missing HMDA data and mitigate the effect of model uncertainty. Our empirical analysis concerns varied institutions with different levels of missing protected class data including a large bank and a non-bank lender.

2 - Prudential Policies And Their Impact On Credit In The United States

Paul Calem, FRB of Philadelphia, paul.calem@phil.frb.org

We analyze impacts on bank lending of two supervisory policies. We find that banks reduced their share of jumbo mortgage originations following the stress test in 2011, but not in later years when they were better capitalized. We find little initial impact of the 2013 Leveraged Lending Guidance, but follow-up FAQs issued late in 2014 marked a significant drop in leveraged lending. Thus, measureable risk and capital appear to have a more immediate impact on lending. Model governance can still have compliance implications—exemplified by banks failing the stress tests on qualitative grounds. Our findings for the 2013 Guidance and FAQ suggest that clarity of regulatory communications also play a role.

3 - Forecast Combination Of Machine Learning Models With Application To Camels Early-warning Systems

Lewis Gaul, Office of the Comptroller of the Currency, lewis.gaul@occ.treas.gov

This paper uses forecast combination methods to predict future CAMELS bank ratings assigned by the Office of the Comptroller of the Currency. We use several individual algorithms and statistical models to forecast future CAMELS ratings with information on lagged financial statement ratios and macroeconomic variables. We then analyze whether combinations of multiple forecasts provide more accurate out-of-sample forecasts of future CAMELS ratings than any individual forecast model. Results indicate that the out-of-sample forecast performance of most individual models varies over time, and that combinations of forecasts generally perform better than any individual model.

■ SB46

209B-MCC

Sharing Economy, Mechanism Design and Networks I

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Santiago Balseiro, Duke University, Durham, NC, United States, sbalseiro@gmail.com

Co-Chair: Ozan Candogan, University of Chicago, Durham, NC, United States, ozan.candogan@chicagobooth.edu

1 - Matching Markets With Search Frictions

Nicholas A. Arnosti, Stanford University, narnosti@stanford.edu

We consider a model in which sellers compete by posting prices and buyers visit sellers sequentially. We show that there is a unique equilibrium outcome, which is constrained efficient.
We then study the consequences of reducing search costs. This benefits buyers, but may either increase or decrease seller revenue. If there are sufficiently many buyers, sellers benefit from lower search costs. Otherwise, the effect on seller revenue depends on the shape of the distribution of buyer values. If it is heavy-tailed (has a decreasing hazard rate), then sellers benefit from lower search costs. If it is light-tailed (has an increasing hazard rate), then seller revenue falls as search becomes easier.

2 - Dynamic Mechanisms With Martingale Utilities

Santiago Balseiro, Duke University, srb43@duke.edu, Vahab Mirrokni, Renato Paes Leme

We study the dynamic mechanism design problem of a seller who repeatedly sells independent items to a buyer with private values under two practically relevant business constraints: (i) a periodic individual rationality constraint, which limits the mechanism to charge at most the buyer's value in each period and (ii) a martingale utility constraint, which imposes that from the perspective of the buyer, the next item's expected utility is equal to the present one's. Our main contribution is the design of a dynamic auction that asymptotically achieves full extraction of buyer surplus as agents become more patient.

3 - Ridesharing Networks

Ozan Candogan, University of Chicago, 7449 9th Street, Unit 472, Durham, NC, 27705-1084, United States, ozan.candogan@chicagobooth.edu, Daniela Saban, Konstantinos Bimpikis

We consider the problem faced by a revenue optimizing ride-sharing platform, which must decide on how to price the rides as well as how to compensate the drivers. These decisions will impact both the entry of customers and the actions of the drivers. We study the impact that the underlying network structure has on the pricing strategy.

4 - Tractable Equilibria For Sponsored Search With Budget Optimizing Bidders

Dragos Florin Ciocan, INSEAD, florin.ciocan@insead.edu, Krishnamurthy Iyer

We examine a model of sponsored search markets where bidders strategically choose their budgets and bids, while the ad network can throttle bidders to optimize its own revenues. We show the equilibria in this market take a simple form and that for these equilibria the network's optimal throttling policy is greedy.

■ SB47

209C-MCC

New Topics in Revenue Management and Pricing

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: So Yeon Chun, McDonough School of Business, Georgetown University, Washington, DC, United States, sc1286@georgetown.edu

1 - Worker Poaching In A Supply Chain: Enemy From Within?

Gad Allon, Northwestern University, g-allon@kellogg.northwestern.edu, Achal Bassamboo, Evan Barlow

Poaching workers has become a universal practice. We explore worker poaching between firms linked in a supply chain. We show that the classical intuition from labor economics is insufficient in explaining poaching between supply chain partners. We also show how and under what conditions worker poaching can actually improve supply chain performance. Finally, we show how the equilibrium identity of the supply chain bottleneck depends on the interaction between hiring, poaching, and productivity.

2 - The Revenue Impact Of Dynamic Pricing Policies In Major League Baseball Ticket Sales

Joseph Xu, University of Pennsylvania, Philadelphia, PA, United States, jiaqixu@wharton.upenn.edu, Senthil Veeraraghavan, Peter Fader

We study RM implementation of multiproduct dynamic pricing by a Major League Baseball franchise for their single game tickets. We develop a comprehensive customer choice model to calibrate and design a dynamic pricing policy for the franchise. Our model also incorporates external factors that drive customer valuation of sports tickets, such as the effect of the home team's on-field performance and the effect of overall attendance level. Our counterfactuals show potential revenue improvement of up to 15% through the effective use of dynamic pricing. We also find that a properly calibrated fixed pricing policy can achieve similar levels of performance as the optimal dynamic pricing policy.

3 - Designing Rewards-based Crowdfunding Campaigns For Strategic Contributors

Soudipta Chakraborty, Duke University, Durham, NC, 27708, United States, sc390@duke.edu, Robert Swinney

We study a model of rewards crowdfunding with the all or nothing funding mechanism. The creator of a crowdfunding campaign sets a target funding level and the campaign is successful only if the funding it receives meets this target. A creator can have two possibly competing objectives: maximize the likelihood of success and maximize the expected total funding. The contributors incur a transaction cost while pledging to a campaign. As a result, they behave strategically and decide whether to pledge at the beginning or to wait till the target is met. We analyze how a creator, who encounters such strategic behavior, can achieve her objectives by optimally using the operational parameters of her campaign.

4 - Setting The Optimal Value Of Loyalty Points

So Yeon Chun, McDonough School of Business, Georgetown University, sc1286@georgetown.edu, Dan Andrei Iancu, Nikolaos Trichakis

A loyalty program introduces a new currency—the points—through which customers transact with a firm. We study the problem of optimally setting the monetary value of points, i.e., pricing in this new currency, in a multi-period setting. We first show that point pricing is different from cash pricing primarily due to the way points are accounted for, as liabilities on the firm's balance sheet, and then we characterize the optimal cash and point pricing policies.

■ SB48

210-MCC

Social Media Analytics for Businesses

Invited: Social Media Analytics

Invited Session

Chair: Panagiotis Adamopoulos, New York University, School of Business, New York, NY, 11111, United States, padamopo@stern.nyu.edu

1 - Monetizing Sharing Traffic Through Incentive Design: Evidence From A Randomized Field Experiment

Tianshu Sun, University of Southern California, 3330 Van Munching Hall, Los Angeles, CA, 20742, United States, tianshu.sun@gmail.com, Siva Viswanathan, Elena Zheleva

Using a large-scale randomized field experiment, we examine whether and how firms can engage customers involved in online social sharing, through the design of novel incentive mechanisms. We find evidence that incentive design has a significant impact on both sender's purchase and referrals, but in a different ways. Specifically, compared to the senders who receive non-shareable promotional code, senders who receives shareable code are less likely to make purchases themselves, but much more likely to make further referrals. We further leverage variation in incentive design to untangle three motives underlying the sender's sharing:self-regarding, other-regarding, group-regarding motive.

2 - Realizing The Activation Potential Of Online Communities

Marios Kokkodis, Boston College, kokkodis@bc.edu

In this work we present a data-driven stochastic framework that identifies which users and when are more likely to become heavy contributors in an online community.

3 - Word Of Mouth Vs. Word Of Health Inspectors: Evidence From Restaurant Reviews

Chenhui Guo, University of Arizona, 1130 E Helen St, McClelland Hall 430, Tucson, AZ, 85721, United States, chguo@email.arizona.edu, Paulo B Goes, Mingfeng Lin

Prior to purchase, consumers are naturally exposed to multiple sources of quality information. We study whether and how consumer word of mouth of restaurants—both volume and valence—is influenced by co-presence of information from health inspectors. We build a simple analytical model and conduct an empirical study using data from a leading consumer review site, showing that the availability of official information has a significant dampening effect on the volume of reviews generated by consumers. Moreover, the effect on valence is significantly positive, with a very small magnitude.

4 - The Role Of Dimensionality Reduction In Binary Classification For Social Network Data

Jessica Clark, New York University, jclark@stern.nyu.edu, Foster Provost

Dimensionality reduction is regarded as a key part of the predictive analytics process. We take a design-science approach to analyzing the role of dimensionality reduction via matrix factorization for binary classification using large, sparse social network data. The experiments in this work (which span a variety of data sets, modeling techniques, and DR methods) find that DR at best provides little advantage in terms of classification performance, and at worst can significantly negatively impact performance. The results emphasize the need for caution when utilizing DR in predictive modeling, which should serve as a guideline for applied data science researchers and industry practitioners.

■ SB49

211-MCC

Case Competition II

Sponsored: Education (INFORMED)

Sponsored Session

Chair: Palaniappa Krishnan, University of Delaware, Newark, DE, United States, baba@udel.edu

1 - Dynamic In-Game advertising: Managing Complex High-Stakes Operations

Alan Scheller-Wolf, Carnegie Mellon University, Pittsburgh, PA, United States, awolf@andrew.cmu.edu, John Turner

Dynamic in-game advertising is an advanced form of advertising in which ads are displayed on electronic billboards, stadium walls, or in other visually appealing spots within the 3D worlds of video games. This case teaches students not only about the economics of online advertising and how to solve complex multi-objective ad planning problems using goal programming, but also covers broader modeling concepts, practical modeling considerations, and discusses relevant strategic issues from the fast-growing and fast-changing online advertising industry.

2 - Shipment Consolidation And Dispatching Problem At Ekol Logistics

Sinem Tokcaer, zmir University of Economics, Izmir, Turkey, sinem.tokcaer@ieu.edu.tr, Ozgur Ozpeynirci, Muhittin H. Demir, Irem Celik

The case considers international freight forwarding operations in Ekol Logistics of Turkey; a leading international logistics company. Less-than-truckload orders are routed either directly to destination, or through a cross dock. Currently, the consolidation and dispatching plan is done manually. The case has two phases: first, students analyze the cost structure to determine the total cost for a given plan and suggest a better one. The second phase involves the construction of the mathematical programming formulation to identify an optimal plan. Students are also required to identify alternative feasible routes to be fed into the formulation, in search for an improved optimal plan.

3 - Inventory Optimization For Rent The Runway

Vincent Slaugh, Cornell University, Ithaca, NY, United States, vslaugh@cornell.edu, Sridhar Tayur

The choice of how many rental dresses to procure in advance of each fashion season plays a critical role in the success of Rent the Runway, an online high-fashion dress rental business. The case leads students through this inventory optimization decision for a single dress style using both queueing and Monte Carlo simulation models implemented in a spreadsheet. Students are encouraged to consider the strengths and weaknesses of each modeling approach and how to incorporate additional model features such as nonstationary demand and the random loss of rental units.

4 - The Safe Birth Clinic

Milind Dawande, The University of Texas at Dallas, Richardson, TX, United States, milind@utdallas.edu, Tim Huh, Ganesh Janakiraman, Mahesh Nagarajan, Yang Bo

The effective utilization of capacity is an important operational goal that managers strive to achieve. Most textbooks use the following simple “bottleneck formula” to calculate process capacity: the capacity of each resource is first calculated by examining that resource in isolation; process capacity is then taken as the smallest (bottleneck) among the capacities of the resources. The main goal of this case is to alert students that, for processes in which activities share resources, the use of the bottleneck formula brings the potential danger of reaching incorrect conclusions about process capacity and may eventually lead to erroneous decisions with significant financial impact.

■ SB50

212-MCC

Decision Making in Healthcare

Sponsored: Minority Issues

Sponsored Session

Chair: Shannon Harris, Ohio State University, 600 Fisher Hall, Columbus, OH, 43210, United States, harris.2572@osu.edu

1 - Simulation Optimization To Inform Decision Making In Birth

Karen T Hicklin, University of North Carolina, Chapel Hill, NC, United States, kthickli@ncsu.edu, Julie Ivy

Of the nearly 4 million births that occur each year in the U.S., almost 1 in 3 is a cesarean section (C-section). Due to the various increased risks associated with C-sections and the potential major complications in subsequent pregnancies, a re-evaluation of the C-section rate has been a topic of major concern. We present a discrete event simulation model of women undergoing a trial of labor with the goals to: (1) model the natural progression of labor for spontaneous and induced laboring patients and (2) optimally decide when an intervention is needed, such as augmentation or C-section, in order to reduce the number of C-sections due to a “failure-to-progress” diagnosis.

2 - Dynamic Control Of A Single Server System When Jobs Change Status

Gabriel Zayas-Caban, University of Michigan, gzayasca@umich.edu

Many systems must contend with allocating resources to jobs whose initial service requirements or costs change when they wait too long. We present a new queueing model for this scenario and use a Markov decision process formulation to analyze assignment policies that minimize holding costs. We provide sufficient conditions under which simple priority rules hold and for when switching curve structures hold. In general, we find that allowing service and/or cost requirements to change changes the structure of optimal controls for resource allocation in queueing systems.

3 - Online Overbooking Strategies In Outpatient Specialty Clinics With No-shows And Advance Cancellations

Shannon Harris, Ohio State University, harris.2572@osu.edu
Jerrold H May, Luis G Vargas

Patient behavior, such as no-shows and cancellations, can lead to issues that heighten outpatient clinic access issues. In this paper, we develop strategies to determine if and when to overbook patients, over a finite horizon, in an online scheduling environment. We incorporate clinic parameters, no-shows, and cancellations to inform the overbooking decisions. We find that the optimal overbooking strategies are a function of both no-shows and cancellations, and that a clinic can, under certain conditions, achieve a greater service reward by overbooking patients than it can by not overbooking. Our work is motivated, in part, by our observations of scheduling at a VHA specialty clinic.

4 - Modeling For The Equitable And Effective Distribution Of Food Donations Under Stochastic Capacities

Irem Sengul Orgut, Quality Analytics Project Manager, Lenovo, Raleigh, NC, United States, isengul@ncsu.edu, Julie Ivy, Reha Uzsoy

Food insecurity is an increasing threat to people’s health status and quality of life. In partnership with the Food Bank of Central and Eastern North Carolina, which distributes donated food to a 34-county service area, our objective is to achieve equitable and effective food distribution among the population at risk for hunger. Counties’ capacities are the main source of uncertainty in this system as they constrain the total food distribution due to the need to distribute food equitably. We develop stochastic models for optimal food distribution and prove structural results. We illustrate our results and perform an extensive numerical study using historical data from our collaborating food bank.

■ SB51

213-MCC

Emergency Response, Recovery, and Resilience

Sponsored: Public Sector OR

Sponsored Session

Chair: Laura Albert McLay, University of Wisconsin-Madison, 3218 Mechanical Engineering Building, 1513 University Avenue, Madison, WI, 53706, United States, laura@engr.wisc.edu

1 - Resilience-based Component Importance Measures For Interdependent Infrastructure Networks

Yasser Almoghathawi, University of Oklahoma, Norman, OK, United States, moghathawi@ou.edu
Kash Barker

Interdependent infrastructure networks are subjected to disruptions due to different disruptive events. Consequently, a failure in one network could lead to a failure in another network. We propose two resilience-based component importance measures to quantify the impact of the disrupted components on the resilience of the interdependent infrastructure networks and rank them according to their criticality to focus on preparedness efforts.

2 - An Integrated Network Design And Scheduling Problem For Network Recovery And Emergency Response

Suzan Afacan, Graduate Student, University of Wisconsin-Madison, Madison, WI, 53705, United States, iloglu@wisc.edu, Laura Albert McLay

Infrastructure recovery is important for delivering time-sensitive services and commodities after a disaster while also repairing network damage. To examine this issue, we present an extension of the p-median problem in the case of extreme events. In the model, we coordinate two types of service providers: (1) recovery crews who repair disrupted roads and (2) emergency responders who deliver services and commodities. The objective is to minimize the cumulative weighted distance between the emergency responders and the calls for service over the time horizon. We also present a new backup coverage model with the same extension. The models are illustrated with the computational examples.

3 - Dynamic Programming For Ambulance Fleet Management

Amir Rastpour, Postdoctoral Fellow, University of Western Ontario, Ivey Business School, 1255 Western Road,, London, ON, N6G0N1, Canada, arastpour@ivey.uwo.ca, Mehmet A. Begen, Armann Ingolfsson, Greg Zaric

We use dynamic programming to model ambulance systems. Our model can potentially assist ambulance dispatchers to proactively take actions to avoid high operational costs, lost calls, and the proportions of urgent calls that are not covered timely, or a weighted sum of these performance measures. Possible actions that we consider are: Calling in additional ambulances from neighboring cities, expediting the service, and repositioning available ambulances following a desired compliance table. We use a detailed simulation model to validate our results.

■ SB52

214-MCC

Proactive Planning Against Weather Events

Sponsored: Public Sector OR

Sponsored Session

Chair: Ozlem Ergun, Northeastern University, 453 Meserve, 360 Huntington Avenue, Boston, MD, 02115, United States, o.ergun@neu.edu

Co-Chair: Mahsa Ghanbarpour Mamaghani, Northeastern University, 360 Huntington Avenue, Boston, MA, 02115, United States, ghanbarpourmamagh.m@husky.neu.edu

1 - A Forecast Driven Model For Prepositioning Supplies In Preparation For A Hurricane

Gina Galindo, University of Del Norte, ggalindo@uninorte.edu.co Rajan Batta

We present a forecast-driven dynamic model for prepositioning relief items in preparation for a foreseen hurricane. The decisions in our model are based on real-time updated information from periodic forecast advisories issued by the National Hurricane Center (NHC). Our approach, which combines Decision Theory and stochastic programming, determines the time to start prepositioning, and the units to be prepositioned at each selected supply point. It also accounts for the possible re-positioning of already prepositioned supplies. Our results show that our model outperforms the alternative wait-and-see approach.

2 - Modeling Proactive Surgery Cancellation With Weather Forecast Updates

Mahsa Ghanbarpour Mamaghani, Northeastern University, Boston, MA, 02148-8208, United States, ghanbarpourmamagh.m@husky.neu.edu, Ozlem Ergun

Severe weather such as hurricanes and snowstorms can dramatically disrupt the delivery of many essential services within a community, including healthcare services. This research introduces proactive surgeries cancellation planning due to snowstorms with considering weather forecast updates. Since the snowstorms can be predicted more accurate in the last steps of planning horizon the problem is formulated as an evaluation of the tradeoff between more accurate forecasts and cost of late cancellations for determining optimal surgeries cancellation.

■ SB53

Music Row 1- Omni

Emerging Trends in Business Innovation

Sponsored: Technology, Innovation Management & Entrepreneurship

Sponsored Session

Chair: Fangyun Tan, Southern Methodist University, 6212 Bishop Blvd, Dallas, TX, 75275, United States, ttan@cox.smu.edu

1 - Impact Of Tabletop Technology On Restaurant Performance

Fangyun Tan, Southern Methodist University, ttan@cox.smu.edu, Serguei Netessine

We analyze a large data set of transactions in a casual restaurant chain to understand the effect of implementing a tabletop technology on service performance (measured in sales and meal duration). We find the technology directly increases sales and significant reduces the meal duration. We provide insights on how to manage technology in restaurant operations.

2 - The Role Of Surge Pricing On A Service Platform With Self-scheduling Capacity

Kaitlin Daniels, Assistant Professor, Olin Business School, Washington University in St. Louis, St Louis, MO, United States, k.daniels@wustl.edu

Platforms like Uber use dynamic pricing policies to manage a workforce of “self-scheduling” providers who decide for themselves how often to work. We show that the optimal dynamic pricing policy substantially increases the platform’s profit relative to contracts with a fixed price or fixed wage (or both) and although surge pricing (which pays providers a fixed percentage of a dynamic price) is not optimal, it generally achieves near optimal profit. Furthermore, we find that providers and consumers are generally better off with surge pricing because providers are better utilized and consumers benefit both from lower prices during normal demand and expanded access to service during peak demand.

3 - Team Leadership And Performance: Combining The Roles Of Direction And Participation

Morvarid Rahmani, Georgia Institute of Technology, 800 West Peachtree Street, NW, Atlanta, GA, 30308-1149, United States, morvarid.rahmani@scheller.gatech.edu, Uday Karmarkar, Guillaume Roels

One of the challenges that project team leaders face is how to combine their roles as individual contributors and managers. In this paper, we propose a model of team leadership and study how a contributor leader should adjust her managing effort over time and with respect to the project characteristics (e.g., team members’ incentives and team size).

4 - Sole Inventor Vs Team Of Inventors: What’s Best?

Tian Chan, Emory University, Atlanta, GA, United States, tianheong.chan@insead.edu, Jurgen Mihm, Manuel Sosa

Should a team of inventors outperform individual inventors in creating groundbreaking innovations? The empirical evidence that examines into scientific papers and technology patents (representing millions of inventive work) suggests that the answer is an unqualified “yes”. However, in this work we use design patent data to show that “teams are better than individuals” is not true in the context of design innovation. While so, we find that collaboration yields future dividends—designers who has collaborated extensively in the past but currently operates alone outperforms either teams or sole designers. We discuss the implications of our results in the organization of innovative work.

■ SB54

Music Row 2- Omni

Meet the Editors of Service Science

Sponsored: Service Science

Sponsored Session

Chair: Paul Maglio, University of California, Merced, School of Engineering, Merced, CA, 95343, United States, pmaglio@ucmerced.edu

In this session, the editors of INFORMS Service Science will discuss the mission and state of the journal and answer questions.

■ SB55

Music Row 3- Omni

Modeling and Optimization for Renewable Energy Integration

Sponsored: Service Science

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Chair: Jian Guo, Western New England University, Western New England University, Springfield, MA, 01119, United States, jian.guo@wne.edu

Co-Chair: Zhaojun Li, Western New England University, Western New England University, Springfield, MA, United States, zhaojun.li@wne.edu

1 - Impact Of Future Wind Power Scenarios On The Distributionally Robust Operation And Cost Of Reserves

Bita Analui, Post Doctoral Scholar, Ira A. Fulton Schools of Engineering, Arizona State University, Tempe, AZ, 85287-9309, United States, Bita.Analui@asu.edu, Anna Scaglione

The increasing share of renewable energy and its intermittency have led to new challenges in modeling and optimization of power system operations. In this work, we present the distributionally robust extension of multistage stochastic optimization of reserves operations under stochastic wind power generation. In this setting, the reference probability model is a scenario tree based on the direct quantization of wind power trajectories. Constructing the alternative scenario trees in the epsilon-neighborhood of the reference tree forms the ambiguity set P, wherein an iterative algorithm determines the minimax solution and identifies the worst case probability model.

2 - The Quest For Zero-carbon Supply Chain: An Onsite Generation Approach

Tongdan Jin, Texas State University, tj17@txstate.edu

Is it feasible to deploy a zero emission production-logistics system using intermittent renewable energy? If so, how to design such eco-friendly supply chain system in a distributed generation environment? In this talk we present a wind- and solar-based onsite generation system to achieve carbon-neutral performance for a multi-facility production-distribution network with affordable cost.

3 - Robust Transmission Planning Under Uncertain Generation Investment And Retirement

Lizhi Wang, Iowa State University, lzwang@iastate.edu, Bokan Chen

We present a new robust optimization model for transmission planning. This model considers the addition of new renewable generation and the retirement of existing generation capacity as sources of uncertainty, anticipates for each transmission plan the worst scenario that would result in the highest investment and operational cost, and identifies the most robust transmission plan with the least costly worst case scenario. We demonstrate this approach with a case study on the WECC 240-bus test system. Results will be illustrated with novel quantification and visualization techniques.

4 - Data-driven Stochastic Unit Commitment For Integrating Wind Generation

Chaoyue Zhao, Oklahoma State University, chaoyue.zhao@okstate.edu

In this talk, we propose a data-driven risk-averse stochastic unit commitment model, where risk aversion stems from the worst-case probability distribution of the renewable energy generation amount, and develop the corresponding solution methods to solve the problem. Given a set of historical data, our proposed approach constructs a confidence set for the distributions of the uncertain parameters using statistical inference and solves the corresponding risk-averse stochastic unit commitment problem. The computational results numerically show how the risk-averse stochastic unit commitment problem converges to the risk-neutral one, which indicates the value of data.

■ SB56

Music Row 4- Omni

Analytical Models in E-business

Sponsored: E-Business

Sponsored Session

Chair: Yonghua Ji, University of Alberta, School of Business, Edmonton, AB, T6G2R6, Canada, yji@ualberta.ca

1 - Announcing Privacy Threshold In Mobile Platform Competition

Zixuan Meng, University of Washington, zxmeng@uw.edu

Smartphones are increasingly necessary for everyday life and consumers find it important to prevent from privacy violations through Apps on mobiles. Android and iOS, two of the most popular App platforms, are different in App privacy levels. IOS, known to have a higher privacy level, chooses to make privacy requirement public. Using vertical differentiation model, we find that when market is fully covered, publicizing privacy threshold motivates both firms lowering privacy level. This helps both firms generate more profit by hurting consumers. This finding contradicts with common belief and calls for awareness of potential harm from a policy that seems protective to consumers.

2 - How Much To Open, How Fast To Fix And Develop? Impacts Of Openness On Software Development And Maintenance

Rakesh R Mallipeddi, Texas A&M University, College Station, TX, 77840, United States, rmallipeddi@mays.tamu.edu
Emre Muzaffer Demirezen, Ram Gopal, Subodha Kumar

Proprietary software vendors have recently begun to emulate the open source software community in opening up part of their software. We analyze the impact of software openness in the context of resource allocation between bug fixing and new version development, an important operations issue that many software vendors face in light of prevalence of software defects. We formulate optimal control models to examine the effects of making the software code open (fully or partially) on the overall quality of the software and the development efforts of its next version.

3 - Crowdfunding Mechanism Design And Its Effect On Fundraising

Aravinda Garimella, University of Washington, aravinda.garimella@gmail.com

Our study examines how entrepreneurs' choices of Funding Type and Rewards Types jointly impact the outcome of crowdfunding campaigns. We begin by providing a conceptual framework that distinguishes between Mechanism and Non-Mechanism aspects of campaign design. We then focus on two mechanisms at play in Reward-Based Crowdfunding platforms. First, entrepreneurs may opt for one of two Funding Types, Fixed Funding or Flexible Funding. Second, entrepreneurs are also heterogeneous in the mix of Reward Types they choose to offer to their backers. Using a rich data set of daily funding information on Indiegogo, we study how these two mechanisms influence funding outcomes and trajectories.

4 - Dynamics And Efficiency Of a Mobile Platform

Ruibing Wang, University of Science and Technology of China, Hefei, China, ruibing@mail.ustc.edu.cn, Qinglong Gou, Yonghua Ji

A mobile platform serves as a multi-sided market which connects users, app developers and advertisers. Different from the traditional multi-sided market, the cross-side network effects between different groups are different. It makes the decision process on advertising investments of platform owners and app developers more challenging. We develop a dynamic model, capturing these impacts, to offer suggestions on their advertisement strategy. We found that platform owners should offer app developers incentives according to the size of their user base or their advertising expenditure. We also Investigate the impact of different kinds of incentive on the system efficiency.

■ SB57

Music Row 5- Omni

Behavioral Research on Inventory and Pricing

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Elena Katok, University of Texas at Dallas, Richardson, TX, United States, ekatok@utdallas.edu

1 - Negotiating Transshipments Prices For Improving Supply Chain Coordination

Sebastian Villa, University of Los Andes, Bogotá, Colombia, villabes@usi.ch, Elena Katok

When retailers face stochastic demand, it is often beneficial for retailers in the same industry to buy or sell product from one another in order to better match supply and demand. This exchange of product at the retailer level is called transshipment. Appropriate ordering decisions and transshipment prices can improve supply chain coordination. We create some experiments to evaluate how subjects decisions deviate (or not) from the theoretical channel-coordinating benchmarks. Initially, we automate the ordering decision, to evaluate how the transshipment prices are negotiated, and then we evaluate retailers' decisions when they do both, negotiate transshipment prices and place orders.

2 - Newsvendors' Decisions Revisited

Tobias Stangl, University of Cologne, tobias.stangl@uni-koeln.de
Elena Katok, Ulrich Thonemann

In our study we revisit most of the proposed explanations for the pull-to-center effect in newsvendor experiments. We conducted an experimental study with 620 students from a core course in operations management. Our newsvendor study comprises two frames and seven critical ratios. In addition we collected data on anchoring, cognitive reflection, overconfidence, and risk aversion. In our data we find no support for assuming that context matters nor for assuming (different) psychological costs of leftovers and stock-outs. We find a risk and gender effect and additional evidence that low cognitive reflection and over-precision increases the pull-to-center effect.

3 - Procurement In The Presence Of Supply Disruptions

Elena Katok, University of Texas at Dallas, ekatok@utdallas.edu

We consider a setting with a supply disruption that may occur after a contract is negotiated. If the disruption can be corrected at a cost, and it is more efficient for the supplier, rather than for the buyer, to correct the disruption, a contract that does not include the disruption contingency leads to inefficient outcome. We examine the effect of communication and the ability to renegotiate in the laboratory. The main finding is that informal commitments improve efficiency a great deal.

4 - Profit-sharing Or Target-with-bonus? A Behavioral Investigation

Kay-Yut Chen, University of Texas at Arlington, UTA, Arlington, TX, 1, United States, kychen@uta.edu
Shan Li, Ying Rong

We experimentally study the profit sharing and the target-with-bonus mechanism in a setting with a principal setting the parameters of the mechanism, and an agent choosing his effort level (moral hazard) and managing a newsvendor store. We find the presence of fairness concerns under both mechanism, and the principal yields higher profit under target-with-bonus mechanism. A behavioral model is constructed to explain the findings.

■ SB58

Music Row 6- Omni

Energy II

Contributed Session

Chair: Alberto J Lamadrid, Assistant Professor, Lehigh University, 621 Taylor Street, R451, Bethlehem, PA, 18015-3120, United States, ajlamadrid@ieee.org

1 - Optimal Transmission Line Switching Under Geomagnetic Disturbances

Mowen Lu, Clemson University, Industrial Engineering Department, 801 7th St. Apt 21B, Los Alamos, NM, 87544, United States, mlu87@g.clemson.edu, Russell Bent, Scott Backhaus, Harsha Nagarajan, Emre Yamangil

Geomagnetically-induced current (GIC) flows induced by geomagnetic disturbances (GMDs) can cause transformer hotspot heating and reactive power losses that can severely impact power grid reliability. We present an optimal transmission line switching model for a power grid experiencing a GMD. We show how convex quadratic relaxations and improved bilinear function relaxations can be used to obtain tight lower bounds. A case study based on a modified single area of the IEEE RTS-96 system demonstrates our model's operating decisions with respect to GMD direction.

2 - Management Of Electric Vehicles Participation In Smart Grids For Demand Response

Nasim Nezamoddini, Ms., State University of New York - Binghamton, 222 Main Street, Apt 1, Binghamton, NY, 13905, United States, nasim.nezam@gmail.com

Electric vehicles (EVs) are potential distributed energy resources that support both the grid-to-vehicle and vehicle-to-grid modes in the smart grid. Their participation in the time-based and incentive-based demand response (DR) programs helps improve the stability and reduce the potential risks to the grid. This research proposes a novel stochastic model from the Independent System Operator's perspective for risk management and participation planning of EVs in the smart grid for DR. The effectiveness of the model in response to various settings such as the area type (residential, commercial, and industrial), the EV penetration level, and the risk level has been investigated.

3 - A Computationally Efficient Branch-and-cut Method For Robust Unit Commitment

Narges Kazemzadeh, Iowa State University, 3004 black engineering, Ames, IA, 50011-2164, United States, narges.kazemzadeh@gmail.com, Sarah M Ryan

Unit commitment seeks the most cost effective generator commitment decisions to meet net load while satisfying operational constraints. Robust optimization is a widely studied approach for optimizing under uncertainty in the load less variable generation. We adopt a branch-and-cut approach to solve a Benders decomposition for the robust formulation with different forms of uncertainty sets. Its improved efficiency relative to the naïve Benders algorithm is demonstrated with numerical experiments.

4 - Modeling And Computation Of Reliable Grid Expansion

Bo Zeng, University of Pittsburgh, Department of Industrial Engineering, Pittsburgh, PA, 15260, United States, bzeng@pitt.edu, Hossein Haghighat

Different from existing capacity expansion model, we consider the non-cooperative market clearing results in bilevel capacity expansion scheme. Numerical results will be presented to demonstrate this novel scheme in practice.

5 - Interdependencies In The Communications And Electrical Networks

Alberto J Lamadrid, Assistant Professor, Lehigh University, 621 Taylor Street, R451, Bethlehem, PA, 18015-3120, United States, ajlamadrid@ieee.org, Basel Alnajjab, Lawrence V. Snyder, Rick Blum, Shalinee Kishore

Managing an electric grid in a reliable and economic manner requires collecting information for grid operators. Part of this information is collected through sensors and a supervisory control and data acquisition (SCADA) system, as well as from data provided by market players in the market clearing process. Therefore, the operation of the system requires three interdependent networks: the electric grid, the communication network and the control network.
This paper presents a model that explicitly connects these three networks, considering the probabilistic nature of possible disruptions and changes in any of the networks.

■ SB59

Cumberland 1- Omni

TSL Keynote Address

Keynote Session

Chair: Stephen D Boyles, The University of Texas at Austin, 301 E. Dean Keeton St. Stop C1761, Austin, TX, 78712, United States, sboyles@gmail.com

1 - City Logistics: Challenges And Opportunities

Martin W P Savelsbergh, Georgia Institute of Technology, School of Industrial and Systems Engineering, Atlanta, GA, 30332-0205, United States, martin.savelsbergh@isye.gatech.edu
Tom Van Woensel

Today, around 54% of the world's population lives in urban areas. By 2050, this share is expected to go up significantly. As a result, city logistics, which focuses on the efficient and effective transportation of goods in urban areas while taking into account the negative effects on congestion, safety, and environment, is critical to ensuring continued quality of life in cities. We review and discuss a variety of current and anticipated challenges and opportunities of city logistics. We hope this helps shaping an appropriate research agenda and stimulates more researchers to enter this exciting field.

■ SB60

Cumberland 2- Omni

Advances in Traffic Equilibrium and Network Loading Models

Sponsored: TSL, Urban Transportation

Sponsored Session

Chair: Yang Liu, National University of Singapore, National University of Singapore, Singapore, 00000, Singapore, iseliuy@nus.edu.sg

1 - Time-based Equilibrium For Staggered Bottleneck Congestion With Heterogeneous Commuters

Yang Liu, National University of Singapore, iseliuy@nus.edu.sg

This paper develops a time-based dynamic user equilibrium (DUE) model with heterogeneous users under the flexible work hour scheme. We first prove that, given the identical work start time, the equivalent traffic assignment can be formulated as a symmetric and convex problem for time-based DUE, which admits unique solution. At short-run DUE, i.e., the staggered work hour scheme is predetermined, DUE is formulated as variational inequality, and the unique solution cannot be guaranteed. At long-run DUE, where commuters have the flexibility to choose work start time, the equivalent convex optimization is formulated. We prove that both DUE solution and commute cost are uniquely determined.

2 - Price Of Satisficing: Bounding The Performance Of Boundedly Rational User Equilibrium

Mahdi Takalloo, University of South Florida, Tampa, FL, United States, mtakalloo@mail.usf.edu
Changhyun Kwon

Due to the lack of full information and personal preferences, network users are mostly satisficing decision makers instead of perfectly rational decision makers. This satisficing behavior results in a traffic pattern, which attains a boundedly rational user equilibrium (BRUE) instead of perfectly rational equilibrium (PRUE). This research uses a perception error model to describe BRUE, and also quantifies how bad the system total travel delay in BRUE can be compare to PRUE.

3 - Path Based Formulations For Generalized Bounded Rationality And Multi-commodity Network Design

Changhyun Kwon, University of South Florida, 4202 E. Fowler Ave. ENB118, Tampa, FL, 33620, United States, chkwon@usf.edu
Longsheng Sun, Mark H Karwan

The route choices of network users could be uncertain when they are satisficing with sub-optimal routes or there are errors in each individual's perception of the route's utility. By modeling perception error, the notion of generalized bounded rationality was recently proposed, providing a unified framework for the two sources of uncertainty in route choices. In this paper, we design path based formulations for route choice uncertainty represented by generalized bounded rationality. We show how to incorporate them into multi-commodity network design problems.

4 - Node Modeling For Congested Urban Road Networks

Saif Eddin G Jabari, New York University Abu Dhabi, sej7@nyu.edu

Node models are responsible for capturing the propagation of traffic dynamics through networks (e.g., spillback dynamics). Holding-free solutions for node models are formally defined. Flow maximization is only a sufficient condition for holding-free solutions. A greedy algorithm is shown to produce holding-free solutions while also respecting the invariance principle. Staging movements through nodes in a manner that prevents conflicting flows from proceeding through the nodes simultaneously is shown to simplify the node models considerably and promote unique solutions.

■ SB61

Cumberland 3- Omni

Advances in Railway Research

Sponsored: Railway Applications

Sponsored Session

Chair: Shantih Marie Spanton, CSX, 31 West Adams Street, Apt 607, Jacksonville, FL, 32202, United States, shantihs@gmail.com

1 - CSX Line-of-Road Simulation

Yu Wang, CSX, Jacksonville, FL, United States, yu_wang@csx.com Jagadish Jampani, Lray Rahn

CSX Line-of-road simulation model implements a heuristic algorithm which can efficiently generate a meet-and-pass plan to dispatch trains through a division in a conflict-free manner. In order to accurately capture the speed variation, a data-mining module was implemented to predict the speed of any train during its trip based on selected attributes of the train at that time. The model has been validated and used for multiple case studies such as impact of train profile change, sub-division capacity analysis, and curfew planning.

2 - Crew Caller Districting With Consideration Of Workload Balance And Geographic Compactness

Siyang Xie, U of Illinois at Urbana-Champaign, Urbana, IL, United States, sxie13@illinois.edu, Yanfeng Ouyang, Kamalesh Somani

Railroads companies everyday receive a large amount of customer calls. These calls are handled by the crew callers distributed in various crew calling desks. Each of these desk is in charge of the calls from a particular region. To improve service quality and save costs, the region assigned to each desk is designed to be compact and the workload of desks are balanced. We formulate the problem as a network-flow based graph partitioning model and design a specialized heuristic to effectively solve the model. We demonstrate the feasibility of our methodology by applying it to the CSX's call center design problem.

3 - Scheduling Preventive Grinding For Railway Maintenance

Masoumeh Taslimi, Operations Research Manager, CSX Transportation, Jacksonville, FL, United States, masoumeh_taslimi@csx.com, Kamalesh Somani, Siyang Xie, Yanfeng Ouyang

Railway is the one of the most valuable assets at railway industries. Periodic grinding has been used to protect railway from deterioration and to prolong the life of existing rail infrastructure. Rail grinding smooths the rail to minimize the impact of rail wear, fatigue, and defects. The grinding schedule is usually determined manually on required frequencies. It is desirable to both maximize the total track miles smoothed by grinding, and also minimize the grinder's total travel distance. In this study, we propose a variant of Vehicle Routing Problem with Time Window to create the grinder's target frequencies at CSX Transportation.

4 - Scheduling Training Activities For Engineers And Conductors

Grigory Pastukhov, CSX, grigoriypas@gmail.com

CSX Transportation constantly hires engineers and conductors to operate trains. In order to make sure that these people are qualified to fulfill their duties, they have to complete extensive training program. We present fully automated scheduling system that creates detailed training plan for each trainee in the system for the whole duration of training.

■ SB62

Cumberland 4- Omni

Aviation Applications Section: Best Student Presentation Competition II

Sponsored: Aviation Applications

Sponsored Session

Chair: Lavanya Marla, University of Illinois, 216E Transportation Building, 104 S. Mathews Ave., Urbana, IL, 61801, United States, lavanyam@illinois.edu

■ SB63

Cumberland 5- Omni

Alternative Fuel Vehicles and Sustainable Transportation

Sponsored: TSL, Urban Transportation

Sponsored Session

Chair: Jee Eun Kang, University at Buffalo, 409 Bell Hall, Buffalo, NY, 14260, United States, jeeeunka@buffalo.edu

Co-Chair: Changhyun Kown, University of South Florida, 4202 E. Fowler Ave. ENB118, Tampa, FL, 33620, United States, chkwon@usf.edu

1 - Economic Analysis On Adopting Strategies Of Electric Vehicles For Urban Parcel Delivery Industry

Nan Ding, University at Buffalo, Nanding@Buffalo.edu, Changhyun Kwon, Rajan Batta

Most existing works of electric vehicles (EVs) address travel distance cost of EVs as the only objective and implement the strategy of replacing an entire fleet of conventional vehicles (CVs) with EVs. Few works consider other costs of EVs or alternative strategy. To fill this gap, this work conducts economic analysis of four different strategies of adopting EVs. The objective of all strategies is to minimize the total cost including distance cost, ownership cost, energy cost, as well as infrastructure and maintenance cost for both CVs and/or EVs. These strategies are implemented and solved by heuristics. Secondly, simulation analysis is conducted under various uncertainties for comparison.

2 - Incorporating Demand Dynamics In Multi Period Capacitated Recharging Location Planning For Electric Vehicles

Anpeng Zhang, University at Buffalo, Buffalo, NY, United States, anpengzh@buffalo.edu, Jee Eun Kang, Changhyun Kwon

We develop a multi-period capacitated flow refueling location problem for electric vehicles (EVs) as EV market responds to the charging infrastructure. We present two market dynamics (sensitive to path specific and general charging opportunities) with two objective of charging location problem (maximizing flow coverage and maximizing electric vehicle demand). A case study on US Northeastern network is presented.

3 - Long-term Planning Of Inter-city Battery Electric Vehicle Fast Charging Stations For The State Of California

Fei Xie, Oak Ridge National Laboratory, Knoxville, TN, United States, xief@ornl.gov, Changzheng Liu, Shengyin Li, Yongxi Huang, Zhenhong Lin

This study focuses on the long-term planning of battery electric vehicle (BEV) inter-city fast charging stations for the state of California in response to the increasing market share of BEVs. Genetic algorithm will be used to solve this large scale problem. We will investigate the trade-off between the high investment cost in the BEV infrastructure and the growing BEV intercity travel demand with higher BEV fleet size.

4 - Intercity Network Of Refueling Stations For Plug-in Electric Vehicles

Mehrnaz Ghamami, Assistant Professor, Michigan State University, 428 S. Shaw Lane, Room 3502, East Lansing, MI, 48824, United States, ghamamim@msu.edu

This study aims at finding the optimum location of charging stations in an intercity network of roads, considering multiple routes and multiple OD pairs on each route. It also captures the optimal routes for various classes of vehicles considering not only refueling time, but also travel time, subject to change by link flows, along the routes. It is worth noting that the location of charging stations affects the route selection of electric vehicle users and the route selection affects the energy consumption, traffic on road, and the optimum location of charging stations as a result. Thus, this study considers these codependent variables.

■ SB64

Cumberland 6- Omni

Applications and Methodological Issues on MCDM

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Danielle Morais, Universidade Federal de Pernambuco, Recife - PE, Brazil, daniellemorais@yahoo.com.br

Co-Chair: Adiel Teixeira De Almeida Filho, Universidade Federal de Pernambuco, Management Engineering Department, Recife, Brazil, adieltaf@cdsid.org.br

1 - A Navy Weapon Selection Throughout Fitradeoff

Adiel Teixeira De Almeida Filho, Assistant Professor, Universidade Federal de Pernambuco, Recife, Brazil, adieltaf@cdsid.org.br, Leonardo A Pessoa, Rodrigo Ferreira, Adiel Teixeira de Almeida

This work presents a multiple criteria decision model for selecting a weapon to be incorporated in a navy ship using the FITradeoff method. A numerical application is presented based on realistic data with regard to the real problem faced by a Brazilian Navy.

2 - A Multicriteria Model For Supplier Selection Based On A Multilinear Utility Function

Felipe Macedo de Morais Pinto, Universidade Federal de Pernambuco, felipe_mmp94@hotmail.com, Adiel Teixeira De Almeida Filho

This work presents an MCDM model based on a multilinear utility function for selecting a maintenance service supplier. Depending on the context, maintenance activities may need to consider other criteria besides cost, which are detailed in the reference Multicriteria and Multiobjective Models for Risk, Reliability and Maintenance Decision Analysis.

3 - Computing Interval Weights For Incomplete Pairwise Comparison Matrices Of Large Dimension – A Weak Consistency Based Approach

Jana Krejcí, PhD Student, University of Trento, Via Sommarive 9, Povo, Trento, 38123, Italy, jana.krejci@unitn.it
Jana Krejcí, PhD Student, University of Bayreuth, Universitat sstr. 30, Bayreuth, D-95440, Germany, jana.krejci@unitn.it, Vera Jandova, Jan Stoklasa, Michele Fedrizzi

We present a novel interactive algorithm for large-dimensional pairwise-comparison problems based on the sequential optimal choice of the pairwise comparisons (PCs) to be provided by the decision maker and the concept of weak consistency. The proposed solution significantly reduces the number of needed PCs by providing sets of feasible values for all missing PCs after each input of a new PC. Interval weights of objects covering all possible weakly consistent completions of the incomplete PCMs are then computed from the resulting incomplete weakly consistent PCM. The algorithm is capable of reducing the number of PCs required in PC matrices of dimension 15 and greater by more than 60% on average.

■ SB65

Mockingbird 1- Omni

Learning Analytics of Massive Open Online Courses (MOOCs)

Sponsored: Information Systems

Sponsored Session

Chair: Sang Pil Han, Arizona State University, Arizona State University, Tempe, AZ, 85281, United States, sangpil78@gmail.com

1 - Cohort Size And User Engagement: A MOOC Field Experiment

Jiye Baek, Boston University, jiyebaek@bu.edu
Jesse C Shore

MOOCs have the potential to transform how people access knowledge, but they face substantial difficulties in keeping users engaged. We conduct a field experiment on the edX platform to identify factors that promote student engagement in MOOC discussion forums, focusing on cohort size. While most prior work show that users in smaller groups participate more per person, our results show that in the MOOC, the students in larger size cohorts interact more per person and that this greater interaction in turn increases student retention and performance. We theorize that larger cohorts produce more forum content and thus increase the resources available to draw marginal students into an engaged state.

2 - Towards Improved Education For Students Of Low Socioeconomic Status: Learning Analytics Of Massive Open Online Courses (MOOCS)

Sang Pil Han, Arizona State University, Main Campus, PO Box 874606, Office:BA 301D, Tempe, AZ, 85287-4606, United States, sangpil78@gmail.com, Mi Hyun Lee, Sunghoon Kim, Sungho Park

Although the new era of free, online learning unfolds, the claim of 'education for all' appears to be overshadowed by the concern over the unequal use of Massive Open Online Courses (MOOCs). MOOCs may not be a viable solution to students across all levels of socioeconomic status (SES). Using learner outcome and demographic data at a MOOC, we examine the effectiveness of two intervention strategies to improve engagements among low SES learners: (1) course verification which allows learners to earn an official credit later and (2) mobile media which enable learners to attend MOOCs anytime/anywhere. From the findings, we draw implications that can help expand access to education to everyone through MOOCs.

■ SB66

Mockingbird 2- Omni

QSR Student Introduction and Interaction and Best Student Poster Competition

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Nan Chen, National University of Singapore, 21 Lower Kent Ridge Road, Singapore, 119077, Singapore, isecn@nus.edu.sg

Co-Chair: Kaibo Wang, Tsinghua University, Department of Industrial Eignieering, Tsinghua University, Beijing, 100084, China, kbwang@tsinghua.edu.cn

1 - Student Introduction And Interaction And Best Student Poster Competition

Nan Chen, National University of Singapore, isecn@nus.edu.sg

This session provides a platform for the interactions between students and senior QSR members. Participating students will present their research in poster and oral presentation form. The best poster will be voted and selected among all posters. We also invite faculty members and industry representatives to interact with students. They will share valuable experience and provide career advice.

■ SB67

Mockingbird 3- Omni

Dynamic Data Driven Application Systems

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Chiwoo Park, chiwoo.park@eng.fsu.edu

Co-Chair: Shiyu Zhou, shiyuzhou@wisc.edu

1 - Structural Damage Growth Prediction Via Integration Of Finite Element Method And Bayesian Estimation Approaches

Yuhang Liu, Graduate Student Research Assistant, University of Wisconsin–Madison, 1513 University Ave., Madison, WI, United States, liu427@wisc.edu, Shiyu Zhou

Damage diagnosis and prognosis play an important role in ensuring the safety of mechanical and civil structures. Existing works are limited to estimation of the damage magnitude at the current time instance. Revealing the evolving path of structural damage is highly desirable for prognosis and remaining useful life prediction. In this paper, we propose a dynamic data-driven hierarchical Bayesian degradation model, which takes advantage of both the physical finite element model and the data driven Bayesian framework, to tackle the structural damage growth prediction. The damage growth trend can be efficient and accurately estimated by Gibbs sampling. Numerical and case studies are presented.

2 - Dynamic Data Driven Visual Surveillance Via Cooperative Unmanned Aerial/ground Vehicles

Sara Minaeian, University of Arizona, Systems and Industrial Engineering, Tucson, AZ, 85721, United States, minaeian@email.arizona.edu, Jian Liu, Young-Jun Son

Unmanned vehicles (UVs) with onboard sensors have recently shown promising performance in various applications such as autonomous surveillance, compared to the fixed sensors. However due to the uncertain and dynamically changing environment, the complex problem of autonomous crowd control requires robust, multi-scale and effective algorithms to be applied in real-time. In this work, we propose an autonomous visual surveillance system based on dynamic data-driven adaptive multi-scale simulation (DDDAMS) for crowd control in a border area. The experimental results reveal effectiveness of the proposed system in accomplishing assigned missions under dynamic conditions.

3 - Efficient Multi-fidelity Decision Making For Dynamic Data Driven Application Systems

Jie Xu, George Mason University, jxu13@gmu.edu
Chun-Hung Chen, Edward Huang

Dynamic data driven application systems enable real-time simulation-based decision making. However, existing simulation optimization algorithms lack the computational efficiency required for real-time decision making. In this talk, we present a Bayesian framework that makes use of data and models of multiple fidelity levels to achieve the computational efficiency necessary for decision support in the context of dynamic data driven application systems.

4 - Dynamic Data Driven Modeling Of Nanoparticle Self-assembly Processes

Xin Li, Florida State University, 2525 Pottsdamer St, Building A, Suite A231, Tallahassee, FL, 32310, United States, xl12d@my.fsu.edu, Chiwoo Park, Yu Ding, Tao Liu

We present a dynamic data-driven modeling strategy, capable of tracking and predicting the transient dynamics of nanoparticle production processes. The proposed methodology is built upon two emerging multi-resolution instruments. The methodology regularly triggers cheap low resolution measurements while triggering expensive high resolution measurements when model predictions fail. The proposed strategy would provide crucial clues to understand nanoparticle productions as well as powerful insights to control the production of nanoparticles for yielding desirable morphology.

■ SB68

Mockingbird 4- Omni

Advanced Maintenance Modeling

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Yisha Xiang, Lamar University, Beaumont, TX, United States, yxiang@lamar.edu

Co-Chair: David W Coit, Rutgers University, Piscataway, NJ, United States, coit@rci.rutgers.edu

1 - Reordering Of Spare Parts Experiencing Two Phase Onshelf Deterioration

Haitao Liao, University of Arkansas, liao@uark.edu

We study maintenance and inventory policies for a system carrying spare parts that experience two-phase on-shelf deterioration. Based on the parts' degradation states, we introduce two different replacement strategies for the spare consumption, i.e., the Degraded-First strategy and the New-First strategy.

2 - A Model Of System Limiting Availability Under Imperfect Maintenance

Suzan Alaswad, Zayed University, suzan.alaswad@zu.ac.ae
Charles Richard Cassady, Edward A Pohl

In this paper, we explore the impact of Kijima Type II imperfect repair model on equipment availability. Our specific interest is in the system steady-state availability. Since the derivation of a closed form expression for the limiting availability is extremely difficult, we use simulation modeling and analysis to estimate the system limiting availability. Next, we develop a meta-model to convert the system reliability and maintainability parameters into the coefficients of the limiting availability estimate without the simulation effort. Lastly, we identify an optimal age-based preventive maintenance policy that maximizes the system's steady-state availability.

3 - Predictive Maintenance For A Multi-unit System

Yisha Xiang, Lamar University, yxiang@lamar.edu
Zhicheng Zhu, David W Coit

Preventive maintenance has been extensively studied. Time-based PM and condition-based maintenance (CBM) are two major approaches for PM. However, time-based PM is often associated with high occurrence of system breakdowns, and CBM might incur more-than-necessary inspections. Recently, predictive maintenance has become popular since it aims to pinpoint when a failure is about to occur and prolong the operational time. However, only a few predictive models consider a multi-unit system. In this paper, we develop an opportunistic predictive maintenance structure for a multi-unit system. Numerical examples are provided to illustrate the proposed predictive maintenance policy.

4 - Reliability Of System With Clusters Of Dependent Degrading Components

Sanling Song, Rutgers University, Busch Campus, Core Building Room 201, Piscataway, NJ, 08854, United States, sanling@scarletmail.rutgers.edu, David W Coit, Qianmei Feng, Yisha Xiang

A reliability model is developed for complex multi-component system with each component subject to multiple failure processes. Degradation paths for certain components are stochastically dependent with clusters of dependent components. Gamma process is used to model the stochastic process of component deterioration. In this new model, two failure processes within each component are dependent due to simultaneous shared exposure to shock process. Furthermore, degradation paths among certain components are considered to be dependent. Components sharing dependent degradation can be determined by the MLE of model parameters.

■ SB69

Old Hickory- Omni

Panel Discussion: Internet of Things (IoT) Data Analytics

Sponsored: CPMS, The Practice Section

Sponsored Session

Moderator: Robin Lougee, IBM Research, IBM TJ Watson Research Center, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States, rlougee@us.ibm.com

1 - Panel Discussion: Internet Of Things (IoT) Data Analytics

Robin Lougee, IBM Research, IBM TJ Watson Research Center, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States, rlougee@us.ibm.com

What are the opportunities and challenges for analytics and operations research when virtually every machine that operates in every market and sector can be connected to the internet? Thought leaders who create IoT technologies, systems, and application solutions will share their experiences, delineate the substance from the hype, and engage in a lively discussion of the most needed areas of future research.

2 - Panelist

Doug Meiser, The Kroger Co., 11450 Grooms Road, Cincinnati, OH, 45242, United States, doug.meiser@kroger.com

3 - Panelist

Srinivas Bollapragrada, GE Global Research Center, 1 Research Circle, K1-5a50a, Niskayuna, NY, 12309, United States, bollapragada@research.ge.com

4 - Panelist

Ihsan Sehgal, IBM, 3039 E Cornwallis Road, Research Triangle Park, NY, 27709, United States, rlougee@us.ibm.com

5 - Panelist

Joseph Byrum, Syngenta, 913 31st Street, West Des Moines, IA, 50265, United States, joseph.byrum@syngenta.com

■ SB70

Acoustic- Omni

Transportation, Freight II

Contributed Session

Chair: Samaneh Shiri, Research Assistant, University of South Carolina, 101 pickens st. APt. G2, Columbia, SC, 29205, United States, shiri@email.sc.edu

1 - Commodity-based Econometric Empty Trip Models

Carlos Alberto Gonzalez-Calderon, Research Associate, Rensselaer Polytechnic Institute, 4 25TH ST, APT 5, Troy, NY, 12180, United States, gonzac8@rpi.edu, Jose Holguin-Veras, Ivan Dario Sanchez-Diaz, Ivan Sarmiento, Johanna Amaya

This paper estimates econometric models of empty trips of different commodities and vehicle types. In doing this, panel models with time-dependent parameters and fixed effects are used to assess how parameters change over time considering different commodities, and to detect the presence of time effects not captured by the other parameters. The performing of the formulation for the different commodities is tested in Colombia.

1 - On The Unique Features Of On-demand Peer-to-Peer Logistics Systems

Jennifer A Pazour, Assistant Professor, Rensselaer Polytechnic Institute, 110 8th street, CII 5217, Troy, NY, 12180, United States, pazouj@rpi.edu

On-demand peer-to-peer logistics systems use a business model for the movement and storage of goods that matches independent supply resources (warehouse space, truck space, delivery services) to demand requests on demand. These systems are part of the growing sharing economy and gig economy. We identify the unique features of these systems, comparing and contrasting them with traditional logistics systems. By mapping the characteristics to supply chain principles, we identify challenges with designing and operating, as well as using these systems for the movement and storage of goods.

2 - The Impact Of U. S. Chassis Supply Models On Drayage Productivity

Samaneh Shiri, Research Assistant, University of South Carolina, 101 pickens st. APt. G2, Columbia, SC, 29205, United States, shiri@email.sc.edu, Nathan Huynh

The U.S. container chassis supply market is changing and new models are emerging recently. Supply chain stakeholders such as drayage companies could be affected by evolving models. To study this effect on drayage operation productivity, drayage problem is formulated as an extension of the multiple traveling salesman problem with time window. The proposed solution method is based on tabu search.

■ SB71

Electric- Omni

Transportation, Public II

Contributed Session

1 - The Simultaneous Vehicle Scheduling And Passenger Service Problem With Flexible Dwell Times

Allan Larsen, Associate Professor, Technical University of Denmark, DTU, Building 115 Room 003, Lyngby, DK-2800, Denmark, alar@dtu.dk, Joao F Fonseca, Evelien van der Hurk, Roberto Roberti, Stefan Røpke

In the SVSPSP-FDT the original timetables of the trips can be changed (i.e., shifted and stretched) in order to minimize a new objective function that aims at minimizing the operational costs plus the waiting times of the passengers at transfer points. The SVSPSP-FDT establishes the possibility of changing trips' dwell times at important transfer points based on expected passenger flows. A compact mixed integer linear formulation of the SVSPSP-FDT capable a solving small instances as well as a meta-heuristic approach to solve medium/large instances are presented. The proposed solution methods are tested on a set of real-life instances from the greater Copenhagen area.

2 - A Static Repositioning Problem With Two Commodities For Bike-sharing Systems

Tiantian Zhu, Nanyang Technological University, 50 Nanyang Avenue, Singapore, 639798, Singapore, zhut0003@e.ntu.edu.sg Xiaofeng Nie

In order to handle the issue of static repositioning for bike-sharing systems, a novel integer optimization model is formulated, defining repositioning activities as transferring both bikes and lockers. To handle larger-scale cases, a new cluster-first route-second heuristic is proposed. Based on a set of modified instances from the literature, the heuristic is tested to show its efficiency.

3 - Impact Of Carpool Lane Availability And Traffic Conditions On Peer-to-peer Ridesharing Demand

Sara Masoud, University of Arizona, 1300 E Fort Lowell Road, # A214, Tucson, AZ, 85719, United States, saramasoud@email.arizona.edu, Neda Masoud, Young-Jun Son

This research examines the impact of carpool lane availability and traffic conditions on ridesharing demand using an agent-based simulation model. The proposed work uses a many-to-one ride-matching algorithm in which each rider can travel by means of transferring between multiple drivers' vehicles. A ride-matching algorithm is embedded in the agent-based microscopic traffic simulation software AnyLogic®. Trip tables derived from a real travel demand data set of Los Angeles, California have been used to calibrate the simulation model. The results of this research will shed light on the types of urban settings that are more receptive towards ridesharing services.

■ SB72

Bass- Omni

Supply Chain Mgt II

Contributed Session

Chair: Mojtaba Mahdavi, PhD Student, University of Auckland, 12 Grafton Road, Auckland, New Zealand, m.mahdavi@auckland.ac.nz

1 - Optimal Procurement Design For A National Brand Supplier In The Presence Of Store Brand Competition

Xiang Fang, Associate Professor, University of Wisconsin-Milwaukee, 3202 North Maryland Avenue, Milwaukee, WI, 53211, United States, fangx@uwm.edu, Xinyan Cao

We consider a supply chain consisting of a national brand supplier and a retailer which intends to develop its own store brand. We develop a game-theoretic framework to analyze the strategic interaction between the two players in the presence of asymmetric information.

2 - Optimizing Array Of Shipping Cartons For Ecom DCS

Manjeet Singh, Research Manager, DHL Supply Chain, 570 Polaris Parkway, Westerville, OH, 43082, United States, manjeet.singhin@dhl.com

Dimensional weight charges previously restricted to large packages are now applied to all packages. This has a large impact on Ecom DCs, we found that even in a small piece pick and pack operation on an average over 50% of shipments are now subjected to dimensional weight. Therefore, optimizing the array of shipping cartons can have a huge impact in combating dimensional weight charges. This study puts a special focus on large shipments, which are subjected to more severe charges. Additionally, it also makes recommendations on when to utilize made to order packaging.

3 - How To Design Effective Supply Chain Strategies Based On The Product And Demand Characteristics

Mojtaba Mahdavi, PhD Student, University of Auckland, 12 Grafton Road, Auckland, New Zealand, m.mahdavi@auckland.ac.nz, Tava Olsen

This paper analyzes how different characteristics of product and demand impact the capacity of supply chain strategies for efficiency and responsiveness. In our modeling work, we particularly discuss the impact of product life cycle, demand variability, contribution margin, and stock-out rate on both inventory and lead-time decisions.

■ SB79

Legends G- Omni

JFIG Paper Competition II

Sponsored: Junior Faculty JFIG

Sponsored Session

Chair: Andrew Schaefer, Rice University, 6100 Main Street - MS 134, Houston, TX, 77005, United States, andrew.schaefer@rice.edu

1 - JFIG Paper Competition II

Andrew Schaefer, Rice University, 6100 Main Street - MS 134, Houston, TX, 77005, United States, andrew.schaefer@rice.edu

The 2016 JFIG paper competition features paper submissions from a diverse array of talented junior faculty members. The prize committee evaluated submissions based on the importance of the topic, appropriateness of the approach, and significance of the contribution. After careful review, the prize committee selected a group of finalists to present their research in one of the two JFIG sessions. For information on the finalists and their papers, please refer to the online program.

2 - Simple Bayesian Algorithms For Identifying The Best Arm In A Multi-armed Bandit

Daniel Russo, Northwestern University, Evanston, IL, Dan.Joseph.Russo@gmail.com

This talk considers the optimal adaptive allocation of measurement effort for identifying the best among a finite set of options or designs. An experimenter sequentially chooses designs to measure and observes noisy signals of their quality with the goal of confidently identifying the best design after a small number of measurements. I propose three simple Bayesian algorithms for adaptively allocating measurement effort. Each is shown to have strong performance in numerical experiments, and a unified analysis establishes each satisfies a strong asymptotic optimality property.

3 - Recovering Statistical Guarantees Via The Empirical Robust Optimization

Henry Lam, the University of Michigan, khlam@umich.edu

We investigate the use of distributionally robust optimization (DRO) in recovering the statistical guarantees provided by the best benchmark that is in line with the central limit theorem, for the feasibility of expected value constraints. We show that the divergence ball, suitably empirically defined, and with its size calibrated by the quantile of a chi-square process excursion, amounts to such guarantees. The construction of this ball deviates from the standard mechanism of DRO in that the ball can have low, or even zero probability of covering the true distribution. Rather its performance is explained by connecting the dual of the DRO with a generalization of the empirical likelihood method.

4 - Staffing to Stabilize the Tail Probability of Delay in Service Systems with Time-Varying Demand

Yunan Liu, North Carolina State University, Raleigh, NC, yliu48@ncsu.edu

Abstract to come.

■ SB86

Gibson Board Room-Omni

Manufacturing II

Contributed Session

Chair: Gourav Dwivedi, Doctoral Student, Indian Institute of Management, Indian Institute of Management, IIM Road, off Sitapur Road, Lucknow, 226013, India, fpm14013@iiml.ac.in

1 - A Lagrangian Relaxation Approach For A Multiproduct Stochastic Production Planning Problem

Reha Uzsoy, North Carolina State University, Dept. of Industrial & Systems Engg, 300 Daniels Hall Camps Box 7906, Raleigh, NC, 27695-7906, United States, ruzsoy@ncsu.edu, Erinc Albey, Karl Kempf

We model a single-stage multi item capacitated production-inventory system with stochastic demand. We present a chance-constrained production planning model that considers forecast evolution, which is solve using Lagrangian relaxation. Computational results show that the proposed approach outperforms previous myopic capacity allocation procedures.

2 - Order Scheduling For A Class Of Electronic Ceramic Manufacturers In Make To Order Environments

Zhongshun Shi, Peking University, Haidian Chengfu Road 298, Founder Building Room 512, Beijing, 100871, China, zhongshun@pku.edu.cn, Hongqiang Gao, Leyuan Shi

Motivated by the applications for a class of electronic ceramic manufacturers, we study the order scheduling on sintering operations in make-to-order environments, where sintering furnaces are modeled as batch processing machines. The order consists of multiple types of jobs with specific demand quantity. We consider the total weighted order completion time as objective function and prove the problem is strongly NP-hard. Efficient heuristics with worst-case analysis and asymptotic performance analysis are also developed. Numerical results demonstrate that the proposed heuristics can give near-optimal solutions for different production scenarios.

3 - A Lagrangian Approach For Coordinating Capacity Negotiations In A Semiconductor Firm

Reha Uzsoy, North Carolina State University, Dept. of Industrial & Systems Engg, 300 Daniels Hall Camps Box 7906, Raleigh, NC, 27695-7906, United States, ruzsoy@ncsu.edu, Ankit Bansal, Karl Kempf

We model the negotiations between a product development organization and a production organization for access to manufacturing capacity for product development activities in the semiconductor industry. We develop a negotiation framework based on Lagrangian decomposition that maximizes overall firm contribution subject to the resource constraints of both organizations. The approach aims to achieve coordinated decisions between the two organizations, and provides a benchmark for alternative models of negotiations.

4 - Modeling And Solution For Supply Chain Scheduling In Cold Rolling

Shengnan Zhao, PhD Candidate, Northeastern University, Shenyang, China, zhaoshengnan_neu@163.com, Lixin Tang, Qingxin Guo

This paper studies a supply chain scheduling problem which is derived from steel production. The problem is to make coil schedules with the aim of balancing the capacity of each production line, and minimizing the total setup cost. To describe the problem, we formulate a MILP model with consideration of practical technological requirements. Then we develop an improved discrete differential evolution (DE) algorithm to solve it. The computational experiments show that the proposed DE algorithm outperforms the compared DE algorithms for solving this problem. In addition, the proposed algorithm is also competitive in comparison with the commercial optimization solver CPLEX.

5 - Analysis Of The Barriers To Implement Additive Manufacturing Technology In The Indian Automotive Sector: A Fuzzy-ISM Approach

Gourav Dwivedi, Doctoral Student, Indian Institute of Management, Indian Institute of Management, IIM Road, Off Sitapur Road, Lucknow, 226013, India, fpm14013@iiml.ac.in, Rajiv K Srivastava, Samir K Srivastava

This paper analyzes the interaction among barriers to implement additive manufacturing (AM) technology in the Indian automotive sector. We use Fuzzy-Interpretive Structural Modeling (Fuzzy-ISM) method to derive hierarchy and direction and to measure the strength of relations among these barriers. Dominant barriers are identified using this approach. The findings may be useful for managers to develop suitable mitigation strategies. This study contributes to AM literature by the structured presentation of the barriers.

■ SB94

5th Avenue Lobby- MCC

Technologoy Tutorial: Palisade Corporation/Bayesia

1 - Palisade: Introduction To Risk And Decision Analysis Using @RISK And The Decision Tools Suite

José Raúl Castro, Palisade Corporation, Ithaca, NY, raul.castro.gc@gmail.com

This software presentation is designed to provide an entry-level introduction into probabilistic analysis and will show how Monte Carlo simulation and other techniques can be applied to your everyday business analyses. Using Monte Carlo simulation, @RISK will analyze many different scenarios all at once, giving you more insight into what could happen. We'll look at example models including a basic revenues/cost/profits model, an NPV model, and a Cost Estimation model, to give you an idea of how quickly you can get started in probabilistic modeling in Excel. If you build models in Excel then Palisade solutions can almost certainly help you to make more informed decisions, right from your desktop. Palisade software and solutions have been used to make better decisions. Cost estimation, NPV analysis, operational risk registers, portfolio analysis, insurance loss modeling, reserves estimation, schedule risk analysis, budgeting, sales forecasting, and demand forecasting are just some of the ways in which the tools are applied. This presentation will demonstrate how easy - and necessary - it is to implement quantitative risk analysis in any business.

2 - Bayesian Networks & BayesiaLab: Artificial Intelligence for Research, Analytics, and Reasoning

Stefan Conrady, BAYESIA USA, Franklin, TN, Contact: stefan.conrady@bayesia.us

The objective of this workshop is to show that "Artificial Intelligence" should not be perceived as a quasi-magic technology that is mostly incomprehensible to normal mortals. We want to illustrate how scientists in any field of study—rather than only computer scientists—can employ AI to explore complex problems. For this purpose, we present Bayesian networks as the framework and BayesiaLab as the software platform. In this context, we demonstrate BayesiaLab's supervised and unsupervised machine learning algorithms for knowledge discovery in high-dimensional, unknown domains. Also, while AI is commonly associated with another buzzword, "Big Data", we wish to prove that AI can be useful for dealing with problems for which we possess little or no data. Here, expert knowledge modeling is critical, and we describe how even a minimal amount of expertise can serve as a basis for sound reasoning aided by AI.

Sunday, 1:30PM - 3:00PM

■ SC01

101A-MCC

Supervised and Unsupervised Methods

Sponsored: Data Mining

Sponsored Session

Chair: Wenjun Zhou, University of Tennessee, 916 Volunteer Blvd, 255 Stokely Management Center, Knoxville, TN, 37996-0525, United States, wzhou7@gmail.com

1 - Group-wise Sufficient Dimension Reduction: With Applications In Forecasting The Equity Risk Premium

Haileab Tesfe Hilafu, University of Tennessee, hhilafu@utk.edu

When there is prior domain knowledge concerning a grouping structure of the predictors, two different approaches of dimension reduction exist: carry out dimension reduction of predictors in each group separately which ignores the inter-dependence among the groups; ignore the grouping structure and reduce the dimension of the predictors jointly. We present a method that bridges these two approaches in the sense that it, simultaneously, utilizes the prior domain knowledge and accounts for potential inter-dependence among the groups of predictors. The proposed method is applied to forecast the equity risk premium from a set of well known macroeconomic and a set of technical variables.

2 - Sufficient Dimension Reduction For Treatment Effect Estimation

Craig Anthony Rolling, Saint Louis University College for Public Health and Social Justice, 1 North Grand Boulevard, Saint Louis, MO, 63103, United States, rollingca@slu.edu, Wenbo Wu

For nonparametric methods of estimating the treatment effect, if the dimension of the baseline covariates is large, implementation becomes difficult and sometimes infeasible due to the curse of dimensionality. Hence, sufficient dimension reduction of baseline covariates can be useful before estimating the treatment effect. We refer to such a dimension reduction subspace as a central treatment effect subspace (CTES). We propose methods to estimate the CTES and its structural dimension, investigate the theoretical properties of these estimators, and demonstrate their effectiveness with numerical studies.

3 - Load Forecasting Using Support Vector Machine With Optimized Parameters

Olufemi A. Omitaomu, Oak Ridge National Laboratory, omitaomuoa@ornl.gov

Load forecasting is central to most of the energy transaction decisions in power systems planning and energy markets. Until now, most approaches for forecasting energy demand rely on monthly electrical consumption data. The emergence of smart meters is changing the data landscape for electric utility companies, and creating opportunities for utility companies to collect and analyze energy consumption data at a much finer temporal resolution. To enhance the estimation of energy demand at the household and network levels, we present an on-line accurate support vector regression technique that uses optimized regression parameters for forecasting real-time energy demand using smart meters data.

4 - Catch Me If You Can: Detecting Pickpocket Suspects From Large-scale Transit Records

Chuanren Liu, Drexel University, chuanren.liu@drexel.edu

Massive data collected by automated fare collection (AFC) systems provide opportunities for studying both personal traveling behaviors and collective mobility patterns in the urban area. We creatively leverage such data for identifying thieves in the public transit systems. We develop a thief active tracking system that identifies pickpocket suspects based on their daily transit records. We first extract a number of features from each passenger's daily activities in the transit systems. Then, we exploit a combination of outlier detection and classification models to identify thieves, who exhibit abnormal traveling behaviors.

■ SC02

101B-MCC

Quality and Statistical Decision Making in Health Care Applications

Sponsored: Data Mining

Sponsored Session

Chair: Cao Xiao, University of Washington, 3900 Northeast Stevens Way, MEB, Seattle, WA, 98195, United States, xiaoc@uw.edu

Co-Chair: Shuai Huang, University of Washington, Seattle, WA, United States, shuaih@uw.edu

1 - Modeling And Analysis Of The Waiting Time Of Rapid Response Process In Acute Care

Nan Chen, Tsinghua University, Room 615, Shunde Building, Tsinghua University, Haidian District, Beijing, 100084, China, chenn618@gmail.com, Xiaolei Xie, Li Zheng

Improving the efficiency of rapid response process in acute care plays a significant role to ensure patient safety. We develop an analytical method to evaluate the waiting time and its variability. We discussed the structural properties and continuous improvement by adding care providers. A bottleneck indicator is introduced and a simple approximation formula is obtained. Case study is introduced to illustrated the application of the method.

2 - Modeling And Prediction Of The Mental Health Conditions Of Web Users

Qingpeng Zhang, City University of Hong Kong, 1, Hong Kong, brianzqp@gmail.com

The digital footprints of Web users left on the Web presents important proxies of their health conditions. In this research, we propose novel machine learning algorithms to model and predict the mental health conditions of Web users based on their online activities on social media. The preliminary results show the potential of using the open source social media data to infer the mental health conditions of people, and help health providers make better decisions.

3 - Learning Semantics Behind Health Status Disclosure On Twitter

Zhijun Yin, Vanderbilt University, Nashville, TN, 37203, United States, zhijun.yin@vanderbilt.edu, Bradley Malin

User generated content in social media is increasingly acknowledged as a rich resource for research into health problems. We in this talk present a framework to investigate how semantics are related with disclosure routines for 34 health issues. Our findings show that health issues related with family members, high medical cost and social support (e.g., Alzheimer's Disease, cancer, and Down syndrome) lead to tweets that are more likely to disclose another individual's health status, while tweets with more benign health issues (e.g., allergy, arthritis, and bronchitis) with biological processes (e.g., health and ingestion) and negative emotions are more likely to contain self-disclosures.

4 - Hospital Operational Health Monitoring: Enabling Organizational Communication Of Key Indicators And Analytics

Diego A. Martinez, Scott R. Levin, Matthew F. Toerper, Johns Hopkins University School of Medicine, Baltimore, MD, dmart101@jhmi.edu

Most hospitals have adopted electronic medical records, yet leveraging these data to optimize hospital operations remains a challenge. Grounded in human-computer interaction and visualization theory, we built a web app to facilitate data exploration and trend analysis. The app allows users to directly explore big data and scientifically assess whether or not an intervention is impacting hospital performance. Keeping clinicians and hospital leadership informed about practice operations can help align them with organizational goals, ultimately leading to better financial performance.

■ SC03

101C-MCC

Doing Good with Good OR I

Invited Session

Chair: Karen Smilowitz, Northwestern University, 2145 Sheridan Road RM D239, Evanston, IL, 60208, United States, ksmilowitz@northwestern.edu

1 - The Operational Challenges Of Sharing-Economies: An Optimal Re-balancing Mechanism For The Bike-Sharing Industry

Pantelis Loupos, Department of Operations Management, Kellogg School of Management, Northwestern University, Evanston, IL 60208, Can Urguny

Bike-sharing programs have been gathering momentum, but their expansion poses operational challenges. We propose a novel solution to the bike re-balancing problem, that is centered around the actions of the riders instead of utilizing trucks for re-balancing. Our findings indicate great promise, whose adoption by bike sharing operators could have a positive impact on the industry.

2 - The Humanitarian Pickup And Distribution Problem

Ohad Eisenhandler, Department of Industrial Engineering, Tel Aviv University, Tel Aviv, Israel, ohadeis@gmail.com, Michal Tzur

We address the logistic challenges of food banks, which collect donated food from suppliers and distribute it to welfare agencies. We model the problem as a routing – resource allocation problem. Motivated by the activity of Israeli and American organizations, we introduce an innovative objective function, which balances equity and effectiveness in this operation, and propose exact and heuristic solution methods.

3 - Data Analytics For Optimal Detection Of Metastatic Prostate Cancer

Christine Barnett, Department of Industrial & Operations Engineering, University of Michigan, 1205 Beal Avenue, Ann Arbor, MI 48109, clbarnet@umich.edu, Selin Merdan

We used data-analytics approaches to develop, calibrate, and validate predictive models to help urologists make prostate cancer staging decisions. These models were used to design guidelines that weigh the benefits and harms of radiological imaging. The Michigan Urological Surgery Improvement Collaborative implemented these guidelines which miss less than 1% of metastatic cancers while reducing unnecessary imaging by more than 40%.

■ SC04

101D-MCC

Gas-Power Market Integration

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Robert Brooks, President, RBAC Inc, 14930 Ventura Blvd. Ste. 210, Sherman Oaks, CA, 91403, United States, rebrooks@rbac.com

1 - Analysis Of Gas / Electric Integration And Coordination In The Eastern Interconnection Of The United States And Canada

Sara Wilmer, Levitan & Associates, Inc., sw@levitan.com

Levitan & Associates has conducted recent analyses of gas-electric integration and coordination on behalf of the Eastern Interconnection Planning Collaborative and the Department of Energy. These analyses examined whether future electric sector demand for natural gas will be able to be accommodated by the available natural gas infrastructure as renewable penetration expands and coal-fired resources are retired. This case study will describe the modeling tools and integrated modeling framework used to conduct the work, and challenges faced both in the representation of real-world gas and electric systems in the selected modeling tools and in the integration of the different modeling tools.

2 - Gas & Power Markets: Forecasting Prices In An Evolving Energy Landscape

Connie S. Trecazzi, Tennessee Valley Authority, cstrecazzi@tva.gov

Environmental regulations in the energy sector paired with a tsunami of shale gas have changed power and natural gas market operations. The shift in regional gas supply is driving infrastructure changes. Lower renewable costs are impacting capacity decisions and affecting reliability requirement decisions. Electricity demand has gone through a paradigm shift as steps taken to improve energy efficiency are realized, changing views on how to model future growth. In this environment, having tools to evaluate the impact of changes in both the electricity and gas markets and pass detailed information between the models is essential to understanding how each assumption impacts both markets.

3 - The Clean Power Plan: The Art And Science Of Quantifying Its Impacts Using Integrated Gas-power Modeling

Rahul Dhal, Developer, EPIS, LLC, 13535 72nd Ave., Ste. 165, Tigard, OR, 97223, United States, rahuldhal@epis.com

Energy policies are, by nature, complex. The mechanisms through which policies attempt to bring about changes in the market regularly involve a large number of stakeholders. Given the decentralized and interconnected nature of U.S. energy sectors, it is very important to develop methods for evaluating the impact of the complex energy policies. In this talk we present a method for evaluating energy policies. Our methodology that integrates industry-standard modeling frameworks for gas and power markets. The integrated gas-power framework allows for evaluation of a wide-range of energy policies. We employ this framework to quantify the impact of the Clean Power Plan on both power and gas markets.

4 - Integrated Natural Gas And Electricity Modeling With RBAC GPCM And GE Maps

Leah Kaffine, Senior Engineer, GE Energy Consulting Group, Schenectady, NY, United States, Leah.Kaffine@ge.com

Natural gas has seen a steady increase in its market share as a fuel for power generation, with continued growth expected. GE Energy Consulting has integrated Multi Area Production Simulation Software (MAPS) with Gas Pipeline Competition Model (GPCM) in order to provide a more detailed spatial and dynamic understanding of the gas-power interaction. While existing models can capture some market dynamics in isolation, the integration of MAPS with GPCM allows for a comprehensive approach to understanding interdependent issues. Ultimately Energy Consulting's integrated modeling allows for a consistent view of the future natural gas demand for power between the two models.

■ SC05

101E-MCC

Power Transmission Planning under Uncertainty

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Rodrigo Moreno, University of Chile, Av. Tupper 2007, Santiago, 8370451, Chile, rmorenovieyra@ing.uchile.cl

1 - A Comparison Of Stochastic And Adaptation Programming Methods For Electric Infrastructure Planning

Patrick Maloney, Iowa State University, Ames, IA, United States, patrickm@iastate.edu, Ali Jahanbani-Ardakani, James McCalley

In this work a recently developed mathematical programming formulation called adaptation is compared with traditional stochastic programming methods in the context of electric infrastructure expansion planning. While the adaptation formulation structure resembles that of a generic stochastic program it deviates from the temporal conventions of traditional expansion planning formulations. Structural comparisons and simulations are investigated to better understand differences in the methods.

2 - Value Of Model Sophistication On Transmission Expansion Planning

Qingyu Xu, Johns Hopkins University, Baltimore, MD, 21218, United States, qxu25@jhu.edu, Saamrat Kasina, Benjamin Field Hobbs

A set of transmission expansion plans for the western North America interconnection are optimized based on several variants of a 300-bus co-optimization model with a range of levels of sophistication, including DC optimal power flow, unit commitment and stochastic planning. The economic benefits of increasing model realism are estimated. The results show consistent impacts of sophistication upon transmission and generation investments, with load flow representations mattering most.

3 - A Five-level Milp Model For Flexible Transmission Network Planning Under Uncertainty: A Min-max Regret Approach

Alexandre Moreira, Imperial College London, a.moreira14@imperial.ac.uk
Goran Strbac, Rodrigo Moreno, Alexandre Street, Ioannis Konstantelos

The benefits of network planning solutions have to be explicitly considered in the context of uncertainty in future realizations of generation infrastructure. Hence this talk presents a novel five-level model to determine optimal transmission expansion plans under generation expansion uncertainty in a min-max regret fashion, when considering flexible network options and n-1 security. In order to solve the five-level model on large-scale networks, we propose an effective outer algorithm.

4 - Uncertainty In Strategic Network Investment: Stochastic vs. Robust Min-max Approaches

Rodrigo Moreno, University of Chile, Santiago, Chile, rmorenovieyra@ing.uchile.cl, Goran Strbac

Benefits of transmission network planning significantly depend on deployment patterns of electricity generation that are characterized by severe uncertainty. In this context, this talk presents various approaches to solve the transmission expansion planning problem under generation expansion uncertainty. In particular, we compare robust and stochastic methods, and discuss about their suitability to properly balance benefits of economies of scale against risks of stranded assets.

■ SC06

102A-MCC

INFORMS 2016 Data Mining Best Student Paper Awards

Sponsored: Data Mining

Sponsored Session

Chair: Mustafa Gokce Baydogan, Bogazici University, Istanbul, Turkey, baydoganmustafa@gmail.com

■ SC07

102B-MCC

Joint Session DM/AI: Data Mining for Decision Making

Sponsored: Data Mining

Sponsored Session

Chair: Iljoo Kim, Saint Joseph's University, Philadelphia, PA, United States, ikim@sju.edu

1 - Studying Agenda Setting Influence Of Online Newspaper Comments

Iljoo Kim, Saint Joseph's University, ikim@sju.edu

In this continued work, we study online comments and their influence in online news articles. Using text-mining techniques, we attempt to explain and/or predict influence of online newspaper comments on the context of the original article or even on creating a new agenda through the discussions among commenters. This is done based on the textual signals embedded within comments as well as news articles.

2 - Crowdiq: Aggregating Crowd Opinions For Stock Price Predictions

Qianzhou Du, Virginia Tech, 100 Otey Street, Room 301, Blacksburg, VA, 24061, United States, qiand12@vt.edu
Hong Hong, Alan Wang, Weiguo Fan

The Wisdom of Crowds (WoC) theory explains how crowd opinions should be aggregated in order to improve the performance of decision making. Diversity, independence, decentralization, and aggregation are important factors to crowd wisdom. Existing opinion aggregation methods fail to collectively consider all the factors of crowd wisdom. We propose a new opinion aggregation method, namely CrowdIQ, to evaluate crowd wisdom using all four factors. We apply CrowdIQ to a stock prediction task using user-generated stock tweets. The result shows that CrowdIQ outperforms baseline methods.

3 - Data Mining For Result Prediction In Sports

Kyuhan Lee, Seoul National University, Seoul, Korea, Republic of, kyuhanlee0119@gmail.com
Jinsoo Park, Buomsoo Kim

The expansion of sports betting has extensively contributed to the increase of public interest on sports result prediction. In academia, as statistical data respecting sports games are readily accessible, abounding research has been conducted regarding the subject. In this paper, unlike the past studies focusing on limited types of data, we use a comprehensive set of data, including statistical data as well as text data, to enhance the accuracy of sports result prediction. We expect that our prediction model produces a preferable outcome comparing to the models of previous research.

4 - Predicting Users' Continuous Participation In Online Health Virtual Community: Demographic And Content Cues

Yanyan Shang, Dakota State University, Madison, SD, United States, yshang@pluto.dsu.edu, Jun Liu, Iljoo Kim

Online health community (OHC) is a platform where people with similar health conditions gather virtually to ask questions, share experiences, provide support, and exchange healthcare knowledge. To be effective, the OHCs have to maintain active continuance participation from their users. The purpose of this study is to identify factors that affect the users' continuance participation. Specifically, we attempt to use data analytics techniques to identify the demographic and content cues that affect the users' continuance participation. The findings of our research help community managers deploy various strategies to encourage the continuance participation of different types of members.

■ SC08

103A-MCC

Undergraduate OR Prize - II

Invited: Undergraduate Operations Research Prize
Invited Session

Chair: Pavithra Harsha, IBM Research, 1101 Kitchawan Road, Room 34-225, Yorktown Heights, NY, 10598, United States, pharsha@us.ibm.com

1 - Hot Sales Logistics Optimization For ET

Ba ak Erman, Bilkent University, Ankara, Turkey, basakerman@gmail.com
Zeynep Yaprak Be ik, Deniz Berfin Karakoç, Umut Müdüro Lu, Yekta Jehat Mizrakli, Egehan Yanik

ET is one of the leading food manufacturer in Turkey. Additonal to standard distribution system, ET has a local distribution system that enables trucks to visit smaller retailers and pursue hot sales. The aim of the project is to increase the efficiency of hot sales where demand by the retailers are better satisfied. The delivery route is divided into two: route from the main depot, which is far from customers, to the customers, and the route between customers. This project aims to maximize the utility of time spend in routes by assigning customers to trucks and identifying depot locations.

2 - Regularized Linear Regression via Robust Optimization Lens

Hari Bandi, Massachusetts Institute of Technology, Cambridge, MA, United States, hbandi@mit.edu, Garud Iyender, Vineet Goyal

There has been research in recent years to understand why regularized linear regression methods work well in the presence of noise. This problem has been approached by establishing relationship between robust optimization and regularized linear regression methods. In this work, we seek to understand the same for general loss functions used widely in Statistics, Machine Learning and Econometrics literature and we propose principled approaches to select regularization functions in order to optimally balance the bias-variance trade-off in regularized regression.

3 - On Comprehensive Mass Spectrometry Data Analysis For Quality Assessment Of Biological Samples

Sameer Manchanda, Purdue University, West Lafayette, IL, United States, Mikaela Meyer, Nan Kong, Qianqian Li, Yan Li

Mass spectrometers have become promising instruments to acquire proteomic information, creating a need for a data analysis platform for classification of mass spectra and identification of important biomarkers. To meet this need, we present a comprehensive pattern recognition platform for spectrum preprocessing and classification. In a case study, the platform achieves higher than 90% sensitivity and specificity in distinguishing rat blood samples stored for different amounts of time and derives fingerprint patterns of serum proteins that are strongly associated with the sample classification.

4 - Allocating Countermeasures To Defend Water Distribution Systems Against Terrorist Attack

Jacob Monroe, North Carolina State University, Raleigh, NC, United States, jgmonroe@ncsu.edu
Elizabeth Ramsey, Emily Zechman Berglund

An agent-based model is developed to simulate the attack and defense of a water distribution system to analyze security resource allocation strategies for protecting against chemical contamination events. A single period attacker-defender game is simulated, in which an attacker seeks to contaminate a system node, and a group of defenders seek to minimize the public health impact from attack. Terrorist decisions are simulated using a multi-attribute utility function. The utility manager assigns personnel and security equipment to nodes using one of three security resource allocation strategies.

■ SC09

103B-MCC

Energy and Environmental Policy

Sponsored: Energy, Natural Res & the Environment I
Environment & Sustainability
Sponsored Session

Chair: Yihsu Chen, University of California Santa Cruz, 1156 High Street, M/S SOE3, Santa Cruz, CA, 95064, United States, yihsuchen@ucsc.edu

1 - The Cost Of Reaching Mexicos Climate Change Goals

Rodrigo Mercado Fernandez, UMass, Amherst, MA, rodmerfdez@gmail.com

This paper analyzes the cost of Mexico reaching its climate change emissions goals, using integrated assessment models, and looks at how this will affect the electricity generation portfolio. These results are compared with the predicted impacts that Mexico's current policies will have on emissions and generation. Lastly this paper identifies policy changes that could help Mexico reach its long-term emissions goals for 2030 and 2050.

2 - On The Inefficiencies Of The US Federal Clean Power Plan

Duan Zhang, University of California Santa Cruz, Santa Cruz, CA, United States, dzhang33@ucsc.edu, Yihsu Chen, Makoto Tanaka

The performance-based standard under the US federal Clean Power Plan relies on trading the emission rate credits (ERCs), which represent the equivalent MWh of energy generated or saved with zero associated CO2 emissions, to equating marginal abatement costs across generating units. We show theoretically the equivalence between the ERCs and the traditional mass-based trading when states are subject to their own performance-based standards. We also identify the conditions under which the inefficiency of the performance-based standard might arise, leading to a divergence of permit prices across states. A numerical 3-node model was built to illustrate our findings.

3 - Feed-in Tariffs Vs. Renewable Portfolio Standards: The Effect Of Market Power

Mari Ito, Tokyo University of Science, Noda, Japan, mariito@rs.tus.ac.jp, Ryuta Takashima, Makoto Tanaka, Yihsu Chen

Recently policies for promoting renewable energy, e.g., feed-in tariffs (FIT) and renewable portfolio standards (RPS) have been introduced in various countries. In this work, we examine an effect of market power in the electricity market on FIT and RPS by bi-level model. For lower level, generation outputs for renewable and non-renewable generators are decided by maximizing their profits whereas for upper level, the fixed price of FIT and the RPS requirement are derived by maximizing a social welfare. In addition, we show how the number of firms affects the fixed price and the requirement.

4 - Tradable Performance-based Co2 Emissions Standards: Walking On Thin Ice?

Yihsu Chen, University of California Santa Cruz, yihsuchen@ucsc.edu, Afzal Siddiqui, Makoto Tanaka

US federal Clean Power Plan (CPP) stipulates a state-specific performance-based CO2 standard and offers considerable flexibility to the states in achieving the target. We analyze the tradable performance standards and related mass-based standard when they are subject to imperfect competition by formulating them either as a complementarity problem or a mathematical program with equilibrium constraints (MPEC). The MPEC is solved as mixed integer problems with a binary expansion. We show that while the cross-subsidy inherent in the performance-based standard that might effectively reduce power prices, it could in inflate energy demand, thereby rendering permits scarce.

■ SC10

103C-MCC

Advances in Energy Systems Modeling

Sponsored: Energy, Natural Res & the Environment, Energy II Other

Sponsored Session

Chair: Rudolf Gerardus Egging, Norwegian University of Science & Technology, Trondheim, Trondheim, 00000, Norway, ruud.egging@iot.ntnu.no

1 - Plug And Abandonment Of Offshore Oil And Gas Fields.

Steffen J. Bakker, Norwegian University of Science and Technology, steffen.bakker@iot.ntnu.no

At the end of a wells life-cycle, the well has to be permanently abandoned. This process is called plug and abandonment (P&A). Decisions in the P&A process depend heavily on uncertain factors such as oil and gas prices, rig rates or well states. Moreover, these decisions have to be taken at different levels. In this presentation we discuss a classification of the P&A process into an operational, tactical and strategic level. For each of these levels we present a corresponding model, where we make use of real options theory and the frameworks of integer and stochastic programming.

2 - Trading Off Demand Side Flexibility Vs. Supply Side Flexibility And Storage In The Electricity System

Hector Maranon-Ledesma, Norwegian University of Science and Technology, hector.maranon-ledesma@iot.ntnu.no

Demand Side Management (DSM) permits a reduction in peak load consumption, a more adaptable demand of electricity, allowing shuting down high emission power plants, and the intermittent renewable resources to be better exploited by the use of flexibility mechanisms.
The EMPIRE electricity sector model is a long-term investment stochastic model. This model has been improved by including DSM at the operational level. The contributions of this work are including DSM in a large scale electric system and highlighting the importance that DSM might acquire in the future European power system.

3 - The Effect Of Drivers Elasticity On The Optimal Pricing And Management Of Electric Vehicles Charging

Chiara Bordin, Norwegian University of Science and Technology, Trondheim, Norway, chiara.bordin@iot.ntnu.no, Stig Ødegaard Ottesen, Asgeir Tomasgard, Siri Bruskeland Ager-Hanssen, Siri Olimb Myhre

The increasing demand for Electric Vehicles (EV) charging puts pressure on the power grids as in some situations the power consumption can exceed the grid capacity. We propose a mathematical model for the indirect control of EV charging that finds an optimal set of price signals to be sent to the drivers according to their flexibility. The objective is to satisfy the demand when there is a capacity lack by minimizing the curtailment of loads and prioritizing the loads shifting. The key contribution is the use of the elasticity concept to forecast the drivers reactions to the price signals. Sensitivity analyses are presented to investigate the elasticity effect on prices and loads management.

4 - Risk Aversion In Imperfect Natural Gas Markets.

Rudolf Gerardus Egging, Norwegian University of Science & Technology, ruud.egging@iot.ntnu.no

We consider risk aversion by natural gas supply companies considering investment in conventional and shale gas resources in a stochastic multi-period mixed complementarity problem. Uncertainty considered includes political risk and resource sizes. We consider shale gas investment in Poland and Ukraine in a realistic market setting in Europe. We discuss investment decisions and profits for varying levels of risk aversion.

■ SC11

104A-MCC

Dense Clusters in Network Optimization

Sponsored: Optimization, Network Optimization

Sponsored Session

Chair: Vladimir Stozhkov, University of Florida, 2330 SW Williston Rd, Apt 2826, Gainesville, FL, 32608, United States, vstozhkov@ufl.edu

1 - Relative Clique Relaxations In Complex Networks

Vladimir Boginski, University of Central Florida, Vladimir.Boginski@ucf.edu

Real-world complex networks exhibit clustered structure: certain groups of nodes (vertices) form “cohesive” or “highly connected” clusters (can also be referred to as “communities”), which can be rigorously characterized using graph-theoretic concepts. In this presentation, we will focus on so-called relative clique relaxation models, which are obtained by relaxing certain metrics that attain their maximum possible values on a clique: edge density, minimum vertex degree, and vertex connectivity. We will discuss optimization problems of identifying such clusters in networks, as well as related asymptotic results on phase transitions in random graphs.

2 - Robust Network Clusters With Small-world Property

Jongeun Kim, University of Florida, Gainesville, FL, United States, kje0510@ufl.edu, Alexander Veremyev, Vladimir Boginski, Oleg A Prokopyev

Networks are popular and effective tools for analyzing real-world systems, such as telecommunication, transportation, and social networks. Network robustness is one of the important issues, because some undesired failures may affect connectivity and functionality of a network. The ideal robust cluster in a network is a clique and clique-relaxation research have been developed in recent decades. In this talk we will address small-world clusters that are robust but also have certain natural properties.

3 - Detecting Essential Proteins Using A Novel Star Centrality Metric

Mustafa Can Camur, North Dakota State University, Fargo, ND, United States, mcancamur@gmail.com

In this talk, we propose a new centrality metric (referred to as star centrality), which aims to incorporate information from the closed neighborhood of the node, rather than strictly from the node itself. More specifically, we turn our focus to degree centrality and show that in the complex protein-protein interaction networks it is a naive metric that can lead to misclassifying importance in the network. We portray the success of the new metric using protein-protein interaction networks, and investigating the significant difference in the importance of individual nodes we observe when transitioning from node degree centrality to star degree centrality.

4 - Estimating The Maximum IUC Using SDP Relaxations

Eugene Lykhovyd, Texas A&M University, lykhovyd@tamu.edu, Sergiy Butenko

If you have a simple, undirected graph, the Independent Union of Cliques (IUC) problem is to find the maximum subset of vertices, in which every connected component is a clique. It is known that this problem can be formulated on 3-uniform hypergraphs as the maximum weak independent set. We propose the estimates for IUC problem based on different SDP relaxations, extending the Lov\'asz estimate for the maximum stable set. The comparison of different approaches is also presented.

■ SC12

104B-MCC

Convex Relaxations for Nonconvex Polynomial Optimization

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Daniel Bienstock, Columbia University, 116th and Broadway, New York, NY, 10027, United States, dano@columbia.edu

1 - LP And SOCP-based Algebraic Relaxations For Polynomial Optimization

Amir Ali Ahmadi, Princeton University, a_a_a@princeton.edu

We present ongoing work on solving polynomial optimization problems using linear and convex relaxations based on a number of ideas, including separation from the set of rank-1 psd matrices, and, in particular, the method of approximate representation of continuous variables as weighted sums of binary variables. We will discuss theory and computational practice. Joint work (Gonzalo Munoz, Chen Chen and Daniel Bienstock).

2 - Online First-order Framework For Robust Convex Optimization

Fatma Kilinc-Karzan, Carnegie Mellon University, fkilinc@andrew.cmu.edu, Nam Ho-Nguyen

We present a flexible iterative framework to approximately solve robust convex optimization problems. Our results are based on weighted regret online convex optimization and online saddle point problems. A key distinguishing feature of our approach from prior literature is that it requires access to only cheap first-order oracles for each constraint individually and does simple online updates in each iteration while maintaining the same convergence rate. For strongly convex functions, we also establish a new improved iteration complexity. As a result, our approach becomes much more scalable and hence preferable in large-scale applications from machine learning and statistics domains.

3 - New And Old Results On Polynomial Optimization

Daniel Bienstock, Columbia University, dano@columbia.edu

We present ongoing work on solving polynomial optimization problems using linear and convex relaxations based on a number of ideas, including separation from the set of rank-1 psd matrices, and, in particular, the method of approximate representation of continuous variables as weighted sums of binary variables. We will discuss theory and computational practice, and attempt to relate our work to earlier results by Renegar and Barvinok. Joint work (Gonzalo Munoz, Chen Chen and Daniel Bienstock).

■ SC13

104C-MCC"

Advances in Mixed Integer Polynomial Optimization

Sponsored: Optimization, Global Optimization

Sponsored Session

Chair: Akshay Gupte, Clemson University, O-321 Martin Hall, Clemson University, Clemson, SC, 29634, United States, agupte@clemson.edu

1 - Exploiting Permutation Invariance To Construct Tight Relaxations

Mohit Tawarmalani, Purdue University, West Lafayette, IN, United States, mtawarma@purdue.edu, Jinhak Kim, Jean-Philippe P. Richard

We construct the convex hull for a set that does not change when the variables are permuted. We illustrate the technique by developing (1) convex hull of matrices with bounded rank and spectral norms, (2) convex envelopes of multi-linear functions over certain domains, and (3) a novel reformulation and relaxation for sparse principal component analysis.

2 - Intersection Cuts And S-free Sets For Polynomial Optimization

Chen Chen, Columbia University, New York, NY, United States, chen.chen@columbia.edu, Daniel Bienstock, Gonzalo Munoz

We develop an intersection cut for generic problems with closed sets. The cut relies on a violation distance oracle and it can be computed in polynomial time in the special case of polynomial optimization. Additional cuts are presented based on S-free sets or convex forbidden zones; for polynomial optimization we adopt the specialized term of outer-product-free sets. We provide some insight into the nature of maximal outer-product-free sets and present two classes of such sets. These two classes give intersection cuts that can be computed in polynomial time. Furthermore, the associated intersection cuts can be strengthened in the case of intersections at infinity.

3 - On The Strength Of Linear Approximations For Multilinear Monomials

Yibo Xu, Clemson University, Clemson, SC, United States, yibox@clemson.edu, Warren P Adams, Akshay Gupte

We analyze worst-case errors associated with approximating multi-linear terms over bounded variables when using linear functions. The error associated with a linear function at a given point is the absolute difference between the actual and functional values. These errors turn out to be dependent on the variable bounds. We identify "best" linear functions that yield the smallest worst-case errors for various sets of bounds, and identify those points at which these errors are realized. The errors favorably compare with those obtained by convex hull representations.

4 - Iterative LP And SOCP-based Approximations To Semidefinite Programs

Georgina Hall, Princeton University, Princeton, NJ, United States, gh4@princeton.edu, Amir Ali Ahmadi

We develop techniques for approximating SDPs with LPs and SOCPs. Our algorithms iteratively grow an inner approximation to the PSD cone using a column generation scheme and/or a change of basis scheme involving Cholesky decompositions.

■ SC14

104D-MCC

Syngenta Crop Challenge in Analytics

Invited: Agricultural Analytics

Invited Session

Chair: Durai Sundaramoorthi, Washington University in Saint Louis, Campus Box 1156, One Brookings Drive, Saint Louis, MO, 63130-4899, United States, dsundaramoorthi@gmail.com

1 - Hierarchical Modeling Of Soybean Variety Yield And Decision Making For Future Planting Plan

Huaiyang Zhong, Stanford University, hzhong34@stanford.edu, Xiaocheng Li, David J Lovell

We introduce a novel hierarchical machine learning mechanism for predicting soybean yield that can achieve a median absolute error of 3.74 bushels per acre in five-fold cross-validation. Further, we integrate this prediction mechanism with a weather forecasting model, and propose three different approaches for decision making under uncertainty to balance yield maximization and risk.

2 - Balancing Weather Risk And Crop Yield For Soybean Variety Selection

Ling Tong, University of Iowa, Iowa City, IA, United States, ling-tong@uiowa.edu, Bhupesh Shetty, Samuel Burer

We propose an optimization-based method to assist a farmer's choice of soybean varieties to plant in order to maximize expected yield while also managing risk, where the primary uncertainty faced by the farmer is due to seasonal weather patterns. By solving a sequence of MIPs, we calculate the efficient frontier between the two competing objectives of maximizing expected yield and guaranteed yield over all possible season types. The coefficients of the MIPs are estimated using a multiple-linear-regression model and a Bayesian-updating scheme applied to the training and evaluation data. Using the efficient frontier, the farmer may choose an optimal solution that fits his/her risk-reward profile.

3 - Decision Assist Tool For Seed Variety To Provide Best Yield In Known Soil And Uncertain Future Weather Conditions

Mehul Bansal, Robert Bosch Engineering and Business Solutions, Bengaluru, Karnataka, India, Mehul.Bansal@in.bosch.com Nataraj Vusirikala

The gap between agriculture produce and demand is ever increasing due to growing world population. There is an urgent need for utilizing all possible methods and technology solutions to bridge this gap. One of the key challenges to increase the agricultural produce is the ability to take right decisions under uncertain climate and weather conditions. In this paper we discuss a method to provide decision assist to the farmer on the best variety of soybean seed to be sown at the start of a season. In order to optimize the yield under uncertain conditions, we use a combination of crop yield modeling, weather forecasting and portfolio optimization techniques to suggest best combination of soybean seed variety. The data used in this method is the historical soybean produce data and the corresponding soil and weather conditions under which the yield was produced, day-wise weather data (temperature, precipitation and solar radiation) at farm sites from 2008 to2014. We recommend planting the following varieties with the given percentages at site 2290 for year 2016: (i) 10% of Variety V107, (ii) 35% of Variety V179, (iii) 10% of Variety V189, (iv) 10% of Variety V193, and (v) 35% of Variety V46.

■ SC15

104E-MCC

Optimization and Learning in Biomedical Applications

Invited: Modeling and Methodologies in Big Data

Invited Session

Chair: Mengdi Wang, Princeton University, NY, United States, mengdiw@princeton.edu

1 - Latent Graphical Models For Mixed Data

Yang Ning, Princeton University, Princeton, NJ, United States, yning@exchange.Princeton.EDU, Jianqing Fan, Han Liu, Hui Zou

Graphical models are commonly used tools for modeling multivariate random variables. While there exist many convenient multivariate distributions such as Gaussian distribution for continuous data, mixed data with the presence of discrete variables or a combination of both continuous and discrete variables poses new challenges in statistical modeling. In this talk, we propose a semiparametric model named latent Gaussian copula model for binary and mixed data.

2 - Hierarchical Knowledge-gradient With Stochastic Binary Feedbacks With An Application In Personalized Health Care

Yingfei Wang, Princeton University, Princeton, NJ, United States, yingfei@cs.princeton.edu, Warren B. Powell

Motivated by personalized health care problems, we consider the problem of sequentially making decisions that are rewarded by ``successes" and ``failures" which can be predicted through an unknown relationship that depends on a partially controllable vector of attributes for each instance. The learner takes an active role in selecting samples from the instance pool. The goal is to maximize the probability of success. Our problem is motivated by healthcare applications where the highly sparsity makes leaning difficult. With the adaptation of an online boosting framework, we develop a knowledge-gradient (KG) policy to guide the experiment by maximizing the expected value of information.

3 - Approximate Newton-type Methods With Cubic Regularization

Saeed Ghadimi, Princeton University, Princeton, NJ, United States, sghadimi@princeton.edu, Tong Zhang, Han Liu

In this talk, we consider a class of second order methods for solving convex optimization problems. In particular, we propose Newton-type methods with cubic regularization when hessian of the objective function is not completely available. Convergence analysis of these methods under different conditions like stochastic setting are also presented.

■ SC16

105A-MCC

Algorithms for Large-Scale Stochastic Programs

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Jikai Zou, Georgia Tech, 225 North Ave, Atlanta, GA, 30332, United States, jikai.zou@gatech.edu

1 - New Linear Algebra Strategies For Stochastic Programming

Nai-Yuan Chiang, United Technologies Research Center, 611 Silver Ln, East Hartford, CT, 06118, United States, chiangn@utrc.utc.com, Yankai Cao, Victor Zavala

We present a clustering-based preconditioning strategy for stochastic programs within an interior-point framework on distributed memory machines. This approach is unique in that the scenario clustering is applied at the linear solver level, not at the outer NLP level, allowing for scenario clusters to change from iteration to iteration. This approach allows one to build a small and sparse pre-conditioner with fewer clusters, and then solve the full KKT system in parallel using GMRES. We also describe the features of our implementation in C++, demonstrate that high scenario compression rates of up to 94% can be obtained, and that speedups of an order of magnitude are achievable.

2 - Optimization Driven Scenario Grouping

Kevin C Ryan, Georgia Institute of Technology, Atlanta, GA, United States, kryan31@gatech.edu, Shabbir Ahmed, Santanu Subhas Dey, Deepak Rajan

Scenario decomposition algorithms for stochastic programs compute bounds by dualizing all nonanticipativity constraints and solving individual scenario problems. We develop an optimization problem that selects a set of nonanticipativity constraints to re-enforce, placing scenarios into `groups'. We show that the proposed grouping problem is NP-hard in general, identify a polynomially solvable case, and present a mixed integer programming formulation. Its effectiveness is demonstrated on a set of standard test instances for two-stage 0-1 stochastic programs. The idea is extended to propose a finitely convergent algorithm for two-stage stochastic programs with a finite feasible region.

3 - MIDAS: A Mixed Integer Dynamic Approximation Scheme

Andy Philpott, University of Auckland, Auckland, New Zealand, a.philpott@auckland.ac.nz, Faisal Wahid, Frederic Bonnans

Mixed Integer Dynamic Approximation Scheme (MIDAS) is a sampling-based algorithm for solving finite-horizon stochastic dynamic programs with monotonic Bellman functions. MIDAS approximates these value functions using step functions, leading to stage problems that are mixed integer programs. We provide a general description of MIDAS, and illustrate it on some instances of revenue maximization problems for hydroelectricity generators.

4 - Nested Decomposition Of Multistage Stochastic Integer Programs With Binary State Variables

Jikai Zou, Georgia Institute of Technology, Atlanta, GA, United States, jikai.zou@gatech.edu, Shabbir Ahmed, Andy Sun

We propose a valid nested decomposition algorithm for multistage stochastic integer programming problems when the state variables are binary. We prove finite convergence of the algorithm as long as the cuts satisfy some sufficient conditions. We discuss the use of well known Benders' and integer optimality cuts within this algorithm, and introduce new cuts derived from a reformulation of the problem where local copies of state variables are introduced. We propose a stochastic variant of this algorithm and prove its finite convergence with probability one. Numerical experiment on a large-scale generation expansion planning problem will be presented.

■ SC17

105B-MCC

Optimizing Chance-Constrained Programming Variants

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Yiling Zhang, University of Michigan, Fleming Administration Building, Ann Arbor, MI, 48109, United States, zyiling@umich.edu

1 - Tight Formulations For Value-at-Risk Minimization Problems

Konstantin Pavlikov, University of Florida, Gainesville, FL, 32611, United States, kpavlikov@ufl.edu, Alexander Veremyev, Eduardo Pasiliao

The problem of minimization of Value-at-Risk via MIP formulations with big M constants is considered. Special emphasis is put to setting the tightest big M for every scenario where it should be positive. We show that the problem of setting the tightest possible M is equivalent to solving another instance of VaR minimization problem. Moreover, we propose a specialized branch-and-bound algorithm to solve the problem that dynamically updates big Ms during its execution. Computational experiments are provided and discussed.

2 - A Two-stage Stochastic Program With Joint-chance Constraints For A Hybrid Wind-conventional Generator System

Bismark Singh, The University of Texas at Austin, Austin, TX, bismark.singh@utexas.edu, David Morton, Surya Santoso

We consider an application of a two-stage joint chance constrained stochastic program with recourse to power generation. As a first stage decision we promise an hour-by-hour firm energy output to the system operator. The conventional generator serves as a recourse option which can be used if the uncertain wind output is not large enough. We seek to ensure that with high probability our promised energy output is met by this generator and wind combination. We computationally investigate this joint-chance constrained model with recourse, using data from Texas

3 - An Integer L-shaped Approach To A Stochastic Program With Endogenous Uncertainty And Chance-constrained Recourse

Gabriel Lopez Zenarosa, Assistant Professor, University of North Carolina at Charlotte, 9201 University City Blvd., Cameron Hall 242, Charlotte, NC, 28223, United States, gzenaros@uncc.edu Oleg A. Prokopyev, Andrew J. Schaefer

We present a stochastic integer program with chance-constrained recourse for the surgery scheduling and one-time rescheduling problem. Our goal is to provide an approach for creating initial surgery schedules that afford agility in day-of-surgery rescheduling so as to minimize the total expected operating-room underutilization under probabilistic overutilization constraints. We use the integer L-shaped method to iteratively refine the initial surgery schedule to enable subsequent rescheduling of surgeries under the scenarios the initial schedule induces.

4 - Solving 0-1 Semidefinite Programs For Distributionally Robust Allocation Of Surgery Blocks

Yiling Zhang, University of Michigan, Ann Arbor, MI, United States, zyiling@umich.edu, Siqian Shen, Ayca Erdogan

We consider surgery allocation in operating rooms (ORs) under random surgery durations. We minimize the cost of opening ORs and surgery assignments, while restricting OR overtime risk via a distributionally robust (DR) chance constraint, built on a moment-based ambiguous set. Following the conic duality, the DR chance-constrained model is equivalent to a 0-1 semidefinite program, solved by a cutting-plane algorithm. Alternatively, we optimize a less conservative 0-1 second-order conic program approximation. We test outpatient treatment instances, and compare different approaches.

■ SC18

106A-MCC

HPC in Optimization 2

Invited: High Performance Computing

Invited Session

Chair: Geoffrey Malcolm Oxberry, Lawrence Livermore National Laboratory, Livermore, CA, United States, goxberry@gmail.com

Co-Chair: Kibaek Kim, Argonne National Laboratory, 9700 Cass Ave, Lemont, IL, 60439, United States, kimk@anl.gov

1 - Updates To PIPS-SBB: Distributed-memory Structure-aware Presolve And Cut Generation

Geoffrey Malcolm Oxberry, Lawrence Livermore National Laboratory, Livermore, CA, United States, oxberry1@llnl.gov Lluis-Miquel Munguia, Cosmin G Petra, Pedro Sotorrio, Thomas Edmunds, Deepak Rajan

Deterministic equivalent formulations of stochastic MIPs from applications such as unit commitment (UC) can exceed available memory on a single workstation. To overcome this issue, we have developed PIPS-SBB, a distributed-memory parallel stochastic MIP solver based on the distributed-memory parallel stochastic LP solver PIPS-S. Our initial work focused on implementing a distributed-memory B&B algorithm that parallelizes LP solves. To further improve performance, we discuss implementing structure-aware variants of presolve methods and cuts, and how these methods improve performance. Based on these results, we discuss a path forward to solving large UC problem instances.

2 - Generating And Solving The Large Scale AC-security Constrained Optimal Power Flow Problems In Parallel

Feng Qiang, Argonne National Laboratory, Lemont, IL, 60439, United States, fqiang@anl.gov, Cosmin G Petra, Joseph A Huchette, Miles Lubin, Mihai Anitescu

In this talk, we present an integrated approach for the modelling and solution of the AC-SCOPF problems using StructJuMP, a newly developed parallel extension of JuMP for modelling large scale optimization problems in Julia and PIPS optimization solver for HPC platforms. We will present a thorough study of the the parallel performance of StructJuMP and PIPS for large scale AC-SCOPF instances on hundreds of nodes.

3 - Paraxpress: A Massively Parallelized MIP Solver Designed To Run On The Largest Supercomputers

Yuji Shinano, Zuse Institute Berlin, Takustrasse 7, Berlin, 14195, Germany, shinano@zib.de, Timo Berthold, Stefan Heinz

The Ubiquity Generator (UG) is a framework for the external parallelization of MIP solvers. It was used to develop ParaSCIP, a distributed memory, massively parallel version of the open source solver SCIP, that runs on up to 80,000 cores in parallel. In this talk, we introduce ParaXpress, for which one of the fastest commercial MIP solvers, the FICO Xpress-Optimizer, has been parallelized by UG. Combining the internal shared-memory parallelization of Xpress and the external parallelization of UG, we aim at a new order of magnitude for supercomputer core-usage in MIP solving.

■ SC19

106B-MCC

Computation and Theory in Network Optimization and Analysis

Sponsored: Computing

Sponsored Session

Chair: Cole Smith, Clemson University, Clemson University, Clemson, SC, 29634, United States, jcsmith@clemson.edu

1 - Models And Algorithms For Maximum Proportional Flow Problems With Semicontinuous Restrictions

Robert Mark Curry, Clemson University, Clemson, SC, United States, rmcurry@g.clemson.edu, Cole Smith

We consider a variation of the multi-source, multi-sink maximum flow problem in which flow must emanate from the source nodes according to a prescribed rate, while flow arrives to the sink nodes at another given rate. Additionally, we restrict flow variables to be semicontinuous, in which the flow must either be 0 or no less than some lower bound. We call this problem the semicontinuous maximum proportional flow problem (SC-MPFP) since the amount of outgoing flow must leave the source nodes and arrive at the sink nodes according to a given proportional pattern. To solve the SC-MPFP, we decompose the formulation and employ a Branch-and-Price algorithm.

2 - Enumeration Algorithms For Infrastructure Resilience Analysis

W Matthew Carlyle, Naval Postgraduate School, mcarlyle@nps.edu, David Alderson

We propose a functional definition of infrastructure resilience based on parametric analysis of two-stage (attacker-defender) and three-stage (defender-attacker-defender) models that require enumeration of a potentially enormous number of optimization problems. We present computational techniques that use bounding arguments to significantly limit the enumeration while still providing useful measures of infrastructure resilience and support the use of faster heuristic algorithms for the most difficult of these problems.

3 - Faster Algorithms For The Time-cost-tradeoff Problem And Minimum Cost K-flow Problems With A New All-min-Cuts Procedure

Dorit S. Hochbaum, University of California, Berkeley, Berkeley, CA, United States, hochbaum@ieor.berkeley.edu

We explore surprising links between the time-cost-tradeoff (TCT) problem in project management and the minimum cost flow problem (MCF) leading to faster algorithms for both problems. The algorithm relies on a new procedure all-min-cuts procedure, which for a given maximum flow, is capable of generating all minimum cuts of equal value very efficiently. This results in faster strongly polynomial algorithms for unit capacity MCF, the K-MCF problem and uniform costs TCT and match the complexity of the fastest algorithm for the assignment problem.

■ SC20

106C-MCC

Novel Dimension Reduction Techniques for High Dimensional Data Using Information Complexity

Invited: Tutorial

Invited Session

Chair: Hamparsum Bozdogan, University of Tenneesse-Knoxville, Oper and Mgmt Sci, Knoxville, TN, 37996, United States, bozdogan@utk.edu

1 - Novel Dimension Reduction Techniques For High Dimensional Data Using Information Complexity

Hamparsum Bozdogan, University of Tennessee-Knoxville, Oper and Mgmt Sci, Knoxville, TN, 37996, United States, bozdogan@utk.edu, Esra Pamukcu

This tutorial introduces and develops two computationally feasible intelligent feature extraction techniques that addresses the potentially daunting statistical and combinatorial problems. First part of the tutorial employs a three-way hybrid between: Probabilistic Principal Component Analysis (PPCA) to reduce the dimensionality of the dependent variables; Multivariate regression (MVR) models that account for misspecification of the distributional assumption to determine a predictive operating model for glass composition for automobiles; and uses the genetic algorithm (GA) as the optimizer along with the misspecification-resistant form of Bozdogan's ICOMP as the fitness function. Second part of the tutorial is devoted to dimension reduction via a novel Adaptive Elastic Net (AEN) regression model to reduce the dimension of a Japanese stock index called TOPIX as the response to build a best predictive model when we have "large p, small n" problem. Our results show the remarkable dimension reduction in both of these real-life examples of wide datasets, which demonstrates the versatility and the utility of the two proposed novel statistical data modeling techniques.

■ SC21

107A-MCC

Monitoring and Prevention of Healthcare Associated Infections

Sponsored: Health Applications

Sponsored Session

Chair: Eduardo Perez, Texas State University, 1, San Marcos, TX, 1, United States, eduardopr@txstate.edu

1 - Optimal Pooling Strategies For Nucleic Acid Testing Of Donated Blood Considering Viral Load Growth Curves And Donor Characteristics

Hadi El-Amine, Virginia Tech, Blacksburg, VA, United States, hadi@vt.edu, Hadi El-Amine, George Mason University, Fairfax, VA, 22030, United States, hadi@vt.edu, Ebru Korular Bish, Douglas R Bish

Blood product safety, in terms of being free of transfusion-transmittable infections (TTIs), is crucial. Nucleic Acid Testing (NAT) technology enables earlier detection of infections but is more expensive, hence, most blood centers administer NAT to pools of blood samples from multiple donors. Since some donor characteristics are uncertain, we develop a chance-constrained model that determines the optimal NAT pool sizes for various TTIs, considering both non-universal (where first-time donors undergo more extensive screening), and universal (i.e., common testing for all donors) strategies, so as to minimize the TTI risk, while remaining within the testing budget with a high probability.

2 - Infection Control In Outpatient Clinics: The Risk- Efficiency Tradeoff

Cory Stasko, Massachusetts Institute of Technology, cstasko@mit.edu,

As HAIs remain a major problem and U.S. healthcare shifts towards outpatient, understanding the risk of HAIs in this environment is important. For a particular clinic, we simulate the potential impacts of two interventions: 1) improving hand hygiene, and 2) separating likely infectious patients from other patients. By creating an integrated discrete event and agent based model to simulate patient flow and the spread of infections, we examine how these two domains interact, testing 891 intervention combinations in terms of wait time, infection exposures, and implementability. Interdependent effects and the tradeoff between risk reduction and operational efficiency are discussed.

3 - Social Desirability Bias In Self-reported Compliance With Hand-hygiene Regulations

Reidar Hagtvedt, University of Alberta School of Business, 2-43 Business Building, Edmonton, AB, T6G 2R6, Canada, hagtvedt@ualberta.ca, Kenneth L. Schultz, Sarah Forgie

We posit Social Desirability Bias (SDB) as an explanation for why self-reported compliance with hand-hygiene (HH) regulations is so much higher than observed compliance. SDB breaks down into self-deception and image management. Using data gathered at a large teaching hospital over six years, we first show that in spite of the two measures being nearly uncorrelated, respondents do know something of their own compliance rate, and secondly, that image-management is a greater effect than self-deception.

4 - Reducing Surgical-site Infections For Coronary Artery Bypass Graft Patients

Eva Lee, Georgia Tech, evakylee@isye.gatech.edu

This is joint with Grady Health Systems. A system-approach is designed to reduce surgical site infection (SSI) which takes into account the inter-dependency of preoperative, intraoperative and postoperative processes. A decision tree model and a simulation-optimization model are developed to identify critical infection factors. Changes involve pre-op sterilization, nasal cleaning, hair-clipping, and optimized antibiotics prophylaxis timing and dosage. E-alerts are also implemented for compliance. The hospital realized a drop of 65% in SSI (from 23% to 8%) in the first six months. It achieved zero percentage thereafter and sustained that rate for 18 months.

■ SC22

107B-MCC

Joint Panel Session: ORHP/HAS/MSOM-Hlth: Challenges and Lessons Learned from Influencing National Policy Change in Organ Transplant

Invited: ORinformed Healthcare Policies

Invited Session

Moderator: Sanjay Mehrotra, Northwestern University, 2145 Sheridan, Evanston, IL, 60208, United States, mehrotra@iems.northwestern.edu

1 - Challenges And Lessons Learned From Influencing National Policy Change In Organ Transplant

Sanjay Mehrotra, Northwestern, mehrotra@northwestern.edu

Policy changes are being debated nationally to reduce disparity and improve efficiency in organ allocation. These issues are contentious within the transplant community as such policy changes impact patient lives lost and finances at the regional and national level. Operations research models have been used to help arrive at recommendations in the past, but get questioned. This session will focus on lesson learned from discussions with the transplant community that would be helpful for policy related research in other areas of work in healthcare. The panelists have worked closely with the transplant community as joint researchers, advisors and reviewers of proposed changes.

2 - Panelist

Andrew J Schaefer, Rice University, andrew.schaefer@rice.edu

3 - Panelist

Sommer Gentry, US Naval Academy, gentry@usna.edu

4 - Panelist

Baris Ata, Northwestern University, a, Evanston, IL, 1, United States, baris.ata@chicagobooth.edu

5 - Panelist

Tim L. Pruett, American Society of Transplant Surgeons (ASTS), Arlington, VA, 22202, United States, tlpruett@umn.edu

6 - Panelist

Yolanda Becker, United Network of Organ Sharing (UNOS), Chicago, IL, United States, ybecker@surgery.bsd.uchicago.edu

■ SC23

108-MCC

Risk Management in Global Food Supply Chains

Sponsored: Health Applications

Sponsored Session

Chair: Retsef Levi, MIT, 100 Main Street, Building E62-562, Cambridge, MA, 02142, United States, retsef@mit.edu

1 - A Data-Driven Approach To Managing Food Safety In Global Supply Chains

Amine Anoun, Massachusetts Institute of Technology, aanoun@mit.edu

Economically motivated adulteration poses a serious threat to public health. Prevention is achieved by sampling food shipments. However, the sampling resources are limited. In an effort to mitigate risk in the shipping supply chains, we develop a data-driven approach to identify risky manufacturers. We obtained over 850,000 shipment records of shrimp to the U.S. from the FDA. We determine structural features of shipping supply chains that correlate with risk of adulteration, at the global scale and in China. We use a Bayesian approach to model both the risk of adulteration, and the sampling procedure of the FDA, and show that our model predicts high risk manufacturers with high accuracy.

2 - Economically Motivated Adulteration In Agriculture Supply Chains

Somya Singhvi, Massachusetts Institute of Technology, Cambridge, MA, United States, ssinghvi@mit.edu, Retsef Levi, Yanchong Zheng

We study how dispersion and quality uncertainty affect adulteration risk in agriculture supply chains. Our model captures the effects of testing accuracy and traceability on adulteration decisions by suppliers. We characterize conditions under which adulteration risk increases with dispersion or quality uncertainty. Further, we also analyze quality assurance policies for manufacturers in the presence of a risk threshold.

3 - The Role Of Farming Supply Chain Structure In Driving Economically Motivated Food Adulteration

Shujing Wang, Massachusetts Institute of Technology-ORC, shujing@mit.edu

We investigate how the structure of farming supply chains and regulatory measures are correlated with the risk of economically motivated adulteration of food products.We define the dispersion of a farming supply chain, which measures how distributed a food manufacturer's farming sources are. We collect farm-level data on over 1,000 Chinese manufacturers in the honey, pork, poultry, egg, and seafood industries to quantify the dispersion of their farming supply chains. Combining farm-level data and quality data, we show that a more dispersed farming supply chain is more prone to the risk of economically motivated adulteration.

■ SC24

109-MCC

Dynamics of Competition

Invited: Strategy Science

Invited Session

Chair: Daniel Levinthal, Wharton School, University of Pennsylvania, Philadelphia, PA, 19104, United States, dlev@wharton.upenn.edu

1 - Changes In Persistence Of Performance Over Time

Claudine Gartenberg, New York University, Stern Business School, New York, NY, 1, United States, cgartenb@stern.nyu.edu
Victor Bennett

One of the central puzzles of strategy is the persistence of superior performance. About a decade ago a stream of research emerged looking at changing persistence over time and finding a trend toward a new "age of temporary advantage". We extend the time series from these analyses and introduce new tools from the literatures on social mobility and economic growth. We find that the trend reversed itself and the beginning of the 21st century has been characterized by increasing persistence of superior performance. This trend is not due to changes in industry composition or newly public listings. Instead we report this reversal both within and across industries and primarily within established firms.

2 - Markets For Technology And The Technological Trajectories Of Entrepreneurial Startups

Mahka Moeen, University of North Carolina, Chapel Hill, NC, 03, United States, mahka_moeen@kenan-flagler.unc.edu
Seth Carnahan

This paper focuses on how entrepreneurial startups shape their opportunity set for participation in the market for technology, by pursuing investments that increase their attractiveness as a technology seller. Because startups in technological proximity to a technology buyer may be considered favorable technology sellers, we suggest that investment by potential buyers in a technical domain is likely to spur investments by startups in the same or proximate domains. We further examine the moderating effects of the direction of scientific progress, commercial applicability, and density of the buyer's alliance portfolio. The empirical context is plant biotechnology field experiments.

3 - The Entrepreneurial Process: Evidence From A Nationally Representative Survey

Aaron Chatterji, Duke University, Faqua School of Business, 100 Fuqua Drive, Durham, NC, 27708, United States, ronnie@duke.edu, Victor Bennett

Using data from a new nationally representative survey of Americans, we document patterns in the process of firm entry via entrepreneurship. Only 1/3 of our respondents have even considered starting a business, motivated in the vast majority of cases by non-pecuniary concerns rather than the pursuit of significant market opportunities. Fewer than half of those who considered starting a business take even the lowest cost steps, like searching the Internet for potential competitors or speaking with a friend. This surprising lack of progress is evident in comparison to nationally representative evidence on job search activities.

4 - Venture Capital Investment Strategies Under Financing Constraints: Evidence From The 2008 Financial Crisis

Annamaria Conti, Georgia Institute of Technology, Atlanta, GA, 30332, United States, annamaria.conti@scheller.gatech.edu
Stuart Graham, Nishant Dass

Employing the 2008 financial crisis as an empirical setting, we examine the investment strategies of venture capitalists (VCs) in response to liquidity supply shocks. While predictably VCs reduce investment, we show that VCs reposition by increasing their share of, and per-round funding to, startups operating in the VCs' core sectors. These effects are driven by more-experienced VCs, and are strongest in early-stage portfolio startups. Consistently, we find superior ex-post performance among crisis-funded portfolio startups operating in more-experienced VCs' core sectors. Our findings point to more-experienced VCs possessing information advantages, especially in their core sectors.

■ SC25

110A-MCC

Latest Developments in Scheduling Research

Invited: Project Management and Scheduling

Invited Session

Chair: Zhi-Long Chen, Professor, University of Maryland, Van Munching Hall, College Park, MD, 20742, United States, zchen@rhsmith.umd.edu

1 - A Polyhedral Study Of The Physician Scheduling Problem With Equalization Constraints

Pelin Damci-Kurt, Lightning Bolt Solutions, South San Francisco, CA, United States, pelin@lightning-bolt.com, Minjiao Zhang

We study a physician scheduling problem in which the goal is to minimize the penalties associated with different requirements over a finite horizon. The problem is divided and solved in two phases according to penalty values. We focus on a relaxation including assignment demand and equalization constraints. We present a class of valid inequalities, and report preliminary computational experiments with them in a branch-and-cut algorithm on our client data sets.

2 - Models For Workforce Scheduling In A Union Shop

John Mittenthal, The University of Alabama, Tuscaloosa, AL, 35487, United States, jmittent@cba.ua.edu, Minjiao Zhang

We develop an assignment problem model for worker to job assignments that deviates as little as possible from a shift supervisor's allocation of these workers. These deviations occur due to worker absences. In addition to validating the model over four weeks of data, we investigate a number of what-if questions.

3 - An Integrated Production Scheduling And Outbound Vehicle Routing Problem

Kunpeng Li, Huazhong University of Science and Technology, likp@hust.edu.cn

In this integrated production scheduling and vehicle routing problem, there is a single machine for production and limited vehicles with capacity constraints for transportation. The objective is to determine the decisions about production scheduling, transportation batching and vehicle routing, to minimize the maximum order delivery time. Based on an optimal property for production scheduling and transportation batching, backward and forward batching methods are developed, which are embedded into an improved genetic algorithm. The results show that the genetic algorithm can provide high quality solutions, compared with a two-stage algorithm and a published genetic algorithm.

4 - Integrated Production, Inventory And Distribution Problems

Zhi-Long Chen, University of Maryland, zchen@rhsmith.umd.edu
Feng Li, Lixin Tang

We consider several integrated production, inventory and delivery problems that arise in practical settings where customer orders have pre-specified delivery time windows and are first processed in a plant and then delivered to the customers by transporters that have fixed delivery departure times. The objective is to find an integrated schedule for processing the orders, keeping finished orders in inventory if necessary, and delivering them to the customers such that the total inventory and delivery cost is minimum. We study complexity and propose algorithms for various problems. For the two most general problems, we propose combined column generation and tabu search heuristic algorithms.

■ SC26

110B-MCC

Auction Design Topics

Invited: Auctions

Invited Session

Chair: Sasa Pekec, Duke University, 100 Fuqua Drive, Durham, NC, 27708-0120, United States, pekec@duke.edu

1 - Stable Matchings With Proportionality Constraints

Thanh Nguyen, Purdue University, nguye161@purdue.edu, Rakesh Vinay Vohra

In designing two sided markets, a stable matching is often desired to satisfy certain additional side constraints. Current literature has mainly focused on constraints where the relevant "right hand sides" are absolute numbers specified a-priori; before agents on the "proposing" side make their participation decisions. There is a danger, then, of over constraining the problem. It is sometimes more natural to express the relevant constraints as proportions. We develop a framework to obtain stable matchings that almost satisfy floor and ceiling proportional side constraints. Our results are based on a generalization of Scarf's lemma, which is of independent interest.

2 - Budget-constrained Procurement

Alexandre Belloni, Duke University, abn5@duke.edu
Giuseppe Lopomo, Leslie Marx, Roberto Steri

We consider a setting where a buyer procures up to D units of a homogeneous good (e.g. a medical drug) but needs to satisfy a hard budget constraint of spending at most B in total payments. Furthermore, the buyer faces suppliers with privately known costs. We characterize the optimal procurement mechanism as well as new simple mechanisms (which are at least as good as the second price auction with reservation price) that are easy to implement via a sequential auction. In particular we highlight how the budget constrain fundamentally alters the structure of the optimal mechanism.

3 - Robust Bidding Policies

Sasa Pekec, Duke University, pekec@duke.edu

We study the best-response decision problem of an auction bidder who wants to maximize her worst-case payoff, while facing uncertainty about rivals' objectives and bids. The information about rivals is modeled via an uncertainty set consisting of all possible realizations of rivals' bids. Maximizing the bidder's worst-case payoff over this set yields robust bidding policies that do not depend on distributional assumptions. Robust bidding policies are constructed for several multi-item auction formats, depending on how supply (homogeneous or heterogeneous items) and demand (unit-demand or multiple-demand bidders) is handled.

■ SC27

201A-MCC

Panel: Emerging Themes in Innovative Operations

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Moderator: Nitin Joglekar, Boston University School of Management, 595 Comm Ave, Boston, MA, 02215, United States, joglekar@bu.edu

Co-Moderator: Stylianos Kavadias, University of Cambridge, Trumpington Street, Cambridge, CB2 1AG, United Kingdom, s.kavadias@jbs.cam.ac.uk

1 - Innovative Operations

Nitin Joglekar, Boston University School of Management, joglekar@bu.edu

We draw upon an expert panel to discuss emerging innovation research themes in the manufacturing and service operations context by raising the following “when, what and how” questions: (i) Are operations essential for creating innovation (e.g. in terms of product and services)? (ii) Are operations essential to compete in innovative ways (e.g. through business model innovations and/or through supply chain innovations)? (iii) Are operations based innovations critical in establishing new businesses (e.g. through entrepreneurship)?

2 - Panelist

Saif Benjaafar, University of Minnesota, saif@umn.edu

3 - Panelist

Raul Chao, University of Virginia, ChaoR@darden.virginia.edu

4 - Panelist

Sanjiv Erat, University of California-San Diego, serat@ucsd.edu

5 - Panelist

Karan Girotra, INSEAD, karan.girotra@insead.edu

6 - Panelist

Guillaume Roels, UCLA, groels@anderson.ucla.edu

7 - Panelist

Manuel Sosa, INSEAD, manuel.sosa@insead.edu

■ SC28

201B-MCC

Empirical Research in Operations Management

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Nathan C. Craig, Ohio State University, 630 Fisher Hall 2100 Neil Avenue, Columbus, OH, 43210, United States, craig.186@osu.edu

1 - Dynamic Optimization Of Multichannel Advertising Campaigns In An Online Advertising Supply Chain

Changseung Yoo, The University of Texas at Austin, Austin, TX, United States, csyoo@utexas.edu, Anitesh Barua, Genaro Gutierrez

We examine channel structures and pricing models in an online advertising supply chain using a proprietary dataset. The supply chain consists of two channels - a network and an exchange - from which an ad agency buys advertising inventory and sells them to an advertiser. We design a nonlinear Kalman filter to estimate an extension of the Sethi advertising model and derive the optimal closed-loop strategies for the advertising agency. We then compare them to the approximate solutions based on the Nerlove-Arrow model and derive managerial insights. Our analyses furnish strong support for the synergy effects between the channel structures due to strategic complementarities between the channels.

2 - Variability In Labor Schedules: Effects On Store Performance And Employee Turnover

Hyun Seok Lee, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States, Hyunseok_Lee@kenan-flagler.unc.edu, Saravanan Kesavan, Camelia Kuhnen

Millions of employees face work schedules that are changed frequently by firms trying to match labor to demand. Prior work has shown that unstable schedules have negative consequences on worker life quality. Here, using detailed personnel records from the retail industry, we find that variability in labor schedule negatively affects store performance metrics such as sales, number of transactions, and employee turnover.

3 - Reference Points In Replacement Purchases

Mahdi Mahmoudzadeh, Georgia Institute of Technology, mahdi.mzh@scheller.gatech.edu

We study reference-points in replacement purchases, trade-ins and upgrades, wherein customers replace their in-use product with its newer version. Through an experimental study, we find that with trade-ins, irrespective of the new version’s innovation level, the secondary market price is the reference-point. With upgrades, however, depending on the innovation level and the manufacturer’s decision on co-production of successive versions, the new version’s price, the current selling price the old version, or the original price of the old version is the reference-point. We also find that the manufacturer can always frame a replacement purchase to induce the same reference-point as in buy-backs.

4 - Rewarding Service And Serving Rewards: Strategic Complications To Order Management

Somak Paul, Doctoral Student, The Ohio State University, 600 Fisher Hall, 2100 Neil Avenue, Columbus, OH, 43202, United States, Paul.865@osu.edu, Nathan C. Craig, Elliot Bendoly

We conduct laboratory experiments to identify how order complexities including strategic-level factor relating to demand management affect the ordering behavior of those in purchasing management roles and thus induce variation in upstream orders. We further investigate how the backorder and surplus cost structure moderates the relationship between the service-dependent demand and order variation. We finally recommend strategic directions for the purchasing manager and suggest personality traits to look for while choosing purchasing managers.

■ SC29

202A-MCC

MSOM Energy and Sustainability

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Yangfang Zhou, Singapore Management University, Singapore, Singapore, helenzhou@smu.edu.sg

1 - Strategic Forward Trading And Technology

Heikki Peura, London Business School, hpeura@london.edu, Derek W Bunn

We analyze how operational factors of production, such as its flexibility and reliability, can influence market prices indirectly through altering the balance of spot and forward trading. As a result, increasing the capacity of intermittent renewable electricity generation, despite its lower marginal cost, may not necessarily reduce prices.

2 - Repositioning Operations In One-way Vehicle Sharing Systems

Long He, National University of Singapore, longhe@nus.edu.sg Zhenyu Hu, Meilin Zhang

We study the repositioning problem in one-way vehicle sharing systems, in order to balance the fleet and meet the demands. We formulate the problem as a dynamic program and also discuss the optimal policy.

3 - Merchant Operations Of An Aluminium Smelter

Selvaprabu Nadarajah, College of Business, University of Illinois at Chicago, Chicago, IL, United States, selvan@uic.edu, Stein-Erik Fleten, Denis Mazieres, David Pisinger, Alessio Trivella

Motivated by an Aluminium producer, we consider the merchant operations of a smelter facing predictable Aluminium demand and volatile electricity prices. This smelter endows a merchant with flexibility to (i) choose between the production, mothballs, and shutdown operating states; and (ii) procure electricity needed for operations using forward contracts with different maturities and underlying currencies. We formulate the management of these flexibilities as a stochastic optimization problem. We overcome the intractability in computing optimal operating and sourcing policies by combining least squares Monte Carlo with stochastic programming. Preliminary findings will be discussed.

■ SC30

202B-MCC

Empirical Studies in Operations Management

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Suresh Muthulingam, The Pennsylvania State University, University Park, PA, United States, suresh@psu.edu

1 - Are Patients Patient? The Role Of Time To Appointment On Patient Flow

Diwas S KC, Emory University, diwas.kc@emory.edu

We examine the effect of wait to appointment on patient flow - specifically, on a patient's decision to schedule an appointment and arrive for that session. Contrary to previously-reported findings, our results suggest that some wait can be beneficial for reducing no-shows.

2 - Product Complexity, Network Position, And Product Innovation

Yingchao Lan, PhD Candidate, The Ohio State University, 2100 Neil Avenue, Fisher Hall 252C, Columbus, OH, 43210, United States, lan.63@osu.edu, John Gray, Aravind Chandrasekaran, Brett Massimino

Despite a consensus that a firm's extended product development network plays a critical role in its innovation performance, empirical evidence linking network position, product complexity, and product innovation performance is scarce. We provide a longitudinal study employing secondary data to investigate these relationships.

3 - Managerial Attention, Reminders And The Energy Efficiency Gap

Enno Siemsen, University of Wisconsin-Madison, esiemsen@wisc.edu, Suvrat Dhanokar

Reminders have been shown to at the individual level increase adherence to medical prescriptions and savings goals. We demonstrate that reminders also help to increase environmental project implementation at the organizational level. Using data from a state technical assistance program, we also demonstrate the contextual effects that make reminders more effective.

4 - Does Learning From Inspections Affect Environmental Performance? - Evidence From Unconventional Oil And Gas Wells

Suresh Muthulingam, The Pennsylvania State University, State College, PA, United States, suresh@psu.edu
Vidya Mani

Manufacturing firms increasingly face environmental inspections that determine whether their operations comply with environmental regulations. We investigate how firms learn from their own inspection experiences as well as from the experiences of other firms. We identify the characteristics of the inspection experience that enable firms to improve their environmental performance.

■ SC31

202C-MCC

Managing Finances and Risk in Supply Chains

Sponsored: Manufacturing & Service Oper Mgmt, iFORM

Sponsored Session

Chair: Panos Kouvelis, Washington University in St. Louis, One Brookings Drive, Box 1156, Saint Louis, MO, 63130, United States, kouvelis@wustl.edu

Co-Chair: Wenhui Zhao, Associate Professor, Shanghai Jiao Tong University, 1954 Huashan Road, Shanghai, 200030, China, zhaowenhui@sjtu.edu.cn

1 - Optimal Monitoring In Collateralized Lending

Dan Andrei Iancu, Stanford University, Stanford, CA, United States, daniancu@stanford.edu, Nikolaos Trichakis, Do Young Yoon

Collateralized lending agreements critically rely on the lender's ability to monitor the value of a borrower's pledged assets, and to decide when these are sufficient to cover the outstanding loan. To further complicate matters, lenders often have to take such decisions under limited information concerning the assets' future value. Our work focuses on the problem of choosing a monitoring and liquidation policy for a lender when a finite number of monitoring times are possible during the life of the loan. We develop a robust optimization model and provide characterizations for the optimal choices involved.

2 - Financial Pooling In A Supply Chain

Alex Song Yang, London Business School, London, United Kingdom, sayang@london.edu, Ming Hu, Qu Qian

Trade credit is common in supply contracts. We find the embedded stretch option of trade credit (i.e., buyers paying suppliers after the agreed due day) allows supply chain partners to pool their liquidity. As such, even as the supplier's financing costs are strictly higher than the buyer's, the buyer may still demand for trade credit. In addition, trade credit is more efficient when the supplier's cost for collecting trade credit is low (e.g., when the retailer trusts the supplier), when the supplier's financing cost is high when facing liquidity shocks, or when the buyer has a more diversied supplier portfolio. Finally, reverse factoring further enhances this pooling benefit.

3 - Effective Donor Fund Allocation For Health Product Procurement

Iva Petrova Rashkova, Washington University in St Louis, irashkova@wustl.edu, Jeremie Gallien

Motivated by Global Fund grant recipients, we study the procurement of health products subject to an uncertain funding schedule. Such schedule includes either periodic lump-sum disbursements or per-unit subsidy agreements, or both. The objective is to minimize expected health costs in the presence of random demand and lost sales inventory dynamics. We design near-optimal financing mechanisms for the allocation of donor funds, characterize their theoretical and computational performance, and discuss managerial insights.

4 - Who Should Finance The Supply Chain: Impact Of Credit Ratings on Supply Chain Decisions

Wenhui Zhao, Associate Professor, Shanghai Jiao Tong University, 1954 Huashan Road, Antai College of Economics and Management, Shanghai, 200030, China, zhaowenhui@sjtu.edu.cn, Panos Kouvelis

We study the impact of credit ratings on supply chain decisions. The retailer can use bank loans and/or trade credits, while the supplier can use bank loans and/or retailer's early payment. The bank's risk premium decreases in the borrower's credit rating. We show if the supplier's credit rating is above a threshold, she will offer zero interest rate trade credits and the retailer will use trade credits only. Otherwise, she will set positive rate so that the retailer uses bank loans only or combines them with trade credits. While a supplier always benefits by working with good credit rating retailers, it may not be necessarily true for the retailer, who may benefit by working with low credit rating suppliers.

■ SC32

203A-MCC

Scheduling III

Contributed Session

Chair: Sangoh Shim, Hanbat National University, Dept of Business Administration, Deokmyung-Dong, Daejeon, 305-719, Korea, Republic of, mizar0110@gmail.com

1 - Integrated Pricing And Production Scheduling Under Make-to-order Strategy

Guohua Wan, Professor, Shanghai Jiao Tong University, 1954 Huashan Road, Antai College of Economics and Management, Shanghai, 200030, China, ghwan@sjtu.edu.cn, Qing Yue, Zhi-Long Chen

we consider a joint pricing and production scheduling problem where the manufacturing firm produces a number of customized products from a base product. At the beginning of each period in a planning horizon, the firm sets the price of the base product as well as the prices for the customized products, and processes the accepted orders on a single production line, so as to maximize the total profit of the orders over the planning horizon. Three specific problems with different order acceptance and processing modes are studied, and computational complexity and solution algorithms are presented.

2 - Optimal Course Scheduling For United States Air Force Academy Cadets

Christopher D. Richards, Colorado School of Mines, Golden, CO, United States, capt.soup@gmail.com

The United States Air Force Academy spends months scheduling approximately 1,500 courses and 4,000 cadets. By building alternatives based on department preferences, we develop an integer program to generate course and cadet schedules which fulfill registration, department and institution needs. Specifically, we observe enrollment and staffing limits, military time requirements, and athletic commitments. Efficient formulation and solution methods including heuristics provide quick turnaround for an iterative process between departments and the registrar. Easily resolving scheduling conflicts ensures all cadets meet crucial commissioning deadlines.

3 - Minimizing The Total Number Of Late Multi-task Jobs On Identical Machines

Hairong Zhao, Purdue University Calumet, 2200 169 Street, Hammond, IN, 46323, United States, hairong@pnw.edu
Lingxiang Li, Haibing Li

We consider scheduling multi-task jobs on identical machines in parallel. Each job consists of one or more tasks that can be processed by any machine. The tasks of a job can be processed concurrently. Preemptions are not allowed. Each job has a release date and a due date. The completion time of a job is the time when all of its tasks have been completed. We focus on the problem of minimizing the number of late jobs. We show that while some special cases are solvable, the general problem is NP-hard and admits no constant approximation algorithm unless =NP. We then present a framework of a general algorithm for the problem and derive from it six heuristics whose performance is evaluated by experimental results.

4 - An Improvement In NSGA II For Resource Constrained Project Scheduling Problem

Fikri Kucuksayacigil, Iowa State University, 610 Squaw Creek Drive, Unit 18, Ames, IA, 50010, United States, fksayaci@iastate.edu

Resource constrained project scheduling problem has been extensively studied. For multi-objective form of this problem, since finding an optimum solution is nearly impossible, several metaheuristic methods have been proposed and implemented. Non-dominated sorting genetic algorithm (NSGA II) has been one of the most effective algorithms in this respect. In this study, we develop a hybrid simulated annealing / NSGA II algorithm to find more diverge and better quality results. The results show that our algorithm visits more solutions in the solution space.

5 - Production Scheduling Of Jobs With Fixed Processing Property On Parallel Machines

Sangoh Shim, Hanbat National University, Dept of Business Administration, Deokmyung-Dong, Daejeon, 305-719, Korea, Republic of, mizar0110@gmail.com

One of the important things for smart factory is an intelligent production scheduling, how to schedule jobs effectively and efficiently. This problem is for scheduling jobs on parallel machines with the fixed processing property in which a group of specific jobs can be processed on the predetermined machine. Usually, even though parallel machines can process various types of jobs, fixed processing are preferred not to deteriorate products' quality. Also, in this problem, when changing process of different groups of jobs, operations for changing type of groups, called as setup, are necessary. To minimize makespan of jobs, several heuristic algorithms are devised.

■ SC33

203B-MCC

Simulation and Optimization III

Contributed Session

Chair: Prasanna Kumar Ragavan, Virginia Tech, Durham Hall, Blacksburg, VA, 24061, United States, rpkumar@vt.edu

1 - Managing Escalations: Equipment Failure And Response Capacity Allocation

Marc Christiaan Jansen, PhD Candidate, Cambridge Judge Business School, Downing College, Regent Street, Cambridge, CB2 1DQ, United Kingdom, mcj32@cam.ac.uk
Nektarios Oraiopoulos, Daniel Ralph

Failure of medical equipment represents a cause of downtime for hospitals and may lead to life-threatening circumstances for patients. At the onset of such failure, the scale of the disruption is typically unknown. This paper examines how contracting decisions between a maintenance service provider and multiple clients can enable efficient allocation of response capacity under imperfect and asymmetric information on the true nature of the disruption.

2 - Illusion Of Control In Resource Allocation Decision Making

Howard Charles Ralph, Visiting Assistant Professor, Western Carolina University, 201 Edgemont Avenue, Liberty, SC, 29657-1110, United States, r_11l1f@hotmail.com

Resource allocation decisions drive the managerial function of control and are basic to business school curricula. Decision problems, deterministic or probabilistic, seek to equip future managers with mathematical tools for optimized solutions, and flexibility to operate under uncertainty. But, "illusion of control" or cognitive biases giving the decision-maker unwarranted confidence, interferes with learning. An exercise has inexperienced decision-makers prioritize a set of realistic allocation problems and explores recorded rationales for features of illusion of control biases.

3 - Flexible High Density Puzzle Storage System

Ehsan Shirazi, West Virginia University, 1204, Van Voorhis Road, Unit B, Morgantown, WV, 26505, United States, ehshirazi@mix.wvu.edu

A puzzle-based storage system has been introduced to replenish and retrieve items from the top and bottom of a highly dense storage system. Each cell of the puzzle storage is considered as a grid. Each grid is able to store an item and or to move items in the south direction. We describe a high density storage system that can retrieve and replenish items from all sides. A puzzle storage with this characteristic is a lot more flexible than what has been introduced before. We will illustrate how this puzzle storage scheme affects replenish and retrieve time based on different network policies, distributions of replenishing and retrieving items, and number of free spaces on the puzzle network.

4 - The Use Of Simulation For Evaluating Forecast Models

Sanjeewa Naranpanawe, Sr Analytical Consultant, SAS Institute, 100 SAS Campus Drive, Cary, NC, 27513, United States, sanjeewa.naranpanawe@sas.com

The normal process of evaluating forecast models are by fitting the model using historical data, evaluating using holdout samples to select the model. However, this single point evaluation of forecast accuracy may not be good at predicting how the model is going to perform in the future. This presentation examines how simulation can be use to evaluate different forecast models.

5 - Adaptive-spline For Integer-order Simulation Optimization

Prasanna Kumar Ragavan, Virginia Tech, Durham Hall, Blacksburg, VA, 24061, United States, rpkumar@vt.edu
Raghu Pasupathy, Michael Taaffe

We present Adaptive-SPLINE to solve simulation optimization (SO) problems where the decision variables are integer-ordered, and the objective function can only be estimated through "noisy" observations from a simulation. Adaptive-SPLINE iterates between a line search and an enumeration procedure, and adaptively determines sampling effort by trading-off stochastic error with structural error. We will discuss consistency and finite-time performance.

■ SC34

204-MCC

Joint Session HAS/MSOM-HC: Analytics in Drug Development

General Session

Chair: Elisa Frances Long, UCLA Anderson School of Management, Los Angeles, CA, United States, elisa.long@anderson.ucla.edu

1 - Continuity In Gatekeepers: Quantifying The Impact Of Care Fragmentation

Vishal Ahuja, SMU Cox School of Business, vahuja@smu.edu
Bradley R Staats,

Care coordination is increasingly being recognized as an criticla aspect of overall patient care. We attempt to establish a quantitative measure of care coordination and study its impact on patient health outcomes. Further, we investigate the mechanism by which coordination affects these outcomes. We use data on patients with diabetes, a chronic condition.

2 - Flexible FDA Approval Thresholds: A Dynamic Programming Approach

Taylor Corcoran, University of California-Los Angeles, taylor.corcoran.1@anderson.ucla.edu, Elisa Frances Long, Fernanda Bravo

Current FDA approval standards require drug companies to demonstrate the efficacy of their product by presenting statistically significant results from clinical trials. Traditionally, this significance level is set to 0.05 or 0.01, but this choice ignores the complexity of the drug approval process. In particular, the current approval threshold does not incorporate the severity and prevalence of the disease being treated, the level of research and development taking place, and the quantity of existing drugs available for the disease. We develop a continuous time dynamic programming model to study how the optimal significance level should depend on characteristics of the drug pipeline.

3 - Is The FDA Too Conservative Or Too Aggressive?: A Bayesian Decision Analysis Of Clinical Trial Design

Andrew W Lo, Charles E. and Susan T. Harris Professor, MIT, 100 Main Street, E62-618, Cambridge, MA, 02142, United States, alo-admin@mit.edu, Andrew W Lo, Charles E. and Susan T. Harris Professor, MIT, 32 Vassar Street, Cambridge, MA, 02139, United States, alo-admin@mit.edu, Leah Isakov, Vahid Montazerhodjat

We explore the application of Bayesian decision analysis (BDA) to minimize the expected cost of drug approval, where the relative costs of Type I and Type II errors are calibrated using burden of disease data. For terminal illnesses with no existing therapies such as pancreatic cancer, the standard Type I error threshold of 2.5% is substantially more conservative than the BDA-optimal threshold of 23.9% to 27.8%. We compute BDA-optimal sizes for 25 of the most lethal diseases and show how a BDA-informed approval process can incorporate all stakeholders' views in a systematic, transparent, internally consistent, and repeatable manner.

4 - A Comparison Between The Robust Risk-aware And Risk-seeking Managers In R&D Portfolio Management

Aurelie Thiele, Associate Professor, Southern Methodist University, Dallas, TX, United States, aurelie@alum.mit.edu
Shuyi Wang

We analyze via simulation two mathematical modeling frameworks that reflect different managerial attitudes toward upside risk in R&D portfolio selection. The manager seeks to allocate a development budget between low-risk, low-reward projects, called incremental projects, and high-risk, high-reward projects, called innovational projects. We study the differences in strategy and portfolio's risk profile that arise between a risk-aware manager, who takes upside risk because he has to for the long-term competitive advantage of his company, and a risk-seeking manager, who will take as big a bet as allowed by the model.

■ SC35

205A-MCC

Frontiers of Supply Chain Research

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain Sponsored Session

Chair: Karen Zheng, MIT Sloan School of Management, Cambridge, MA, 02142, yanchong@mit.edu

1 - Dual Co-product Technologies: Implications For Process Development And Adoption

Brian Tomlin, Tuck School of Business, brian.tomlin@tuck.dartmouth.edu, Ying-Ju Chen, Yimin Wang

Many industries operate technologies in which multiple outputs (co-products) are jointly produced. Three important attributes of a co-product technology are its production cost, its overall yield, and its co-product split. Process development often wrestles with an inherent trade-off: improvement in one attribute comes at the expense of another. In this talk, we first explore production and pricing decisions for a firm with two technologies and then use this foundation to examine implications for process development and process adoption.

2 - Impact Of Grocery Store Density And Market Structure On Food Waste

Elena Belavina, University of Chicago Booth School of Business, elena.belavina@chicagobooth.edu

Food waste is one of the major contributors of greenhouse gas emissions. If food waste was a country, it would be third largest polluter shortly after US and China. About $1 trillion dollars of food is wasted every year, which is equivalent to 1% of GDP globally. This study explores the impact of store density and market structure on consumer food waste.

3 - Self-policing In A Supply Chain Under Threat Of Public Disclosure

Sang-Hyun Kim, Associate Professor, Yale University, New Haven, CT, United States, sang.kim@yale.edu, Saed Alizamir

We study incentive dynamics among supply chain members and an external stakeholder (e.g., NGO) that impact environmental performance. A buyer inspects a supplier's production in its supply chain to detect and correct environmental compliance violations. The buyer's primary motive is to deter the NGO from discovering the violation first and publicize it, from which the buyer incurs a reputational penalty. The buyer and the NGO engage in a game to competitively set their inspection intensities, which influence the supplier's decision to restore compliance. Together, the actions made by all parties determine the environmental outcome and and social welfare.

4 - Increasing Retail Sales Via Improved Store Staffing: An Empirical Study With Implemented Results

Santiago Gallino, Dartmouth College, santiago.gallino@tuck.dartmouth.edu, Marshall L Fisher, Serguei Netessine

We analyzed 30 months of a retailer's history on store-month sales and potential sales drivers to measure the impact of store selling staff level on revenue. We identified a third of the stores where our analysis indicated that increasing staffing would increase sales. The retailer confirmed this finding via a 16 store test which showed that a 10% increase in sales staff resulted in a 9.9% sales increase, and was highly profitable. The retailer is now implementing our finding in other stores.

■ SC36

205B-MCC

Information and Risk in Supply Chain Networks

General Session

Chair: Kostas Bimpikis, Stanford Graduate School of Business, 650 Knight Way, Stanford, CA, 94305, United States, kostasb@stanford.edu

1 - Inventory Management With Censored Demand Data: The Adversarial Case

Michail Markakis, Universitat Pompeu Fabra, mihalis.markakis@upf.edu

We consider a repeated newsvendor problem where the demand distribution is unknown ex ante and has to be learned from sales/censored data. To shed light to scenarios where the demand may be non-stationary, e.g., exhibiting trends or seasonalities, we model the problem as a game between the inventory manager and an oblivious opponent, who prior to the game decides a sequence of demands for the different periods arbitrarily. We propose randomized inventory management policies that perform well with respect to the regret criterion, i.e., the difference between a policy's cumulative cost and the cumulative cost of the best fixed action/ordering decision in hindsight, for any given demand sequence.

2 - Optimizing Local Content Requirements Under Technology Gaps

Shiliang Cui, Georgetown University, shiliang.cui@georgetown.edu, Lauren Xiaoyuan Lu

We study the optimal Local Content Requirements (LCR) and innovation policies of a developing economy in which a foreign Original Equipment Manufacturer (OEM) produces and sells a final product. We find that as the domestic component supply base becomes more cost efficient, surprisingly, the OEM's profit could decrease.

3 - Take-rate Crowdsourcing Contracts

Yun Zhou, University of Toronto, Toronto, ON, Canada, yzhou.zj@gmail.com, Ming Hu

Motivated by the surge pricing strategy by the ridesharing platforms, we consider the pricing problem in a two-sided market. The total amount of supply is an increasing function of the wage and the amount of demand depends on the price. We model supply and demand uncertainty by a number of different scenarios, and show that the take-rate price contract is optimal for maximizing the platform's profit or the total utility of the platform and the supply side when only the market size is scenario dependent. In more general cases, we derive performance bounds for the take-rate contract.

■ SC37

205C-MCC

Revenue Management, Assortments and Choice Models

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain Sponsored Session

Chair: Ozge Sahin, Johns Hopkins University, Brooklyn, NY, United States, ozge.sahin@jhu.edu

1 - Consumer Choice Under Rational Inattention And Implications For Assortment Planning

Tamer Boyaci, ESMT Berlin, Berlin, 10178, Germany, Tamer.Boyaci@esmt.org, Frank Huettner, Yalcin Akcay

We study the choice behavior of rationally inattentive customers who optimally acquire information about available options with ex-ante uncertain values through potentially different channels with different costs. Customers trade-off the benefits of better information obtained by asking questions with the associated cost. We quantify acquired information and its cost through a novel function based on conditional mutual information. We solve the consumer's choice problem and analytically characterize the resulting optimal choice behavior. We illustrate some properties of the choice behavior and discuss implications for assortment planning.

2 - Assortment Optimization For Choosy Customers

Jake Feldman, Washington University in St. Louis, jbfeldman@wustl.edu

We study two different choice models that capture the purchasing behavior of customers who only consider purchasing one of two substitutable products. We refer to these customers as choosy. The first choice model captures substitution behavior through probabilistic transitions between products. The second choice model that we study assumes each customer is characterized by a ranking of the products. An arriving customer will purchase her highest ranked product that is offered. Since we model choosy customers, we assume that these rankings contain at most two products. This paper focuses on the assortment optimization problem under these two choice models.

3 - Learning Consumer Tastes From Dynamic Assortments: A Nonparametric Bayesian Model

Canan Ulu, Georgetown University, cu50@georgetown.edu
Dorothee Honhon

We study dynamic assortment decisions of a firm learning about consumer tastes by observing sales. Each period, the firm offers an assortment to maximize expected total profits over a finite horizon given its beliefs on consumer tastes. The consumers then choose a product that maximizes their utility and the firm updates its beliefs on consumer tastes after having observed sales. We model consumer tastes as locations on a Hotelling line and develop a nonparametric Bayesian learning model using Polya tree priors. We develop upper bounds on the firm's total profit based on information relaxations and study the performance of various heuristic policies with respect to these upper bounds.

4 - The Price Of Flexibility

Hoda Bidkhori, Swanson School of Engineering, University of Pittsburgh, Pittsburgh, PA, United States, bidkhori@pitt.edu
Dimitris Bertsimas, Albert Dunning

Process flexibility is a popular operations strategy that has been employed in many industries to help firms respond to uncertainty in product demand. Additional flexibility comes at a cost that firms must balance against the reduction of risk it can provide. We reduce the price of flexibility by taking an optimization approach to the process flexibility design problem. Unlike many approaches in the literature, we consider systems that may have nonhomogenous parameters and unbalanced capacity and demand. We formulate the problem as a robust adaptive optimization model, and propose a computationally tractable method for solving this model using standard integer optimization software.

■ SC38

206A-MCC

Collaborative New Product Development

Sponsored: New Product Development

Sponsored Session

Chair: Niyazi Taneri, Singapore University of Technology and Design, Singapore, Singapore, na, Singapore, niyazitaneri@sutd.edu.sg

1 - The Role Of Operations In Alliances For New Product Development

Niyazi Taneri, Singapore University of Technology and Design, niyazitaneri@sutd.edu.sg, Arnoud De Meyer

We review contract theory and hypothesize its implications for the choice between collaborative alliances (where both parties exert joint efforts) and sequential alliances (where, for the most part, the partner takes over going forward). We test these hypotheses through the analysis of a dataset of over 2000 biopharmaceutical alliances.

2 - Optimal Sequential Investments In Product Development With Exogenous Technologies And Learning

Shantanu Bhattacharya, Singapore Management University, shantanub@smu.edu.sg, Stylianos Kavadias, Sameer Hasija

We determine the optimal investments for a firm when the product development opportunities come over time from two distinct exogenous technologies. Upfront investment in a product platform from a technology that is currently available gives higher returns from opportunities based on the platform technology in the future, due to the associated learning effects. We formulate the resource allocation problem and characterize the optimal development investments that determine the firm product development roadmap. We show that the firm's optimal resource investment in platform development has a nuanced relationship with the relative speed of arrival of the new technology.

3 - Business Model For Technology-intensive Supply Chains

Junghee Lee, University of California, San Diego, junghee.lee@rady.ucsd.edu
Krishnan Vish, Hyoduk Shin

In technology licensing, controversy has swirled among firms and policymakers about royalty base choice between subsystem and full system. We study the impact of royalty base on innovator's business model decisions from R&D investment to manufacturing integration in Technology Intensive Supply Chain. We identify the key drivers, market heterogeneity and production cost, for the controversy and provide managerial and political implications. Interestingly, the innovator can be better off with a strong competitor when market inequality is low or the competitor is strong enough.

■ SC39

207A-MCC

Market Microstructure and Optimal Trading

Sponsored: Applied Probability

Sponsored Session

Chair: Costis Maglaras, Columbia University, New York, NY, United States, c.maglaras@columbia.edu

Co-Chair: Ciamac Cyrus Moallemi, Columbia University, New York, NY, United States, ciamac@gsb.columbia.edu

1 - Trading The Close — Market Impact And Optimal Execution

Costis Maglaras, Columbia University, c.maglaras@columbia.edu

The "close" concentrates a significant amount of daily liquidity for various market structure reasons. In this talk I will describe a market impact model for "Market-On-Close" (MOC) orders, and its consequences on optimal execution profiles.

2 - Portfolio Liquidity Estimation And Optimal Execution

Kai Yuan, Columbia University, kyuan17@gsb.columbia.edu

We develop a tractable model to estimate portfolio liquidity costs through a multi-dimensional generalization of the optimal execution model of Almgren and Chriss. Our model allows for the trading of standardized liquid bundles of assets (e.g., ETFs or indices). We show that in a "large universe" asymptotic limit, where the correlations across a large number of assets arise from relatively few underlying common factors, the liquidity cost of a portfolio is essentially driven by its idiosyncratic risk. Moreover, the additional benefit of trading standardized bundles is roughly equivalent to increasing the liquidity of individual assets.

3 - Optimal Execution In Hong Kong Given A Market-on-close Benchmark

Christoph Frei, University of Alberta, Edmonton, AB, Canada, cfrei@ualberta.ca, Nicholas Westray

For stocks traded on the Hong Kong Exchange, the median of five prices taken over the last minute of trading is currently chosen as the closing price. We introduce a stochastic control formulation to target such a median benchmark in an empirically justified model which takes the key microstructural features into account. We solve this problem by providing an explicit and efficient algorithm which can be used for the dynamic linear approximation of any square-integrable random variable. Implementing the algorithm on the stocks of the Hang Seng Index, we find an average improvement of around 6% in standard deviation of slippage compared to an average trader's execution.

4 - Mean Field Games Of Singular Control With Applications

Joon Seok Lee, UC Berkeley, 2938 McClure Street, # A207B, Oakland, CA, 94609, United States, ljshope@berkeley.edu
Xin Guo

We introduce a mean field game framework with singular controls. To solve this singular control problem with multiple agents, we derive the Kolmogorov forward equation for the singular control, which is a generalization of the mean fi eld game with regular controls. Both single controls with a bounded velocity and singular controls with a finite variation will be analyzed. Finally, we will present some applications to real options and systemic risk.

■ SC40

207B-MCC

Computational Issues in Productivity and Efficiency Measurement

Invited: Data Envelopment Analysis

Invited Session

Chair: Jose Dula, Virginia Commonwealth University, Snead Hall, 301 W. Main Street, Richmond, VA, 23284, United States, jdula@vcu.edu

1 - Validating DEA As A Rating Tool: The Case Of CMS's Nursing Home Compare.

Jose Dula, Virginia Commonwealth University, jdula@vcu.edu
Marie-Laure Bougnol

The US government's CMS agency rates more than 15000 nursing homes nationwide using a star system. The outcomes are disseminated in various ways including a user friendly and informative web page. We report on a study comparing the government's ratings with classifications obtained with DEA using the same model and data. We answer the question: How would DEA fare as a tool to rate complex entities such as nursing homes?

2 - Dea Computation For The Big Data – A Proactive Approach

Wen-Chih Chen, National Chiao Tung University, Hsinchu, Taiwan, wenchih@faculty.nctu.edu.tw, Yueh-Shan Chen

This talk presents a computation strategy to determine the DEA efficiencies of a massive data set. The strategy proactively searches for the references of a data point under evaluation by solving small-size linear programs (LPs). The size of each individual LP solved is controlled within a guarantee upper bound. The approach does not rely on the data density, and can improve the computational performance significantly.

3 - Segmented Concave Least Squares: An Automatic Classification Method With An Application To The Analysis Of The Room Rates Of Hotels In Finland

Abolfazl Keshvari, Aalto University School of Business, Helsinki, Finland, abolfazl.keshvari@aalto.fi

In this paper, segmented concave least squares estimator is introduced. It estimates a piecewise linear concave function, wherein the number of linear segments (k) is pre-specified. Two extreme cases of this problem are ordinary least squares (k=1) and concave least squares (k=n, the number of observations). The estimator is used to analyze the room rates of hotels in Finland and to classify them into three groups based on their pricing strategies.

■ SC41

207C-MCC

Finance Section Student Paper Competition

Sponsored: Financial Services

Sponsored Session

Chair: Rafael Mendoza, McCombs School of Business, 1, Austin, TX, 1, United States, rafael.mendoza-arriaga@mccombs.utexas.edu

Co-Chair: Tim Siu-Tang Leung, Columbia University, New York, NY, United States, tl2497@columbia.edu

1 - Robust Versus Sparse Portfolio Selection: Insights And Alternatives

Yufei Yang, Singapore University of Technology and Design, Singapore, Singapore, eeyufei@gmail.com
Selin Damla Ahipasaoglu, Jingnan Chen

In this talk, we will provide an in-depth discussion on the robustness and sparsity trade-off in finding the mean-variance portfolio. We extend the classical mean-variance framework by incorporating an ellipsoidal uncertainty set and fixed transaction costs. We demonstrate that the optimal portfolio can be approximated by a linear combination of three benchmark portfolios, and discuss how the number of traded assets changes with respect to uncertainty level and transaction cost.

2 - Portfolio Liquidity Estimation And Optimal Execution

Kai Yuan, Columbia Business School, Broadway, New York, NY, 10027, United States, kyuan17@gsb.columbia.edu

We develop a tractable model to estimate portfolio liquidity costs through a multi-dimensional generalization of the optimal execution model of Almgren and Chriss. Our model allows for the trading of standardized liquid bundles of assets (e.g., ETFs or indices). We show that in a “large universe” asymptotic limit, where the correlations across a large number of assets arise from relatively few underlying common factors, the liquidity cost of a portfolio is essentially driven by its idiosyncratic risk. Moreover, the additional benefit of trading standardized bundles is roughly equivalent to increasing the liquidity of individual assets.

3 - Spectral Portfolio Theory

Shomesh E Chaudhuri, Massachusetts Institute of Technology, Cambridge, MA, 0, United States, shomesh@mit.edu
Andrew W Lo

Economic shocks can have diverse effects on financial market dynamics at different time horizons, yet traditional portfolio management tools do not distinguish between short- and long-term components in alpha, beta, and covariance estimators. In this paper, we apply spectral analysis to quantify stock-return dynamics across multiple time horizons. Using the Fourier transform, we decompose asset-return variances, correlations, alphas, and betas into distinct frequency components. These decompositions allow us to identify the relative importance of specific time horizons in determining each of these quantities, as well as to construct mean-variance-frequency optimal portfolios.

4 - Long Term Risk: A Martingale Approach

Likuan Qin, Northwestern University, Evanston, IL, 60208, United States, likuan.qin@gmail.com

This paper extends the long-term factorization of the stochastic discount factor introduced and studied by Alvarez and Jermann (2005) in discrete time ergodic environments and by Hansen and Scheinkman (2009) and Hansen (2012) in Markovian environments to general semimartingale environments. The transitory component discounts at the stochastic rate of return on the long bond and is factorized into discounting at the long-term yield and a positive semimartingale that extends the principal eigenfunction of Hansen and Scheinkman (2009) to the semimartingale setting. The permanent component is a martingale that accomplishes a change of probabilities to the long forward measure, the limit of T-forward measures. The change of probabilities from the data generating to the long forward measure absorbs the long-term risk-return trade-off and interprets the latter as the long-term risk-neutral measure.

■ SC42

207D-MCC

Stochastic Systems in Finance

Sponsored: Financial Services

Sponsored Session

Chair: Alexandra Chronopoulou, Assistant Professor, University of Illinois, Urbana-Champaign, 117 Transportation bldg. MC-238, 104 S. Mathews Ave., Urbana, IL, 61801, United States, achronop@illinois.edu

1 - Statistical Inference For Long Memory Stochastic Volatility Models

Alexandra Chronopoulou, University of Illinois, Urbana-Champaign, achronop@illinois.edu

Long memory stochastic volatility (LMSV) models have been used to explain the persistence of volatility in the market, while rough stochastic volatility (RSV) models have been shown to reproduce statistical properties of low frequency financial data. In these two classes of models, the volatility process is often described by a fractional Ornstein-Uhlenbeck process with Hurst index H, where H>1/2 for LMSV models and H<1/2 for RSV models. The goal of this talk is to propose a general methodology for the estimation of the parameters of the above models, the filtering of the volatility process, and the calibration of the Hurst index, H, which will then be applied to the option pricing on the S&P 500 index.

2 - Optimal Randomized Unbiased Monte Carlo Simulation Of Discounted Costs

Zhenyu Cui, Stevens Institute of Technology, zcui6@stevens.edu

In this talk, we consider the problem of estimating the expected infinite-horizon cost of running a stochastic system with stochastic fluctuations using Monte Carlo simulation. We propose a randomized unbiased estimator based on truncating the simulation horizon at an independent random time. The problem of determining the optimal randomization distribution of the truncation random variable is formulated as minimizing the “work-variance product” proposed by Glynn and Whitt (1992). We solve this optimization problem explicitly and prove that it is always optimal to use a “shifted” distribution. Numerical experiments illustrate our findings. (This is joint work with Lingjiong Zhu).

3 - Monte Carlo Estimation Of Sensitivities From Analytic Characteristic Functions

Runqi Hu, University of Illinois, Urbana-Champaign, runqihu2@illinois.edu, Liming Feng

Sensitivity analysis is transformed into simulating a probability expectation through the likelihood ratio method (LRM). In this paper, we apply Hilbert transform inversion in evaluating a cdf on a uniform grid from its characteristic function and provide explicit bound for estimation bias. In one dimension cases, the bound allows one to determine the size and fineness of the grid and numerical parameters for the inversion. For multidimensional cases, the parameters can be determined by a procedure that will be proved to converge, and work well practically. In the numerical experiments part, the method is applied in estimating both European and Asian option deltas under CGMY model.

4 - Sensitivity Of The Eisenberg-Noe Network Model To The Relative Liabilities

Mackenzie Wildman, University of California, Santa Barbara, CA, United States, mackenzie.wildman@gmail.com
Zachary Feinstein, Weijie Pang, Birgit Rudloff, Eric Schaanning, Stephan Sturm

The Eisenberg-Noe algorithm gives a clearing payment vector for a system of interconnected financial institutions in which some banks are unable to fulfill their obligations to other banks in full. The network model takes as input a relative liability matrix which gives the liabilities owed from each bank to its counterparties. In practice, these liabilities are generally unknown and must be estimated. We perform sensitivity analysis on this relative liability matrix and obtain a worst-case scenario in terms of the payoff to a “society” node. We illustrate our results on an EBA dataset of European banks.

■ SC43

208A-MCC

Spatial Risk and Decision Analysis

Sponsored: Decision Analysis

Sponsored Session

Chair: Gilberto Montibeller, Loughborough University, Loughborough, United Kingdom, g.montibeller@lboro.ac.uk

1 - Spatial Risk Analysis In Emergency Management

Nikolaos Argyris, Loughborough University, Loughborough, United Kingdom, n.argyris@lboro.ac.uk, Simon French

In any emergency, there is a great deal of uncertainty, often geographical or spatio-temporal uncertainty. For instance, an industrial accident may lead to a plume of contamination, putting populations at risk downwind. The path of a hurricane provides another example that is of obvious concern to emergency managers. We consider how analysts can communicate spatio-temporal uncertainty to those handling the crisis. We review the somewhat limited literature on the representation of spatial uncertainty on maps. We note that many cognitive issues arise and that the potential for confusion is high. We then make some suggestions based upon the idea of presenting multiple scenarios.

2 - Spatial Preference Functions For Risk Analysis

Jay Simon, American University, jaysimon@american.edu, L Robin Keller

When outcomes are defined over a geographic region, measures of spatial risk regarding these outcomes can be more complex than traditional measures of risk. One of the main challenges is the need for a cardinal preference function that incorporates the spatial nature of the outcomes. We explore preference conditions that will yield the existence of spatial measurable value and utility functions, and discuss their application to spatial risk analysis.

3 - Multi-criteria Spatial Risk Analysis For Resource Allocation Decisions

Gilberto Montibeller, Full Professor of Management Science, Loughborough University, Loughborough, United Kingdom, g.montibeller@lboro.ac.uk, Valentina Ferretti

There is a broad literature on spatial multi-criteria evaluation in the environmental domain and some attempts of conducting risk analysis in this context. Most of these attempts neither employ a proper decision analytical framework nor provide a clear conceptualization for allocating resource on mitigating actions. To address these weaknesses we conceptualize a multi-criteria spatial risk analysis assessment, which may support spatial decision-making processes. The framework employs expected multi-attribute utility and portfolio decision analysis concepts in a spatial context. A case study on flooding evaluation and defense building illustrates its application in practice.

■ SC44

208B-MCC

Modeling of Uncertainty and Preference in Decision Analysis

Sponsored: Decision Analysis

Sponsored Session

Chair: Christopher Hadlock, Austin, TX, United States, cchadlock@gmail.com

Co-Chair: Robert Hammond, Chevron, Houston, TX, United States, robertkh@gmail.com

1 - Johnson Quantile-parameterized Distributions

Christopher Hadlock, The University of Texas at Austin, cchadlock@gmail.com, J. Eric Bickel

It is common practice in decision analysis to elicit quantiles of continuous uncertainties, and then fit a continuous probability distribution to the corresponding probability-quantile pairs. This process is inconvenient because it requires access to a curve-fitting process, and the best-fit distribution will often not honor the assessed points. By strategically extending the Johnson Distribution System, we design the new J-QPD distribution system, which is directly parameterized by and honors any symmetric percentile triplet of low-base-high assessments in conjunction with known support bounds, eliminating the need to apply a fit procedure.

2 - The Metalog Distributions

Thomas Keelin, Keelin Reeds Partners, 770 Menlo Avenue, Suite 230, Menlo Park, CA, 94025, United States, tomk@keelinreeds.com

The metalog distributions constitute a new system of continuous univariate probability distributions designed for flexibility, simplicity, and ease of use. The system includes quantile-parameterized unbounded, semi-bounded, and bounded distributions, each of which offers shape flexibility that compares favorably with Pearson distributions and others. Applications in fish biology and hydrology show how metalogs enable unprecedented insight into CDF data. A decision analysis application shows metalogs aided a decision that would have been made wrongly based on traditional discrete methods.

3 - Reexamining The Viability Of Scoring Rules

Zachary Smith, The University of Texas at Austin, zack.smith@utexas.edu, J. Eric Bickel

There are a number of widely used proper scoring rules used to elicit and rank expert opinions. However, not all rules have the property of being additive, in the sense that the score for marginal distributions and joint distributions are comparable. Scoring rules without this property are sensitive to the presentation of information as well as the information itself. We characterize scoring rules that are additive, and consider practical implications for some commonly-used rules.

■ SC45

209A-MCC

Panel: Systemic Risk Issues in Counterparty Risk and Central Clearing

Invited: Risk and Compliance

Invited Session

Moderator: Agostino Capponi, Columbia University, 500 West 120th street, New York, NY, 10027, United States, ac3827@columbia.edu

1 - Panel on Systemic Risk Issues In Counterparty Risk And Central Clearing

Agostino Capponi, Columbia University, ac3827@columbia.edu

The panel is formed by six leading experts in the area of systemic risk and central clearing counterparties. The discussion will be centered on the economics of clearinghouses and their role in promoting financial stability. Pro and cons of central clearing will be highlighted and possible unintended consequences will be discussed.

2 - Panelist

John Birge, Chicago Booth School of Business, jbirge@chicagobooth.edu

3 - Panelist

Akhtarur Siddique, Office of Comptroller of Currency, Akhtarur.Siddique@occ.treas.gov

■ SC46

209B-MCC

Dynamic Pricing with Substitution, Learning and Reference Price Effects

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Candace Arai Yano, University of California-Berkeley, IEOR Dept. and Haas School of Business, Berkeley, CA, 94720, United States, yano@ieor.berkeley.edu

1 - Optimal Use And Replenishment Of Substitutable Raw Materials In Non-Stationary Capacitated Systems With Dynamic Price

Izak Duenyas, University of Michigan-Ann Arbor, duenyas@umich.edu

We consider a make-to-order setting where a firm can use either of two kinds of materials (or their mixture) to produce an end product using a shared production line with stochastic capacity. The materials are substitutable but one has a higher conversion rate and the other is cheaper, and their availability is uncertain. We show that a Use-down-to/Balancing Production Policy and modified Order-up-to Ordering Policy is optimal. Although the optimal policy is hard to compute using brute-force due to curse of dimensionality, we use its structure to develop an algorithm that solves for it efficiently. We also conduct sensitivity analysis of the optimal policy and find counter intuitive results.

2 - A Squared-coefficient-of-variation Rule For Learning And Earning

N. Bora Keskin, Duke University, Durham, NC, United States, bora.keskin@duke.edu

Consider a price-setting firm that sells products over a continuous time horizon. The firm is uncertain about the sensitivity of demand to price changes and updates its prior belief on an unobservable sensitivity parameter by observing demand responses. We derive and solve a PDE to show how the value of learning should be projected onto prices in an optimal fashion.

3 - Dynamic Pricing With Stochastic Reference Price Effects

Xin Chen, UIUC, xinchen@illinois.edu, Zhenyu Hu, Yuhan Zhang

We study a dynamic pricing problem of a firm facing stochastic reference price effect. Randomness is incorporated in the formation of reference prices to capture exogenous factors that affect consumers' memory processes. We derive an explicit expression for the optimal pricing strategy which allows us to obtain the distribution of the steady state reference price. We compare the expected steady state reference price to the steady state reference price in a deterministic model and we find that the former one is always higher. A transformation technique is presented to show how one can extend the analysis to higher dimensional problems in which consumers have heterogeneous reference prices.

4 - Hidden City Travel And Its Impact On Airfare: The Case With Competing Airlines

Jaelynn Oh, University of Utah, jaelynn.oh@business.utah.edu
Tim Huh

We study the impact of hidden-city ticketing on airfare pricing in a setting where two airlines compete on a hub-and-spoke flight network.

■ SC47

209C-MCC

New Topics in Revenue Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Stefanus Jasin, University of Michigan, Ann Arbor, MI, United States, sjasin@umich.edu

1 - Managing Dynamic Mobile Push Advertisements At Alibaba

Van Anh Truong, Columbia IEOR, vt2196@columbia.edu

In recent years, e-commerce companies are seeing an increasing amount of transactions completed via mobile platforms, such as apps in iOS and Android systems. In China, the e-commerce market share of a mobile app developed by Alibaba Group, which has been installed on several hundred million devices, is rapidly replacing that of traditional e-commerce markets hosted on webpages. We study the problem of managing the allocation of push notifications sent to users by this app which recommends products tailored to every user.

2 - Efficient Algorithms For Dynamic Pricing Problem With Reference Price Effect

Zhenyu Hu, National University of Singapore (NUS), bizhuz@nus.edu.sg

We analyze a dynamic pricing model in which demand at each period depends on not only the current price but also past prices through reference prices. A unique feature but also a significant challenge in this model is the asymmetry in reference price effect which implies the underlying optimization problem is non-smooth and no standard optimization methods can be applied. We identify a few key structural properties of the problem, which enable us to develop strongly polynomial time algorithms to compute the optimal prices for several plausible scenarios. We further conduct numerical experiments to study the optimal price path and demonstrate the value of dynamic pricing when demands are seasonal.

3 - Optimal Stopping And Worker Selection In Crowdsourcing: An Adaptive Sequential Probability Ratio Test Framework

Xi Chen, Stern, NYU, xchen3@stern.nyu.edu

In this talk, we propose an adaptive sequential probability ratio test (Ada-SPRT) that obtains the optimal experiment selection rule, stopping time,and final decision rule under a single Bayesian decision framework. Our motivating application comes from binary labeling tasks in crowdsourcing, where the requestor needs to simultaneously decide which worker to choose to provide the label and when to stop collecting labels to save for budget. We characterize the structure of the optimal adaptive sequential design that minimizes the Bayes risk through log-likelihood ratio statistic and develop dynamic programming based algorithms for both non-truncated and truncated tests.

4 - Dynamic Joint Pricing And Order Fulfillment For E-commerce Retailers

Yanzhe Lei, University of Michigan, Ann Arbor, MI, United States, leiyz@umich.edu, Stefanus Jasin, Amitabh Sinha

We consider a dynamic joint pricing and order fulfillment optimization problem in the e-commerce retailing context, where a retailer sells a catalog of products to customers from different locations and fulfills orders through multiple fulfillment centers. The objective is to maximize the total expected profits, defined as revenues minus shipping costs. We propose two heuristics that are easily implementable, and show both theoretically and numerically their good performances compared to reasonable benchmarks.

■ SC48

210-MCC

Social Media in Marketing and Talent Management

General Session

Chair: Fujie Jin, Indiana University, 1309 East Tenth Street, Suite 4100, Bloomington, IN, 47405, United States, jinfujie@wharton.upenn.edu

1 - Social Media Marketing In Product Harm Crisis

Shu He, University of Connecticut, shuhe@utexas.edu

We conceptualize the dual roles of a firm's social media strategy—-offensive and defensive marketing strategies—-and study how non-focal firms adjust these two components of strategy in response to a product-harm crisis. We use daily social media activity of 56 major airlines on Twitter around the time of an airplane crash to study how non-focal airlines harness these two functions before and after the crisis. We find that a non-focal airline increases its defensive marketing effort but decrease its offensive marketing effort after the crash. The adjustment of offensive marketing decrease is significantly attenuated by whether the non-focal airline directly competes with the focal airline.

2 - Influence Of Social Media On Flash Sales: An Empirical Analysis

Karthik Kannan, Georgia Tech, karthikbabu.nk@scheller.gatech.edu, Jeffrey Hu, Sridhar Narasimhan

The emergence of e-commerce platforms has democratized both the production and consumption of goods and services. While anyone can offer their services through these platforms, sellers with little brand recognition have to overcome high search cost faced by prospective buyers in order to succeed in these markets. We study two mechanisms - flash sales and social media - used by sellers to promote their products by collecting sales and social media data from 24,446 products sold in a popular e-commerce platform.

3 - Does Reputation Management On Social Media Boost Career? Evidence From The Market For Executives

Yanzhen Chen, University of Texas at Austin, Austin, TX, United States, yanzhen@utexas.edu, Huaxia Rui, Andrew Whinston

Our paper studies the impact of reputation management (RM) on executives' careers gathering evidence from their Twitter usage. Our structural model, which is based on a Two-Sided Matching Model, is able to exploit the characteristics of all of the candidates so as to identify separate RM's influences in bargaining power as well as sorting during the hiring process. The results show that in the recruiting process of CEO and CMO markets, both out-/underperformed applicants benefit from RM. However, in compensation bargaining, RM is profitable only for outperformed candidates. RM can help more than 40% of CEOs and may increase their compensation by more than $10 million per year.

4 - Gravity In Open Source Software Production

Xuan Ye, New York University, New York City, NY, United States, xye@stern.nyu.edu, Prasanna Tambe

Using data on over 2 million hourly contributions contributed over eight years to GitHub.com, this paper investigates how the geographic organization of contributors influences open source production in corporate sponsored projects. Specifically, we test the extent to which time zones play a role in open source software contribution. We find strong evidence of such a bias in open source software production. Concentration of contributors within the same time zone is correlated with greater contribution levels, and this is robust to user fixed-effects.

■ SC49

211-MCC

Social, Political, and Economic Applications of Social Media Analysis

Invited: Social Media Analytics

Invited Session

Chair: Amanda Andrei, MITRE Corporation, 7515 Colshire Dr, Mclean, VA, 22102, United States, aandrei@mitre.org

1 - Characterizing Traffic Accident Detection Through Twitter And Open Data

Jared Mowery, MITRE Corporation, jmowery@mitre.org

Several recent studies have shown that Twitter can be used to detect traffic disruptions with high precision. This study builds on those results by incorporating open data including real-time traffic speed sensor measurements and weather data, measuring the recall of traffic accident detection against New York City police records, and by characterizing the probability of detection as a function of the severity of the accident.

2 - Assessing Patient Abuse At Nursing Homes Via Classification Of Online Reviews

Jing Jian, MITRE Corporation, jjian@mitre.org

This study demonstrates a correlation between a maximum entropy classifier's assessment of indications of patient abuse in online reviews for nursing homes and the results of Medicare facility inspections. Over 8,000 reviews were analyzed, representing over 4,000 facilities. Aggregating reviews for nursing homes with similar numbers of deficiencies from the inspections indicates the Pearson correlation coefficient approaches approximately 0.65 as the number of reviews increases.

■ SC50

212-MCC

Achieving Professional Success by Managing the Work/Life Balance

Sponsored: Women in OR, MS

Sponsored Session

Chair: Dorothee Honhon, Associate Professor, University of Texas at Dallas, 800 W. Campbell Road, Richardson, TX, 75080, United States, dorothee.honhon@utdallas.edu

1 - Achieving Professional Success By Managing The Work/life Balance

Dorothee Honhon, University of Texas at Dallas, dorothee.honhon@utdallas.edu

The discussion will center around achieving research productivity and teaching effectiveness while managing a family, dealing with society's expectations and peer pressure, dividing household duties, etc.

■ SC51

213-MCC

Analytical Research in Humanitarian Service Delivery

Sponsored: Public Sector OR

Sponsored Session

Chair: Mahyar Eftekhar, Arizon State University, Arizon State University, Tempe, AZ, 00, United States, eftekhar@asu.edu

1 - Leading Diverse Teams In Humanitarian Aid Field Offices: A Case For Intergroup Leadership

Mojtaba Salem, Kuehne Logistics University, Hamburg, Germany, Mojtaba.Salem@the-klu.org, Maria Besiou, Niels Van Quaquebeke, Louisa Meyer

The humanitarian system struggles sometimes with adequate operational leadership. We study, via an online survey with 123 humanitarian practitioners, how operational leadership can effectively work with the unique challenges of having multiple and highly diverse teams in the humanitarian field offices. We focus on the improvement of intergroup relations and reduction of potential tensions between international and local staff in the same field office. It is shown statistically that group orientated leadership has a positive impact on the operational excellence of response.

2 - Policies For Fleet Operations And Procurement In Humanitarian Development Programs

Milad Keshvari Fard, ESSEC Business School, Av Bernhard Hirsch BP 50105, Cergy Pontoise Cedex, 95021, France, milad.keshvarifard@essec.edu, Felix Papier, Mahyar Eftekhar

Fleet management is known as a pivotal component of humanitarian service delivery. Considering essential constraints (e.g. budget uncertainty, and environmental conditions at the field), we design a heuristic to identify the optimal fleet sizing and mission fulfillment over time. The objective of our model is to minimize the social cost.

3 - Models And Metrics To Assess Humanitarian Response Capacity

Jason Acimovic, Penn State University, acimovic@psu.edu

The race to meet vital needs following sudden onset disasters leads response organizations to establish stockpiles of inventory that can be deployed immediately. Even though the value of one organization's stock deployment is contingent on others' decisions, decision makers lack evidence regarding sector capacity to assess the marginal contribution (positive or negative) of their action. To our knowledge, there exist no metrics describing the system capacity across many agents to respond to disasters. To address this gap, our analytical approach yields new humanitarian logistics metrics based on stochastic optimization models.

4 - Supply Management Strategies In Emergency Relief Operations

Mahyar Eftekhar, Arizona State University, BA 433, Main Campus, P.O. Box 874706, Tempe, AZ, 85287, United States, eftekhar@asu.edu, Jeannette Song, Scott Webster

To fulfill beneficiaries' demands, humanitarian organizations should design a cost-efficient and time-effective procurement policy. We consider and analyze two common supply management policies: pre-positioning and local-purchasing. Our analysis takes demand characteristics, supply uncertainty, and budget limitations into account.

■ SC52

214-MCC

Public Policy for Energy and the Environment

Sponsored: Public Sector OR

Sponsored Session

Chair: Zana Cranmer, University of Massachusetts - Amherst, 160 Governors Drive, Amherst, MA, 01003, United States, acranmer@umass.edu

Co-Chair: Erin Baker, University of Massachusetts - Amherst, 160 Governors Drive, Amherst, MA, 01003, United States, edbaker@ecs.umass.edu

1 - Benefit Cost And Distributional Effects Analysis For Solar PV In The United States

Parth Vaishnav, Carnegie Mellon University, Pittsburgh, PA, United States, parth.vaishnav@gmail.com, Ines Azevedo

Solar irradiance varies by location and time, as do the private benefits of solar PV. The health, environmental and climate change (HECC) benefits of displacing a unit of grid electricity production, which stem from reduced emissions of CO2, NOx, SOx and PM also vary by time and location. We present a location-specific cost-benefit analysis that quantifies the county-level costs, benefits, and distribution of benefits for residential solar PV in the continental United States, emphasizing an environmental justice perspective.

2 - Expert Elicitation Of The Proliferation Resistance Of Using Small Modular Reactors For The Expansion Of Civilian Nuclear Systems

Jonas Siegel, University of Maryland, College Park, MD, United States, jsiegel@umd.edu, Elisabeth A Gilmore, Nancy Gallagher, Steve Fetter

SMRs could allow for more proliferation resistant designs, manufacturing arrangements and fuel cycle practices at widespread deployment compared to large reactor designs. Here, we conduct an expert elicitation involving the pairwise comparison of future nuclear energy systems that may be feasibly deployed in 2050. The experts do not consistently judge the SMR deployment scenario to have greater overall proliferation resistance than those that rely on larger nuclear generation options. The experts identify two features that are facilitated by SMRs, specifically international safeguards and the operation of multinational fuel cycle facilities, as improving proliferation resistance.

3 - Power Plants Compliance With Co2 Emissions Regulations: The Effect Of Policy Mechanisms, And Technological And Fuel Price Uncertainty

Dalia Patino Echeverri, Duke University, dalia.patino@duke.edu

Under and Alternative Compliance Payment mechanism regulators set a CO2 emissions rate target, a fee (the ACP) to be paid for every ton of emissions in excess of the target, and a deadline to permanently reduce emissions (by installing controls, improving efficiency, reducing generation, or replacing with low carbon technologies). We explore the effects of an ACP policy through the use of a Stochastic Mixed Integer Linear Program representing the investment decision of a regulated electric utility under different ACP designs, and fuel price, and technology uncertainty.

4 - Valuing Offshore Wind Energy

Zana Cranmer, University of Massachusetts Amherst, MA, acranmer@umass.edu, Erin Baker

Much attention has been paid to the environmental costs of offshore wind, such as bird mortality. We are addressing the environmental benefit of offshore wind in the context of climate change. Measuring this value is complex, as it depends importantly on the policy environment and the energy system. We propose a model for the environmental value of offshore wind and show that the policy context determines whether that value is derived from reducing the cost of abatement or reducing the damages associated with emissions. We use a global integrated assessment model, GCAM, to estimate the value, with a focus on the Atlantic coast of the US.

■ SC53

Music Row 1- Omni

Advances in Research Exploring the Link between Learning and Innovation

Sponsored: Technology, Innovation Management & Entrepreneurship

Sponsored Session

Chair: Onesun Steve Yoo, University College London, One Canada Square, London, E14 5AB, United Kingdom, o.yoo@ucl.ac.uk

1 - Design Of Resource Competitions For R&D Projects

Pascale Crama, Singapore Management University, pcrama@smu.edu.sg

Academic research is funded by governments as well as by university administered research funds (UARF) at research universities. Government funding is based on arm's length, competitive peer reviews of project proposals, whereas UARF funding is more relationship-based. We evaluate the impact of these two funding sources and their differing funding rules on the novelty of the projects being funded and social welfare creation. Our research points to the importance of an appropriate design of the two-stage funding system to increase social welfare.

2 - Staged Ideation In Crowdsourced Problem Solving

Nilam Kaushik, University College London, uceikau@ucl.ac.uk

Crowdsourcing ideation platforms are increasingly gaining traction and are being used by firms to tap into the wisdom of crowds to generate ideas and to solve problems. Some such platforms are based on a multi-staged ideation paradigm where ideas are elicited from the user community for an open problem. A few ideas are selected for further refinement which involves updating the idea based on feedback from the user community. Refined ideas are subsequently evaluated and a subset is chosen for winning. Using a novel dataset from a crowdsourcing innovation platform, we investigate factors that affect the selection of an idea into the refinement stage and further into the winning stage.

3 - Research And Development Competition With Spillovers And Uncertain Completion Times

Wenxin Xu, University of Illinois at Urbana-Champaign, wxu9@illinois.edu

Dharma Kwon, Jovan Grahovac

We examine a game-theoretic model of two firms that are competitively engaged in R&D projects and address two questions: (1) What is the impact of natural spillover upon innovative firms' payoffs? (2) Does an innovative firm have an incentive to unilaterally increase the spillover to its competitor? To answer these questions, we investigate the impact of natural spillover on R&D investment strategies when the R&D completion times are uncertain and either firm can receive spillover from the other. We characterize the Nash equilibrium of the model and find that natural spillover may or may not diminish the profit of the more efficient firm.

4 - A Theoretical Analysis Of The Lean Startup's Agile Product Development Process

Onesun Steve Yoo, University College London, onesun.yoo@ucl.ac.uk, Tingliang Huang, Kenan Arifoglu

We provide a theoretical foundation for the lean startup's agile product development process. It helps us better understand why lean start-up works, and also predict when it does not work. We discuss the implications of our results to research and practice.

■ SC54

Music Row 2- Omni

Mathematical Modeling and Data Analytics in the Service Industry

Sponsored: Service Science

Sponsored Session

Chair: Mohammadsadegh Mobin, Western New England University, 1215, Wilbraham road, WNE university, Springfeild, MA, 01119, United States, mm337076@wne.edu

Co-Chair: Zhaojun Li, Western New England University, 1215, Wilbraham Road, WNE University, Springfield, MA, 01119, United States, zhaojun.li@wne.edu

1 - Analyzing The Predictive Power Of Early Warning Systems In Healthcare

Nasibeh Azadeh-Fard, Visiting Professor, Rochester Institute of Technology, Industrial and Systems Engineering Department, Rochester, NY, 14623, United States, azadehfard@gmail.com, Navid Ghaffarzadegan, Jaime Camelio

Early warning systems have been widely used in healthcare to predict adverse outcome. The prediction power of early warning systems, however, is an empirical question. The objective of this study is to assess the predictive power of early warning systems and prognostic risk indicators in predicting different outcomes in health such as mortality, disease diagnosis, adverse outcomes, care intensity, and survival.

2 - Reverse Bullwhip Effect In Pricing In Retail Industry

Ziaul Haq Adnan, University of North Carolina at Charlotte, Charlotte, NC, United States, zadnan@uncc.edu

Ertunga Ozelkan

Bullwhip effect in pricing refers to the amplified variability of prices. If the variability is amplified towards downstream (upstream), we refer to it as reverse (forward) bullwhip effect in pricing. In this paper, we consider both simultaneous and sequential (e.g. wholesale and retail leading) game structures. We show analytical results and parametric examples for concave, linear, and convex demand functions. We conclude that forward bullwhip effect in pricing occurs for all concave and linear demand functions, and reverse bullwhip effect in pricing occurs for some convex demand function. The rate of amplification of variability in prices varies for different game structure.

3 - A Simulation Approach To Plan DesignV&V Activities For The New Product Reliability Improvement

Mohammad Sadegh Mobin, Western New England University, 1215 Wilbraham Road, Springfield, MA, 01119, United States, mm337076@wne.edu", Zhaojun Li, Mohammad Dehghanimohammadabadi

Product failure modes, their effects, and a set of verification and validation (V&V) activities are outputs of conducting the design failure modes and effect analysis (DFMEA) in the early stages of developing a new product. A robust method for planning V&V activities is needed to mitigate all critical design failure modes by considering cost and timeframe constraints. In this paper, an integrated simulation-DEA (Data Envelopment Analysis) model is proposed to provide the efficient product design V&V activities' plans by considering the uncertainty of V&V process parameters.

4 - Design Of Coordinating Contracts In Volume Discount Group Purchasing

Abdollah Mohammadi, University of North Carolina - Charlotte, 532 Lex Dr., Charlotte, NC, 28262, United States, amoham17@uncc.edu, Ertunga Ozelkan

This study investigates supply chain coordination using contracts in the context of group purchasing (GP), where there is a supplier, a GP agent and multiple customers. In GP the underlying contract between a supplier and the GP agent is quantity discount, while between the agent and the customers it can be a different type of contract. In this study, we specifically investigate revenue sharing or buyback contracts and discuss how and when they coordinate and align objectives of all members of the supply chain.

■ SC55

Music Row 3- Omni

Emerging Topics in Service Operations

Sponsored: Service Science

Sponsored Session

Chair: Mike Pinedo, NYU, NYU, NYC, NY, 10012, United States, mpinedo@stern.nyu.edu

Co-Chair: Yuqian Xu, NYU, NYU Stern School of Business, NYC, NY, 10012, United States, yxu@stern.nyu.edu

1 - Vertical Opaque Selling Under Demand Uncertainty

Rachel Chen, UC Davis, rachen@ucdavis.edu

This paper studies opaque selling with vertically differentiated products when demand is uncertain. The quality of the product a consumer receives depends on the realization of the random demand. We show that it is more profitable to offer an opaque product of the vertically differentiated products than to offer a transparent product line.

2 - When Prospect Theory Meets Consumer Choice Models

Ruxian Wang, Johns Hopkins Carey Business School, Baltimore, MD, 21202, United States, ruxian.wang@jhu.edu

According to prospect theory, when the price is higher or lower than a reference point, customers perceive a utility loss or gain. We incorporate the extra utility changes into popular choice models. An empirical study shows that the new choice models can better characterize customer choice behavior.

3 - Price Formation And Efficiency In Ride Sharing Services

Yi Xu, University of Maryland, yxu@rhsmith.umd.edu, Liu Ming, Tunay Tunca, Weiming Zhu

Using data obtained from a leading company, we construct a structural model to estimate price formation in ride-sharing services based on operational characteristics such as the number of consumers and the utilization of drivers. Further, we conduct counterfactual analysis to examine efficiency and welfare implications.

4 - When Do Financial Firms Relocate? A Stochastic View

Michael Pinedo, New York University Stern School of Business, 44 West 4th St. KMC8-152, New York, NY, United States, mpinedo@stern.nyu.edu, Yuqian Xu, Lingjiong Zhu

We consider a financial firm makes the relocation decision based on two perspectives: i) higher expected utility in relocation, and ii) higher probability in achieving certain utility. In this paper, we use the hiring lead time which is a random variable to capture the difficulty in hiring, and thus how this factor impact the relocation decision. At the same time, we integrate in our model the uncertainty and variation in employee capability as well as the uncertainty in their willingness to relocate.

■ SC56

Music Row 4- Omni

Crowdsourcing and Sharing Economy

Sponsored: EBusiness

Sponsored Session

Chair: Wei Chen, University of Arizona, 1130 East Helen Street McClelland Hall 430, Tucson, AZ, 85721-0001, United States, weichen@email.arizona.edu

1 - Do Ride Sharing Services Affect Traffic Congestion? An Empirical Study Of Uber Entry

Yili Hong, Arizona State University, Tempe, AZ, United States, ykhong1@asu.edu, Ziru Li, Zhongju Zhang

Sharing economy, which leverages information technology to re distribute unused or underutilized assets to people who are willing to pay for the services, has received tremendous attention in recent years. Its creative business model has disrupted many traditional industries by fundamentally changing the mechanism to facilitate the matching of demand with supply. In this research, we investigate how Uber affects traffic congestion in the urban areas of the United States. Findings from this research provide evidence on the potential effect of ride sharing services in the transportation industry, contributing to the understanding of the sharing economy and government policy decisions.

2 - Room Sharing Economy And Destination Tourism

Wei Chen, University of Arizona, 3750 E Via Palomita, Apt 23103, Tucson, AZ, 85718, United States, weichen@email.arizona.edu, Lijia Xie

While significant debate has surrounded the entry of room-sharing services, limited empirical work uncovers the impact of such services to traveler activity, particularly, tourism flow and satisfaction at local destinations. We exploit a set of natural experiments, the entry of two major room-sharing services, Tujia.com and Xiaozhu.com, into markets of China between 2011 and 2015. The study underscores the connection of peer-to-peer accommodation availability to relocation of traveler spending, extended stays and improved experience which are critical to the local tourism industry gains. Important implications of theory, practice, and policy making will be provided.

3 - The Role Of Syndication In Democratizing Capital Flow In Online Equity-crowdfunding

Qiang Gao, City University of New York, New York, NY, 85719, United States, qiangg@email.arizona.edu, Mingfeng Lin

Equity crowdfunding provides opportunities for startups to raise funds from large number of online potential investors. However, the issue of information asymmetry not only remains as the major barrier for financing these early stage companies but is actually exacerbated by the “virtual” nature of these marketplaces. This paper examines whether syndication, a group of investors who collaborate to pool resources and share risks, in online equity crowdfunding, can alleviate this issue and democratize the access to capital and investment opportunities. We further investigate the drivers for the formation of such syndicates.

4 - “Release Early, Release Often”? The Impact Of Release Frequency In Open-source Software Co-creation

Wei Chen, University of Arizona, weichen@email.arizona.edu Vish Krishnan, Kevin Zhu

A central virtue of OSS is the contributions from the communities, yet our knowledge of how to coordinate and maximize the benefit of such contributions for market success is limited. In this paper, we uniquely formalize, analyze, and validate the impact of product release frequency as a coordinating mechanism in the adoption of open-source products. We build a dynamic structural model to characterize the optimal release strategy from the project owner’s perspective. The theoretical and empirical results have important implications for managing technology-enabled collaboration in open-source communities and for research on open-source software, open innovation, and software adoption.

■ SC57

Music Row 5- Omni

Consumer Behavior and Pricing Optimization

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Nikolay Osadchiy, Emory University, Atlanta, GA, United States, nikolay.osadchiy@emory.edu

1 - Pricing Under Anticipation

Javad Nasiry, Hong Kong University of Science and Technology-HKUST, nasiry@ust.hk, Ioana Popescu

We model the purchase behavior of consumers by accounting for anticipatory feelings triggered by the prospect of buying at a discount, as well as for the disappointment when anticipated outcomes fail to materialize. We show that sales policies can outperform uniform pricing when a monopolist sells to anticipating customers.

2 - Mental Accounting, Reference Price Adaptation, And The Pricing Of Flat-rate Contracts

Manel Baucells, University of Virginia, 100 Darden Blvd, Charlottesville, VA, 22903, United States, baucellsm@darden.virginia.edu, Woonam Hwang

We propose a model where consumers possess a mental account that stores the worth of items purchased and yet to be consumed. Reference prices act as the book values of these items, and are determined by a psychological process of adaptation to the price evoked by the trade. The model is integrative, in that it explains a wide array of observed anomalies such as sunk-cost effects, payment depreciation, reluctance to trade, preference for pre-payment, and the flat-rate bias. We explore the pricing implications of the model when it comes to flat-rate pricing.

3 - Tell Me What I Want: A Study Of Personalized Assortment Planning For Learning Consumers

Yulia Vorotyntseva, University of Texas at Dallas, Richardson, TX, 7508, United States, yxv120230@utdallas.edu Dorothee Honhon, Canan Ulu

We model retailer’s and consumer’s simultaneous learning about the consumer’s idiosyncratic preferences. In each period the retailer chooses an assortment of products to offer the consumer and learns about her preferences by observing the choice. The consumer picks one product, gets a noisy signal about its utility and updates her beliefs in Bayesian fashion. We use this model to study structural properties of the firm’s optimal assortment policy and to quantify the value of information about the consumer’s experience, such as feedback surveys.

4 - Optimal Dynamic Upgrade

Xiao Zhang, PhD Candidate, The University of Texas at Dallas, 800 West Campbell Rd, Richardson, TX, 75080, United States, xiao.zhang@utdallas.edu, Metin Cakanyildirim, Ozalp Ozer

Upgrade, a strategy used in travel industry to balance supply-demand mismatches among products of different quality levels, is usually implemented either at the booking time or at the consumption time. We study a revenue management problem of a firm which sells two products and offers upgrade option anytime when necessary. The optimal policy specifies the timing of the upgrade option and how many customers should be offered this option.

■ SC58

Music Row 6- Omni

Energy III

Contributed Session

Chair: Benjamin D. Leibowicz, Assistant Professor, University of Texas at Austin, 204 E. Dean Keeton St., Stop C2200, Austin, TX, 78712, United States, bleibowicz@gmail.com

1 - Modelling Electricity Balancing Market Prices And Premiums

Ezgi AVCI-SURUCU, Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands, avcisurucu@rsm.nl, Wolfgang Ketter, Gerhard-Wilhelm Weber

In smart electricity markets, the increased penetration of renewable sources reveals the need for decision support systems. For developing reasonable bidding strategies, market participants need intelligent agents to make informed decisions about the trade-off between sales in the day-ahead market or in the balancing market. In this paper, by considering a detailed system-level data; firstly we examine the market efficiency by fractal analysis to understand the level of price predictability. Further, due the invalidity of normality and linearity assumptions, we propose non-parametric non-linear models to provide strategic tools for policy makers and market participants.

2 - A Game Theoretic Approach For Load-shifting In The Smart Grid With Storage Capacity

Murat Erkoc, Associate Professor, University of Miami, 1251 Memorial Drive, Eng. Building. Room 282, Coral Gables, FL, 33146, United States, merkoc@miami.edu, Eeyad Al-Ahmadi

We study the load-shifting problem within the context of smartgrid demand response for an electricity market composed of a single energy provider and multiple consumers. We consider the case where the energy provider has the option of installing and managing client storage devices at consumer sites. The provider acts as the leader and decides on price discounts and storage decisions across a finite time horizon. The consumers, acting as followers, respond by deciding if and how they shift their consumption from their nominal demand. We investigate the joint impact of price discounts and storage option on player incentives and peak-to-average ratios.

3 - Essential Aspects Of Power System Resource Planning In Developing Community Of Microgrid

Aida Khayatian, PhD Student, University of Houston, 4722 Calhoun Rd, E206 Engineering Bldg 2, Houston, TX, 77204, United States, akhayatian@uh.edu, Masoud Barati, Gino J Lim

This paper addresses Microgrid expansion planning problem which helps Community Microgrid companies to decide whether or not they invest on Microgrid installation in a competitive electricity market. Integrated resource planning, demand-side management, environmental issues, the competitiveness of power investors, energy efficiency, rural electrification, future load growth and possible power outage in the face of uncertainty and reliability are challenges faced by power system planners. This paper develops a model and policy for Microgrid expansion planning in a competitive electricity market under uncertainty by considering these challenges.

4 - Technology-push, Demand-pull, And Strategic R&D Investment

Benjamin D. Leibowicz, Assistant Professor, University of Texas at Austin, 204 E. Dean Keeton St., Stop C2200, Austin, TX, 78712, United States, bleibowicz@gmail.com

A bilevel modeling framework is constructed to determine the optimal combination of technology-push and demand-pull interventions for a given technology policy application. The inner agents are profit-maximizing firms who solve a two-stage stochastic decision problem with product and process R&D investments. The outer agent is a welfare-maximizing policymaker. Findings illustrate how the optimal technology policy combination varies with the primary motivation for innovating and the relative strengths of three important market failures (incomplete appropriability of R&D, a negative production externality, and imperfect competition).

■ SC59

Cumberland 1- Omni

Spatial Analysis in Transportation & Logistics

Sponsored: Transportation Science & Logistics

Sponsored Session

Chair: EunSu Lee, Assistant Professor, New Jersey City University, 160 Harborside Plaza 2, #234H, Jersey City, NJ, 07311, United States, elee3@njcu.edu

1 - Understanding The Integration Of Freight Supply Chain By Integrating Pairwise Decision Mechanism

Dapeng Zhang, Hyperloop Tech Inc., dapeng@hyperlooptech.com

This paper develops an innovative econometric model to understand joint response. The first part explains the matching process in a many-to-one matching structure; The second part characterizes the joint decision making process of mutually-selected decision makers. The two parts are integrated by recognizing their dependency that is essentially a sample selection process: a joint response is only observed for matched decision makers. The proposed model is estimated using a Bayesian Markov-Chain Monte-Carlo approach. The likelihood functions and posterior distributions are derived and followed by simulation studies to test parameter recovery capability.

2 - Spatial Optimization For Designing Public Water Supply Systems

EunSu Lee, New Jersey City University, elee3@njcu.edu

To supply safe and clean water is critical for urban life. The objective of this study is to provide spatial and optimization approach for public water supply. The model considers existing and potential water sources to design public water supply network. This study concerns demand-supply balance and age and safety of the existing and network.

■ SC60

Cumberland 2- Omni

Facility Layout

Sponsored: TSL, Facility Logistics

Sponsored Session

Chair: Pratik J Parikh, Wright State University, 3640 Col. Glenn Hwy, Dayton, OH, 45435, United States, pratik.parikh@wright.edu

1 - Towards Calculating Realistic Walking Paths In Warehouses: A New Approach

Sabahattin Gokhan Ozden, Graduate Research Assistant, Auburn University, Shelby Center 3333, Auburn, AL, 36849, United States, gokhan@auburn.edu, Alice E. Smith, Kevin Gue

We consider a visibility graph as a new way of routing order pickers in traditional and fishbone layout warehouses.. The traditional method of calculating distances is not realistic for many warehouse designs, especially those with non-traditional aisle structures. By using a visibility graph we not only consider paths that are more realistic for non-traditional layouts but can also make unbiased comparisons between traditional and non-traditional layouts for order picking operations.

2 - Retail Layouts For Maximal Exposure

Pratik J. Parikh, Wright State University, 3640 Colonel Glenn Highway, 207 Russ Engineering Center, Dayton, OH, 45435-0001, United States, pratik.parikh@wright.edu, Corinne H. Mowrey

Industry practice suggests that over 70% of purchase decisions are made in the store, and that store design influences shoppers' buying decisions. Arguably one of the most important attributes of store design is product exposure; i.e., what the customer sees. We seek to optimize the design of a store section in order to maximize exposure to a traveling shopper while accounting for bi-directional traffic flow. Results from our approach suggest that layouts that combine both acute (or obtuse) and 90° rack orientations generate substantially higher exposure than traditional layouts for given floor-space and minimum rack-display constraints.

3 - A Multi-objective Intermodal Network Design Considering The Effect Of Carbon Tax

Sunderesh S Heragu, Oklahoma State University, sunderesh.heragu@okstate.edu, Xiaoren Duan

In this paper, we analyze a real world coal transportation intermodal network across 15 states in US including highway, railway and inland waterway. With a motivation to minimize the economic cost and environment cost simultaneously, we propose multi-objective optimization models to analyze intermodal transportation with economic, time performance and environmental considerations. A time penalty parameter is introduced to simulate the real coal transportation behavior through the mathematical model. The breakeven point for tax rate is 13 dollars per ton, which can provide minimum carbon emission without increasing the transportation cost.

■ SC61

Cumberland 3- Omni

Fleet Sizing Models

Sponsored: Railway Applications

Sponsored Session

Chair: Dharma Acharya, President, KOSU Services LLC, 241 Auburndale Dr., Ponte Vedra, FL, 32081, United States, acharya.dharma@gmail.com

Co-Chair: Michael Gorman, Prof., University of Dayton, Dayton, OH, 12345, United States, mgorman1@udayton.edu

1 - Fleet Sizing Model Overview

Michael Gorman, University of Dayton, mgorman1@udayton.edu

Appropriate fleet sizing is critical for rail asset utilization and service. I will discuss the basic trade-offs for the fleet sizing decision, discussing both deterministic and stochastic approaches. I will present rail fleet sizing and other literature, and discuss approaches taken in practice. Key discussion points surrounding the fleet sizing decision will be raised.

2 - Fleet Sizing Model Case - Freight Railroad Perspective

Clark Cheng, Senior Director Operations Research, Norfolk Southern Railway, 1200 Peachtree Street NE, Atlanta, GA, 30309, United States, Clark.Cheng@nscorp.com, Andy Yoon, Xin Zhang

We will present a freight car fleet planning tool that evaluates the long-term impact of fleet management decisions based on demand forecast, budget and costs. The tool has been in use at Norfolk Southern for the last 10 years to assist with decision making in freight car acquisitions to maximize long-term profits in the future years.

3 - Intermodal Equipment Fleet Sizing

Bruce Patty, Veritec Solutions, bpatty@veritecsolutions.com

This presentation will review approaches used to determine the number of both containers and chassis needed to support projected volumes. Models used to estimate chassis demand by location will be discussed based on the experience of the author as AVP-Equipment Strategy at Pacer Stacktrain. Offhire and onhire planning will also be included in the session.

4 - Fleet Sizing Model: Railroad And Shipper Perspective

dharma acharya, KOSU Services LLC, acharya.dharma@gmail.com

In this session, we will present how some railroads and shippers perform fleet sizing of their rail car fleet to move the forecast shipments. We will also discuss issues associated with uncertain demand forecast and cycle times. Additional functionality requirements to meet the future business needs will also be presented.

■ SC62

Cumberland 4- Omni

Aviation Applications Section: Best Student Presentation Competition III

Sponsored: Aviation Applications

Sponsored Session

Chair: Lavanya Marla, University of Illinois, 216E Transportation Building, 104 S. Mathews Ave., Urbana, IL, 61801, United States, lavanyam@illinois.edu

Entrants for the Best Student Paper Presentation competition will be presenting their papers.

■ SC63

Cumberland 5- Omni

Network Design and Maintenance in Transportation

Sponsored: TSL, Intelligent Transportation Systems (ITS)

Sponsored Session

Chair: David Rey, UNSW Australia, School of Civil and Environmental Engineering, UNSW, 2072, Australia, d.rey@unsw.edu.au

1 - Scheduling Work Zones In Networks Of Service Vehicles

Dening Peng, Arizona State University, 699 South Mill Avenue, Tempe, AZ, 85281, United States, dening.peng@asu.edu, Pitu B Mirchandani

A mixed integer linear programming model is developed to schedule work zones in transportation networks of service vehicles (e.g. trucks). For links with active work zones, the available capacity of that link is reduced. The origin-destination flow demands are given, and they route through the network based on available capacities on the links to achieve the total minimum cost. The goal is to schedule the work zones so that all maintenance work can be completed before a given completion date while the total flow cost over the project period is minimized. An innovative randomized fix-and-optimize heuristic is developed to solve the problem with much better efficiency than commercial solvers like CPLEX.

3 - Optimal Deployment Of Autonomous Vehicle Lanes With Endogenous Market Penetration

Zhibin Chen, University of Florida, 1, Gainesville, FL, 32603, Lihui Zhang, Yafeng Yin, Fang He

This paper first models the evolution of autonomous vehicle (AV) market penetration on a multimodal transportation network that includes conventional vehicles (CVs) and AVs. A time-dependent mathematical approach is then proposed to optimize the deployment plan of AV lanes such that the social cost is minimized. The AV lanes are exclusive lanes for AVs, and the deployment plan will dictate when and where, and how many AV lanes to be deployed.

4 - Road Extension Prioritization And Scheduling Problem

Mersedeh Tariverdi, University of Maryland, College Park, Washington, DC, 20009, United States, mercedeh@umd.edu, David Rey, Saeed Asadi Bagloee

Budget scarcity as well as limited resources in road construction may have a significant toll on the completion of the projects. Therefore it is of highest importance to arrive at a knowledge based decision support system for projects prioritization and scheduling. We represent this problem as a bi-level program where the objective function maximizes the return of projects' completion defined as the total savings derived from traffic improvement. The interconnections among the projects as well as prerequisites requirements are imposed using mixed integer constraints. An efficient solution algorithm is developed based on an outer approximation approach.

5 - A Branch And Price Algorithm For The Work-zone Scheduling Problem

David Rey, University of New South Wales, School of Civil and Environmental Engineering, Sydney, Australia, d.rey@unsw.edu.au, Hillel Bar-Gera, Vinayak Dixit, S. Travis Waller

We address the work-zone scheduling problem which consists in finding the optimal schedule for the coordination of road occupancy projects in a transport network over a planning period. Road works and maintenance operations which require partial or total road closures over a period of time may considerably impact network performance and result in significant delays. In addition, the effects of conducting multiple work-zone projects simultaneously may be non-additive, hence increasing the difficulty to anticipate congestion effects. We present a new branch and price algorithm for the work-zone scheduling problem which relies on the enumeration of work-zone project combinations.

■ SC64

Cumberland 6- Omni

DAAD Special Session on Multiobjective Optimization for Improved Modeling of Complex Systems

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Stefan Ruzika, University of Koblenz-Landau, Universitätsstraße 1, Koblenz, 56070, Germany, ruzika@uni-koblenz.de

1 - Efficient Computation Of The Search Region In Multi-objective Optimization

Kerstin Daechert, Chair of Management Science and Energy Economics, University of Duisburg-Essen, Germany, kerstin.daechert@uni-due.de

Multi-objective optimization methods often proceed by producing new solutions in an iterative way. For this purpose it is important to determine and update the search region. It can be described by a set of so-called local upper bounds whose components are defined by already known nondominated points. In this talk we concentrate on how to design this update efficiently with the help of a specific neighborhood structure among local upper bounds. Thanks to this structure we can quickly identify all local upper bounds that have to be updated with respect to a new nondominated point. Besides, the neighborhood structure provides new theoretical insight into the search region for more than two objectives.

2 - A General Approximation Method For Bicriteria Minimization Problems

Stefan Ruzika, Department of Mathematics/Natural Sciences University of Koblenz-Landau Universitätsstraße 1 56070 Koblenz (Germany), ruzika@uni-koblenz.de

We present a general technique for approximating bicriteria minimization problems with positive-valued, polynomially computable objective functions. Given 0 < ≤ 1 and a polynomial-time -approximation algorithm for the corresponding weighted sum problem, we show how to obtain a bicriteria (· (1 + 2), · (1 + 2/))-approximation algorithm for the budget-constrained problem whose running time is polynomial in the encoding length of the input and linear in 1/ . Moreover, we show that our method can be extended to compute an (· (1 + 2), · (1 + 2/))-approximate Pareto curve under the same assumptions.

3 - Bicriteria Analysis Of The Fixed-charge Network Flow Problem - Separating Fixed Costs And Flow Costs

Michael Stiglmayr, University of Wuppertal, Wuppertal, Germany, stiglmayr@math.uni-wuppertal.de

The fixed-charge network flow problem is an inherently biobjective optimization problem: Minimize fixed (design) costs and minimize flow costs. In its classical form the sum of these two objectives is minimized which corresponds to the weighted-sum scalarization of the associated biobjective problem.
However, design costs and flow costs are not directly comparable, since design costs occur once, while flow costs are due periodically. In this talk we present heuristic and exact solution approaches based on the two-phase method and ranking algorithms.

4 - Multi-objective Optimization Of Coupled Systems

George Fadel, Mechanical Engineering Department Fluor Daniel Engineering Building Clemson University, Clemson SC 29634 USA, fgeorge@clemson.edu

An engineering problem consists of two multi-objective problems that must be coordinated. The top level focuses on the optimal placement of components under the hood of a car, with design variables which specify the location of the various non-convex components in a non-convex volume, and non-overlap constraints. Then, the optimization of shape and size of a battery pack that is one of the components placed under the hood is conducted. We show how the two problems can be assigned to separate teams, and their optimizations can be coordinated, enabling the chief designer to allow the sub-problem or the upper level design team to be driving the solution.

■ SC65

Mockingbird 1- Omni

Machine Learning, Big Data and Economics

Sponsored: Information Systems

Sponsored Session

Chair: Beibei Li, Carnegie Mellon University, Heinz College, Pittsburgh, PA, 15213, United States, beibeili@andrew.cmu.edu

1 - Modeling User Engagement In Mobile Content Consumption With Tapstream Data

Yingjie Zhang, Carnegie Mellon University, yingjie2@andrew.cmu.edu

Low engagement rate and high attrition rate have been major challenges for the success of mobile apps. To date, little is known towards how companies can improve user engagement and business revenues through designing effective in-app pricing strategies. We propose a structural model by accounting for time-varying nature of engagement and consumer forward-looking behavior. We analyze mobile tapstream data from a popular mobile reading app. Our results enable us to tailor optimal pricing strategy to each consumer based on their engagement status. Interestingly, we found such engagement-specific pricing strategy leads to lower average price for consumers and higher overall business revenues.

2 - Examine Large Scale App Usage Structure By Graphical Model

Jinyang zheng, University of Washington, Seattle, zhengjy@uw.edu

Identifying an app which generates usage to other app(s) is not only a crucial task for industrial practitioner, but also challenging for researchers given the larger scale of App network. With a state of art graphical model method, we overcome the limitation of traditional econometric causal inference models and examine the causal relationship in emerging App market among Chinese users. Our model generates a causal diagram displaying usages of what app would that of each specific app leads to. Spillover effects of certain app and sequential causal effects can be easily identified, suggesting significant role of graphical model in business analytics and big data related research.

3 - Airbnb And Hotel Latent Quality

Uttara Ananthakrishnan, Carnegie Mellon University, uttara@cmu.edu

Sharing economy has empowered consumers to communicate their needs with one another and thus has helped them to assume the role of both suppliers and producers seamlessly. In this paper, using a natural experiment set up and a novel dataset, we analyze how Airbnb has impacted the traditional way of conducting the hotel business. We study if the hotels have responded to the increasing number of Airbnbs by increasing their quality and whether this response varies across different types of hotels. We analyze the hotel industry's response across different dimensions in quality by not only considering star ratings, but also user sentiments and latent quality expressed in textual content of reviews.

4 - How Much Is An Image Worth? An Empirical Analysis Of Property's Image Aesthetic Quality On Demand At Airbnb

Shunyuan Zhang, Carnegie Mellon University, Pittsburgh, PA, United States, shunyuaz@andrew.cmu.edu
Dokyun Lee, Param Vir Singh, Kannan Srinivasan

Sharing economy platforms such as Airbnb are challenged with product quality uncertainty. To solve the issues, Airbnb has implemented strategies such as professionally taking high quality photos for hosts and calling them verified. This paper studies the impact of having verified photos. To assess the aesthetic quality of images, we use machine learning techniques. Employing Difference-in-Difference method we find rooms with verified photos are on average 9% more frequently booked. We separate the effect of photo verification from photo quality and find an extra $2,455 in yearly earnings brought by high photo quality. We find asymmetric spillover effects across rooms in the same neighborhood.

■ SC66

Mockingbird 2- Omni

Additive Manufacturing

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Prahalad Krishna Rao, Assistant Professor, Binghamton University, P.O. Box 6000, Binghamton, NY, 13902-6000, United States, prao@binghamton.edu

1 - Accelerated Process Optimization For Laser-based Additive Manufacturing By Leveraging Similar Prior Studies

Amir M Aboutaleb, Mississippi State University, Industrial & Systems Engineering Department, Mississippi State University, MS, 39762, United States, aa1869@msstate.edu, Linkan Bian

Manufacturing parts with target properties and quality in Laser-Based Additive Manufactured (LBAM) parts is crucial towards enhancing the "trustworthiness" of this emerging technology. We propose a novel process optimization method by directly utilizing experimental data from previous studies as the initial experimental data to guide the sequential optimization experiments of the current study. We conduct a real-world case study that optimizes the relative density of parts manufactured using a Selective Laser Melting system. A combination of optimal process parameters is achieved within 5 experiments.

2 - Online Detection For Cyber Attacked Additive Manufactured Parts By Real-time Sensing And Analysis

Chenang Liu, Virginia Tech, Blacksburg, VA, 24061, United States, lchenang@vt.edu, Tomilayo Komolafe, Zhenyu Kong, Jaime Camelio

Cyber security of additive manufacturing (AM) is important for some critical applications such as defense industry. This work focuses on the online detection of attacked AM parts by real-time sensing using network analysis based data fusion techniques. Using the effective features extracted from multiple sensor data, the discrepancy between normal and attacked AM parts can be detected effectively. The case study show that the proposed method can successfully detect the attacked parts, but does not cause false alarm for the sample normal part.

3 - Laplacian Eigen Compressive Sensing For Dimensional Integrity Classification In Additive Manufacturing

Prahalad Rao, Binghamton University, prahalad.k.rao@gmail.com

This work relates the effect of parameters, namely, infill and extrusion temperature in fused filament fabrication (FFF) additive manufacturing (AM) process on pre-selected geometric dimensioning and tolerancing (GD&T) features. Next, a method is proposed to classify the part quality in terms of the geometric integrity using minimal number of laser-scanned point cloud data. The proposed method combines spectral graph theory with compressive sensing, as a means of supervised classification of part geometric integrity.

■ SC67

Mockingbird 3- Omni

Decision Analysis Approaches and Predictive Modeling to Managing Uncertainty in Manufacturing and Service Systems Design & Operations

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Zhenyu Kong, Virginia Tech, 1145 Perry Street, Blacksburg, VA, 24060, United States, zkong@vt.edu

1 - Self-organizing Network For Variable Clustering And Predictive Modeling

Hui Yang, Penn State University, huy25@engr.psu.edu

Rapid advancement of sensing and information technology brings the big data, which presents a gold mine of the 21st century to advance knowledge discovery. However, big data also brings significant challenges for data-driven decision making. In particular, it is common that a large number of variables (or predictors, features) underlie the big data. Complex interdependence structures among variables challenge the traditional framework of predictive modeling. This paper presents a new methodology of self-organizing network for variable clustering and predictive modeling.

2 - Forecasting Of Weather-driven Damage In A Distribution System Of Electric Power

Zhiguo Li, IBM, hardthinking@gmail.com

Electric utilities spend a large amount of resources and budget on managing unplanned outages, the majority of which are driven by weather. A major ongoing effort is to improve their emergency preparedness process, in order to reduce outage time, reduce repair costs, and improve customer satisfaction. This paper proposes a method for forecasting the number of damages of different types that will result from a weather event in a power distribution system. The proposed method overcomes practical issues with sparsity of historical damage and weather records, and its performance is evaluated on real utility data. This work is the core of an approach called Outage Prediction and Response Optimization.

3 - Prognostics Of Surgical Site Infections Using Dynamic Health Data

Yan Jin, University of Washington - Seattle, yanjin@uw.edu, Shuai Huang

Surgical Site Infection (SSI) is a national priority in healthcare research. To achieve better SSI risk prediction models, there have been emerging mobile health (mHealth) apps that can closely monitor the patients and generate continuous measurements of many wound-related variables and other evolving clinical variables. Since existing predictive models of SSI have quite limited capacity to utilize the evolving clinical data, we develop the corresponding solution to improve these mHealth tools with decision-making capabilities for SSI prediction. We derive efficient algorithms and demonstrate the advantage of our new predictive model on a real-world dataset.

4 - Spatiotemporal Model With Dirichlet Process Mixing For Nonnormal And Nonstationary Data

Jia Liu, Virginia Tech, jliu@vt.edu

In real-life, sensor data often violate assumptions of normality and stationarity required by many prevalent statistical methods. In order to acquire accurate prediction and interpolation by sensor data, a nonparametric spatiotemporal model is proposed, which takes non-normality and non-stationarity of data into account. In this model, spatial correlation is captured by Dirichlet process mixture model using particle filter. Moreover, temporal correlation is incorporated into this model by using recurrent Dirichlet process. This model can be used in various fields with data exhibiting non-normality and non-stationarity to achieve accurate interpolation and prediction.

■ SC68

Mockingbird 4- Omni

Panel Discussion: Funding Opportunities

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Moderator: Abhishek K Shrivastava, Florida State University, Tallahassee, FL, United States, ashrivastava@fsu.edu

Co-Chair: Hui Wang, FSU, TBD, TBD, FL, 00000, United States, hwang10@fsu.edu

1 - Panel Discussion On Funding Opportunities

Abhishek Shrivastava, Florida State University, FAMU-FSU College of Engineering, Tallahassee, FL, 32310, United States, ashrivastava@fsu.edu

In this panel, program officers from NSF will discuss funding opportunities in their programs. The panelists are Dr. Joanne Culbertson, Dr. David Mendonca, Dr. Jon Leland and Dr. Alexandra Medina-Borja

2 - Panelist

Alexandra Medina-Borja, US National Science Foundation, 2507 Fowler St, Falls Church, VA, 22046, United States, alexandra.medinaborja@upr.edu

3 - Panelist

David Mendonca, NSF, Arlington, VA, 22230, United States, mendonca@nsf.gov

4 - Panelist

Joanne Culbertson, National Science Foundation, 4201 Wilson Boulevard, Arlington, VA, 22230, United States, jculbert@nsf.gov

■ SC70

Acoustic- Omni

Transportation, Freight III

Contributed Session

Chair: Carlos Alberto Gonzalez-Calderon, Rensselaer Polytechnic Institute, 4 25th St, Apt 5, Troy, NY, 12180, United States, gonzac8@rpi.edu

1 - A Multi-commodity Intermodal Traffic Assignment Between Rail And Truck

Lokesh Kumar Kalahasthi, Rensselaer Polytechnic Institute, 22 College Ave, Troy, NY, 12180, United States, kalahl@rpi.edu Trilce Marie Encarnacion, Jose Holguin-Veras, John E Mitchell

The goal of the paper is to obtain an optimization model that gives a freight traffic assignment on a combined network of road and rail; that could be used to assess the freight modal split including vehicle types and intermodal transfers. Authors of this paper have conducted In-Depth-Interviews (IDI) with shippers, carriers and receivers regarding the factors influencing their mode choice. The challenge is to incorporate the findings from these IDIs into a mathematical model. Major findings include commodity type, backhaul, shipment limit, transfer time, reliability in transit time restrictions. The model also incorporates the variation in the rail pricing based on origin and destination.

2 - Reliable Routing Of Multicommodity Road-rail Intermodal Freight Under Uncertainty

M. Majbah Uddin, University of South Carolina, 300 Main Street, Civil and Environmental Engineering, Columbia, SC, 29208, United States, muddin@cec.sc.edu, Nathan Huynh

A reliable routing model for multicommodity shipments on a road-rail intermodal freight transport network, where network elements are subject to uncertainty, is proposed. A stochastic mixed integer program is formulated which minimizes not only operational costs but also penalty cost associated with unsatisfied demand. This study provides a novel distribution-free approach to ensure probabilistic guarantees on the resulting routing plan. Case study on a small network reveals the key characteristics of the proposed model.

3 - Shipment Consolidation And Dispatching With Cross-docks

Sinem Tokcaer, Izmir University of Economics, Fevzi Cakmak Mh, Sakarya Cd No:156, Izmir, 35330, Turkey, sinem.tokcaer@ieu.edu.tr, Ahmet Camci, Ozgur Ozpeynirci

Freight forwarders dealing with long haul transportation establish their own consolidation systems in order to reduce costs by economies of scale and efficient use of owned or rented vehicles. Such consolidation systems usually include cross-docking terminals to provide additional services and reduce the travelling time of the vehicles. We propose a shipment consolidation and dispatching problem with cross-docks, and develop a mathematical programming model. The model suggests the consolidation and transportation plans. We propose lower and upper bounds, develop a Variable Neighborhood Search algorithm, and test the performances of develop methods on randomly generated instances.

4 - Freight Trip Generation (FTG), Freight Generation FG) And Service Trip Attraction (STA) In New York City (NYC) And Capital Region

Carlos Alberto Gonzalez-Calderon, Rensselaer Polytechnic Institute, 4 25th St, Apt. 5, Troy, NY, 12180, United States, gonzac8@rpi.edu, Jose Holguin-Veras, Shama Campbell, Lokesh Kumar Kalahasthi

This paper presents a thorough analyses and econometric models explaining the Freight Trip Generation (FTG), Freight Generation (FG) and the Service Trips Attraction (STA) in the New York City and Capital Region. The team conducted a detailed survey including the number of deliveries (received), shipments (sent), type of cargo, weight of shipment, industry sector, truck type, who transports the cargo (vendor or receiver). This study serves as a tool for transportation planners in understanding the freight patterns in urban areas.

■ SC71

Electric- Omni

Transportation, Public III

Contributed Session

Chair: Mehdi Zamanipour, University of Arizona, 7415 Seneca Ridge Dr, McLean, VA, 22102, United States, zamanipour@email.arizona.edu

1 - Developing an Integrated Approach To Optimize Vehicle And Driver Scheduling Problem With Equilibrium Constraint

Bisheng He, Southwest Jiaotong University, 111#, 1st Section, Northern 2nd Ring Road, Chengdu, 610031, China, bishenghe@home.swjtu.edu.cn, Xiaobo Liu, Gongyuan Lu, Wei Xiao

We optimized vehicle and driver scheduling problem considering equilibrium constraint to maintain their equal workload. An integer programming model was established and solved by integrating a heuristic algorism and a commercial solver. Comparison results indicated that this method could effectively improve the scheduling efficiency and equilibrium based on a real world case from Ji'nan Transit Company.

2 - How Tight Capacity Constraints Invoke Bounded Rationality And How To Consider Bounded Rationality In Designing Dynamic Capacitated Transit Service Network

Jiangtao Liu, Arizona State University, 2026 S Hammond Drive, Apt 205, Tempe, AZ, 85282, United States, jliu215@asu.edu, Xuesong Zhou

This talk will discuss how tight capacity constraints invoke bounded rationality and how to address bounded rational decision rules of travelers in a dynamic transit service network with tight capacity constraints. Within a space-time network, we propose an agent-based single-level integer linear programming model, which can be further decomposed as two efficiently solvable subproblems through Lagrangian decomposition.

3 - Study on The Taxi Fleet Of Electric Vehicles With Battery Swapping

Lei Li, Zhejiang University, 866 Yuhangtang Rd, West Lake District, Hangzhou, 310058, China, lilei.simon@gmail.com, Qingwei Jin

In this paper, we consider that a company is using electric vehicles with battery swapping to satisfy the urban taxi traveling demand. We construct a choice model based on the utility of the taxi drivers which reflects the adoption model of electric taxi vehicles. Based on the adoption model, the company is trying to maximize its profit based on the optimal decisions of battery capacity and service price. We set up a revenue model to find these optimal decisions and consider the impacts of technology advancements. We also extend this model to a mixed case in which the swapping stations serves both taxis and private vehicles.

4 - Pricing Analysis And Optimization Of Mobility On Demand Service

Hao Zhou, Research Scientist, Ford Motor Company, 2101 Village Road, Dearborn, MI, 48124, United States, haozhou@umich.edu

Mobility On Demand (MoD) is a new transportation system that allows users to make on demand ride request using devices such as smartphone or tablet. The MoD back-end service tries to dynamically schedule these requested rides to maximize ride-sharing while minimizing waiting time. This research tries to analyze 1) under what conditions such MoD system can be functioning efficiently, and 2) what would be the right pricing scheme for this kind of MoD system.

5 - An Integrated Priority Optimization And Intelligent Traffic Signal Control Model

Mehdi Zamanipour, University of Arizona, 7415 Seneca Ridge Dr, McLean, VA, 22102, United States, zamanipour@email.arizona.edu, Govind Vadakpat

In this research, an integrated priority and adaptive signal control model is developed that can intelligently consider connected vehicles and priority eligible vehicles at both intersection level and section level in a low connected vehicles penetration rate environment. Fundamentals of shockwave theory and queue estimation techniques are used in the mathematical model. Standard traffic control methods including coordinated-actuated operation are taken in to consideration. The study also conducts a sensitivity analysis on the Dedicated Short Range Communication (DSRC) by virtually extending the range.

■ SC72

Bass- Omni

Supply Chain Mgt III

Contributed Session

Chair: Qinshen Tang, National University of Singapore, Business School, I Business Link, Singapore, Singapore, tang@u.nus.edu

1 - An Empirical Analysis Of Supply Chain Finance Adoption

David Wuttke, EBS University, Burgstr. 5, Oestrich-Winkel, 65375, Germany, david.wuttke@ebs.edu, Eve Rosenzweig, H. Sebastian Heese

We empirically test hypotheses derived, in part, from the literature on adoption of Supply Chain Finance (SCF) by buyers and their suppliers. We identify payment terms, payment terms extensions, and annual spend as important drivers of adoption speed. We also examine the ways in which the institutional environment of a supplier influences the speed of SCF adoption. In doing so, we provide a fairly comprehensive set of insights for buyers who seek to implement SCF with their suppliers.

2 - Models For Evaluating And Monitoring Supply Chain Network Design Efficiency

Hakan Yildiz, Assistant Professor, Michigan State University, Department of Supply Chain Management, 370 N Business Complex, East Lansing, MI, 48824, United States, yildiz@broad.msu.edu, Sri Talluri, Jiho Yoon, John M Wassick

In order to evaluate and monitor the real life effectiveness of a new supply chain network design, we employ a statistical control chart that monitors an integrated performance index generated from data envelopment analysis (DEA), which effectively considers multiple performance measures and the relationships between them. In addition, this methodology is used to trigger the re-evaluation of the network design. Moreover the clustering methods used can help management focus on improvement strategies and resource allocations.

3 - Supply Chain Performance With A Target Oriented Retailer

Qinshen Tang, National University of Singapore, Business School, I Business Link, Singapore, Singapore, tang@u.nus.edu, Gongtao Lucy Chen, Melvyn Sim

We study a supply chain with one supplier and one target-oriented retailer, who decides the order quantity to maximize his ability to reach a target profit, which is evaluated by a CVaR satisficing measure. We investigate how the retailer's target-oriented preference affects the supply chain performance. With a linear target formation model, the supplier can significantly benefit from the retailer's target-attaining behavior. The supply chain can also perform better with a target-oriented retailer than with a risk-neutral retailer. More interesting is, the target-oriented retailer can sometimes help the supply chain achieve the same efficiency level as in a centralized system.

■ SC79

Legends G- Omni

Health Care, Modeling III

Contributed Session

Chair: Hamoud Sultan Bin Obaid, PhD student, University of Oklahoma, 1027 E Brooks St., Apt E, Norman, OK, 73071, United States, hsbinobaid@gmail.com

1 - Strategic Nurse Allocation Policies For A Pediatric Intensive Care Unit

Osman Tuncay Aydas, University of Wisconsin-Milwaukee, 3202 N Maryland Avenue, S466, Milwaukee, WI, 53202, United States, otaydas@uwm.edu, Anthony D. Ross, Kaan Kuzu

We study integrated nurse staffing and scheduling in Pediatric Intensive Care Units. Feasible nurse schedules are generated using algorithms for the mixed-integer programming models developed in this work. Main objective is to reduce nurse staffing costs while balancing the under- and over staffing risks. We include a novel methodology for estimating nurse workloads by considering patient acuity and activity in the unit.

2 - Wait Time Announcements At Hospital Emergency Departments

Marco Bijvank, University of Calgary, 2500 University Dr. NW, Calgary, AB, T2N 1N4, Canada, marco.bijvank@haskayne.ucalgary.ca, Zhankun Sun

A number of Canadian hospitals have started publishing live emergency department (ED) wait times online in an effort to provide patients with expectations on how long they will have to wait to be seen for non-urgent care after initial assessment by a triage nurse. We accurately predict the state-dependent wait times at emergency departments based on a busy-period analysis for a multi-class, multi-server priority queue with delayed feedback. We illustrate the robustness and impact of the predictor on patient flow and patient care with a case study at four major hospitals in the Calgary area.

3 - Allocation Of Medical Interventions In Outbreak Control: The Case Of Ebola Virus

Farbod Farhadi, Roger Williams University, 1 Old Ferry Road, Bristol, RI, 02809, United States, ffarhadi@rwu.edu

The outbreak of Ebola in 2014 in western Africa is one of the fastest and deadliest outbreaks in history of viral diseases, causing a reported 28 thousand suspected cases and over 11 thousand deaths, according to WHO, leading to over 70% fatality rate. Further outbreaks of the disease may occur in the future and fast and effective containment strategies to control the spread is vital. In this study a model for efficient allocation of medical interventions for outbreak containment is presented.

5 - Cyclic Physician Scheduling Using Goal Programming

Hamoud Sultan Bin Obaid, PhD Student, University of Oklahoma, 1027 E Brooks St., Apt E, Norman, OK, 73071, United States, hsbinobaid@gmail.com, Theodore B Trafalis

A two-phase approach to construct a three-month schedule for physicians at an outpatient clinic is proposed. The goal of the proposed model is to minimize the variability of clinic and surgery sessions over the three-month period and utilize resources. From mathematical point of view, the goal is to reduce the complexity of solving this problem. The data used in this problem is obtained from King Khaled Eye Specialist Hospital in Saudi Arabia.

■ SC86

Gibson Board Room-Omni

Manufacturing III

Contributed Session

Chair: Zahra Sedighi Maman, Auburn University, Auburn, AL, 36849, United States, zzs0016@auburn.edu

1 - Minimum Cost Allocation Of Quality Improvement Targets: The Effects Of Forgetting And Knowledge Decay

Didun Peng, Purdue University, 610 Purdue Mall, West Lafayette, IN, 47906, United States, peng67@purdue.edu Weijia Wang, Robert Plante, Jen Tang

This paper incorporates knowledge depreciation in two dimensions of learning: forgetting in autonomous learning and induced learning. We first present a comprehensive quality cost progress function to account for both learning and forgetting effects, where the forgetting effects are imbedded in the progress function components of accumulated production and induced learning. Within the context that a manufacturer allocates quality improvement targets to its suppliers, an optimization model is developed to allocate induced learning activities that minimize the total system cost. A numerical examples of an internal supplier process is used to demonstrate the model.

2 - Sustainability and Changeability In Manufacturing System

Shima Ghanei, University of Minnesota -Duluth, 105 Voss Kovach Hall,1305 Ordean Court, Duluth, MN, 55812, United States, ghane009@d.umn.edu, Tarek Al Geddawy

Changeable Manufacturing Systems (CMS) are designed to quickly adapt to changing market requirements by transition from a configuration to the next. Not only is the reconfiguration cost dependent on degree of system convertibility and scalability, but also dependent on what time of the year during which it is performed, since energy pricing changes within and between seasons. This paper presents a new linear mixed integer mathematical model to maximize sustainability of CMS on the tactical level. It is solved by CPLEX solver in GAMS software to analyze influence of volatile energy pricing and variable demand on system convertibility and scalability which can affect layout configuration selection.

3 - Printing The Future: Using Analytics To Advance Additive Manufacturing

Sarah Powers, Oak Ridge National Laboratory, One Bethel Valley Rd., P.O. Box 2008, Oak Ridge, TN, 37831, United States, powersss@ornl.gov

Recent advances in additive manufacturing have led to many success stories of large 3D printed objects and leave the industry poised for rapid growth. This work describes a multi-pronged approach for data discovery, engaging multiple analytic tools as well as a framework to ingest and house the data itself in an effort to identify areas for process improvement and promote the potential for advanced defect detection.

4 - A Short Note On The Effect Of Sample Size On The Estimation Error In Cp

Zahra Sedighi Maman, Auburn University, Auburn, AL, 36849, United States, zzs0016@auburn.edu, William Murphy, Saeed Maghsoodloo, Fatemeh HajiAhmadi, Fadel Megahed

Process Capability indices such as Cp are used extensively in manufacturing industries. In practice the parameter for calculating Cp is rarely known and is frequently replaced with estimates from an in-control reference sample. This study explores the optimal sample size required, with some practical tools to achieve a desired error of estimation using absolute percentage error of different Cp estimates.

Sunday, 3:10PM - 4:00PM

■ Keynote

Davidson Ballroom A-MCC

Optimizing the Kiel Canal – Online Routing of Bidirectional Traffic

Keynote Session

Michael Trick, IFORS President, Carnegie Mellon University, Pittsburgh, PA 15213-3890, trick@cmu.edu

1 - Optimizing The Kiel Canal – Online Routing Of Bidirectional Traffic

Rolf H Mohring, Beijing Institute of Scientific and Engineering Computing, Beijing, China, rolf.moehring@me.com

We introduce, discuss, and solve a hard practical optimization problem that deals with routing bidirectional traffic on the Kiel Canal, which is the world's busiest artificial waterway with more passages than the Panama and Suez Canal together. The problem arises from scarce resources (sidings) that are the only locations where large ships can pass each other in opposing directions. This requires decisions on who should wait for whom (scheduling), in which siding to wait (packing) and when and how far to steer a ship between sidings (routing), and all this for online arriving ships at both sides of the canal. The lecture is based on joint work with Elisabeth Lübbecke and Marco Lübbecke.

■ Keynote

Davidson Ballroom B-MCC

Creating the Exascale Ecosystem for Science

Invited: Plenary, Keynote

Invited Session

Bogdan Bichescu, The University of Tennessee, Knoxville, TN 37996-0525, bbichescu@utk.edu

1 - Creating The Exascale Ecosystem For Science

Jeff Nichols, Oakridge National Laboratory, Oak Ridge, TN, United States, malonelt@ornl.gov

The way we tackle grand challenge science questions at the national scale has changed over the past two decades with the advent of both modeling and simulation (M&S) and "big data" becoming more recognized and supported discovery paradigms. In fact, most large scientific problems today are solved as integrated solutions of experiment, theory, M&S, and data analytics. The past several decades of high performance computing have focused on delivering compute intensive systems and their performance measured by how fast they can accomplish a simple matrix multiply (e.g., high performance linpack). Today's complex workflows require not only compute intensive capabilities, but also capabilities that target data analytics approaches such as deep learning, graph analytics, or map reduce. In this talk I will describe several scientific areas that require an integrated approach and discuss the ecosystem [ORNL's Leadership Computing Facility (OLCF) and its Compute and Data Environment for Science (CADES)] that we have created. We continue to invest in the evolution of this ecosystem to enable successful delivery of important scientific solutions across a broad range of disciplines.

■ Keynote

Davidson Ballroom C-MCC

Analytic + IT + Deployment = Real World Impact

Keynote Session

Robin Lougee, IBM TJ Watson Research Center, Yorktown Heights, NY 10598, rlougee@us.ibm.com

1 - Analytic + IT + Deployment = Real World Impact

Ramayya Krishnan, Carnegie Mellon University, Pittsburgh, PA, United States, rk2x@cmu.edu

The Heinz College is home to two highly ranked graduate schools: 1) Information Systems and Management and 2) Public Policy and Management, a deliberate structure which exists only at Carnegie Mellon University (CMU). Founded by noted Management Scientist W. W. Cooper to educate "men and women capable of intelligent action", the unique structure of the college gives its educational programs a holistic focus on societal problem solving. This focus translates into teaching cutting-edge information technologies and analytic methods and providing students with multiple opportunities to apply them to solve real world problems that matter. This focus also means an emphasis on structuring unstructured problems and an education in the skills required to be effective at that structuring and at decision making, and engendering change through deployment. In this keynote, I will provide an overview of our award winning analytics program and describe how we combine industry-funded research centers and their partner ecosystems to provide students with multiple opportunities to learn an array of analytic skills and problem-solving expertise in order to be effective in the real world.

■ SC94

5th Avenue Lobby-MCC

Wiley/Provalis Research

Technology Tutorial: Wiley/Provalis

1 - Provalis Research will Showcase its Integrated Collection of Text Analytics Software

Normand Peladeau, Provalis Research, Montreal, QC, Canada. peladeau@provalisresearch.com

Abstract Available Online.

2 - Wiley: Interested in Publishing for the Wiley Series in Operations Research and Management Science?

James Cochran, University of Alabama, Tuscaloosa, AL, jcochran@cba.ua.edu

The Wiley Series in Operations Research and Management Science is a broad collection of books that meet the varied needs of researchers, practitioners, policy makers, and students who use or need to improve their use of analytics. The workshop will include presentations on the following: • The Mission of the Series for the Betterment of the Community • The Proposal Process: Maximizing your Success • What's Next: The Writing, Review, and Publishing Process • Q&A In addition to the presentation, you will be able to meet with Founding Series Editor James J. Cochran and Wiley Editor Susanne Steitz-Filler to discuss any further questions or potential book ideas you may have.

Sunday, 4:30PM - 6:00PM

■ SD01

101A-MCC

Interpretable Machine Learning in Social Science

Sponsored: Data Mining

Sponsored Session

Chair: Tong Wang, MIT, Cambridge, MA, United States, tongwang@mit.edu

1 - Interpretable Decision Sets: A Joint Framework For Description And Prediction

Himabindu Lakkaraju, Stanford University, himalv@cs.stanford.edu

One of the most important obstacles to deploying predictive models is the fact that humans do not understand and trust them. In this talk, I will present interpretable decision sets, a framework for building predictive models that are highly accurate, yet also highly interpretable. We formalize decision set learning via an objective function that simultaneously optimizes for accuracy, conciseness, and meaningfulness of the rules. We prove that our objective is a non-monotone submodular function, and efficiently optimize it with a 2/5 approximation guarantee. Our experiments demonstrate that interpretable decision sets help humans understand their data better than other interpretable models.

2 - Exploring Complex Systems Using Semi-parametric Graphical Models

Mladen Kolar, University of Chicago, mkolar@chicagobooth.edu

Extracting knowledge and providing insights into the complex mechanisms underlying noisy high-dimensional data sets is of utmost importance in many scientific domains. Networks are an example of simple, yet powerful tools for capturing relationships among entities over time. For example, in social media, networks represent connections between different individuals and the type of interaction that two individuals have. Unfortunately the relationships between entities are not always observable and need to be inferred from nodal measurements. I will present a line of work that deals with the estimation and inference in high-dimensional semi-parametric elliptical copula models.

3 - Causal Rule Set For Subgroup Identification

Tong Wang, University of Iowa, tongwang@mit.edu

We propose an interpretable classifier for causal analysis, Causal Rule Set (CRS), that discriminates between two types of subgroups, one that benefits from the treatment (Effective Class), and one does not (Ineffective class). CRS uses a set of interpretable rules to present and characterize an Effective class. We present a Bayesian framework with priors that favor simple models, and a Bayesian logistic regression that models the relation between outcomes and a set of observed (attributes) and inferred objects (subgroup membership). The simulation studies and experiments on real data sets show that distributing treatment according to a CRS model enhances the average treatment effect.

■ SD02

101B-MCC

Data Analytics and Modeling for Medical Prognosis and Decision Making

Sponsored: Data Mining

Sponsored Session

Chair: Shouyi Wang, University of Texas-Arlington, Arlington, TX, United States, shouyiw@uta.edu

1 - Disgnosis Of Posttraumatic Stress Disorder Using Functional Near Infrared Spectroscopy (fNIRS) signals And Data Mining Techniques

Rahil Hosseini, University of Texas at Arlington, rahilsadat.hosseini@mavs.uta.edu

In this paper we extract various feature groups from FNIRS records that are from the experiment about digits memorizing and recalling; it includes three phases in each trial; encode, maintain and recall; we show the discovered patterns between two classes for some selected features. Specifically the results show that the last phase which is when the subject tries to recall the digits, is the most significant part and with extracted features from Statistics, Autocorrelation and SVDNorm; it is enough for highly accurate classification.We discuss a new proposed feature derived from SVD (Singular Value Decomposition) of raw data in channels. It demonstrated promising results in classification. Third contribution is comparison of feature selection methods to reduce the dimension of the feature matrix. We compare the performance through number of selection and sensitivity and specificity and their average. The proposed method includes Mutual Information (MI) guided sparse models that outperform the existing features selection techniques. The existing models are ''minimum Redundancy and Maximum Relevancy" (mRMR), and ''Sparse Group Lasso" (SGL). We propose ''Mutual Information and Least Absolute Selection and Shrinkage Operator" (MILASSO) ''Mutual Information Sparse Group Lasso" (MISGL). All these techniques are applied to classify PTSD veterans and healthy controls using ''Support Vector Machines" (SVM). Last contribution is finding the Region of Interest (ROI), we conclude that two specific areas on brain are the most significant ones which are directly related to memorizing

2 - Pattern Classication And Analysis Of Memory Processing In Depression Using Eeg Signals

Kin Ming Puk, University of Texas at Arlington, bookbook0089@gmail.com

An automatic, EEG-based approach of diagnosing depression with regard to its effect on memory is presented. EEG signals are extracted from 15 depressed subjects and 12 normal subjects during experimental tasks of reorder and rehearsal. After pre-processing noisy EEG signals, seven groups of mathematical features are extracted and classification with SVM is conducted under a five-fold cross-validation, with accuracy of up to 70% - 100%. The contribution of this paper lies in illustrating the usefulness of the classification framework in facilitating the analysis and visualization of the difference of EEG signals between depressed and control subjects in memory processing.

3 - Discriminating Parkinson's Disease (pd) Using Functional Connectivity And Brain Network Analysis

Shouyi Wang, University of Texas at Arlington, shouyiw@uta.edu

In this study, we explored the use of functional connectivity patterns in fMRI data to classify subjects on the basis of Parkinson's disease. We explore various brain networks and features. We partition our fMRI data in 5 filtered frequency ranges. We use a proximal support vector machine paired with a minimum-redundancy and maximum-relevance feature selection method on each frequency range. We use a majority voting ensemble classification method on the results of the proximal support vector machine classification results. Our results indicate that the ensemble method is effective compared to a single broad frequency range, and that Bonferroni correction may enhance classification results.

■ SD03

101C-MCC

Doing Good with Good OR II

Invited: Doing Good with Good OR

Invited Session

Chair: Chase Rainwater, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States, cer@uark.edu

1- Optimizing Breast Cancer Diagnostic Decisions to Reduce Overdiagnosis

Sait Tunc, Department of Industrial and Systems Engineering, University of Wisconsin-Madison, Madison, WI 53706, stunc@wisc.edu, Oguzhan Alagoz, Elizabeth S. Burnside

Although the early diagnosis of breast cancer through screening mammography saves thousands of lives every year, overdiagnosis of breast cancer may cause harm without benefit. We propose a comprehensive large-scale optimization model to address overdiagnosis by making better-informed diagnostic decisions and provide the exact optimal policies that potentially save up to 9% of the biopsied population from overdiagnosis..

2 - A Decision Support System for the Management of Aid-In-Kind Donations for Turkish Red Crescent

Semih Boz, Department of Industrial Engineering, Bilkent University, Ankara, Turkey, Semih Kaldirim, Bilge Kaycioglu, Buse Eylul Oruc, Eren Ozbay, Mirel Yavuz, Sinan Derindere, Ali Erkan, Pinar Ozkurt

Turkish Red Crescent is the main body for collection and distribution of donations in Turkey, and this project aims to improve their donation collection and distribution processes by proposing a decision support system with numerous subsystems; e.g. implementing new process flows and their accompanying decisions. The proposed system is approved by TRC and it is being integrated to their systems.

■ SD04

101D-MCC

Optimizing Urban Infrastructure Resilience Under Climate Change

Sponsored: Energy, Natural Res & the Environment I Environment & Sustainability

Sponsored Session

Chair: Mohammad Ramshani, University of Tennessee, 524 John D. Tickle Building, Knoxville, TN, 37996, United States, mramshan@vols.utk.edu

1 - Optimizing Green Roof Integrated Photovoltaics Placement Under Climate Change

Mohammad Ramshani, University of Tennessee, mramshan@vols.utk.edu, Xueping Li, Anahita Khojandi, Olufemi A Omitaomu

We develop a two-stage stochastic model to optimally place green roofs and/or Photovoltaic panels under climate change uncertainty, with the aim of improving urban system resilience. Different climate forecasts from different climate models are taken into account as different scenarios. The interaction between green roofs and Photovoltaic panels in terms of efficiency is considered. An efficient L-shaped algorithm is developed. Computational studies along with sensitivity analysis are conducted.

2 - Optimal Planning Of Green Infrastructure Placement Under Precipitation Uncertainty

Masoud Barah, University of Tennessee, mbarah@vols.utk.edu, Anahita Khojandi, Xueping Li, Jon Hathaway

Green Infrastructures (GIs) are low cost, low regret strategies that can dramatically contribute to stormwater management. We develop a multi-objective stochastic programming model to determine the optimal placement of GIs across a set of candidate locations in a watershed to minimize the excess runoff under short-term and medium-term precipitation uncertainties. We calibrate the model using precipitation projections and stormwater system's hydrologic responses to them. We obtain the optimal GI placement for a watershed and perform sensitivity and robustness analyses to provide insights.

3 - Optimal Placement Of Green Infrastructure Under Uncertainty

Anahita Khojandi, University of Tennessee, 603 W Main St., Apt 801, Knoxville, TN, 37902, United States, anahitakhojandi@gmail.com, Mohit Shukla, Xueping Li, Mohammad Ramshani

Despite the environmental and societal benefits of Green Infrastructure (GI), they are mostly planned and established in response to an existing problem rather than being actively incorporated into the early stages of urban planning. In this paper, we present a stochastic model that would allow urban planners to incorporate uncertainties in population and climate predictions, land use and budgetary constraints and the 'connectivity' between GIs into the decision making process of GI placement on a county or city scale land area. The proposed approach is tested on data from a real county to evaluate its utility.

■ SD05

101E-MCC

ENRE Award Session

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Andy Sun, Georgia Institute of Technology, Atlanta, GA, 30332, United States, andy.sun@isye.gatech.edu

■ SD06

102A-MCC

INFORMS 2016 Data Mining Best Student Paper Awards II

Sponsored: Data Mining

Sponsored Session

Chair: Mustafa Gokce Baydogan, Bogazici University, Istanbul, Turkey, baydoganmustafa@gmail.com

■ SD07

102B-MCC

Joint Session DM/AI: Predictive Analytics in Data Science

Sponsored: Data Mining

Sponsored Session

Chair: Xi Wang, University of Iowa, S210 John Pappajohn Business Building, Iowa City, IA, 52242-1000, xi-wang-1@uiowa.edu

1 - Link Prediction In Multi-relational Networks For Online Health Communities

Xi Wang, The University of Iowa, xi-wang-1@uiowa.edu Kang Zhao

Online Health Communities (OHCs) are a popular resource for those with health problems to exchange information and support. Users often interact via multiple communication channels, such as online discussions, blogs, and private messages. Connections among users via different channels form a multi-relational social network. Using data from a smoking cessation network, this study aims to predict links between users in one sub-network based on information from other sub-networks. Our findings regarding tie formation will inform the development and ongoing management of online health communities.

2 - Purchase Prediction Based On Multilevel Association Rule Mining

Xinxue Qu, College of Business, Iowa State University, Ames, IA, 50010, United States, quxinxue@iastate.edu, Zhengrui Jiang

Recommender systems are one of the most widely deployed applications in E-commerce. The goal of this study is to improve existing association-rule-based methods to increase the quality of product recommendations. There are two important factors in our method. First, due to the huge number of products in stores, market basket data is often sparse. Second, competing products are often highly substitutable, and consumers may be open to alternatives. The method we propose infers the level of similarity/substitutability between pairs of products from product category information. Experimental results show multilevel association rules can lead to a higher accuracy of purchase predictions.

3 - Risk Information Disclosure And Project Success Rate

Yang Pan, University of Maryland, ypan@rhsmith.umd.edu

Since information asymmetry between funders and creators is a critical issue in crowdfunding platform, many policies are introduced to improve the information transparency and make markets more efficient. One of the mechanisms is mandatory disclosure imposed by platform. We aim to understand how disclosed risk information has an effect on project outcomes. We study this question on a popular crowdfunding site requiring project creators disclose potential risk information about projects. We analyze the detail content of the disclosed risk information with text mining techniques and test the association between self-disclosed risk information and successful rate of crownfunding projects.

■ SD10

103C-MCC

INFORMS Prize

Invited: INFORMS Prize

Invited Session

Chair: Julia Morrison, Marriott International, Department 51/974.18, Bethesda, MD, 20817, United States, julia.e.morrison@marriott.com

1 - 2016 INFORMS Prize Presentation by GeneralMotors

Michael Harbaugh, General Motors, Warren, MI, United States, michael.harbaugh@gm.com, Robert Inman, Peiling Wu-Smith, Yilu Zhang

General Motors, 2016 INFORMS Prize Winner, will survey its sustained application of analytics and operations research. Highlights will include Vehicle Health Management: using advanced analytics to predict failure of certain automotive systems before customers are affected, Optimizing New Vehicle Inventory: determining first how much, and second what mix of vehicles to hold in dealer inventory, andRevenue Management for Vehicle Content and Packaging: leveraging customer preferences to package and price vehicle content that will sell best.

■ SD11

104A-MCC

Network Optimization

Sponsored: Optimization, Network Optimization

Sponsored Session

Chair: Alexander Nikolaev, Assistant Professor, University at Buffalo, 312 Bell Hall, Buffalo, NY, 14260, United States, anikolae@buffalo.edu

1 - Optimal Seed Activation Scheduling For Influence Maximization In Social Networks

Mohammadreza Samadi, Operations Research Consultant, American Airlines, Fort Worth, TX, United States, Mohammadreza.Samadi@aa.com, Alexander Nikolaev, Rakesh Nagi

Influence maximization problem selects a set of influential nodes, called seeds, in a social network to spread the influence over the network maximally. We critique the basic assumption of influence maximization problem in the literature on controlling cascades only through the early starters and present Seed Activation Scheduling Problem (SASP) in two-level networks. The SASP is a sequential seed selection problem that results in optimal budget allocation over the campaign time horizon. The problem is modeled as a mixed-integer program for blogger-centric marketing campaigns and an efficient heuristic algorithm is presented using column generation method.

2 - From Local To Global Connections: A New Random Graph Model To Explain The Structural Properties Of Real-world Networks

Rakesh Nagi, U of Illinois at Urbana-Champaign, Department of Industrial & Enterprise Systems, 117 Transportation Building, MC-238, Urbana, IL, 61801, United States, nagi@illinois.edu Sushant Khopkar, Alexander Nikolaev

Online Social Network (OSN) data are hard to interpret. Many OSN users have lots of connections, easily surpassing 150 - the Dunbar number. We present a random graph formation model that explains social tie formation by bridging the gap between the Watts-Strogatz and scale free networks. It shows how the information about "talented" individuals may propagate from their friends towards the masses, with a power law in degree emerging via the mechanism fundamentally different from preferential attachment (PA): while PA assumes full visibility, our model relies on local information exchanges. We report and interpret the model parameter estimates for several real-world networks.

3 - Constrained Sparse Optimization For Tensor Based Modeling Of Student Learning In Collaborative Environments

Alireza Farasat, University at Buffalo, afarasat@buffalo.edu

Educational systems have witnessed a substantial transition from traditional educational methods mainly using text books, lectures, etc. to newly developed systems which are artificial intelligent-based systems personally tailored to the learners. In this study, a constrained sparse tensor-based factorization approach is proposed for modeling of student learning in collaborative environments. The main challenge of modeling students learning is the fact that learning occurs over time therefor. We develop a probabilistic, constrained based approach to the tenser factorization model which enables capturing the underlying dynamics of students learning over time.

4 - Generalized Cascade Model And Seed Bounds For Disease Spread In Social Networks

Arash Ghayoori, U of Illinois at Urbana-Champaign, Urbana, IL, 61801, United States, ghayoor2@illinois.edu, Rakesh Nagi

In this talk, we introduce a new diffusion model for social networks, which generalizes most of the previously introduced diffusion models. We establish its relevance in disease spread (epidemiology) as well as viral marketing. An upper bound on the size of the influential set ("seed" set of nodes that if become infected, will eventually result in making the entire network becoming infected) is also obtained for a special case of this model. We show this bound to be tight by providing a simple algorithm that outputs an influential set with size nearly equal to this upper bound.

■ SD12

104B-MCC

Convexification Techniques in Integer Programming

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Sercan Yildiz, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA, 15213, United States, syildiz@email.unc.edu

1 - Sparse Pseudoinverses Via LP And SDP Relaxations Of Moore-Penrose

Jon Lee, University of Michigan, jonxlee@umich.edu

Pseudoinverses are ubiquitous tools for handling over- and under-determined systems of equations. For computational efficiency and also in the context of identifying Gaussian models having a sparse precision matrix, sparse pseudoinverses are desirable. Recently, sparse left and right pseudoinverses were introduced, using 1-norm minimization and linear programming. We introduce new sparse pseudoinverses by developing tractable convex relaxations of the wellknown Moore-Penrose properties. In the end, we have several new sparse pseudoinverses that can be calculated via linear and semi-definite programming.

2 - Optimal Truss Topology Design By Mixed Integer Conic Optimization

Tamas Terlaky, Lehigh University, terlaky@lehigh.edu, Mohammad Shahabsafa, Ali Mohammad-Nezhad, Luis F Zuluaga

We present novel models, including Mixed Integer Linear Optimization (MILO) and Mixed Integer Second Order Cone Optimization (MISOCO) models, for Truss Topology Design Optimization. We discuss how classes of non-convex models can be reformulated as MILO and MISOCO models. We present our approach to solve the MISOCO models through adding Disjunctive Conic Cuts in a BCC framework. Additionally, we present an efficient line search method developed to solve the original non-convex model. Preliminary computational results indicate the effectiveness of our novel approaches.

3 - Low-complexity Relaxations And Convex Hulls Of Disjunctions On The Positive Semidefinite Cone And General Regular Cones

Sercan Yildiz, Postdoctoral Researcher, Statistical and Applied Mathematical Sciences Institute, Durham, NC, United States, syildiz@email.unc.edu, Fatma Kilinc-Karzan

This talk concerns two-term disjunctions on a regular cone K. The resulting disjunctive sets provide fundamental non-convex relaxations for mixed-integer conic programs. We develop a family of structured convex inequalities which together characterize the closed convex hull of such a set in the original space. Under certain conditions on the choice of disjunction, a single inequality from this family is enough for a closed convex hull description. In the case where K is the positive semidefinite cone, we show that these inequalities can be represented in conic form for a class of elementary disjunctions. For more general disjunctions, we present tight conic relaxations.

■ SD13

104C-MCC

New Algorithms for Global Optimization and MINLP I

Sponsored: Optimization, Global Optimization

Sponsored Session

Chair: John W Chinneck, Carleton University, Ottawa, ON, Canada, chinneck@sce.carleton.ca

1 - Nonlinear Objective Decomposition By Binary Decision Diagrams

David Bergman, University of Connecticut, david.bergman@business.uconn.edu, Andre Augusto Cire

In recent years the use of decision diagrams for discrete optimization has grown in popularity, with a focus on linear integer optimization. In this talk, an expansion to nonlinear objective functions will be discussed. The work proposes the use of decision diagrams to model the objective function, which are then linked together through a network flow linearization. Experimental results on problems arising in revenue management, portfolio optimization, and healthcare exhibit orders-of-magnitude improvement in solution times compared with state-of-the-art nonlinear solvers.

2 - Identifying And Exploiting Special Features In Mixed Integer Nonlinear Programs

Linus E Schrage, LINDO Systems, Inc., linus.schrage@chicagobooth.edu

Most MINLP problems have the following features to varying degrees: convexity, linearizability, conic representability, common expressions, monotonicity, decomposability, and symmetry. We describe methods for identifying these features and performance improvements possible by exploiting these features.

3 - A Fast Heuristic For Global Optimization

John Chinneck, Carleton University, chinneck@sce.carleton.ca, Mubashsharul Shafique

Our CCGO multistart heuristic trades off some accuracy to gain speed. It generally finds good quality solutions quickly. The main steps are a scatter of initial points, rapid movement towards feasibility via Constraint Consensus, clustering, simple point improvement, and local solver launch. Much of the work is done concurrently. Recent work improves the initial point scatter to provide better exploration of useful areas of the variable space. Our results are very promising in comparison to several existing global optimizers, especially for larger nonconvex models.

4 - A Dantzig-Wolfe Decomposition With Nonlinear Subproblems For Recursive Circle Packing

Ambros Gleixner, Zuse Institute Berlin, Takustr. 7, Berlin, 14195, Germany, gleixner@zib.de
Stephen John Maher, Benjamin Müller, Joao Pedro Pedroso

A large fraction of the total costs in tube industry arises from delivery inside rectangular containers. The problem of minimizing the number of containers to transport a set of different tubes can be modeled as a nonconvex MINLP: the recursive circle packing problem (RCPP), which is practically unsolvable for any state-of-the-art MINLP solver.

We present a branch-and-price algorithm that handles recursiveness in the master problem and solves nonconvex MINLPs for column generation. Our computational results using the MINLP solver SCIP show that this algorithm solves small-sized instances to proven optimality and produces better solutions than the best known heuristic for larger RCPP instances.

■ SD14

104D-MCC

Big Data Analytics and Applications in E-Commerce

Sponsored: Analytics

Sponsored Session

Chair: Linwei Xin, U of Illinois at Urbana-Champaign, Urbana, IL, 12345, United States, lxin@illinois.edu

1 - A Nonparametric Sequential Test For Online Experiments

Vineet Abhishek, @WalmartLabs, Sunnyvale, CA, United States, vineet.abhishek@gmail.com, Shie Mannor

We propose a nonparametric sequential test that aims to address two practical problems pertinent to online randomized experiments: (i) how to do hypothesis test for complex metrics; (ii) how to prevent type 1 error inflation under continuous monitoring. The proposed test does not require knowledge of the underlying probability distribution generating the data. We use the bootstrap to estimate the likelihood for blocks of data followed by mixture sequential probability ratio test. We validate this procedure on data from a major online e-commerce website and show that the proposed test controls type 1 error at any time, has good power, and allows quick inference in online randomized experiments.

2 - Implementing Tailored Base-surge Inventory Policies At Walmart.com

Linwei Xin, U of Illinois at Urbana-Champaign, lxin@illinois.edu
John Bowman, Huijun Feng, Zhiwei Qin, Long He, Jagtej S Bewli

We consider the following dual-sourcing inventory problem: one supplier is reliable but has a longer lead time; the other one is not always reliable but has a shorter lead time. The objective is to minimize the inventory cost. We propose a so-called Tailored-Base Surge policy. Under such a policy, a constant order is placed at the slow supplier in each period, while the order placed at the fast supplier follows an order-up-to rule. We test Tailored-Base Surge using data from Walmart.com, where lead time differences of many import items could be as large as 12 periods. Our result shows that Tailored-Base Surge outperforms other heuristics such as dual-index and single-sourcing base-stock policies.

■ SD15

104E-MCC

High Dimensional Data Analysis via an Optimization Lens

Invited: Modeling and Methodologies in Big Data

Invited Session

Chair: Dimitris Bertsimas, Massachusetts Institute of Technology, Cambridge, MA, 1, United States, dbertsim@mit.edu

1 - Optimal Classification Trees

Jack Dunn, Operations Research Center, MIT, jackdunn@mit.edu

Decision trees are widely used to solve the classical statistical problem of classification. We introduce a new method for constructing optimal decision trees using Mixed-Integer Optimization, and develop high-performance heuristics for these formulations that offer significant improvements over traditional greedy approaches and run in comparable times. We show in a large and diverse collection of synthetic and real-world instances that our Optimal Classification Trees improve substantially over CART and related methods such as Random Forests.

2 - Sparse High-dimensional Regression: Exact Scalable Algorithms And Phase Transitions

Bart van Parys, Operations Research Center, MIT, vanparys@mit.edu

We present a new binary convex reformulation and duality perspective to the sparse regression problem. We devise a novel cutting plane method and provide evidence that it can solve exact sparse regression problems for problem sizes in the 100,000s. Our sparse regression formulation has the property that as the number of samples increases its exact solution recovers the true signal very fast (faster than the Lasso in fact), while for small sample sizes, our approach takes a large amount of time to solve the problem, but most importantly the optimal solution does not recover the true signal.

3 - Compressed Sensing Via A Modern Optimization Lens

Lauren Berk, Operations Research Center, MIT, lberk@mit.edu

We develop tractable algorithms that provide provably optimal solutions to compressed sensing problems. These methods include new first order methods and a cutting planes method that operates in a reduced variable space, preserving tractability as problem sizes grow.

4 - Sparse Convex Regression

Nishanth Mundru, Massachusetts Institute of Technology, Cambridge, MA, 02139, United States, nmundru@mit.edu, Dimitris Bertsimas

Given data (xi, yi) (d+1), i=1,..,n, the problem of convex regression finds a convex function f: d   that minimizes the error ∑i (yi - f(xi))2. We propose a cutting plane algorithm that scales to (n,d) = (10^4,10) in minutes and (n,d) = (10^5,10^2) in hours. Sparse convex regression finds the best k out of d features, and solves for the optimal convex function on that subset. Using Mixed integer optimization methods and first order convex optimization based heuristics, we extend our algorithm to model sparsity, and solve the problem to provable optimality for (n,d,k) = (10^4,10^2,10) in minutes.

■ SD16

105A-MCC

Buffered Probability of Exceedance and Applications

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Matthew Norton, University of Florida, 355 Tigert Hall, Gainesville, 32611, United States, mdnorton@ufl.edu

1 - Buffered Probability Of Exceedance And Applications To Machine Learning

Matthew Norton, University of Florida, mdnorton@ufl.edu

We present a new characterization of uncertainty, called Buffered Probability of Exceedance (bPOE), specifically addressing its application to machine learning. Using ideas from Robust Optimization, we show that Robust bPOE minimization provides a highly flexible framework for binary classification which encompasses support vector machines (SVM's), including SVM variants which utilize Robust Optimization and various convex/non-convex regularization schemes. While also providing a more concrete interpretation for various SVM formulations, the proposed framework reveals a fundamental connection between many regularization schemes and Robust Optimization principals.

2 - Buffered Probability Of Exceedance: Methodology And Applications

Stan Uryasev, University of Florida, uryasev@ufl.edu

This paper investigates a new probabilistic characteristic called buffered probability of exceedance (bPOE). With bPOE, it is possible to count outcomes similar to a threshold value, rather than only outcomes exceeding the threshold. To be more precise, bPOE counts tail outcomes averaging to some specific threshold value. bPOE can be considered as an important supplement to POE. We will discuss the Cash Matching problem for a Portfolio of Bonds. We minimize bPOE that assets exceed liabilities.

3 - Smoothed Buffered Probability Of Exceedance: A New Class Of Probability-like Uncertainty Measures

Alexander Mafusalov, University of Florida, mafusalov@ufl.edu

Buffered probability of exceedance (bPOE) is a risk-averse alternative to probability of exceedance and cumulative distribution function. Minimization of bPOE is reduced to convex programming or even LP for a wide class of problems. However, being a non-smooth function, bPOE is not always well suited for gradient optimization. In addition, bPOE reverses the curve of CVaR values, while another family of risk measures might be preferable in a given application. This paper introduces a new class of smooth probability-like uncertainty measures, which are based on bPOE. Dual representations and other mathematical properties, along with advantages in optimization, are studied.

4 - Approximation Of A Distribution With A Finite Mixture Of Some Other Distributions Using Cvar Norm

Giorgi Pertaia, University of Florida, Gainesville, FL, United States, georgepertaia@gmail.com

CVaR norm is applied to approximate a distribution with a finite mixture of some other distributions. A finite mixture is a weighted sum of simple distributions (such as normal or triangular). Despite the simplicity of underlying distributions, the finite mixture can model a wide variety of distributions with heavy tails. Classical approach of fitting the mixture relies on Maximum Likelihood estimation, which, in general, leads to a nonconvex optimization problem (with many local minima where the optimization algorithms might get trapped). In contrast, procedures using CVaR norm minimization lead to convex programming, which can be reduced to linear programming problems.

■ SD17

105B-MCC

Polyhedral Methods in Integer Programming under Uncertainty

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Weijun Xie, Georgia Institute of Technology, 225 North Ave, Atlanta, GA, 30332, United States, wxie33@gatech.edu

1 - Decomposition Methods For Solving Distributionally Robust Two-stage Stochastic Integer Programs

Sanjay Mehrotra, Northwestern University, mehrotra@northwestern.edu, Manish Bansal, Kuo-Ling Huang

We present a cutting surface L-shaped method for solving 2-stage distributionally robust mixed integer programs. We show the finite convergence of the algorithm under suitable conditions. Wasserstein and moment based uncertainty sets are considered. Numerical results will be presented that demonstrate the performance of our approach and illustrate its ability to perform distributional sensitivity analysis.

2 - An Integer Programming Approach For Two-sided Chance-constrained Programs

Xiao Liu, The Ohio State University, liu.2738@osu.edu Simge Kucukyavuz, Fatma Kilinc-Karzan

We study two-sided chance-constrained programs with a finite probability space. We reformulate this class of problems as a mixed-integer program. We study the key substructure of the reformulation and propose valid inequalities that define the convex hull of this substructure. Finally, we propose polynomial optimization and separation algorithms for the optimization problem over this substructure.

3 - A Polyhedral Approach To Online Bipartite Matching

Alfredo Torrico, Georgia Institute of Technology, Atlanta, GA, United States, atorrico3@gatech.edu, Alejandro Toriello, Shabbir Ahmed

We study the i.i.d. online bipartite matching problem, a dynamic version of the classical model where one side of the bipartition is fixed and known in advance, while nodes from the other side appear one at a time as i.i.d. realizations of a uniform distribution, and must immediately be matched or discarded. We consider various relaxations of the polyhedral set of achievable matching probabilities, introduce valid inequalities, and discuss when they are facet-defining. Several of these relaxations correspond to ranking policies and their time-dependent generalizations.

4 - On Risk Averse Submodular Minimization

Weijun Xie, Georgia Institute of Technology, Atlanta, GA, United States, wxie33@gatech.edu, Shabbir Ahmed

This paper studies a risk averse submodular minimization problem (RASMP) under a knapsack constraint. Many problems can be reformulated as RASMP (e.g., chance constrained problems, mean-risk models, optimization with conditional-value-at-risk, etc). Approximation algorithms are proposed for RASMP by rounding an optimal solution to a suitable convex relaxation. We also propose new valid inequalities by partitioning binary variables into groups, and their separation.

■ SD18

106A-MCC

Marketing VI

Contributed Session

Chair: Gary Chao, Kutztown University, 888 Kingston Ln, Breinigsville, PA, 18031, United States, chao@kutztown.edu

1 - Product Life Cycle Among Different Generations

Gary Chao, Kutztown University, PO Box 730, Department of Business Administration, Kutztown, PA, 19530, United States, chao@kutztown.edu, Maxwell Hsu

The launch of a new product needs a larger commitment in time, money, and managerial resources. The new product introduction requires careful planning to ensure the expected market success of a new product. We would like to study how frequently and when an automaker introduced the new models, how an automaker designed their product line, what factors influence the diffusion. We attempt to fit longitudinal data across brands to the Bass diffusion model and examine the generation change within the same model from different automakers in order to identify the factors influencing car sales.

■ SD19

106B-MCC

Parallel Computing for Optimization and Data Analysis

Sponsored: Computing

Sponsored Session

Chair: Jonathan Eckstein, Rutgers University, Rutgers University, Piscataway, NJ, 00000, United States, jeckstei@rci.rutgers.edu

1 - The Rectangular Maximum Agreement Problem And Its Data Analysis Applications

Ai Kagawa, Rutgers University, ai.kagawa@gmail.com

The NP-hard rectangular maximum agreement (RMA) problem finds a "box" that best discriminates between two weighted datasets. Its data analysis applications include boosting classification methods and boosted regularized regression. We describe a specialized parallel branch-and-bound method for RMA.

2 - Object-parallel Solution Of Lasso Problems

Gyorgy Matyasfalvi, Rutgers University, 100 Rockafeller Road, Piscataway, NJ, 08854, United States, matyasfalvi@gmail.com Jonathan Eckstein

We describe an "object-parallel" C++ approach to implementing first-order optimization methods. As an example application, we solve large-scale Lasso problems on a distributed-memory supercomputer with the spectral projected gradient (SPG) method. We can efficiently accommodate highly unbalanced sparsity patterns.

3 - Asynchronous ADMM-like Optimization Algorithms

Jonathan Eckstein, Rutgers University, jeckstei@rci.rutgers.edu

Drawing on some recent work on asynchronous decomposition methods for monotone inclusions, this talk develops a class of parallel convex optimization algorithms that resembles the alternating direction method of multipliers (ADMM) but operates asynchronously. Unlike prior work on asynchronous variants of the ADMM, the new algorithm's convergence theory does not rely on either restrictive assumptions on the problem instance or on random invocation of subproblems. Instead, it needs only a basic "fairness" restriction that there be some upper bound on the ratio of the longest and shortest possible subproblem solution times. Stochastic programming applications may also be discussed.

■ SD20

106C-MCC

A Unified Framework for Optimization under Uncertainty

Invited: Tutorial

Invited Session

Chair: Warren B Powell, Princeton University, 230 Sherrerd Hall, Dept of Operations Research and Financial Eng, Princeton, NJ, 08544, United States, powell@princeton.edu

1 - A Unified Framework For Optimization under Uncertainty

Warren B Powell, Princeton University, 230 Sherrerd Hall, Dept Of Operations Research And Financial Eng, Princeton, NJ, 08544, United States, powell@princeton.edu

Stochastic optimization, also known as optimization under uncertainty, is studied by over a dozen communities, often (but not always) with different notational systems and styles, typically motivated by different problem classes (or sometimes different research questions) which often lead to different algorithmic strategies. This resulting "jungle of stochastic optimization" has produced a highly fragmented set of research communities which complicates the sharing of ideas. This tutorial unifies the modeling of a wide range of problems, from dynamic programming to stochastic programming to multiarmed bandit problems to optimal control, in a common mathematical framework that is centered on the search for policies. We then identify two fundamental strategies for finding effective policies, which leads to four fundamental classes of policies which span every field of research in stochastic optimization.

■ SD21

107A-MCC

Healthcare, General

Contributed Session

Chair: Julie Lynn Hammett, Texas A&M University, 301 Holleman Dr E, Apt 728, College Station, TX, 77840, United States, jhammett@tamu.edu

1 - Analysis Of Physician Productivity In Emergency Departments

Krista Foster, University of Pittsburgh, Mervis Hall, Roberto Clemente Drive, Pittsburgh, PA, 15260, United States, kmf88@pitt.edu, Jennifer S Shang

We present our analysis of a cohort of U.S. emergency departments. We use visit-level data to analyze hospital processes and develop models for physician productivity.

2 - A Review And Extension Of Clinically Significant, Automated Estimation Of End Systolic And End Diastolic Volumes In Cardiac MRIs

Michael Kim, Booz Allen Hamilton, 3930 Valley Ridge Drive, Fairfax, VA, 22033, United States, mikeskim@gmail.com

We review the winning methods in Kaggle's Second Annual Data Science Bowl. The top three algorithms automatically measure endsystolic and enddiastolic volumes in cardiac MRIs using data from more than 1000 patients. The results were found to be clinically significant. An analysis of the winning solutions is presented with a focus on extension through ensembling and transfer learning. In particular, we architect a machine learning pipeline to extend the top algorithms to the case of cancer detection given a time series of prostate MRIs.

3 - The Risks Of Risk Adjusted Mortality Rates And A Proposed Alternative Measure

Thomas Raymond Sexton, Professor, Stony Brook University, 317 Harriman Hall, Stony Brook, NY, 11794-3775, United States, Thomas.Sexton@StonyBrook.edu, Christine Pitocco

We consider the widespread use of the risk-adjusted mortality rate (RAMR) to evaluate hospital performance. We demonstrate that the RAMR, as currently employed, has significant methodological flaws. We propose an alternative to the RAMR that is based on standard statistical theory and methods. Applying our measure yields a more complete and accurate evaluation of hospitals.

4 - Effects Of Artificial Agents Based Ordering On The Supply Chain Of Perishables

Harshal Lowalekar, Assistant Professor, Indian Institute of Management-Indore, Prabandh Shikhar, Rau-Pithampur Road, Indore, 453331, India, lwlherschelle@gmail.com, Raghu Santanam, Ajay Vinze

We develop a blood bank game which contains a mix of human and computer based hospital blood banks who order blood at regular intervals from a regional bank. The objective of all the agents is to minimize their total inventory costs. The computer agents use a near-optimum policy to determine their order sizes. We show that presence of a large number of computer based agents in the supply chain leads to a systematic increase in the order sizes of the hospital banks which leads to a severe perceived blood shortage in the region. The performance of the supply chain worsens when the computer agents have the capability to learn from their past performance.

5 - Remote Patient Monitoring System Framework: A User Perspective

Julie Lynn Hammett, Texas A&M University, 301 Holleman Dr E, Apt 728, College Station, TX, 77840, United States, jhammett@tamu.edu, Michelle M. Alvarado, Mark Alan Lawley

Healthcare providers are facing an increasing number of patients requiring long-term care, introducing new challenges to providing fast and affordable care. We present ongoing research to create a framework for the design, development, and implementation of remote patient monitoring (RPM) for chronic care. We highlight the stakeholder needs, system requirements and component interdependencies. We describe RPM's need for automated solutions that support clinical decisions and deliver interventions. This technology must be interchangeable to suit the varied needs and characteristics of many patients. We show that these solutions can improve chronic care management.

■ SD22

107B-MCC

Disaster Relief Supply Chains and Operations

Sponsored: Public Sector OR

Sponsored Session

Chair: Felipe Aros-Vera, Ohio University, Stocker Center 277, 1 Ohio University, Athens OH, OH, 45701, United States, aros@ohio.edu

1 - Pre-positioning Emergency Relief Items Before A Typhoon With An Uncertain Trajectory

Joline Uichanco, University of Michigan, Ross School of Business, jolineu@umich.edu

We describe a collaborative work with the Philippine government on a pre-positioning model in preparation for an oncoming typhoon. Pre-positioning relief aid before a typhoon is challenging due to the uncertainties in locations and quantities of future demand. We develop a prediction model for the number of affected population by fitting a dataset of typhoon effects to a hierarchical linear model. Our model reveals a significant relationship between wind speed and affected population. We propose a bi-objective stochastic pre-positioning model which balances fairness and effectiveness of the pre-positioning strategy.

2 - Ecuador Earthquake Relief Support: Observations From Fieldwork Research

Johanna Amaya, Rensselaer Polytechnic Institute, Troy, NY, United States, amayaj@iastate.edu, Johanna Amaya, Iowa State University, Ames, IA, 50011, United States, amayaj@iastate.edu, Cinthia Perez Siguenza, Jose Holguin-Veras

This talk presents an overview of the disaster response logistics that took place after the earthquake in Ecuador. The talk discusses the preliminary results of the fieldwork research conducted by the authors in the aftermath of the disaster.

3 - Objectives' Misalignment In Humanitarian Operations: The Role Of Earmarking

Laura Turrini, Kuehne Logistics University, laura.turrini@the-klu.org, Maria Besiou

Effectiveness of humanitarian programs depends both on the donors' willingness to support the program and on the program implementation by the international humanitarian organization (IHO). Donors donate with the aim of reaching as more beneficiaries as possible. IHOs also have the same objective, but face constraints on how they can use the available funds. A big constraint comes from the donors themselves, who often earmark their funding. In this paper, we analyze the donors' and IHOs' decision-making in an effort to shed more light on how decisions for earmarking are taken. The aim is to give recommendations to the IHOs on how to align donors' objectives to theirs.

4 - Willingness-to-pay Models On Post-disaster Environments

Diana Ramirez-Rios, Research Assistant, Rensselaer Polytechnic Institute, Troy, NY, 12180, United States, ramird2@rpi.edu Jose Holguin-Veras, Johanna Amaya, Trilce Marie Encarnacion, Shaligram Pokharel, Victor Cantillo, Luk Wassenhove

This paper introduces an economic valuation for the level of anxiety of an individual under deprivation conditions as anxiety is well-known measure of psychological distress in a community. More specifically, this research estimated the willingness-to-pay for water of individuals who have been affected by disasters, under different scenarios of deprivation and expectation. The level of anxiety is measured by the effect that the expected time to normality introduces to WTP, and results indicate that that as the time to recover increases, the level of suffering increases. "

■ SD23

108-MCC

Applications in Physician Scheduling

Sponsored: Health Applications

Sponsored Session

Chair: Andreas Fügener, Universität zu Köln, 123334, Germany, andreas.fuegener@uni-koeln.de

1 - Decision Support For Physician Rostering: Development Of Models And Implementation Of Software

Jens Brunner, University of Augsburg, jens.brunner@unikat.uni-augsburg.de, Andreas Fuegener

In order to cope with steadily increasing healthcare costs, hospitals try to schedule their physicians efficiently and effectively. We consider a scheduling problem at large teaching hospitals in Germany. We formulate mixed-integer linear programming models for duty- and workstation assignments subject to union contracts as well as individual agreements of the physicians. To promote for job satisfaction we take into account fairness and preferences. We present the status of the software development and discuss lessons learned from the project and highlight some barriers when it comes to implementation of decision support systems in practice.

2 - Neonatal Physician Scheduling At The University Of Tennessee Medical Center

Charles E Noon, University of Tennessee-Knoxville, Knoxville, TN, United States, cnoon@utk.edu, Melissa R Bowers, Wei Wu, Kirk Bass

The default approach for scheduling hospital coverage is to distribute the various types of shifts equally among the covering physicians. This "equality" approach insures that each physician works his/her fair share of overnights, weekends, etc. We present a new model that incorporates individual shift-type preference so that each physician attains a schedule that is equivalent or superior to his/her "equality" schedule. We formulate and solve the model as a mixed integer program. We demonstrate its benefits by using the approach to schedule hospital coverage for a neonatology group.

3 - Equitable Scheduling Of Resident Shifts

Hernan Abeledo, George Washington University, abeledo@gwu.edu, Anthony Coudert

Creating shift schedules for resident physicians is a notoriously difficult task that is typically done manually by the chief residents. Shift assignments need to observe a large number of rules while populating a complex schedule structure. A key goal is that the schedule be perceived as fair by all residents. We present an integer programming model used to schedule anesthesiology residents at the George Washington University Hospital. The fairness objective is addressed through a point system proposed by the residents.

4 - Re-scheduling Of Physicians In Case Of Unexpected Absences

Andreas Fügener, University of Cologne, andreas.fuegener@uni-koeln.de, Christopher Gross, Jens Brunner

Scheduling physicians is a complex task as legal requirements, levels of qualification, and preferences for different working hours should be considered. Unplanned absences, e.g. due to illness, additionally drive the complexity. In this study, we discuss an approach to deal with the following trade-off: Changes to the existing plan should be kept as small as possible. However, an updated plan should still meet the requirements regarding work regulation, qualifications needed, and employee preferences. We present a mixed-integer programming model to create updated plans following absences of scheduled personnel and apply it to real-life data from a German university hospital.

■ SD24

109-MCC

New Directions in Non-Market Strategies

Invited: Strategy Science

Invited Session

Chair: Jason Snyder, University of Utah, Eccles School, Salt Lake City, UT, 9, United States, Jason.snyder@eccles.utah.edu

1 - Locked In? Noncompete Enforceability And The Mobility And Earnings Of High-tech Workers

Jin Woo Chang`, University of Michigan, Ann Arbor, MI, United States, jinwooch@umich.edu, Natarajan Balasubramanian, Mariko Sakakibara, Jagadeesh Sivadasan, Evan Starr

We use matched employer-employee data from 30 U.S. states to examine how the enforceability of noncompete contracts affects the length of job spells and the level of wages. Exploiting inter-state variation in the degree of enforceability and controlling for worker-, job-, and state-level characteristics, we find that a unit standard deviation increase in enforceability is associated with a 3.6% increase in the length of job-spells for high-wage workers in technology industries. We also find persistent wage suppressing effects that last throughout their employment history. Together, these are consistent with noncompetes reducing the bargaining power of employees relative to their employers.

2 - On A Firm's Optimal Response To Pressure For Gender Pay Equity

David Ross, University of Florida, 55, Gainesville, FL, 32611, United States, David.Ross@warrington.ufl.edu David Anderson, Cristian Dezsö, Margret Bjarnadottir

We present a theory of how a firm would respond to pressure for gender pay equity by strategically distributing raises and adjusting its organizational structure. Using mathematical reasoning, simulations, and data from a real employer, we show that (a) employees in low-paying jobs and whose job-related traits typify men at the firm are most likely to get raises; (b) counterintuitively, some men will get raises and giving raises to certain women would increase the pay gap; (c) a firm can reduce the gender pay gap as measured by a much larger percentage than the overall increase in pay to women at the firm; and (d) "ghettoizing" women in select jobs can help a firm reduce its pay gap.

■ SD25

110A-MCC

Managing Uncertainties in Projects

Invited: Project Management and Scheduling

Invited Session

Chair: Janne Kettunen, The George Washington University, Washington, DC, United States, jkettune@gwu.edu

1 - Zooming In On The Innovator's Bias Within Organizations

Fabian Sting, Erasmus University Rotterdam, Rotterdam School of Management, fsting@rsm.nl, Christoph Fuchs, Maik Schlickel

Firms in competitive industries strive for process innovations, and one source of such ideas is the firm's workforce. In the selection process, firms rely on input from ideating employees - input that might contain systematic errors (biases) and/or unsystematic errors (noise). We study such errors by analyzing the process innovation ideas considered by an automotive manufacturer. Our data set is unique in that it includes information on idea generation, employee evaluation, standardized value calculation, selection, and implementation. Overall, our findings contribute to a more differentiated yet theoretically coherent understanding of the innovator's bias in organizations.

2 - To Better Manage Risks In New Product Development Portfolio Selection – Be Risk Neutral

Janne Kettunen, Assistant Professor, The George Washington University, 2201 G Street, NW, Washington, DC, 20052, United States, jkettune@gwu.edu, Shivraj Kanungo

We investigate trade-offs between risk and return in multi-period new product development (NPD) portfolio selection problems, where new development projects become periodically available. Our analytical and computational results show that, paradoxically, a risk-neutral NPD portfolio selection approach provides higher return and lower risk than a risk-averse selection approach. This result can explain why leading innovators tend to employ a risk-neutral NPD selection approach. The risk of the NPD portfolio can be mitigated by (i) reviewing portfolios more frequently and (ii) increasing the proportion of derivative products instead of platform products.

3 - Project Portfolio Selection – A Behavioral Study

Sebastian Schiffels, Technical University of Munich, Munich, 80333, Germany, sebastian.schiffels@wi.tum.de, Thomas Fliedner, Rainer Kolisch

Choosing the right set of projects is a key driver of success and failure in new product development. We conducted experimental studies based on the knapsack problem to address the question which decision rules individuals apply to select a portfolio as well as how cognitive limitations influence their selection. Grounded in portfolio selection practice, we investigate subjects' adherence to four heuristics. Decision making is partially explained by adherence to two simple rules, but problem complexity limits the application of such rules as subjects apply a local search. Furthermore, decision maker prefer projects with low risk resulting in portfolios with few high risk high impact projects.

4 - Initiating Supplier New Product Development Projects: A Behavioral Investigation

David Wuttke, EBS University, Wiesbaden, Germany, david.wuttke@ebs.edu, Karen Donohue, Enno Siemsen

Using a combination of analytical models and laboratory experiments, we study the effectiveness of buyer contract mechanisms, including breach penalties and profit sharing, on incentivizing product innovation at the supplier level. Our results provide insight into how the mechanisms can be altered to better account for supplier-specific behavior.

■ SD26

110B-MCC

Auctions and Trading Agents

Invited: Auctions

Invited Session

Chair: Wolfgang Ketter, Rotterdam School of Management, Rotterdam, Netherlands, wketter@rsm.nl

1 - Using Optimal Grid Resources For Coordinating Electric Vehicle Charging

Konstantina Valogianni, IE Business School, Madrid, Spain, konstantina.valogianni@ie.edu, Alok Gupta, Wolfgang Ketter, Soumya Sen, Eric F Van Heck

We propose a social welfare maximization mechanism to optimally schedule EV charging, ensuring the lowest overall delay for the EV owners. At the same time, our mechanism creates electricity peak demand reduction which is important for improving sustainability in the grid. Our solution has lower computational complexity, compared to state of the art mechanisms, making it easily applicable to practice, where large numbers of EVs need to be charged. We prove the theoretical optimal conditions that must hold in order to have maximum social welfare in the grid. We validate our mechanism on real-world data and find both peak demand and delay reduction.

2 - Truthful Approximation Mechanisms for Knapsack Bidders

Martin Bichler, Soeren Merting, Technische Universitat Munchen, Munich, Germany. bichler@in.tum.de

In markets such as digital advertising markets, bidders want to maximize value for impressions subject to a budget constraint. This type of utility function is typically implemented in bidding agents, but it differs from quasilinear utility functions in important ways. We refer to such bidders as knapsack bidders. We study the offline mechanism design problem and analyze truthful approximation mechanisms to maximize social welfare. Serial dictatorship mechanisms are shown to be strategy-proof and Pareto-optimal, but they can have low welfare. We propose a randomized mechanism with an approximation ratio of 4. Our mechanism draws on a fractional deferred acceptance algorithm and randomized rounding, and it illustrates how the relax-and-round principle can be implemented in an important non-quasilinear environment.

3 - Modelling Electricity Balancing Market Prices And Premiums: A Non-parametric Non-linear Approach

Ezgi Avci-Surucu, PhD Student, Rotterdam School of Management, Rotterdam, Netherlands, avcisurucu@rsm.nl Wolfgang Ketter, Gerhard Wilhelm-Weber

In smart electricity markets, the increased penetration of renewable sources reveals the need for decision support systems. For developing reasonable bidding strategies, market participants need intelligent agents to make informed decisions about the trade-off between sales in the day-ahead market or in the balancing market. In this paper, by considering a detailed system-level data; firstly we examine the market efficiency by fractal analysis to understand the level of price predictability. Further, due the invalidity of normality and linearity assumptions, we propose non-parametric non-linear models to provide strategic tools for policy makers and market participants.

■ SD27

201A-MCC

Empirical Research in Finance and Operations

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: William Schmidt, Cornell University, United States, ws366@cornell.edu

1 - Optimal Timing Of Inventory Decisions Under Price Uncertainty

Nikolay Osadchiy, Emory University, nikolay.osadchiy@emory.edu, Vishal Gaur, Sridhar Seshadri, Marti Subrahmanyam

We study the problem of optimal inventory order timing when the selling price and demand are random and their forecasts improve with time. We show that the optimal timing of inventory ordering decision follows a simple threshold policy in the price variable with a possible option of non-purchasing, and is independent of the demand. Given this policy structure, we evaluate the benefits of timing flexibility using the best pre-committed order timing policy as the benchmark.

2 - Wisdom Of Crowds: Forecasting Using Prediction Markets

Ruomeng Cui, Kelley School of Business, Indiana University, Bloomington, IN, 47401, United States, cuir@indiana.edu Achal Bassamboo, Antonio Moreno-Garcia

Prediction markets are virtual markets created to aggregate predictions from the crowd. We examine data from a public prediction market and internal prediction markets run at three corporations. We study the efficiency of these markets in extracting information from participants. We show that the distribution forecasts, such as sales and commodity prices predictions, generated by the crowds are perfectly calibrated. In addition, we run a field experiment to study drivers of forecast accuracy.

3 - Linking Operational Performance To Financial Distress In The U.S. Airline Industry

Yasin Alan, Vanderbilt University, Nashville, TN, United States, yasin.alan@owen.vanderbilt.edu, Michael A Lapre

We study the impact of four areas of operational performance -revenue management, operational efficiency, service quality and operational complexity- on financial distress in the U.S. airline industry using quarterly data from 1988 through 2013. Our findings suggest that operational metrics convey useful information regarding future financial distress even after controlling for financial ratios that predict bankruptcies.

4 - Operational Transparency With Investors

William Schmidt, Cornell University, ws366@cornell.edu,
Ananth Raman

There is abundant evidence that operational disruptions are damaging to firm value. This depends not only on characteristics of the firm and its supply chain but also the level of operational transparency with investors. While the former has been widely studied, little is known about the implications of operational transparency. We examine this issue by taking advantage of an exogenous regulatory shock. A well-defined set of firms was excluded from fully complying with the new rules, creating a natural quasi-experiment which we exploit. Our research suggests that credible transparency with investors can alleviate over 50% of the loss in market value from operational disruption announcements.

■ SD28

201B-MCC

Energy Operations and Policy

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Ozge Islegen, Kellogg School of Management, Evanston, IL, United States, o-islegen@kellogg.northwestern.edu

1 - The Economics Of Residential Solar PV Adoption

Ozge Islegen, Kellogg School of Management, o-islegen@kellogg.northwestern.edu, Basak Kalkanci

Given the new policies, federal and state incentives, we show how net metering rules, rate plans and options to finance solar projects affect the adoption of residential solar PV.

2 - Remuneration Of Flexibility Using Operating Reserve Demand Curves: A Case Study Of Belgium

Anthony Papavasiliou, CORE, UCL, tpapva@hotmail.com
Yves Smeers

We investigate an energy-only market design, referred to as operating reserve demand curves (ORDC), that rewards flexibility by adjusting the real-time energy price to a level that reflects the value of capacity under conditions of scarcity. We test the performance of the mechanism by developing a model of the Belgian electricity market. We verify that (i) none of the existing combined cycle gas turbines of the Belgian market can cover their investment costs, and (ii) the introduction of ORDC restores economic viability for most combined cycle gas turbines in the Belgian market.

3 - Robust Supply Function Equilibrium In Renewable Energy Markets

Yuanzhang Xiao, Northwestern University, Evanston, IL, United States, yuanzhang.xiao@northwestern.edu, Chaithanya Bandi, Ermin Wei

We consider a market where energy suppliers submit supply functions and bid to fulfill inelastic demand. Suppliers have renewable energy generation (with zero cost) and conventional energy generation (with variable costs). Each supplier performs robust optimization against worst-case realizations of its renewable energy generation and opponents' costs of conventional energy generation. We analyze the resulting robust supply function equilibrium and its efficiency.

4 - An Analysis Of Demand Response Programs In The Wholesale Electricity Market

Asligul Serasu Duran, Kellogg School of Management, Evanston, IL, 60208, United States, a-duran@kellogg.northwestern.edu, Baris Ata, Ozge Islegen

This project explores the impact of the participation and compensation of demand response (DR) providers in the wholesale electricity market on the generation portfolio, electricity prices and social welfare. Specifically, we model a supply function equilibrium for generators and DR providers. Then, we analyze the change in the generation portfolio, and in the welfare of the market participants due to varying compensation rates of DR providers.

■ SD29

202A-MCC

Energy Resource Valuation, Investment and Management

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Owen Wu, Associate Professor, Indiana University, 1309 E. 10th Street, Bloomington, IN, 47405, United States, owenwu@indiana.edu

1 - Valuing Distributed Energy Resources In Electricity System Planning: Locational Benefits And Economies Of Unit Scale

Jesse Jenkins, Massachusetts Institute of Technology, jessedj@mit.edu

Distributed energy resources (DERs), including distributed generation, storage, and demand response, create new options for the provision of electricity services. Employing a new MILP formulation of the electricity capacity planning problem, this work evaluates the value of DERs and how they compete with conventional resources. Tradeoffs between "locational benefits" of DERs—e.g. loss mitigation, network capacity deferral, constraint mitigation—and economies of unit scale are considered, and cases where DERs are economically attractive contributors to a least-cost system mix are presented.

2 - Combined Heat And Power Production – Valuing Flexible Operation In An Uncertain Environment

Christoph Weber, University Duisburg-Essen, christoph.weber@uni-due.de

CHP provides an efficient means of converting fuels into power and heat. At the same time operation of CHP units is restricted by thermodynamical and technical constraints and subject to the double uncertainty of power prices and heat demand. The contribution explores the impact of operational flexibility both in the CHP unit (extraction condensing vs. backpressure turbines) and in the system configuration (back-up heat boiler). Analytical results are derived and a numerical application is presented.

3 - Economic Feasibility Of Compressed Air Energy Storage Under Market Uncertainty

Reinhard Madlener, Director FCN, Full Professor of Energy Econ & Mgt, RWTH Aachen University, Mathieustrasse 10, Aachen, 52074, Germany, RMadlener@eonerc.rwth-aachen.de, Eide Hammann, Christoph Hilgers

In light of increased levels of intermittent renewable electricity generation, energy storage is one option to balance supply and demand and thus to support the security of power supply. Compressed air energy storage (CAES) is a large-scale technology that has received considerable attention in recent years. As conventional CAES uses natural gas as an auxiliary fuel operators are exposed to price risks on two commodity markets. The more advanced adiabatic version, in contrast, features higher cycle efficiencies but at the downside of higher capital outlays. We apply real options analysis to investigate the economic viability of both technology variants in an uncertain market environment.

4 - Merchant Energy Trading In A Network

Selva Nadarajah, University of Illinois at Chicago, selvan@uic.edu, Nicola Secomandi

We formulate the merchant trading of energy on a network of storage and transport assets as a Markov decision problem. We overcome the intractability of this model by applying linear optimization in novel ways for approximate dynamic programming: (i) Iterative extensions of least squares Monte Carlo techniques based on value/continuation function approximations (V/CFAs) that are separable/non-separable and piecewise linear concave in the storage inventory levels; (ii) an extended reoptimization heuristic; and (iii) a perfect information dual bound based on a separable and linear VFA. We compare these methods on realistic natural gas instances, highlighting near-optimal methods.

■ SD30

202B-MCC

Establishing Trust in Operations

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Ryan Buell, Harvard Business School, Boston, MA, United States, rbuell@hbs.edu

1 - Managing Supplier Risks Via Diversification Versus Improvement: An Experimental Evaluation

Basak Kalkanci, Scheller School of Management, Basak.Kalkanci@scheller.gatech.edu

Using economic experiments, we evaluate the performance of supplier diversification versus improvement to mitigate supply chain risks of a buyer facing suppliers with different costs and risk profiles. We show that the buyers diversify their orders more than theory and the orders are artificially inflated to benefit from quantity hedging. We also demonstrate that sourcing commitment may hurt a buyer by reducing the buyer's supplier improvement effort, contrary to theory.

2 - Understanding And Managing Customer-induced Negative Externalities In Congested Self-service Environments

Hyun Seok Lee, University of North Carolina at Chapel Hill, Chapel Hill, NC, 27514, United States, Hyunseok_Lee@kenan-flagler.unc.edu, Saravanan Kesavan, Vinayak Deshpande

This paper identifies a new problem, i.e., the negative impact of congestion (using archival data at retailer A), demonstrates the mechanisms driving the problem (using observational data from field study at retailer B), proposes a solution to the problem, and discusses its implementation at two different retailers (using field experiments at retailers A and B). More importantly, we identify a new phenomenon called thwarting behavior, defined as a systematic change in customers' behavior when they experience congestion that imposes negative externalities on other customers.

3 - The Impact Of Decision Rights And Long Term Relationships On Innovation Sharing

Ruth Beer, Indiana University, Kelley School of Business, ruthbeer@indiana.edu, Hyun-Soo Ahn, Stephen Leider

We study a supplier's incentives to share an innovation with a buyer when sharing the innovation increases efficiency but makes the supplier vulnerable to the buyer sharing it with other suppliers. We show, both theoretically and experimentally, that the supplier's optimal decision depends on the length of the relationship and in particular, on how the buyer allocates decision rights among its employees.

■ SD31

202C-MCC

Issues in Supply Chains, Risk Management and Finance

Sponsored: Manufacturing & Service Oper Mgmt, iFORM

Sponsored Session

Chair: Juan Camilo Serpa, McGill University, 1001 Rue Sherbrooke O, Montreal, QC, H3A 1G5, Canada, juan.serpa@sauder.ubc.ca

1 - Mitigating Disruption Cascades In Supply Networks

Nitin Bakshi, London Business School, London, United Kingdom, nbakshi@london.edu, Shyam Mohan

The losses from supply chain disruptions arise not only due to direct damage at firms, but also from the interruption of normal operations because of lack of supply; that is, due to disruption cascades from suppliers in the adjacent tiers and beyond. To curtail such losses, firms can make ex-ante investments in mitigation and recovery strategies. In this paper, we use a game-theoretic approach to study firms' equilibrium investments, and the associated efficiency (in comparison with the centralized benchmark), and its dependence upon network topology.

2 - Cancelability In Trade Credit Insurance

S. Alex Yang, London Business School, sayang@london.edu, Christopher J Chen, Nitin Bakshi

Trade credit insurance (TCI) is a risk management tool commonly used by suppliers to guarantee against buyers defaulting when purchasing on credit. In most TCI policies, the insurer can cancel this "guarantee" during the insured period. We explore the role of cancelability in TCI. We find that the utility of cancelability in TCI is linked to the insurer's monitoring role (tracking the buyer's continued creditworthiness during the insured period, which enables the supplier to make more efficient shipping decisions). Our findings help explain the historical dominance of cancelable contracts in TCI, and they also offer insight into the recent industry trend of offering non-cancelable TCI coverage.

3 - Trade Credit In Competition: A Horizontal Benefit

Heikki Peura, London Business School, hpeura@london.edu
S. Alex Yang, Guoming Lai

Prior research has focused on how trade credit benefits firms by improving vertical supply chain relationships. We offer a novel perspective by examining whether trade credit benefits suppliers through a horizontal channel. Under the classic Bertrand framework, we analyze two competing firms' price decisions with and without trade credit, and find that when the firms are financially constrained, trade credit allows them to soften horizontal price competition. Studying the firms' optimal contract choice, we further find that this horizontal benefit of trade credit may complement its vertical roles.

■ SD32

203A-MCC

Scheduling IV

Contributed Session

Chair: Yumei Huo, Associate Professor, City University of New York, 2800 Victory Boulevard, 1N 215, Staten Island, NY, 10314, United States, yumei.huo@csi.cuny.edu

1 - An Improved Algorithm On Two-stage Scheduling With An Outsourcing Option

Kangbok Lee, City University of New York, York College, 94-20 Guy R Brewer Boulevard, Queens, NY, 11451, United States, kangbok.lee3@gmail.com, Xiaojuan Jiang, An Zhang, Yong Chen, Guangting Chen

We consider a two-stage scheduling problem with an outsourcing option where each operation can be outsourced. The objective is to minimize the sum of the makespan and the total outsourcing cost where the outsourcing cost of an operation is the product of the operation's processing time and the unit processing time cost of that stage. There was a study on Greedy algorithm with regard to the worst-case analysis. In this work, by reanalyzing the Greedy algorithm, we derive the tight worst-case performance ratio and proposed a new approximation algorithm with a better worst case performance ratio.

2 - Can Distance-driven Online Scheduling Be Better Than Order-driven?

KeLin Luo, Xi'an Jiaotong University, Xianning West Road 29, Xi'an, 710049, China, luokelin@stu.xjtu.edu.cn

Taxi arrangement, instance delivery, and intra-city express has been considered as a dispensable part of everyday life. The orders appear in real-time and in a certain area. The serving net is established by summarizing the order's properties, including time distribution, periodic distribution, and regional distribution. Then we can redefine the orders according their time and physical distances by special numbers, such as non-increasing numbers. We presented an online algorithm and verified the effectiveness and efficiency of this algorithm by comparing it with the order-driven scheduling. We refrain from the myopia of local optimum or global optimum accompanying with the substantial cost.

3 - A Dynamic Lot Sizing Based Discounted Cash Flow Model Considering Working Capital Requirement Financing Costs

Thomas G Yeung, Associate Professor, Ecole des Mines de Nantes, 4 rue Alfred Kastler BP 20722, La Chantrerie, Nantes, 44307, France, thomas.yeung@mines-nantes.fr, Yuan Bian, David Lemoine, Nathalie Bostel-Dejax, Jean-Laurent Viviani, Vincent Hovaleque

Companies always need free cash flow to efficiently react against uncertainty and ensure solvency. However, classical dynamic lot-sizing models only consider the physical flow of products. In this paper, we introduce a first link between the dynamic lot-sizing problem and financial aspects of working capital requirements (WCR). We propose a new generic WCR model along with a dynamic lot-sizing-based discounted cash flow model for single-site, single-level, single-product and infinite capacity cases. A polynomial algorithm is also presented with numerical tests in order to compare our approach with the traditional dynamic lot-sizing approach.

4 - Two Machine Scheduling Subject To Arbitrary Machine Unavailability

Yumei Huo, Associate Professor, City University of New York, 2800 Victory Boulevard, 1N 215, Staten Island, NY, 10314, United States, yumei.huo@csi.cuny.edu

We study two machine scheduling subject to arbitrary machine unavailability. The jobs are resumable. We consider both the single criterion and the bi-criteria problems concerning makespan and the total completion time. Liu and Sanlaville have shown that makespan minimization problem is solvable in polynomial time, leaving other three optimization problems still open: total completion time; total completion time subject to the constraint that the makespan is minimum; and makespan subject to the constraint that total completion time is minimum. In this research, we show all these three open problems are in P by giving optimal polynomial time algorithms.

■ SD33

203B-MCC

Recent Advances in Simulation

Sponsored: Simulation

Sponsored Session

Chair: Jing Dong, Northwestern University, Evanston, IL, United States, jing.dong@northwestern.edu

Co-Chair: Jose Blanchet, Columbia University, New York, NY, United States, jose.blanchet@gmail.com

1 - On Calibrating Statistical Distances

Huajie Qian, University of Michigan, 2302 St Francis Drive, Apt B118, Ann Arbor, MI, 48104, United States, hqian@umich.edu Henry Lam

We present a general framework to calibrate the statistical distance dictating the size of the uncertainty sets for distributionally robust optimization used in stochastic or simulation optimizations under uncertainty. We discuss the implications on the statistical guarantees of the resulting objective values and feasibility. We also compare these guarantees to sample average approximation.

2 - Multi-resolution Gaussian Markov Random Fields For Discrete Optimization Via Simulation

Eunhye Song, Northwestern University, Evanston, IL, United States, EunhyeSong2016@u.northwestern.edu
Barry L Nelson, Jeremy C Staum

The Gaussian Markov Improvement Algorithm (GMIA), an optimization via simulation algorithm based on Gaussian Markov random fields (GMRF), has computational advantages in solving problems on a large discrete solution space. We extend GMIA to a multiresolution algorithm (MR-GMIA) to solve even larger problems. The solution space is divided into regions; each region becomes a “solution” in a region-level GMRF while solutions within each region are represented by a solution-level GMRF. Using complete expected improvement, MR-GMIA guides the search toward promising regions and promising solutions within the selected regions with global inference about the optimality gap for termination.

3 - Unbiased Monte Carlo Computations For Optimization And Functions Of Expectations

Yanan Pei, Columbia University, yp2342@columbia.edu, Jose Blanchet, Peter W Glynn

We present general principle for the design and analysis of unbiased Monte Carlo estimators for quantities such as functions of expectations. Our estimators possess finite work-normalized variance under mild regularity conditions. We apply our estimator to various settings of interest, such as optimal value estimation in the context of Sample Average Approximations, unbiased estimators for particle filters and conditional expectations.

4 - Estimation In The Tail Of The Gaussian Copula

Raghu Pasupathy, Purdue University, West Lafayette, IN, 47907, United States, pasupath@purdue.edu

We present ecoNORTA for efficient constrained random vector generation within the Gaussian and NORTA contexts. We propose three importance-sampling estimators for such settings, the first of which actively exploits knowledge of the local structure of the feasible region around a dominating point to achieve bounded relative error. The second and third estimators, for use in settings where information about the constraint set is not readily available, do not exhibit bounded relative error but are shown to achieve a slightly weaker form of efficiency. Numerical results on various example problems show promise.

■ SD34

204-MCC

Joint Session HAS/MSOM-HC: Models and Analytics in Healthcare Operations

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Joel Goh, Harvard Business School, Boston, MA, United States, jgoh@hbs.edu

1 - Accurate Prediction Of Case Duration

Amirhossein Meisami, University of Michigan, Ann Arbor, MI, United States, meisami@umich.edu, Nick Kastango, Christopher Thomas Borum Stromblad, Mark P Van Oyen

The primary goal of this study is to analyze the abundant data available prior to surgery and leverage this information to produce accurate case length predictions via novel statistical learning methodologies. We will be working with a rich database from Memorial Sloan Kettering Cancer Center to identify the essential features in defining case duration variability. The research also focuses on reducing the uncertainties and variations imposed by rare events that may arise in various procedures during a case.

3 - Admission Of Long Stay Patients In A Busy Pediatric ICU

Fernanda Bravo, Assistant Professor, UCLA Anderson School of Management, Los Angeles, CA, United States, fernanda.bravo@anderson.ucla.edu, Michael McManus

This work studies admission policies for complex patients in the ICU of a large pediatric academic hospital. There are four different patient types: medical, emergency, surgical, and transfers. Within these, long-stay-patients use a large amount of resources and limit the access to the unit. The ICU must always remain available for emergencies before accommodating elective admissions. As a result, many children are queued for complex surgeries and medical workups. We study policies to decide when to admit an long-stay-patient depending on the current ICU status, and future patients’ arrivals.

4 - Scheduling Work In Radiology

Maria R. Ibanez, Harvard Business School, mibanez@hbs.edu

Using detailed data on millions of radiological studies interpreted by physicians, we study the drivers of speed and quality of the interpretation, and identify implications for scheduling and allocation of work across workers.

■ SD35

205A-MCC

Strategic Queueing

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Laurens Debo, Dartmouth College, Tuck School of Business, Hanover, NH, 03755, United States, Laurens.G.Debo@tuck.dartmouth.edu

Co-Chair: Luyi Yang, University of Chicago, Booth School of Business, Chicago, IL, 60637, United States, luyi.yang@chicagobooth.edu

1 - Queueing With Strategic Balking And System Design

Yichen Tu, University of North Carolina, Chapel Hill, NC, United States, yichen1@live.unc.edu, Nur Sunar, Serhan Ziya

We analyze a queueing system where customers decide whether to join or balk the system depending on the expected benefit they receive by joining a system. In this setting, we characterize the optimal choice of system design from the perspective of a social welfare optimizer. We also conduct numerical studies to shed light on the benefit of different system design choices.

2 - Risk/return Trade-off In Queues With A Nonlinear Waiting Cost Function

Hossein Abouee-Mehrizi, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, haboueemehrizi@uwaterloo.ca, Ata G Zare, Renata Konrad

We consider an M/M/1 queueing system and assume that each customer receives a value by getting served and suffers from a waiting cost. To analyze customers’ behavior, we consider the risk/return trade-off and a nonlinear waiting cost function. Customers are impatient and have a mixed attitude with respect to the risk. Before reaching a certain point in time, customers are risk-seeking, but after that they become risk-averse. We assume that customers follow a joint balking and abandonment strategy. We fully characterize the equilibrium joint balking and abandonment strategy and show that three types of equilibria may exist: global, myopic, and farsighted.

3 - Optimal Information Disclosure In M/M/1 Queues

Shiliang Cui, Georgetown University, 548 Rafik B. Hariri Building, 37th & O Streets, NW, Washington, DC, 20057, United States, shiliang.cui@georgetown.edu, Jinting Wang

Queue length is a very important parameter for customers to make a joining decision or not. We study optimal information disclosure policies in M/M/1 queues.

4 - Want Priority Access? Refer Your Friend To Move Up In Line

Luyi Yang, University of Chicago, lyang6@chicagobooth.edu
Laurens G Debo

This paper studies the referral priority program, an emerging business practice adopted by a growing number of technology companies that manage a waitlist of customers. The program enables existing customers on the waitlist to gain priority access if they successfully bring in new customers. We find that the effectiveness of this novel mechanism as a marketing tool for customer acquisition and an operational approach for waitlist management depends crucially on the base arrival rate of the system. Referrals may not be generated when the base arrival rate is either too high or too low. Even when customer refer, the program could backfire (i.e., reduces the system throughput and customer welfare).

■ SD36

205B-MCC

Economics of Operations Management

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: Kenan Arifoglu, UCL, London, United Kingdom, k.arifoglu@ucl.ac.uk

1 - Money-back Guarantees When Physical And On-line Retailers Compete

Hang Ren, University College London, hang.ren.13@ucl.ac.uk Tingliang Huang, Ying-Ju Chen, Christopher S Tang

We study the pricing and product return policies when physical and on-line stores compete. We find that the on-line store offers money-back guarantees when its salvage advantage outweighs total return hassle. Interestingly, better service quality may hurt the on-line store. When consumers can showroom, i.e., buying online after trying the product offline, the on-line store should offer hassle-free money-back guarantees. Moreover, the showrooming behavior may benefit the physical store while harming the online store.

2 - Licensing Contracts In Conspicuous Markets

Prateek Raj, University College London, p.raj.12@ucl.ac.uk, Kenan Arifoglu

We study licensing decision of a brand owning firm that sells its primary product to conspicuous customers who value the brand exclusivity, and also licenses its brand name to a licensing firm. We compare efficiency of fixed-fee, royalty and mixed contracts and also explore the role of licensing under competition.

3 - Selling New Products Through Consumer Learning

Yufei Huang, University of Bath, y.huang@bath.ac.uk, Bilal Gokpinar, Christopher S. Tang, Onesun Steve Yoo

Due to uncertain valuation of a new product, consumers often seek to learn more about the product before making purchasing decisions. In general, consumers can learn from the firm directly, from making an individual effort to learn, or from other consumers indirectly (through social learning). In this paper, we present a unified framework of consumer learning in the context of rational and heterogeneous consumers. Our goal is to examine, from the firm's perspective, when and why (i) investing in firm-induced learning can be superior to variable pricing, (ii) subsidizing individual learning can be beneficial, and (iii) investing in social learning (e.g., online forums) can be harmful.

4 - Is Reshoring Better Than Offshoring Under Offshore Supply Dependence?

Hu Bin, University of North Carolina, Chapel Hill, NC, United States, bin_hu@unc.edu, Li Chen

We investigate offshore supply dependence's impact on the offshoring-reshoring comparison. We find that offshore supply dependence may hamper a reshoring manufacturer's responsiveness to demand information updates, such that reshoring may yield lower profits than offshoring in many cases, including when reshoring has no direct cost disadvantages. We then show that offshore supply dependence also affects how customs duties and shipping costs influence the offshoring-reshoring profit comparison. We further identify common-component designs as an approach to mitigate reshoring firms' offshore supply dependence and help promote reshoring in its presence.

■ SD37

205C-MCC

Value Chain Transformations for Sustainability

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Dan Andrei Iancu, Stanford University, 655 Knight Way, Stanford, CA, 94305, United States, daniancu@stanford.edu

Co-Chair: Joann de Zegher, Stanford University, Y2E2 Suite 226, Stanford, CA, 94305, United States, jfdezegher@stanford.edu

1 - Retail Clusters In Developing Countries

Xuying Zhao, University of Notre Dame, Xuying.Zhao.29@nd.edu, Hong Guo, Chao Ding, Jing-Sheng Jeannette Song

A retail cluster refers to a collection of horizontally differentiated retailers of a particular business sector locating in close proximity. Retail clusters are commonly seen in developing countries. In this paper, we develop a game-theoretic model to explore why the retail cluster phenomenon is so popular in developing countries and how the governments in these countries can foster retail clusters and leverage them to improve social welfare.

2 - Achieving Sustainability Commitments In Commodity Supply Chains

Joann Francoise de Zegher, Stanford University, Stanford, CA, United States, jfdezegher@stanford.edu, Hau Leung Lee, Dan Andrei Iancu, Erica Plambeck

How can downstream companies in commodity supply chains incentivize small producers to mitigate deforestation while also improving farmer welfare? Motivated by field research in the palm oil industry, we propose an incentive based on early payments. The dynamics of this incentive are distinct from a price premium incentive, due to characteristics of small-farmer cash flow needs upstream and large discrepancies in borrowing abilities of different supply chain tiers. We build a theoretical model to analyze this setting and ground our analysis through empirical work in the complex palm oil supply chain originating in Indonesia.

3 - Effective Medical Surplus Recovery

Can Zhang, Georgia Institute of Technology, Atlanta, GA, 30309, United States, czhang2012@gatech.edu, Atalay Atasu, Beril L Toktay, Wee Meng Yeo

We analyze a Medical Surplus Recovery Organization (MSRO) that recovers and manages reusable medical products to fulfill the needs of under-served healthcare facilities in developing countries. Using a game theoretic analysis, we identify loss of effectiveness caused by competition among recipients in a recipient-driven model implemented by the MSRO. We then present operational mechanisms that can improve the MSRO's total value provision and we numerically validate our results using real life data.

■ SD38

206A-MCC

Innovation and Entrepreneurship

Invited: New Product Development

Invited Session

Chair: Raul Chao, University of Virginia, UVA, Charlottesville, VA, United States, ChaoR@darden.virginia.edu

1 - Risk Aversion And Joint Problem Solving: Experimental Evidence

Marc Christiaan Jansen, Cambridge Judge Business School, Downing College, Regent Street, Cambridge, CB2 1DQ, United Kingdom, mcj32@cam.ac.uk, Nektarios Oraiopoulos, Niyazi Taneri

We examine the effect of risk aversion on collaborative problem solving between two partners. We design an experiment that measures subjects' risk aversion and allocates subjects to treatments accordingly. We show that subjects perform relatively well in sharing the risk between them, but underperform relatively to the optimal investments levels.

2 - Strategic Positioning In Global Entrepreneurship Ecosystems

Hyunwoo Park, Postdoctoral Fellow, Georgia Institute of Technology, Atlanta, GA, 30332, United States, hwpark@gatech.edu, Rahul C Basole, Raul Chao

Strategic positioning is particularly critical for entrepreneurial ventures, which face a difficult trade-off in balancing legitimacy through similarity versus innovativeness through differentiation. Using a computational approach based on data mining, text analytics, and network visualization, we seek to gain an understanding of the structure of strategic positioning of nearly 60,000 companies in 35 global entrepreneurial ecosystems.

3 - Won't Leave You At The Altar: Designing Alternative Mechanisms For Startup Supply Chain Development

Emre Guzelsu, Boston University, bguzelsu@bu.edu Brad Lee, Nitin Joglekar

Startup supply chain development spans two stages, early experimentation without revenue followed by production scale-up and revenue generation. Early experimentation involves single sourcing with another startup, while production offers dual sourcing opportunity. We explore alternative mechanisms for startup supplier alignment across both stages using a game theoretic framework.

4 - Optimal Supplier Allocation In Collaborative Product Development With Competing Internal Teams

Svenja Sommer, HEC Paris, 1, Rue de la Liberation, Jouy-en-Josas, France, sommers@hec.fr, Timofey Shalpegin, Christian Van Delft

To reduce the uncertainty inherent in development, manufacturers sometimes deploy competing internal teams, each working on a different technology or design. Often this development takes place in collaboration with key suppliers. We explore how manufacturers should allocate suppliers (with different capabilities) to these teams, considering the impact on supplier efforts.

SD39

207A-MCC

Queueing Systems and Approximations

Sponsored: Applied Probability

Sponsored Session

Chair: John Hasenbein, University of Texas-Austin, Austin, TX, United States, jhas@mail.utexas.edu

1 - Optimal Routing To Remote Queues

Yunan Liu, NC State University, Raleigh, NC, United States, yliu48@ncsu.edu, Shucangchi He, Yao Yu

We develop optimal routing policies for remote queueing systems, in which each arrival, after being routed to join one of several single-server queues in parallel, will experience a pre-arrival delay. Motivated by service systems in which system state (e.g., queue length and waiting time) is available for routing decisions, we intend to use pre-arrival delays to model commute times of arrivals, such as patients' transportation times before arriving at clinics and data packets' transmission times to web servers. In order to minimize the delay, we propose a new state-dependent probabilistic routing policy.

2 - Complete Resource Pooling In Open Shop Networks

Shuangchi He, National University of Singapore, Singapore, heshuangchi@nus.edu.sg, Gideon Weiss, Hanqin Zhang

In an open shop network, each customer needs to go through all stations once, but the order of visiting each station is irrelevant. Can this flexibility in service order give us an edge in reducing customer waiting times? In this paper, we consider an open shop network consisting of two stations. We find routing and sequencing policies that are asymptotically optimal when the open shop network is operated in heavy traffic. We prove that under the obtained scheduling policies, customer waiting times in an open shop network are asymptotically close to the waiting times in a GI/GI/2 queue with the same traffic intensity.

3 - Stein Method And Moderate Deviations For Steady-state Diffusion Approximations

Jim Dai, Cornell University, jd694@cornell.edu, Fang Xiao

Service levels such as no more 5% of callers have to wait 3 minutes orlonger are common performance measures for many service systems. Iwill use the Erlang-C system to explain how Stein method can be used todevelop moderate deviations bounds for steady-state diffusionapproximations of these performance measures. This is the joint work with Xiao Fang at NUS and Chinese University of Hong Kong.

4 - Optimal Service Rate And Admission Control For A Queue

Levent Kocaga, Yeshiva University, kocaga@yu.edu

We study the joint service rate and admission control problem for a multi-server service system modeled as a G/M/N+GI queue. We consider the infinite horizon discounted cost criterion as well as the infinite horizon average cost criterion where costs are associated with customer waiting, customer abandonment, and service rate control. Instead of solving the potentially intractable original queueing control problem, we solve an approximating diffusion control problem (DCP) and show that the optimal control is of threshold and feedback type. We utilize the solution to the DCP to construct a control policy for the original queueing control problem.

SD40

207B-MCC

Supply Chain Mgt

Contributed Session

Chair: Xinghao Yan, Western University, London, ON, Canada, xyan@ivey.uwo.ca

1 - Simulation And Optimization For Reevaluating Order Fulfillment Plans In An Online Retail Environment

Amir Hossein Kalantari, University of Wisconsin Milwaukee, Milwaukee, WI, United States, kalanta2@uwm.edu, Matthew Petering

Online retailing has expanded dramatically in recent years and is expected to continue growing in the future. Online retailers typically operate a number of fulfillment centers that are located in different geographical regions. When an order is placed, it must be assigned to one or more fulfillment centers. The decision of choosing which fulfillment centers satisfy which orders is very critical and there is an opportunity for the retailer to significantly reduce shipping costs by making the right decisions. In our research, we use a combination of discrete event simulation and optimization to investigate the effects of different strategies and compare their effectiveness.

2 - The Value Of Aggregated Information Sharing In Supply Chains

Vladimir Kovtun, Yeshiva University Syms School of Business, New York, NY, vladimir.kovtun@yu.edu

We study a two-stage supply chain where the retailer's order is the aggregate of two stationary ARMA processes. We determine when there is value to sharing the individual processes and when there is additional value to sharing the shocks. We also determine the supplier's mean squared forecast error under no sharing, process sharing, and shock sharing. We find instances when process sharing has no value which are not present in earlier literature.

3 - Coordination Of The Supply Chain With Quality Improvement And Customer Returns

Xinghao Yan, Western University, London, ON, Canada. Contact: xyan@ivey.uwo.ca

We study a supply chain with both quality improvement and customer returns. We analyze the retailer's incentive for refund price and the supplier's incentive for quality improvement. We also design coordinating contracts for the supply chain, which is influenced by several factors: contract format, profit negotiation, and first-mover right.

SD41

207C-MCC

Financial Engineering and Risk Management

Sponsored: Financial Services

Sponsored Session

Chair: Ning Cai, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China, ningcai@ust.hk

Co-Chair: Yingda Song, University of Science and Technology of China, Jinzhai Road, Hefei, 230026, China, songyd@ustc.edu.cn

1 - Simulating Risk Measures

Steven Kou, National University of Singapore, matsteve@nus.edu.sg

Risk measures, such as value-at-risk and expected shortfall, are widely used in risk management. We propose a simple general framework, allowing dependent samples, to compute these risk measures via simulation. The framework consists of two steps: In the C-step, we control the relative error in the simulation by computing the necessary sample size needed for simulation, using a newly derived asymptotic expansion of the relative errors for dependent samples; in the S-step, the risk measures are computed by using sorting algorithms. Numerical experiments indicate that the algorithm is efficient even at the 0.001 quantile level. This is a joint work with Wei Jiang.

2 - Valuation Of Path-dependent Equity And Credit Derivatives

Ning Cai, Hong Kong University of Science & Technology, ningcai@ust.hk

We study the pricing problems of path-dependent equity and credit derivatives within a general hybrid equity-credit framework, i.e., under generalized jump to default extended exponential Levy models with local volatilities. More precisely, under this general model, we propose a unified approach to pricing various equity derivatives and credit derivatives, including defaultable corporate bonds, European options, barrier options, CDS, and EDS. Numerical results indicate that our pricing methods are accurate, efficient, and easy to implement. This is joint work with Haohong Lin from HKUST.

3 - A Unified Framework For Options Pricing Under Regime Switching Models

Yingda Song, University of Science and Technology of China, Hefei, China, songyd@ustc.edu.cn

Regime changes are prevalent in the financial markets, yet it is challenging to price options in presence of regime switching. In this talk, we provide a unified framework for pricing options under a wide class of regime switching models. Based on our framework, we study the effects of regime switching on the prices and hedge parameters of various types of options, as well as the yield spread of a structural credit model.

■ SD42

207D-MCC

The OTC Derivatives Market Reform and the Subsequent Interplay betwen Banks and CCPs

Sponsored: Financial Services

Sponsored Session

Chair: Ghamami Samim, Federal Reserve Board, 20th St and Constitution Ave NW, Washington, DC, 20551, United States, samim.ghamami@frb.gov

1 - OTC Derivatives Reform and the Subsequent Interplay Between Banks and Central Counterparties

Samim Ghamami, Federal Reserve Board, samim.ghamami@frb.gov

We first discuss the G-20 reform program in the over-the-counter (OTC) derivatives markets and the subsequent Basel risk capital, collateral, liquidity, and leverage regulation. Next and after a brief review of derivatives central counterparties (CCPs), we present the paper "Does OTC derivatives reform incentivize central clearing?" Ghamami and Glasserman [2016].

■ SD43

208A-MCC

Values and Decision-Making

Sponsored: Decision Analysis

Sponsored Session

Chair: Johannes Siebert, University of Bayreuth, Universitätsstr. 30, Bayreuth, 95440, Germany, Johannes.Siebert@uni-bayreuth.de

1 - Identifying, Structuring, And Using Personal Strategic Life Objectives

Ralph L. Keeney, Duke University, San Francisco, CA, United States, keeneyr@aol.com

Most individuals desire a quality life, but have not articulated the objectives necessary to pursue and reasonably achieve such a life. This presentation discusses how to identify your personal strategic life objectives and how to use them to enhance the quality of your life.

2 - Identifying, Structuring, And Comparing Objectives Of Terrorists

Detlof von Winterfeldt, Center for Risk and Economic Analysis of Terrorism Events (CREATE), University of Southern California, Los Angeles, CA, CA 90089, United States, winterfe@usc.edu
Johannes Siebert, Richard S John, Gregory Keeney, Heather Rosoff

The risk of terrorism is of great concern to many countries and significant resources are spent to counter this threat. A better understanding of the motivation of terrorists and their reasons for selecting certain modes and targets of attack can help improve the decisions to allocate resources in the fight against terrorism. We develop methods using principles of decision analysis and value-focused thinking to identify, structure, and compare objectives of terrorists. We use our methods to provide the key decision makers in the Pentagon with a sound basis for fighting the terrorist groups.

3 - Enhancing Life Satisfaction By Improving Proactive Cognitve Skills

Johannes Siebert, University of Bayreuth, Johannes.Siebert@uni-bayreuth.de, Reinhard Kunz

The Proactive Decision Making scale, which is based on the concepts of value-focused thinking and decision quality, measures proactive personality traits and cognitive skills in decision-making. We show that proactive cognitive skills can explain up to 36% of life satisfaction, i.e. proactive decision makers are more satisfied with their decisions and with their lives. Furthermore, we provide empirical evidence that proactive cognitive skills can be trained in a course on decision-making. We recommend schools, colleges, and universities to offer more courses on decision-making to enhance student`s proactive cognitive skills and satisfaction with their decisions and lives.

■ SD44

208B-MCC

Robust Decision Analysis

Sponsored: Decision Analysis

Sponsored Session

Chair: Erin Baker, Univ of Massachusetts-Amherst, Amherst, MA, United States, edbaker@ecs.umass.edu

1 - Robust Sensitivity Analysis In Climate Change Modelling

Emanuele Borgonovo, Bocconi University, emanuele.borgonovo@unibocconi.it, Max D. Morris, Elmar Plischke

In several situations, analysts are not able to assign a unique distributions to the inputs of a computer code. Especially when alternative opinions are received by experts, analysts may combine alternative assessments using a mixture. The removal of the unique distribution assumption creates several issues in global sensitivity analysis, which we address systematically in this work.

2 - Climate Informed Decision Analysis: Do We Need Probabilities?

Casey Brown, University of Massachusetts, Amherst, casey@engin.umass.edu

The projected impacts of climate change often include untenable implications for many infrastructure systems. Planners and policy makers seek the best possible sources of climate change projections and information to assist their decision making needs. However, the dominance of climate science oriented toward mitigation of greenhouse gas emission questions leads to a disorientation of research focused on adaptation to climate change impacts. A break from "impact analysis" methods is needed, and a climate informed decision analysis is proposed in response. The question of use of probabilities, in particular, is analyzed. <!—EndFragment—>

3 - Finding Common Ground When Experts Disagree: Robust Portfolio Decision Analysis

Erin Baker, Univ. of Massachusetts - Amherst, edbaker@ecs.umass.edu, Valentina Bosetti, Ahti Salo

We address the problem of choosing a portfolio of policies under "deep uncertainty." We introduce the idea of belief dominance as a way to derive a set of non-dominated portfolios and robust individual alternatives. The belief dominance concept allows us to synthesize multiple expert - or model - based beliefs by uncovering the range of alternatives that are intelligent responses to the range of beliefs. We illustrate our approach using an important problem in the climate change and energy policy context: choosing among clean energy technology R&D portfolios.

■ SD45

209A-MCC

Quantitative Methods in Risk Management

Invited: Risk and Compliance

Invited Session

Chair: Agostino Capponi, Columbia University, 500 West 120th Street, New York, NY, 10027, United States, ac3827@columbia.edu

1 - Managing Systemic Risk In Inhomogeneous Financial Networks

Nils Detering, University of California Santa Barbara, Santa Barbara, CA, 93106, United States, detering@pstat.ucsb.edu, Thilo Meyer-Brandis, Konstantinos Panagiotou, Daniel Ritter

To quantify and manage systemic risk in the interbank market, we propose a weighted, directed random network model. The vertices in the network are financial institutions and the weighted edges represent credit exposures between them. Our model resembles the strong degree of heterogeneity observed in empirical data and generalizes earlier work based on the configuration model to inhomogeneous random graphs with unbounded variance of the degree sequence. We study the networks resilience to local shocks (only a few initially defaulted institutions) and derive capital charges, which ensure the networks resilience.

2 - Information Relaxation Bounds And The Dynamic Assortment Problem

David Brown, Duke University, dbbrown@duke.edu, Jim Smith

n this talk, we discuss the use of information relaxation bounds to generate performance bounds for dynamic programming problems. We focus on the dynamic assortment problem (Caro and Gallien 2007) and show how the information relaxation bounds improve upon Lagrangian relaxation bounds.

3 - Path-dependent And Randomized Strategies In Barberis' Casino Gambling Model

Xunyu Zhou, Columbia University, Manhattan, New York City, NY, United States, xz2574@columbia.edu

We consider the dynamic casino gambling model initially proposed by Barberis (2012) and study the optimal stopping strategy of a pre-committing gambler with cumulative prospect theory (CPT) preferences. We illustrate how the strategies computed in Barberis (2012) can be strictly improved by reviewing the betting history or by tossing an independent coin, and we explain that the improvement generated by using randomized strategies results from the lack of quasi-convexity of CPT preferences. Moreover, we show that any path-dependent strategy is equivalent to a randomization of path-independent strategies.

4 - Optimal Exit Time From Casino Gambling: Strategies Of Pre-committed And Naive Gamblers

Xuedong He, Chinese University of Hong Kong, xdhe@se.cuhk.edu.hk

We study the strategies of a pre-committed gambler, who commits her future selves to the strategy she sets up today, and of a naive gambler, who fails to do so and thus keeps changing plans at every time. We identify conditions under which the pre-committed gambler, asymptotically, adopts a stop-loss strategy, exhibits the behavior of disposition effect, or does not exit. When the utility function is piece-wise power and the probability weighting functions are concave power, we derive the optimal strategy of the pre-committed gambler in closed-form whenever it exists. Finally, we study the actual behavior of the naive gambler and highlight its marked differences from that of the pre-committed gambler.

■ SD46

209B-MCC

Revenue Management: From Theory to Practice

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Georgia Perakis, Massachusetts Institute of Technology, Cambridge, MA, United States, georgiap@mit.edu

1 - The Role Of Vendor Funds In Promotion Planning

Lennart Baardman, MIT, Cambridge, MA, United States, Georgia Perakis, Kiran Venkata Panchamgam

Vendor funds are integral to promotion planning. Vendor funds are trade deals in which manufacturers offer discounts to retailers, encouraging them to promote their products, while demanding pass-through to the customers. We model the problem of selecting vendor funds to maximize profit while taking into account the impact on promotional pricing as a QIP. First, we use a strategic model to analyze the optimal strategies of both the manufacturer and the retailer. Additionally, to solve the tactical problem, we use Lagrangian relaxation to propose an approximation algorithm with analytical performance guarantees. Finally, computational results show near-optimal practical performance.

2 - Revenue Management For The Shipping Industry Under Limited Foresight

Max Biggs, Massachusetts Institute of Technology, Cambridge, MA, United States, maxbiggs@mit.edu, Georgia Perakis

We study a scenario where a shipping company has limited foresight into cargo availability in future periods. It is possible that a high valued cargo may discharge in unpromising region with scarce or low valued cargoes, thus jeopardizing profit in subsequent time periods. We model this situation using a finite horizon Markov Decision Process and present a ranking algorithm which solves optimally in polynomial time. We also explore fast heuristics, and test these algorithms on a simulation that uses real shipping data to evaluate their performance in a practical setting. We also show extensions for uncertain shipping rates.

3 - Submodular Batch Scheduling

Daniel Chen, MIT, Cambridge, MA, United States, dcchen@mit.edu, Retsef Levi, Georgia Perakis

Consider an online retailer shipping out orders from a warehouse. Multi-item orders take up capacity in a holding area until all items are picked. This holding area is often the cause of bottlenecks, so we formulate the submodular batch scheduling problem to maximize throughput. We wish to schedule jobs in batches to minimize the sum of job completion times. The processing time of each batch is given by a submodular cost function, and the completion time of each job is given by the completion time of the batch. We show this problem is strongly NP-hard, but propose several practical methods, including a 4-approximation algorithm.

4 - The Periodic Joint Replenishment Problem Is Strongly NP-hard

Tamar Cohen, MIT, tcohen@mit.edu, Liron Yedidsion

The Joint Replenishment Problem (JRP) deals with the prospect of saving resources through coordinated replenishments in order to achieve substantial cost savings. In the JRP it is required to schedule the replenishment times of numerous commodities in order to supply a constant demand per commodity. In this research we answer a long-standing open question regarding the computational complexity the periodic JRP. This problem received a lot of attention over the years and many heuristic and approximation algorithms were suggested. However, in spite of the vast effort, the complexity of the problem remained unresolved. In this research, we provide a proof that the problem is indeed strongly NP-hard.

■ SD47

209C-MCC

Online Learning and Revenue Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Maxime Cohen, Google Research, Google, New York, NY, 10012, United States, maxccohen@google.com

Co-Chair: Ilan Lobel, New York University, New York, NY, United States, ilobel@stern.nyu.edu

1 - Dynamic Pricing And Learning With Online Retail Rankings

N. Bora Keskin, Duke University, Durham, NC, United States, bora.keskin@duke.edu, Arnoud V. den Boer

In online market environments such as Amazon or Google Shopping, firms receive advertisement space if they satisfy certain conditions. Beforehand, it is not clear if the benefits of this increased exposure outweigh the potential costs. We investigate this question in a dynamic pricing-and-learning setting.

2 - Dynamic Pricing With Demand Covariates

Sheng Qiang, Stanford University, sqiang@stanford.edu, Mohsen Bayati

We consider a generic problem that a firm sells products over T periods without knowing the demand function. The firm sets prices to earn revenue and learn the demand function. In each period before setting the prices, the firm observes some demand covariates, which may be predictive of the demand. Demand covariates can include marketing expenditure, consumer's attributes, weather, etc. We prove that in this setting the greedy policy achieves asymptotically optimal performance. We also show that inclusion of any set of demand covariates as potential variables for the demand estimation (even though they could be independent of the demand) would make greedy policy asymptotically optimal.

3 - Optimistic Gittins Indices

Vivek Farias, MIT, vivekf@mit.edu, Eli Gutin

We consider the multi-armed bandit problem in the Bayesian setting wherein one seeks to minimize expected regret. Gittins indices provide an optimal algorithm for the maximization of discounted, infinite horizon rewards (as opposed to regret minimization) in this very setting. So motivated, we propose an index rule we dub 'optimistic' Gittins indices. We show that this rule achieves logarithmic regret with an optimal constant, matching the Lai-Robbins lower bound for the problem — the strongest possible guarantee possible. The algorithm also offers excellent performance relative to recently studied approaches such as Thomspon and Information Directed Sampling.

4 - Feature-based Dynamic Pricing

Ilan Lobel, NYU Stern, New York, NY, 10012, United States, ilobel@stern.nyu.edu, Maxime Cohen, Renato Paes Leme

We consider the problem faced by a firm that receives highly differentiated products in an online fashion and needs to price them in order to sell them to its customer base. Products are described by vectors of features and the market value of each product is linear in the values of the features. The firm does not initially know the values of the different features, but it can learn the values of the features based on whether products were sold at the posted prices in the past. We propose an algorithm that combines ideas from contextual bandits and the ellipsoid method, and show that it has a worst-case regret that is quadratic in the dimensionality of the feature space and logarithmic in the time horizon.

■ SD48

210-MCC

Social Media Analytics for Competitive Advantage

Invited: Social Media Analytics

Invited Session

Chair: Vilma Todri, New York University, New York, NY, 11111, United States, vtodri@stern.nyu.edu

1 - Social Influence And Changing Circumstances In The Creation, Maintenance, And Disruption Of Habits In Global Health Behavior

Christos Nicolaides, Massachusetts Institute of Technology, chrisnic@mit.edu

In this research I analyze a unique, granular dataset of individual-level exercise data from more than 10 million users worldwide for about seven years to (a) measure the regularity of exercise behavior, (b) identify factors that predict a behavior continuing, (c) compare social influence in running for individuals with and without running habits, and (d) estimate the consequences of common disruptions to circumstances cues for habitual behaviors. I use modern causal inference techniques to address central questions in the psychology of habits with applications to interventions — especially social interventions — to influence exercise behavior and adoption of consumer exercise products.

2 - Location-based Advertising And Contextual Mobile Targeting

Dominik Molitor, New York University, dmolitor@stern.nyu.edu

Understanding how location-based advertising (LBA) can be utilized to increase sales in stores is important for offline retailers. LBA is a means to target users by making use of their location via GPS-enabled smartphones. Further, the ubiquitous nature of smartphones increases the importance of additional contextual factors such as time and weather. In particular, we analyze how contextual factors can be used to improve the prediction of responses to mobile promotions by applying unique GPS data. In particular, we examine the interplay between location, time, weather as well as co-location and users' responses to mobile promotions.

3 - The Effect Of Referral Source On News Article Readership And Sharing Patterns

Sagit Bar-Gill, Massachusetts Institute of Technology, Cambridge, MA, United States, sbargill@mit.edu, Shachar Reichman, Xitong Li

The ongoing transition to online and mobile news consumption is both a challenge and an opportunity to news providers. Readers are consuming more content online, and are increasingly relying on third-party aggregators and social media to find what content to read. We employ analytic tools and fine grained news consumption data to study the effect of online referral sources on readership and sharing patterns on the Christian Science Monitor website. We explore differences in traffic patterns coming from social media and news aggregators, and examine whether the effects of referral source differ for mainstream compared to niche content.

4 - Trade-offs In Digital Advertising: Modeling And Measuring Advertising Effectiveness And Annoyance Dynamics

Vilma Todri, New York University, vtodri@stern.nyu.edu
Anindya Ghose, Param Vir Singh

This study captures the trade-offs between effective and annoying digital advertising exposures. A hidden Markov model (HMM) is proposed that allows us to investigate the extent to which display advertising has an enduring impact on consumers' purchase decision and whether display advertising can stimulate annoyance to consumers; we provide a conceptual framework for understanding whether persistent digital display advertising exposures constitute a mechanism of annoyance. We also study the structural dynamics of the effective and annoying display advertising effects by allowing the corresponding effects to be contingent on the latent state of the funnel path consumers reside.

■ SD49

211-MCC

Text Analysis within Social Media

Invited: Social Media Analytics

Invited Session

Chair: Fay Cobb Payton, North Carolina State University, Campus Box 7229, Raleigh, NC, 27695, United States, fay_payton@ncsu.edu

1 - Text Analytics - The Power Of Storytelling

FayCobb Payton, Professor, Information Systems, NCSU, fay_payton@ncsu.edu

Numbers do not lie. This is a typical framework for positivists (often quantitative) researchable questions. This session will provide the introduction and a case study of why text analytics can be a powerful tool for complex, often unstructured data sources. A following session will provide insights into incorporating text analytics into organizational and research objectives.

2 - Unlocking Your 80%: Unearthing New Insights With Text Analytics

Christina Engelhardt, SAS Institute, Christina.Engelhardt@sas.com

How can your organization harness the staggering volumes of textual data coming from social & online media and your own proprietary systems? Join us as we explore some of the challenges and exciting opportunities these rich, yet complex, data sources provide us. Session topics include: • Why you should consider incorporating text analytics into your data science, research, and operational work streams• How to align technology, data sources, and the various text methods with your use case and objectives• Examples of how leading organizations are leveraging Text Analytics

3 - Hierarchical Machine Learning Approach To Detecting Anomalous Behavior In Online Social Media Forums

Naveen Kumar, University of Memphis, Memphis, TN, 38152, United States, nkumar7@memphis.edu, Deepak Venugopal, Robin Poston

The detection of anomalous behavior in online social media is a challenging problem due to complex interactions between several user characteristics such as review veracity, velocity, volume, and variety. We propose a novel two stage hierarchical machine learning approach that increases the likelihood of detecting anomalies by analyzing different actions of individual users and then characterizing their collective behavior. Specifically, we model user characteristics as univariate/multivariate distributions and then combine these distributions using mixture models to obtain a unified view of a user's behavior. We apply our approach to real-world reviews and obtain promising results.

■ SD50

212-MCC

Dr. William Massey: A Dynamic Legacy

Sponsored: Minority Issues

Sponsored Session

Chair: Jamol Pender, Cornell University, 206 Rhodes Hall, Ithaca, NY, 14853-3801, United States, jamol.pender@gmail.com

1 - Dynamic Rate Queues

Jamol Pender, Cornell University, jamol.pender@gmail.com

Inspired by healthcare and transportation systems, this talk will summarize the past, present, and future of dynamic rate queues and their impact on our society.

2 - Dr. William Massey: A Dynamic Legacy

Robert Hampshire, University of Michigan, hamp@umich.edu

In this talk we will explore the applications of time varying queues to problems in urban transportation. We show how Bill Massey's fundamental contributions to queueing theory and applied probability can be applied to smart parking systems, bike sharing and car sharing services

3 - The Dynamics 0f Queueing Transience With Dynamic Rates

William A Massey, Professor, Princeton University, ORFE Department, Sherrerd Hall, Princeton University, Princeton, NJ, 08544, United States, wmassey@princeton.edu

Inspired by communication and healthcare services, this talk summarizes the methods developed with many collaborators over the decades to understand the transient behavior of dynamic rate queues. This analysis is needed when confronted with the dynamic parameters found in time-inhomogeneous Markovian queueing models. The static equilibrium analysis for the steady state of constant rate queues no longer applies.
Constants summarizing the transient behavior for these steady state systems yield to the natural substitute of deterministic dynamical systems. We can then approximate the optimal behavior of these queues by controlling this related family of ordinary differential equations.

■ SD51

213-MCC

Decision-making Models for Public Health Systems

Sponsored: Public Sector OR

Sponsored Session

Chair: Chaitra Gopalappa, University of Massachusetts - Amherst, 120D Marston Hall, 160 Governors Drive, Amherst, MA, 01003, United States, chaitrag@umass.edu

1 - Estimating Disease Burden Of A Potential H7N9 Pandemic Influenza Outbreak In The United States

Walter Silva Sotillo, USF, silvasotillo@mail.usf.edu

Recent emergence of H7N9 influenza virus in China resulted in 571 laboratory-confirmed cases of human infections causing 212 deaths (37% fatality rate). Researchers have developed early estimates of some of the epidemiological parameters to characterize H7N9 virus in China. We use data from recent reports, an agent-based simulation model and stratified sampling to estimate disease burden of a potential H7N9 pandemic outbreak in the United States.

2 - Using The HIV Optimization And Prevention Economics (HOPE) Model For Evaluating HIV Interventions In The United States

Emine Yaylali, Centers for Disease Control and Prevention, wqq3@cdc.gov, Paul Farnham, Stephanie Sansom, Katherine A. Hicks, Amanda Honeycutt, Emily Tucker

The HOPE model is a detailed, dynamic compartmental model of HIV disease progression and transmission in the United States. We parametrized and calibrated the model to closely match the population of people living with HIV between 2006 and 2010, to project HIV transmission into the future. The population was stratified by age, sex, circumcision status, race/ethnicity, transmission group, and risk level. Outcomes included HIV incidence, prevalence, and care status. We employed the HOPE model to evaluate the cost-effectiveness of HIV interventions and explore HIV prevention policy questions.

3 - Access-to-Medicines (ATM) Vaccine Supply Chain Design: Astakeholder Framework

Nico Vandaele, KU Leuven, Naamsestraat 69, Leuven, 3000, Belgium, nico.vandaele@kuleuven.be
Catherine Jenny Decouttere, Mauro Bernuzzi, Stef Lemmens

Supply chains supportive of ATM, like vaccine supply chains, impose considerable additional challenges on the supply chain design process. We embed the modeling in a broader stakeholder based framework, which will substantially enhance the societal and human impact of the ATM supply chain service delivery. Our approach contains stakeholder mapping and system delineation, key performance indicator development, scenario generation including modelling, scenario ranking and final design selection.

4 - A Methodology For Parameterization Of State-transitions For Cancer Progression In Populations With Limited Longitudinal Cancer Database

Chaitra Gopalappa, University of Massachusetts, Amherst, chaitrag@umass.edu, Carel Pretorius, Jeremy Lauer

Economic analyses of cancer screening strategies specific to populations in low and middle income countries (LMICs) are limited. Barriers include absence of cancer progression models parameterized specific to these populations. This study addresses this gap.

■ SD52

214-MCC

Public Sector OR Problems with Geographic Considerations

Sponsored: Public Sector OR

Sponsored Session

Chair: Ronald G McGarvey, University of Missouri, E3437D Lafferre Hall, Columbia, MO, 65211, United States, mcgarveyr@missouri.edu

1 - Dynamic Decision Modeling For Inland Waterway Disruptions

Rachel Holmer, University of Arkansas, reholmer@email.uark.edu, Hueon Lee, Mahboubeh Madadi, Shengfan Zhang, Heather Nachtmann

There is much uncertainty associated with inland waterway transportation. Natural or man-made disruption on the inland waterway system can have widespread economic and societal impacts, and their consequences can be significant. In this research, a Markov decision process model was developed to identify optimal decisions in the event of a weather-related disruption to minimize the barge owner's loss, incorporating the uncertainty associated with the reopening of the waterway and deteriorating value of the cargo. Historical lock and dam unavailability data and related weather data were collected and analyzed to build a prediction model on lock and dam closure and reopening.

2 - Identifying Optimal Multi-state Collaborations For Reducing Co2 Emissions By Co-firing Biomass In Coal-burning Power Plants

Bayram Dundar, University of Missouri, Columbia, MO, 65201-3738, United States, Bd5zc@mail.missouri.edu
Ronald McGarvey, Francisco X Aguilar

EPA has recently proposed a rule that aims to achieve a total US carbon emission reduction of 32 percent below 2005 levels by 2030. An increase in co-firing woody biomass with coal is one approach electricity providers could take towards achieving these reductions. We develop a mixed integer linear programming model to identify min-cost approaches for reducing carbon emissions via biomass co-firing subject to spatially-explicit biomass availability constraints, utilizing a robust optimization approach to address uncertainties in power plant modification costs and emission rates. We apply this model to a set of 18 states in the northern US to identify optimal sets of multi-state collaborations.

3 - Estimates Of Successful Illegal Entry Across The U.S. Southwest Land Border

Brian Rieksts, Institute for Defense Analyses, brieksts@ida.org

We present a methodology to estimate successful illegal entry across the United States southwest land border. A repeated trials model based on repeated apprehensions was used to estimate these flows. Both administrative data and survey data were evaluated and used to construct these estimates.

4 - A Robust Optimization Evaluation Of The Potential For Reliance On Locally-produced Foods

Ronald G. McGarvey, University of Missouri, Columbia, MO, United States, mcgarveyr@missouri.edu, Bayram Dundar, Christine Costello

Strategies focused on local food production may generate new risks due to yield variability. We develop a robust optimization (RO) model to determine, for a given center C, the minimum radius R of a circle containing sufficient cropland and pasture to produce food items that satisfy the calorie and nutrient needs of the population residing within distance R of any point within that circle. We first run the model using historical yield averages for two US cities, assuming no variability. We then run our RO model using historical yield data over ten years to estimate variability. We compare the two model results to illustrate the impact of data uncertainty on meeting sustainable local food for communities.

■ SD53

Music Row 1- Omni

Organizational Innovation

Sponsored: Technology, Innovation Management & Entrepreneurship

Sponsored Session

Chair: Sinan Erzurumlu, Babson College, 231 Forest St, Brookline, MA, 02457, United States, serzurumlu@babson.edu

1 - Business Start-up Operations

Nitin Joglekar, Boston University School of Management, joglekar@bu.edu

Evidence on operational innovations (OI), based on connectivity based analytics and low cost intelligent robotics, points to the co-evolution between business models and OI. We argue that this evolution offers opportunities to develop new types of decision support models.

2 - Communication, Incentives, And The Execution Of A Strategic Initiative

Jeremy Hutchison-Krupat, University of Virginia, krupatj@darden.virginia.edu

Senior leadership can influence a direct report through incentives and communication. Financial incentives are credible and precisely specified, but offer limited flexibility, whereas communication is flexible, but lacks precision and must be deemed credible to affect a direct report's actions. We study senior leadership who seeks to add an initiative to their portfolio. Early on, its potential to create value is not well-understood, however, senior leadership eventually obtains knowledge on its potential which they may communicate to their direct report.

3 - Relationship-specific Agreements Between The Service Provider And The Firm In The Gig Economy

Sinan Erzurumlu, Babson College, serzurumlu@babson.edu
Jonathan Sims

In this research we explore the interactions between the service providers and the firm in the gig economy. We analyze survey data to understand the relationship-specific norms and agreements between the service provider and the firm through the lens of psychological contracting.

4 - How Cost Reduction And Change Of Technology Significantly Changed The Demand Of A Product. Case Story Based On Daily Demand Data From 2012-2016

Eric Bentzen, Copenhagen Business School, eb.om@cbs.dk

Senior leadership can influence a direct report through incentives and communication. Financial incentives are credible and precisely specified, but offer limited flexibility, whereas communication is flexible, but lacks precision and must be deemed credible to affect a direct report's actions. We study senior leadership who seeks to add an initiative to their portfolio. Early on, its potential to create value is not well-understood, however, senior leadership eventually obtains knowledge on its potential which they may communicate to their direct report.

■ SD54

Music Row 2- Omni

Simulation of Healthcare Service Systems

Sponsored: Service Science

Sponsored Session

Chair: Wai Kin Chan, Rensselaer Polytechnic Institute, 110 8th St., CII 5015, ISE Dept., RPI, Troy, NY, 12180, United States, chanw@rpi.edu

1 - Optimizing Hospital Service Levels Via Resource Allocation

Weiwei Chen, Assistant Professor, Rutgers University, 1 Washington Park, Newark, NJ, 07901, United States, wchen@business.rutgers.edu, Siyang Gao, Hainan Guo

This talk introduces a resource allocation problem typically encountered in hospitals. Service levels in a hospital will vary as the resources are allocated differently. These performance measures can be evaluated via simulation. We aim to find the optimal allocation that maximizes one service level while satisfying the other service level requirements. Such an optimization is subject to random noises in simulation and the limit on computing budget to run simulation. To this end, we formulate the problem as a simulation optimization problem, and derive the corresponding optimal computing budget allocation policy.

2 - Simulation Of Infectious Disease Propagation

Susan M Sanchez, Professor, Naval Postgraduate School, Monterey, CA, 93950, United States, ssanchez@nps.edu, Paul J. Sanchez

We explore the behavior of a new stochastic model of infectious disease propagation. The model tracks individual outcomes, but without creating connectivity graphs for all members of the population. Accordingly, it is readily scalable to large populations, while preserving the impact of variability during the critical early stages of an outbreak. Initial explorations show behaviors similar to the observed course of historical outbreaks: while many outbreaks fizzle out quickly, some flare into more widespread epidemics. Such results may better inform decision makers about risk.

3 - Association Between Staff Behavior And Patient Experience Of Care In Acute-care Hospitals

Eduardo Perez, Assistant Professor, Texas State University, San Marcos, TX, United States, eduardopr@txstate.edu David P. Dzubay, Anthony Stahl

This research proposes a new framework to assess the performance of hospitals across multiple domains of patients' experiences. We examine whether key systemic characteristics of hospitals are associated with a better experience for patients. In particular, we investigated the effects of nurses and hospitalists activities on patients' ratings of their care. A case study is presented that considers data from the intensive care units from multiple hospitals in Central Texas.

4 - Simulating The Size Distribution Of Hospital Service Systems

Wai Kin Chan, Rensselaer Polytechnic Institute, chanw@rpi.edu, Baojun Gao, Nancy Deng

This talk introduces an agent-based simulation model for simulating the growth process of a hospital service system. In this model, hospitals grow or reduce their size to react to (and compete for) patient demand. Patients, as another type of agents in the model, select a hospital to visit based on multiple factors. The objective of the agent-based model is to understand what factors influence the growth of hospitals in a way that the hospital size distribution converges to the size distribution consistent with the actual size distribution observed in a real hospital size dataset.

■ SD55

Music Row 3- Omni

Modeling and Simulation of Education as a Complex System

Sponsored: Service Science

Sponsored Session

Chair: Maryam Alsadat Andalib, PhD Student, Virginia Tech, 1185 Perry Street, 536F Whittemore Hall, Blacksburg, VA, 24061, United States, maryam7@vt.edu

1 - Cross-sectional Surveys: Inferring Total Time In State Using Only Elapsed Time-to-date

Richard C Larson, Massachusetts Institute of Technology, rclarson@mit.edu

We survey populations whose members are in a temporary state, asking time already spent in the temporary state. Leveraging longevity bias, we derive distributions of total time spent in the state for: random & fixed times of surveying, random & fixed times of entering the state, and sampling only those who have already spent some minimal specified time in the state.

2 - Exploring The United States Behavioral And Social Science Research (BSSR) Workforce Through Dynamic Modeling

Julie Maurer, Ohio State University, maurer.99@osu.edu

The behavioral and social sciences research (BSSR) workforce in the United States is a segment of the STEM researcher workforce that is of growing concern. There is considerable interest in the health of the BSSR workforce as demonstrated by a recent Executive Order (EO 13707, 2015) recognizing the value of such research in informing effective policy creation. Given its complexity and the challenges of understanding the heterogeneity of its scientists, a hybrid model (combining system dynamics and agent based approaches) is developed in this study to explore and better understand the complex dynamics of the supply and demand in the BSSR workforce and the effects of various policy interventions.

3 - Different Modes Of Scientific Progress In HIV/AIDS

Arash Baghaei Lakeh, Virginia Tech, arashb@vt.edu Navid Ghaffarzadegan

There is a variation in research focus of scientific communities from different countries on various aspects of HIV/AIDS disease. In this research, we are employing topic finding methods to distinguish different trends of HIV/AIDS research over the past two decades. Our data includes the abstracts of more than 200,000 papers published over this period on HIV/AIDS. We then show differences of focus on HIV research in different countries and investigate the underlying reasons for such variation.

4 - Modeling And Analysis Of The Leaking Pipeline: Diversity In The United States Higher Education

Maryam Alsadat Andalib, Virginia Tech, Blacksburg, VA, United States, maryam7@vt.edu, Navid Ghaffarzadegan

Moving towards an equitable education system provides underrepresented groups with equal educational and economic opportunities. Many studies have attempted to identify the important causes of the existing gender and ethnicity gaps in higher education and the policy leverages with the goal of increasing equity. But the body of research investigating the effectiveness of different policy leverages is methodologically narrow. In this research, we specifically aim at identifying the important causes of disparities in the US higher education, and introduce policies to improve education equity as well as long term achievements of underrepresented minorities through a system dynamics approach.

■ SD56

Music Row 4- Omni

Health & IT

Sponsored: EBusiness

Sponsored Session

Chair: Laura Brandimarte, University of Arizona, Tucson, AZ, United States, lbrandimarte@email.arizona.edu

1 - There's An App For That: Addressing The Handoff Problem In Healthcare Using Mobile

Idris Adjerid, Notre Dame University, iadjerid@nd.edu Corey M Angst, Ralph Gross

Healthcare and mobile technologies seem like a natural union with the potential for considerable value to providers and patients. With this in mind, we study a novel mobile application designed to address the handoff problem between the Emergency Department and inpatient units. Leveraging data on more than 145,000 Emergency Department visit over 4.5 years alongside detailed logs of app usage, we find that use of the app reduced patient length of stays in the ED by 4-6%, effectively eliminating the additional time that an admitted patient spends in the ED.

2 - CPOE Adoption Impacts On Medicare Reimbursements

Hilal Atasoy, Temple University, hilal.atasoy@temple.edu

Computerized Physician Order Entry (CPOE) systems allow physicians to seamlessly enter information in patient records compared to paper-based records, potentially leading to higher quality of care. On the other hand, the ease of capturing information into electronic medical records can be deliberately used by hospitals to inflate their reimbursement requests from Medicare by overstating the complexity of patients' diagnoses. We study the relationship between CPOE adoption and reported patient complexity of hospitals. We find that, on average, the adoption of CPOE systems is associated with an increase in the case mix index. This increase is significantly higher among for-profit hospitals.

3 - Not What The Doctor Ordered: Physician Mobility And Technology Adoption

Brad N Greenwood, Temple University, brad.n.greenwood@gmail.com, Corey M Angst, Kartik Krishna Ganju

In this work we investigate the relationship between EMR implementation and physician mobility. Strikingly, although significant anecdotal evidence would suggest that EMR implementation is associated with an exodus of physicians, we find that this reaction is strongly moderated by hospital characteristics, physician characteristics, and the type of EMR implemented.

4 - Detecting Anomalous Patterns Of Care Using Health Insurance Claims

Sriram Somanchi, University of Notre Dame, 344 Mendoza College of Business, Notre Dame, IN, 46556, United States, somanchi.1@nd.edu, Edward McFowland

Patient care data using health insurance claims can be used to improve clinical practice by analyzing patterns across patients and providing actionable insights. Our goal in this project is to analyze this complex patient care data in order to identify interesting patterns in patient care that have led to anomalous health outcomes. Specifically, we detect treatments in the outpatient patient care that have significantly deviated from the regular treatment process and have affected health outcomes either negatively or positively. This can further help both in terms of improving patient health and reducing health care costs.

■ SD57

Music Row 5- Omni

Joint Session BOM/RMP: Consumer Behavior in Pricing and Loyalty

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Anton Ovchinnikov, Queen's School of Business, Kingston, ON, Canada, ao37@queensu.ca

1 - Impact Of Tiered Incentives On Behavior: Case Of The Airline Loyalty Programs

Tong Guo, University of Michigan, Stephen M Ross School of Business, 701 Tappan Street, Ann Arbor, MI, 48109, United States, tongguo@umich.edu, A. Yesim Orhun

This paper explores the impact of status incentives provided by a major U.S. airline on the purchasing behavior of its frequent flier program members. We leverage a database of complete transaction histories of more than six million members to study within-person changes in the distribution of price and route characteristics of tickets purchased from the airline as members progress towards a status goal. We present novel empirical manifestations of increased customer loyalty on market outcomes.

2 - Stockpile Or Redeem: How Do Consumers Value Loyalty Program Points

So Yeon Chun, McDonough School of Business, Georgetown University, sc1286@georgetown.edu, Rebecca Hamilton

Loyalty programs are designed to reward customers for buying more or buying more frequently from a firm. Typically, customers earn points for their purchases, which can then be exchanged for additional products and services. In a sense, these loyalty program points function as a currency that consumers can spend (redeem) on a purchase instead of money. We conduct a series of behavioral lab experiments to examine differences in the way customers think about loyalty points as compared to money, and how they choose whether to make a purchase with cash or points.

3 - Which Customers Are More Valuable In A Dynamic Pricing Situation?

Jue Wang, Queen's School of Business, Kingston, ON, Canada, jw171@queensu.ca, A. Yesim Orhun, Anton Ovchinnikov

We consider a firm that dynamically price its inventory and examine whether customers who purchase at higher prices indeed add higher marginal value to the firm. We present modeling and computational results which are calibrated on a unique data set from a major travel firm.

4 - Strategic Consumers, Revenue Management And The Design Of Loyalty Programs

Anton Ovchinnikov, Queen's School of Business, ao37@queensu.ca, So Yeon Chun

Several major firms recently switched their loyalty programs from quantity/'mileage'-based toward 'spending-based'. We study the impact of this switch on firm's profit and consumer surplus. We present a novel model of strategic consumers' response to firm's pricing and loyalty program decisions, incorporate such response into the firm's pricing and loyalty program design problem, compare several plausible loyalty-program designs, and discuss managerial implications.

■ SD58

Music Row 6- Omni

Energy IV

Contributed Session

Chair: Byungkwon Park, Ph.D student, University of Wisconsin - Madison, 202 N Eau Claire Avenue, # 314, Madison, WI, 53705, United States, bpark52@wisc.edu

1 - Two-stage Multi-agent Stochastic Optimization In Power Systems

Shasha Wang, Clemson University, 107 Wyeth LN, Central, SC, 29630, United States, shashaw@g.clemson.edu
Harsha Gangammanavar, Sandra D Eksioglu, Scott J. Mason

We present a two-stage stochastic optimization framework for a multi-agent system in which the global objective function incorporates individual agents' objective functions. Our approach applies to the problem of managing energy in microgrids that contain integrated renewable energy resources. A sequential sampling-based, stochastic approach—stochastic decomposition—is used to analyze the problem. Computational experiments are conducted and demonstrate the effectiveness of our proposed methodology using real world case study data.

2 - Analysis Of Co2 Emission Performance And Abatement Potential For Municipal Industrial Sectors In Jiangsu, China

Jie Zhang, Hohai University, Nanjing, China, zhangjie_jie@126.com, Jigan Wang, Zhencheng Xing

As the main source of CO_2 emissions in China, industrial sector has been faced with the tremendous pressure of reducing emissions. Based on the analysis of SBM-Undesirable model, GIS visualization method, kernel density estimation and industrial abatement model, we find that there exists a significant spatial inequality of CO_2 emission performance across various regions in Jiangsu, the largest CO_2 emitter in China, but the regional disparity has been narrowing during our study period. Additionally, average annual industrial CO_2 emission reductions in Jiangsu can attain 15654.00 (10 thousand tons), accounting for 28.2% of its average annual actual emissions.

3 - Production Intermittence In Spot Electricity Markets

Olivier Massol, IFP School, 228-232 Avenue Napoleon Bonaparte, Rueil-Malmaison, 92852, France, olivier.massol@ifpen.fr, Albert Banal-Estanol, Augusto Ruperez-Micola

This paper analyses the influence of production intermittence on spot markets. We use both game theory concepts and an agent-based simulation approach derived from the Camerer and Ho (1999) behavioral model. Controlling for costs, we find that intermittent technologies yield lower prices when incumbents have individual market power, but higher when they do not have it. This happens when firms are risk-neutral and risk-averse, and also under different intermittence and ownership configurations. Replacing high-cost assets with low-cost ones results in higher prices than letting them co-exist.

4 - A Sparse Tableau Analysis Formulation For The Security-constrained Optimal Power Flow

Byungkwon Park, PhD Student, University of Wisconsin-Madison, 202 N Eau Claire Avenue, # 314, Madison, WI, 53705, United States, bpark52@wisc.edu, Christopher DeMarco

The nonlinear security-constrained optimal power flow (SCOPF) is computationally challenging, with difficulties in obtaining even feasible points due to the nonconvexity of power flow equations and the large dimension when many contingencies are considered. As illustrated in literature on semidefinite programming for OPF, a well-chosen formulation can yield better solutions, more efficiently. To this end, this work considers a range of SCOPF problems in new sparse tableau formulations that explicitly maintain port currents and voltages of all grid elements, and examines computational time and quality of solutions with different nonlinear solvers.

■ SD59

Cumberland 1- Omni

Advances in Transportation Modeling

Sponsored: Transportation Science & Logistics

Sponsored Session

Chair: Tarun Rambha, University of Texas, Austin, TX, United States, tarun.1988@utexas.edu

1 - Throughput Analysis For Horizontal Traffic Queues under Safety Constraints

Mohammad Motie, University of Southern California, 1119 W 29th Street, Apt 7, Los Angeles, CA, 90007, United States, motiesha@usc.edu

We consider horizontal traffic queues (HTQ), where vehicle arrival and departure locations are sampled from spatial distributions. We consider first and second order car following models that guarantee no collision. HTQ is a state-dependent queuing system, where the service rate depends on the configuration of vehicles. We combine queuing- theoretic and dynamical systems tools, to provide novel insights into the service rate dynamics and busy period distribution for HTQ. These tools are used to compute bounds on throughput, which closely match simulations. Our throughput analysis illustrates the interplay between car-following behavior, road geometry, and arrival and departure statistics.

2 - Lost Demand And Redistribution In Bike Sharing Systems

Konstantina Mellou, Massachusetts Institute of Technology, Cambridge, MA, United States, kmellou@mit.edu, Patrick Jaillet

Spatial imbalances in bike sharing systems often lead to unavailability of resources (bikes or docks) and, as a result, lost customer demand. Our goal is to model redistribution operations that will allow the company to improve its level of service. An optimization approach is used, combined with decomposition and heuristics, and the performance of our methods is evaluated with tests on real datasets. Lost customer demand, which is often not considered since it cannot be registered in the system data, is also taken into account.

3 - A Destination-based Algorithm For User Equilibrium With Recourse Using Split Proportions

Tarun Rambha, University of Texas, Austin, TX, 6, United States, tarun.1988@utexas.edu, Stephen Boyles, Avinash Unnikrishnan

When travelers receive en route information and select routing policies that minimize expected cost, user equilibrium with recourse models can help predict the resulting network state. We propose a new destination based algorithm to solve such models using link proportions and compare its performance with existing methods.

4 - Optimal Patrol Planning For Urban Parking Enforcement Considering Driver's Parking Behavior

Chao Lei, University of Illinois at Urbana–Champaign, 2063 S. Orchard St. Apt A, Urbana, IL, 61801, United States, lei8785@gmail.com

In the aim of designing an effective parking patrolling scheme for the parking enforcement agency, we propose a bi-level optimization approach to help the agency determine the patrolling schedule and routing plan in the upper level while considering the drivers' parking payment decisions in the lower level. Both a mixed-integer formulation and a continuum approximation (CA) model are developed. The numerical study shows that, due to its advantage in computational performance, the CA approach provides a good alternative to handle the large scale problems.

■ SD60

Cumberland 2- Omni

Emerging Data Analytics in Transportation Modeling

Sponsored: TSL, Urban Transportation

Sponsored Session

Chair: Xian-Biao Hu, Metropia, 1790 E. River Rd., Suite 140, Tucson, AZ, 85718, United States, xb.hu@metropia.com

1 - Contextual Driving Risks Analysis Using Individualized Dynamic Smartphone

Xian-Biao Hu, Metropia Inc., xb.hu@metropia.com

Traditional driving risk study is usually based on crash history data and can only be performed at aggregate level. Latest information and communications technology allows individualized data collection, but most researches rely solely on user GPS trajectories data but fail to consider other critical risk factors in the surrounding environment that also contribute to crash risk. To bridge this gap, a new approach that collects individualized driving behavior data from smartphone GPS module, combined with geographical network information and dynamic traffic conditions is presented to identify driving risk factors and evaluate driving behaviors under various contexts.

2 - Put Bluetooth Data In A Good Use: A Case Study In Tucson, Arizona

Shu Yang, University of Arizona, shuyang@email.arizona.edu
Yao-Jan Wu

A Bluetooth based traffic data collection and analysis system is developed and integrated into the regional transportation district network system. Fully utilizing the Bluetooth-based data requires comprehensive data quality assurance including data decomposition, imputation, and outlier detection. A case study is conducted in Tucson to demonstrate a one-stop solution for Bluetooth-based traffic performance measurement.

3 - Developing A Simulation Model Of A Tram Network By Using Historical RFID Data

Yong-Hong Kuo, The Chinese University of Hong Kong, Hong Kong, Hong Kong, yhkuo@cuhk.edu.hk, Janny M. Y. Leung, David S.W. Lai, Henry K.F. Cheung, Joshua Hiew

In this talk, we will present a real-world application that utilizes historical RFID data for the development of a simulation model of a tram network. The historical data about the tram locations are used to model the travel times of trams at different times of the day. Our simulation model allows the tram company to examine the impacts of different tram schedules on the service requirements and other performance measures.

4 - Accident Impacts on Traffic Mobility In Concern Of Network Features

Chenshuo Sun, Tsinghua University, Haidian District, Beijing, 100084, China, scs14@mails.tsinghua.edu.cn

It is hypothesized that there may be associations between intersection's accident-impact proneness and its location, as well as accident impacts and its origination. To substantiate such hypothesis, four topological measurements are assigned to intersections. Then, accident impacts specified in four aspects are quantified from both macroscopic and microscopic perspective. This study employs one macro-level model and three micro-level models. The results prove that intersection's accident-impact proneness is closely related to the network features of its location, also accident's infectiousness, network damage and delay are closely related to the network features of its origination.

■ SD61

Cumberland 3- Omni

RAS Problem Solving Competition

Sponsored: Railway Applications

Sponsored Session

Chair: Lingyun Meng, Beijing Jiaotong University, menglingyun2001@hotmail.com

Problem Solving Competition

This session is reserved for the finalists of the RAS Problem Solving Competition (PSC). The presenters and their abstracts won't be determined until we finish the judging process, which happens around mid-October. The selection committee will identify the top three teams who will present their results during the session. This year's competition addresses how to route trains through a complex railway network, with limited infrastructure capacity, while planning maintenance tasks.

■ SD62

Cumberland 4- Omni

Aviation Applications Section: Awards Finalists

Sponsored: Aviation Applications

Sponsored Session

Chair: Senay Solak, University of Massachusetts Amherst, 121 Presidents Drive, Isenberg 318, Amherst, MA, 01003, United States, solak2@isenberg.umass.edu

1 - Metaheuristics For Efficient Aircraft Scheduling And Re-routing at Busy Terminal Control Areas

Marcella Sama, Roma Tre University, Rome, Italy, sama@ing.uniroma3.it

This work improves a state-of-the-art optimization solver for the real-time management of landing and take-off operations in a busy terminal maneuvering area. The solver computes a good initial solution for the aircraft scheduling problem with fixed routes, and then improves it by routing flexibility. Metaheuristics based on variable neighborhood search, tabu search and hybrid schemes are proposed. Experiments are performed on an Italian terminal maneuvering area to simulate various types of disturbances. Solutions of remarkable quality are computed within a short time.

2 - Customized Offers In Airline Revenue Management

Michael Witmann, Massachusetts Institute of Technology, Cambridge, MA, United States, wittman@mit.edu

I propose an approach for decoupling the customized offer generation problem from the well-studied airline revenue management (RM) problem. After generating a baseline assortment of fare products and observing a passenger's characteristics, an airline can choose to customize that passenger's offer by either adjusting the products in the assortment or changing the offered prices for those products. For implementation, heuristics are developed that are compatible with the airline RM methods and systems currently in use at large airlines.

3 - Optimization Models For Speed Control In Air Traffic Management

James Jones, University of Maryland, College Park, MD, United States, jonesjc1@umd.edu

We propose four sets of models that use speed control to enhance the level of coordination by FAA managers at the tactical and pre-tactical level to account for the uncertainty at the time of planning. The first approach, assumes control of all airborne flights 500 nm from the destination airport while assuming no control over flights originating less than 500 nm. The second assumes control over all flights. In the third and fourth approach we propose enhancements for equitably rationing airport access to carriers and new GDP control procedures and flight operator planning models.

4 - Modeling In Air Transportation: Cargo Loading And Itinerary Choice

Virginie Lurkin, University of Liege, Liege, Belgium, vlurkin@ulg.ac.be

We examine two problems as part of this presentation. The first is a cargo loading problem. The aim is to load a set of containers and pallets into a cargo aircraft that serves multiple airports. Our work is the first to model cargo transport as a series of trips consisting of several legs at the end of which pickup and delivery operations might occur. The second problem we examine involves the estimation of itinerary choice models that include price variables and correct for price endogeneity using a control function that uses several types of instrumental variables.

■ SD63

Cumberland 5- Omni

Dynamic Routing and Logistics

Sponsored: TSL, Freight Transportation & Logistics

Sponsored Session

Chair: Nicholas Kullman, University of Washington, Seattle, WA, United States, Nick.Kullman@gmail.com

1 - Dynamic Pickup And Delivery Problem With Transfers

Afonso H. Sampaio, Eindhoven University of Technology, Eindhoven, Netherlands, A.H.Sampaio.Oliveira@tue.nl, Lucas Petrus Veelenturf, Tom Van Woensel

We consider the Dynamic Pickup and Delivery Problem with Transfers (d-PDP-T) in which a set of transportation requests arrive in real-time and must be assigned to a fleet of vehicles. Unlike most variants of the PDP, the pairing constraint is not hard in the d-PDP-T and requests can be transferred from one vehicle to another at transfer locations. Our research focus is to address the operational issues and to evaluate costs/benefits when such transfers are introduced in a dynamic environment. It is especially relevant for transportation companies that provide on-demand services and that need to plan several service requests per day. We discuss some preliminary modelling and solution approaches.

2 - Anticipatory Preemptive Depot Revisits For A Dynamic Same-day Delivery Problem

Dirk Mattfeld, TU Braunschweig, Braunschweig, Germany, d.mattfeld@tu-bs.de, Marlin Wolf Ulmer, Barrett Thomas

We consider a single-vehicle stochastic and dynamic one-to-many pickup and delivery problem (SDPD) motivated by a same-day delivery application. An uncapacitated vehicle delivers goods from a depot to customers during a shift. Dynamic customer orders occur stochastically within the shift. Before serving these orders, the vehicle revisits the depot to pick up the according goods. Since the shift is limited, not every order can be assigned to the vehicle. Objective is to maximize the number of assigned orders. For the SDPD, we present an anticipatory preemptive depot revisit policy (APDR) based on approximate value iteration. We show how APDR significantly increases the number of assignments.

3 - Electric Vehicle Routing With Mid-route Recharging And Uncertain Charging Station Availability

Nicholas Kullman, University of Washington, nkullman@uw.edu Justin Goodson, Jorge E Mendoza

We consider the problem of routing a single electric vehicle (EV) and allow for mid-route recharging at stations with uncertain availability. The uncertainty in charging station availability complicates the planning of mid-route recharging, which is necessitated by EVs' restricted driving ranges; longer recharging times for EVs compound this difficulty. We present a stochastic dynamic programming approach to route planning that hedges against these uncertainties.

4 - Joint Capacity Logistics And Inventory Control Of Mobile Modular Production Systems

Satya Sarvani Malladi, Georgia Institute of Technology, mss@gatech.edu, Alan Erera, Chelsea C White III

Mobile modular production systems enable better response to spatial and temporal variations in demand. How should the logistics of such systems be planned taking into account uncertainty of demand? We try to evaluate value added by mobile modular production through several approaches.

■ SD64

Cumberland 6- Omni

Evolutionary Bilevel Multi-criterion Optimization Methods and Applications

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Kalyanmoy Deb, Professor, Michigan State University, 428 S. Shaw Lane, 2120 EB, Michigan State University, East Lansing, MI, 48824, United States, kdeb@egr.msu.edu

1 - Impacts Of Climate Uncertainty On A Bilevel Optimization Framework For Targeting Agricultural Conservation Policy

Moriah Bostian, Lewis and Clark College, mbbostian@lclark.edu

We characterize the problem of spatially targeting agricultural conservation practices to improve water quality as a multiobjective bilevel optimization problem, integrating a biophysical model of the watershed with an economic production model to estimate policy costs. Weather is an important driver of water quality and agricultural production. We solve for the Pareto frontier for water and production objectives under changing climate conditions, based on a range of leading climate projections. We use the solution values to assess the robustness of policy targets to climate uncertainty.

2 - Solving Optimistic Bilevel Programs By Iteratively Approximating Lower Level Optimal Value Function

Pekka Malo, Aalto University School of Buisness, pekka.malo@aalto.fi, Kalyanmoy Deb, Ankur Sinha

The difficulties in bilevel programming arise primarily from the nested structure of the problem. In this paper, we propose a metamodeling based solution strategy that attempts to iteratively approximate the optimal lower level value function.

3 - Optimal Allocation Of Restoration Practices Using Indexes For Stream Health

Brad Barnhart, U.S. EPA ORD/NHEERL/WED/EEB, bradleybarnhart@gmail.com

The optimal placement of agricultural and urban (i.e., green infrastructure) management practices in order to achieve both economic and environmental objectives is a commonly posed problem. However, the majority of studies seek to optimize objectives related to intermediary environmental outputs (e.g., N and P nutrient loadings, stream temperature, sediment concentrations) and do not address impacts on overall indexes of stream health. Therefore, we investigate on how best to include indexes within a bi-level optimization framework to better characterize objectives when targeting management practices.

4 - Robust And Reliability-based Bi-level Multi-criterion Optimization

Zhichao Lu, Michigan State University, mikelzc1990@gmail.com

Practical optimization and decision making problems involve uncertainties in decision variables and parameters. In this talk, we shall suggest robust and reliability based methods for bilevel problems using evolutionary methods. Results on two practical methods will be presented.

■ SD65

Mockingbird 1- Omni

Analytical Models

Sponsored: Information Systems

Sponsored Session

Chair: Zhe Zhang, University of Texas Dallas, University of Texas Dallas, Richardson, TX, 75080, United States, zxz145430@utdallas.edu

1 - Altruism or Shrewd Business? Implications Of Technology Openness on Platform Innovations And Competition

Hongyan Xu, Chongqing University, School of Economics & Business Admin, Chongqing, 400030, China, xuhongyan@cqu.edu.cn, He Huang, Geoffrey Parker, Yinliang Tan

There is a growing number of platforms that commit to open their technologies. In contrast to the previous literature focusing on the network effect, our study reveals a novel explanation on why firms are willing to open their technologies. The main intuition is due to the fact that technology openness can alleviate the unwarranted innovation competition caused by the uncertainty belonging to technology closeness. We also discuss the impact of technology openness on individual and total innovations and illustrate that this intuition is robust under several extended models.

2 - Share Your Health Information And Help Me Save Your Life: Effects Of Hie Use On Healthcare Outcomes – An Empirical Investigation

Emre Demirezen, School of Management, Binghamton University, Binghamton, NY, United States, edemirezen@binghamton.edu Eunho Park, Ramkumar Janakiraman, Subodha Kumar

In the last decade, the U.S. government has been aggressively promoting the use of electronic health records and the establishment of regional healthcare information exchanges (HIEs). HIEs facilitate the exchange of electronic health information among healthcare practitioners that is considered to be beneficial for the society. However, the real benefits of HIEs are not well understood. Hence, we work with an HIE provider based in the state of New York to investigate the benefits of HIEs.

3 - Platform Integration In The Age Of The Internet Of Things

Burcu Tan, Tulane University, btan@tulane.edu, Edward G Anderson, Geoffrey Parker

Many two-sided platforms (e.g., eBay, Google, iOS, Android, Twitter, Amazon) provide development tools, such as software development kits (SDKs) and application programming interfaces (APIs), to facilitate third party content development. While crucial to platform success, these tools are costly to create. We develop an analytic model to explore the key trade-offs behind investment in development tools and how that investment coordinates with pricing decisions in a two-sided market. We model these decisions under various scenarios including monopoly and competitive platforms as well as symmetric and asymmetric platforms.

4 - Interoperability, Organization Form And Cooperative Games In Public Safety Networks

Barrie R Nault, University of Calgary, nault@ucalgary.ca Hong Guo, Yipeng Liu

We analyze tradeoffs in the provision of public safety networks when network assets are distributed across districts, causing a district to value network assets in other districts as well as in its own district. Modeling centralized and decentralized organization forms we incorporate interoperability among distributed network assets. We find that the optimal/equilibrium interoperability increases in the cross-district spillovers from network assets. We show that the districts' incentive to adopt centralized provision depends on the sharing rule for the cost of interoperability effort, and we find that certain sharing rules have a corresponding cooperative game analogue.

■ SD66

Mockingbird 2- Omni

2016 QSR Best Student Paper Competition

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Chiwoo Park, chiwoo.park@eng.fsu.edu

1 - 2016 QSR Best Student Paper Competition

Chiwoo Park, Florida State University, chiwoo.park@eng.fsu.edu

Best Student Paper Award recognizes excellence among QSR student members. Four finalists for the Best Student Paper Award will make presentations. The winner will be announced at the QSR business meeting during the conference.

■ SD67

Mockingbird 3- Omni

Foundations of Accuracy for Additive Manufacturing

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Qiang Huang, University of Southern California, Los Angeles, CA, United States, qiang.huang@usc.edu

Co-Chair: Arman Sabbaghi, Purdue University, West Lafayette, IN, United States, sabbaghi@purdue.edu

1 - Deformation Model Transfer Via Equivalent Effects Of Lurking Variables In Additive Manufacturing

Arman Sabbaghi, Assistant Professor, Purdue University, 150 N. University Street, West Lafayette, IN, 47907, United States, sabbaghi@purdue.edu, Qiang Huang

The transfer of a deformation model across different settings of lurking variables in additive manufacturing is addressed with a novel framework that fuses the Rubin causal model with the effect equivalence concept. Model transfer in this general framework is formulated through the total equivalent amount of the lurking variables in terms of a base factor with respect to a key model feature. The weakest sufficient condition on the data-generating and assignment mechanisms in a new setting is identified that permits inference for its total equivalent amount with respect to the mean. Bayesian methodology for modeling the total equivalent amount are developed under this condition.

2 - Implications Of Assuming Incorrect Model Equivalence For Additive Manufacturing

Matthew Plumlee, University of Michigan, mplumlee@umich.edu

Additive manufacturing control is often limited by the few number of homogeneous parts produced. Thus purely data-driven approaches can fail to give anything but large uncertainty quantification bounds for producing a new part. One solution to this problem is to let additive manufacturing systems to learn from each other by assuming that they could produce exactly the same resulting parts. In this talk, some preliminary results are used to explain the potential ramifications of assuming that a model for one additive manufacturing system can produce similar results as another system under a specialized design plan.

3 - Prescriptive Analytics For Understanding Of Out-of-plane Deformation In Additive Manufacturing

Yuan Jin, University of Southern California, Los Angeles, CA, 90089, United States, yuanjin@usc.edu, Joe Qin, Qiang Huang

Geometric accuracy control is crucial to fulfill the promise of additive manufacturing (AM). We have been establishing a generic methodology to represent, predict and compensate 3D deformation of AM built products. Built upon our previous study, this work aims at 1) developing a prescriptive approach to understand the out-of-plane deformation due to complex inter-layer interactions; 2) establishing a Bayesian approach to infer the predictive deformation model for out-of-plane complex shapes. Experiments are conducted to validate the prescriptive model.

4 - Shape Deviation Modeling For Additive Manufacturing With Different Process Parameters

Longwei Cheng, HKUST, lchengae@connect.ust.hk

Reducing the dimensional error of the fabricated products is a critical quality issue for the wide application of additive manufacturing (AM) technologies in industry. Process parameters in fabrication significantly affect the shape deviation of products. In this work, we establish an in-plain shape deviation prediction scheme that predicts the final shapes of products with the information of both process parameters and 2D input shapes. The corresponding shape error compensation strategy is derived, which greatly improves the dimensional accuracy of products. The methodology is validated through experimental studies of fused deposition modeling (FDM) process.

■ SD68

Mockingbird 4- Omni

Process Monitoring, Diagnosis, and Prognosis in Complex Systems

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Qiang Zhou, City University, 1, Kowloon, 1, Hong Kong, q.zhou@cityu.edu.hk

Co-Chair: Li Zeng, Texas A&M University, College Station, TX, United States, lizeng@tamu.edu

1 - High Dimensional Process Monitoring Using Sparse Principal Component Analysis

Mohammad Nabhan, Georgia Institute of Technology, nabhan@gatech.edu, Jianjun Shi

Dimension reduction techniques, such as PCA and PLS, have been used for process monitoring in statistical process control. However, in high dimensional settings they suffer from inconsistency and interpretability issues. Sparse principal component analysis (SPCA) has been shown to be more consistent in these settings. Due to its sparse nature, it allows for better interpretation. This article proposes a monitoring and diagnostics scheme utilizing SPCA to reduce the dimensionality of the data while improving interpretability. The method is effective under certain stipulations on the spatial structure of the data streams. The proposed method is validated through simulation and a case study.

2 - Monitoring Low-e Glass Manufacturing Using Optical Profiles

Qian Wu, Texas A&M University, College Station, TX, 77840, United States, hi_qianwu@tamu.edu, Li Zeng

In this study we develop a method for process monitoring using optical profiles collected from low-E glass products. The proposed method uses a piecewise polynomial mixed-effect model to characterize the complex shape of optical profiles and a T2 control chart to monitor the estimated random effects for change detection. We investigate a potential problem caused by high correlations of random effects in implementing this method and propose a remedy based on regressor transformation for this issue. A case study will be shown, indicating the proposed method fits the real optical profiles and performs well in process monitoring.

3 - Remaining Useful Life Prediction In Populations With Heterogeneity

Raed Kontar, University of Wisconsin - Madison, Madison, WI, United States, alkontar@wisc.edu

Degradation signal data used for prognosis are often imbalanced as most units are reliable and only few tend to fail at early stages of their life cycle. Such imbalanced data may hinder accurate remaining useful life (RUL) prediction especially in terms of detecting pre-mature failures as early as possible. . In this paper, we propose a degradation signal-based RUL prediction method to address the imbalance issue in the data. The proposed method introduces a mixture prior distribution to capture the characteristics of different groups within the same population and provides an efficient and effective online prediction method for the in-service unit under monitoring.

4 - Statistical Monitoring And Fault Diagnosis Of Vibration Signal Based On Wavelet Transform

Wei Fan, City University of Hong Kong, Kowloon, Hong Kong, weifan8-c@my.cityu.edu.hk, Qiang Zhou

To effectively monitor and detect the early fault of rolling bearing, a wavelet-based statistical process control method is proposed and studied. The vibration signal is decomposed by orthonormal wavelet transform. The generalized likelihood ratio test is taken into consideration to detect the shift of the wavelet coefficients. To increase the detection power of the small shift, the proposed control chart takes the exponentially weighted moving average of the logarithm of the likelihood ratio. Both the simulation studies and the experimental cases show the effectiveness of the proposed method.

■ SD69

Old Hickory- Omni

Pierskalla II

Award Session

Chair: Baris Ata, University of Chicago, Booth School of Business

Co-Chair: Anton Skaro, Northwestern University, Feinberg School of Medicine

Co-Chair: Sridhar Tayur, Carnegie Mellon University, Tepper School of Business

1 - Pierskalla Award

Vikram Tiwari, Vanderbilt University Medical Center, Nashville, TN, Contact: vikram.tiwari@vanderbilt.edu

The Health Applications Society of INFORMS sponsors an annual competition for the Pierskalla Award, which recognizes research excellence in the field of health care management science. The award is named after Dr. William Pierskalla to recognize his contribution and dedication to improving health services delivery through operations research. The Pierskalla award information can be found on the website at: https://www.informs.org/Community/HAS/Pierskalla-Award

2 - Online Decision-Making with High-Dimensional Covariates

Hamsa Bastani, Mohsen Bayati, Stanford University, Stanford, CA, bayati@stanford.edu

Big data has enabled decision-makers to tailor treatment decisions based on their clinical information. This involves learning a model of decision rewards conditional on individual patient covariates. These covariates are high-dimensional; typically only a small subset of the observed features are predictive of a decision's success. We formulate this problem as a multi-armed bandit with high-dimensional covariates, and present a new efficient bandit algorithm based on the LASSO estimator. Our analysis establishes that our algorithm achieves near-optimal performance in comparison to an oracle that knows all the problem parameters. The key step in our analysis is proving a new oracle inequality that guarantees the convergence of the LASSO estimator despite the non-i.i.d. data induced by the bandit policy. We illustrate the practical relevance of our algorithm by evaluating it on a real-world clinical problem of warfarin dosing. A patient's optimal warfarin dosage depends on the patient's genetic and medical records. We show that our algorithm outperforms existing bandit methods as well as physicians to correctly dose patients.

3 - Do Mandatory Overtime Laws Improve Quality? Staffing Decisions and Operational Flexibility of NursingHomes

Lauren Xiaoyuan Lu, University of North Carolina, Chapel Hill, NC, lauren_lu@unc.edu, Susan Feng Lu

During the 2000s, over a dozen U.S. states passed laws that prohibit health care employers from mandating overtime for nurses. Using a nationwide panel dataset from 2004 to 2012, we find that these mandatory overtime laws reduced the service quality of nursing homes, as measured by an increase in deficiency citations. This outcome can be explained by two undesirable changes in the staffing hours of registered nurses: decreased hours of permanent nurses and increased hours of contract nurses per resident day. We observe that the increase in deficiency citations concentrates in the domains of administration and quality of care rather than quality of life, and the severity levels of the increased citations tend to be minor rather than major. We also find that the laws' negative effect on quality is more severe in nursing homes with higher percentage of Medicare-covered residents. These observations are consistent with the predictions of a stochastic staffing model that incorporates demand uncertainty and operational flexibility. Further, we rule out an alternative hypothesis that the quality decline is induced by an increase in nurse wages.

4 - Data-Driven Incentive Design in the Medicare Shared Savings Program

Anil Aswani, UC Berkeley, Berkeley, CA, aaswani@berkeley.edu, Zuo-Jun Shen, Auyon Saddiq

The Medicare Shared Savings Program (MSSP) was created to control escalating Medicare spending by incentivizing providers to deliver healthcare more efficiently. Providers that enroll in the MSSP earn bonus payments for reducing spending to below a risk-adjusted financial benchmark. To generate savings, a provider must invest to improve efficiency, which is a cost that is absorbed entirely by the provider under the current contract. This has proven to be challenging for the MSSP, with a majority of participating providers unable to generate savings. In this paper, we formulate the MSSP as a principal-agent model and take a data-driven approach to redesigning the MSSP contract. We propose a new type of contract that includes a performance-based subsidy that partially reimburses the provider's investment. We prove that there exists a subsidized contract that dominates the current MSSP contract by producing a strictly higher expected payoff for Medicare and the provider. We then present a maximum likelihood approach for estimating the parameters of the principal-agent model, using a dataset containing the financial performance of providers.

5 - Prioritizing Hepatitis C Treatment in U.S. Prisons

Turgay Ayer, Georgia Tech, Atlanta, GA, Boston, MA, ayer@isye.gatech.edu , Anthony Bonifonte, Can Zhang, Anne Spaulding, Jagpreet Chhatwal

High prevalence of HCV in prisons offers a unique opportunity to control the HCV epidemic. Newest HCV treatments drugs are effective but providing treatment is outrageously expensive. We propose a restless bandit modeling framework to support hepatitis C treatment prioritization decisions in U.S. prisons. From the interpretation of this closed-form expression, we anticipate the performance of Whittle's index would degrade as the treatment increases. Using a detailed agent-based simulation model, we show our proposed policy can significantly improve overall health outcomes compared with the current practice. Our results shed light on issues in hepatitis C prioritization: 1) considering remaining sentence length and injection drug use (IDU) status and liver health state in prioritization decisions can lead to a performance improvement; 2) when linkage-to-care rate outside prison is small while treatment capacity in prison system is relatively large, patients with shorter remaining sentence lengths should be prioritized; and 3) for patients with advanced liver disease, IDUs should not be prioritized unless their reinfection is very-well controlled.

■ SD70

Acoustic- Omni

Transportation, General

Contributed Session

1 - Solving The Privately Owned Automated Vehicles Assignment Problem

Theresia van Essen, Delft University of Technology, Mekelweg 4, Delft, 2628 CD, Netherlands, j.t.vanessen@tudelft.nl, Gonçalo Correia

We propose a new model to study how replacing privately owned non-automated vehicles with shared automated ones affects travel time, congestion and parking demand in an urban area. As automated vehicles will reduce the value of travel time, it is expected that travel time will increase. In addition, congestion is on the one hand expected to increase because of the empty trips, and on the other hand expected to decrease because of a reduction in the number of vehicles on the road. Parking demand is expected to decrease as the utilization of the vehicles will increase. The model is applied to a case study based on the city of Delft, the Netherlands.

2 - Developing Interrelated Airport Facilities under Uncertainty: A Network Flow Formulation

Yanshuo Sun, University of Maryland, 1173 Glenn Martin Hall, College Park, MD, 20742, United States, yssun@umd.edu, Paul Schonfeld

Interactions between user flows and facilities are quite complex in an airport system. Thus, capacity expansion decisions for these facilities are largely interrelated. A network flow formulation is proposed for coordinating such development decisions so that a balanced capacity configuration is likely to be obtained. The nonlinear congestion effect, which is common in most airport facilities, is considered and uncertainties in demand and aircraft mix are also included. The stochastic mixed integer nonlinear program is reduced to a deterministic mixed integer program and thus solved.

3 - From Trend Spotting To Trend Setting: Modeling The Impact Of Major Technological And Infrastructural Changes On Travel Demand

Feras El Zarwi, PhD Candidate, University of California at Berkeley, 2100 Channing Way, Apt 415, Berkeley, CA, 94704, United States, feraselzarwi@gmail.com

Transformative mobility will revolutionize travel and activity behavior but we should be cautious with how the future is going to play out. This research project proposes a methodological framework tailored to address impacts of technological innovation to understand and predict long-range trends in travel behavior. We integrate hidden markov and discrete choice models to predict long-range trends in travel behavior as a result of adopting new services. The model is estimated on a longitudinal travel diary dataset from Santiago, Chile. The proposed quantitative methods are critical in assessing how policies/strategies can influence trends of travel behavior to guide transformative mobility.

4 - Using Regression Tree Models To Improve Freeway Incident Duration Prediction A Comprehensive Case Study In Maryland Region

Xuechi Zhang, Graduate Research Assistant, University of Maryland, 0147C Engineering Lab Building, College Park, MD, 20740, United States, zhangxc90@gmail.com, Ali Haghani, Yeming Hao

Timely and accurate prediction of freeway incident duration is not only useful for providing travelers with re-routing strategies, but can also reduce their in-vehicle anxiety. This research proposed several regression tree based models to improve the incident duration prediction accuracy by fusing heterogeneous information, i.e. incident information, weather and traffic conditions. A comprehensive case study with real-world data in Maryland Region was conducted to evaluate and demonstrate the proposed models. Further, practical implications from the case study were given.

■ SD71

Electric- Omni

Transportation, Rail

Contributed Session

Chair: Emmanuel Martey, University of Delaware, 302 DuPont Hall, Newark, DE, 19716, United States, enmartey@udel.edu

1 - Optimization Techniques For Railways

Srinivasa Prasanna, Professor, IIIT-Bangalore, 26/C, Hosur Road, Electronics City, Opposite Infosys Technologies, Bangalore, 560100, India, gnsprasanna@iiitb.ac.in"

We present optimization techniques used in portions of the Indian Railway System, the largest in the world. We present techniques used for timetabling and investment planning, under large scale demand uncertainty. Many of these problems are at the scale of grand computational challenges (with 10'000 of trains and 1000's of control points), and the talk will present a few pieces of how portions of this problem can be simplified and made amenable to optimization techniques (convex/non-convex). Exemplary results will be discussed.

2 - Railway Capacity Analysis And Cyclic, Combined Train Timetabling And Platforming For A Single Track, Bidirectional Railway Line

Matthew Petering, University of Wisconsin-Milwaukee, Industrial and Manufacturing Engineering Dept, Ems E367, Milwaukee, WI, 53201, United States, mattpete@uwm.edu, Mojtaba Heydar

We present the literature's first mixed integer linear program for cyclic train timetabling and platforming on a single track, bi-directional railway line. There are T train types and one train of each type is dispatched per cycle. The decisions to be made include the sequencing of the train types on the main line and the assignment of train types to station platforms. Two conflicting objectives—minimizing cycle length and minimizing total train journey time—are considered.

3 - A MIP Model For High-speed Train Platforming Problem With Route Conflicts Constraints

Gongyuan Lu, Assistant Professor, Southwest Jiaotong University, 111#, 1st Section, Northern 2nd Ring Road, School of Transportation and Logistics, Chengdu, China, lugongyuan@swjtu.cn, Guangyuan Zhang, Yuan Wang

The biggest challenge in solving high-speed train platforming problem (HTPP) is to route trains without conflicts. Especially in a large multi-yard railway station, the conflicts between routes and platforms can easily make the scale increase dramatically. A MIP model aiming at minimize train delay is formulated to generate flexible train schedule without violating route conflicts. This research has been applied in largest high-speed train station in Asia.

4 - Predicting Cascading Effects Of Local Disruptions In A Large Scale Rail Network

Patrick Briest, McKinsey & Co, Kennedydamm 24, Dusseldorf, 40027, Germany, patrick_briest@mckinsey.com, Sebastian Albert, Robin Blöhm, Florian Brummer, Christian Gruß, Eike-Dennis Rausch

We propose a stochastic simulation model to determine network-wide effects of locally induced disruptions in a large scale rail system. We extend the model previously described by Berger et al. to include (A) dynamic diversion routing to mimic how traffic controllers will try to route trains around disrupted parts of the network and (B) track capacities and a load-dependent delay component. We present computational results based on detailed delay distributions extracted from multiple years of Deutsche Bahn's operations data and simulation runs using both current and historic schedules of regional, long-distance and cargo traffic in the Deutsche Bahn network.

5 - Probability Analysis Of The Severity Of Train Derailments Using Copula Models

Emmanuel Martey, University of Delaware, 302 DuPont Hall, Newark, DE, 19716, United States, enmartey@udel.edu, Nii Attoh-Okine

In spite of their relatively low occurrence, train derailments have been a major concern due to their high consequence. Derailment severity may depend on various factors such as speed, accident cause and residual train length. It is important to know the dependencies between these variables in order to better understand how to reduce derailment severity. This paper presents the copula approach as a technique for modeling dependencies between the various variables. Copulas link arbitrary marginal distributions to form a joint multivariate distribution with a particular dependence structure. Copulas are suitable for modelling multivariate data with non-normality, tail dependency or skewness.

■ SD72

Bass- Omni

Supply Chain Mgt IV

Contributed Session

Chair: Shabnam Rezapour, University of Oklahoma, 2248 Houston Ave. apt 2, Norman, OK, 73071, United States, shabnam_rezapoor@yahoo.com

1 - Upstream Supplier And Downstream Customer Networks: An Empirical Investigation

Marcus A Bellamy, Boston University, Rafik B. Hariri Building, 595 Commonwealth Avenue, Boston, MA, 02215, United States, bellamym@bu.edu, Soumen Ghosh, Manpreet Singh Hora

We examine the relationship dependence characteristics and structural configuration of a firm's supply chain as drivers of its performance using supply chain relationship data from the Bloomberg database. We demonstrate how firm performance may be influenced by the manner in which its cost is concentrated upstream as a customer, its revenue is concentrated downstream as a supplier, and its supply network is structured.

2 - Capacity Expansion Under Demand Uncertainty With Uncertain Probabilities

Heejung Kim, University of California- Berkeley, Berkeley, CA, 94720-1777, United States, kimheejung@berkeley.edu, Philip Kaminsky

Pharmaceutical industries make capacity investment decisions while clinical trials for products are running. The demands are highly dependent on the test results, and estimating exact probability distribution of the results is difficult. We focus on developing and understanding capacity expansion models that are robust to any possible probability distributions using multistage stochastic programming for different objectives - minimizing expected cost, value at risk and conditional value at risk.

3 - Supply Chain Partner Environmental Health And Firm Performance

Marcus A Bellamy, Assistant Professor, Boston University, Rafik B. Hariri Building, 595 Commonwealth Avenue, Boston, MA, 02215, United States, bellamym@bu.edu

We empirically examine the relationship between the environmental initiatives and outcomes of a firm's supply chain partners and firm performance. We draw from environmental, financial, and supply chain data to identify key mechanisms related to the environmental health of a firm's supply chain that influence its economic performance.

4 - Component Procurement And End Product Assembly In An Uncertain Supply And Demand Environment

Ramesh Bollapragada, San Francisco State University, School of Business, 1600 Holloway Avenue, San Francisco, CA, 94132, United States, rameshb@sfsu.edu, Saravanan Kuppusamy, Uday S Rao

In this paper, we examine a multi-product, multi-component, procurement and assembly problem with both supply and demand uncertainties. We explicitly model the uncertainty using a stochastic program that facilitates procurement and assembly decisions. We present a stochastic linear programming model of the problem which we solve using its deterministic equivalent with a finite number of scenarios. We identify the key cost drivers that need attention from managers in the manufacturing industry, when there is limited knowledge of future demand and component availability.

5 - Correlation Between Supply Networks' Strategic And Operational Risk Mitigation Strategies

Shabnam Rezapour, University of Oklahoma, 2248 Houston Ave. apt 2, Norman, OK, 73071, United States, shabnam_rezapoor@yahoo.com, Janet K. Allen, Farrokh Mistree

A supply network's performance is affected by two types of uncertainty: 1) disruptions distorting its topology; and 2) variations affecting its flow planning. We show that strategic risk mitigation strategies, such as robustness and resilience, and operational risk mitigation strategies, such as reliability, neutralizing impacts of disruptions and variations respectively are correlated. A model is developed to simultaneously determine robustness, resilience and reliability. Our findings show that the correlation between: i) robustness and resilience is negative; ii) robustness and reliability is positive; and iii) resilience and reliability is negative.

■ SD79

Legends G- Omni

Health Care, Modeling IV

Contributed Session

Chair: Utpal Kumar Bhattacharya, Associate Professor, Indian Institute of Management Indore, Pitampur Road, Prabandh Sikhar, Indore, 453556, India, utpalb@iimidr.ac.in

1 - Optimal Radiotherapy Treatment Policy Based On Tumor Biological Response: A Partially Observable Markov Decision Process Framework

Nasrin Nouri, PhD Student, University of Houston, 9701 Meyer Forest Dr., Apt 6207, Houston, TX, 77096, United States, nouri.nasrin@gmail.com

In radiotherapy treatment planning the prescribed dose is delivered in equal fractions of dose during 30 to 40 sessions to give healthy organs time to recover. Depending on tumor state, the tumor growth and its response to radiation will change, hence a dynamic treatment plan is required. It is not possible to observe the tumor before each session through CT images so we are faced to uncertainty of tumor state. In this study we develop a partially observable Markov decision process to provide optimal treatment policy when the density of tumor is uncertain. This approach provides the optimal policy determining when to choose a less effective, less harmful dose over a more effective, more harmful dose.

2 - Reserving Walk-in Times In Primary Care

Brigitte Werners, Professor, Ruhr-University Bochum, Fac. Management and Economics, Bochum, 44780, Germany, or@rub.de

For a primary care physician with varying workday demand, capacity reservation for walk-ins and scheduled appointment slots is optimized on a tactical level. Number and position of the scheduled appointments influence waiting times for patients, capacity for treatment and the utilization of PCPs. A multi-criteria mixed-integer linear programming model is suggested to find an acceptable compromise solution. Results are evaluated by an extensive stochastic simulation study.

3 - Econometric Model Of Critical Care Outreach Team And Intensive Care Unit

Ali Haji Vahabzadeh, The University of Auckland Business School, Private Bag 92019, Auckland, 1142, New Zealand, a.vahabzadeh@auckland.ac.nz, Valery Pavlov

To analyse the role and functionality of the critical care outreach team (CCOT) in hospitals, and particularly, its interactions with the ICU, we develop an econometric model of CCOT and ICU. This allows us to estimate the impact of CCOT intervention in detecting the critically ill patients in the ward on the ICU length-of-stay, potential ICU readmission and patient outcome.

■ SD86

Gibson Board Room-Omni

Manufacturing IV

Contributed Session

Chair: Ali AlArjani, PhD Candidate, University of Wisconsin - Milwaukee, 4848 N. Lydell Ave, Apt 141, Milwaukee, WI, 53217, United States, alarjan2@uwm.edu

1 - Setting Optimal Planned Leadtimes In A Configure To Order Manufacturing System

Sjors Jansen, PhD Candidate, Eindhoven University of Technology (TU/e), P.O. Box 513, Paviljoen E13, Eindhoven, 5600MB, Netherlands, s.w.f.jansen@tue.nl, Zumbul Atan, Ton de Kok, Ivo Adan

We study the production planning in Configure To Order (CTO) manufacturing systems. The system consists of multiple stages that converge to one final assembly stage. Leadtimes per stage are stochastic due to extensive testing at the end of each stage. Our goal is to determine optimal planned leadtimes for each stage such that the total expected production costs are minimized. We derive Newsvendor equations for each individual stage. This set of equations is solved and the exact optimal planned leadtimes for each stage are obtained. These equations give an important insight in the dynamics of the system, since they indicate to what extend a specific stage can be blamed for the lateness of the final product.

2 - Introduction Of A Motor Assembly Test Bed To Verify Manufacturing Technology

Jungryul Bae, Korea Institute of Industrial Technology (KITECH), Seoul, Korea, Republic of, somanythat@naver.com, SeHwan Ahn, YongJu Cho, Chul Kim, Hyunchul Tae

A Testbed is a place of verifying newly developed manufacturing technologies before apply it in practice. We built a motor-assembly Testbed that comprises seven connected facilities in a line. We have tested several manufacturing technologies including simulation, quality management, and IoTs on the Testbed. In this presentation, we aim to introduce our Testbed and share our experience. The final goal of the Testbed is to enhance the localization ratio of a convergence of the IoTs and manufacturing technology.Keywords: Connected Smart Factory (CSF), Testbed, IoTs, manufacturing technology.

3 - Modeling The Impact Of Product Variety On Inventory: Application To Strategic Assembly Sequencing And Supply Chain Design

Jeonghan Ko, University of Michigan; Ajou University, 1205 Beal Ave., Industrial & Operations Engineering, Ann Arbor, MI, 4810, United States, jeonghan@umich.edu, Heng Kuang

This paper models the impact of variety on assembly supply chain design when limited commonality exists between products. We derive theorems on the impact of product variety on safety inventory, and provide a measure to approximate the impact. The theorems and new measure are applied in two problems: optimal process sequencing and optimal assembly decomposition. We prove that to prioritize the process with a smaller number of variants will reduce the supply chain cost no matter the commonality is.

4 - Finite Capacity Material Requirement Planning System For Supply Chain Network

Benyaphorn Paopongchuang, Sirindhorn International Institute of Technology, Pathum Thani, 12121, Thailand, bp322@njit.edu
Benyaphorn Paopongchuang, New Jersey Institute of Technology, Newark, NJ, 07102, United States, bp322@njit.edu, Pisal Yenradee

Available Finite Capacity Material Requirement Planning (FCMRP) systems have some limitations. They are designed to determine production and purchasing plans in only one factory not in a multi-level supply chain network. Most systems lack of optimization capabilities. In addition, they do not manage bottleneck effectively. The proposed algorithm tries to develop FCMRP system that also considers finite capacity of some key suppliers and customers.

5 - Similarity Coefficient Model For Solving an Oil Global Facility Location Problem

Ali AlArjani, PhD Candidate, University of Wisconsin - Milwaukee, 4848 N lydell Ave, Milwaukee, WI, 53217, United States, alarjan2@uwm.edu

Solve an oil global facility location problem by a new similarity coefficient model for cluster analysis that model ranks multiple countries and cluster them in groups each group have similar attributes.

■ SD91

Davidson Ballroom A-MCC

Joint Session HAS/MSOM-HC: Statistical Decision-Making with Applications in Healthcare

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Mohsen Bayati, Stanford University, Stanford, CA, United States, bayati@stanford.edu

Co-Chair: Hamsa Bastani, Stanford University, 10 Comstock Circle, Apt 304, Stanford, CA, 94305, United States, hsridhar@stanford.edu

1 - Approximation Methods For Adaptive Clinical Trial Design

John R Birge, University of Chicago, John.Birge@ChicagoBooth.edu

2 - An Analytics Approach To Designing Drug Therapies For Cancer

John M Silberholz, MIT, Cambridge, MA, 02139, United States, josilber@mit.edu, Dimitris Bertsimas

We present a data-driven approach to planning clinical trials and designing novel drug therapies for metastatic breast cancer (MBC). First, we describe construction of a large database of MBC clinical trial results and tools to help clinicians visualize the data. Next, we use statistical models to predict efficacy and toxicity outcomes of trials before they are run, with implications for selecting between multiple drug therapies for testing. Finally, we use optimization models to design novel therapies that strike a balance between maximizing patient outcomes and learning about new drugs; initial evaluation suggests these models may improve trial outcomes compared to current practice.

3 - Online Decision-making With High-dimensional Covariates

Hamsa Sridhar Bastani, Stanford University, 10 Comstock Circle, Apt 304, Stanford, CA, 94305, United States, hsridhar@stanford.edu, Mohsen Bayati

Big data has enabled decision-makers to personalize choices based on an individual's observed characteristics. We formulate this problem as a multi-armed bandit with high-dimensional covariates, and present a new efficient algorithm that provably achieves near-optimal performance. The key step in our analysis is proving convergence of the LASSO estimator despite non-iid data induced by the bandit policy. We evaluate our algorithm using a real patient dataset on warfarin dosing; here, a patient's optimal dosage depends on her genetic profile and medical records. Our algorithm outperforms existing bandit methods as well as physicians to correctly dose a majority of patients.

4 - Estimating Average Treatment Effects In High-dimensional Observational Studies

Stefan Wager, Stanford University, Stanford, CA, United States, swager@stanford.edu, Susan Athey, Guido Imbens

There are many studies where researchers are interested in estimating average treatment effects and are willing to rely on the unconfoundedness assumption, which requires that treatment assignment is as good as random conditional on pre-treatment variables. The unconfoundedness assumption is often more plausible if a large number of pre-treatment variables are included in the analysis, but this can worsen the finite sample properties of existing approaches to estimation. In this paper, we propose a new method for estimating average treatment effects in high dimensions that achieves the semi-parametric efficiency bound without requiring any modeling assumptions on the propensity score.

■ SD92

Davidson Ballroom B-MCC

INFORMS Optimization Society Prize Session

Award Session

Chair: Suvrajeet Sen, University of Southern California, 3715 McClintock Ave, Los Angeles, CA, 90089, United States, s.sen@usc.edu

1 - Optimization SocietyAwards

Suvrajeet Sen, University of Southern California, 3715 McClintock Ave, Los Angeles, CA, 90089, United States, s.sen@usc.edu

The Optimization Society sponsors four awards annually. They are a) the Khachiyan Prize for lifetime contributions in optimization, b) the Farkas Prize for exceptional mid-career accomplishments, c) the Young Optimization Researcher award, and finally, d) the student paper prize competition. These awards are highly competitive and coveted, and this session is dedicated to congratulating the winners, and their lasting contributions to optimization. The award winners will present brief overviews of their prize-winning contributions.

■ SD93

Davidson Ballroom C-MCC

Panel: Trends in Service Systems Research Funded by NSF: Overview of Opportunities for the Human-technology Frontier

Panel Session

Moderator: Alexandra Medina-Borja, NSF/ UPRM, PFI: BIC - Smart Service Systems, Falls Church, VA, United States, amedinab@nsf.gov

1 - Trends In Service Systems Research funded byNSF: Overview Of Opportunities For The human-technology frontier

Alexandra Medina-Borja, US National Science Foundation, Arlington, VA, 2, United States, alexandra.medinaborja@upr.edu

An overview of interdisciplinary funding opportunities for researchers modeling the interaction between humans and engineered systems that could enable the smart service systems of the future. Requirements and opportunities will be discussed by one of the NSF cognizant program officers in this program.

2 - Panelist

David Mendonca, Rensselaer Polytechnic Institute, New York, NY, 0, United States, mendod@rpi.edu

Monday, 8:00AM - 9:30AM

■ MA01

101A-MCC

Learning from Uncertain Data with High Dimensionality

Sponsored: Data Mining

Sponsored Session

Chair: Neng Fan, University of Arizona, Engineering Bldg, Room 312, 1127 E. James E. Rogers Way, Tucson, AZ, 85721, United States, nfan@email.arizona.edu

1 - Multiclass Support Vector Machines With Labeling Uncertainty

Wanlu Gu, University of Arizona, wanlugu@email.arizona.edu

The multiclass support vector machines (SVMs) is an extension of the conventional SVM in machine learning, and it builds the classification hyperplanes based on a set of training data points. In practice, the real collected data may have noise or uncertainty. In this talk, we consider the observed data with noise on the labels, and construct models and algorithms to learn from this type of uncertain data. To model the uncertainty, the noise probability is assumed to the labeling noise from one class to the others. Then some novel optimization models are proposed and also validated through numerical experiments to check the difference with noise free models.

2 - Sparse Support Vector Machines With Data Uncertainty

Ammon Washburn, University of Arizona, wammonj@email.arizona.edu

Data with high dimensionality and uncertainty comes about when there are too many features and the data is unreliable, replicated or missing. Without taking these issues properly into account, classification models will overfit the training data. In order to deal with these two problems, sparse representations and chance-constrained programming have emerged separately. We will show how to implement both ideas by modifying Support Vector Machines in a way that is not overly conservative which we call Decoupled Margin-Moment SVM. Numerical experiments are performed on collected pancreatic cancer data.

3 - Graph Clustering Of Data With Uncertainties

Yujia Zhang, University of Arizona, yujiazhang@email.arizona.edu

In this talk, we will review models and algorithms for clustering of data with uncertainties. First, the methods to model data uncertainty will be reviewed. Second, we mainly concentrate on the graph models for clustering. Finally, algorithms for solving these models will be reviewed and compared.

4 - Constrained Clustering Of Uncertain Data

Derya Dinler, PhD Candidate, Middle East Technical University, ODTU Endustri Muhendisligi Bolumu, Cankaya, Ankara, 06800, Turkey, dinler@metu.edu.tr, Mustafa Kemal Tural

We consider a constrained clustering problem where the locations of the data objects are subject to uncertainty. Each uncertainty set is assumed to be either a closed convex bounded polygon or a closed disk. The final clustering is expected to be in accordance with a given number of instance level constraints. We propose a mixed-integer second order cone programming formulation for the considered clustering problem which is only able to solve small-size instances. For larger instances, approaches from the semi-supervised (constrained) clustering literature are modified and compared in terms of computational time and quality.

■ MA02

101B-MCC

New Advancements in Using Data Analytics for Healthcare Applications

Sponsored: Data Mining

Sponsored Session

Chair: Talayeh Razzaghi, Clemson University, 100 McAdams Hall, Clemson, SC, 29634, United States, talayeh.razzaghi@gmail.com

1 - Using Density To Identify Fixations In Gaze Data: Optimization-based Formulations And Algorithms

Andrew C Trapp, Worcester Polytechnic Institute, atrapp@wpi.edu

Eye tracking is an increasingly common technology with a variety of practical uses. Eye-tracking gaze data can be categorized into two main events: fixations, which represent attention, whereas saccades occur between fixation events. We propose a novel manner to identify fixations based on their density, which concerns both the fixation duration as well as its inter-point proximity. We develop two mixed-integer nonlinear programming formulations and corresponding algorithms to recover the densest fixations in a data set. Our approach is parameterized by a unique value that controls for the degree of desired density. We conclude by discussing computational results and insights on real data sets.

2 - Leveraging Longitudinal Healthcare Data For Inverse Classification

Michael Lash, University of Iowa, michael-lash@uiowa.edu, Nick Street

Inverse classification is the process of manipulating a test point to minimize the predicted probability of a specific class label. Such a process has been shown to be beneficial to healthcare-related problems such as lifestyle modification and treatment recommendations. Past work in this area has focused on single snapshots in time, which does not account for the history or behavioral changes of patients. In this work we incorporate longitudinal information into our inverse classification model and demonstrate its effectiveness in mitigating the long-term risk of cardiovascular disease.

3 - Stability And Performance Of Healthcare Access Supply-demand Systems Affected by Stochastic Time Delays

Sara Nourazari, California State University-Long Beach, Bellflower Boulevard, Long Beach, CA, 90840, United States, Sara.Nourazari@csulb.edu, Rifat Sipahi, James Benneyan

Time delays are an inevitable aspect of many healthcare supply-demand systems and can potentially lead to undesirable outcomes and decision making challenges. We propose an approach to characterize "expected" stability maps of healthcare access supply-demand systems affected by random time delays following a known probability distribution. This study aims to enable broader insight into the effects of random process delays, and across a wide range of test applications in healthcare queue management, demonstrates minimized undesirable oscillatory behaviors and improved system performance.

■ MA03

101C-MCC

Daniel H. Wagner Prize Competition I

Invited: Daniel H. Wagner Prize Competition

Invited Session

Chair: C. Allen Butler, Daniel H Wagner Associates, Inc., 2 Eaton Street, Hampton, VA, 23669, United States, Allen.Butler@va.wagner.com

1 - Calibrated Route Finder – Social, Environmental And Cost-effective Truck Routing

Mikael Ronnqvist, Professor, Universite Laval, Pavillion Adrien-Pouliot, Bureau 3345, 1065 Avenue De La Medecine, Quebec, QC, G1V OA6, Canada, mikael.ronnqvist@gmc.ulaval.ca Gunnar Svenson, Patrik Flisberg, Lars-Erik Jönsson

Finding the best route with many conflicting objectives is very difficult. The online system Calibrated Route Finder has been developed in collaboration among many companies and organizations and successfully addresses the problem. A key component is an inverse optimization process that establishes more than 100 weights to balance social values, environmental impacts, traffic safety, stress, fuel consumption, CO2 emissions, and costs. In addition, methodological and analytic developments now enable measurement and inclusion of perceived hilliness and curviness as well as strict rules where to drive. The system has been in operations since 2009 and is today used by about 100 companies.

2 - Vungle Inc. Improves Monetization Using Data Analytics

Ioannis Fragkos, Erasmus University, Burgemeester Oudlaan 50, Rotterdam, Netherlands, fragkos@rsm.nl, Bert De Reyck, Yael S Grushka-Cockayne, Casey Lichtendahl, Hammond Guerin

Big data have enabled firms to customize their services to unprecedented levels of granularity. In mobile advertising, once a customer enters the network, the ad-serving decision must be made in milliseconds. In this work, we describe the design and implementation of an algorithm we developed for Vungle Inc., one of the largest global mobile ad networks, that incorporates machine learning methods to make personalized ad-serving decisions. When compared to the company's legacy algorithm, our algorithm generated a 23% lift, which represents a $1 million increase in monthly revenue.

■ MA04

101D-MCC

Low-Carbon Power Sector: Policy and Technology Analysis

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Afzal Siddiqui, University College London, Department of Statistical Science, London, WC1E 6BT, United Kingdom, afzal.siddiqui@ucl.ac.uk

1 - Strategic Offering Of A Flexible Producer

Tuomas Rintamäki, Aalto University, Espoo, Finland, tuomas.rintamaki@aalto.fi, Afzal Siddiqui, Ahti Salo

Imbalances caused by intermittent renewable generation may give an opportunity to a strategic producer to exert market power. We study offering strategies of a flexible producer in day-ahead and intraday markets using a bi-level model in which the upper-level represents the profit maximization of the producer and the lower-level problems clear both markets sequentially. Using data from the Nordic power market, we find that the flexible producer can increase its profit by withholding production and by causing transmission grid congestion in both markets. Moreover, we compare the welfare impacts of the strategies to those of perfect competition and the dispatch policies in Morales et al. (2014).

2 - Power And Heat Market Model

Vilma Virasjoki, Aalto University, Espoo, Finland, vilma.virasjoki@aalto.fi, Afzal Siddiqui, Behnam Zakeri, Ahti Salo

Power markets are changing, i.a. due to an increasing share of renewable energy. This will also have effects on combined heat and power (CHP) plants and further on the district heating (DH) sector. It is thus essential to understand the financial and technical interrelations of these asymmetrically regulated sectors. We use complementarity modelling to study this linkage and give a numerical example using the Nordic energy system. We model the power system as a mix of DC and DC load flow linearized AC lines. We formulate perfect competition and Cournot oligopoly models and use GAMS to solve the market equilibrium. The results provide insights e.g. into the market power impacts on CHP and DH operations.

3 - Market Power In Electricity Markets In South-east Europe

Verena Viskovic, PhD Student, UCL, 1-19 Torrington Place, 2 Cubitt Street, London, United Kingdom, verena.viskovic.13@ucl.ac.uk, Yihsu Chen, Afzal Siddiqui, Makoto Tanaka

We examine the effect of market power in electricity and permits markets via single and bi-level model. We analyse potential scenarios of ownership structure in the post-privatisation phase in South-East Europe. We expect producers with market power to be able to influence electricity prices through permits market. In addition, we study the effect of virtual divestitures in mitigating market power.

4 - Variability Management In Long-term Investment Models

Lina Reichenberg, Chalmers University of Technology, lina.reichenberg@chalmers.se, Sonja Wogrin, Afzal Siddiqui

Time representation in large-scale energy investment models has been typically governed by variability in demand. However, as CO2 abatement is becoming a stronger driving force, variability enters also on the generation side. As a response to this, two families of alternative time reduction methods have been developed: one based on representative days and the other on using time slices based on variable resources. We investigate the performance of these two families of methods, in terms of accuracy in predicting the system plant capacity mix and CPU time.

■ MA05

101E-MCC

Remuneration of Flexibility in Electricity Markets

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Anthony Papavasiliou, CORE, UCL, Voie du Roman Pays 34, Louvain la Neuve, B-1348, Belgium, tpapva@hotmail.com

1 - A Revenue Adequate, Cost Recovering, Uniform Pricing Scheme For Wind Generation

Golbon Zakeri, University of Acukland, g.zakeri@auckland.ac.nz Geoff Pritchard, Mette Bjorndal, Endre Bjorndal

In 2010, Pritchard et. al proposed a stochastic program that would accommodate absorbing electricity generation from wind into an electricity market. We will present a strict improvement over this mechanism which is based on uniform pricing, is revenue adequate in every scenario, recovers cost for each generator in expectation, is incentive compatible and displays a number of other desirable properties.

2 - Operating Reserve Demand Curves For Improved Pricing In Electricity Markets With Renewable Energy

Audun Botterud, Argonne National Laboratory, abotterud@anl.gov, Zhi Zhou, Todd Levin

We present a probabilistic method for determining operating reserve demand curves (ORDCs) in electricity markets, accounting for the uncertainty in wind power forecasts. We present case studies analyzing how ORDCs influence incentives for short-term operations as well as long-term generation expansion in electricity markets with increasing shares of renewable energy. Finally, we discuss to what extent ORDCs reward flexible resources through improved pricing of energy and reserves.

3 - Ramp Capability Pricing: Environmental, Economic And Reliability Outcomes In Markets With High Penetration Of Renewables And Flexible CCS Plants

Dalia Patino Echeverri, Assistant Professor, Duke University, 9 Circuit Drive, Box 90328, Durham, NC, 27708, United States, dalia.patino@duke.edu, Rubenka Bandyopadhyay

Ramp Capability (RC) pricing, recently implemented by MISO, is expected to improve economics and reliability by adequately compensating flexible ramping resources. Coal-fired power plants retrofit with flexible Carbon Capture and Storage (CCS) systems, would allow air emissions reductions and improved system ramping capability. This paper explores the effects of dispatching CCS in a market with RC products. A modified Unit Commitment/Economic Dispatch (UC/ED) with CO2 emissions constraint and RC pricing, simulates 10-minute, annual operations of a scaled version of the MISO power generation fleet, to estimate changes in generators revenue, systems costs, reliability and air emissions.

4 - Deterministic Market Designs With Efficient Scheduling Of Flexible Ramping Products

Stefanos Delikaraoglou, Technical University of Denmark, Elektrovej, Building 325, room 105, Kgs. Lyngby, 2800, Denmark, stde@dtu.dk, Yves Smeers, Anthony Papavasiliou, Pierre Pinson

The variable and uncertain nature of stochastic renewables calls for revised market designs to optimally allocate available flexibility between energy and ramping services. Unlike stochastic dispatch models that endogenously co-optimize these services, deterministic models require the explicit definition of ramping products, e.g., CAISO market design. However, these products pertain only to capacity and thus disregard the energy cost from the deployment of flexible resources. Contrary to existing penalty-based heuristics, we propose a systematic approach, using nested Benders decomposition, to bring the deterministic dispatch close to the stochastic ideal in terms of costs and prices.

■ MA06

102A-MCC

Social Media Analytics

Sponsored: Data Mining

Sponsored Session

Chair: Julie Zhang, University of Massachusetts Lowell, One University Avenue, Lowell, MA, 01854, United States, Juheng_Zhang@uml.edu

1 - Challenging The Spatial Homogeneity Of Online Reviews

Theodoros Lappas, Stevens University of Technology, tlappas@stevens.edu

The popularity of online reviews has led to the emergence of large review-hosting platforms that rank businesses by aggregating their reviews. The standard aggregation approach naively considers only the review's text, stars, and date, while ignoring the reviewer's circumstances. In this work we hypothesize that the reviewer's role as a local or visitor has a significant effect on the content and valence of his review. Our study reveals significant differences between the two populations and provides strong evidence against spatial homogeneity. We provide a detailed analysis of our findings and discuss their implications for consumers, business owners, and review-hosting platforms.

2 - Aspect Mining For Discovering Demand-side Knowledge In Online Customer Reviews

Zhilei Qiao, Virginia Tech, qzhilei@vt.edu, G. Alan Wang

Online reviews provide important demand-side knowledge from customers to improve mobile app product quality. However, discovering and quantifying potential app product new feature requests and defects from large amounts of unstructured text is a nontrivial task. In this paper, we propose a Latent Domain-Side Knowledge Analysis (LDSKA) that identifies the most critical app product new features and corresponding product feature status, simultaneously. Experimental results demonstrate that our proposed model outperforms existing LDA model. Our research has significant managerial implications for app developers, app customers and app platform providers.

3 - Strategically Information Disclosure On Social Media

Julie Zhang, University of Massachusetts Lowell, Juheng_Zhang@uml.edu

With the prevalence of social media, more firms are using social media to disclose financial information. Unlike 10-k forms, firms have freedom to choose when and how to disclose "good" or "bad" news on social media. There are strategic behaviors of firms in information disclosure on social media. We investigate the strategic information disclosure of firms on social media.

4 - On Predicting Social Protest Using Social Media

Rostyslav Korolov, Doctoral Student, Rensselaer Polytechnic Institute, 110 Eighth street, Troy, NY, 12180, United States, korolr@rpi.edu, Di Lu, Jingjing Wang, Guangyu Zhou, Claire Bonial, Clare Voss, Lance Kaplan, William A Wallace, Jiawei Han, Heng Ji

We study the possibility of predicting a social protest based on social media messaging. We suggest that the frequency of text concerning the stages in the process of mobilization may be used to predict an imminent protest. We utilized several Natural Language Processing techniques to identify mobilization in social media. Our experiments with Twitter data collected before and during the 2015 Baltimore events show a correlation over time between volume of Twitter communications related to mobilization and occurrences of protest, thereby enabling estimation of the likelihood of a protest.

■ MA07

102B-MCC

Business Process Intelligence

Sponsored: Data Mining

Sponsored Session

Chair: Zhe Shan, University of Cincinnati, Cincinnati, OH, United States, zhe.shan@uc.edu

1 - Tree-based Models For Longitudinal Data

Peng Wang, University of Cincinnati, wangp9@ucmail.uc.edu Dan Liu, Brittany Green

Classification and regression tree (CART) has been broadly applied due to its simplicity of explanation, automatic variable selection, visualization and interpretation. Previous algorithms for constructing CART for longitudinal data suffer from the computational difficulties in estimation of covariance matrix at each node. We proposed to utilize the quadratic inference function (QIF) and developed a new criterion, named RSSQ, to select the best splits. The proposed approach incorporates correlation wihout estimating the correlation parameters. Therefore we could improve the efficiency of the partition results and prediction accuracy. This is joint work with Dan Liu and Brittany Green

2 - Mining Process Patterns Via Electronic Medical Record Audit Logs

He Zhang, University of South Florida, hezhang@usf.edu

Mining the process patterns in the access logs from information systems can provide useful insights for the workow patterns. One important issue in process mining is that the workow is usually highly dynamic and the access logs are noisy. We presenta framework to analyze process models with noisy data at an abstract level. We implement our approach using several months of data from a large academic medical center. Empirical results show that our framework can extract the process models effectively.

3 - Feature Selection For Quality Assessment Of Predicted Protein Structures

Shokoufeh Mirzaei, California State Polytechnic University - Pomona, CA, smirzaei@cpp.edu

In the context of computational biology a scoring function determines the quality of a predicted protein structure. The Goal of this paper is to find a subset of protein features that are critical in identifying native protein structures in order to develop a scoring function. In pursuit of this goal, our method of research consists of 1) identify a set of protein features suggested by the literature, 2) use a variety of feature selection methods to select the best subset of features 3) use deep learning techniques in machine learning to identify new features. The final Outcome of this research is a subset of protein features and a new scoring function which predicts the quality of protein models.

4 - Healthcare Fraud Analysis Using Sequential Data Mining

Babak Zafari, Babson College, Boston, MA, United States, zafari.babak@gmail.com

It is estimated that at least three percent of annual health care spending is lost to overpayments. However, the large size and complexity of the health care system make comprehensive auditing infeasible. This resulted in the use of data mining approaches to detect unusual payments. In this talk, we propose the use of pattern discovery methods to find the anamolies in the medical claims payment data.

■ MA08

103A-MCC

Crowd-based Innovation

Invited: Business Model Innovation

Invited Session

Chair: Bilal Gokpinar, UCL, London, United Kingdom, b.gokpinar@ucl.ac.uk

1 - Experience Breadth And Problem-solving In Crowdsourcing Contests: An Empirical Investigation

Anant Mishra, George Mason University, Fairfax, VA, 22030, United States, amishra6@gmu.edu, Nirup M Menon, Shun Ye

Online crowdsourcing contests have become a popular mechanism for addressing challenging problems. In this study, we use a multi-dimensional classification scheme to represent a contestant's breadth of experience on a crowdsourcing platform, and examine how it impacts her performance in a contest. Using detailed archival data from TopCoder, a crowdsourcing platform that hosts contests across software development problem domains (e.g., architecture, design, testing), our results demonstrate that a contestant's breadth of experience has a nuanced relationship with her performance in a contest.

2 - Spatial Distribution Of Alternative Finance

Mingfeng Lin, University of Arizona, 1130 E. Helen St, Tucson, AZ, 85721, United States, mingfeng@eller.arizona.edu, Bryan Zhang

Will online alternative finance help reduce the geographical imbalance of capital that the literature has long documented of the traditional finance? Are funding distributions geographically more equitable online, and are there differences across different types of crowdfunding forms? We answer these questions by leveraging detailed transactions data from multiple major crowdfunding platforms in the UK. We compare the spatial flow in online debt crowdfunding to bank lending, and online equity crowdfunding to venture capital and private equity financing. We also compare the funding flow between different types of crowdfunding. Results show some surprising and interesting patterns.

3 - The Role Of Customer Investor Involvement In Crowdfunding Success

Philipp Cornelius, University College London, London, United Kingdom, philipp.cornelius.12@ucl.ac.uk, Bilal Gokpinar

Entrepreneurs and organisations increasingly use crowdfunding to fund innovation projects through a large number of customer investments. The growing literature on the topic has predominantly studied crowdfunding in terms of its financing mechanism. The involvement of customers during crowdfunding, however, goes beyond the provision of capital. As investors and prospective product customers, crowdfunders want to influence crowdfunding campaigns. Can project creators benefit from this or does an increased influence of the crowd push products into too many directions and deter other customers from funding?

■ MA09

103B-MCC

Energy System Design and Optimization

Invited: Energy Systems Management

Invited Session

Chair: Kai Pan, University of Florida, 303 Weil Hall, Gainesville, FL, 32611, United States, kpan@ufl.edu

1 - An Asynchronous Dual Decomposition Algorithm For Stochastic Unit Commitment

Ignacio Aravena, PhD Student, Université catholique de Louvain, Voie du Roman Pays 34 bte L1.03.01, Louvain-la-Neuve, 1348, Belgium, ignacio.aravena@uclouvain.be, Anthony Papavasiliou

We present an asynchronous dual decomposition algorithm for solving transmission constrained stochastic unit commitment (UC) under multi-area renewable production uncertainty with a sub-hourly resolution. Dual iterations rely upon asynchronous subgradient methods, while primal candidates are recovered from dual subproblem solutions. The algorithm is implemented on a high performance computing cluster and its performance is compared to a deterministic UC model with exogenous reserve targets. The superior performance of stochastic UC in terms of expected cost, reliability, and run time is demonstrated on an industrial scale test case of the Central Western European region.

2 - Valid Inequalities For Hydro Genco Self-scheduling Optimization

Minseok Ryu, University of Michigan, Ann Arbor, MI, United States, msryu@umich.edu, Antonio J. Conejo, Ruiwei Jiang

We study on a self-scheduling optimization problem for a hydro generation company (GENCO) that manages a set of interconnected hydro reservoirs. We consider a class of key physical and operating characteristics of hydro reservoirs and generators in practical settings, including the minimum up/down time, the prohibited operating zones, and the nonlinear performance curves. We employ a mixed-integer linear programming (MILP) approach to formulate or approximate these characteristics. The MILP approach facilitates the use of many efficient computational tools, e.g., optimization solvers and valid inequalities. Finally, numerical experiments are conducted based on a real-world case study.

3 - A Bi-level Decision Dependent Stochastic Programming Model For Generation Investment Planning

Yiduo Zhan, University of Central Florida, yzhan@knights.ucf.edu Qipeng Zheng

A multistage bilevel decision dependent stochastic model is presented to tackle the generation investment planning problem. This model addresses both exogenous and endogenous uncertainties. The upper-level focuses on a long-term generation planning problem. The lower-level represents an electricity pricing problem that addresses the market clearing consideration with local transmission network. A linear reformulation solution approach is developed for nonlinear terms. The optimization model is implemented to CPLEX with C++. Real-world scenarios are tested.

4 - Optimal Bidding Strategy For Electricity Market Participants Considering Wind And Price Uncertainties

Kai Pan, University of Florida, 411 Weil Hall, Gainesville, FL, 32611, United States, kpan@ufl.edu, Yongpei Guan, Jean-Paul Watson

An optimal bidding strategy is derived for independent power producers (IPPs) by attending both day-ahead (DA) and real-time (RT) markets as a price taker. The IPP submits an offer of generation amounts to the DA market, for which a multistage adaptive optimization setting is explored for submitting RT market offers for each hour as a recourse by utilizing the more accurate forecasting of renewable output and RT price as the forecast range shrinks. This proposed strategy is theoretically justified of its significant advantages over existing alternative ones. The numerical studies show the promising future of adapting the proposed strategy and verify the effectiveness of the proposed cutting planes.

■ MA10

103C-MCC

SpORts: Bracketology

Sponsored: SpORts

Sponsored Session

Chair: Laura Albert McLay, University of Wisconsin-Madison, 1513 University Avenue, Madison, WI, 53706, United States, laura@engr.wisc.edu

1 - A Modified Logistic Regression Markov Chain Model For Ranking College Basketball And Football Teams And Forecasting Game Outcomes

Laura Albert McLay, University of Wisconsin-Madison, laura@engr.wisc.edu

Selecting the teams for the College Football Playoff for NCAA Division IA men's football is a controversial process performed by the selection committee. We present a method for forecasting the four team playoff weeks before the selection committee makes this decision. Our method uses a modified logistic regression/Markov chain model for rating the teams, predicting the outcomes of the unplayed games, and simulating the unplayed games in the remainder of the season to forecast the teams that will be selected for the four team playoff. You can check out the methodology and results at http://bracketology.engr.wisc.edu/

2 - Sampling From The 9,223,372,036,854,775,808 Possible Brackets In The Ncaa Men's Basketball Tournament Using The Power Model

Arash Khatibi, University of Illinois, Urbana, IL, 61802, United States, khatibi2@illinois.edu, Douglas M King, Maryam Kazerooni, Sheldon H Jacobson

This paper proposes the Power Model to estimate the winning seed distribution out of 9,223,372,036,854,775,808 possible brackets for the NCAA basketball tournament. The Power Model incorporates both the possibility of upsets and the better performance of stronger seeds by quantifying the relative strength of each pair of teams as a power function of their seed numbers. The Power Model is assessed based on the aggregate performance of one million brackets, which are generated for the five most recent tournaments (2012-2016) and scored using the ESPN scoring system.

3 - Predicting The Other Bracket Analysis Of The Selection Process For The National Invitation Tournament

Stephen Hill, University of North Carolina - Wilmington, hills@uncw.edu

In this work the selection process for college basketball's National Invitation Tournament (NIT) is examined. Using historical selection data, models are constructed from variables that are shown to be strong predictors of NIT tournament selection. Model quality is also assessed.

■ MA11

104A-MCC

Network Optimization Models and Applications I

Sponsored: Optimization, Network Optimization

Sponsored Session

Chair: Jorge A Sefair, Arizona State Univerity, 699 S. Mill Ave., BYENG 330, Tempe, AZ, 85281, United States, jorge.sefair@asu.edu

1 - Optimizing The Recovery Of Disrupted Multi-echelon Assembly Supply Chain Networks

Huy Q Nguyen, Rensselaer Polytechnic Institute, 110 8th Street, 5119 Center for Industrial Innovation, Troy, NY, 12180, United States, nguyeh7@rpi.edu, Thomas Sharkey, John E. Mitchell, William (Al) Wallace

We consider the problem of recovering multi-echelon assembly supply chain networks from large-scale disruptive events. Each supplier within this network assembles a component from a series of sub-components received from other suppliers. We show that scheduling rules applied locally at each supplier can optimize key recovery metrics including minimizing the maximum tardiness of any order of the final product of the supply chain network and minimizing the time to recover from the event. Our approaches are applied to a data set modeling an industry partner's supply chain.

2 - Network Level Traffic Management Through Selective Ramp Metering

Dening Peng, Arizona State University, Dening.Peng@asu.edu, Pitu B. Mirchandani

The vast literature on ramp metering has mostly focused on strategies for local traffic controls on an isolated freeway segment or freeway system, without considering integrated network-wide traffic diversions. The research presented investigates the coordinated ramp metering problem with the consideration of network-wide traffic diversions caused by ramp capacity changes from ramp metering. A nonlinear programming optimization model is developed to determine the optimal ramp metering rates for the entire traffic network and the corresponding user equilibrium traffic flow pattern. A gradient-based search algorithm is developed to solve the model efficiently.

3 - A New Methodology For Sewer Systems Design

Daniel Duque, Universidad de los Andes, d.duque25@uniandes.edu.co, Andres L Medaglia

The sewer network design problem consists of determining both the layout and the hydraulic design of the sewer system. In this work, we propose an iterative framework to design minimum-cost sewer networks. The layout selection is modeled as a variant of the Network Design Problem. Once the layout is defined, the hydraulic design is modeled as a Shortest Path Problem, in which the underlying graph resembles the diameter and slope of each pipe. Both procedures are solved iteratively to improve the objective function until a termination criterion is met. Our methodology compares favorably against traditional hydraulic-based techniques and commercial software.

4 - Dynamic Maximum Flow With Geographic Conflict Considerations

Navid Matin Moghaddam, Arizona State University, Tempe, AZ, United States, nmatinmo@asu.edu, Jorge A. Sefair

We study the problem of finding the maximum number of agents traveling between two known nodes in a network within a specified time horizon. Paths used by agents must not be conflicting, meaning that no two agents can be closer to each other than a given distance at any time. For this purpose, we need to find not only the path for each agent but also a schedule to traverse the network. Typical examples of this problem include the transportation of hazardous materials and transportation operations under geographic failures. Here, we present an exact solution method to solve this problem.

■ MA12

104B-MCC

Integrated Methods and Decomposition Approaches

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Joris Kinable, Carnegie Mellon University, Pittsburgh, PA, United States, jkinable@cs.cmu.edu

1 - Decomposition By Decision Diagrams

Andre Augusto Cire, University of Toronto - Scarborough, acire@utsc.utoronto.ca, David Bergman

Decision diagrams (DDs) have recently been applied to a variety of optimization problems, often closing long-standing instances from classical benchmarks. This success is primarily driven by a DD's ability to capture combinatorial structure. We exploit this characteristic and propose a novel solution method which decomposes a problem into highly-structured portions, where the solutions of each portion can be compactly represented using a DD. The DDs are then connected using mathematical programming, which represents a reformulation of the original problem. Preliminary results suggest that this new approach can improve upon both standard integer programming models and a single DD approach.

2 - Scalable Segment Abstraction Method For Advertising Campaign Admission And Inventory Allocation Optimization

Tuomas W Sandholm, Carnegie Mellon University, sandholm@cs.cmu.edu, Tuomas W Sandholm, Optimized Markets, Inc., Pittsburgh, PA, United States, sandholm@cs.cmu.edu, Fei Peng

Publishers enable advertisers to create increasingly targeted campaigns. This dramatically increases the publisher's complexity when optimizing campaign admission and inventory allocation to campaigns. We develop an optimal anytime algorithm for abstracting audience segments into coarser segments that are not too numerous for optimization. Compared to Walsh et al. [AAAI-10], it yields 45x to 142x speedup and significant improvement in quality. This stems from a quadratic-time (as opposed to doubly exponential or heuristic) algorithm for finding an optimal split of an abstract segment, a better scoring function for evaluating splits, and splitting time lossily like other attributes.

3 - A Branch-and-Check Approach To Solve A Wind Turbine Maintenance Scheduling Problem

Louis-Martin Rousseau, Professor, Ecole Polythechnique de Montreal, Montréal, QC, Canada, louis-martin.rousseau@polymtl.ca Louis-Martin Rousseau Froger, Michel Gendreau, Jorge E. Mendoza, Éric Pinson

The problem consist in finding a maintenance planning that maximizes the production of wind turbines while taking into account wind predictions, multiple task execution modes, and task technician assignment constraints. We introduce an exact method to solve this challenging problem. We first propose new integer linear programming formulations of this problem. Then, on this basis, we build up a Benders- based branch-and-cut approach making use of Benders cuts as well as problem-specific cuts. The results suggest that our method significantly outperforms the direct resolution of integer linear programming models and a previously developed hybrid metaheuristic approach.

4 - Branch And Price And Check For Vehicle Routing With Location Constraints

Pascal Van Hentenryck, University of Michigan, pvanhent@umich.edu

This paper considers a vehicle routing problem with pickup and delivery, time windows and location constraints. Locations can become congested if insufficient resources are available, upon which vehicles must wait until a resource becomes available before proceeding. This talk presents a branch-and-price-and-check model that uses a branch-and-price to solve the core vehicle routing problem and a constraint programming subproblem to check the feasibility of the location resource constraints. Combinatorial nogood cuts are added to the master problem when resource constraints are violated. Experimental results show the benefits of the approach.

■ MA13

104C-MCC

Nonconvex Optimization: Theory and Algorithms

Sponsored: Optimization, Global Optimization

Sponsored Session

Chair: Evrim Dalkiran, Wayne State University, 4815 Fourth St, Detroit, MI, 48202, United States, evrimd@wayne.edu

1 - Computational Experimentation With Cutting Planes For Convex-transformable Functions

Carlos Nohra, Carnegie Mellon University, Department of Chemical Engineering, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, cnohrakh@andrew.cmu.edu Nikolaos Sahinidis

Factorable relaxations of global optimization problems can be strengthened via the use of functional transformations. In this work, we consider a new method to strengthen factorable relaxations which exploits convex-transformability of intermediate expressions. We integrate recently developed relaxations into the software BARON and study their effect on the convergence of the branch-and-reduce algorithm. Our implementation relies on the generation of cutting planes corresponding to supporting hyperplanes of convex relaxations of convex-transformable functions. We present extensive computational results on problems from a collection of publicly available test sets.

2 - RLT And McCormick Relaxations For Polynomial Programming Problems

Evrim Dalkiran, Wayne State University, evrimd@wayne.edu

A polynomial programming problem can be equivalently formulated as a quadratically constrained quadratic program (QCQP) by introducing new variables that represent nonlinear monomials. In this talk, we discuss strength and tractability of the standard Reformulation-Linearization Technique (RLT) and J-set relaxations constructed for the original and quadrified formulations, and identify the superior relaxation depending on the problem characteristics. Extensive computational results are provided to demonstrate the effectiveness of the relaxations using problems from the literature and randomly generated test instances.

3 - Polyhedral Results For Combinatorially-constrained Network Flows

Jean-Philippe P. Richard, University of Florida, richard@ise.ufl.edu Danial Davarnia

Various problems that arise in railroad operations can be formulated as network flow problems with additional combinatorial constraints. In this talk, we describe two such requirements, and present mip formulations for them. We then show that valid inequalities can be derived for these combinatorial constraints in the space of original variables, limiting the need to introduce auxiliary binary variables. We report computational results that show that relaxation bounds obtained with these cutting planes are stronger, and faster to derive than those generated by commercial mip solvers on the problem natural mip formulations.

4 - New Formulation-based Methods In Distance Geometry

Leo Liberti, CNRS, Palaiseau, 91128, France, liberti@lix.polytechnique.fr

The fundamental problem of distance geometry asks to find a realization of a finite, but partially specified, metric space in a Euclidean space of given dimension. Unless some structure is known about the structure of the instance, it is notoriously difficult to solve these problems computationally, and most methods will either not scale up to useful sizes, or will be unlikely to identify good solutions. We propose a new heuristic algorithm based on a semidefinite programming formulation, a diagonally-dominant inner approximation of Ahmadi and Hall's, a randomized-type rank reduction method of Barvinok's, and a call to a local nonlinear programming solver.

■ MA14

104D-MCC

Data Analytics in Revenue Management Applications

Sponsored: Analytics

Sponsored Session

Chair: Jian Wang, The RainMaker Group, 4550 North Point Parkway, Alpharetta, GA, 30022, United States, jwang@LetItRain.com

1 - Discrete Choice Models In Airline Revenue Management Applications: Challenges And Opportunities.

Emmanuel Carrier, Delta Airlines, emmanuel.carrier@delta.com
Laurie A. Garrow

Although they are appealing as they reproduce the passenger's decision process, discrete choice models have failed to gain traction in airline RM applications. We examine the reasons for this lack of success despite significant academic research and successful applications in other industries. However, several trends are converging to make choice models more attractive. As RM techniques evolve in response to emerging data sources such as competitor fare data, the development of ancillary products and shifts to the distribution landscape, we discuss the relevance of choice models for new airline RM applications from dynamic pricing to ancillary products.

2 - New Developments In Airline Capacity Sharing Model With Movable Curtain

Ang Li, PROS, Inc., Houston, TX, United States, ali@pros.com, Darius Walczak

We present our new results on the single-leg capacity sharing model with a moveable curtain. In particular, these include structural properties of the model, and an algorithm rendered by these to solve the associated dynamic program. We also show a more general problem formulation where the curtain is only allowed at a few positions on the aircraft.

3 - Forecasting Hotel Room Sales By Utilizing Online User Reviews

Jian Wang, VP, R&D, The RainMaker Group, 4550 North Point Parkway, Alphretta, GA, 30022, United States, jwang@LetItRain.com, Sneha Bishnoi, Han Wu

In traditional hotel revenue management (RM), room sales are forecasted mostly based on transaction data. With the availability of "big data" such as online social reputation, hotel RM practitioners become more interested in improving room sales forecasting by utilizing these external data. In this talk, we present some empirical results of forecasting hotel room sales by using online reviews and scores of TrustYou and TripAdvisor along with transaction data. We then compare the results with some traditional forecasting models that use transaction data only.

■ MA15

104E-MCC

Recent Advances in Optimization for Structured High-Dimension Problems

Invited: Modeling and Methodologies in Big Data

Invited Session

Chair: Mingyi Hong, Iowa State University, 118 Pearson Hall, Ames, IA, 50021, United States, mingyi@iastate.edu

1 - Improved Sampling Complexity For Non-convex Optimization And Learning

Guanghui Lan, Georgia Institution of Technology, Atlanta, GA, United States, george.lan@isye.gatech.edu

We present an improved complexity result on the number of samples required to find an approximate global solution to a general nonconvex stochastic optimization problem. We discuss the consequence of this result on machine learning based on nonconvex optimization models, e.g., for some of those arising from deep learning.

2 - Smart: The Stochastic Monotone Aggregated Root-finding Algorithm

Damek Davis, UCLA, damek@math.ucla.edu

We introduce the Stochastic Monotone Aggregated Root-Finding (SMART) algorithm, a new randomized operator-splitting scheme for finding roots of finite sums of operators. SMART is similar to the class of incremental aggregated gradient algorithms, which minimize finite sums of functions; the difference is that we replace gradients of functions with objects called operators. By replacing gradients with operators, we increase our modeling power, and we simplify the application and analysis of the resulting algorithms. Among other features, SMART incorporates block-coordinate and asynchronous parallel updates.

3 - A First Order Free Lunch For The Sort-Lasso Optimization: Linear Convergence Without A Price

Tuo Zhao, Johns Hopkins University, tour@cs.jhu.edu

Many machine learning techniques sacrifice convenient computational structures to gain estimation robustness and modeling flexibility. Here we study this fundamental tradeoff through SQRT-Lasso for sparse linear regression. We explain how novel optimization techniques address these computational challenges. Particularly, we propose a pathwise smoothing proximal algorithm for solving the SQRT-Lasso optimization problem. Theoretically, we provide a novel model-based perspective for analyzing the smoothing optimization framework, which allows us to establish R-linear convergence guarantee for our algorithm. This implies that solving SQRT-Lasso is almost as easy as solving Lasso.

4 - Fast Stochastic Methods For Nonconvex Optimization

Sashank Reddi, CMU, sjakkamr@cs.cmu.edu

We study stochastic methods for nonconvex finite-sum problems. Stochastic gradient descent (SGD) is the de-facto algorithm used for solving optimization problems of this form. However, SGD suffers from slow convergence due to the inherent variance in the stochastic gradients. To tackle this issue, we develop fast stochastic algorithms for the nonconvex finite-sum problem and show that they are provably faster than both SGD and batch gradient descent. We also analyze a subclass of nonconvex problems on which these methods attain linear convergence to the global optimum. Our methods are based on variance reduction techniques, that have recently surged into prominence for convex optimization.

■ MA16

105A-MCC

Data Driven Optimization

General Session

Chair: Andrew Lim, National University of Singapore, 15 Kent Ridge Drive, Singapore, 119245, Singapore, andrewlim@nus.edu.sg

Co-Chair: Michael Jong Kim, University of Toronto, 5 King's College Road, Toronto, M5S3G8, Canada, mikekim@mie.utoronto.ca

1 - Solving The Dual Problems Of Dynamic Programs Via Regression

Enlu Zhou, Georgia Institute of Technology, enlu.zhou@isye.gatech.edu, Helin Zhu, Fan Ye

We develop a framework of regression approach to approximating the optimal dual penalties for the dual problems of general dynamic programs, by exploring the structure of the function space that consists of all the feasible dual penalties. The resulted approximations maintain to be feasible dual penalties, and thus yield valid dual bounds on the optimal value function. We further show that the proposed framework is computationally efficient, and the resulted dual penalties lead to numerically tractable dual problems.

2 - The Coherent Loss Function For Classification

Huan Xu, National University of Singapore, Singapore, isexuh@nus.edu.sg, Wenzhuo Yang, Melvyn Sim

Binary classification involves minimizing 0-1 loss, which is intractable. To address this, previous methods consider minimizing the *cumulative loss* - the sum of convex surrogates of the 0-1 loss of each sample. We revisit this paradigm and develop instead an *axiomatic* framework by proposing a set of salient properties on functions for binary classification and then propose the *coherent loss* approach, which is a tractable upper-bound of the empirical classification error over the *entire* sample set. We show that the proposed approach yields a strictly tighter approximation, while preserving the convexity of the underlying optimization problem, and links this approach with robust SVM.

3 - Inverse Optimization Of Convex Risk Functions

Jonathan Yu-Meng Li, University of Ottawa, Ottawa, ON, Canada, Jonathan.Li@telfer.uottawa.ca

The theory of convex risk functions has now been well established as the basis for identifying the family of risk functions that should be used in risk-averse optimization problems. Despite its theoretical appeal, the implementation of a convex risk function remains difficult, as there is little guidance regarding how a convex risk function should be chosen so that it also well represents one's own risk preferences. In this work, we present an inverse optimization framework that imputes a convex risk function based on solution data from some risk-averse optimization problems. Unlike classical inverse optimization, no parametric assumption is made about the risk function.

4 - Robust Empirical Optimization

Andrew Lim, National University of Singapore, Singapore, Singapore, andrewlim@nus.edu.sg, Jun-ya Gotoh, Michael Jong Kim

We analyze the out-of-sample performance of robust empirical optimization and show that it asymptotically optimizes the mean-variance reward under the data generating model. We also introduce the notion of robust cross-validation as a method of calibrating the empirical robust optimization problem. Theoretical and experimental comparison to empirical optimization is also provided.

MA17

105B-MCC

Optimizing Power System Operations Under Uncertainty

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Yu Zhang, University of California, Berkeley, 200 California Hall, Albany, CA, 94720, United States, yuzhang49@berkeley.edu

1 - Unit Commitment Under Gas-supply Uncertainty And Gas-price Variability

Antonio J. Conejo, The Ohio State University, 1971 Neil Av., Columbus, OH, 43210, United States, conejonavarro.1@osu.edu Ramteen Sioshansi, Bining Zhao

We propose a two-stage stochastic optimization model to analyze the scheduling of power units under natural gas-supply uncertainty and natural gas-price variability. The first stage of this model represents the day-ahead scheduling stage, while the second stage represents real-time operations via scenarios. We use this model to analyze the effect of two types of gas-supply conditions. First, we analyze a case involving low-cost gas supply with gas-transmission issues. We then examine a case involving higher-cost gas supply, which is used solely to attain feasibility with fast ramping events.

2 - Stochastic Market Clearing With High-penetration Wind Power

Yu Zhang, University of California, Berkeley, yuzhang49@berkeley.edu, Georgios Giannakis

Integrating renewable energy into the modern power grid requires risk-cognizant dispatch of resources to account for the stochastic availability of renewables. Toward this goal, day-ahead stochastic market clearing with high-penetration wind energy is pursued in this work. The objective is to minimize the social cost, which consists of conventional generation costs, end-user disutility, and a risk measure of the system re-dispatching cost based on the conditional value-at-risk. The resulting convex optimization problem is solved via the sample average and the alternating direction method of multipliers. Numerical results corroborate the merits of the proposed approaches.

3 - Integrated Generator Maintenance And Operations Scheduling Under Uncertain Failure Times

Beste Basciftci, Georgia Institute of Technology, Atlanta, GA, United States, beste.basciftci@gatech.edu Murat Yildirim, Shabbir Ahmed, Nagi Gebraeel

In this study, we formulate an integrated generator maintenance and operations scheduling problem as a stochastic mixed integer program by considering unexpected failure times. We generate failure scenarios based on the remaining life time distributions of the generators. We adopt a scenario decomposition approach to solve this problem in a distributed framework that identifies and evaluates solutions by solving scenario subproblems. Finally, we present computational experiments demonstrating the effectiveness of the approach.

MA18

106A-MCC

Theory of Integer Optimization

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Alberto Del Pia, University of Wisconsin, Madison, Madison, WI, United States, delpia@wisc.edu

1 - Facet Separation With One Linear Program

Laurence Wolsey, Université catholique de Louvain, laurence.wolsey@uclouvain.be, Michele Conforti

Given polyhedron P and and a point x*, the separation problem for polyhedra asks to certify that x* in P and if not, to determine an inequality that is satisfied by P and violated by x*. This problem is central in cutting plane methods for Integer Programming and the “quality” of the violated inequality is an essential feature in the performance of such methods. In this talk we address the problem of finding efficiently an inequality that is violated by x* and either defines an improper face or a facet of P. We provide some evidence that our method works on structured and unstructured problems.

2 - Ellipsoidal Mixed-Integer Representability

Jeffrey Poskin, University of Wisconsin - Madison, Wisconsin, WI, United States, poskin@wisc.edu, Alberto Del Pia

Representability results for mixed-integer linear systems play a fundamental role in optimization since they give geometric characterizations of the feasible sets that can be formulated by mixed-integer linear programming. We consider a natural extension of mixed-integer linear systems obtained by adding just one ellipsoidal inequality. The set of points that can be described, possibly using additional variables, by these systems are called ellipsoidal mixed-integer representable. In this work, we give geometric conditions that characterize ellipsoidal mixed-integer representable sets. “

MA19

106B-MCC

Evaluating the Performance of Optimization Solvers

Sponsored: Computing

Sponsored Session

Chair: Paul Brooks, Virginia Commonwealth Univ, Virginia Commonwealth Univ, Richmond, VA, 00000, United States, jpbrooks@vcu.edu

1 - IPET: Interactive Performance Evaluation Tools For Benchmarking Optimization Software

Gregor Hendel, ZIB, hendel@zib.de

The optimization community has recently seen an increasing number of non-standard benchmark measures for evaluating solver performance, which some data processing tools do not deliver. The benchmark evaluation starting from the parsing of raw solver log data until the preparation of publication-ready tables can be time-consuming and error-prone if done by hand. In this talk, we will first review some of the specialized benchmark measures used for optimization software. We will then present a Python tool named IPET to speed-up repetitive tasks during benchmarking. We will give an overview of the tool and show examples how automated benchmark scripts can be created using IPET.

2 - Surrogate Models For Algorithm Configuration

Meinolf Sellmann, IBM Research, Yorktown Heights, NY, United States, meinolf@us.ibm.com

Automatic algorithm configurators are important tools for improving program performance. Local search approaches in particular have proven very effective for tuning. We study the use of non-parametric models in the context of population-based algorithm configurators. We introduce a model designed specifically for the task of predicting high-performance regions in the parameter space. Moreover, we introduce the ideas of genetic engineering of offspring. Numerical results show that model-based genetic algorithms significantly improve our ability to effectively configure algorithms automatically.

3 - Tuning Of Optimization Software Parameters For Mixed Integer Programming Problems

Toni P Sorrell, Virginia Commonwealth University, Richmond, VA, United States, tpsorrel@vcu.edu, Paul Brooks, David Edwards

The tuning of optimization software is of key interested to researchers solving mixed integer programming (MIP) problems because the efficiency of the optimization software is can be greatly impacted by the solver’s parameter settings and the structure of the MIP. A designed experiment approach is used to fit a model that would suggest settings of the parameters that provided the greatest impact on the primal integral. Primarily, this research focuses on using classes of MIPs to not only obtain good parameter settings for a practitioner to use on future instances of the same class of MIPs, but to also gain understanding of why the settings work well for that class of MIPs.

4 - Deploying MPL Optimization Models With Google Web Services API’s

Bjarni Kristjansson, President, Maximal Software Inc., 2111 Wilson Boulevard, Suite 700, Arlington, VA, 22201, United States, bjarni@maximalsoftware.com

Over the past decade the IT has been moving steadfastly towards utilizing software on clouds using Web Services API’s. The old standard way of deploying software on standalone computers is slowly going away. Google has been one of the leading software vendors in this area and publishes several web API’s which can be quite useful for deploying optimization applications. In this presentation we will demonstrate several Google API’s, including the Google Sheets API, Google Maps API, and Google Visualization API and show how they can be integrated with the MPL OptiMax Library for deploying optimization to service both web and mobile clients.

■ MA20

106C-MCC

Healthcare Analytics: Big Data, Little Evidence

Invited: Tutorial

Invited Session

Chair: Joris van de Klundert, Erasmus University, Institute of Health Policy & Management, 2983 HE Ridderkerk, Netherlands, vandeklundert@bmg.eur.n

1 - Healthcare Analytics: Big Data, Little Evidence

Joris van de Klundert, Erasmus University, Institute of Health Policy & Management, 2983 HE Ridderkerk, Netherlands, vandeklundert@bmg.eur.n

While the healthcare sector contributes more than ten percent of GDP in most developed countries and is approaching twenty percent in the US, it remains a relatively modest area in the field of Operations Research, Management Science, and Analytics. There is considerable room for a larger and more valuable contribution, especially in view of the important advancements in information technology taking place in healthcare across the globe, which are already contributing to reducing the global burden of disease. In order for Analytics professionals and scientists to reach the full contribution potential of their discipline, it is beneficial to understand the dominant research paradigms and results of clinical and health sciences research. These sciences are rooted in empirical evidence, in empirical data, thus offering connection opportunities. In this tutorial we review the current position of Analytics as covered in the Operations Research and Management Science literature, and outline a path for the science of Analytics to enlarge its contribution to the health of populations.

■ MA21

107A-MCC

Applications of Health Systems Analytics

Sponsored: Health Applications

Sponsored Session

Chair: Muge Capan, Christiana Care Health System, Value Institute, 4755 Ogletown-Stanton Road, 2nd Floor, Suite 2E55, Newark, DE, 19718, United States, Muge.Capan@ChristianaCare.org

1 - Sepsis: Sepsis Early Prediction Support Implementation System

Nisha Nataraj, North Carolina State University, NC, United States, nnatara@ncsu.edu, Julie Ivy, Muge Capan, Ryan Arnold, James R Wilson

Sepsis can be broadly defined as an infection plus systemic manifestations of the infection. It remains the most expensive condition in hospitals as well as one of the leading causes of in-hospital mortality. Using a discrete-event simulation framework, this research aims to develop personalized intervention policies for patients with sepsis. Specifically, we focus on the toll comorbidities and pre-existing conditions take on the manner in which sepsis presents and the associated impact they have on decision making.

2 - Validation And Implementation Of Early Warning System To Synthesize Acuity, Clinical Judgment, And Workload

Stephen Hoover, Christiana Care Health System, Value Institute, Newark, DE, United States, Stephen.Hoover@ChristianaCare.org
Muge Capan, Justin M Glasgow, Susan Mascioli, Eric V. Jackson

We present the validation and implementation of a clinical early warning system. An analytical framework was developed to quantify physiological deterioration that results in adverse events by integrating a published Early Warning Score and a new Nurse Screening Assessment tool. Survival Analysis and Monte Carlo methods were used to validate our approach. Relevant system costs and workload implications were analyzed. Findings indicate potential for reduction in variation of care and prevention of unnecessary ICU transfers. Iterative implementation processes highlighted the importance of multidisciplinary teams and systemwide education when modifying complex healthcare systems.

3 - Patient Access To Specialty Endocrinology Care

Henry Ballout, University of Michigan, Ann Arbor, MI, United States, haballou@umich.edu, Pranjal Singh, Amy Cohn, Amy E. Rothberg

Recurrent patient visits add tremendous complexity to modeling capacity utilization for healthcare professionals. To assist an endocrinology clinic at the University of Michigan, we present a temporal database that takes prospective patient appointment and provider availability data and enables capacity analysis through a compilation of daily snapshots. Using this database, we investigate the clinics issues regarding access and adherence to the program's highly structured timeline.

4 - Robust Optimization Framework To Account For Prediction Errors For Cancer Diagnosis

Selin Merdan, University of Michigan, smerdan@umich.edu

Multiple diagnostic tests are often available for diagnosing diseases such as cancer; however, how best to use these tests to render a diagnosis is challenging because there is often a tradeoff between the benefits of diagnosis and the harms and costs associated with the diagnostic tests themselves. We present a robust optimization model for determining the optimal assignment of composite diagnostic tests based on individual patient risk factors to achieve an optimal balance between the benefits and harms of diagnostic tests. We further provide a specific example in the context of radiologic imaging to detect metastatic prostate cancer.

■ MA22

107B-MCC

Healthcare Policy, Personalized Treatment, and Coalitions: Operations Research Approaches

Invited: ORinformed Healthcare Policies

Invited Session

Chair: Pooyan Kazemian, Harvard Medical School, 25 Shattuck Street, Boston, MA, 02115, United States, pooyan.kazemian@mgh.harvard.edu

Co-Chair: Mark P. Van Oyen, University of Michigan, Ann Arbor, MI, United States, vanoyen@umich.edu

1 - Depression Care Management: Personalized Assessment To Cost-effective Population Interventions

Shan Liu, Assistant Professor, University of Washington, Seattle, WA, 98195, United States, liushan@uw.edu
Shuai Huang, Ying Lin, Xuelu Yang, Jiaqi Huang, Weiwei Shang

Depression affects 1 out of 10 Americans. While electronic health record (EHR) provides an unprecedented information infrastructure, we need a system perspective and an associated computational platform, and a seamless integration with decision-analytic models to link the design of personalized disease interventions to cost-effective population management. We are developing methods to 1) analyze and predict the heterogeneous depression trajectories of a patient population from EHR, 2) characterize the hidden disease processes and design personal intervention schedules, and 3) evaluate their cost-effectiveness to monitor and treat depression across a range of care scenarios.

2 - National Policy Impact Of High-cost Biologics For Ophthalmologic Use

David W. Hutton, University of Michigan, dwhutton@umich.edu

In the last decade, high-cost biologics have taken center stage in the treatment of complex degenerative eye diseases. Biologics for ophthalmologic use consume one-sixth of Medicare's part B drug budget. We examine how OR-based tools can be used to forecast and evaluate the national policy impact of these therapies (on both outcomes and costs). We see how different parties frame the problems differently and make different modeling choices. We discuss how different ways of using OR-based tools can influence policy. We explore open challenges evaluating the value of information and understanding how to evaluate decisions made jointly between patients and providers.

3 - On Personalized Allocation Of Treatments

Mohsen Bayati, Stanford University, bayati@stanford.edu, Hamsa Sridhar Bastani, Khashayar Khosravi

Growing availability of data has enabled practitioners to tailor medical treatments at the individual-level. This involves learning a model of decision outcomes conditional on individual-specific covariates or features. Recently, "contextual bandits" have been introduced as a framework to study these online decision making problems. In this talk we discuss statistical challenges that arise in such data-driven allocation of treatments.

4 - From Incident To Inpatient: How Healthcare Coalitions Can Improve Community Response

Jonathan Helm, Indiana University, helmj@indiana.edu
Alex Mills, Andres Jola-Sanchez, Mohan V Tatikonda, Bobby Courtney

Healthcare coalitions are a new type of organization that can coordinate casualty distribution among available hospitals in a metropolitan area after a multiple casualty incident. Using data from a major metro area, we show the value of different types of coordination regarding hospitals' capacity information. We find that, while coalitions were initially create for large disasters, significant value comes in coordinate metropolitan area hospital resources on a much smaller scale. We also identify what types of information are most valuable for these organizations to collect and disseminate. This leads to interesting policy implication for the further funding and creation of such coalitions.

■ MA23

108-MCC

Human Resource Analytics in Anesthesia

Sponsored: Health Applications

Sponsored Session

Chair: Franklin Dexter, University of Iowa, 200 Hawkins Drive, 6-JCP, Iowa City, IA, 52242, United States, franklin-dexter@uiowa.edu

1 - Comparing Providers Based On An “obvious” Short-term Clinical Outcome: Pain Scores

Jonathan Porter Wanderer, Vanderbilt University, Nashville, TN, 37204, United States, jon.wanderer@Vanderbilt.Edu

In this presentation, we will review a “obvious” metric for comparing supervising anesthesiologists: their patients’ pain scores on admission to the recovery room. Using modeling, we will evaluate the appropriateness of this metric and analyze the degree to which these scores are useful in evaluating the performance of supervising anesthesiologists. Spoiler alert: this is not as useful a metric as it may first appear.

2 - Comparing Anesthesia Providers Based On Discrepancies In Their Controlled Substance Reconciliation Logs

Richard H. Epstein, University of Miami, repstein@med.miami.edu

Accurate accounting of controlled drugs is required in the US under the Controlled Substances Act. However, discrepancy rates of 15% between automated drug cart transactions and administration records in the anesthesia information management systems (AIMS) have been reported. We describe how we reduced our discrepancy rate from 15% to 3.5% through a sequential process involving daily, individualized email reports, a near real-time tool publicly showing the transaction balance compared to the AIMS, and involvement of the pharmacy to contact individuals with discrepancies. Although there were a few extreme outliers, discrepancies were widely distributed, requiring a system based approach.

3 - Comparing Faculty Anesthesiologists Based On Daily Evaluations Of Quality Of Supervision By The Resident Physicians

Franklin Dexter, University of Iowa, franklin-dexter@uiowa.edu

Since July 2013, resident physicians (and nurse practitioners) evaluate daily the anesthesiologists in our department based on quality of supervision. The uni-dimensional 9-item scale is valid and psychometrically dependable. Graduate students evaluate the faculty daily. In 9 papers, we have learned: what is being measured, achievable response rates, lack of important covariates, appropriate Bernoulli CUSUM analysis, role of feedback, minimum perceived acceptable scores, lack of correlation with individual productivity, lack of advantage to faculty specialization, and improvement over time. Textual analysis of resident comments showed behaviors associated with better scores.

4 - Privacy Policies For Protecting Human Resources

Liam O’Neill, University of North Texas, liam.oneill@unthsc.edu

The dominant paradigm of information privacy is based on de-identification. We calculated the percent uniqueness for hospital surgical patients from a database of 2.8 million hospital records. Only three attributes were considered: hospital name, fiscal quarter, and surgical procedures. For patients undergoing two or more procedures, 64.4% of records were found to be unique. For a patient selected at random, the probability of matching this record to state database was 42.8% (SE < 0.1%). Data sharing plans, as required by some journals and funding agencies, may place patient and clinician privacy at risk. Compliance with HIPAA alone is insufficient to protect health data from re-identification.

■ MA24

109-MCC

Organizational Structures and Innovation

Invited: Strategy Science

Invited Session

Chair: Todd Zenger, University of Utah, Eccles School of Business, Salt Lake CIty, UT, 9, United States, todd.zenger@eccles.utah.edu

1 - Organizational Structure, Attention Allocation Andinnovation In The Multidivisional Firm

John Joseph, University of California, Irvine, CA, 9, United States, john2@uci.edu, Alex Wilson

We propose that in order to understand how organizations develop inventions with greater impact, we must not only consider the formal divisionalization of the firm, but also its attention structure. We find that unit attention which is either highly specialized (distinct from other units) or highly integrated (similar to other units) yields higher quality inventions. We suggest that this U-shape relationship reflects the need for attentional coherence to product quality inventions. We test our theory using novel organizational structure and topic modeling of patent data from Motorola. Our findings have implications for theories of organizational design and innovation.

2 - Stage-gate Processes And Selection In Innovation

Ronald Klingebiel, Frankfurt School of Finance and Management, 1, Frankfurt, Germany, r.klingebiel@fs.de, Peter Esser

We examine resource allocation at stage gates of the innovation process at former handset manufacturer Sony Ericsson, illuminating project discontinuation behavior. We find that with financials unavailable early on, escalation can be unknowable as well as a bias. Further, the propensity to search and update financials declines as projects near completion, accompanying known self-justification and goal-substitution effects. Finally, projects, for which negative information does get translated into business case updates, are more likely to be continued than projects with stable or improving financials. This strong form of escalation suggests a counter-intuitive effect of attention.

3 - Intra-firm Collaboration Boundaries And The Efficacy Of Innovation

Andy Wu, Harvard Business School, Soldiers Field, Boston, MA, 02163, United States, awu@hbs.edu, David Hsu, Vikas Aggarwal

What are the implications of alternate approaches to organizing the inventive human capital of a knowledge-intensive firm? We empirically examine how the locus of technical experience diversity within a firm influences firm-level innovation output. Using a sample of biotechnology start-ups we find that organizing human capital so that there is greater indirect diversity (i.e., where technical experience diversity lies outside the locus of production) yields greater firm-level innovation benefits compared to organizing human capital so that there is greater direct diversity (i.e., where technical experience diversity lies inside production units themselves).

4 - How Do Pilots Work? Examining Pilot Use In New Practice Transfer?

Megan Lawrence, Vanderbilt University, Owen Graduate School of Management, Nashville, TN, 3, United States, megan.lawrence@vanderbilt.edu

This paper examines how the use of pilots influences new practice implementation. Using data from a Fortune 100 retail chain that implemented a new restocking process, I compare implementation performance in 280 stores. I propose and test that pilots enable learning from outside experiences. I find that stores only learn from the pilot store in their own district, even when closer to another district’s pilot. Stores’ prior performances relative to their pilot influence the extent to which they learn from their own experiences. Lastly, I provide evidence that the most likely alternative mechanism - peer effects - may also be present but that these effects do not eliminate the learning findings.

■ MA25

110A-MCC

Modern Project Management

Invited: Project Management and Scheduling

Invited Session

Chair: Nicholas G Hall, Ohio State University, Columbus, OH, United States, hall.33@osu.edu

1 - Opportunities For Behavioral Research In Project Management

Enno Siemsen, University of Wisconsin, esiemsen@wisc.edu

Behavioral research in operations management is on the rise. The field of Project Management seems ripe for more applications of behavioral research. How do team members react to deadlines and reminders? How are projects selected and abandoned? What is the impact of multi-tasking, and how does assigning new resources change team dynamics? These are all important research topics, and I will both highlight past and current work in these areas, as well as opportunities for future research.

2 - Information Protection In New Product Development Projects

Xiaoqin Wen, Shanghai University, wenxq_8@163.com, Nicholas G Hall

Motivated by the threat of industrial espionage during new product development, a project company minimizes information leakage by using decoy work. The competitor validates the information it observes in a cost-effective way, based on three alternative prior assumptions about its validity. We model this problem as a two stage Stackelberg game, identify an equilibrium solution, and obtain managerial insights. Coordinated setting of the project deadline and budget is needed to protect the project. Counterintuitively, it benefits the project company to announce that it uses decoy work.

3 - Research Challenges In Project Management

Ted Klastorin, University of Washington, tedk@u.washington.edu

A great deal of previous project management research has focused on scheduling problems. But the research issues faced by project managers are far more complex and just as challenging as those faced by supply chain managers. In this talk, I will explore many of these issues and directions for future research studies, with an emphasis on problems associated with decentralized projects.

4 - Research Opportunities In Project Scheduling

Rainer Kolisch, Technical University of Munich, rainer.kolisch@tum.de

Operations Research has been applied in project scheduling for more than half a century. This talk summarizes achievements and outlines research opportunities.

■ MA26

110B-MCC

Dynamic Matching

Invited: Auctions

Invited Session

Chair: John Dickerson, Carnegie Mellon University, 9219 Gates-Hillman Center, Pittsburgh, PA, 15213, United States, dickerson@cs.cmu.edu

1 - Dynamics Matching With Departures

Maximilien Burq, Massachusetts Institute of Technology, Cambridge, MA, United States, mburq@mit.edu
Vahideh Manshadi, Itai Ashlagi, Patrick Jaillet

We study dynamic matching in an infinite-horizon market with stochastic arrivals and departures, in which some agents are a priori more difficult to match than others. We analyze the effect of batching for policies that match agents through cycles of length 2 or 3. We show that if only cycles of length 2 are allowed, the benefit of batching is not significant. However for 3-cycles, batching can result in a considerable gain over greedy. Furthermore, using data from the National Kidney Registry, we provide simulations that confirm our theoretical results.

2 - Dynamic Matching In Over-the-counter Markets

Yu An, Stanford, Stanford, CA, United States, yua@stanford.edu
Zeyu Zheng

We model the dynamics of liquidity premium in an OTC market with heterogeneous assets. A monopolistic dealer matches supply and demand flows in order to maximize his profits. Inventory building by the dealer increases the average waiting time for those customers who rejected immediacy offers, and therefore helps the dealer extract rents via liquidity premium. The dealer's dual role of liquidity provision and matchmaking creates inefficient monopoly, and in equilibrium, he holds too much inventory compared to the first best. Our result helps explain the recent growth in all-to-all trading platforms in the corporate bonds market, as they circumvent these inefficiencies.

3 - Toward A Credit-based Mechanism For Dynamic Kidney Exchange

John Dickerson, Carnegie Mellon University, dickerson@cs.cmu.edu, John Dickerson, University of Maryland, College Park, MD, 20742, United States, dickerson@cs.cmu.edu

We discuss progress toward creating a credit-based matching mechanism for dynamic barter markets—-and kidney exchange in particular—-that is both strategy proof and efficient, that is, it guarantees truthful disclosure of donor-patient pairs from the transplant centers and results in the maximum global matching. We show that no such mechanism that supports cycles and chains of any length can be both long-term individually rational and economically efficient; we then give light assumptions under which such a mechanism can exist.

■ MA27

201A-MCC

Empirical Research in Operations II

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Nils Rudi, INSEAD, 1 Ayer Rajah Avenue, Singapore, 138676, Singapore, nils.rudi@insead.edu

1 - Fitting, Clustering And Forecasting Product Life Cycles: Model And Empirical Validation

Jan A Van Mieghem, Harold Stuart Professor, Northwestern University, 1, Evanston, IL, 60209-2001, United States, vanmieghem@kellogg.northwestern.edu
Kejia Hu, Jason Acimovic, Douglas Thomas

We present an approach to fit product life cycle (PLC) curves from historical demand data and use them to predict/forecast demands of ready-to-launch new products. We propose three types of models to fit PLC: the BASS diffusion model, the polynomial model and the piecewise-linear model and compare their goodness-of-fit and complexity for fitting different categories of products. Using time-series clustering techniques, we cluster the fitted PLC curves into several representative patterns. Finally, we validate out-of-sample forecast accuracy using actual demand data of a computer company.

2 - Managing Multichannel Delivery Of Healthcare Services: Case Of Telemedicine In Rural India

Kraig Delana, London Business School, PhD Program Office, London, NW1 4SA, United Kingdom, kdelana@london.edu, Kamalini Ramdas, Sarang Deo

Telemedicine is a potent intervention to improve healthcare access for difficult-to-reach populations. We investigate the impact of the introduction of rural telemedicine facilities on access to eye care for patients in rural India using more than 4 million patient visit observations from the largest eye care system in the world. In particular, we exploit growth in the network of telemedicine centers over time and space to identify changes in where and how early patients seek care using a difference-in-differences methodology. Our results have implications for effective multichannel delivery of complex services such as healthcare.

3 - Forecasting Demand For New Products: Combining Subjective Rankings With Historical Data

Marat Salikhov, INSEAD, Boulevard de Constance, Fontainebleau, 77305, France, marat.salikhov@insead.edu
Nils Rudi

We combine subjective ranking inputs with historical data for new product demand forecasting. The methods yields good fit with data, both for order statistics of proportions of total demand and for predicting the actual demand.

■ MA28

201B-MCC

Online Retailing

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Dorothee Honhon, University of Texas at Dallas, Richardson, TX, United States, dorothee.honhon@utdallas.edu

Co-Chair: Xiajun Amy Pan, University of Florida, Gainesville, FL, United States, amy.pan@warrington.ufl.edu

1 - Probabilistic Selling For Vertically Differentiated Products: The Role Of Salience

Quan Ben Zheng, University of Florida, quan.zheng@warrington.ufl.edu, Xiajun Amy Pan, Janice E Carrillo

This paper studies probabilistic selling for vertically differentiated products, whereby consumers do not know the exact identity of a product until after making the purchase. Our work discovers the crucial role of consumers' salient thinking behavior: consumers focus on and overweight the salient attribute of a product in their perception. We show that probabilistic selling can improve the seller's profit with salient thinkers even when this strategy does not emerge with rational consumers. Consumers' salient thinking behavior enables the seller to utilize the probabilistic product to transform the consumers' choice context and direct their attention to quality.

2 - Maximizing Profitability In Online Retail Through Free Shipping Threshold

Jiaqi Xu, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15217, United States, jiaqixu@wharton.upenn.edu, Gerard P Cachon, Santiago Gallino

We present a data-driven model to analyze the profit implication of an online retailer's free shipping threshold decision. A key component of our model derives from the empirical observation that customers often increase their basket size at checkout to qualify for free shipping (order padding). We find that a free shipping threshold policy is effective when the extra sales from order padding do not substantially reduce the total amount of future purchases, the retailer charges only a small portion of the fulfillment cost for orders that do not qualify for free shipping, and product handling costs for returns are low.

3 - Learning From Clickstream Data In Online Retail

Bharadwaj Kadiyala, PhD Candidate, The University of Texas at Dallas, Richardson, TX, United States, bharadwaj.kadiyala@utdallas.edu, Dorothee Honhon, Canan Ulu

We study the problem of an e-tailer who learns about consumer preferences from observing sales or clickstream data on his website in a Bayesian fashion. We use a ranking-based model to represent consumer choice for two types of products: basic products for which consumers have well-defined preferences and fashion products for which consumers discover their preferences via browsing. We prove that, when the e-tailer learns from clickstream data, it may be optimal to show products on the search page, but display them as unavailable later on their product information page. We also numerically estimate the value of learning from clickstream data versus learning from sales data only.

MA29

202A-MCC

Improving Supply Chain Responsibility Through Regulation and External Actions

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Robert Swinney, Duke University, Durham, NC, United States, robert.swinney@duke.edu

1 - Pollution Regulation And Market Structure: Equilibria, Profits And Welfare Effects

Krishnan S Anand, University of Utah, 1655 E Campus Center Dr Rm 7211, David Eccles School Of Business, Salt Lake City, UT, 84112, United States, anand@eccles.utah.edu
Francois C. Giraud-Carrier

Opponents of pollution regulation claim that regulations choke businesses, hurt welfare and destroy economic growth. We model two popular regulations— Cap-and-Trade and Taxes— under imperfect competition, and prove that well-chosen regulation can simultaneously improve firms' profits, consumer surplus and welfare. Further, firms can be induced to perfectly internalize their pollution externalities, without being charged a penny in taxes. Our results suggest that the paramount factor in framing pollution regulations should be their impact on consumers rather than on producers.

2 - Extended Producer Responsibility (EPR) For Pharmaceuticals

Isil Alev, Boston College, isil.alev@bc.edu
Atalay Atasu, Beril L Toktay, Ozlem Ergun

Following their popularity for non-consumables, EPR-based implementation models have gained traction for managing pharmaceutical overage. We analyze the effectiveness of these models for pharmaceuticals, particularly Source Reduction (SR) and End-of-Pipe Control (EC), by developing a game-theoretic model of pharmaceutical chain with a focus on factors causing overage. We show that the pharmaceutical context may imply stronger preference for adopting the EC model as compared to non-consumables. We also show that an alignment of stakeholder preferences for the model choices can be achieved under a larger set of conditions for pharmaceuticals.

3 - Prevention Or Prosecution: An Analytical Approach To Modern Slavery In Supply Chains

Shawn Bhimani, Duke University, Durham, NC, United States, shawn.bhimani@gmail.com

We explore current human trafficking prevention schemes by modeling the interaction between a regulator and a business. By analyzing the incentive systems at play, we provide insights on how to effectively motivate integral stakeholders in the fight against corrupted supply chains.

MA30

202B-MCC

Sustainable Operations I

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Basak Kalkanci, Georgia Institute of Technology, Atlanta, GA, United States, basak.kalkanci@scheller.gatech.edu

1 - Operational Challenges For Distributed Manufacturing In Developing Countries

Andre Du Pin Calmon, INSEAD, Fontainebleau, France, andre.calmon@insead.edu

We model and analyze a distributed manufacturing system set-up by a social enterprise that produces fashion accessories in Kenya. This company selects and works with a network of small artisan workshops with diverse characteristics in terms of quality and production capacity. Furthermore, when adding a new workshop to the network, there is uncertainty regarding that workshop's features and performance. We model the problem of allocating production orders to workshops as a stochastic learning problem. We also allow for "fairness" constraints, which encode the company's social objectives. We illustrate the performance of different allocation policies through numerical simulations.

2 - Sustainable Operations Versus Corporate Social Responsibility: A Cross – Country Analysis Of Value Chain Transparency

Ryan Buell, Harvard Business School, rbuell@hbs.edu
Basak Kalkanci

We study the differential impact of transparency into a company's sustainable operations relative to transparency into its "extracurricular" CSR activities. Through a series of cross-country experiments engaging participants in the US, India, China, Bangladesh, Mexico, and Turkey, we explore whether stakeholders respond more favorably to transparency that reveals sustainable operations (e.g. reducing water consumption or paying a living wage) than to transparency that reveals sustainable investments that fall outside the operation (e.g. donating an equivalent amount of drinking water or investing an equivalent amount in the community around a factory).

3 - A Dynamic Mechanism For Achieving Sustainable Supply Of High Quality Products

Fang Liu, Nanyang Technological University, Singapore, Singapore, Liu_Fang@ntu.edu.sg, Tracy Lewis, Jing-Sheng Jeannette Song

Several leading companies have realized the importance of sustainable quality supply and have initiated programs to achieve it. This paper investigates whether the guidelines in such programs provide the right incentives and information structures for all parties to participate in order to achieve the intended long-term goals.

4 - New Business Models For Industrial Park Operators

Ioannis Siskos, Kuhne Logistics University, ioannis.siskos@the-klu.org, Luk N Van Wassenhove

Industrial parks operators (IPOs) are interested in symbiotic projects developed in their parks. We use static monopoly and competition modelling in order to explore the cost and pricing conditions under which by-product synergies that are not realized by the candidate firms would be undertaken by the IPO.

MA31

202C-MCC

Energy and Commodity Merchant Operations

Sponsored: Manufacturing & Service Oper Mgmt, iFORM

Sponsored Session

Chair: Selvaprabu Nadarajah, College of Business, University of Illinois at Chicago, 601 S Morgan St, Chicago, IL, 60607, United States, selvan@uic.edu

1 - Risk Neutral And Risk Averse Approximate Dynamic Programming Methods For Bidding In The Energy Market

Daniel R. Jiang, University of Pittsburgh, Pittsburgh, PA, 15261, United States, drjiang@pitt.edu, Warren B Powell

In order to better assess the value of energy storage, we consider the problem of bidding into an hour-ahead market with the goal of "trading" physical energy, i.e., performing energy arbitrage. We describe an approximate dynamic programming method that exploits the monotone structure of the problem in order to obtain near-optimal bidding strategies for a risk-neutral formulation of the objective function. Additionally, in this application (and many others), it can be important to incorporate risk-aversion into the decision making process. We discuss a method that allows us to construct risk-averse bidding polices, optimized under dynamic quantile-based risk measures.

2 - Keeping Options Open When Just One Can Be Exercised: When To Pick A Winner

Daniel Ralph, University of Cambridge, d.ralph@jbs.cam.ac.uk
Rutger-Jan Lange

Given several, costly R&D projects for low carbon electricity, when should be any be abandoned to eventually pick the winner? We study parallel competing projects where the performance of each project is governed by a general Ito process, while opportunities to drop underperforming options (or select the winner) follow a Poisson process. We show how to construct the option value as the limit of an increasing sequence of lower bounds. This general multidimensional theory underlies many complex real-world stopping decisions, and offers the first opportunity to solve this class of problems optimally.

3 - Policy Uncertainty And Real Options On Switching Of Peak Power Plants

Stein-Erik Fleten, Norwegian University of Science and Technology, stein-erik.fleten@iot.ntnu.no, Marius Johansen, Alois Pichler, Carl J Ullrich

We examine empirically how economic factors, government policy, and strategic interactions a
ffect managers' decisions to switch between operating and stand-by states for peaking electric power generators. We model the switching decisions using a structural model of a dynamic optimal decision game. We focus on the power markets in the Northeastern United States, where annual observations of such decisions are available. The results indicate that regulatory uncertainty significantly increases firms' perception of switching costs, and that large power producers are noticeably more influenced by their economic environment in their decision-making than small firms.

■ MA32

203A-MCC

Scheduling V

Contributed Session

Chair: Nermine Harraz, Associate Professor, Alexandria University - Faculty of Engineering, Alexandria, Egypt, nharraz@alexu.edu.eg

1 - Two Stage, Single Lot, Lot Streaming Problem For A 1 + M Hybrid Flow Shop

Sanchit Singh, Virginia Tech, 1206 University Terrace, Apt F, Blacksburg, VA, 24060, United States, sanchit@vt.edu

This paper considers a single lot, lot-streaming problem for a hybrid flow shop consisting of a single machine at Stage 1 and M identical machines at Stage 2. The aim is to find optimal number, sizes and allocation of sublots to the machines at Stage 2 for minimizing make span. An exact algorithm is developed with polynomial time search to obtain an optimal schedule when the sublot sizes are continuous. A branch-and-bound based method is also developed for the case of integer sublot sizes that employs tight bounds. Its performance is tested against the direct solution of the MIP formulation by CPLEX.

2 - Ideal Schedules

Kangbok Lee, City University of New York, York College, 94-20 Guy R Brewer Boulevard, Queens, NY, 11451, United States, kangbok.lee3@gmail.com, Joseph Leung, Michael L Pinedo

An ideal schedule is referred to as a schedule minimizing both maximum and total completion times simultaneously and an ideal problem is a problem where every instance of the problem has an ideal schedule. We identify the boundary between ideal and non-ideal problems and investigate the algorithms for ideal schedules under different job characteristics such as processing times, release dates, precedence constraints, and eligibility constraints.

3 - An Exact Model For Solving The Hybrid Flow Shop Scheduling Problem

Nermine Harraz, Associate Professor, Alexandria University - Faculty of Engineering, Alexandria, Egypt, nharraz@alexu.edu.eg

This work presents a model to solve the hybrid Flow Shop Scheduling problem. The developed Mixed Integer Programming model considers optimizing a dual criteria objective function to minimize a convex sum of makespan and the number of tardy jobs under various constraints. The constraints consider unrelated parallel machines, precedence relations, stage skipping, machine eligibility, operations lag time, machine release times, and sequence dependent anticipatory and non-anticipatory setup times. An exact solution is used to solve the model and to implement it in a real world packaging case. The output shows that the model is efficient and applicable easily under different conditions.

■ MA33

203B-MCC

Simulation I

Contributed Session

Chair: Simon Mak, Graduate Student, Georgia Institute of Technology, North Ave NW, Atlanta, GA, 30332, United States, smak6@gatech.edu

1 - Dynamic Simulation Of Marine Port Resiliency

Henry Lester, University of South Alabama, PO Box 8172, Mobile, AL, 36689, United States, hlester@southalabama.edu, Raymond L Smith

Marine port system resiliency indicates the degree a port can resist and recover from a potential disruption. Essential measures of this port resiliency include operational factors subject to excessive burdens. This paper presents an approach to capturing marine port behaviors with respect to system operational factors. The procedure utilizes a system dynamic simulation model to analyze port operations under unpredictable and fluctuating loads to isolate significant critical port infrastructure components. The resultant critical components will provide a basis for future public policy decision analysis pertaining to marine port resiliency subject to extreme events.

2 - An Optimal Stopping Approach To Portfolio Risk Measurement

Kun Zhang, Mr, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong, Hong Kong, 000, Hong Kong, kunzhang6-c@my.cityu.edu.hk, Guangwu Liu, Bingfeng Zhang

Portfolio risk measurement under the nested setting involving a two-level simulation procedure is a challenging computational problem. To reduce the computational burden, we propose an optimal stopping approach in which only one observation is required in the inner-level simulation for each outer-level scenario. In particular, we show that conditional value-at-risk (CVaR) of a portfolio can be represented as the solution to an appropriately constructed optimal stopping problem. Then the least squares method is employed to solve it, leading to a fast lower bound algorithm for portfolio CVaR. Numerical results show that this approach works well and produces accurate estimates of portfolio CVaR.

3 - A Simulation Model For Assessing Mitigation Strategies Against Cyber Attacks

Soumyo D Moitra, Senior Member of Technical Staff, Software Engineering Institute, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, smoitra@sei.cmu.edu

Defending information networks from cyber attacks is a major concern. We propose a simulation model that helps analyze the risks involved in different defense strategies. The model considers attack categories, vulnerabilities in target hosts and the probabilities of a negative impact as a function of attack categories and host states. The host states are modeled as functions of mitigation strategies. Thus the effectiveness of alternative mitigation strategies can be estimated. An illustrative example is presented and the advantages of this approach are discussed.

4 - Support Points: A New Method For Compacting Distributions

Simon Mak, Graduate Student, Georgia Institute of Technology, North Ave NW, Atlanta, GA, 30332, United States, smak6@gatech.edu

In this presentation, we introduce a new method for compacting a continuous distribution into a finite set of representative points, which we call support points. These points not only provide theoretical advantages over both Monte-Carlo (MC) and quasi Monte-Carlo (qMC) methods in integration, but can also be computed for any distribution in practice. To generate support points efficiently in high-dimensions, a blockwise coordinate descent algorithm is proposed which exploits closed-form majorization-minimization updates. Simulation studies and a real-world Bayesian example show that support points provide a sizable reduction in integration error compared to MC and qMC methods.

■ MA34

204-MCC

Networks in Healthcare

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Itai Gurvich, Kellogg School of Management, Evanston, IL, United States, i-gurvich@kellogg.northwestern.edu

1 - Network Effects In Epidemic Propagation

Kimon Drakopoulos, Massachusetts Institute of Technology, kimondr@mit.edu

In this paper we analyze data on the evolution and propagation of influenza across the United States and discover that compartmental epidemic models enriched with environment dependent terms have fair prediction accuracy, and that the effect of inter-state traveling is negligible compared to the effect of intra-state contacts.

2 - Distance, Quality, Or Relationship? Interhospital Transfer Of Heart Attack Patients

Lauren X Lu, Associate Professor, University of North Carolina, Chapel Hill, NC, United States, lauren_lu@unc.edu, Susan F Lu

We empirically investigate the pattern of where heart attack patients are transferred between hospitals. Our conditional logit analysis shows that the relationship of being affiliated with the same multihospital system plays a dominant role in the choice of transfer destinations, compared to distance and quality. When using 30-day readmission rate to evaluate the health outcome of transferred patients, we find that relationship-based transfers are associated with a much higher readmission rate than distance-based and quality-based transfers.

3 - Digital And Physical Team Interaction: How Team Size And Stability Determine Hospitalist Productivity

Jan A Van Mieghem, Northwestern University, vanmieghem@northwestern.edu, Itai Gurvich, Lu Wang, Nicholas D Soulakis

We present and empirically test a team evolution model of how team size and team stability determine the productivity of a focal member who acts as an information hub. In our healthcare field study, the focal member is a hospitalist that coordinates patient care among an extensive care team that comprises the patient's digital and the hospitalist's physical team. The physical team consists of care providers who interact directly (via phone, text, or face-to-face) with the hospitalist regarding the patient and whose activities we captured using a time and motion study. The digital team consists of providers that input information to the patient's Electronic Health Record (EHR).

4 - Market Failure in Kidney Exchange

Itai Ashlagi, Stanford University, Stanford, CA, iashlagi@stanford.edu

A market for kidney exchange has grown in recent years. Kidney exchange allows patient-donor incompatible pairs to swap donors. The number of transplants from kidney exchanges has grown to be 10% of live kidney donations in the U.S., but growth has stagnated in the last few years. Focusing on the U.S. market, we use administrative records to document that: (1) the market is fragmented across many competing exchange programs, (2) participants in the largest exchange program are adversely selected. (3) smaller exchange programs conduct inefficient exchanges. We propose a supply and demand model to explain how these outcomes can arise as equilibrium behavior, due to the social and private incentives of hospitals being misaligned. We use the model and data to develop simple and efficient alternative mechanisms.

■ MA35

205A-MCC

Breakthroughs in Teaching Operations

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Ryan Buell, Harvard Business School, Soldiers Field Road, Boston, MA, 02163, United States, rbuell@hbs.edu

1 - The Use Of Technology To Improve Engagement Through Accountability

Gad Allon, Wharton School, Philadelphia, PA, 19010, United States, gadallon@wharton.upenn.edu

I will be discussing the use of technology to manage formative assessment before, during and after class, and improve learning in settings that encourage learning through discovery (case studies, exercises, etc). Specific attention will be given to teaching topics in operations management.

2 - Innovations In Teaching Operations Management At UCLA

Guillaume Roels, Anderson School of Management, UCLA, guillaume.roels@anderson.ucla.edu

In this presentation, I will review some recent innovations we have introduced at UCLA to make Operations & Technology Management one of the most popular courses in the core at UCLA. Some of these innovations are (i) striving to make the content more relevant to students, based on their job aspirations, (ii) structuring the class to deliver the best experience, and (iii) fostering student engagement.

3 - Architecting New Business Models (in the classroom)

Karan Girotra, INSEAD, karan.girotra@insead.edu

I will present a short summary of how we have redesigned MBA-level core and elective classes around the study of disruptive business models. These courses use traditional operations management tools to analyze and architect new business models. Pedagogically, we employ an experiential workshop format-participants identify and refine real-world disruptive business models.

4 - IDEO: Human-centered Service Design – Multimedia-enhanced Teaching And Learning

Ryan Buell, Harvard Business School, rbuell@hbs.edu

As technology matures, so does the demand for dynamic, media-rich educational content. "IDEO: Human-Centered Service Design" is a multimedia case study that focuses on the design thinking process at IDEO, one of the world's leading design firms. The case follows a team of IDEO designers as they reinvent the movie-going experience for the emerging middle class in Peru. During this session, I will demo the case, which can be successfully taught to undergraduates, MBA students, and executives. I will also discuss the lessons my colleagues and I have learned through teaching it, about how multimedia can enhance (or unwittingly detract from) the teaching and learning experience.

■ MA36

205B-MCC

Emerging Issues in Supply Chain

General Session

Chair: Hyun-Soo Ahn", University of Michigan, Ann Arbor, MI, United States, hsahn@umich.edu

Co-Chair: Hakjin Chung, University of Michigan, 701 Tappan Avenue, Ann Arbor, MI, 48103, United States, hakjin@umich.edu

1 - On Multi-Attempt Approximation Of Choice Model And Its Application To Assortment Optimization

Hakjin Chung, University of Michigan, hakjin@umich.edu

It is known that any random-utility based choice model can be approximated to any degree of accuracy by a mixture of logits. We consider the problem of approximating an arbitrary mixture of logits with a series expansion. The degree of the expansion can be interpreted as the number of attempts that a customer is willing to make before leaving the system because his preferred product is not available. There are at least two benefits of using this approximation: the optimization problem becomes tractable and its parameters can be estimated using linear regression. We derive some bounds.

2 - Non-stationary Product Release Pattern

Lai Wei, University of Michigan, laiwi@umich.edu
Stefanus Jasin, Roman Kapuscinski

Companies continuously release new generations of products with new features to generate revenue and enlarge market share, especially in auto and software industry where customers are willing to pay for technology updates. One of the most widely adopted release strategy is a non-stationary mid-cycle strategy, where minor improvements follow a major improvement. Although people has been looking into the decisions in product release management, most of the works focus on trade-offs that do not lead to such non-stationary strategy. In this paper, we identify the main drivers to the non-stationary mid-cycle strategy and show the situations where such policy is optimal.

3 - Flexibility Design Of Unbalanced Supply Chains Via Extended Probabilistic Expanders

Hao Shen, Tsinghua University, Beijing, China, chenhao14@mails.tsinghua.edu.cn, Yong Liang, Zuo-Jun Max Shen

We study the design of flexible supply chains by finding sparse structures that perform almost as well as the fully flexible structure in unbalanced and symmetrical systems. We propose a class of sparse structures called extended probabilistic expanders, and show that our structures perform well in the expectation sense. We also present an efficient randomized algorithm to construct extended probabilistic expanders. We prove that for a mildly unbalanced system, our structure is the asymptotically sparsest design. Numerical results show that our design has good performance compared with varieties of known well-performing structures.

4 - Rationale For Supply Partnership With Downstream Rival: Information Asymmetry And Dual Sourcing

Seung Hwan Jung, Washingtn University in St. Louis, St. Louis, MO, United States, seunghwan.jung@wustl.edu

We consider the opportunities of horizontal cooperation at the component supply level between two firms that are rivals at the end-product market. We consider a two-echelon supply chain in which a vertically integrated (VI) firm sells a component to a component outsourcing (CO) firm that has private demand information. The VI firm has its own brand which competes with the CO firm's product. Under this circumstance, we characterize firms' sourcing and pricing decisions. We offer insights for supply partnership in horizontal outsourcing cases, with an emphasis on the complementary role of information asymmetry and dual sourcing.

■ MA37

205C-MCC

Securing Sustainable Future

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Elena Belavina, University of Chicago Booth School of Business, Chicago, IL, United States, elena.belavina@chicagobooth.edu

1 - Grocery Access Market Structure And Food Waste

Elena Belavina, University of Chicago, elena.belavina@chicagobooth.edu

Access to grocery, or how dense is the network of retail stores in a neighborhood, varies extensively as a result of zoning laws and other city government initiatives. Similarly, some markets are dominated by one chain, while others have a high degree of competition with a lot of independent grocery stores. This paper studies how access to grocery stores, and the extent and nature of competition in the grocery retail market influences food waste.

2 - Pricing, Product Display, Inventory And Waste Management For Deteriorating Products.

Dorothee Honhon, University of Texas at Dallas, Richardson, TX, United States, dorothee.honhon@utdallas.edu Xiajun Amy Pan, Zumbul Atan

We consider the problem of a retailer managing the inventory and the prices of products whose quality deteriorates over time. We show that by appropriately displaying the most/least fresh products on the store shelves, the retailer can, in some cases, increase profits and reduce waste.

3 - The Impact Of Legislation on Food Waste

Alexandra Heeney, Stanford University, Stanford, CA, 9, United States, aheeney@stanford.edu, Warren H Hausman, Erica Plambeck

Worldwide, 30-40% of all food is wasted, which has a significant environmental impact: agriculture is responsible for 22% of all greenhouse gas emissions. This research explores whether California's AB32 and renewable energy legislation (that exempts farmers from carbon tax) increases the negative environmental impact of the food system (by preventing the true cost of food to propagate down the supply chain making food waste relatively inexpensive). Further, we study how the supply chain structure and design contribute to food waste and strategies for mitigating this.

4 - Design Implications Of Extended Producer Responsibility For Durable Products

Ximin (Natalie) Huang, Georgia Institute of Technology, 800 West Peachtree Street, NW, Atlanta, GA, 30308, United States, ximin.huang@scheller.gatech.edu, Atalay Atasu, Beril L Toktay

We consider a monopolist who has two product design options to manage the end-of-life costs/revenues associated with its products: making products more durable or recyclable. We explore how the recyclability and durability choices are affected by the requirements of take-back legislation.

■ MA38

206A-MCC

Meet the Editors Panel – NPD, Innovation, and Technology

Invited: New Product Development

Invited Session

Moderator: Sanjiv Erat, University of California-San Diego, UCSD, La Jolla, CA, United States, serat@ucsd.edu

1 - Meet The Editors Panel - NPD, Innovation, andTechnology

Joel Wooten, University of South Carolina, 1014 Greene St., Columbia, SC, 29208, United States, joel.wooten@moore.sc.edu

This interactive session aims at assisting readers and researchers in staying informed on the most important topics and the latest development in New Product Development, Technology, and Innovation Management.

2 - Panelist

Cheryl Gaimon, Georgia Institute Of Technology, Scheller College Of Business, Atlanta, GA, 30308, United States, cheryl.gaimon@scheller.gatech.edu

3 - Panelist

Moren Levesque, York University, Schulich School Of Business, Toronto, ON, Canada, mlevesque@schulich.yorku.ca

■ MA39

207A-MCC

Applied Probability and Machine Learning II

Sponsored: Applied Probability

Sponsored Session

Chair: Sewoong Oh, UIUC, 2011 Savanna Dr, Champaign, IL, 61822, United States, sewoong79@gmail.com

1 - Online Rules For Control Of False Discovery Rate

Adel Javanmard, Assistant Professor, University of Southern California, Bridge Memorial Hall, 3670 Trousdale Parkway, Los Angeles, CA, 90089, United States, ajavanma@marshall.usc.edu, Andrea Montanari

Multiple hypothesis testing is a core problem in statistical inference and arises in almost every scientific field. A common error criteria in this context is the false discovery rate (FDR). In this talk, we consider the problem of controlling FDR in an "online manner". Concretely, we consider an ordered, possibly infinite, sequence of null hypotheses where at each step the statistician must decide whether to reject current null hypothesis having access only to the previous decisions. We introduce a class of generalized alpha-investing procedures and prove that any rule in this class controls FDR in online manner. Time permitting, we will discuss applications for Ad click predictions and A/B testing.

2 - Newton Stein Method: An Optimization Method For Glms

Murat Erdogdu, Stanford University, erdogdu@stanford.edu

We consider the problem of efficiently computing the maximum likelihood estimator in Generalized Linear Models (GLMs) when the number of observations is much larger than the number of coefficients (n>>p>>1). In this regime, optimization algorithms can immensely benefit from approximate second order information. We propose an alternative way of constructing the curvature information by formulating it as an estimation problem and applying a Stein-type lemma, which allows further improvements through sub-sampling and eigenvalue thresholding. Our algorithm enjoys fast convergence rates, resembling that of second order methods, with modest per-iteration cost.

3 - Data-driven Rank Breaking For Efficient Rank Aggregation

Ashish Khetan, UIUC, Urbana, IL, United States, Khetan2@illinois.edu

Rank aggregation systems collect ordinal preferences from individuals to produce a global ranking. Rank-breaking is a common practice to reduce the computational complexity of learning the global ranking. The individual preferences are broken into pairwise comparisons and applied to efficient algorithm. However, naive rank-breaking approaches can result in inconsistent estimates. The key idea to produce accurate and unbiased estimates is to treat the pairwise comparisons unequally, depending on the topology of the collected data. In this paper, we provide the optimal consistent rank-breaking estimator. This allows us to characterize the trade-off between accuracy and complexity.

4 - On The Capacity Of Information Processing Systems

Kuang Xu, Stanford University, Stanford, CA, United States, kuangxu@gmail.com, Laurent Massoulie

We analyze a family of information processing systems, where a finite set of experts or servers are employed to extract information about a stream of incoming jobs, each associated with a hidden label. An inspection by an expert produces a noisy outcome that depends both on the job's hidden label and the type of the expert, and occupies the expert for a finite time duration. A decision maker's task is to dynamically assign inspections so as to accurately recover all job labels while keeping the system stable. Crowdsourcing, diagnostics and experiment designs are among our chief motivations. Our main result is an asymptotically optimal inspection policy that utilizes the fewest experts.

■ MA40

207B-MCC

Supply Chain/ Inventory in Applied Probability I

Sponsored: Applied Probability

Sponsored Session

Chair: Yehua Wei, Duke University, Durham, Durham, NC, 27708, United States, yehua.wei@duke.edu

1 - Online Resource Allocation With Limited Flexibility

Arash Asadpour, NYU Stern, New York, NY, 10012, United States, aasadpou@stern.nyu.edu, Xuan Wang, Jiawei Zhang

We consider a class of online resource allocation problems in which there are n types of resources with limited initial inventory and n demand classes. In this paper, we focus on a special class of structures with limited flexibility, the long chain design, which was proposed by Jordan and Graves (1995) and has been an important concept in the design of sparse flexible processes. We show the effectiveness of the long chain design in mitigating supply-demand mismatch under a simple myopic online allocation policy. In particular, we provide an upper bound on the expected total number of lost sales that is irrespective of how large the market size is.

2 - Inventory Management For Assemble To Order Systems With General Bill Of Materials And Deterministic Lead Times

Qiong Wang, University of Illinois at Urbana - Champaign, qwang04@illinois.edu, Martin I Reiman, Haohua Wan

We study inventory management for minimizing the long-run average cost in Assemble-to-Order inventory systems. In our previous work, we have developed a stochastic programming based approach that gives rise to a lower bound on the cost objective, and for systems with identical lead times, asymptotically-optimal replenishment and allocation policies. Here we generalize our policies to prescribe a complete solution for systems with general Bill of Materials and general deterministic lead times. Our discussions focus on the design of a novel replenishment policy for the general case and asymptotic optimality of the entire approach.

3 - Managing Multi-period Production Systems With Limited Process Flexibility

Yuan Zhong, Columbia University, 500 W. 120th St., Mudd 344, New York, NY, 10027, United States, yz2561@columbia.edu Cong Shi, Yehua Wei

We develop a theory for the design of process flexibility in a multi-period production system. We propose and formalize a notion of “effective chaining” termed the Generalized Chaining Condition (GCC). We show that any partial flexibility structure that satisfies GCC is near-optimal under a class of policies called the Max-Weight policies. Furthermore, we show that GCC can be satisfied using just k arcs, where k is the equal to the number of products plus the number of plants.

4 - A Joint-replenishment System With Convex Purchase Costs

Paul H Zipkin, Duke University, Paul.Zipkin@Duke.edu

We consider the problem of replenishing inventories of several items facing stochastic demands, where the order cost is jointly convex, representing diseconomies of scale such as capacity limits. We want to find a good policy and also to understand the qualitative behavior of the system. To these ends, we show that the system enjoys a property called M-natural-convexity. This is a powerful analytical tool, but it poses some technical challenges.

■ MA41

207C-MCC

FSS Tutorial

Sponsored: Financial Services

Sponsored Session

Chair: Rafael Mendoza, McCombs School of Business, Austin, TX, United States, rafael.mendoza-arriaga@mccombs.utexas.edu

■ MA42

207D-MCC

Systemic Risk and Financial Networks

Sponsored: Financial Services

Sponsored Session

Chair: Agostino Capponi, Columbia University, New York, NY, United States, ac3827@columbia.edu

Co-Chair: Agostino Capponi, Columbia University, New York NY, United States, agcappo@gmail.com

1 - An Empirical Analysis Of The Centrally Cleared Credit Default Swaps Market

W. Allen Cheng, Columbia University, 500 W 120th st, 333 Mudd, New York, NY, 10027, United States, wc2232@columbia.edu

In this talk we present an empirical analysis of regulatory Credit Default Swaps data collected by the U.S. Commodity Futures Trade Commission according to Title 17 Chapter 1 part 39 of the Code of Federal Regulations. We discuss salient features of traded contracts, open positions, and margin posting. We also investigate feedback effects in price volatility and intraday margin calls.

2 - Systemic Risk And Liquidity Provision

Xu Sun, Columbia University, xs2235@columbia.edu, Agostino Capponi, David D Yao

We introduce an interbanking network model in which banks interact with each via borrowning/lending transactions, and can be assisted by a regulator who injects capital into the system to prevent insolvency. The regulated system follows a reflected multi-dimensional Ornstein-Uhlenbeck process with state dependent drift coefficient. We investigate how the concentration of interbanking activities affects the earliest intervention time as well as the market concentration, i.e the heterogeneity of asset value in the system.

3 - Systemic Risk Under Heterogeneous Beliefs

Benjamin Bernard, Columbia University, bb2794@columbia.edu Agostino Capponi

We consider an interbank network of bilateral exposures, where each bank only knows its own contracts but not the exposures between other pairs of banks. Defaults are costly and may lead to financial contagion that spreads through the network. We model this spread of insolvency as a dynamic game, where banks have the ability to intervene and join a rescue consortium to save the insolvent banks. Banks will do so only if an intervention is incentive compatible given their beliefs on the network. We analyze the set of sequential equilibria in these games with heterogeneous beliefs and contrast the results to the equilibrium outcomes with complete information.

4 - Model Risk In Financial Networks

Peng-Chu Chen, Purdue University, West Lafayette, IN, United States, chen621@purdue.edu, Agostino Capponi

We introduce a financial network model which accounts for uncertainty in the interbank liabilities. We define the systemic loss uncertainty as the difference between the maximum and minimum loss in the financial system. We investigate how the level of interbank intermediation in the financial system impacts systemic loss uncertainty. Our findings indicate the existence of a threshold above which higher intermediation reduces both systemic loss and the resulting uncertainty. When the intermediation level falls below, further increases reduce the minimum and maximum loss, but this comes at the expenses of higher uncertainty in the loss outcome.

■ MA43

208A-MCC

Decision Analysis, Game Theory, and Disaster Management I

Sponsored: Decision Analysis

Sponsored Session

Chair: Jun Zhuang, University at Buffalo, SUNY, Buffalo, NY, United States, jzhuang@buffalo.edu

Co-Chair: Jing Zhang, University at Buffalo, SUNY, Buffalo, NY, United States, jzhang42@buffalo.edu

1 - Linear Programming Input Output Models For Energy Resilience

Adam Ng Tsan Sheng, National University of Singapore, isentsa@nus.edu.sg

We develop an approach to study the energy supply resilience of an economy using linear programming and economic input-output analysis. In particular, we propose an energy resilience index by examining the maximum level of energy supply reduction that the economy can endure without sacrificing domestic demands. A mixed integer model is developed to compute the resilience index efficiently. The methodology is applied to a case study using China data to study the energy resilience under different generation portfolio assumptions. We demonstrate how our models can be used to uncover important inter-sectoral dependencies. Extensions of the approach to include recovery effects are also presented.

2 - Agent-based Modeling For Resilience Of Disaster Recovery

Fei He, Texas A&M University, Kingsville, Kingsville, TX, United States, Fei.He@tamuk.edu, KumareshBabu Murugesan

Disaster recovery involves multiple stakeholders and various uncertainties associated with environment and community behaviors. This research use agent-based modeling and game theory to investigate the uncertainty and interdependence in the household and business for disaster recovery. The effects of disaster mitigation, and stake holders' learning capability to disaster recovery are investigated.

3 - Modeling Fire Risk And Resource Allocation For Fire Protection And Safety

Vineet Madasseri Payyappalli, PhD Student, University at Buffalo, SUNY, Buffalo, NY, United States, vineetma@buffalo.edu, Adam Behrendt, Jun Zhuang

Fire-related hazards are an everyday phenomenon, and firefighting in the United States owe to more than one million firefighters in about 30,000 fire departments across the country. The estimated total cost of fire was $329 billion in 2011, and yet there is little work in the literature about risk assessment, cost-benefit analysis, and resource allocation in fire protection. Using a data-driven study, we propose empirical and theoretical models to assess risk levels and develop risk-reduction strategies that include optimal resource allocation, optimal facility design, and optimal routing solutions.

4 - Crisis Information Distribution Among Official Users In Twitter Based On Hurricane Sandy

Bairong Wang, University at Buffalo, The State University of New York, 338 Bell Hall, Buffalo, NY, 14260, United States, bairongw@buffalo.edu, Jun Zhuang

Our study analyzes how crisis information about Hurricane Sandy is distributed from official Twitter accounts to the common Twitter users based on 6 social media key performance indicators (KPIs). Our results show that (a) the six KPIs are significantly different among governmental organizations (GOs), non-governmental organizations (NGOs) and news agent users; (b) the networks formed by mention and re-tweet are effective methods to reach more public members; (c) the information coverage could be expanded to more stakeholders in disaster scenario; (d) distributing speed is faster among networks formed by news agent users than GO and NGO users.

■ MA44

208B-MCC

Environmental Decision Analysis

Sponsored: Decision Analysis

Sponsored Session

Chair: Melissa A Kenney, University of Maryland, College Park, MD, United States, kenney@umd.edu

1 - Robust Decision Making Methods For Water Resource Management Under Climate Change Uncertainty

Seth Guikema, University of Michigan, sguikema@umich.edu, Julie Shortridge, Ben D Zaitchik

Water resource systems must be managed under deep, long-run uncertainty about the impacts of climate change on water quantity and quality in a given basin. Standard approaches for decision making under uncertainty have limitations in this context. We summarize work done to further develop an alternative approach, based on the Robust Decision Making method (RDM). RDM seeks not to find the optimal solution to a given management problem but to find solutions that are robust in the sense of doing well under a wide range of future conditions. We demonstrate the method with an application to water resource management in the Lake Tana basin.

2 - Multi-criteria, Interactive Optimization For Design Of Watershed Plans

Andrew Hoblitzell, Indiana University Purdue University Indianapolis, Indianapolis, IN, 46202, United States, ahoblitz@umail.iu.edu, Meghna Babbar-Sebens, Snehasis Mukhopadhyay

Multi-objective optimization has yielded numerous algorithms for design of solutions to real-world planning problems. The inclusion of decision makers (DMs) within the optimization algorithm's search process, especially for planning problems with DM-specific, subjective, qualitative, and/or unquantifiable criteria, has gained interest recently. Our work focuses on modifications made to our existing watershed planning decision support system, called WRESTORE. Interactive genetic algorithms and reinforcement-based machine learning algorithms are used for search and optimization, while neural networks and other methods are utilized for the modeling of human users' criteria.

3 - Using Visualization Science To Diagnose And Improve Global Change Indicator Understandability

Michael D Gerst, University of Maryland, mgerst@umd.edu Melissa A Kenney

Indicators are variables that stakeholders believe summarize relevant trends. They have become an increasingly important part of continuous assessment of global environmental change. For indicators to be effective, they need to be understood by diverse audiences. Using visualization science, we have diagnosed and redesigned a set of global change indicators, showing how simple visual changes can lead to large improvements in understandability.

4 - Understanding Homeowner Decisions On System Configuration For Parcel Level Storm Water Management

Royce Francis, George Washington University, seed@email.gwu.edu, Domenico C Amodeo

A common problem faced by many older U.S. cities is the management of storm water to prevent the over flow of sewage and pollutants into local waterways. Many cities have addressed this problem through grey infrastructure improvements, as well as promoting low impact development (LID) on private and public property. Previous researchers have proposed models for assessing optimal LID installations and predicting consumer behavior in response to incentives. We explore what an optimal storm water management program would look like in light of these models, with the high level aim of learning best practices in system configuration from observing consumer choices.

■ MA45

209A-MCC

Agent-based Modeling and Simulation - Overview

Sponsored: Simulation

Sponsored Session

Chair: Charles M Macal, Argonne National Laboratory, Argonne, IL, United States, macal@anl.gov

1 - Agent-based Modeling And Simulation – Overview

Charles M Macal, Argonne National Laboratory, macal@anl.gov

Agent-based modeling and simulation (ABMS) is an approach to modeling systems comprised of autonomous, interacting agents. Applications are growing rapidly in fields ranging from modeling the stock market to predicting the spread of epidemics. Complex adaptive systems, emergent behavior, and self-organization are a few of the notions from ABMS. This session provides an overview of ABMS, covers its foundations, development toolkits and methods, practical aspects, and the relationship of ABMS to conventional OR. Key ABMS resources, publications, and communities are identified. It concludes by suggesting research challenges to advance the field of ABMS for the coming years.

■ MA46

209B-MCC

Pricing, Revenue Management and Operations in Retailing

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Mehmet Sekip Altug, Assistant Professor, George Washington University, 2201 G. Street, NW, Washington, DC, 20052, United States, maltug@gwu.edu

1 - Assortment Optimization Under A Synergistic Version Of The Multinomial Logit Model

Venus Lo, Cornell University, Ithaca, NY, United States, vhl8@cornell.edu, Huseyin Topaloglu

We consider the revenue management problem of offering an optimal subset of goods when there are product synergies. The traditional multinomial logit choice model suffers from Independence of Irrelevant Alternatives and offering a larger subset must decrease each goods' choice probabilities. Our synergistic model has a similar structure but offering selected pairs of goods together can boost their choice probabilities. In the special case where synergy exists in a linear fashion, we provide an efficient dynamic program and show that the optimal subset can be found in one step by solving a simple linear program.

2 - Reining In Onion Prices By Introducing A Vertically Differentiated Substitute: Models, Analysis, And Insights

Muge Yayla-Kullu, Associate Professor, University of Central Florida, Orlando, FL, United States, mugeyayla@hotmail.com
Omkar D Palsule-Desai, Nagesh Gavirneni

We examine the pricing ordeal in India's onion markets caused by the fresh produce traders. As a remedy, policy makers have been proposing to establish processed produce competition in the market by either cooperatives or private firms. We formulate and analyze this situation in a mathematical model that captures (i) competition between non-profit and for-profit organizations, (ii) consumers' valuation discount for the processed produce, and (iii) perishability of the fresh produce. We identify and discuss the conditions under which (i) it is optimal to introduce the processed produce; and (ii) the processed onion should be managed by cooperatives instead of private firms.

3 - Impact Of Encroachment When Competing Manufacturers Sell Through A Common Retailer

Parshuram Hotkar, Doctoral Student, University of Texas, Austin, University Station, B6500, Austin, TX, 78712, United States, parshuram@utexas.edu, Steve Gilbert

We consider a setting in which two manufacturers sell partially substitutable products through a common retailer, and examine the impact of the development of a direct sales channel for one of the manufacturers. We find that the retailer's ability to purchase from another manufacturer can alter many of the results that have been obtained for how encroachment affects the interactions between a manufacturer and a retailer. In addition, we find that the non-encroaching manufacturer can benefit from his rival's direct channel.

4 - Effectiveness Of Targeted Return Management On Retailer's Profitability

Tolga Aydinliyim, Assistant Professor, Baruch College, CUNY, New York, NY, United States, Tolga.Aydinliyim@baruch.cuny.edu
Mehmet Sekip Altug

As retailers offer more flexible return policies, customer abuse and fraudulent returns are also on the rise. In order to combat that situation, instead of changing the return policies for everyone, retailers started to implement a tool that identifies those "renters". In a price-setting newsvendor framework, we first study the retailer's uniform return policy in which the retailer offers the same return policy to everyone; then we study a targeted return policy where the retailer identifies the renters segment and offers a different return policy to that segment. We argue how and when targeted return management leads to improvement in retailer's profitability.

■ MA47

209C-MCC

Optimizing Pricing for Multiple Substitutable Products

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Candace Arai Yano, University of California-Berkeley, IEOR Dept. and Haas School of Business, Berkeley, CA, 94720, United States, yano@ieor.berkeley.edu

1 - Dynamic Pricing And Replenishment Of Vertically Differentiated Products With Customer Upgrades

Oben Ceryan, Drexel University, Philadelphia, PA, 19104, United States, oceryan@drexel.edu, Izak Duenyas, Ozge Sahin

We study the impact of product upgrades on a firm's pricing and replenishment policies by considering a multiple period, two-stage model where the firm first sets prices and replenishment levels, and after observing the demand, it decides whether to upgrade any customers to a higher quality product. We characterize the structure of the optimal upgrade, pricing, and replenishment policies and find that offering upgrades assists in preserving the vertical price differentiation between products.

2 - Dynamic Pricing Of Vertically Differentiated Products With Sales Milestones

Chi-Guhn Lee, University of Toronto, chi@mie.utoronto.ca, Sajjad Najafi

We study the dynamic pricing of multiple substitutable products over a finite horizon subject to sales milestone constraints. Customers are utility maximizer and consider the relative importance between the price and the quality of product. We formulate the problem as a Markov decision process with probabilistic constraints and relax the constraints following the Lagrangian relaxation to apply KKT conditions. The proposed model is specifically suitable for applications in which the achievement of sale targets plays a crucial role for managers such as residential real estate sales and penetration strategy.

3 - Optimizing Pricing For Multiple Substitutable Products

Kevin Li, University of California - Berkeley, kbl4ew@berkeley.edu

We address a retailer's problem of setting prices, including promotion prices, over a multi-period horizon for substitutable products within a category, considering the effects of reference prices on customers' strategic buying behavior, including stockpiling. We utilize an embedded model in which customers make purchasing and consumption decisions over multiple periods to maximize utility. We present structural results and examples that provide insights into the properties of optimal policies.

4 - Pricing Two Substitutable Products With Limited Demand Information

Zhi-Long Chen, Professor, University of Maryland, 691 Market Street East, College Park, MD, 20742, United States, zchen@rhsmith.umd.edu, Ming Chen

We consider a practical dynamic pricing problem with two substitutable products involving a number of business rules and constraints commonly seen in practice. There is limited demand information. A case with inter-product substitution only, and a case with both inter-product substitution and intertemporal substitution are studied. We propose DP algorithms for both cases, and for the latter, more general, case, we develop a fully polynomial time approximation scheme. We derive a number of managerial insights.

■ MA48

210-MCC

Social Media Analytics for Business Applications

Invited: Social Media Analytics

Invited Session

Chair: Yuheng Hu, University of Illinois-Chicago, 601 S Morgan St, Chicago, IL, 60607, United States, yuhenghu@gmail.com

1 - Content Complexity, Similarity, And Consistency In Social Media: A Deep Learning Approach

Gene Moo Lee, University of Texas at Arlington, Arlington, TX, United States, gene.lee@uta.edu
Donghyuk Shin, Shu He, Andrew B Whinston

We investigate the effect of social media content on customer engagement using company-generated posts from Tumblr. We employ state-of-the-art machine learning approaches to extract features from textual and visual sources that effectively capture their semantics. With such semantic representations, we develop novel complexity, similarity, and consistency measures of social media content. The results show that proper visual stimuli, complementary textual content, and consistent themes have positive effects on the engagement, and that content demanding significant concentration levels have the opposite effects. This work shows how unstructured data can be translated into insights.

2 - Does Twitter Sentiment Move Stock Prices: Evidence From An Event Study Of The Amsterdam Exchange

Yixin Lu, George Washington University, yixinlu@gwu.edu

The tremendous amount of information that accumulates and propagates via social media has profound impact on individual businesses as well as the entire market environment. This research focuses on the impact of twitter sentiment on leading stocks traded on the Amsterdam Exchange. By combining event study and sentiment analysis, we demonstrate that twitter peaks are strongly associated with abnormal returns. However, such association is asymmetric with respect to the valence of the sentiment.

3 - Patient Base And Price Premium For Online Health Consultations

Liwei Chen, University of Cincinnati, vivienclw@gmail.com, Arun Rai, Xitong Guo

Online health consultation communities (OHCCs) enable physicians to signal professional competence and compassionate care for patients, and allow patients to spread online reviews with peer patients. We examine the interactions between the signaling and online feedback mechanisms that explain how physicians build trust with patients and gain social and economic advantages in healthcare services. We scraped multilevel data and traced physicians biweekly over one year from an OHCC in China. Using mixed effects modeling, we find interesting interaction effects between trustworthiness signals and properties of feedback on online patient base and price premium.

■ MA49

211-MCC

Tutorials and Examples of Software and Methods for Social Media Analytics

Invited: Social Media Analytics

Invited Session

Chair: Theodore T Allen, Ohio State University, Columbus, OH, 43210, United States, allen.515@osu.edu

1 - NLP, LDA, SMERT, k-Means And Efficient Estimation Methods

Zhenhuan Sui, Ohio State University, sui.19@osu.edu

We describe some of our recent advances in more efficient estimation for text-based clustering and topic discovery. Also, we illustrate the capability of VBA code for text processing and benchmark popular methods including k-means clustering and Latent Dirichlet Allocation in terms of computational efficiency and accuracy.

2 - Innovative Scheduling And Kriging-Based Optimization Methods In VBA

Sayak Roychowdhury, Ohio State University, rowchowdhury.6@osu.edu

A suite of techniques for scheduling and simulation optimization is described based on VBA and our own innovations. Results showing improved performance compared with alternatives for scheduling and inventory policy-making are described. Possible roles for the methods support social media analytics are also described.

3 - Cybersecurity Using Interdiction

Murat Karatas, University of Texas, Manor Road, Austin, TX, 78722, United States, mkaratas@utexas.edu, Nedialko Dimitrov

Recent cyber-attacks on private and public groups highlight the importance of a proper cybersecurity structure. Having well-structured cybersecurity decreases the vulnerability of the system. We present a network interdiction model to find the optimal strategy for a cyber physical network. Our model considers the specifics of the network structure.

■ MA50

212-MCC

Life After the PhD: Early Career Development Panel

Sponsored: Minority Issues

Sponsored Session

Moderator: Julie Ivy, North Carolina State University, 111 Lampe Drive, Raleigh, NC, 27695, United States, jsivy@ncsu.edu

1 - Life after The PhD: Early Career Development Panel

Julie Ivy, North Carolina State University, jsivy@ncsu.edu

■ MA51

213-MCC

New Models in Criminology

Sponsored: Public Sector OR

Sponsored Session

Chair: Lawrence Wein, Stanford University, 655 Knight Way, Stanford, CA, 94305, United States, lwein@stanford.edu

1 - Machine Learning For Crime Series Detection And Criminal Recidivism Prediction

Cynthia Rudin, Duke University, LSRC Building D101, 308 Research Drive Campus Box 90129, Durham, NC, 27708-0129, United States, cynthia@cs.duke.edu, Berk Ustun, Tong Wang

I will discuss machine learning algorithms for two problems: crime series detection, and recidivism prediction. In crime series detection, the goal is to identify crimes that were committed by the same individual(s). We cast this as a clustering problem with cluster-specific feature selection, in joint work with the Cambridge Police Department. The recidivism prediction problem is cast as a supervised classification problem, where the goal is to produce a scoring system, which is a sparse linear model with integer coefficients. This work was a finalist in the 2015 Doing Good with OR competition, and part of the winning entry of the 2016 Innovative Applications in Analytics Award.

2 - Optimizing Ballistic Imaging Operations

Can Wang, Stanford University, Stanford, CA, United States, canw@stanford.edu, Mardy Beggs-Cassin, Lawrence M Wein

Ballistic imaging can solve crimes by comparing images of cartridge casings to a database of images from past crimes. Many cities lack the capacity to process all of their images. Using data from Stockton, CA, we allocate limited capacity to maximize the hit rate. The hit rate can be doubled by giving crime scene evidence priority over test fires, and ranking cartridge types by their hit rate and processing evidence from only top-ranking cartridge types.

3 - Using Informed Heuristics For Pretrial Release

Jongbin Jung, Stanford University, jongbin@stanford.edu

We present a simple and intuitive strategy for creating statistically informed decision rules that are easy to apply and easy to understand, in the context of pretrial release. These simple informed heuristics take the form of a weighted check list and can be applied without the aid of a computer, but perform on par with state-of-the art machine learning methods. The rules can be readily constructed with moderate statistics knowledge using common and freely available software packages, facilitating adoption by practitioners in a wide array of fields.

4 - Assessing Risk-based Policies For Pretrial Release And Split Sentencing In Los Angeles County Jails

Lawrence Wein, Stanford University, lwein@stanford.edu Mericcan Usta

Court-mandated downsizing of the CA prison system has led to overcrowding in CA jails. We model the flow of individuals in the Los Angeles County jail system, from arraignment through post-sentence supervision. We optimize joint pretrial release and split-sentencing policies that are based on the type of criminal charge and the risk category as determined by the CA Static Risk Assessment tool. Policies that offer split sentences to all low-level felons optimize the trade-off between public safety and jail congestion.

■ MA52

214-MCC

Recent Developments in Humanitarian Logistics

Sponsored: Public Sector OR

Sponsored Session

Chair: Kezban Sokat, Northwestern University, 2145 Sheridan Road, Room C210, Evanston, IL, 60208, United States, kezban.yagcisokat@u.northwestern.edu

1 - The Vaccination Campaign Routing Problem

Melih Celik, Middle East Technical University, Ankara, Turkey, cmelih@metu.edu.tr, Bahar Cavdar, Haldun Sural

This study considers the routing of vaccination campaigns in developing country settings, where a team selects from a set of regions to visit and sequences these visits, subject to special time window constraints. The objective is to maximize the total number of people reached. A two-stage heuristic is proposed, where the first stage solves a b-matching problem to determine the regions to visit each day, whereas the second stage solves a modified orienteering problem to determine the routes.

2 - Cash, Vouchers Or In-kind Aid: A Game Theory Approach To Determine Optimal Aid Transfers

Christos Bitos, Kühne Logistics University, Hamburg, Germany, Christos.Bitos@the-klu.org, Maria Besiou

This research aims to determine the conditions for optimal aid transfers in the aftermath of a disaster or during a long-term development program. By using the principles of game theory, we consider the strategic interactions between Humanitarian Organizations (HO) and local markets, and discern how these interactions affect the distribution of aid to communities. We consider the effects of local market supply chain fluctuations, and how the market fluctuates in response to local and national crises. Ultimately, we hope to develop a framework to contextualize the intricacies of humanitarian relief distribution that can be applied broadly.

3 - An Agent-based Modeling Approach To Assess Coordination Among Humanitarian Relief Providers

Jessica Heier Stamm, Kansas State University, Manhattan, KS, United States, jlhs@k-state.edu, Megan Menth

Coordination between humanitarian organizations during disaster response may improve efficiency, reduce duplication of efforts, and lead to better outcomes for beneficiaries. We employ agent-based simulation to examine coordination strategies among humanitarian organizations that make post-disaster location decisions regarding temporary service facilities. For example, over 4,000 temporary learning facilities were needed after the 2015 Nepal earthquakes damaged or destroyed numerous school buildings. Our model is informed by data from the Nepal response and a survey of humanitarian professionals. We find that coordination strategies impact efficiency, effectiveness, and equity.

4 - Real-time Data In Humanitarian Response

Kezban Yagci Sokat, Northwestern University, kezban.yagcisokat@u.northwestern.edu, Irina Dolinskaya, Karen Smilowitz

State of the art humanitarian logistics models have been developed over the past decades. Most of these models assume availability of data. We study the impact of granularity in real time data on the humanitarian logistics models. We show that in the limited data environment higher granularity might lead better results.

■ MA53

Music Row 1- Omni

Decision Analytics for Technology Management

Sponsored: Technology, Innovation Management & Entrepreneurship

Sponsored Session

Chair: Tugrul Daim, Professor, Portland State University, Engineering and Technology Management Department, P.O. Box 751, Portland, OR, 972070751, United States, ji2td@pdx.edu

1 - GPS For Innovation

Jianxi Luo, Singapore University of Technology & Design, luo@sutd.edu.sg

Engineers, firms or governments continually explore innovation opportunities and roadmaps. However, related activities and decisions are traditionally based on intuition or experiences. InnoGPS is developed to provide scientifically-grounded and data-driven support for decisions regarding innovation directions. It integrates an empirical network map of technologies that represent the total technology space, and various map-based functions that allow users to navigate through the technology space, locate themselves, explore technologies within and across neighborhoods, and identify capability-building paths. InnoGPS is a "GPS for Innovation" in the technology space.

2 - Integrating Bibliometrics And Social Network Analysis For Identifying Knowledge Sources

Tugrul U Daim, Portland State University, ji2td@pdx.edu, Edwin Garces

At an era when technologies are developing rapidly, decision making becomes even more challenging. However data analytics have shown that data can be used effectively to help decision making in such environments. Several management strategies for technological innovations require expert judgments and thus making the expert identification very crucial. This paper integrates SNA and Bibliometric Analysis to determine the lead authors and their network. The main objective of this paper is to present cases from the power sector where this method was used to identify experts for applications such as technology roadmapping or forecasting.

3 - Evaluating Research Centers: Case Of NSF's I/URUC Program

Elizabeth Gibson, Portland State University, 14396 SW Pennywort Ter, Tigard, OR, 97224, United States, elgibson@pdx.edu

This research is focused on gaining deeper insights into US National Science Foundation (NSF) science and engineering research center challenges and motivated to develop a method that effectively measures the performance of these organizations. While research has addressed organizational performance at the micro, or single-actor level for universities or companies and at the regional or national macro level, the middle level where the NSF centers reside is largely missing. The bulk of the cooperative research center studies use either case-based methods or bibliometric data to measure traditional research outputs. Many are excellent studies; however, they only focus on a piece of the performance measurement problem. There is a need for more research to understand how to measure performance and compare performance of cooperative research centers formed in a triple-helix type partnership involving government, industry and academia.

4 - Design Support Of Salient Research Project By Integrated Approach Of Text And Citation Analysis

Yuya Kajikawa, Tokyo Institute of Technology, kajikawa@mot.titech.ac.jp

Bibliometrics has been a powerful tool to comprehend the current status and to analyze R&D trends but most of approach is descriptive. We proposed alternative approach to design salient research project by integrating citation analysis with text analysis. Explicit research cluster is extracted by citation relationships and implicit potential ones are by text analysis. This approach can help to find neglected opportunities between different research domains. This approach can also visualize plausible path how academic can contribute to development of industrial technology and to solve social issues. Efficiency and effectiveness of the approach are demonstrated in case studies.

■ MA54

Music Row 2- Omni

Analytics and Operations Research for the IT Services Industry

Sponsored: Service Science

Sponsored Session

Chair: Aly Megahed, IBM Research - Almaden, 650 Harry Road - Office D3-428, San Jose, CA, 95120, United States, aly.megahed@us.ibm.com

1 - Maximum Accuracy Is Not Always Optimal

Ray Strong, IBM, San Jose, CA, United States, hrstrong@us.ibm.com, Aly Megahed, Janet Blomberg, Pablo Pesce, Yasuharu Katsuno, Sunhwan Lee

The optimal features of a machine learning classifier or prediction model depend on the users of the analytics results. When the users have responsibility for acting on the results, as in the case of a sales force for cloud services, it is often more important to produce simple, understandable, and credible rules than to optimize for best prediction accuracy.

2 - An Optimization Approach To Revenue Forecasting In Multi-Staged Sales Pipelines

Aly Megahed, IBM, San Jose, CA, United States, aly.megahed@us.ibm.com, Peifeng Yin, Hamid Reza Motahari Nezhad

Services organizations manage a pipeline of sales opportunities with variable engagement lifespans and contract values. Accurate forecasting of contract signings by the end of a time period (e.g., a quarter) is vital for such organizations to effectively manage the pipelines. We present a machine learning framework for this problem and introduce a novel nonlinear optimization approach for finding the optimized weights of a sales forecasting function. Our model also optimally determines the number of historical periods to use within the framework. We present a linear alternative model to the aforementioned model and present numerical results that show the superior performance of our method.

3 - Value Of Integrated Travel Data To The Organization Productivity

Pawan Chowdhary, Senior Research Engineer, IBM Research, 650 Harry Road, E3-238, San Jose, CA, 95120, United States, chowdhar@us.ibm.com, Guangjie Ren, Raphael Arar

In large enterprise, travel is integral part to meet customers, attend events and to deliver services. But travel data is fragmented from planning a trip to expense submission due to the sourcing from multiple vendors at each stage. We can derive greater value by learning from the booking and spend patterns, and leverage analytics for advanced booking, to negotiate better cost with vendors, identify market with short term demand forecast, etc. which can bring ten's of millions of cost savings. We will present our findings and analysis used to derive the savings and productivity enhancement.

■ MA55

Music Row 3- Omni

Modeling, Optimization, and Data Analytic in the Service Industry

Sponsored: Service Science

Sponsored Session

Chair: Mohammad Sadegh Mobin, Western New England University, Springfield, MA, United States, mm337076@wne.edu

Co-Chair: Zhaojun Li, Western New England University, Springfield, MA, United States, zhaojun.li@wne.edu

1 - Resource Balancing In Intermodal Freight Networks

Amirali Ghahari, University of Arkansas, 4116 Bell Engineering Center, Fayetteville, AR, 72701, United States, aghahari@uark.edu, Edward A Pohl

Freight transportation networks provide a system to move containers that are filled with goods from one point to another. These movements are the main source of profit for companies. When each node in a network does not have equal number of incoming and outgoing containers, some nodes will have surpluses while shortages occur at others. This fact causes accumulation of containers at a few nodes in the network and shortages at others which would shut down the transportation network. To resolve this, operators should perform rebalancing moves. This research examines the planning problem to balance resources in an intermodal transportation network for one of the major transportation companies in the US.

2 - A Modified Age Replacement Model

Maryam Hamidi, University of Arizona, mhamidi@email.arizona.edu

The classical age replacement model is revisited when the scheduled arrival time of the replacement is also a decision variable in addition to the scheduled preventive replacement time. The equipment is replaced as scheduled unless it breaks down earlier, in which case replacement is performed immediately. If the replacement arrives before it is needed, then inventory cost arises, and if it is not available when needed then shortage cost of delayed production is the loss of the company. The production cycle is repeated without any change, therefore the expected net cost per unit time is computed by renewal theory. The existence of finite optimum is proved and the computer method is introduced to find it.

3 - Maximizing Availability In Operations And Maintenance Planning Of Airline Fleet

Javad Seif, Graduate Research Assistant, University of Tennessee-Knoxville, Tullahoma, TN, 37388, United States, jseif@utk.edu, Andrew Junfang Yu

In this paper, operations and maintenance planning (OMP) is modeled as a mixed-integer linear program with a case study in the airline industry. The objective is to maximize the availability of a fleet of aircraft over a planning horizon subject to their operations and maintenance requirements. An existing flight and maintenance planning (FMP) model is significantly extended by generalizing it to an OMP model, which makes the model more practical and suitable for a wider range of applications in both manufacturing and service industries.

■ MA56

Music Row 4- Omni

Economics of IS in the Age of Big Data

Sponsored: EBusiness

Sponsored Session

Chair: Wael Jabr, Georgia State University, 35 Broad Street, Robinson College of Business, Atlanta, GA, 30303, United States, wjabr@gsu.edu

1 - Antecedents And Consequences Of Information Augmentation In Make-to-order Electronic Supply Chain

Ling Xue, Georgia State University, lxue5@gsu.edu
Arun Rai, Peijian Song, Cheng Zhang

In this study, we consider a phenomenon of information augmentation: in addition to passing the demand information from the consumers to the supplier, the retailer generates ad hoc coordination information to direct the order-fulfilment processes at the supplier side. Using transaction-level data from an international make-to-order supplier chain, we find that information augmentation is positively associated with product customization level and negatively associated with supplier relationship. We also find that information augmentation leads to higher fulfilment costs and lower probabilities of product return, and higher net profits for the retailer.

2 - Opening The Black Box: The Impact Of Telehealth And Latent Health Status On Patient Readmissions

Sezgin Ayabakan, The University of Baltimore, Baltimore, MD, 21201, United States, sayabakan@ubalt.edu
Indranil R Bardhan, Zhiqiang Eric Zheng

We investigate the effect of unobserved patient health status on patient readmission rates and the impact of telehealth on patient health status. We implement a hidden Markov model with a large, inpatient panel dataset of Congestive Heart Failure patient visits along with the American Hospital Association IT Supplement data. We reveal latent health states of patients and find that telehealth exerts a positive impact only on patients in less healthy states, while this impact diminishes as patients' health improves. These results suggest that focusing solely on readmission rates can be misleading, without regard to patients' health status.

3 - Leveraging Customer Feedback Through App Reviews

Kambiz Saffarizadeh, Georgia State University, Atlanta, GA, United States, ksaffarizadeh1@Student.gsu.edu, Wael Jabr, Mark Keil

Online app markets (e.g. Apple App Store) exhibit heavy customer engagement in the form of reviews that could help software developers adjust to user needs and become more competitive in crowded app markets. Using a panel dataset on 12,231 apps and document similarity methods, we develop a model that relates app success to developers' integration of user feedback.

4 - Crisis Management Of Customer Sentiments In Social Media: Empirical Study

Kyungsun Rhee, University of Washington, 4725 24th Avenue NE, # 405, Seattle, WA, 98105, United States, ksr22@uw.edu

In this paper, we will examine how firms strategically bundle news reports in order to intervene diffusion patterns of negative sentiments in social media after the event occur in companies. By conducting text mining and estimating unique data set on Twitter empirically, this paper will contribute to literature by providing managerial insights of ways to control social media.

■ MA57

Music Row 5- Omni

The George B. Dantzig Dissertation Prize

Invited: The George B. Dantzig Dissertation Prize

Invited Session

Chair: Henri Groenevelt, University of Rochester, W. E. Simon Graduate School of Business Administration, Rochester, NY, 14627, United States, groenevelt@simon.rochester.edu

1 - Dynamic Monitoring And Control Of Irreversible Chronic Diseases With Application To Glaucoma

Pooyan Kazemian, Harvard Medical School, Boston, MA, United States, pooyan.kazemian@mgh.harvard.edu

To effectively manage chronic disease patients, clinicians must know (1) how to monitor each patient (i.e., when to schedule the next office visit and which subset of tests to take), and (2) how to control the disease (i.e., what levels of controllable risk factors will sufficiently slow disease progression). Our research addresses these questions simultaneously and provides the optimal solution to a novel linear quadratic Gaussian state space model. Glaucoma is discussed as a case study.

2 - Multiple Criteria Decision Engineering To Support Management In Military Healthcare And Logistics Operations

Nathaniel D. Bastian, Pennsylvania State University, 137 Arbor Bluff Drive, Pleasant Gap, PA, 16823, United States, nathaniel.bastian@fulbrightmail.org

The U.S. Military Health System (MHS) is a unique, complex health system with many healthcare and logistics challenges requiring effective management. We introduce multiple criteria decision engineering methods to assist strategic decision-making and to support the complex planning and management of MHS resources, personnel, logistics, and financial incentives. This contribution has helped senior military leaders make better, more informed, quicker, data-driven resource management decisions amongst conflicting objectives, along with the risks and uncertainties associated with those decisions.

3 - Smarter Tools For (Citi) Bike Sharing

Eoin O'Mahony, Uber, Itaca, NY, United States, eoin@uber.com

Bike-sharing systems are becoming increasingly prevalent in urban environments. These systems generally consist of stations where users can take out or drop off bikes, and may return a bike to a free dock at any station. New York City launched the largest bike sharing system in North America, Citibike, in May 2013 with over 300 stations and 5000 bikes. We have worked with Citibike since launch, using analytics and optimization to change how they manage the system. In this talk we will cover two areas of our work with Citibike; planning through data and rebalancing with optimization.

4 - Optimizing A Menu Of Multi-format Subscription Plans For Ad-Supported Media Platforms

Vamsi Krishna Kanuri, University of Miami, 501 Kosar Epstein Bldg, School of Business Administration, Coral Gables, FL, 33146, United States, vkanuri@bus.miami.edu

Media content distribution has changed extensively in the past decade. Content, which was once distributed through traditional formats such as television, radio and print, is now available through contemporary digital formats such as smartphone and tablet apps, with many possible versions (e.g., presence or absence of ads.) Consequently, many media firms facing markets comprised of heterogeneous consumers with varying content consumption preferences are now offering 'menus' of multi format-version subscription bundles for their consumers to choose from. Yet, little systematic model-based guidance exists for configuring and pricing menu options. Moreover, most media firms are 'audience-building platforms' that serve at least two distinct customer groups (content consumers and advertisers) with inter-related demands. Therefore, constructing a menu of content subscription bundles that maximizes total profit from both consumers and advertisers is a formidable challenge. This research proposes a theory-driven implementable model-based approach that can aid media platforms in addressing this challenge.

5 - Stochastic Models To Optimize Biomanufacturing Operations

Tugce Martagan, Eindhoven University of Technology, School of Industrial Engineering, Eindhoven, Netherlands, t.g.martagan@tue.nl

An interdisciplinary framework is developed to reduce costs and lead times in biomanufacturing operations. The proposed framework consists of Markov decision models that dynamically control and optimize the fermentation and purification operations. We characterize the structural properties of the optimal operating policies, and propose a new zone-based decision making approach to quantify the risks and costs in biomanufacturing operations. We provide guidelines that are easy to implement in practice, and develop approximation procedures to solve industry size problems.

■ MA58

Music Row 6- Omni

Energy V

Contributed Session

Chair: Jaeyoung Cho, Assistant Professor, Lamar University, 6195 N Major Dr., Beaumont, TX, 77713, United States, jcho@lamar.edu

1 - A New Computational Method For Rolling-horizon Stochastic Optimization In Power Systems

Site Wang, Clemson University, Freeman Hall, Fernow Street, Clemson, SC, 20634, United States, sitew@clemson.edu
Harsha Gangammanavar, Sandra D Eksioglu, Scott J. Mason

We investigate a multi-period, economic dispatch problem in a power system with high penetration of renewable resources. We propose a rolling horizon stochastic programming framework to analyze this problem. We solve this problem over a one-day horizon with sub-hourly intervals using novel warm-up techniques developed for the stochastic decomposition algorithm. We compare our stochastic approach with existing deterministic methods via extensive computational studies on real-scale systems.

2 - Greening The Vehicle Fleet: Evidence From Norway's Co2 Feebate

Shiyu Yan, Norwegian School of Economics, Bergen, Norway, shiyu.yan@nhh.no

To improve vehicle fuel efficiency and reduce CO_2 emissions, Norway linked vehicle registration taxes to CO_2 intensities, later adapted into feebate. We exploit a detailed vehicle registration dataset by econometric techniques. We find that the vehicle tax contributes to a purchase shift towards low-emitting cars. The results show that 1000NOK tax increase for a vehicle is associated with a 1.13%-1.58% registrations reduction. A pattern of rising CO_2 taxes across cars results in an elasticity (-0.06) of CO_2 intensities with respect to CO_2 prices. The estimated tax effect implies that the CO_2 differentiated vehicle registration tax explains 79% of the reduction in average CO_2 intensity of new cars.

3 - System Frequency Regulation In Renewable Dominated Power Systems With A Large Penetration Of Electric Vehicles

Miguel Carrion, Universidad de Castilla-La Mancha, Avda Carlos III s/n, Toledo, Spain, miguel.carrion@uclm.es,
Rafael Zárate-Miñano

Future power systems based on intermittent and asynchronous units may favor frequency fluctuations owing to a) a high presence of generating units with volatile power output, b) a reduction in the number of units participating in the frequency regulation and c) a reduction in the kinetic energy stored in the rotating parts of the system. In this context, we analyze the impact of using plug-in electric vehicles to provide frequency regulation in renewable-dominated power systems. This problem is formulated as a stochastic unit commitment that takes into account the uncertainty of renewable resources and frequency regulation capabilities. The proposed formulation is tested in a realistic case study.

4 - Developing A Decision Support Tool For Expanding Waste-to-Energy Technology Within The Department Of Defense

Adam Haag, Lieutenant, Student, Naval Postgraduate School, Naval Postgraduate School, 1 University Circle, Monterey, CA, 93943, United States, achaag@nps.edu

This study seeks to improve the the DOD's existing decision support tool with an additional module, which may increase the diversity and breadth of Waste-to-Energy technology within the DoD.

5 - Multiple UAV Assisted Power Network Damage Assessment

Jaeyoung Cho, Assistant Professor, Lamar University, 6195 N Major Dr., Beaumont, TX, 77713, United States, jcho@lamar.edu
Gino J Lim, Seonjin Kim

We presents a two-phase mathematical framework for efficient power network damage assessment using unmanned aerial vehicle (UAV). In the first phase, a two-stage stochastic integer programming optimization model is presented for damage assessment in which the first stage determines the optimal UAV locations anticipating an arrival of an extreme event, and the second stage is to adjust the UAV locations, if necessary, when the arrival time of the predicted extreme event becomes closer with updated information. UAV paths to scan the power network are generated in the second phase while minimizing operating costs of the UAVs.

■ MA59

Cumberland 1- Omni

Network Design and Operations

Sponsored: Transportation Science & Logistics

Sponsored Session

Chair: Ali Asadabadi, George Mason University, College Park, College Park, MD, 20783, United States, ali.asadabadi@gmail.com

1 - The High Speed Train Timetable Planning Problem For The Chinese Railways

Paolo Toth, University of Bologna, Bologna, Italy, paolo.toth@unibo.it

We consider the Train Timetabling Problem (TTP) for the planning of high-speed trains on the Beijing-Shanghai line. We are given a set of feasible timetables for the trains already planned along the line, and the main goal consists of scheduling as many additional trains as possible. We are allowed to modify the timetables of the trains, even by changing their stopping patterns, i.e. by removing some stops. A second objective is to obtain a regular schedule with respect to stopping patterns. We propose an Integer Linear Programming Model and a heuristic algorithm. Extensive computational experiments on real-world instances of the Chinese Railways are reported.

2 - Optimal Transportation And Shoreline Infrastructure Investment Planning Under Stochastic Climate Future

Ali Asadabadi, George Mason University - Fairfax, Fairfax, VA, 22030, United States, ali.asadabadi@gmail.com,
Elise D Miller-Hooks

The problem of optimal long-term transportation investment to protect from and mitigate against the impacts of climate change is modeled as a multi-stage, stochastic, bi-level, mixed-integer program. A recursive noisy genetic algorithm is presented to address large-scale applications. It is demonstrated on a Washington, D.C. Greater Metropolitan area case study.

3 - Global Optimization Solution Methods For Transportation Network Design Problems

David Z.W. Wang, Nanyang Technological University, 50 Nanyang Avenue, Singapore, 639798, Singapore, wangzhiweiI@ntu.edu.sg

Transportation network design problems (NDP), which determine the optimal road expansion and addition plan with assumption of various user equilibrium principles, are conventionally modelled into a bilevel programming or MPEC. The NDPs are typically nonlinear and nonconvex. We develop global optimization solution methods, applying various linearization and relaxation techniques, to obtain the global optimal solution to the NDPs. Both continuous and discrete NDPs are considered, while typical user equilibrium principles including deterministic user equilibrium and stochastic user equilibrium will be employed.

4 - Optimal Layout Of Transshipment Facilities Under Traffic Equilibrium In A Continuous Space

Zhaodong Wang, University of Illinois, Wright Street, Urbana, IL, 61801, United States, zwang137@illinois.edu
Yanfeng Ouyang

This talk focuses on generalizing the location-routing problem into one that considers traffic congestion and equilibrium in a continuous space. We present a new proof that a regular hexagon shape is optimal for facility service regions under congestion. Numerical experiments are implemented to verify the correctness of our analytical solution and theoretical results are used as a building block to develop approximate solutions to more general heterogeneous cases.

■ MA60

Cumberland 2- Omni

Fleet and Marketplace Optimization for Mobility-on-Demand (MOD) Systems

Sponsored: TSL, Urban Transportation

Sponsored Session

Chair: Samitha Samaranayake, Cornell University, 317 Hollister Hall, Ithaca, NY, 14853, United States, samitha@alum.mit.edu

1 - Queueing-theoretical Models For Mobility-on-demand Systems: Theory And Algorithms

Frederico Rossi, Stanford University, Stanford, CA, United States, frossi2@stanford.edu, Marco Pavone

In this talk I will present recent advances towards modeling and controlling autonomous mobility-on-demand (AMoD) systems, an emerging mode of personal transportation wherein robotic, self-driving vehicles transport customers on-demand. First, I will present queueing-theoretical models inspired by the theory of Jackson and BCMP queueing networks. Such models provide structural insights about the performance of AMoD systems and guidelines for the design of routing algorithms for the robotic vehicles. Then, I will discuss large-scale coordination algorithms for AMoD systems that are aimed at throughput maximization and can handle congestion and charging constraints.

2 - Fleet Management In Mobility-on-Demand Systems With Shared Rides

Samitha Samaranayake, Cornell University, samitha@alum.mit.edu

We consider a MoD system with ridesharing between passengers. Inherent to the formulation are two important attributes: (i) the need to rebalance empty vehicles and (ii) the ability to identify lucrative ridesharing corridors via trip chaining. We present a mixed-integer linear programming (MILP) formulation of the problem and show how a heuristic (feasible) solution to the problem can be obtained in polynomial-time by independently solving the ride-matching and rebalancing problems. This approximate solution can be used as a initial guess when solving the coupled problem via an MILP solver.

3 - Dynamic Pricing In Ride-share Platforms

Siddhartha Banerjee, Cornell University, sbanerjee@cornell.edu

Much of the success of ride-sharing platforms like Lyft and Uber is ascribed to their ability to do fast-timescale dynamic pricing - where prices can react to instantaneous system state, and across very small geographic areas. We explore the value of such dynamic pricing via a model which combines a queueing model for the dynamics of the platform's operations with strategic models of both passenger and driver behavior. In particular, we suggest that dynamic pricing may not be better than the optimal static price, but rather, allows the platform to realize the optimal price with limited knowledge of system parameters. Joint work with Ramesh Johari, Carlos Riquelme, and the data science team at Lyft.

4 - Marketplace Optimization At Uber

Robert Phillips, Uber, Palo Alto, CA, United States, robert.phillips@uber.com

The rapid acceleration of the sharing economy has introduced a myriad of challenges for two-sided marketplaces. This talk will address how optimization and machine learning are powering the dynamic marketplace at Uber, a platform that has connected over one billion riders and drivers across more than 60 countries. Topics that will be surveyed include dynamic pricing, matching riders in uberPOOL, and real-time on-demand delivery services.

■ MA61

Cumberland 3- Omni

Intermodal Transportation

Sponsored: Railway Applications

Sponsored Session

Chair: Mike D Prince, BNSF Railway, Fort Worth

1 - Intermodal Empty Railcar Distribution Optimization

Shantih Spanton, CSX Transportation, Jacksonville, FL, Shantih_Spanton@csx.com, Jagadish Jampani

Optimization models to effectively reposition the empty railcars. The forecasting model predicts the future demand for the containers and trailers, which is subsequently translated into railcars. This demand data is converted into equivalent number of railcars which is input into the optimization model. In addition, train profiles, network and terminal attributes are input into the optimization model. The model also predicts when and where the loaded railcars will become available in the selected optimization time horizon. This optimization model is embedded with a real time tool that is used by the intermodal railcar distribution team.

2 - Intermodal Hub Simulation

Mike Prince, BNSF Railway, Contact: mike.prince@bnsf.com

Intermodal hubs are the facilities at which BNSF Railway's intermodal trains interface with customers. This presentation will discuss an AnyLogic simulation model that was developed for the purpose of assisting in the capital expansion planning process for these facilities.

3 - Utilizing Rail Information In Intermodal Operations

Georgi Tasev, Schneider, Contact: TasevG@Schneider.com

Accurate train ETA information is critical to intermodal dray operations and directly influences the ability to serve customers effectively. In this session, we will review how Schneider uses train information provided by our rail partners to optimize key operations, such as appointment setting and dispatch. In addition, we will cover the analysis that was completed to study the accuracy of rail ETA information at key time intervals. Lastly, we will discuss the implementation and results of building a direct feed for train ETA information into Schneider's system.

■ MA62

Cumberland 4- Omni

Determinants of Aviation Strategies and Market Outcomes

Sponsored: Aviation Applications

Sponsored Session

Chair:SufficMartin E Dresner, University of Maryland-College Park, R H Smith School of Business, College Park, MD, 20742, United States, mdresner@rhsmith.umd.edu

1 - The Impact Of Predicted Quality On Customer's Quality Assurance Behaviors In The Us Airline Industry

Woohyun Cho, University of New Orleans, New Orleans, LA, United States, wcho@uno.edu
Dong-jun Min, Pamela Kennett-Hensel

We empirically examine the drivers of customers' voluntary quality assurance behaviors (QAB). Using survey data and archival data from the US airline industry, we show that whereas an increase in predicted quality of airlines departure operations (e.g., on-time performance and flight frequencies) leads to a decrease in the level of QAB (i.e., customer wait time for their flight at the airport), an increase in price leads to an increase in QAB. Our finding also indicates that the expense of exercising QAB reduces QAB. We emphasize the importance of properly measuring the impact of predicted quality and price on the customer's role, as it may help share the cost of managing quality with their customers.

2 - Passenger Facility Charge Vs. Airport Improvement Program Funds: A Dynamic Network Dea Analysis For U.S. Airport Financing

Bo Zou, University of Illinois at Chicago, 2073 Engineering Research Facility, 842 West Taylor Street, Chicago, IL,n Univ60607, United States, bzou@uic.edu
Young-Tae Chang, Hyosoo Park, Nabin Kafle

Passenger Facility Charge (PFC) and the Airport Improvement Program (AIP) are two major sources to finance U.S. airports. This paper develops a novel dynamic network DEA framework to investigate the substitutability between PFC and AIP funds. We find that the studied U.S. airports can substitute PFC for 8-35% of the current AIP funds and contribute significantly to the proposed plan of the US congress to cut AIP funding. In addition, the amount of PFC-for-AIP funds substitution negatively correlates with the productive efficiency of airports. The findings send an important message for future policy reforms on U.S. airport financing.

3 - Measuring Competition Intensity And Product Differentiation: Evidence From The Airline Industry

Benny Mantin,University of Waterloo, bmantin@uwaterloo.ca
David Gillen, Tuba Delibasi

Measuring the degree of competition in markets is essential for policy and decision makers. Commonly used structural indices (e.g., HHI) overlook how firms compete with each other and the intensity of the competition. We propose a new competition measure: Schedule (Temporal) Differentiation Metric, STDM, which encapsulates firms' market shares as well as the degree of overlap and substitution between the competing services—critical elements in service industries. We demonstrate the STDM using aviation markets revealing a significant improvement in explaining prices, how the effect varies across fare percentiles, and how the insights change with the business models of the competing firms.

4 - Economic Effects Of European Union's External Aviation Policy
Megersa Abate, Swedish National Road and Transport Research Institute, megersa.abate@vti.se

■ MA63

Cumberland 5- Omni

Continuous Space Location Modeling

Sponsored: Location Analysis

Sponsored Session

Chair: John Gunnar Carlsson, University of Southern California, 3715 McClintock Ave, Los Angeles, CA, 90089, United States, spajcarlsso@usc.edu

1 - On The Dual And Rectangular Bounds For Continuous Facility Location Problem
Nadere Mansouri, SMU, nmansouri@mail.smu.edu
Halit Uster

Lagrangian dual and Rectangular bounds (a rectangular distance location problem specifically devised) are two of the lower bounding techniques for a continuous facility location problem. We present results comparing these bounds at any Weiszfeld iteration and upon convergence.

2 - Delivering Packages Jointly With A Truck And A Drone
John Gunnar Carlsson, University of Southern California, jcarlsso@usc.edu

One of the most talked-about developments in transportation and logistics in recent years has been the potential use of drones for transporting packages. We use a continuous approximation analysis to study a hybrid system in which delivery trucks act as a mobile "base" for launching drones.

3 - The Competitive Facility Location Problem Under Disruption Risks
Lawrence V Snyder, Associate Professor, Lehigh University, 200 West Packer Ave., Mohler Lab, Bethlehem, PA, 18015, United States, lvs2@lehigh.edu, Ying Zhang, Ted K Ralphs

Two players sequentially locate facilities, competing to capture market share. Facilities face disruption risks, and each customer seeks the nearest operational facility for service, regardless of who operates it. The problem combines competitive location and location with disruptions, an important combination that has been absent from the literature. We model the problem as a Stackelberg game, and formulate the leader's decision problem as a binary bilevel optimization problem. We propose a branch-and-cut algorithm and a variable neighborhood decomposition search heuristic. Computational results suggest that high quality solutions can be found quickly.

■ MA64

Cumberland 6- Omni

MCDA Methods and Applications

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Roman Slowinski, Poznan University of Technology, Poland, roman.slowinski@cs.put.poznan.pl

1 - Context Matters: Effects Of Product Type And Information Overload On Choice Accuracy
Jyrki Wallenius, Professor, Aalto University School of Business, Helsinki, Finland, jyrki.wallenius@aalto.fi
Pekka J Korhonen, Pekka Malo, Tommi Juhani Pajala, Niklas Ravaja, Outi Somervuori

We report on the results of an experiment, which utilizes a new method for generating many similar choice problems, enabling the objective measurement of choice accuracy.We show that the product type matters for choice accuracy. Moreover, we show that information overload is a relevant phenomenon in MCDM experiments. However, what matters is the quality of information, not just the quantity. When we add information that does not change the dominance relations between products, choice accuracy is not degraded.

2 - Decision Under Risk And Uncertainty As A Multi-quantile Decision Problem
Roman Slowinski, Poznan University of Technology, Poznan, Poland, roman.slowinski@cs.put.poznan.pl
Salvatore Corrente, Salvatorend,&nbGreco, Benedetto Matarazzo

We formulate the problem of decision under risk & uncertainty as a multiple criteria decision problem, where criteria are some quantiles of the outcome distribution, which are meaningful for the decision maker. To solve the multiple criteria decision problem, we apply the robust ordinal regression approach. We validate all the methodology on the classic newsvendor problem where we apply GRIP and ELECTRE^GKMS methods to recommend a solution respecting preferences of the decision maker.

■ MA65

Mockingbird 1- Omni

Gamification and User Engagement

Sponsored: Information Systems

Sponsored Session

Chair: Lei Wang, Pennsylvania State University, University Park, PA, 16801, AssigUnited States, luw21@smeal.psu.edu

1 - Measuring The Impact Of Crowdsourcing On Mobile App User Engagement And Retention: A Randomized Field Experiment
Zhuojun Gu, Pennsylvania State University, zqg5077@psu.edu
Ravi Bapna, Jason Chan, AlokcustomGupta

In this paper, we propose a new strategy for enhancing mobile app user engagement and retention by introducing crowdsourcing features that involve users through the design of the app itself. We measure the causal impact of crowdsourcing by conducting a randomized field experiment on a social mobile game platform. We find higher user retention level could be achieved by allowing users to submit content and customize their products. And sustained user engagement and retention are enhanced most when both submission and access options are available.

2 - Cultivate Consumer Engagement With Mobile And Gamification
Lei Wang, Pennsylvania State University, State College, PA, 16802, United States, Lxluw21@smeal.psu.edu, Siyuan Liu

Despite the growing popularity of gamification and its potentials on customer engagement, we still have very little knowledge about gamification and its impact on customer engagement. In this research, we conduct a large-scale randomized field experiment in a shopping mall in Asia to investigate the impact of gamification on cultivating customer engagement. Our results will allow us to effectively measure the causal impact of gamification and provide insights on quantifying and improving the impacts of gamification on customer engagement and mobile advertising. This study also provides important implications on how firms could benefit from gamification.

3 - What Do Mobile Applications Bring a Longer Tail? An Empirical Study Of Sales Concentration In Online Cchannels
Shahryar Doosti, University of Washington, Foster School of Business, Mackenzie Hall, Seattle, WA, 98195, United States, shahryar@uw.edu, Yong Tan, Youwei Wang

This work uses a dataset from a leading e-retailer which offers two online channels, the desktop channel and mobile applications, to study the effect of long tail on product sales in each channel. Our findings show that the long tail effect exists in mobile application channel. In other words, there is more product variation and less sales concentration on mobile app compared to desktop channel.

■ MA66

Mockingbird 2- Omni

Model Calibration

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Matthew Plumlee, University of Michigan, Ann Arbor, MI, United States, mplumlee@umich.edu

1 - Bayesian Calibration Of Inexact Computer Models
Matthew Plumlee, University of Michigan, mplumlee@umich.edu

Bayesian calibration is used to study computer models in the presence of both a calibration parameter and model bias. The parameter in the predominant methodology is left undefined. Among other problems, this results in an issue where the posterior of the parameter is sub-optimally broad. To date, there has been no generally accepted alternatives. This paper proposes using Bayesian calibration where the prior distribution on the bias is orthogonal to the gradient of the computer model. Problems associated with Bayesian calibration are shown to be mitigated through analytic results in addition to numerical and real examples.

2 - Stabilizing Gradient Enhanced Kriging With Sparsity Constraints
Peter Qian, University of Wisconsin,re thepeter.qian@wisc.edu

Gaussian processes are widely used for emulating computer simulations. It is known that the use of partial derivative information can dramatically improve function estimation. However, the use of partial derivative information comes at the cost of high numerical instability. We investigate an approach to mitigate this instability by exploiting the possibility that some partial derivatives may introduce enough error due to numerical instability to significantly degrade predictive accuracy. Experimental results indicate this procedure can dramatically reduce numerical error in interpolation. Applications to model calibration will also be discussed.

3 - Model Calibration With Censored Data
Fang Cao, Georgia Institute of Technology, Atlanta, SGA, United States, fcao6@gatech.edu, Shan Ba, William A Brenneman, Roshan Joseph

The purpose of model calibration is to make inference about the unknown parameters of a computer model. The Kennedy-O'Hagan approach is widely used for calibration which accounts for the inadequacy of the computer model while simultaneously estimating the calibration parameters. In many applications censorship occurs when exact outcome of the physical experiment is not observed but is known to fall within a certain region. In such cases KO approach cannot be used directly and we propose a method to incorporate the censoring information when performing calibration. The method is applied to study the stability of liquid and the results show significant improvements over traditional methods.

■ MA67

Mockingbird 3- Omni

Maintenance and Reliability Planning

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Murat Kurt, Merck & Co, Inc, 351 N. Sumneytown Pike, North Wales, PA, 19454, United States, murat.kurt7@gmail.com

Co-Chair: Anahita Khojandi, University of Tennessee, everykhojandi@utk.edu

1 - Optimal Design Of Hybrid Sequential Testing For A System With Mixtures Of One-shot Units
Yao Cheng, Rutgers University, Department of Industrial & Systems Engineering, Piscataway, NJ, 08809, United States, yao.cheng.ise@gmail.com, Elsayed Elsayed

Non Destructive Testing is conducted to determine the functionality of the units without permanent damage in order to estimate the units' reliability. In this presentation, we investigate a system composed of non-identical units with different characteristics and subjected to hybrid reliability testing (Destructive and NDT). It is of interest to optimally design the hybrid sequential reliability testing. After conducting a number of hybrid testing, we decrease the sample size of the destructive testing as the accuracy of reliability metrics estimation improves. Eventually, we only need to conduct NDT only. The efficiency and accuracy of the proposed methods are validated.

2 - Wind Farm Replacement In A Markov Modulated Environment
David Abdul-Malak, University of Pittsburgh, dta10@pitt.edu, Jeffrey P. Kharoufeh

In this talk we will present a model for jointly replacing wind turbine components in a wind farm setting. Components are assumed to degrade in a shared, exogenous, Markov modulated environment. Continuous state variables and a high dimensional state space cause the problem to be computationally intractable. To overcome these complications, structural results are proven and a reinforcement learning (RL) approach is employed.

3 - An Enhanced Copula-based Prognosis For Proactive Maintenance Of Lithium-ion Batteries
Zhimin Xi, University of Michigan-Dearborn, zxi@umich.edu

Data-driven prognostics typically requires sufficient offline training data sets for accurate remaining useful life (RUL) prediction for the purpose of proactive maintenance of engineering products. We investigate performances of typical data-driven methodologies when the amount of training data sets is insufficient to better understand the methodology limitation. An enhanced copula-based approach is specifically developed for the scenarios with insufficient run-to-failure training data sets. RUL prediction of lithium-ion batteries in terms of the capacity degradation is employed for the demonstration.

4 - Optimizing Periodic Inspection Frequencies For a Class Of Stochastically Degrading Systems
David Kaufman, University of Michigan-Dearborn, Dearborn, MI, United States, davidlk@umich.edu, Mahboubeh Madadi, Murat Kurt

We consider existing models that optimize repair-replacement decisions for systems the degradation status of which follow a discrete time Markov chain over a set of finite states and can be revealed only by costly inspections. Given worse conditions imply higher operation costs, we utilize first-order stochastic dominance relationship among the powers of IFR-structured degradation matrices to propose approximately-optimal periodic inspection decisions that minimize the total expected discounted cost due to operation, repair and inspection. We illustrate our approach through numerical examples.

■ MA68

Mockingbird 4- Omni

Panel: IOT-enabled Data Analytics: Opportunities, Challenges and Applications

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Moderator: Kaibo Liu, kliu8@wisc.edu

1 - LoT-enabled Data Analytics: Opportunities, Challenges And Applications
Kaibo Liu, University of Wisconsin - Madison, kliu8@wisc.edu

The goal of this session is to push the frontier in IoT application and the enabled data analytics research. The session provides a forum where participants can describe current opportunities, identify important problems and areas of application, explore emerging challenges, and formulate future research directions.

2 - LoT And Data Analytics
Tobin Jansenberger, American Family Insurance, tjansenb@amfam.com

3 - LoT Analytics
Rong Duan, AT&T, rongduan@research.att.com

4 - LoT Data Analytics
Subrat Sahu, Caterpillar Inc, sahu_subrat@cat.com

5 - LoT Data Analytics
Gul Ege, SAS, Gul.Ege@SAS.com

■ MA69

Old Hickory- Omni

Game Theory and Competitive Applications

Sponsored: Military Applications

Sponsored Session

Chair: Brian J Lunday, Assistant Professor, Air Force Institute of Technology, 2950 Hobson Way, WPAFB, OH, 45433, United States, brian.lunday@afit.edu

1 - 1 Vs. (n-1) Modeling For Project Scheduling Interdiction
Zachary Little, The Perduco Group, 3610 Pentagon Boulevard #110, Beavercreek, OH, 45431, United States, zach.little@theperducogroup.com

A bilevel programming problem is developed for a one-to-many game involving project scheduling interdiction. As a coalition, the many (n-1) adversaries aim to minimize the total cost of a set of project schedules given a time/cost trade-off. The single interdictor aims to maximize this same total cost for the coalition's project schedules. The modeling framework and use of duality are discussed, with emphasis placed on coalition interaction for this study. Initial results examine the impact of player perceptions on interdictor and coalition decisions.

2 - Approximate Dynamic Programming For Missile Defense Interceptor Fire Control
Matthew J Robbins, Air Force Institute of Technology, Wright-Patterson AFB, OH, United States, matthew.robbins@afit.edu, Michael T Davis, Brian J Lunday

A missile defense system must protect assets against multiple offensive missile salvos over time. The defender must determine how many interceptors to fire at each incoming missile. We develop a Markov decision process (MDP) model to determine optimal fire control policies. Approximate dynamic programming (ADP) is utilized to explore the efficacy of applying approximate methods to the problem. We obtain policy insights by analyzing subsets of the state space that reflect a range of possible defender interceptor inventories. The ADP policy provides high-quality decisions for a substantial proportion of the state space, achieving a 7.7 percent mean optimality gap in the baseline scenario.

3 - Containing The Mess Of Optional Meals Via Approximate Dynamic Programming

Sandra Jackson, Instructor, United States Military Academy, West Point, NY, United States, sandra.jackson@usma.edu, Keith DeGregory, Matthew Fletcher

On any given day, the United States Military Academy Mess Hall provides three meals to the Corps of Cadets, approximately 4,400 people. These meals are simultaneously served meaning the entire Corps arrives, eats, and departs at the same time. In recent years, the Academy has allowed cadets to option out of formally mandatory meals thus moving what was a consistent demand to a stochastic one. As a result, the Academy Mess Hall experiences a stochastic demand similar to dining facilities in the active Army. Variable demand opens the door to food waste and the question of how to make sequential resourcing decisions under uncertainty, a problem for which approximate dynamic programming is suited to solve.

4 - Heterogeneous Surface-to-air Defense Battery Location: A Game Theoretic Approach

Brian Lunday, Air Force Institute of Technology, brian.lunday@afit.edu Nicholas Boardman, Matthew Jd Robbins

We examine a game theoretic model for the location of air defense batteries having different interceptor capabilities, and we find high quality solutions using the game tree search technique Double Oracle, within which we embed either of two alternative heuristics to solve an important subproblem for the attacker. We test and compare these solution methods to solve a designed set of 52 instances having parametric variations. Enhancing the solution methods with alternative initialization strategies, our superlative methodology attains the optimal solution for 75% of the instances tested and solutions within 2.12% of optimal, on average, for the remaining 25% of the instances.

■ MA70

Acoustic- Omni

Transportation, Maritime I

Contributed Session

Chair: Hossein M Soroush, Kuwait University, Department of Statistics & Operations Research, PO Box 5969, Safat, 13060, Kuwait, h.soroush@ku.edu.kw

1 - Understanding Vehicle Movement Patterns With Artificial Neural Networks

Burak Cankaya, Lamar University, 13960 Hillcroft St. Apt 724, Houston, TX, 77085, United States, mbcankaya@gmail.com

Geographical Identification System (GIS) is utilized by most of the vehicles and cellphones in recent years. This research proposes an alternative type of methodology to understand vehicle movement patterns with historic geospatial data. This research investigates the vehicle movement patterns with artificial neural networks and compares the results with other machine learning methodologies including decision trees and random forest algorithm. The methodology will be applied on a case study, which is strategic Gulf of Mexico Ports' vessel traffic data. The result of the study will explain the question “Can we understand vessel movement patterns and optimize the vessel traffic?

2 - A Discrete Simulation Of A New Container Terminal – The Case Of Hamad Port Of Qatar

Ghaith Rabadi, Professor, Old Dominion University, Engineering Management Systems Engineering, Engineering Systems Building, Room 2102, Norfolk, VA, 23529, United States, grabadi@odu.edu Mariam Kotachi, Moahmed K Msakni, Mohammad Al-Salem, Ali Diabat

A discrete even simulation is developed for a future container terminal of Hamad’s new port of Qatar. The simulation models vessel arrivals, ship to shore crane operation, container movement from vessels to yard via yard trucks and the operations in the opposite direction from the yard to the vessels. Furthermore, external trucks dropping off and picking up containers from the yard are also modeled. Berth allocation and crane assignment methods are embedded in the simulation. Preliminary analysis and scenarios are presented.

3 - Modeling The Service Network In Container Terminals Considering Process Integration And Decomposition

Qingcheng Zeng, Professor, Dalian Maritime University, School of Transportation Management, Dalian, 116026, China, qzeng@dlmu.edu.cn

Process integration/decomposition and process variation are pair of critical decision variables in service network design. In this paper, the variation of each service process of container terminals is analyzed. A cyclic queue network model is developed. Principles of integration or decomposition, methods of stabilizing the processes are proposed.

4 - A Vessel Scheduling Transportation-inventory Problem With Stochastic Demands

Hossein M Soroush, Kuwait University, Department of Statistics & Operations Research, P.O. Box 5969, Safat, 13060, Kuwait, h.soroush@ku.edu.kw Salem Al-Yakoob

We study a vessel scheduling transportation-inventory problem to transport a product from a source to a destination where demands are stochastic and penalties are imposed on the shortages/excesses in storage levels. The goal is to schedule a set of heterogeneous fleet to meet the demands with acceptable level of reliabilities while minimizing the expected total cost.

■ MA71

Electric- Omni

Supply Chain, Shipping I

Contributed Session

Chair: Tao Lu, Erasmus University, Rotterdam, Netherlands, lutao0927@hotmail.com

1 - Shipping Peak Demand For Online Sellers

Ju Myung (J.M.) Song, Rutgers Business School, PhD Program, Washington Park, Room 430C, Newark, NJ, 07102, United States, jumyungsong@gmail.com, Yao Zhao

Online retailing is changing the landscape of retail industry in countries as Amazon’s market cap has recently doubled that of Wal-Mart in the US. Different from brick and mortar, online sellers rely on 3rd party logistics for the delivery of the goods but the hugely spiked demand during holiday seasons (Christmas in the US, Singles’ day in China) poses a substantial challenge for the 3PLs to deliver on time. To better manage demand, 3PLs such as UPS, require the sellers to make reservation and to pay a surcharge for extra work. In this paper, we discuss how these shipping arrangements may affect the online sellers’ inventory decisions, how to coordinate the channel for the sellers and shippers to win-win.

2 - Explosive Storage Location Assignment Problem For Amazon Class Internet Fulfillment Warehouses

Sanchoy Das, New Jersey Institute of Technology, University Heights, Newark, NJ, 07102, United States, das@njit.edu, Jingran Zhang

We establish a storage assignment heuristic for Internet Fulfillment Warehouses. xSLAP is based on an explosive policy, whereby the same item is stored simultaneously in small lots in a large number of locations. Compared with classical storage policies used in traditional warehouses, an explosive policy leverages demand correlated storage assignment by commingling SKUs in the same bin, bins in close proximity, or bins in the same zone. The xSLAP heuristic optimizes the downstream picking processes by finding the optimal assignment of items in order to meet quick customer orders fulfillment.

3 - Analysis Of Hub Ports In Southeast Asia And Northeast Asia

Richard W Monroe, Longwood University, 7413 Nicklaus Cir, Farmville, VA, 23909, United States, monroerw@longwood.edu

Major seaports in Southeast Asia and Northeast Asia have experienced significant growth in the last two decades. Several ports are known as “hub” ports due to the dominant volume of transshipments. This paper will present descriptive statistics for the major ports in Asia among the Top 50 Container Ports in the world. A secondary analysis will focus on a smaller sample of the top hub ports to compare the growth of container volume for those ports with higher transshipment volumes. The differences between hub ports and other ports will also be discussed.

4 - Approximate Dynamic Programming For An Empty Container Repositioning Problem In A Cyclic Route

Shaorui Zhou, Assistant Professor, Sun Yat-sen University, Guangzhou, China, zshaorui@gmail.com, Fan Wang

In this work, we study an empty container repositioning problem in a cyclic route with uncertain demands. We formulate it as a stochastic dynamic programming problem. We study two special cases: in case 1, the route covers only 2 ports and we propose a optimal t ld policy due to the separability of the value function; In case 2, the route covers 3 ports, and the optimal policy can be characterized by state-dependent threshold points. For general case, in order to overcome curse of dimensionality, we propose an approximate dynamic programming algorithm. We compare the performance with heuristics. Numerical results demonstrate the efficiency of the algorithm.

5 - Shipping To Time-sensitive Customers With Competing Carriers

Tao Lu, Erasmus University,o applRotterdam, Netherlands, lutao0927@hotmail.com, Ying-Ju Chen, Jan C Fransoo, Chung-Yee Lee

We consider a shipper selling a kind of products to a destination market where customers obtain higher utility if they receive the product earlier but their time-sensitivity is heterogeneous. Two carriers provide transportation services with different speeds, and compete by quoting freight rates. By splitting shipments between carriers, the shipper may enjoy the benefit of product differentiation through selling early-arrived products at a premium price. However, driven by the underlying trade-off between product differentiation and competition, we show that product differentiation via dual-mode shipping may be inferior to simply restricting to a single shipping mode.

■ MA72

Bass- Omni

Supply Chain Mgt V

Contributed Session

Chair: Youran Fu, University of Pennsylvania, 3730 Walnut Street, Room 532, Philadelphia, PA, 19104, United States, youranfu@wharton.upenn.edu

1 - Coordinating A Textile Supply Chain In Post Multi Fibre Agreement Era: A Developing Economy Perspective

Arnablass="Bisi, Johns Hopkins University Carey Business School, 100 International Drive, Baltimore, MD, 21202, United States, abisi1@jhu.edu, Arnab Adhikari, Badrifrom mNarayanan

The abolishment of the Multi Fibre Agreement (MFA) in 2005 opened up a plethora of export opportunities of textile and cotton for the textile supply chain of many developing economy countries such as India and China. On the other hand, it leads to a shortage of low-cost raw material in these countries and affects the apparel production. In this context, we adopt a realistic three-level structure to represent the textile supply chain of a developing economy country and focus on designing appropriate coordination mechanisms using cost sharing and revenue sharing contracts.

2 - Coordination And Competition In A Supply Chain: Franchise Contract And Facility Sharing Contract

Tulika Mukherjee, Postdoctoral Fellow, Concordia University, 1455 Boulevard de Maisonneuve, Montreal, QC, H3G 1M8, Canada, jum.tulika@gmail.com

A two-suppliers-one-retailer supply chain model is developed for a marketing channel where all the partners either compete or collaborate to enhance their profit. Competitive and collaborative strategies under franchise contract and facility sharing contract are analysed with a game theoretic lens. Finally, a comprehensive computational analysis is carried out to validate our model.

3 - How Prominence Effect & Repeated Channel Interactions Can Lead To Slotting Allowances

Yourann Fu, University of Pennsylvania, 3730 Walnut Street, Room 532, Philadelphia, PA, 19104, United States, youranfu@wharton.upenn.edu, JiaqiconfliXu, Gerard P Cachon

We develop a supply chain model in which the retailer owns two types of shelf space - a prominent and an inconspicuous shelf space. We show that under this setting, slotting allowances can arise even in the absence of retailer competition as the result of collusion between manufacturers when there is repeated channel interaction. We discuss implications of the retailer's sales effort and shelf space values on channel coordination.

■ MA79

Legends G- Omni

Health Care, Modeling V

Contributed Session

Chair: Erin Garcia, Graduate Student, Georgia Institute of Technology, 755 Ferst Drive, Atlanta, GA, 30332, United States, egarcia3@gatech.edu

1 - Analysis Of Blood Banking System Operations At The Time Of Low Demand

Amir H. Masoumi, Assistant Professor of Management, Manhattan College, 4513 Manhattan College Parkway, Bronx, NY, 10471, United States, amir.masoumi@manhattan.edu, Min Yu

We investigate a new trend of demand for human blood which has significantly affected the operations of blood banks in the US over the past few years. Using a supply chain network optimization model, we analyze the effectiveness of the changes made to such systems including downsizing of operations, closure of facilities, as well as mergers and acquisitions.

2 - Reducing Operating Room Time In Robotic Surgery Using Simulation

Yueran Zhuo, University of Massachusetts Amherst, 121 Presidents Drive, Amherst, MA, 01003, United States, yzhuo@som.umass.edu, Senay Solak

Robotic surgery procedures differ from classical surgeries due to the reduced role that the surgeon plays during the operation. In order to study potential performance improvement options in this increasingly common type of surgery, we build a simulation model based on data collected from several urogynecology robotic surgery cases. The model is then used to assess the value of several alternative process improvement ideas aimed at reducing operating room time.

3 - Scheduling Multidisciplinary Cancer Clinics

Anne G. Leeftink, University of Twente, Enschede, Netherlands, a.g.leeftink@utwente.nl, Ingrid M. Vliegen, Erwin Hans

Many hospitals start multidisciplinary clinics to assure timely care. Their planning requires an open access approach. The number and timing of regular appointments influences the performance for the open access patients. Furthermore, since the appointment schedule of the first physician determines the referral rate to the other clinicians, the timing of the open access slots influences the waiting time as well.
This study's objective is to jointly develop a blueprint appointment schedule for all clinicians. Since this can only be analytically solved for small problem instances, we developed a novel local search heuristic to handle real-life instances, which we applied to a real life case study.

4 - Seasonal Variations In Spatial Access To Pediatric Asthma Treatment Across The US

Erin Garcia, Graduate Student, Georgia Institute of Technology, 755 Ferst Drive, Atlanta, GA, 30332, United States, egarcia3@gatech.edu

Asthma is a chronic condition that affects over 7 million children in the US, many of whom will have a preventable severe health outcome due to their asthma. Disease control is as important as underlying severity for a child's health, and is directly related to the quality of the medical care received. Geographic access to care varies by state, provider type, and patient insurance status. This work uses Medicaid Claims data to analyze the seasonal variations in both available provider capacity and patient demand for asthma visits to understand their impact on the health outcomes of asthmatic children. We also propose interventions to decrease seasonal variations and improve access to care year round.

■ MA86

Glbson Board Room-Omni

Marketing I

Contributed Session

Chair: Libo Sun, PhD Student, University of Science and Technology of China, 96# Jinzhai Road, Hefei, Anhui, PR China, Hefei, 230026, China, libosun@mail.ustc.edu.cn

1 - Mindfulness Effect On Technology Acceptance Process In The Context Of Bounded Rationality

Emine Erdogan, PhD Candidate, Rutgers The State University of New Jersey, Newark, NJ, 07102, United States, ee134@scarletmail.rutgers.edu

This study investigates how decision making processes in accepting a new technology have been influenced by consumers' mindfulness. Based on the theory of bounded rationality and TAM, the study will propose the concept of "bounded mindfulness"and will measure it by testing the effects of ambiguity, and time pressure related to the consumers acceptance of high tech vehicles. Previous research suggests that mindfulness can be described by alertness, awareness, and openness to novelty and negatively correlated with heuristic processing. Moving from this, the paper aims to investigate the impact of consumer mindfulness on information processing and its consequences in high tech vehicles adoption .

2 - Considering Customer Representatives' Risk Preference: Acquisition And Retention Delegation Strategies Under The Spoiling Effect

Yi Liao, Professor, Southwestern University of Finance and Economics, 425 Mount Prospect Avenue, 404, Newark, NJ, 07104, United States, yiliaoswufe@gmail.com

In this study, we focus on the spoiling effect and use the discrepancies between customer acquisition and retention efforts to capture how the spoiling effect influences customer demand. We compare firms' performance using the following three strategies: the delegation of acquisition model, in which customer acquisition is delegated to customer representatives; the delegation of retention model, in which customer retention is delegated to customer representatives; and the total delegation model, in which both tasks are delegated to customer representatives. Our main finding is that the spoiling effect significantly affects acquisition and retention efforts and firm profitability.

3 - Price Competition And Direct-to-consumer Advertising In Prescription Drug Markets

Abhik Roy, Professor, Quinnipiac University, Department of Marketing, School of Business (SB-DNF), Hamden, CT, 06518-1949, United States, abhik.roy@quinnipiac.edu
Mary Schramm

We examine the relationship between direct-to-consumer advertising (DTCA), and interdependent pricing among firms marketing competing drugs to patients within the same therapeutic area. We propose that DTCA is a coordinating mechanism, where a firm signals its willingness to be a Stackelberg price leader by spending heavily on advertising promoting the drug formulation, not just its own brand within the category. Propositions are developed about the impact of ad effectiveness, ad spending and substitutability on the occurrence of a Stackelberg system. Evidence to support these propositions is provided through empirical analysis of data from a number of prescription drug categories.

4 - A Dominant Retailer's Strategic Response To More Efficient Weak Retailer

Ehsan Bolandifar, Assistant Professor, Chinese University of Hong Kong, 9/F, Cheng Yu Tung Buliding, No., 12, Chak Cheung Street, Shatin, N.T., Hong Kong, 999077, Hong Kong, ehsan@baf.cuhk.edu.hk, Zhong Chen, Fuqiang Zhang

We construct a multi-stage model to study the strategic interaction between national brand manufacturer, a dominant and weak retailers. We show that more efficiency on the weak retailer's end makes the dominant retailer reduce its joint advertisement level for the national brand and offers lower market prices, while it also receives a discount form the national brand manufacturer. We also show that manufacturer does not always benefit from improvement in its operational efficiency of its retailers. Similarly, dominant retailer does not always benefit from cheaper store brand procurement costs.

5 - Direct Sales, Agent Selling or Reselling? Firms' Channel Structure With Consumers' Channel Preference

Libo Sun, PhD Student, University of Science and Technology of China, 96# Jinzhai Road, Hefei, Anhui, PR China, Hefei, 230026, China, libosun@mail.ustc.edu.cn, Yugang Yu

Numerous firms exert themselves to adopt multiple channels to sell products. However, even when facing identical products, consumers' choices among these channels could be diverse due to channel preference. We use a stylized theoretical model to answer two key questions faced by a monopoly manufacturer: (1) how does consumers channel preference (CCP) affect its channel structure, namely, when should the manufacturer choose a sin-gle-channel and when should it adopt a dual-channel instead? Furthermore, should the manufacturer choose an independent reseller or an agent platform when it intends to leverage external force? We respectively derive the manufacturer's optimal channel deci-sions when consumers show positive and negative CCP to the manufacturer's direct channel. We find that: (1) compared with centralized case, the manufacturer prefers to adopt dual-channel in a larger area in decentralized case; (2) the manufacturer will choose a dual-channel either when consumers' CCP to direct channel is positive or negative enough; (3) the exact forms of dual channel depends on the thresholds of the agent fee charged by the platform.

■ MA94

5th Avenue Lobby-MCC

Technology Tutorial: MathWorks/Artelys

Technology Tutorial

1 - MathWorks: Data Analytics With MATLAB

Mary Fenelon, MathWorks, Natick, MA, United States, mary.fenelon@mathworks.com

MATLAB has evolved to become a platform for predictive and prescriptive analytics. Engineering, Finance, Data Science, and IT teams are using MATLAB to build today's advanced analytics systems ranging from risk analysis to predictive maintenance and telematics to advanced driver assistance systems and sensor analytics. Join us to see how MATLAB can help you: • Access, explore, and analyze data stored in files, on the web, and from data warehouses • Clean, explore, visualize, and combine complex multivariate data sets • Prototype, test, and refine predictive models using machine learning methods • Build and solve prescriptive models and analyze results • Share your results with others We'll highlight our newest features for Big Data, machine learning, deep learning, and optimization through examples such as load forecasting, Monte Carlo simulation, predictive maintenance, and embedded sensor analytics.

2 - Artelys: Solving Large Least-Squares Models With The Artelys Knitro Nonlinear Optimization Solver

Richard Waltz, Artelys, 150 N Michigan Avenue, Suite 800, Chicago, IL, 60601, United States, Richard.waltz@artelys.com

Artelys Knitro is the premier solver for nonlinear optimization problems. This software demonstration will highlight the latest Knitro developments, including a new specialized API, as well as enhanced algorithms, for large-scale nonlinear least-squares models. We will demonstrate how to solve least-squares models using Knitro through a variety of interfaces such as R, MATLAB and C/C++, and also provide some benchmarking results. In addition, we will summarize some of the other recent developments in Knitro.

Monday, 10:00AM - 10:50AM

■ Monday Plenary

Davidson Ballroom-MCC

Philip McCord Morse Lecture: Margaret L. Brandeau

Plenary Session

Chair: Mike Magazine, University of Cincinnati, Cincinnati, OH 45221-0130, mike.magazine@uc.edu

1 - Public Health Preparedness: Answering (Largely Unanswerable) Questions With Operations Research

Margaret Brandeau, Stanford University, Stanford, CA, United States, brandeau@stanford.edu

Public health security - achieved by effectively preventing, detecting, and responding to events that affect public health such as bioterrorism, disasters, and naturally occurring disease outbreaks - is a key aspect of national security. However, effective public health preparedness depends on answering largely unanswerable questions. For example: What is the chance of a bioterror attack in the United States in the next five years? What is the chance of an anthrax attack? What might be the location and magnitude of such an attack? This talk describes how OR-based analyses can provide insight into complex public health preparedness planning problems - and thus support good decisions.

Monday, 11:00AM - 12:30PM

■ MB01

101A-MCC

Data Mining Under Uncertainty

Sponsored: Data Mining

Sponsored Session

Chair: Erhun Kundakcioglu, Ozyegin University, Nisantepe District Orman Street / Cekmekoy, Istanbul, 34794, Turkey, erhun.kundakcioglu@ozyegin.edu.tr

1 - Approximation Algorithms For Solving Large-scale Classification Problems

Neng Fan, University of Arizona, nfan@email.arizona.edu

To deal the classification of data with uncertainties, the distributionally robust optimization models are proposed for the support vector machines. First the problems are reformulated as semidefinite programs or second order cone programs. To solve these problems on large-scale data sets, we design a stochastic subgradient algorithm. The numerical experiments will be presented to show the efficiency of our algorithms.

2 - Margin Maximization Via Benders Decomposition To Solve Multiple Instance Learning Problems

Emel Seyma Kucukasci, Istanbul Commerce University, Istanbul, 34840, Turkey, eskucukasci@ticaret.edu.tr
Emel Seyma Kucukasci, Bogazici University, Istanbul, 34342, Turkey, eskucukasci@ticaret.edu.tr, Mustafa Gokce Baydogan

Multiple instance learning (MIL) aims to solve classification problem where bags of instances form the input data. Margin maximization model of MIL classification is a MINLP problem. We develop a Benders decomposition algorithm for MINLP solution to deal with large datasets. A hybrid approach combining Benders decomposition and bagging procedure is proposed to test the generalizability of the results. Computational results on publicly-available molecular activity prediction, image annotation and text classification datasets are also provided.

3 - Response Modeling With Semi-supervised Support Vector Regression

Dongil Kim, Korea Institute of Industrial Technology, 89 Yangdaegiro-gil, Ipjang-myeon, Seobuk-gu, Cheonan, Korea, Republic of, dikim01@kitech.re.kr, Sungzoon Cho

Two-stage response model has been proposed to maximize a profit of a marketing campaign by estimating the purchase amount of customers. In this paper, we propose a response modeling with Semi-Supervised Support Vector Regression (SS-SVR). In SS-SVR, label distributions of unlabeled data are estimated to consider label uncertainty. Then, training data are generated by oversampling from the unlabeled data and their estimated label distributions. Finally, a data selection algorithm is employed to reduce the training complexity. The experimental results conducted on a real-world marketing dataset showed that the proposed method improved the model accuracy and expected profit, efficiently.

4 - Support Vector Linear Regression With Multiple Instance Data

Ihsan Yanikoglu, Ozyegin University, Istanbul, Turkey, ihsan.yanikoglu@ozyegin.edu.tr, Erhun Kundakcioglu

We present a Support Vector Regression (SVR) framework for multiple instance (MI) data, which consists of bags of pattern vectors instead of individual instances. This setting has interesting applications such as image annotation, drug activity prediction, and causal inference over time. We provide formulations for MI regression, prove the problem is NP-hard, propose and compare efficient heuristics for the problem.

■ MB02

101B-MCC

Data Mining in Healthcare

Sponsored: Data Mining

Sponsored Session

Chair: Ramin Moghaddass, University of Miami, 1251 Memorial Drive, MEB 308, Coral Gables, FL, 33146-0630, United States, ramin@miami.edu

1 - A Simple And Direct Projection Approach To Handling Covariate Shift

Fulton Wang, MIT, fultonw@mit.edu

Covariate shift is commonplace in the healthcare setting - the training population, for which labelled data is available, often differs in covariate distribution from the test population, for which predictions must be made. Covariate shift can lower test prediction accuracy even if the relation of covariates to outcomes is the same in both populations. While past methods have searched for a subspace in which the covariates of the two populations are similar, we instead propose a method that directly finds a subspace with which high test prediction accuracy can be achieved.

2 - Optimized Risk Scores In Healthcare Applications

Berk Ustun, MIT, ustunb@mit.edu, Cynthia Rudin

Risk scores are simple models that let users quickly assess risk by adding, subtracting, and multiplying a few small numbers. These models are widely used in healthcare, but difficult to create because they need to be risk-calibrated, use small integer coefficients, and obey operational constraints. We present a new approach to fit risk scores by solving a discrete optimization problem. We formulate the risk score problem as a MINLP, and present a cutting-plane algorithm to recover its optimal solution by solving a MIP. We use our approach to build optimized risk scores for two healthcare applications: (i) seizure prediction in the ICU; (ii) ADHD screening.

3 - Making Impact Through Identifying Impactable Members

Margrét Bjarnadóttir, University of Maryland, margret@rhsmith.umd.edu

A large body of research focuses on identifying patients at risk, for example for hospital readmission, appointment no-shows and declining health. However in many cases interventions to avoid adverse outcomes prove unsuccessful as patients may not be impactable, due to health status and/or the social environment. We introduce the concept of jumpers: patients at risk of adverse outcomes but who go undetected by traditional case management. We discuss the application of data mining methods to identify these members in two different settings: Diabetes management and Medicaid ED use management.

■ MB03

101C-MCC

Daniel H. Wagner Prize Competition II

Invited: Daniel H. Wagner Prize Competition

Invited Session

Chair: C. Allen Butler, Daniel H Wagner Associates, Inc., 2 Eaton Street, Hampton, VA, 23669, United States, Allen.Butler@va.wagner.com

1 - Data-driven Optimization For Multi-disciplinary Staffing In Mayo Clinic Improves Patient Experience

Mutafa Y. Sir, Mayo Clinic, 200 First Street SW, Rochester, MN, 55905, United States, sir.mustafa@mayo.edu, David M Nestler, Thomas R. Hellmich, Devashish Das, Micheal J Laughlin, Michon Dohlman, Kalyan Pasupathy

Emergency Department (ED) patient volumes fluctuate throughout the day leading to delays. Therefore, it is critical to match the staff capacity to the patient demand. A data-driven approach applied regression trees to system-generated data to produce an ideal patient volume representing ED load under optimal staffing conditions. The ideal patient volume was then used to optimize multi-disciplinary staffing levels. The new shift design significantly improved several patient-centered metrics.

2 - Optimizing New Vehicle Inventory At General Motors

Robert Inman, General Motors, 30500 Mound Road, Warren, MI, 48092, United States, robert.inman@gm.com, Michael Frick, Thomas Hitchman, Robert Muiter, Jonathan Owen, Gerald Takasaki

Getting inventory right enables GM to meet customer demand more efficiently. Optimizing new vehicle inventory has two dimensions: determining how many vehicles, and determining which vehicle configurations. Knowing the best aggregate number of vehicles helps manage production and pricing. Knowing the best mix of vehicles helps dealer ordering. Instead of finding “how many” to provide a given fill rate, we find the inventory that maximizes aggregate variable profit. Instead of determining “which vehicles” by simply ranking vehicle configurations by sales, we apply a practical set-covering approach to span customer demand.

■ MB04

101D-MCC

Topics in Power Generation Scheduling

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Yongpei Guan, University of Florida, 303 Weil Hall, Gainesville, FL, 32611, United States, guan@ise.ufl.edu

1 - Stochastic Scheduling For Large Scale Wind Integrated Power Systems

Lixin Tang, The Institute of Industrial Engineering and Logistics Optimization, Northeastern University, Insititue of Industrial Engineering and, Logistics Optimization, Northeastern, Shenyang, 110004, China, lixintang@mail.neu.edu.cn, Jin Lang

We propose a stochastic optimization problem which takes into account the volatility of large scale wind power integrated power systems. A scenario generation method which contains the information of forecast error distribution and fluctuation distribution for short-term wind power is proposed. The problem is formulated as a MINLP model. A Lagrangian relaxation algorithm is developed to solve the model.

2 - A Decomposition Approach For Hydropower Operation And Maintenance Scheduling

Miguel F. Anjos, Professor and Canada Research Chair, GERAD & Polytechnique Montreal, Montreal, QC, Canada, miguel-f.anjos@polymtl.ca, Jesus A. Rodriguez, Pascal Côté, Charles Audet

The generator maintenance scheduling problem is of great importance for power generation companies not only to prevent costly generator breakdowns, but also because of the impact of planned outages on the system operation. In hydroelectricity generation, the solution of this scheduling problem is complicated by uncertain water inflows, non-linear relationships between physical variables, and multiple interdependencies in space and time. Since the simultaneous solution of the hydro maintenance and operation problem is hard to achieve, we propose a linearized formulation and a decomposition approach for this problem. This work is based on the real case of Rio Tinto Aluminium in Canada.

3 - A Polyhedral Study Of The Integrated Minimum-up/-down Time And Ramping Polytope

Yongpei Guan, University of Florida, Gainesville, FL, United States, guan@ise.ufl.edu, Kai Pan

We study the polyhedral structure of an integrated minimum-up/-down time and ramping polytope, which has broad applications in variant industries. By exploring its structures, we derive strong valid inequalities and explore a new proof technique to prove these inequalities are sufficient to describe variant two-period and three-period convex hulls. For multi-period cases, we derive generalized facet-defining strong valid inequalities with efficient polynomial time separation algorithms to improve the computational efficiency. Extensive computational experiments are conducted to verify the effectiveness of our strong valid inequalities.

4 - Integrated Expansion Planning Framework For Interconnected Power Systems; Heat Supply; And Gas Infrastructure

Yasaman Mozafari, University of Calgary, Calgary, AB, Canada, y.mozafari@ucalgary.ca, William Rosehart

Increasing gas-fired generation capacity and interest in highly efficient combined heat and power generation units (CHPs) in power systems imply interdependencies between electricity, heat, and gas infrastructure. More efficient expansion planning results can be obtained by effectively modeling these couplings in the planning optimization problem. In this work, a comprehensive integrated framework for expansion planning of power systems, heat supply, and gas infrastructure is proposed. Modeling the independencies substantially reduces the cost and GHG emissions incurred in energy sector, which is illustrated through the simulation results for Alberta energy system.

■ MB05

101E-MCC

2016 INFORMS BOM Section Best Working Paper Awards

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Stephen Leider, University of Michigan, Ann Arbor, MI, leider@umich.edu

1 - A Behavioral Study On Abandonment Decisions In Multi-Stage Projects

Javad Nasiry, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, nasiry@ust.hk, Xiaoyang Long, Yaozhong Wu, Yaozhong Wu

We experimentally investigate continuation/abandonment decisions in a multi-stage project under two conditions: when the project is reviewed at every stage and when review opportunities are limited. We find systematic deviations from the optimal solution: subjects may wrongly continue or abandon the project, and their decisions are path dependent. We propose a behavioral model which explains the behavioral regularities.

2 - Ideation-Execution Transition In Product Development

Evgeny Kagan, University of Michigan, Ann Arbor, MI, kagan@umich.edu, Stephen Leider, William Lovejoy

We show experimentally that design performance is significantly worse when designers decide for themselves how to schedule the development process. We demonstrate several remedies for situations when external allocation of time to development phases is not possible. Managers can improve performance by “nudging” individuals towards early physical build, or by requiring them to commit to a transition time beforehand. However, the most effective way to improve performance is contingent transition - a requirement to present a prototype that exceeds a minimum performance hurdle.

3 - Impact of Queue Configuration On Service Time: Evidence From A Supermarket

Yong-Pin Zhou, University of Washington, Seattle, WA, yongpin@uw.edu, Jingqi Wang

We study how queue configuration affects server’s service time using data from a supermarket. We find that servers in dedicated queues are about 10.7% faster than those in pooled queues, after controlling for the queue length, mainly due to a direct social loafing effect. We also demonstrate that pooling has an indirect negative effect on the service time through its impact on the queue length. In aggregation, the social loafing effect dominates and servers slow down (a 6.86% increase in service time) in pooled queues.

■ MB06

102A-MCC

Data Mining in Text Analytics

Sponsored: Data Mining

Sponsored Session

Chair: Onur Seref, Virginia Tech, Pamplin 1007, Blacksburg, VA, 24061, United States, seref@vt.edu

1 - Tracking The Evolution Of User Interests In Online Communities

Theodoros Lappas, Stevens University of Technology, tlappas@stevens.edu

Online communities are the hubs of our virtual world. A community is typically focused on a broad area, such as sports or politics. Interested users participate in the community by joining discussion threads on relevant topics within the scope of the general theme. In this work, we hypothesize that a user’s level of interest in each topic is correlated with her maturity within the community. We evaluate our hypothesis on datasets from different domains and present a temporal user-interest model. Our study provides insight on the nature of user generated content and has strong implications for any application based on user interests.

2 - A Network-based Model For Conversation Decomposition In Text Mining

Sukhwa Hong, Virginia Tech, Blacksburg VA, United States, sukhwa@vt.edu, Onur Seref, Michelle Seref, Alan Abrahams

We present a network-based framework to identify and cluster conversational phrases in classes of text data using prevalence scores of n-gram structures and their connections. Our framework extends the “bag-of-words” models by network-based clustering methods to create sub-graphs of connected n-grams. The paths in these sub-graphs represent sequences of words, which form conversational phrases with richer contextual meaning. We use sequence alignment methods to identify variations of these phrases and apply the proposed framework to study a collection of discussion posts from the automotive industry. We compare effectiveness of our method to standard “bag-of-words” models such as LDA.

3 - Two Are Better Than One? An Empirical Study On Crowd Performance For Stock Prediction

Hong Hong, Xiamen University, Xiamen, China, hongh@vt.edu Qianzhou Du, Alan G. Wang, Weiguo Fan, Di Xu

Online investment communities have been a popular venue for individual investors to share and interact with each other. Prior research confirms the importance of crowd wisdom in the stock markets context, but fails to investigate the impact of crowd characteristics on crowd performance. Guided by the Crowd Wisdom theory, we conduct an empirical study using data collected from Stocktwits to fill this research gap. Our findings show that diversity, independence, and decentralization are positively related to crowd performance. In addition, crowd size significantly moderates the influence of crowd characteristics on crowd performance. This study has both theoretical and practical implications.

4 - An Intelligent Multilayer Hotel Recommender System

Ashkan Ebadi, University of Florida, Gainesville, FL, United States, ashkan.ebadi@ufl.edu, Adam Krzyzak

Techniques behind the recommender systems have been improved over the time. Recommenders help users to find their required products or services through analysing and aggregating other users’ activities and behaviour. In this paper, we propose an accurate multi-layer hybrid hotel recommender system that uses multi-aspect rating. We used large-scale data of different types and designed a system that is able to suggest hotels which are tailored to the given user. The system employs natural language processing and topic modelling techniques to assess sentiment of users’ reviews. The recommender engine contains several sub-systems where each sub-system contributes to the final recommendations.

■ MB07

102B-MCC

New Product Development

Invited: New Product Development

Invited Session

Chair: Jeremy Kovach, TCU, Fort Worth, TX, 76109, United States, j.j.kovach@tcu.edu

1 - An Economic Model Of Knowledge Outsourcing

Jaeseok Lee, Georgia Institute of Technology, 710 Peachtree St. NE, Apt. 312, Atlanta, GA, 30308, United States, jaeseok.lee@scheller.gatech.edu, Cheryl Gaimon, Karthik Ramachandran

We introduce a game-theoretic model of knowledge outsourcing. We study how the interaction between a knowledge buyer and supplier is affected by two distinctive aspects of knowledge outsourcing: absorptive capacity and the ability to leverage prior knowledge. We also investigate how uncertainty and information asymmetry influence the equilibrium outcomes.

2 - Effect Of Incentive Design On Location Decision Of Collaborative Product Development Teams

Sara Rezaee Vessal, HEC Paris, sara.rezaee-vessal@hec.edu Svenja C Sommer

To successfully compete on an international scale, multinationals increasingly turn towards globally dispersed product development teams, both to draw on a diverse set of expertise and to access moreaccurate local market knowledge. However, dispersion also creates additional challenges for collaboration, which can have negative effects on project performance. In this study, we compare dispersed and co-located teams and address the question how to incentivise them. We show that despite the current trend among firms, geographically dispersed teams are not always the optimal structure, especially when collaboration is in the form of information sharing.

3 - Optimal Price And Customization Of A Conspicuous Product

Cheryl Druehl, George Mason University, cdruehl@gmu.edu, Jesse Bockstedt

Technology has reduced the cost of mass customization, while the availability of design tools has allowed users to easily customize products. The mass customization of conspicuous goods, where utility rises from displaying the product to others, allows consumers to create uniqueness and exclusivity. The firm trades-off the cost vs the demand-enhancing impact of customization. Customers trade-off the cost to customize vs a good that better fits their preferences and their desire for exclusivity. The firm considers: How much customization to have at a given additional marginal cost? What should prices be for the standard and custom goods? Is a monopolist better off with both product offerings?

4 - Modeling Product Demand Using Customer Review Data

Hallie Cho, INSEAD, hallie.cho@insead.edu, Sameer Hasija, Manuel Sosa

Review sites have become a popular destination for consumers seeking product information such as general consensus about a product’s quality or tales of other’s first hand experience with a product. These online reviews suffer from personal bias, which makes them unreliable for potential buyers. However, this collection of personal biases can be of interest to manufacturers since reviews often highlight consumers’ preferences and perceptions of product quality. We explore in what ways these customer reviews are useful for manufacturers using data from the U.S. automobile industry.

■ MB08

103A-MCC

Empirical Research in Operations and Service Innovation

Invited: Business Model Innovation

Invited Session

Chair: Jose A Guajardo, University of California - Berkeley, Berkeley, CA, United States, jguajardo@berkeley.edu

1 - Corporate Responsibility Or Greenwashing? An Empirical Analysis Of The Social Impact Of Corporate Social Responsibility Activities

Jun Li, Ross School of Business, University of Michigan, junwli@umich.edu, Andrew Wu

Corporate Social Responsibility (CSR) activities have been increasingly criticized by the public as greenwashing as they fail to deliver the intended social impacts. While most existing research on CSR focus on its link to profitability, little research studies the social impact of CSR. In this paper, we leverage a large-scale dataset collected during the last 9 years to examine the social impact of CSR efforts worldwide, and how voluntary vs. mandatary CSR reporting impacts the effectiveness of CSR.

2 - Surfacing The Submerged State: Operational Transparency Increases Trust In And Engagement With Government Services

Ryan Buell, Harvard Business School, rbuell@hbs.edu Ethan Porter, Michael Norton

As Americans’ trust in government nears historic lows, frustration with government performance approaches record highs. We propose that Americans’ views of government can be reshaped by increasing government’s operational transparency - that is, the extent to which citizens can see the often-hidden work that government performs. Across three studies using laboratory and field data, we provide converging evidence that increasing operational transparency can improve citizens’ views of and increase and sustain their engagement with government.

3 - Mobile Technology In Retail

Jose A Guajardo, University of California-Berkeley, jguajardo@berkeley.edu

We empirically analyze central aspects of the impact of mobile technology in retail in the context of the overall customer shopping experience.

4 - Ration Gaming And The Bullwhip Effect: A Structural Econometric Study

Rob Bray, Kellogg, robertlbray@gmail.com

We develop a dynamic discrete choice estimator of (s, S) inventory models. We apply this estimator to a 5,320-SKU, 1,371-day sample from a Chinese supermarket to quantify the effect of ration gaming.

■ MB09

103B-MCC

Development of Electricity Systems

Invited: Energy Systems Management

Invited Session

Chair: Todd Levin, Argonne National Laboratory, 970 S. Cass Avenue, Lemont, IL, 60439, United States, tlevin@anl.gov

1 - Capacity Expansion Planning With Intermittent Energy Resources

Dong Gu Choi, Pohang University of Science and Technology (POSTECH), Pohang, Korea, Republic of, dgchoi@postech.ac.kr, Daiki Min, Jonghyun Ryu

Recently, renewable energy resources have been rapidly integrated into the electricity sector around the world and some recent studies about the capacity expansion planning for electric power system integrating renewable energies have been published. However, the most of these studies did not explicitly interpret the impact of the intermittency and non-dispatchability of some renewable energies on the system reliability. In this study, we propose a stochastic programming model to establish the long-term electricity capacity expansion planning for an electric power system integrating large size intermittent renewable energies with the consideration of the system reliability.

2 - Optimal Capacity Planning In Non-Interconnected Regions: Case Of Saudi Arabia

Bandar Alqahtani, Duke University, 9 Circuit drive, Box 90328, Durham, NC, 27514, United States, dalia.patino@duke.edu, Dalia Patino Echeverri

We conduct a techno-economic and environmental evaluation of the electricity generation options available to supply residential and commercial loads in remote areas in Saudi Arabia, over the next 25 years. A capacity planning model considers and compares the alternatives of developing distributed electricity generation versus the option of building a transmission interconnection to the national grid, operated by the Saudi Electricity Company.

3 - Examining Life Cycle Environmental Impacts Of Energy Storage For Power System Reserves

Jeremiah Johnson, University of Michigan, Ann Arbor, MI, United States, jxjohns@umich.edu, Yashen Lin, Noah Mitchell-Ward, Johanna Mathieu

Due to their speed of response and accuracy, energy storage systems may be a preferable alternative to conventional generation in providing power system reserves. We calculate the environmental impacts using lithium ion batteries for this ancillary service application using a life cycle assessment (LCA) framework, while solving an optimal power flow (OPF) problem under a series of grid configurations. Through this OPF-LCA integration, we demonstrate that (1) the impacts of materials and manufacturing are typically far smaller than use phase impacts and (2) there are many system configurations that yield a net increase in life cycle emissions when using energy storage for power system reserves.

4 - Demand Response Resource Quantification With Detailed Building Energy Models

Elaine Thompson Hale, Senior Engineer, National Renewable Energy Laboratory, Golden, CO, United States, elaine.hale@nrel.gov, Henry Horsey, Noel Merket, Brady Stoll, Ambarish Nag

Demand response is a broad suite of technologies that enables operational changes in electrical load in support of power system reliability and efficiency. Although demand response is not a new concept, there is new appetite for comprehensively evaluating its technical potential in the context of renewable energy integration. The complexity of demand response makes this task difficult—we present new methods for capturing the heterogeneity of potential responses from buildings, their time-varying nature, and metrics such as thermal comfort that help quantify likely acceptability of specific demand response actions. Computed with an automated software framework, the methods are scalable.

■ MB10

103C-MCC

Energy Models: Diversity and Complementarity

Sponsored: Energy, Natural Res & the Environment, Energy II Other Sponsored Session

Chair: Denis Lavigne, Royal Military College St-Jean, St-Jean-sur-Richelie, QC, Canada, denis.lavigne@cmrsj-rmcsj.ca

1 - OSeMOSYS And LEAP Energy Modeling Using an Extended UTOPIA Model

Denis Lavigne, Professor, Royal Military College St-Jean, C.P. 100, succ. Bureau-chef, Richelain, QC, J0J 1R0, Canada, denis.lavigne@cmrsj-rmcsj.ca

Energy Models have been used extensively for decades. Leaders and decision makers need to have a basic understanding of such tools to gain insight on the existing (and future) energy systems and their different components. OSeMOSYS (optimization) and LEAP (simulation) offer a package with a smooth learning curve, allowing non-experts and low-budget organizations the possibility to use powerful yet simple software to make coherent analyses. An extended version of OSeMOSYS' UTOPIA model will be presented as a study example that can easily be performed and a link with LEAP will be proposed.

2 - Complementarity Modeling Of Electricity And Renewable Energy Credit Markets To Inform Effective Renewable Energy Policy Formation

Kristen R. Schell, Postdoctoral Fellow, University of Michigan, Ann Arbor, MI, United States, krschell@umich.edu
Joao Claro, Manuel Loureiro

To date, 84% of the world's countries have instituted a renewable energy target, or Renewable Portfolio Standard (RPS). Despite this global prevalence, policy design and target implementation varies widely. This study combines complementarity modeling of the electricity and renewable energy credit markets with generation expansion planning to meet an RPS, to assess the impacts different RPS policy designs have on social welfare, renewable energy investment, electricity prices and greenhouse gas emissions. The policy recommendations move toward optimal policy design to minimize externalities.

3 - The Application Of Promethee With Prospect Theory - opportunities And Challenges The Application Of Promethee With Prospect Theory In The Context Of Energy Sector Management

Jutta Geldermann, Prof. Dr., Georg-August-University Goettingen, Platz der Goettinger Sieben 2, Goettingen, 37073, Germany, jgelder@gwdg.de, Katharina Stahlecker, Nils Lerche

The incorporation of elements from Prospect Theory into PROMETHEE enables the decision maker to integrate reference dependency as well as to express loss aversion. To illustrate occurring opportunities and challenges of the developed approach, the results of an application concerning the identification of a sustainable bioenergy concept as well as the feedback from decision makers are presented. Additionally, potential approaches concerning a corresponding sensitivity analysis and the consideration of risk or uncertainty are discussed. Furthermore, the applicability of the developed approach for long-term decision support in energy systems analysis will be discussed.

4 - Multi-stage Investment Decisions In Renewable Generating Capacity: Comparison Of Different Approaches

Maria Ruth Dominguez Martin, PhD, University of Castilla - La Mancha, Avenida Carlos III, s/n, Toledo, 45071, Spain, Ruth.Dominguez@uclm.es, Miguel Carrion, Antonio J. Conejo

Renewable generating capacity needs to be significantly increased in power systems if the effects of global warming are to be mitigated. Moreover, due to the high uncertainty involved in long-term planning exercises, investment decisions are usually made in several stages as uncertainty unfolds over time. In this work we propose a multi-stage stochastic-programming investment model in renewable generating capacity, and apply different approaches to solve it. Specifically, we solve the proposed problem using stochastic programming under both multi-stage and rolling window frameworks, and linear decision rules, and compare the results with the deterministic approach.

■ MB11

104A-MCC

Network Optimization Models and Applications II

Sponsored: Optimization, Network Optimization Sponsored Session

Chair: Jose Luis Walteros, University at Buffalo, SUNY, 413 Bell Hall, Buffalo, NY, 14213, United States, josewalt@buffalo.edu

1 - Integer Programming Models For Bipartitioning A Graph Enforcing Structure Constraints

Chrysafis Vogiatzis, North Dakota State University, chrysafis.vogiatzis@ndsu.edu

In this talk, we consider the problem of partitioning a graph into two distinct subgraphs, where one of the subgraphs satisfies a structural property. In literature, it is common to bipartition a graph using a normalized cut criterion; this well-studied problem leads to the creation of two similarly weighted subgraphs. There exist cases though, when one of the partitions needs to possess a certain structure or "motif". We investigate some structures, and propose ways to formulate and solve the problem. Computational results are also presented.

2 - Computing The Maximum Lifetime Flow Of A Network With Short Node Lifetimes

Hugh Medal, Mississippi State University, hugh.medal@msstate.edu

We study an extension of the maximum flow problem in which nodes have a limited amount of energy available and energy is consumed when the node sends or receives flow. The objective is to maximize the total s-t flow over the lifetime of the network, i.e., until node energy depletions result in a cutset. We present a polynomial-time algorithm as well as computational results.

3 - A Stochastic Programming Approach For Selecting Inland Waterway Maintenance Projects

Khatereh Ahadi, University of Arkansas, Fayetteville, AR, United States, kahadi@uark.edu, Kelly Sullivan

We consider the problem of selecting a budget-limited subset of maintenance actions to maximize the expected tonnage of commodities that can be transported through the system. Our model incorporates uncertainty due to shoaling and unpredictable water conditions. Due to the maritime transportation network's size, along with the variety of commodities transported via waterway, the maintenance project selection problem is large and complex, and small gains in efficiency can have a significant economic impact. We model this problem as a stochastic programming model, develop solution approaches, and analyze computational results.

4 - Convoy Formation Process

Azar Sadeghnejad Barkousaraie, University at Buffalo (SUNY), Buffalo, NY, United States, azarsade@buffalo.edu, Rajan Batta, Moises Sudit

A motor convoy may consist of hundreds of vehicles organized together for the purpose of control and secure movement. Besides specific constraints of convoy routing, length of a convoy, as a single transportation unit, shall not be neglected, which differentiates it from other transportation problems. Convoy formation process addresses an essential decision on how to constitute convoys and plan their movements on limited number of routes. The purpose of this research is to show the effect of convoy length on its movement and how it can be manipulated to better satisfy specific constraints of convoy movement problem.

■ MB12

104B-MCC

Joint Session APS/Optimization: Advances in Causal Inference Using Optimization

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Nathan Kallus, Cornell University and Cornell Tech, 111 8th Avenue #302, New York, NY, 10011, United States, kallus@cornell.edu

Co-Chair: Juan Pablo Vielma, Massachusetts Institute of Technology, Cambridge, MA, United States, jvielma@mit.edu

Co-Chair: Jose R. Zubizarreta, Columbia University, New York, NY, United States, zubizarreta@columbia.edu

1 - Multivariate Matching Methods For Causal Inference That Are Balance-variance Pareto Optimal And Optimal Kernel Matching

Nathan Kallus, Assistant Professor, Cornell University and Cornell Tech, 111 8th Avenue #302, New York, NY, 10011, United States, kallus@cornell.edu

We present minimax and Bayesian optimality criteria for non-parametric matching for causal inference. These lead to extensions of existing methods, including nearest-neighbor (Cochran 1953) and coarsened exact matching (Iacus et al. 2011), that optimally and automatically adjust balance vis-à-vis matched sample variance. We develop a new optimal matching method we call optimal kernel matching (OKM), whose superiority we demonstrate theoretically (optimal rates) and empirically (with real data). We connect our theory to equal percent bias reduction (Rubin 1976), which we generalize to non-linear response functions, showing OKM can achieve uniform error reduction in non-linear settings.

2 - Large-scale Optimal Matching For Design-based Inference Using Integer Programming

Jose R. Zubizarreta, Columbia, New York, NY, United States, zubizarreta@columbia.edu, Juan Pablo Vielma

In observational studies in business research and empirical operations management, matching methods are often used to approximate the ideal study that would be conducted if it were possible to do it by controlled experimentation. In this paper, we present an alternative approach to matching using integer programming, discuss its theoretical properties, and illustrate its performance in real-world data sets.

3 - Leveraging Multiple Outcomes In Matched Observational Studies

Colin Fogarty, Massachusetts Institute of Technology, Cambridge, MA, United States, colin.b.fogarty@gmail.com

We demonstrate that when performing multiple comparisons in an observational study, the loss in power from controlling the familywise error rate can, through the solution of a quadratically constrained linear program, be attenuated when assessing the robustness of the study's findings to unmeasured confounding. We show that this allows for uniform improvements in the power of a sensitivity analysis both for the overall null across outcomes and for outcome-specific null hypotheses when compared to combining individual sensitivity analyses. We illustrate our method through an example examining the impact of smoking on naphthalene levels in the body.

■ MB13

104C-MCC

Uncertain Linear Optimization

Sponsored: Optimization, Global Optimization

Sponsored Session

Chair: Jiming Peng, associate professor, University of Houston, 4800 Calhoun Road, Houston, TX, 77204, United States, jopeng@uh.edu

1 - Assessing Systemic Risk In Financial Market Under Uncertain Liabilities

Jiming Peng, University of Houston, jopeng@uh.edu

We consider the linear optimization model for assessing the systemic risk in a financial network where only partial information on the coefficient data matrix in available. We develop iterative procedures to identify the worst-case and the best-case. Our theoretical analysis and numerical experiments illustrate that the potential risk caused by the failure of a single bank in the network is much more severe than what's have been estimated in the literature.

2 - Vulnerability Analysis Of Financial Networks

Aein Khabazian, University of Houston, aeinkhabazian@gmail.com Jiming Peng

In this paper, we analyze the vulnerability of a financial network based on the linear optimization model introduced by Eisenberg and Noe (2001), where the right hand side of the constraints is subject to market shock and only partial information regarding the liability matrix is revealed. We conduct a new sensitivity analysis to characterize the conditions under which a single bank is solvent, default or bankrupted, and estimate the probability that some financial institute in the network will be bankrupted under mild assumptions on the market shock and the network structure. We also present some numerical experiments to verify the theoretical conclusions in the paper.

3 - A Copositive Perspective On Two-stage Adjustable Robust Linear Programming

Guanglin Xu, University of IOWA, guanglin-xu@uiowa.edu

We consider a two-stage adjustable robust linear optimization problem in which the right-hand side is uncertain and belongs to a convex and compact uncertainty set. We propose a copositive representation for the two-stage problem. We then provide a tractable inner approximation for the copositive program, which leads to a better performance compared to the well-known affine-rule policy. We show the effectiveness of our approach on several numerical examples.

■ MB14

104D-MCC

Data Analytics

Sponsored: Analytics

Sponsored Session

Chair: Harrison Schramm, CANA Advisors, 1, Pacific Grove, CA, 93950, United States, harrison.schramm@gmail.com

1 - Robust Non Parametric Tests To Identify Treatment Effects

Noor E. Alam. M.D., Northeastern University, md.alam@neu.edu

We proposed a number of non-parametric robust testing tools to handle uncertainty in detecting treatment effect from observational studies data. In this work, we present an alternative to the standard non-parametric hypothesis tests by leveraging the power of discrete optimization technique. Its been found that our tests are robust to the choice of experimenter.

2 - Linear Probability Models And Big Data: Prediction, Inference, And Selection Bias

Galit Shmueli, National Tsing Hua University, Hsinchu, Taiwan, galit.shmueli@iss.nthu.edu.tw, Suneel Babu Chatla

Linear probability models (LPM) - linear regression models applied to a binary outcome - are used in various fields. We perform a simulation study to evaluate the pros and cons of LPMs compared to logit and probit, especially with Big Data. We consider common uses of binary outcome models: inference and estimation, prediction and classification, and selection bias. We find that coefficient directions, statistical significance and marginal effects yield results similar to logit and probit. LPM coefficients are consistent up to a multiplicative scalar. For classification and selection bias, LPM is on par with logit/probit in terms of class separation and ranking, but lacking for propensities

3 - Managing Brokers For The Sales Of A Complex New Product

Vahideh Abedi, California State University Fullerton, Fullerton, CA, United States, vabedi@fullerton.edu, Rahul Bhaskar

Firms introducing a new product typically rely on sales efforts of brokers to enhance sales. Customers make their purchase decision not only based on the word of mouth they have received from other customers about the product, but also based on the collective information received from the brokers. Therefore, brokers act synergistically to generate sales while competing. We develop an analytical framework for this sales process and show how it can facilitate important managerial decision making.

■ MB15

104E-MCC

Stochastic and First-order Methods for Data Analysis

Invited: Modeling and Methodologies in Big Data

Invited Session

Chair: Guanghui Lan, Gatech, Atlanta, GA, United States, george.lan@isye.gatech.edu

1 - An Optimal Randomized Incremental Gradient Method

Yi Zhou, Georgia Institute of Technology, yizhou@gatech.edu

We introduce a deterministic primal-dual gradient (PDG) method that can achieve the optimal black-box iteration complexity for solving finite-sum convex optimization problems using a primal-dual termination criterion. We also develop a randomized version (RPDG) method, which needs to compute the gradient of only one randomly selected smooth component at each iteration, but can possibly achieve better complexity than PDG in terms of the total number of gradient evaluations. We also show that the complexity of the RPDG method is not improvable by developing a new lower complexity bound for a general class of randomized methods for solving large-scale finite-sum convex optimization problems.

2 - Decentralized Primal-dual Gradient Method

Soomin Lee, Georgia Institute of Technology, Atlanta, GA, United States, soomin.lee@isye.gatech.edu

We present a decentralized primal-dual gradient method for optimizing a class of finite-sum convex optimization problem whose objective function is given by the summation of m smooth components together with other relatively simple terms. The smooth components are distributed over a network of m agents with time-varying topology, but all agents share common components whose structure is suitable for efficiently computing the proximal operator. In our method, each agent alternatively updates its primal and dual estimates by computing the primal and dual proximal operator, and by communicating these estimates with other agents in the network. We provide convergence results of this method.

3 - Decomposing Linearly Constrained Nonconvex Problems By A Proximal Primal Dual Approach

Mangyi Hong, Iowa State University, mingyi@iastate.edu

We propose a new decomposition approach named the proximal primal dual algorithm (Prox-PDA) for smooth nonconvex linearly constrained optimization problems. We show that whenever the penalty parameter in the augmented Lagrangian is larger than a given threshold, the Prox-PDA converges to the set of stationary solutions, globally and in a sublinear manner. Interestingly, when applying a variant of the Prox-PDA to the problem of distributed nonconvex optimization (over a connected undirected graph), the resulting algorithm coincides with the popular EXTRA algorithm, which is only known to work in convex cases.

■ MB16

105A-MCC

Data-driven and Robust Optimization

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Linwei Xin, U of Illinois at Urbana-Champaign, Urbana, IL, 61801, United States, lxin@illinois.edu

1 - Distributionally Robust Stochastic Optimization With Wasserstein Distance

Rui Gao, Georgia Institute of Technology, rgao32@gatech.edu, Anton J Kleywegt

We consider a distributionally robust stochastic optimization (DRSO) problem, in which the ambiguity set contains all the distributions that are close to the nominal distribution in terms of Wasserstein distance and satisfies certain correlation structure. Comparing to the widely-used -divergence and moment method, Wasserstein distance yields a more reasonable worst-case distribution. We derive a tractable dual reformulation of the DRSO by constructing the worst-case distribution explicitly via the first-order optimality condition.

2 - Robust Extreme Event Analysis

Clementine Mottet, Boston University, cmottet@bu.edu, Henry Lam

We propose a robust optimization approach to estimate extreme event performance measures. This approach aims to alleviate the issue of model misspecification encountered by conventional statistical methods that is amplified by a lack of data typically occurring in the tail region. We demonstrate the use of shape constraints to mitigate this issue and develop a solution scheme for the resulting optimizations. We show some numerical results and compare our approach to extreme value theory.

3 - Data-driven Optimization Of Reward-risk Ratio Measures

Ran Ji, George Mason University, Fairfax, VA, 22030, United States, jiran@gwu.edu, Miguel Lejeune

We study a class of distributionally robust optimization problems with ambiguous expectation constraints on reward-risk ratios. We develop a reformulation and algorithmic framework based on the Wasserstein metric to model ambiguity and to derive probabilistic guarantees that the ambiguity set contains the true probability distribution. The reformulation phase involves the derivation of the support function of the ambiguity set and the concave conjugate of the ratio function. We design bisection algorithms to efficiently solve the reformulation. We specify new ambiguous portfolio optimization models for various ratios. Computational results will be presented.

4 - Two-stage Distributionally Robust Unit Commitment Using Moment Information

Yuanyuan Guo, University of Michigan, yuanyg@umich.edu Ruiwei Jiang

As the renewable energy takes a growing share of the electricity markets, a considerable number of new renewable generators (e.g., wind and solar farms) are incorporated into daily power system operations. Because of fluctuating weather conditions or a lack of complete historical data, it can be challenging to accurately estimate the joint probability distribution of the renewable energy. In this paper, based on a small amount of historical data, we propose a two-stage distributionally robust unit commitment model that considers a set of plausible probability distributions. This model is less conservative than classical robust unit commitment models.

■ MB17

105B-MCC

Risk Measures on Stochastic Programs

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Saravanan Venkatachalam, Wayne State University, 42 W. Warren Ave, Detroit, MI, 48202, United States, saravanan.v@wayne.edu

1 - A Computational Study Of Recent Approaches To Risk-averse Stochastic Optimization

Alexander Vinel, Auburn University, 3301 Shelby Center, Auburn, AL, 36849, United States, alexander.vinel@auburn.edu

We present a computational study evaluating some recent approaches to risk-averse stochastic optimization. We focus on the classes of coherent and convex measures of risk, including higher-moment coherent measures and certainty-equivalent convex measures. While the bigger part of the study is devoted to portfolio optimization model, other problems with real-life data are considered. Our main goal is to evaluate the performance of various recently proposed techniques and determine the properties that can be used in guiding the specific choices of decision criteria in practice.

2 - Risk Parity In The Context Of Risk-averse Stochastic Optimization

Nasrin Mohabbati Kalejahi, PhD Student, Auburn University, Auburn, AL, United States, nasrin@auburn.edu, Alexander Vinel

The concept of risk parity has been recently studied in the area of financial portfolio management. The idea behind it is to promote diversification in the portfolio by ensuring that each asset is equally contributing to the total risk. In this work we propose to consider risk parity in the context of modern risk measure theory, by studying risk parity based on conditional value-at-risk and other coherent measures. We are interested in evaluating the quality of the decisions that arise from this stochastic optimization framework in both financial and engineering applications.

3 - Computational Study For Two-stage Stochastic 0-1 Integer Programs With Absolute Semi Deviation Risk Measure

Saravanan Venkatachalam, Wayne State University, Saravanan.v@wayne.edu, Lewis Ntaimo

We present a methodology for absolute semi-deviation (ASD) risk-measure for stochastic 0-1 programs. ASD risk-measure models lack the typical block structure amenable for decomposition. The proposed methodology uses information from expected excess, and uses cutting planes based on sub-gradient information. Computational results for a supply chain application will be presented.

4 - Decomposition For Multistage Stochastic Programs With Quantile And Deviation Risk Measures

Prasad Parab, PhD Student, Texas A&M University, College Station, TX, United States, prasaddparab@tamu.edu, Lewis Ntaimo

We present decomposition for multistage stochastic linear programs (MSLPs) with quantile and deviation mean-risk measures. Incorporating certain risk measures makes MSLPs very difficult to decompose and solve. In particular, we study stochastic decomposition based algorithms for MSLPs with quantile deviation and absolute semideviation risk measures. A comparative study of the two mean-risk measures will be presented.

■ MB18

106A-MCC

Recent Advances in Theory and Applications of IPCO

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Manish Bansal, Northwestern University, C234 Technological Institute, 2145 Sheridan Road, Evanston, IL, 60202, United States, manish.bansal@northwestern.edu

1 - Decomposition For Loosely Coupled Mixed-integer Programs: A Multiobjective Perspective

Merve Bodur, Georgia Institute of Technology, merve.bodur@gatech.edu, Natashia Boland, Shabbir Ahmed, George L Nemhauser

We consider loosely coupled mixed-integer programs (MIPs), that consist of (possibly a large number of) interrelated subsystems and a small number of constraints, which link blocks of variables that correspond to different subsystems. Motivated by recent developments in multi-objective programming (MOP), we develop a MOP-based branch-and-price algorithm to solve loosely coupled MIPs. We discuss the similarities and differences of our algorithm with the traditional branch-and-price algorithm. Also, we present computational results on instances with knapsack structure in the subsystems.

2 - Maximum Demand Rectangular Location Problem

Manish Bansal, Northwestern University, Evanston, IL, United States, manish.bansal@northwestern.edu, Kiavash Kianfar

We introduce a new generalization of the classical planar maximum coverage location problem by positioning a given number of rectangular service zones (SZs) on the 2-D plane to cover a set of existing (possibly overlapping) rectangular demand zones such that the total covered demand is maximized. We refer to this problem as Maximum Demand Rectangular Location Problem (MDRLP) which also has application in camera-frame selection for telerobotics. We present an improved algorithm for the single-SZ MDRLP, which is at least two times faster than the existing exact algorithm. We then provide theoretical properties for multi-SZ MDRLP and an exact algorithm to solve it along with our computational results.

3 - Cutting Planes fromMultiple-term Disjunctions

Egon Balas, Carnegie Mellon University, eb17@andrew.cmu.edu

(Less than 600 characters excluding spaces): Lift-and-project cuts from split disjunctions have their counterpart as intersection cuts from a (feasible or infeasible) LP tableau, and thus can be generated by pivoting in the latter. This correspondence breaks down in the case of general disjunctions: here the bases of the CGLP and associated L&P cuts can be either regular or irregular. Irregular cuts do not correspond to intersection cuts and cannot be obtained by pivoting in the LP tableau; they tend to be more numerous and stronger than regular cuts. Some irregular L&P cuts can be generated without recourse to a higher dimensional CGLP, as generalized intersection cuts from the disjunction underlying the L&P cut.

■ MB19

106B-MCC

Models and Methods for Large-Scale Mixed-Integer Optimization

Sponsored: Computing

Sponsored Session

Chair: Simge Kucukyavuz, Ohio State University, Ohio State University, Columbus, OH, United States, kucukyavuz.2@osu.edu

1 - Two-stage Stochastic Programming Models Under Multivariate Risk Constraints

Merve Merakli, Ohio State Universtity, Columbus, OH, United States, merakli.1@osu.edu, Simge Kucukyavuz, Nilay Noyan

In this study, we consider multicriteria risk-averse two-stage stochastic programming problems. The aim is to find the best decision for which the associated random outcome vector of interest is preferable to a specified benchmark with respect to the multivariate polyhedral conditional value-at-risk relation. In this case, classical decomposition methods can not be used due to complicating risk constraints. We propose an exact solution algorithm based on Benders decomposition and show its convergence. Computational experiments are performed on a disaster relief network design problem.

2 - Chance-constrained Stochastic Programming Under Variable Reliability Levels With An Application To Humanitarian Relief Network Design

Özgün Elçi, Sabanci University, Istanbul, 34956, Turkey, nnoyan@sabanciuniv.edu, Nilay Noyan, Kerem Bulbul

A recently introduced class of models treats reliability levels associated with chance constraints as decision variables and trades off the actual cost against the cost of the selected reliability levels. Leveraging recent methodological advances for solving chance-constrained linear programs with fixed reliability levels, we develop strong MIP formulations for this new variant with variable reliability levels. In addition, we introduce an alternate cost function type associated with the reliability levels which requires capturing the value-at-risk associated with a variable reliability level. We apply the proposed modeling approach to a new humanitarian relief network design problem.

3 - Bilevel Risk Averse Formulations Of Stochastic Programming Problems

Deniz Eskandani, Rutgers University, 100 Rockafeller Rd, Piscataway, NJ, 08854, United States, deniz.eskandani@rutgers.edu Jonathan Eckstein

We describe a bilevel programming technique to time-consistently formulate 3-stage stochastic programs without using nested risk measures. For some classes of applications, we empirically demonstrate that its behavior can be dramatically different from standard formulations.

4 - Irreducible Infeasible Subsystem Decomposition For Stochastic Integer Programs With Probabilistic Constraints

Lewis Ntaimo, Associate Professor, Texas A&M University, College Station, TX, United States, ntaimo@tamu.edu Bernardo Pagnoncelli

Probabilistically constrained stochastic integer programs (PC-SIPs) are very challenging to solve and linear programming (LP) provides very weak bounds on the optimal value. This work considers a decomposition approach using irreducible infeasible subsystem (IIS) inequalities for strengthening the LP-relaxation of PC-SIPs. Preliminary computational results will be presented.

■ MB20

106C-MCC

Research and Teaching Opportunities in Project Management

Invited: Tutorial

Invited Session

Chair: Nicholas G Hall, Ohio State University, 658 Fisher Hall, 2100 Neil Avenue, Columbus, OH, 43210-1144, United States, hall.33@osu.edu

1 - Research And Teaching Opportunities inProject Management

Nicholas G Hall, Ohio State University, 658 Fisher Hall, 2100 Neil Avenue, Columbus, OH, 43210-1144, United States, hall.33@osu.edu

One-fifth of the world's economic activity, with an annual value of $12 trillion, is organized using the business process of project management. This process has exhibited dramatic growth in business interest in recent years, with a greater than 1000% increase in Project Management Institute membership since 1996. Contributing to this growth are many new applications of project management. These include IT implementations, research and development, software development, corporate change management, and new product and service development. However, the very different characteristics of these modern projects present new challenges. The partial resolution of these challenges within project management practice over the last 20 years defines numerous interesting opportunities for academic researchers. These research opportunities make use of a remarkably broad range of methodologies, including robust optimization, cooperative and noncooperative game theory, nonlinear optimization, predictive analytics, empirical studies, and behavioral modeling. Furthermore, the $4.5 trillion that is annually at risk from a shortage of skilled project managers, and the 15.7 million new jobs in project management expected by 2020, provide great opportunities for contributions to project management education. These educational opportunities include the integration of case studies, analytics challenges, online simulations, in-class games, self-assessment exercises, videos, and guest speaker presentations, which together form an appealing course for both business and engineering schools.

■ MB21

107A-MCC

Applications of Stochastic Models in Medical Decision Making Problems

Sponsored: Health Applications

Sponsored Session

Chair: Mohammad Reza Skandari, University of British Columbia, #420 2053 Main Mall, Vancouver, BC, V6T-1Z2, Canada, reza.skandari@sauder.ubc.ca

1 - Patient-centered HIV Viral Load Monitoring Strategies In Resource-limited Settings

Diana Maria Negoescu, University of Minnesota, negoescu@umn.edu, Heiner Bucher, Eran Bendavid

Viral load (VL) testing is the most critical monitoring tool for assessing the effectiveness of treatment in HIV patients. The optimal frequency of VL monitoring remains unknown, despite it being the costliest routine monitoring tool for HIV in Sub-Saharan Africa. We formulate a model parameterized using person-level longitudinal data to simulate adherence behavior and disease dynamics over time, and to develop monitoring schedules that adapt to patient characteristics. We then evaluate the total costs and quality-adjusted life years achieved by monitoring VL at fixed intervals (status quo), as well as at variable intervals based on an individualized risk assessment of virologic failure.

2 - Timing The Use Of Breast Cancer Risk Information In Biopsy Decision Making

Mehmet Ayvaci, University of Texas at Dallas, Jindal School of Management, Dallas, TX, United States, ayvaci@stanford.edu, Mehmet Eren Ahsen, Srinivasan Raghunathan, Zahra Gharibi

Available clinical evidence is inconclusive on whether radiologists should use the patient risk profile information when interpreting mammograms. On the one hand, risk profile information is informative and can improve radiologists' performance, but on the other hand, it may impair their judgment by introducing biases in mammography interpretation. Therefore, it is important to assess whether and when profile information use translates into improved outcomes. We model the use of profile information in mammography using a decision theoretic approach and explore the value of profile information.

3 - Developing Near-optimal Biomarker-based Prostate Cancer Screening Strategies

Christine Barnett, University of Michigan, Ann Arbor, MI, United States, clbarnet@umich.edu
Brian Denton

Recent advances in the development of new biomarker tests, which physicians use for the early detection of cancer, have the potential to improve patient survival by catching cancer at an early stage. We describe a partially observable Markov decision process (POMDP) to compute near-optimal prostate cancer screening strategies. We present results based on Monte Carlo simulation to compare the policies developed using our approximated POMDP methods with those recommended in the medical literature.

4 - Optimizing Breast Cancer Diagnostic Decisions While Minimizing Overdiagnosis

Sait Tunc, University of Wisconsin-Madison, Madison, WI, United States, stunc@wisc.edu, Oguzhan Alagoz, Elizabeth S Burnside

Although the early diagnosis of breast cancer saves millions of lives every year, overdiagnosis of breast cancer may cause harm without benefit. We propose a large-scale MDP that uses multi-dimensional cancer risk vectors to incorporate cytologic grade to the breast cancer diagnostic decision problem and concomitantly reduce the overdiagnosis. We present efficient algorithms to find the exact solution to the given large-scale MDP, and introduce upper bounds to further improve the computational performance.

■ MB22

107B-MCC

Policy Evaluation from Operations to Public Health

Invited: ORinformed Healthcare Policies

Invited Session

Chair: Diwakar Gupta, University of Minnesota and National Science Foundation, Minneapolis, MN, United States, guptad@umn.edu

1 - Facilitating Early Diagnosis Of Tuberculosis In India

Sarang Deo, Indian School of Business, sarang_deo@isb.edu

High incidence of TB in India is driven by long diagnostic delay resulting from poor practices of unorganized private providers, who are often patients' first point of contact. We develop an operational model of patients' diagnostic pathways and calibrate it using data collected from household surveys. We use it to estimate the impact of new technology and improved provider behavior on reduction of diagnostic delay. We also develop a stylized economic model of private providers and estimate the monetary incentive required to achieve reduction in diagnostic delay. These models have informed the design of a large pilot program funded by the Gates Foundation in two Indian cities of Mumbai and Patna.

2 - Casualty Distribution To Hospitals In The Aftermath Of Mass-casualty Events

Nilay T Argon, University of North Carolina, Chapel Hill, NC, 27514, United States, nilay@unc.edu, Alex Mills, Serhan Ziya

Following a disaster, emergency responders must transport a large number of casualties to hospitals by limited transportation resources. Based on a Markov decision process formulation, we develop heuristic policies that use limited information on travel times and congestion levels to determine how to allocate ambulances to casualty locations and which hospitals should be the destination for those ambulances. By means of a realistic simulation study, we show that the proposed heuristics provide substantial improvement in the expected number of survivors, even when only limited information about the system state is available.

3 - Hospital-physician Gainsharing Contract Design

Diwakar Gupta, University of Minnesota, Minneapolis, MN, United States, guptad@umn.edu, Mili Mehrotra, Xiaoxu Tang

Participation in the bundled payments for care improvement (BPCI) initiative has provided hospitals the ability to gainshare with physicians. We formulate a model to study the contracts that hospitals could offer physicians based on their historical as well as ongoing performance improvement. Physicians have private information about their costs of achieving different improvement targets. Physicians may choose to either enter the gainsharing agreements with the hospital or continue to operate under the fee-for-service schedule. We characterize the optimal contracts and analyze the distribution of the gains within a game-theoretic setting.

■ MB23

108-MCC

Healthcare Analytics: Collaborations with Practitioners

Sponsored: Health Applications

Sponsored Session

Chair: Bruce L Golden, University of Maryland-College Park, 1, Simpsonville, MD, 2, United States, bgolden@rhsmith.umd.edu

Co-Chair: Sean Barnes, Univ of Maryland-College Park, 4352 Van Munching Hall, University of Maryland, College Park, MD, 20742, United States, sbarnes@rhsmith.umd.edu

1 - Understanding Emergency Department Jumper Behavior: Actionable Insights From Claims Data Using Machine Learning

Xia (Summer) Hu, University of Maryland - College Park, College Park, MD, 20740, United States, xhu64@umd.edu
Sean Barnes, Margret Bjarnadottir, Bruce L Golden

Emergency Department (ED) "jumpers" refers to patients whose ED consumption levels have changed drastically over consecutive periods (e.g. frequent to non-frequent, or vice versa). Based on yearly insurance claim records, we leverage various learning algorithms to predict ED jumpers, whose behaviour are usually difficult to capture using traditional methods. Further, we analyze the characteristics of jumpers via clustering based on Bayesian Information Criteria. Based on this analysis, we provide actionable insights about preventable ED usage and risk management.

2 - Impact Of State And Federal Policy Changes By Socioeconomic Status On Emergency Medicine Practice In Maryland

David Anderson, CUNY Baruch, davidrybergandersonr@gmail.com, Edward Andrew Wasil, Bruce L Golden, Laura Pimentel, Jon Mark Hirshon, Fermin Barrueto

We study the effect of the implementation of the Affordable Care Act (ACA) and a Global Budgeting Revenue (GBR) structure for hospital reimbursement on the operations of Maryland emergency departments. Using a 24-month longitudinal dataset of monthly ED performance, we find that ACA/GBR implementation leads to a decrease in admission rate, increased revenue capture by hospitals, a decrease in the percent of uninsured patients, and a small increase in volume. Further, we find that all of the changes are more pronounced at hospitals with patient populations coming from lower socioeconomic status zip codes.

3 - Risk-adaptive E-triage In Emergency Medicine: A Prospective Analysis

Scott R Levin, Johns Hopkins School of Medicine, slevin33@jhmi.edu, Matthew Toerper, Diego A. Martinez, Heather Gardener, Eric Hamrock, Sean Barnes

Unprecedented levels of crowding and consequential delays in care have intensified the need for accurate triage in emergency departments (ED). For the majority of ED patients, the projected clinical course at presentation not is obvious. Almost half of adult ED visits nationally are triaged to emergency severity index (ESI) Level 3; the ambiguous midpoint of a 5-Level algorithm standard in the US. The objective of our electronic (e) triage tool is to improve differentiation of ED patients by enabling data-driven prognostication of risk of critical events and illness severity. The tool, prospectively evaluated at multiple sites, demonstrates improved detection of critically ill patients.

4 - An Evolutionary Computation Approach For Optimizing Multi-level Data To Predict Individual Patient Outcomes

Sean Barnes, Univ of Maryland-College Park, sbarnes@rhsmith.umd.edu, Suchi Saria, Scott R Levin

Widespread adoption of electronic health records and objectives for meaningful use have increased opportunities for data-driven applications in medicine and healthcare. Optimally specifying multi-level patient data—which can be defined at varying levels of granularity—for predictive modeling is a challenge that must be addressed. We present a general evolutionary computational framework to optimally specify multi-level data to predict individual patient outcomes. We evaluate its performance in predicting critical events for emergency department patients across five populations.

5 - Control System For Electronic Triage In The Emergency Department: Integrating The User Into Development Loop

Diego A. Martinez, Scott R. Levin, Johns Hopkins University School of Medicine, Baltimore, MD, dmart101@jhmi.edu

The potential for machine learning systems to improve via exchange of information with knowledgeable users has yet to be explored in much detail. In a pilot study in an emergency department of a large hospital, nurses were presented with triage level predictions, and they were able to provide feedback through a real-time communication system. The types of some of this feedback seem promising for assimilation of clinical gestalt by machine learning systems. The results show that to benefit from clinical gestalt; machine learning systems must be able to absorb information in a graceful manner and provide clear explanations of their predictions.

■ MB24

109-MCC

Strategy and Uncertainty

Invited: Strategy Science

Invited Session

Chair: Hart Posen, University of Wisconsin, University, Milwaukee, WI, 4, United States, hposen@bus.wisc.edu

1 - High On Innovation: The Impact Of Liberalization Policies On Creative Outcomes

Laurina Zhang, Ivey Business School, Western University, London, ON, Canada, lzhang@ivey.uwo.ca, Keyvan Vakili

We investigate the impact of two social liberalization policies and one anti-liberalization policy on innovation. We find that liberalization policies increase state-level patenting while the anti-liberalization policy reduces patenting. Liberalization policies increase incumbent inventors' patenting rate and the rate of entrance into inventorship. The policies do not impact average innovation quality but patents filed after liberalization are more likely to be built upon novel technological recombinations and cite more recent prior art. The findings highlight the impact of the social context on the rate and direction of innovation.

2 - Seeding The S-curve? The Role Of Early Adopters In Diffusion

Christian Catalini, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA, 00, United States, catalini@mit.edu, Catherine Tucker

In October 2014, all 4,494 undergraduates at MIT were given access to Bitcoin. As a unique feature of the experiment, students who would generally adopt only mature and established technologies were placed into an early-adopter condition: suddenly they had to decide to either learn more about Bitcoin and try to use it, to bet on its volatile future by holding it, or to simply cash out and convert it into US dollars. In this paper, we explore the students' response to the digital currency, and in particular how randomly delaying different types of students relative to their peers affected their adoption decision. Our results point to a novel mechanism through which early-adopters may influence diffusion.

3 - The AQ Model Of Probabilistic Judgment And Patterns Of Risk And Return

Ulrik W. Nash, University of Southern Denmark, Odense, Denmark, uwn@sod.dias.sdu.dk

We have long known that uncertainty about the world is crucial for understanding profit. Moreover, there are reasons to suspect that differences in the degree of uncertainty that firms perceive about the same situation may be a fundamental cause of their performance heterogeneity. Here I introduce the AQ model of probabilistic judgment and use it to predict the flow of money between firms in factor markets. Heterogeneous distributions of profit that capture observed patterns of risk and return summarize these flows.

4 - The Impact Of Learning And Overconfidence On Entrepreneurial Entry And Exit

Hart E Posen, University of Wisconsin-Madison, Madison, WI, 53705, United States, hposen@wisc.edu, John Chen, David Croson, Daniel Elfenbein

Research examining entrepreneurial entry and performance highlights the phenomena of excess entry and delayed exit. We develop a computational model wherein agents learn from experience both pre- and post-entry making endogenous entry and exit decisions. The model suggests excess entry and delayed exit result from a common process — entrepreneurs' ongoing efforts to learn about their prospects and act according to their updated information. One interesting result is that a population of unbiased entrants exhibits beliefs that overestimate their true success probabilities, providing a rational explanation for empirical patterns typically explained by individuals' biases.

■ MB25

110A-MCC

Project Management Methodologies

Invited: Project Management and Scheduling

Invited Session

Chair: Yael S Grushka-Cockayne, Darden School of Business, Charlottesville, VA, United States, GrushkaY@darden.virginia.edu

1 - Multifarious Project Management Methodologies

Vered Holzmann, Tel Aviv University, veredhz@post.tau.ac.il, Yael S Grushka-Cockayne, Hamutal Weisz, Daniel Zitter

In order for a project manager to deliver an effective and efficient solution to the customer's needs, an adaptable methodology for the planning and execution of the project is to be adopted. Following the paradigm that "one size does not fit all", meaning each project has different characteristics that should be taken into consideration when selecting the appropriate management method for a project, this study suggests the exploitation of several methodologies in a project to effectively and efficiently delivery of a successful product. The conceptual framework is based on an integration of the waterfall, agile, and TOC methods to be applied in complex projects derived from specific attributes.

2 - Limiting Financial Risk From Catastrophic Events In Project Management.

Peter D Simonson, North Dakota State University, Fargo, ND, United States, psimonson@mac.com, Joseph Szmerekovsky

For a project manager, planning for uncertainty is a staple of their jobs and education. But the uncertainty associated with a catastrophic event presents difficulties not easily controlled with traditional methods of risk management. This dissertation proposes to bring and modify the concept of a project schedule as a bounded "Alphorn of Uncertainty" to the problem of how to reduce the risk of a catastrophic event wreaking havoc on a project and, by extension. The dissertation will present new mathematical models underpinning the methods proposed to reduce risk as well as simulations to demonstrate the accuracy of those models.

■ MB26

110B-MCC

Assignment and Matching Markets

Invited: Auctions

Invited Session

Chair: Thayer Morrill, North Carolina State University, Raleigh, NC, United States, thayermorrill@gmail.com

1 - Which School Assignments Are Legal?

Thayer Morrill, North Carolina State University, thayermorrill@gmail.com

A plaintiff must demonstrate that actions caused her harm and that this harm is redressable in order to have legal standing. We define a set of assignments to be legal if whenever a student is harmed (has justified envy) there is no legal assignment where she is assigned to that school (her harm is not redressable). We show that for any school assignment problem, there is a unique set of legal assignments; the set of legal assignment is a superset of the assignments that eliminate justified envy; but the Lattice Theorem, Decomposition Lemma, and Rural Hospital Theorem all hold. Moreover, there is a unique, Pareto efficient, legal assignment: the assignment made by Kesten's EADA when all students consent.

2 - School Choice Under Partial Fairness

Umut Dur, North Carolina State University, udur@ncsu.edu

A recent trend in school choice suggests that districts are willing to violate certain types of priorities in order to improve students' welfare. We generalize the school choice problem by allowing such violations. We characterize the set of efficient outcomes for a school choice problem in this setting. We introduce a class of algorithms, denoted Student Exchange under Partial Fairness (SEPF), which guarantees to find a constrained efficient matching for any problem. Any efficient matching which improves upon a stable matching can be obtained via an algorithm within the SEPF class. We offer two applications, each corresponding to a different interpretation of priority violations.

3 - Optimization In Team Formation

Hoda Atef-Yekta, University of Connecticut, Hoda.AtefYekta@business.uconn.edu

In this talk we discuss a binary quadratic programming formulation for team-formation problems. We develop a column generation scheme which provides orders of magnitude speedups over existing algorithms, and compare the solutions obtained with those found by existing mechanisms on measures of efficiency, fairness, stability, and the effect of strategic behavior.

■ MB27

201A-MCC

Empirical Research in Operations

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Antonio Moreno-Garcia, Kellogg School of Management, 2001 Sheridan Rd, Evanston, IL, 60208, United States, a-morenogarcia@kellogg.northwestern.edu

1 - Regulation And Efficiency In Government Procurement: A Regression Discontinuity Approach

Juan Camilo Serpa, McGill University, Montreal, QC, Canada, juan.serpa@mcgill.ca, Ruomeng Cui, Eduard Calvo

We study the effect of public regulation on contracting efficiency in the U.S., where efficiency is measured through delay times and budget overruns. To explore this effect, we use data from 12 million procurement contracts from the federal government, and exploit a natural experiment introduced Federal Acquisition Streamlining Act (FASA).

2 - On The Competitive And Collaborative Implications Of Category Captainship

Yasin Alan, Vanderbilt University, Nashville, TN, United States, yasin.alan@owen.vanderbilt.edu, Jeffrey P Dotson, Mumin Kurtulus

We empirically examine the impact of a category captainship implementation performed by a large U.S. grocer on various parties involved, including the retailer, the captain, and the competing manufacturers. Our findings verify some of the hypotheses developed in the relevant theoretical literature and refute others.

3 - The Effects Of Menu Costs On Operational Efficiency In Retail

Yannis Stamatopoulos, McCombs School of Business, Austin, TX, United States, yannis.stamos@mccombs.utexas.edu, Antonio Moreno-Garcia, Achal Bassamboo

It is well-documented that retail prices exhibit a certain degree of inertia. That is, prices often do not immediately respond to changes in demand and/or cost conditions. To explain this phenomenon, economists have employed the notion of menu costs, which summarize all price adjustment costs faced by firms (e.g., the costs of printing and distributing price tags). We empirically study the effect of menu costs on operational efficiency in retail.

4 - The Value Of Fit Information In Online Retail: Evidence From A Randomized Field Experiment

Santiago Gallino, Dartmouth College, Hanover, NH, santiago.gallino@tuck.dartmouth.edu, Antonio Moreno-Garcia

By implementing a series of randomized field experiments, we study the value of virtual fit information in online retail. Customers are randomly assigned to a treatment condition where virtual fit information is available or to a control condition where virtual fit information is not available. Our results show that offering virtual fit information increases conversion, basket sizes, average price of purchased products, and revisits to the site, while reducing fulfillment costs arising from returns and home try-on behavior.

■ MB28

201B-MCC

New Models for Pricing

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Gustavo Vulcano, NYU, 44 West Fourth St, New York, NY, 10012, United States, gvulcano@stern.nyu.edu

1 - The Theory Of Large-scale Bundle Size Pricing

Tarek Abdallah, New York University, New York, NY, United States, tabdalla@stern.nyu.edu, Arash Asadpour, Joshua Reed

Bundle size pricing (BSP) is a non-traditional multi-dimensional selling mechanism where the seller prices the size of the bundle rather than the different possible combinations of bundles. In BSP, the seller offers the customer a menu of different sizes and prices. The customer then chooses the size that maximizes his surplus and customizes his bundle accordingly. We present a theoretical framework to analyze the large scale BSP problem. We show that, in the presence of a homogeneous population of consumers, as the number of items grows large, the optimal BSP is to offer a single size which depends on the consumers' budgets and the marginal costs.

2 - Coordinating Supply And Demand On An On-demand Service Platform: Price, Wage, And Commission Rate

Jiaru Bai, University of California- Irvine, Irvine, CA, 92617, United States, jiarub@uci.edu, Kut C So, Christopher S Tang, Hai Wang, Xiqun Chen

We study an on-demand service platform with heterogeneous customers and independent service providers. Customers are sensitive to both price and waiting time for the service, and service providers decide to participate in the platform based on their own reservation wage rates. The platform needs to select the optimal price and wage rates to maximize its own profit subject to some target service requirement.

3 - Price Competition With Consumer Price Perception

Dana Popescu, INSEAD, dana.popescu@insead.edu

While e-commerce has made price comparisons across retailers easier, consumers still have limited ability to search for the best deal on every product all the time. Most often, consumers form perceptions about the price competitiveness of a retailer by comparing the distribution of prices for only a subset of items across different retailers. If they perceive that a retailer has the lowest prices, then consumers can be inclined to purchase products from that retailer without a search, depending on the search costs and the expected savings from finding a better deal. In a market with heterogeneous products and multiple sellers we analyze the best pricing strategy for a retailer and its implications.

■ MB29

202A-MCC

Incentive Mechanisms and Sustainability

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Xi Chen, University of Michigan-Dearborn, 2290 HPEC, 4901 Evergreen Rd, Dearborn, MI, 48128, United States, xichenxi@umich.edu

1 - Distribution Strategies For Supporting Poor Retailers In Developing Countries

Luyi Gui, The Paul Merage School of Business, UC Irvine, luyig@uci.edu

We analyze cooperative distribution strategies for supporting poor retailers in in the rural areas of developing countries that lack efficient infrastructure and distribution channels. We examine the effectiveness of two distribution strategies that are widely observed in practice: (1) purchasing cooperatives, (2) non-profit wholesaler. In particular, we consider how these mechanisms can promote the number of poor retailers and consumer welfare.

2 - The Impact Of Product Design On Closed Loop Supply Chain Coordination: Incentives For Input Material Reduction Vs. Enhanced Recycling

Tolga Aydinliyim, Baruch College, Tolga.Aydinliyim@baruch.cuny.edu, Eren Basar Cil, Nagesh N Murthy

We consider a setting wherein a buyer procures standard-size forgings from a supplier, and performs machining, which yields final components and significant scrap. Adopting a principal-agent framework, we investigate coordination implications while accounting for information asymmetry issues, and find that improved recycling across the supply chain can significantly mitigate decentralization cost.

3 - The Effectiveness Of Consumption- Versus Production-based Emission Tax Under Demand Uncertainty

Xi Chen, University of Michigan-Dearborn, xichenxi@umich.edu

In recent years, there has been a debate on whether emission taxes should be imposed at the points of production or directly at points of consumption. We investigate this important issue through a system that integrates tax mechanism design decision of the policy maker, with the production, pricing, and emission reduction decisions of a manufacturer, as well as the price sensitivity and demand uncertainty of consumers.

4 - Incentives And Emission Responsibility Allocation In Supply Chains

Sanjith Gopalakrishnan, University of British Columbia, Vancouver, BC, Canada, sanjith.gopalakrishnan@sauder.ubc.ca, Daniel Granot, Frieda Granot, Greys Sosic, Hailong Cui

Given an assignment, by a dominant supply chain leader, for direct and indirect responsibilities of GHG emissions to the various firms in a supply chain, we adopt cooperative game theory to derive a responsibility allocation, which is the Shapley value of an associated cooperative game. It satisfies several desirable properties - (i) it is easy to compute, (ii) it is uniquely characterized by some compelling axioms, and (iii) among all footprint balanced allocations, it incentivizes firms to exert abatement efforts that minimize the maximum deviation from the socially optimal pollution level.

■ MB30

202B-MCC

Sustainable Supply Chains

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Vishal Agrawal, Georgetown University, 37th and O Streets, Washington, DC, 20057, United States, Vishal.Agrawal@georgetown.edu

1 - An Analysis Of Recycled Content Claims Under Demand Benefit And Supply Uncertainty

Aditya Vedantam, State University of New York at Buffalo, Buffalo, NY, United States, adityave@buffalo.edu, Ananth V Iyer, Paul Lacourbe

We investigate the drivers of a manufacturer's recycled content claim decision under demand benefit for recycled content and uncertainty in municipal supply. Two types of claims are identified - batch specific and batch average. We compare both types of claims and impact on manufacturer profit, recycled input and raw material usage. We parameterize our model to the fiberglass insulation industry and suggest insights.

2 - How Does Precision Affect The Adoption Of Energy Efficiency Practices? - Evidence From The Field And Laboratory Data

Suresh Muthulingam, The Pennsylvania State University, State College, PA, United States, suresh@psu.edu, Saurabh Bansal

This study aims to provide a comprehensive picture of how precision can affect the adoption of energy efficiency initiatives. We utilize three studies that start by establishing the impact of precision on the adoption of energy efficiency initiatives and then examine the mechanisms that govern how precision affects the adoption decisions. We find that precision has a positive impact on the adoption of energy efficiency practices. Additionally, the impact of precision is more pronounced in the presence of budgetary constraints. Finally, we identify trust as an important moderator of the precision effect.

3 - Government Subsidies For Green Technology Development Under Technology Uncertainty

Seung Hwan Jung, Washington University in St. Louis, St Louis, MO, United States, seunghwan.jung@wustl.edu, Tianjun Feng, Fuqiang Zhang

This paper investigates the subsidy design problem for green technology development by firms in an evolving market. We find that the subsidy plays a key role in improving social welfare under different industry environments. We also derive insights into how the subsidy policy affects firms' operational strategy.

4 - Price Vs. Revenue Protection: An Analysis Of Government Subsidies In The Agriculture Industry

Foad Iravani, University of Washington, Seattle, WA, United States, firavani@uw.edu, Saed Alizamir, Hamed Mamani

The agriculture industry plays a critical role in the U.S. economy and various industry sectors depend on the output of farms. To protect farmers' income, the U.S. government offers two subsidy programs to farmers: the PLC program which pays farmers a subsidy when the market price of a crop falls below a reference price, and the ARC program which pays a subsidy when a farmer's revenue is below a guaranteed level. We develop models to analyze the effects of these programs on consumers, farmers, and the government. We calibrate our model with USDA data and provide insights about the effects of crop characteristics and market characteristics on the relative performance of PLC and ARC.

■ MB31

202C-MCC

Operations and Finance Interface

Sponsored: Manufacturing & Service Oper Mgmt, iFORM

Sponsored Session

Chair: Fehmi Tanrisever, Bilkent University, 6800 Bilkent, Ankara, Turkey, tanrisever@bilkent.edu.tr

1 - Mitigating Disruption Risks In Delivery Supply Chains To Serve Contracted Customers

Mert Hakan Hekimoglu, Rensselaer Polytechnic Institute, Troy, NY, United States, hekimm@rpi.edu, John H Park, Burak Kazaz

Motivated by an implementation in a Fortune 150 company, this paper helps a firm determine its capacity expansion decisions as a mitigation strategy against disruptions in a delivery supply chain. We formulate the firm's capacity planning problem using a two-stage stochastic model. While risk aversion generally leads to an increase in capacity investment, we find a surprising result that capacity may decrease with risk aversion. Our capacity expansion model is projected to make a 48% savings in the total expected operating costs stemming from disruptions under risk aversion.

2 - Competitiveness Of Supply Chains: A Financial Market Perspective

Gerd J. Hahn, German Graduate School of Management and Law, Heilbronn, Germany, gerd.hahn@ggs.de, Jochen Becker

In this paper, we analyze supply chain performance across various industries using financial statement and stock market data. By this means, we identify relevant value drivers from a supply chain perspective and show their impact on market valuation.

3 - Managing Price And Demand Risk In Flour Milling

Fehmi Tanrisever, Bilkent University, Bilkent University, Merkez Kampus Lojmanlari 80/5, Ankara, 06800, Turkey, tanrisever@bilkent.edu.tr, Junchi Tan, Zumbul Atan

We explore the value of downward substitution under stochastically evolving exogenous prices. In particular, we consider a multi-period inventory problem, in which a firm procures two kinds of substitutable inputs to be blended at a certain ratio to produce and sell a final output whose demand and price are uncertain. In this setup, we establish the conditions for the optimality of a base-stock policy and derive the optimal myopic policy for a firm's procurement and substitution decisions.

■ MB32

203A-MCC

Structural Estimation in Operations

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Gabriel Weintraub, Columbia University, New York, NY, United States, gweintraub@columbia.edu

1 - The Efficacy Of Incentives In Scaling Up Marketplaces

Ashish Kabra, INSEAD, Boulevard de constance, Fontainebleau, 77305, France, ashish.kabra@insead.edu, Elena Belavina, Karan Girotra

Marketplaces spend billions in incentives to achieve scale, which is key to the efficacy and survival of marketplaces. Using detailed transaction data from a leading transportation marketplace, we estimate and compare the effects of incentives given to the "buyer" side and "seller" side of the marketplace as well as the effect of threshold and linear incentives.

2 - Spatial Competition And Preemptive Entry In The Discount Retail Industry

Fanyin Zheng, Columbia Business School, fz2225@gsb.columbia.edu

This paper studies how discount retailers make store location decisions by estimating a dynamic game model. It extends the empirical models of dynamic oligopoly entry by allowing for spatially interdependent entry and introducing machine learning tools to infer market divisions from data. The results suggest that preemptive incentives are important in chain stores' location decisions and that they lead to loss of production efficiency.

3 - Ergodicity And The Estimation Of Markov Decision Processes

Robert Bray, Kellogg, r-bray@kellogg.northwestern.edu

I create a class of dynamic discrete choice estimators that exploit Markov chain ergodicity. The empirical likelihood of a Markov decision process depends only on the differences in the value function. And whereas the value function converges with Bellman contractions at the rate of cash flow discounting, the value function differences converge at the rate of cash flow discounting times the rate of Markov chain mixing (the subdominant eigenvalue of the state transition matrix). With this strong convergence result, I make Rust's (1987) nested fixed point (NFXP) estimator 200 times faster in problems with more than 2,000 states.

4 - When Demand Projections Are Too Optimistic: A Structural Model Of Product Line Decisions

Andres I Musalem, U. de Chile / Complex Engineering Systems Institute, Beauchef 851, Santiago, 8370456, Chile, amusalem@duke.edu

A methodology is proposed to estimate structural models of product line competition. Not accounting for this endogeneity leads to overoptimistic estimates of demand due to a sample selection bias, which may generate misleading managerial recommendations. The methodology is illustrated using simulated and real data.

■ MB33

203B-MCC

Simulation II

Contributed Session

Chair: Li Li, Southwest Jiaotong University, No.111, North Section Second Ring Road, Chengdu, China, speciallili@home.swjtu.edu.cn

1 - Operationalizing Industry Cluster Strategies

Tayo Fabusuyi, Numeritics & Carnegie Mellon University, 5520 Baywood Street, Floor #3, Pittsburgh, PA, 15206, United States, tfabusuyi@cmu.edu, Juergen Pfeffer

Local economic development organizations are often tasked with promoting the health of the regional economy. However, the unique composition of each geographical area calls for a distinct approach that reflects the peculiarities of the local economy. We present an approach by which the information in input-output is modeled and enriched using network analysis. Using a simulated policy intervention, we show how the approach can provide insight on regional economies and provide an application to industry cluster analysis.

2 - A Comparison Of Gaussian Process Modeling Software

Collin Erickson, Northwestern University, 2145 Sheridan Road, Room C210, Evanston, IL, 60208, United States, collinerickson@u.northwestern.edu, Bruce Ankenman, Susan M Sanchez

We have found that different software packages can give different results when fitting the same Gaussian process model, often called kriging. We compare various packages on a variety of test problems, finding that the accuracy of predictions can differ significantly. An attractive feature of Gaussian process fitting is that the model includes an estimate of predictive variance. We focus on evaluating the reliability of this predictive error from these various packages. When fitting the same data and model, the run times of certain packages can also differ by orders of magnitude. The study takes a practitioners point of view, using each package with minimal tuning.

3 - Time Management Policies In A Queueing System

Ji-Eun Kim, PhD Student, The Pennsylvania State University, Imperial Towers, University Park, PA, 16801, United States, jxk594@psu.edu, David A. Nembhard, Hyeong Suk Na

Many job assignment problems are organized from a company's perspective to meet the demands of a schedule or to maximize workers' productivity, often ignoring the heterogeneity of pacing styles among workers. We show that if one considers the diversity in pacing styles, system productivity can be increased using one or more approaches. The purpose of this study is to test job assignment policies to be used in a queueing system considering servers' diversity in deadline reactivity. Empirical course website data was used to test a range of job assignment policies.

4 - Coordinating Station And Network Capacity In Urban Rail Transit System

Li Li, Southwest Jiaotong University, No.111, North Section 1, Second Ring Road, Chengdu, China, speciallili@home.swjtu.edu.cn, Haifeng Yan, Gongyuan Lu, Wu You

The performance of urban rail transportation is impacted by fluctuated passenger demand due to both the capacity constraint of station and line. The feature of high accessibility and volume makes a well coordinated train line plan in urban rail network very hard to be achieved. This research will present a stochastic integer programming model to demonstrate the mutual influence between passenger demand and train line plan. This model is solved by a simulation based approach which is applied in a real-world case in Chongqing Rail Transit Company.

■ MB34

204-MCC

Simulation and Stochastic Optimization

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Douglas Morrice, University of Texas-Austin, 2110 Speedway Stop B6500, Austin, TX, 78712-1750, United States, douglas.morrice@mccombs.utexas.edu

1 - Multimodularity In The Stochastic Appointment Scheduling Problem With Discrete Arrival Epochs

Christos Zacharias, Assistant Professor, University of Miami, Coral Gables, FL, United States, czacharias@miami.edu, Tallys Yunes

We address the problem of designing appointment scheduling strategies that account for patients' no-show behavior, non-punctuality, emergency walk-ins and random service times. We maintain the discrete nature of the appointment scheduling problem by considering arrival epochs with discrete supports. We demonstrate that the optimal scheduling strategy minimizes a multimodular function, and a local search algorithm terminates with a globally optimal solution.

2 - Appointment Scheduling With Multiple Providers And Stochastic Service Times

Michele Samorani, Santa Clara University, Santa Clara, CA, United States, samorani@ualberta.ca, S Abolfazl Soltani, Bora Kolfal

We consider a multi-server appointment scheduling problem in which patients may not show up, and those who show up require stochastic service times. We model this problem as a Markov Chain and solve it through complete enumeration. Then, we employ statistical learning techniques to detect patterns among optimal solutions. We develop an effective heuristic method which uses these patterns to build near-optimal solutions. Our numerical experiments show that our methods result in higher-quality schedules than those obtained by existing models. We also test our heuristic with a field experiment made in collaboration with a local legal counseling clinic afflicted by high service time variability.

3 - Coordinated Appointment Scheduling Of An Integrated Practice Unit

Douglas Morrice, The University of Texas, Austin, douglas.morrice@mccombs.utexas.edu, Dongyang Ester Wang, Kumar Muthuraman, Jonathan F Bard, Luci Leykum, Susan Noorily

In this research, we develop a coordinated approach to patient appointment scheduling that enables a patient to receive multiple services on a single visit. The approach is compared to heuristics used in practice. A case study in pre-operative care involving the integration of Anesthesiology and Internal Medicine is used to motivate and illustrate the results.

■ MB35

205A-MCC

Empirical Research in Healthcare Operations

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Mor Armony, New York University, Stern School of Business, New York, NY, 10012, United States, marmony@stern.nyu.edu

1 - Refining Workload Measure In Hospital Units: From Census To Acuity-adjusted Census In Intensive Care Units

Song-Hee Kim, Marshall School of Business, University of Southern California, Los Angeles, CA, United States, songheek@marshall.usc.edu, Edieal Pinker, Joan Rimar, Elizabeth Bradley

We aim to better understand the impact of ICU workload on patient outcomes, so that practitioners and researchers can use such understanding to provide high quality care despite increased hospital crowding. Using data from two ICUs and a dynamic measure of patient acuity, we show when acuity-adjusted workload is high sicker patients are discharged and longer-term outcomes are affected. Our findings suggest 1) ICUs need to track changes in patient acuity and 2) future studies of ICU workload should take patient acuity into account in workload measures. Using a simulation study, we show how high acuity-adjusted workload can be prevented by reducing seasonality in patient arrivals.

2 - Data-driven Appointment Scheduling Under Uncertainty: The Case Of An Infusion Unit In An Oncology Center

Nikolaos Trichakis, MIT, Cambridge, MA, United States, ntrichakis@mit.edu, Avishai Mandelbaum, Petar Momcilovic

We develop a novel, data-driven approach to deal with appointment sequencing and scheduling in a multi-server system, where both customer punctuality and service times are stochastic. Our approach relies on an infinite-server queuing model approximation. We calibrate our model using a data set of unprecedented resolution, gathered at a large-scale outpatient oncology practice, and illustrate how our approach can be utilized to improve infusion scheduling. We also demonstrate the performance of our approach by comparing it with existing state-of-the-art sequencing and scheduling algorithms.

3 - The Effect Of Online Reviews On Physician Demand: A Structural Model Of Patient Choice

Yuqian Xu, NYU, yxu@stern.nyu.edu, Mor Armony, Anindya Ghose

Social media platforms for healthcare services are changing how patients choose doctors. In this paper, we wish to derive the impact of online information on patient choice of outpatient care doctors. We are especially interested in how operational factors influence demand. We propose a random coefficient logit model to characterize consumer heterogeneity in doctor choices, taking into account both numeric and textual user-generated content with text mining techniques. Our interdisciplinary approach provides a framework that combines machine learning and structural modeling techniques with empirical operations management.

■ MB36

205B-MCC

Empirical and Theoretical Models in Supply Chains

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: Anyan Qi, The University of Texas at Dallas, Business School, Richardson, TX, 11111, United States, axq140430@utdallas.edu

Co-Chair: Ozge Sahin, Johns Hopkins University, 100 International Drive, Baltimore, MD, 21202, United States, ozge.sahin@jhu.edu

1 - Assessing Uncertainty From Point Forecasts

Zhi Chen, INSEAD, Singapore, Singapore, Zhi.Chen@insead.edu, Anil Gaba, Dana Popescu

This paper develops a parsimonious model for combining correlated point forecasts into a probability distribution for the quantity of interest. The model is compared with other commonly used methods that either ignore the lack of dependence between the point forecasts and/or use a certainty equivalent approach in estimating the distribution parameters, hence ignoring the parameter uncertainty. We further illustrate the implications for a decision maker in a newsvendor setting, where our model leads to profits that are higher on average when compared to the other widely used methods.

2 - Analytical And Empirical Study Of Complementarities In An Online Advertising Supply Chain And Their Impact On Optimal Operating Policies And Profits

Changseung Yoo, PhD Student, The University of Texas at Austin, Austin, TX, United States, changseung.yoo@phd.mccombs.utexas.edu, Anitesh Barua, Genaro Gutierrez

We examine channel structures and pricing models in an online advertising supply chain using a proprietary dataset. We develop analytic as well as structural econometric models that enable us to and quantify synergy effects between them. While the extant literature emphasizes choosing between pricing models, we show that using multiple models in concert yields higher overall profitability due to strategic complementarities among the pricing schemes. We then explore the operating implications of the complementarities and their impact on profits and supply chain efficiency, and devise information/profit sharing contracts that boost the supply chain profit towards the benchmark scenario.

3 - Supplier Centrality And Auditing Priority In Socially Responsible Supply Chains

Jiayu Chen, The University of Texas at Dallas, Richardson, TX, United States, jxc144030@utdallas.edu, Anyan Qi, Milind Dawande

We consider a supply network where buying firms' brand may be damaged by sourcing from suppliers who fail to comply with socially responsible standards. To mitigate the risk, firms may audit their suppliers. We derive firms' equilibrium auditing strategy and propose approaches to mitigate the inefficiency.

4 - Dynamic Coordination In A Supply Chain With Production Capacity Uncertainty

Zhongjie Ma, Purdue University, 403 W State Street, West Lafayette, IN, 47906, United States, ma220@purdue.edu, Qi Feng, J. George Shanthikumar

We study the effect of upstream supply capacity uncertainty on the inventory decisions in a two-stage supply chain from both centralized and decentralized perspectives. Extending the notion of stochastic linearity and directional concave order, we show that the centralized problem is concave via transformation. This observation allows us to extend the well-known Clark-Scarf decomposition results to the multi-echelon inventory system with random capacity. Furthermore, we discuss the mechanism to dynamically coordinate the supplier's and retailer's decisions when they each possess private information.

■ MB37

205C-MCC

Socially and Environmentally Responsible Operations Management

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Michael Lim, U of Illinois at Urbana-Champaign, Champaign, IL, United States, mlim@illinois.edu

Co-Chair: Karthik Murali, University of Alabama, Tuscaloosa, Tuscaloosa, AL, United States, kmurali@cba.ua.edu

1 - Optimal Feed-in Tariff Policies: The Role Of Technology Manufacturers

Shadi Goodarzi, HEC, Paris, France, shadi.goodarzi@hec.edu Sam Aflaki, Andrea Masini

We assess the effectiveness of feed-in tariff policies in promoting renewable energy technologies taking into account technology manufacturers' decisions. Modeling a three-tier supply chain that includes potential adopters, technology manufacturers and a grid operator, we show that the ability of feed-in tariffs to induce renewable energy adoption is strongly affected by the technology manufacturers' market characteristics.

2 - Product Allocation Under The Risk Of Recall

Long He, National University of Singapore, longhe@nus.edu.sg, Ying Rong, Zuo-Jun Max Shen

When product recalls happen, companies not only have to deal with additional logistics costs but also a damaged reputation. To alleviate the severe consequences of product recall, we develop a model to compare dedicated and uniform product allocation strategies with associated sourcing plans. We also discuss the impacts of key factors in the performance comparison.

3 - Reducing Carbon Emissions In Grocery Retail

Ekaterina Astashkina, INSEAD, Boulevard de Constance, Fontainebleau, 77305, France, ekaterina.astashkina@insead.edu, Elena Belavina

We build a stylized model for traditional and online grocery retail chains to understand the drivers of the consumer and retailer carbon footprint, including emissions that come from food waste and transportation. In our model, consumers make endogenous choices between different channels and the associated food-buying policies, while retailers optimally manage their inventory replenishment. We find that, in most cases, the availability of an online retailer reduces the emissions associated with the grocery sector in a city. We also consider the effectiveness of alternate policy instruments including sales and carbon taxes, and identify actions that improve the behavior of the worst offenders.

4 - Optimizing Water Pollution Monitoring System: Regulation Policy Guideline For Curbing Nutrient Pollution

Michael Lim, U of Illinois at Urbana-Champaign, Champaign, IL, 61820, United States, mlim@illinois.edu

We examine regulatory guidelines of surface water quality to curb nutrient pollution resulting from various farming activities. Specifically, we formulate an optimization model that captures the government's regulation decision taking into account farmers' moral hazard issues: determining the optimal location of monitor stations along with optimal penalty schemes for each watershed district. We explore the model using the Illinois State water network to ensure practical relevance and to obtain further insights on regulation policy.

■ MB38

206A-MCC

Behavioral Modeling with Social Data

Invited: Social Media Analytics

Invited Session

Chair: Tauhid Zaman, MIT, 77 Mass Ave, Boston, MA, 02139, United States, zlisto@mit.edu

1 - Optimal Policies For Finding Users Hiding In Social Networks

Christopher Marks, MIT, cemarks@mit.edu

During 2015 we collected data from approximately 5000 Twitter accounts belonging to ISIS users, ISIS supporters, and other users that appeared to be closely connected to the ISIS network. We observe that many of these users are frequently suspended, only to immediately open new accounts from which they continue their online activities. We present a dynamic search method for finding new accounts belonging to previously suspended users that relies on machine learning methods to generate model inputs. We analyze this search method in the context of dynamic programming and provide some insights into characteristics of an optimal search policy.

2 - Optimal Following Policies In Social Networks Using Integer Programming And Network Centrality

Tauhid Zaman, Massachusetts Institute of Technology, zlisto@mit.edu, Krishnan Rajagopalan

We consider the problem of interacting with users in a social network in order to maximize the number of followers obtained. We formulate the problem as an integer program (IP). We then show how to dramatically speed the time needed to solve the IP by modifying the objective using network centrality functions. Through simulations on real social networks, we find that our modified IP can increase the number of followers obtained versus random and pure network centrality based policies.

3 - Bayesian Inference Of User Geolocation Using Social Media Activity Time Series

Matthew Robert Webb, MIT, Cambridge, MA, United States, mrwebb@mit.edu

We propose a novel Bayesian classification algorithm to determine the global location of Muslim extremists from their social media activity based on their unique pattern of life. The tenants of Islam require five daily prayers; but rather than being set, prayer times are determined by the location of the Sun in relation to the Earth's horizon. By assuming Muslim users will not utilize social media during prayers, we attempt to infer their longitude and latitude based on their pattern of inactivity.

4 - The Value Of Social Media To Online Content

Michael Zhao, MIT, Cambridge, MA, United States, mfzhao@mit.edu, Sinan Aral

Many believe social media drives online content consumption and vice versa. The potential of this positive feedback loop is critical to marketers, publishers, politicians, and beyond. However, this type of relationship induces endogeneity problems that make casual identification difficult. We overcome this challenge by constructing a unique article-location panel dataset using proprietary data from a large online and print media company. We employ a novel IV estimation strategy by using location-specific weather patterns as instruments for social media sharing thereby allowing us to identify the degree to which social media effects the demand for online content.

■ MB39

207A-MCC

Panel: Future of Applied Probability

Sponsored: Applied Probability

Sponsored Session

Chair: David Goldberg, GA Institue of Technology, Atlanta, GA, United States, dgoldberg9@isye.gatech.edu

1 - Future Of Applied Probability

David Goldberg, GA Institue of Technology, 755 Ferst Drive, Atlanta, GA, 30332-0205, United States, dgoldberg9@isye.gatech.edu

An opportunity for the entire Applied Probability Community to discuss the future of the field.

2 - Panelists

Applied Probability Community, Applied Probability Community, INFORMS, Catonsville, MD, 21228, United States, meetings@informs.org

■ MB41

207C-MCC

Advances in Quantitative Finance

Sponsored: Financial Services

Sponsored Session

Chair: Rafael Mendoza, McCombs School of Business, University of Texas, Austin, TX, 78712, United States, rafael.mendoza-arriaga@mccombs.utexas.edu

1 - On Latency And Volatility

Richard Sowers, University of Illinois, r-sowers@illinois.edu

We present a simple model of the effects of latency on the properties of observed asset prices. In our model, latency is a delay between the observed asset price and its true, but latent fundamental price. Because of latency, the observed asset price shadows the true but latent asset price at some deformed time away. Deformation in a clock gives rise to fluctuations in volatility. We provide an asymptotic result that links latency to the volatility of volatility.

2 - Energy Production & Games With Stochastic Demand

Ronnie Sircar, Princeton, sircar@princeton.edu

The dramatic decline in oil prices, from around $110 per barrel in June 2014 to around $30 in January 2016 highlights the importance of competition between different energy sources. Indeed, the price drop has been primarily attributed to OPEC's strategic decision not to curb its oil production in the face of increased supply of shale gas and oil in the US, coupled with reduced demand from China. We model these phenomena as dynamic Cournot games in a stochastic demand environment, and illustrate how traditional oil producers may react in counter-intuitive ways in face of competition from alternative energy sources.

3 - Welfare Analysis Of Dark Pools

Krishnamurthy Iyer, Cornell University, Ithaca, NY, United States, kriyer@cornell.edu, Ramesh Johari, Ciamac Cyrus Moallemi

We investigate the welfare implications of operating alternative market structures known as "dark pools" alongside a "lit" dealer market. Our setting consists of intrinsic traders and speculators, with heterogeneous private information as to an asset's value, who endogenously choose between the two venues. We establish that while the dark pool attracts relatively uninformed traders, the orders therein experience adverse selection. Moreover, the informational segmentation created by a dark pool leads to greater transaction costs in the lit market. From this, we conclude that there exist reasonable parameter regimes where the introduction of a dark pool decreases the overall welfare.

■ MB42

207D-MCC

Crowd-Commerce Applications in Operations and Revenue Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Rene A Caldentey, University of Chicago, Chicago, IL, United States, rene.caldentey@chicagobooth.edu

Co-Chair: Yifan Feng, The University of Chicago, 5807 S Woodlawn Ave, Chicago, IL, 60637, United States, yfeng4@chicagobooth.edu

1 - Learning Customer Preferences Through Crowdvoting

Yifan Feng, University of Chicago, Chicago, IL, 60637, United States, yfeng4@chicagobooth.edu, Rene A Caldentey, Christopher Ryan

We study a seller introducing a new product with multiple potential product designs into the marketplace. In order to pick the design that is most likely to be preferred by customers, the seller uses an online system that allows potential buyers to vote for their preferred designs. We study how to dynamically customize each individual voter's choice set, in order to most efficiently learn overall customer preferences. We propose an algorithm that balances breadth of choice and accuracy in determining the best product. We show this algorithm is asymptotically optimal in speed of learning.

2 - Simultaneous Vs. Sequential Crowdsourcing Contests

Lu Wang, University of Toronto, Rotman School of Management, 105 St George Street, Toronto, ON, M5S 3E6, Canada, lu.wang12@rotman.utoronto.ca, Ming Hu

In a crowdsourcing contest, innovation is outsourced to an open crowd. We consider two alternative crowdsourcing mechanisms for an innovative product involving multiple attributes. One is to run a simultaneous contest, where the best is selected from the single solution simultaneously submitted by each contestant. The other is to run multiple sequential sub-contests, with each dedicated to one attribute and a later sub-contest built on the best outcome from earlier sub-contests. While both mechanisms have their own advantages, either could win over depending on situations.

3 - Contests And Inequality

Mohamed Mostagir, University of Michigan, Ann Arbor, MI, United States, mosta@umich.edu, Yesim Orhun, Hamidreza Tavafoghi

Contests are one of the standard mechanisms that firms employ to extract the most effort from participants, whether these participants are crowd workers or the firm's own personnel. We study contests that are repeatedly played by the same agents, with a focus on how information revelation about past play impacts future efforts. We show that such revelation can be detrimental to aggregate effort, and discuss how regulations (e.g. the SEC Dodd-Frank act) that require employers to reveal wages in an attempt to curb inequality can lead to unexpected effects that ultimately result in higher inequality amongst workers in environments that resemble contests, i.e. where wages follow a rank-based structure.

■ MB43

208A-MCC

Applied Decision Analysis

Sponsored: Decision Analysis

Sponsored Session

Chair: Saurabh Bansal, Penn State University, Penn State University, State College, PA, 16802, United States, sub32@psu.edu

1 - Analyzing Both The Cost And Strategic Value Of Sustainable Supply Chains

Jason Merrick, Virginia Commonwealth University, jrmerric@vcu.edu, Paul Brooks, Lance Saunders

The Brazilian government will require the use of additives in all gasoline fuel starting in 2017. We use optimization modeling to help our industry partner design their new supply chain network and study the cost of reducing carbon emissions. However, we then use decision analysis to study the strategic value of sustainable supply chain designs in obtaining market share. In our case study, the strategic value outweighs the cost of reducing emissions.

2 - Eliciting Newsvendor Quantile: Direct Or Decomposed Assessments?

Saurabh Bansal, Penn State, sub32@psu.edu

We consider the newsvendor problem that is commonly used in practice. We report the results of a laboratory study in which participants provide (i) direct solution to the problem, (ii) decomposed solution to the problem. Our results help identify the optimal discretion levels that should be provided to managers.

3 - Supporting The Prioritization Of Emerging Animal Health Threats For The UK Department Of Agriculture With Decision Analysis

Gilberto Montibeller, Loughborough University, Loughborough, United Kingdom, g.montibeller@lboro.ac.uk

Gilberto Montibeller, Decision Consulting Ltd., Leicester, United Kingdom, g.montibeller@lboro.ac.uk, L. Alberto Franco

Emerging animal health threats pose serious risk to humans and countries, and represent a serious challenge for both analysts and policy makers. We employed a decision analytic framework to develop a risk management support system to help the UK Department of Agriculture (DEFRA) with the prioritisation of such threats, providing an effective mechanism for ranking them and supporting the design of policy recommendations. The system is supporting the recommendations of DEFRA's Veterinary Risk Management group since 2009. Benefits for the client include increased rigour in evidence gathering, transparent assessments, and a traceable and more streamlined decision process.

4 - How Did We Integrate Optimization And Machine Learning In our Solution Tool at Mckinsey

Halil I Cobuloglu, Sr. Research Analyst, McKinsey & Company, 404 Wyman Street, Waltham, MA, 02451, United States, halil.cobuloglu@gmail.com, Dimitris Bertsimas, Nathan Uhlenbrock, Prodipto Ghosh

In this project, we have developed a territory optimization tool for our clients. In order to reach solution fast, we have integrated various algorithms including machine learning and optimization techniques in our model. This tool helps companies efficiently use their limited sources and optimize their territories with more balanced workload.

■ MB44

208B-MCC

Panel: Advice from Award Winning Researchers

Sponsored: Decision Analysis

Sponsored Session

Moderator: Andrea Hupman Cadenbach, University of Missouri - St. Louis, St Louis, MO, United States, cadenbach@umsl.edu

This panel discussion features several distinguished researchers who have won awards from the Decision Analysis Society. Panelists will discuss the processes behind their research that contributed to their success and share advice for junior faculty, postdoctoral researchers, and PhD candidates.

1 - Panelist

L Robin Keller, Professor, University of California - Irvine, Irvine, CA, United States, LRKeller@uci.edu

2 - Panelist

James S Dyer, University of Texas - Austin, j.dyer@mccombs.utexas.edu

3 - Panelist

Robert Clemen, Duke University, clemen@duke.edu

4 - Panelist

Ali E Abbas, Professor and Director of DECIDE, University of Southern California, Los Angeles, CA, 90089, United States, aliabbas@usc.edu

■ MB45

209A-MCC

Advances in Simulation Optimization

Sponsored: Simulation

Sponsored Session

Chair: Weiwei Chen, Assistant Professor, Rutgers Business Schoo l, 1 Washington Park, Newark, NJ, 07901, United States, wchen@business.rutgers.edu

Co-Chair: Siyang Gao, City University of Hong Kong, City University of Hong Kong, Kowloon, Hong Kong, siyangao@cityu.edu.hk

1 - Generalized Likelihood Ratio Method For Stochastic Derivative Estimation

Yijie Peng, Fudan University, pengy10@fudan.edu.cn, Michael Fu, Jianqiang Hu

We propose a generalized likelihood ratio method for stochastic derivative estimation in a general framework that can handle discontinuities in both the sample performance and sample path. The classical likelihood ratio method is a special case where the parameter does not appear in the sample performance. In addition, the new method generalizes the push-out likelihood ratio method. The framework also includes most settings where infinitesimal perturbation analysis applies, although the actual estimator differs in general. Examples demonstrate the proposed method works for a broad set of applications, many of which cannot be handled by existing methods.

2 - Advanced Simulation Optimization Approach

Loo Hay Lee, National University of Singapore, iseleelh@nus.edu.sg, Chun-Hung Chen

In this talk, we will present some potential research topics in simulation optimization and discuss some of the preliminary work.

3 - Challenges In Applying Ranking And Selection After Search

David Eckman, Cornell University, Ithaca, NY, United States, dje88@cornell.edu, Shane Henderson

It is often appealing to reuse simulation replications taken during a simulation optimization search as input into a ranking-and-selection procedure. However, even when replications are i.i.d. and independent across systems, we show that when the search uses the observed performance of explored systems to identify new systems, conducting ranking-and-selection procedures that reuse the search replications can result in probabilities of correct (and good) selection below the prespecified level. We also show a similar deterioration in the guarantees of subset-selection procedures.

4 - A Partition-based Random Search For Stochastic Constrained Optimization Via Simulation

Weiwei Chen, Rutgers Business School, wchen@business.rutgers.edu, Siyang Gao

This research focuses on the global optimization over finite solution space with deterministic objective function and stochastic constraints. Due to the random noise observed in the constraints, the feasibility of a solution is unknown and can be best evaluated by simulation. We propose a partitioning scheme to explore the solution space and develop a feasibility detection procedure for the sampled solutions. A partition-based random search approach with multi-constraint feasibility detection (PRS-MFD) is then proposed to search for the optimal solution. The efficiency of PRS-MFD is shown by numerical experiments, and it is proved to converge to the set of global optima with probability one.

■ MB46

209B-MCC

Revenue Management and Assortment Optimization

Sponsored: Revenue Management & Pricing"

Sponsored Session

Chair: Hamid Nazerzadeh, University of Southern California, Marshall School of Business, Los Angeles, CA, 90089, United States, nazerzad@marshall.usc.edu

1 - Real-time Optimization Of Personalized Assortments

Negin Golrezaei, University of Southern California, golrezae@usc.edu

Motivated by the availability of real-time data on customer characteristics, we consider the problem of personalizing the assortment of products for each arriving customer. Using actual sales data from an online retailer, we demonstrate that personalization based on each customer's location can lead to over 10% improvements in revenue compared to a policy that treats all customers the same. We propose a family of index-based policies that effectively coordinate the real-time assortment decisions with the back-end supply chain constraints. We allow the demand process to be arbitrary and prove that our algorithms achieve an optimal competitive ratio.

2 - Online Personalized Resource Allocation With Customer Choice

Van-Anh Truong, Columbia University, New York, NY, United States, vt2196@columbia.edu, Guillermo Gallego, Anran Li, Xinshang Wang

We introduce a general model of resource allocation with customer choice. This problem has a number of applications, including personalized assortment optimization, revenue management of parallel flights, and web- and mobile-based appointment scheduling. We derive online algorithms that are asymptotically optimal and achieve the best constant relative performance guarantees for this class of problems.

3 - Assortment Personalization In High Dimension

Madeleine Udell, Cornell University, Ithaca, NY, United States, udell@cornell.edu, Nathan Kallus

We show how to perform assortment personalization in sublinear time by imposing a natural low rank structure on the problem. In the static setting, we show that this model can be efficiently learned from surprisingly few interactions. In the dynamic setting, we show that structure-aware dynamic assortment personalization can have regret that is an order of magnitude smaller than structure-ignorant approaches.

4 - Position Auctions With Search Cost

Heng Zhang, University of Southern California, Heng.Zhang.2019@marshall.usc.edu, Leon Yang Chu, Hamid Nazerzadeh

Companies such as eBay, Amazon, and Google have created e-commerce platforms that connect online sellers and online users. In this work, we study how these platforms should rank the products displayed to their users. We present a general model that captures several important aspects of these environments including consumer's search cost. Our analysis highlights the inefficiencies that can be created due to the asymmetry of information among the sellers and the platform. We present an optimal mechanism as well as a simple near-optimal heuristic.

■ MB47

209C-MCC

Multi-product Revenue Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: David Simchi-Levi, Massachusetts Institute of Technology, Cambridge, MA, United States, dslevi@mit.edu

Co-Chair: He Wang, MIT, 77 Massachusetts Ave, Cambrdige, MA, 02139, United States, wanghe@mit.edu

1 - Reaping The Benefits Of Bundling Under High Production Costs

Will Ma, MIT, willma353@gmail.com, David Simchi-Levi

It has long been known that selling different goods in a single bundle can significantly increase revenue, but that this is no longer the case if the goods have high production costs. We introduce a simple pricing scheme, called Pure Bundling with Disposal for Cost (PBDC), that captures the benefits of bundling under high costs, extracting all of the surplus in settings where previous simple mechanisms could not. We also prove a theoretical guarantee on the performance of PBDC that holds for arbitrary independent valuation distributions, by adopting and improving techniques from mechanism design literature. Finally, we perform extensive numerical experiments which support the efficacy of PBDC.

2 - New Algorithms And Guarantees For Assortment Optimization Under General Choice

Clark Pixton, MIT, Cambridge, MA, United States, cpixton@mit.edu, David Simchi-Levi

We present new algorithms for static assortment optimization which apply to general choice models. We show theoretical guarantees, and demonstrate performance via computational experiments. These algorithms sit between the work of Jagabathula (2016) and the choice model assortment optimization literature.

3 - Using Early Click Information In Online Flash Sales Campaigns

Stefano Nasini, Assistant Professor, IESEG School of Management, Lille/Paris, France, s.nasini@ieseg.fr, Victor Martínez de Albéniz, Arnau Planas

In online flash sales, products are heavily discounted during very short sales periods. There is significant uncertainty over product sales, that can be reduced using the chain of sequential decisions that customers take in the website. We build a statistical model based on four layers of conditional probabilities: from (1) clicks to the main webpage to (2) clicks to a particular campaign to (3) request for information of a specific product to (4) final purchase decision. We use information from clicks occurring in the first hours of a campaign to reoptimize prices. We finally test our model with real data.

4 - Offline Assortment Optimization In The Presence Of An Online Channel

Srikanth Jagabathula, NYU Stern School of Business, New York, NY, United States, sjagabat@stern.nyu.edu, Daria Dzyabura

Firms are increasingly selling through both offline and online channels. The offline offerings allow the customers to physically evaluate the products and, as a result, impact the demand in both channels. Given this, we address how firms should select an offline assortment to maximize profits across both channels; we call this the showcase decision problem. We introduce a new model to incorporate the impact of physical evaluation on consumer preferences. We validate this model using a conjoint study; propose algorithms, with approximation guarantees, to determine the profit/sales maximizing assortments; and demonstrate up to 40% improvement in profits on real-world data.

■ MB48

210-MCC

Marketing Insights from Social Media

Invited: Social Media Analytics

Invited Session

Chair: David A. Schweidel, Emory University, 1300 Clifton Road NE, Atlanta, GA, 30322, United States, dschweidel@emory.edu

1 - Is All That Twitters Gold? Effects Of Online Chatter On Stock Market Returns And Stock Market Volatility

Abhishek Borah, University of Washington, abhi7@uw.edu

This study uses natural language processing to extract various dimensions across different sources of Tweets and ascertain their importance. The authors evaluate the effect of Twitter on both 1) Stock Market Returns using a Multivariate Dynamic Descriptive Panel Data Model, and 2) Stock Market Volatility using a Multivariate GARCH model. The authors find that 1) Tweets predict stock market returns and volatility in stock returns 2) Sentiment is the most important dimension and spillover effects between volatility in tweets and stock returns differ in sign depending on the sentiment of tweets, and 3) Firms' new product announcements affect tweets.

2 - Social TV, Advertising, And Sales

Beth L. Fossen, Kelley School of Business, Indiana University, Bloomington, IN, United States, bfossen@indiana.edu
David A Schweidel

The rapid growth of social TV - defined as the integration of social media with television programming - has outpaced the field's understanding of how marketers can extract value out of such activities. In this research, we explore the relationship between social TV, television advertising, and sales by investigating how viewer engagement with television programs and advertisements impacts online shopping behavior. This work aims to address (1) if online chatter about television advertisements spurs sales for the advertised brand and (2) whether television programs with high online social activity are more beneficial to advertisers.

3 - Modeling Latent Homophily In Large-scale Social Networks: A Markov Random Field Approach

Liye Ma, University of Maryland, liyema@rhsmith.umd.edu

The rapid growth of social media platforms makes large scale social network data commonplace. Inferring consumer preference and developing targeting strategies using such data, however, remain challenging. In this study, we introduce a modeling technique, Gaussian Markov Random Fields (GMRF), to model the latent homophily of connected consumers. We show that GMRF can be applied to networks of arbitrary topology, that its conditional independence property is conceptually appealing, and that model parameters have intuitive interpretations. We analyze different model configurations incorporating one or more GMRFs, and demonstrate its application using a mobile network dataset.

4 - Deriving Brand Insights With Social Media Analytics

David A Schweidel, Emory University, dschweidel@emory.edu

Interest in social media continues to grow. While much research has focused on the use of social media as a communication platform, limited work has probed the viability of social media data as a source of marketing insights. In this research, we examine ways in which brands may benefit from the analysis of social media data. We consider two specific applications: assessing brand health and identifying shifts in online word of mouth.

■ MB49

211-MCC

Predicting Business Outcomes Using Social Media

Invited: Social Media Analytics

Invited Session

Chair: Youran Fu, University of Pennsylvania, Philadelphia, PA, United States, youranfu@wharton.upenn.edu

1 - The Operational Value Of Social Media Information

Ruomeng Cui, Kelley School of Business, Indiana University, cuir@indiana.edu, Santiago Gallino, Antonio Moreno-Garcia, Dennis Zhang

We empirically explore how social media information helps sales forecasting. Using daily sales data from an online apparel company and publicly available Facebook posts (users' comments and likes data), we apply various machine learning methods and find a statistically significant improvement in sales forecasts.

2 - Stock Market Movement Prediction Using Disparate Data Sources: A Probabilistic Prediction Model

Bin Weng, Auburn Univeristy, Auburn, AL, 36849, United States, bzw0018@auburn.edu, Hamidreza Dolatsara, Fadel Mounir Megahed

The stock market prediction has attracted much attention from academia as well as business. In recent years, social media and Internet search behavior are considered as new sources that affect human's behavior and decision-making. The purpose of this study is to develop a probabilistic model to predict short-term stock movement by comparing machine learning methods using disparate data sources. This study not only uses traditional historic market data but also the data from technical analysis, social media, and the internet. Finally, a stock prediction tool with machine learning methods incorporated has been developed for predicting the stock's short-term movement with high accuracy.

3 - The Value Of Social Media Data In Color Trends Forecasting

Youran Fu, The Wharton School, University of Pennsylvania, Philadelphia, PA, 19104, United States, youranfu@wharton.upenn.edu, Marshall L Fisher

We partnered with a leading apparel retailer to investigate how to use social media data to improve fashion color trend forecasting. We find that using fine-grained Twitter data and a Google search volume index to predict product-color sales three months out can significantly reduce forecast error compared to conventional methods.

4 - Understanding The Role And Impact Of Discussions On The Quality Of User Generated Content – The Case Of Wikipedia.

Srikar Velichety, University of Arizona, srikarv@email.arizona.edu

We investigate the impact of discussions on the quality of peer-produced content. Using a data science approach on the complete population of English language articles in Wikipedia, we demonstrate the predictive and explanatory power of discussions in article quality. We also compare and contrast the value of discussion characteristics with the article characteristics.
Our results show that discussions add value to the predictive model by increasing both the precision and recall. On the explanatory side, we find that discussions drive both edits and diverse edits leading to better quality. Implications for theory building and policy setting in peer-production environments are discussed.

■ MB50

212-MCC

MIF Rising Young Scholars Award

Sponsored: Minority Issues

Sponsored Session

Chair: Julie Ivy, North Carolina State University, 111 Lampe Drive, Campus Box 7906, Raleigh, NC, 27695, United States, jsivy@ncsu.edu

1 - MIF Rising Young Scholars Award

Julie Ivy, North Carolina State University, jsivy@ncsu.edu

This session will feature research presentations by the MIF Rising Young Scholar Award recipients(s). The names of the presenters will be determined after the application evaluation has been completed.

■ MB51

213-MCC

Community-Based Operations Research I

Sponsored: Public Sector OR

Sponsored Session

Chair: Michael P Johnson, Associate Professor, University of Massachusett - Boston, McCormack Hall, 3rd Floor, Room 428A, 100 Morrissey Blvd., Boston, MA, 02125, United States, Michael.Johnson@umb.edu

1 - Pro Bono Analytics - What Nonprofits Can Learn From Operations Researchers, And Vice Versa

David Hunt, Oliver Wyman, david.hunt@oliverwyman.com
Michael P Johnson

Pro Bono Analytics is an INFORMS program that matches volunteers with nonprofit organizations working in underserved areas and for underserved populations. The nonprofits tend to be small and without the resources to utilize traditional operations research and advanced analytical methods. This talk will focus on how to communicate the value of OR/analytics to nonprofits, and perhaps more importantly, what we have learned about applying OR/analytical methods to problems that truly matter to our nonprofit clients.

2 - Is Crime A Real Estate Problem? A Case Study Of The Neighborhood Of East Liberty, Pittsburgh

Tayo Fabusuyi, Numeritics & Carnegie Mellon University, Pittsburgh, PA, United States, tfabusuyi@cmu.edu

This study documents the innovative efforts of a community development organization (CDO) in the City of Pittsburgh's East End towards combating crime in the neighborhood of East Liberty. Through a community driven process, the CDO was able to establish the nature of the problem and create a strategic intervention to address it. The intervention, which focuses on the identification of crime hot spots coupled with place-based management, along with initiatives designed to increase collective efficacy, resulted in a 49% decrease in crime within the neighborhood's residential area over a span of five years.

3 - Can Improving Youth Decision-making Skills Make Them Less Vulnerable For Sex Traffickers?

Kendra Taylor, KEYfficiencies, Inc, Atlanta, GA, United States, Kendra@KEYfficiencies.com

The old adage "an ounce of prevention is worth a pound of cure" summarizes the motivation for addressing an alarming market for sex trafficking of children in Atlanta, Georgia. Several groups have begun passing legislation, raising awareness, rescuing those previously labeled child prostitutes. With approximately 5,000 students between the ages of 12 and 14 at risk for being victims in the sex trade, much still remains to be done in the area of prevention. The purpose of this study is to assess the potential of a pilot program to reduce the supply of vulnerable children by addressing the role of poor decision-making skills, by engaging adult advisors, and by creating positive peer groups.

4 - Measuring Success: Community Analytics For Local Economic Development

Michael P Johnson, University of Massachusetts Boston, michael.johnson@umb.edu

Main Street organizations develop local development initiatives that support economic and social goals. We describe an application of value-focused thinking and community-based operations research to identify economic development performance metrics and decision alternatives for local development interventions. Using interviews with stakeholders in three Boston communities, we show how values structures vary across communities and stakeholder groups and how attributes can be quantified using a variety of data sources. We conclude by presenting a composite values structure to support improved operations management and strategy design for all Boston Main Street districts.

■ MB52

214-MCC

Resilience Management Concepts for Infrastructure and Service Systems

Sponsored: Public Sector OR

Sponsored Session

Chair: Joost Santos, George Washington University, 800 22nd St NW, Suite 2830, GWU Science and Engineering Hall, Washington, DC, 20052, United States, joost@gwu.edu

1 - Evaluation Of Resilient Point-of-use Water Treatment Technologies Using Multi-attribute Decision-making Analysis

Sheree Ann Pagsuyoin, University of Massachussetts Lowell, sheree_pagsuyoin@uml.edu, Joost Reyes Santos, Jana S Latayan

Many point-of-use (POU) water treatment technologies are now available in the market as a result of efforts to address the persistent poor access to safe water and high incidences of waterborne diseases in low-income regions of the world. While the availability of options is ideal, this has also created a challenge in selecting technologies that are suitable in local settings. In this work, we present an application of Multi-Attribute Decision-Making analysis to rank and select options for POU water treatment in a poor rural community. Six technologies were considered: SODIS, boiling, chlorination, biosand filtration, ceramic pot filtration, and flocculation-disinfection.

2 - Decision Analytics Using Plural Resilience Metrics For Adaptive Supply Chain Management

Shital Thekdi, University of Richmond, sthekdi@richmond.edu, Joost Reyes Santos

Recent events have highlighted the need for supply chain systems to effectively recover, adapt, and reorganize after disruptions. Common modeling methods use single measures of performance in decisions for investing in resilience. However, complex systems such as those involving movement of goods and services require competing units of measurement, such as workforce availability, health, capacity, and safety. This presentation provides a framework for: 1) Data-analytic modeling of resilience with competing measures of performance, and 2) Multi-criteria and multi-stakeholder investment analytics. The proposed framework will be demonstrated on a distributed supply chain network.

3 - Integrating Community Capitals With Resilient Insurance Strategies For Flood Risk Mitigation

Leyla Sadigh, Research Assistant, George Washington University, Washington, DC, 20052, United States, leyla.sadigh@arup.com
Ajita Atreya, Ekundayo Shittu

In this paper, we explore the role of insurance decision making in influencing community resilience along the five dimensions of capital - physical, financial, human, social, and natural. We integrate these five capitals in a dynamic computable general equilibrium model with the demand and supply side of community resilience (measured across robustness, redundancy, resourcefulness, and rapidity) through insurance. Our focus on flood insurance is to achieve a better understanding of how risk perceptions in capital influence insurance-purchasing decisions and identify strategies that encourage investments in flood mitigation measures.

4 - Development Of Multi-attribute Decision Framework For Selecting Flow Control Structures In Irrigation Canals

Sheree Pagsuyoin, University of Massachussetts Lowell, MA, sheree_pagsuyoin@uml.edu

The stiff competition for water between agriculture and non-agricultural users makes it necessary to have effective management of irrigation networks in farms. However, the process of selecting flow control structures in irrigation networks is highly complex and involves multi-level decision makers. In this work, we apply multi-attribute decision making methodology to select and prioritize among check and intake structures for irrigation canals. The relevant attributes for selecting structures were also identified, and a robust scoring system was developed. The model was then applied to analyze the Qazvin irrigation network, one of the oldest and most complex irrigation networks in Iran.

■ MB53

Music Row 1- Omni

Emerging Scholars in Technology Management

Sponsored: Technology, Innovation Management & Entrepreneurship

Sponsored Session

Chair: Gulru Ozkan-Seely, University of Washington Bothell, School of Business, 18115 Campus Way NE, Box 358584, Bothell, WA, 98011, United States, gulru@uw.edu

1 - What Is The Role Of The State In Entrepreneurship And Venture Performance?

Daniel Armanios, Carnegie Mellon University, darmanios@cmu.edu

What is the role of the state in entrepreneurship and venture performance? I find three roles that the state plays during the venturing process. Public-private institutions play an intermediary role that connects private entrepreneurs to public resources. Public research organizations play an integrator role that develops and transfers public knowledge for private commercial use. Local governments play an implementer role that tailors national policies to local markets. In these three roles, I provide more nuance regarding the state's role in entrepreneurship and advance institutional theory, especially its nexus to entrepreneurship and emerging markets.

2 - The Digital Commons: Tragedy Or Opportunity? The Effect Of Crowdsourced Digital Goods On Innovation And Economic Growth

Frank Nagle, University of Southern California, naglef@marshall.usc.edu

This dissertation is comprised of four studies that explore the transformative nature of the digital commons with a focus on crowdsourced digital goods (CDGs) and open source software. The first chapter explores how lower information costs are leading firms to increasingly engage with external digital communities. The second chapter examines the impact of CDGs at a macro-level and shows that GDP calculations do not properly account for "digital dark matter". The third chapter empirically measures the productivity impact of using CDGs at the firm level. The final chapter investigates how firms that contribute to the development of CDGs enhance their ability to extract value from using them.

3 - Optimal Award Scheme In Innovation Tournaments

Ersin Korpeoglu, UCL School of Management, e.korpeoglu@ucl.ac.uk, Laurence Ales, Soo-Haeng Cho

In an innovation tournament, an organizer solicits innovative ideas from a number of independent agents. Agents exert efforts to develop their solutions, but their outcomes are unknown due to technical uncertainty and/or subjective evaluation criteria. We derive necessary and sufficient conditions under which the winner-take-all scheme that awards only the best solution is optimal. Under these conditions, the organizer should offer a larger winner prize when he seeks a higher number of good solutions, but interestingly the organizer need not raise the winner prize when anticipating more participants to a tournament. Finally, we compare rank-based compensation with other compensation rules.

4 - Demand Heterogeneity And The Adoption Of Platform Complements

Joost Rietveld, Rotterdam School of Management, rietveld@rsm.nl, J P Eggers

We offer a demand-based view on how platform evolution affects the sales of complements. Differences between early and late adopters of the platform create heterogeneous demand conditions that affect both average complement performance and variance in the types of complements that are more or less successful. Using a dataset of 2,921 console video games, we find that platform evolution has a negative effect on games' sales. Furthermore, as the platform evolves, the sales disparity between new intellectual property (IP) games and games based on existing game properties grows to the detriment of new IP games. The sales disparity between superstar games and flops also widens as the platform evolves.

5 - Extreme Performance In Creative Settings: Where Do Stars Come From?

Haibo Liu, University of California Riverside, Riverside, CA, United States, Haibo.Liu@ucr.edu, Jurgen Mihm, Manuel Emilio Sosa

Despite being rare, stars make disproportionately influential contributions to their fields. This paper studies the role of inter-personal collaboration in the emergence of star designers. We examine how the quality of a collaborator (star vs. non-star) moderates the influence of two important contextual factors of collaboration: social network cohesion and expertise similarity. By distinguishing collaborators based on their quality, we reconcile contrasting results regarding those two contextual factors in prior literature. We test our predictions on a large longitudinal data set consisting of all designers who were granted a design patent in the United States from 1975 through 2010.

■ MB54

Music Row 2- Omni

Optimal Services and Coordination Strategies of O2O Channel in Fast Fashion Supply Chain

Sponsored: Service Science

Sponsored Session

Chair: Qi Xu, Donghua University, Glorious Sun School of Business and Management, Donghua University, Shanghai, 200051, China, xuqi@dhu.edu.cn

1 - Coordination In Apparel Dual-channel Supply Chain With Asymmetric Cost Information

Qi Xu, Donghua University, Shanghai, China, xuqi@dhu.edu.cn, Wenjie Wang

This paper discusses the coordination in apparel dual-channel supply chain with asymmetric cost information. We propose the dual-channel supply chain models under asymmetric cost information and symmetric information scenario respectively. Considering the seasonal characteristics of apparel product, the flexible price contract is applied to adapt the apparel supply chain coordination with asymmetric cost information. The impact of asymmetric demand information on the profits of partners in the supply chain is analyzed.

2 - Optimal Service Decision Consideration Demand Shift Between Online And Offline In Supply Chain System

Dandan Fan, Donghua University, sunshinemarcle@163.com

The paper discusses the optimal service decision under two kinds of situations, the one is demand shift between online and offline when the demand is influenced by service level, the other is demand no shift. The centralized and decentralized service decision models are established. The centralized decision mode means the brands suppliers provide products to themselves stores, and the decentralized decision mode means the brands suppliers provide products to tradition stores. Then, the paper investigates the optimal service strategy of O2O centralized system. For the O2O decentralized system, the conditions of the service level to realize Nash equilibrium is analyzed.

3 - Impact Of Experience Service On Fast Fashion Retail O2O Channel

Lixia Xu, Donghua University, Shanghai, China, 37857909@qq.com

O2O channel is a brand new retailing mode which integrates both characteristics of online and offline channels. Experience service has been become main factor in the operation of fast fashion retail O2O channel. This new channel can help the retailer tap new customer segments and generate additional demand. To study the impact of channel service competition and customer acceptance of O2O channel, a competition model based on price and service sensitivity was established. The comparison of experience service level and O2O chain profit between online and offline was presented. Numerical analysis was conducted on profit allocation of supply chain under different customer acceptance of O2O channel.

4 - Fast Fashion O2o Channel Optimal Service Under Different Revenue Model

Qi Xu, Donghua University, xuqi@dhu.edu.cn, Fan Dandan

Considering two kinds of revenue modes, one is offline stores' revenue sharing and the other is revenue no-sharing, this paper built the optimal O2O services decision models in fast fashion O2O supply chain, according to the offline stores is brand owner themselves or alliance business. Further,the collaboration of this O2O supply chain is discussed. Finally, the numerical simulation are done by analyzing the impact of variables to profits , such as, the rate of service substitution between online and offline, price, the optimal service level, rate of revenue sharing and subsidized price, etc.

MB55

Music Row 3- Omni

Inventory Management I

Contributed Session

Chair: Jagtej S Bewli, Director, Product Management, WalmartLabs, 850 Cherry Avenue, San Bruno, CA, 94066, United States, jbewli@walmartlabs.com

1 - Inventory And Transportation Decisions For Two-echelon Closed-loop Supply Chain Under Emission Constraint

Jian Li, PhD Candidate, Xi'an Jiaotong University, No.28 Westing Xianning Road, Xi'an, +86-029-710049, China, ljlcxwxz@stu.xjtu.edu.cn, Qin Su

Closed-loop supply chain (CLSC) may cause more direct carbon emissions of used product due to the reverse logistics and remanufacturing. In this paper, we address the inventory and transportation management issue on CLSC system consisting of supplier, manufacturer and retailer under cap-and-trade mechanism, and develop a two-echelon system. Extra carbon permits can be taken as a kind of environment resource as well as product to be traded and circulate. Further, we consider decentralized decision-making with supplier, manufacturer and retailer being Stackelberg leader, respectively, and have a comparative analysis with centralized decision-making of CLSC through two numerical studies.

2 - An Inventory Problem With Substitution And Bayesian Estimation

Ulku Gurler, Professor, Bilkent University, Department of Industrial Engineering, Ankara, 06800, Turkey, ulku@bilkent.edu.tr

In this study we consider an inventory problem with two substitutable products. We use a bayesian approach to estimated the demand and substitution rates and investigate the impact of the estimation method on inventory replenishment.

3 - Managing Perishable Inventory Systems With Multiple Demand Classes

Rui Chen, University of Toronto, 105 St George St, Toronto, ON, M5S 3E6, Canada, rui.chen@rotman.utoronto.ca
Hossein Abouee Mehrizi, Opher Baron, Oded Berman

We study a multi-period stochastic perishable inventory system with multiple demand classes that have different requirements on the age of acceptable products. At the end of each period, the firm can savage inventory of any age. An example is a food supplier selling products to retailers that have different market size or have different geographical locations. We characterize the structure of optimal ordering, allocation, and disposal policies. We examine the effectiveness of the optimal control and how to best try and improve the control of perishables. We also propose an effective and computationally-efficient heuristic,which is 5% away from the optimal.

4 - The Design Of A Responsive Vaccine Supply Chain By The Incorporation Of Production Capacity Into The Guaranteed Service Approach

Stef Lemmens, KU Leuven, Naamsestraat 69 Box 3555, VAT BE 0419.052.173, Leuven, 3000, Belgium, stef.lemmens@kuleuven.be, Catherine Jenny Decouttere, Nico Vandaele, Mauro Bernuzzi, Amir Reichman

Both literature and industrial evidence emphasize the importance of the design of a responsive vaccine supply chain as the manufacturing lead times are long and highly variable. We model the buffer exchange between supply chain responsiveness, multi-echelon inventory and production capacity by the incorporation of queuing networks into the guaranteed service approach. Furthermore, we apply our methodology to a real-life rotavirus vaccine supply chain.

5 - Portfolio Management Approach To Inventory Optimization

Jagtej S Bewli, Director, Product Management, WalmartLabs, 850 Cherry Avenue, San Bruno, CA, 94066, United States, jbewli@walmartlabs.com

Choosing the right inventory 'investment' for each SKU in the assortment can improve service levels while reducing overall inventory. However, in spite of significant advancement and research in inventory optimization techniques, inventory policies in industry still managed based on ABC classification of SKUs.Inventory recommendations from mathematically optimal inventory policies may not always line up with human intuition therefore educating the business user is key to driving adoption.

MB56

Music Row 4- Omni

Firm Competitive Strategies

Sponsored: EBusiness

Sponsored Session

Chair: Chao Ding, University of Hong Kong, KKL 807, Pok Fu Lam, Hong Kong, chao.ding@hku.hk

1 - Promotion Design In Free To Play Mobile Games

Sean Raphael Marston, Western Kentucky University, sean.marston@wku.edu, Ismail Civelek, Yipeng Liu

In-game purchases, virtual goods/promotion design for heterogeneous consumers and strong competition are key challenges for game providers. This paper addresses determination of optimal promotion offerings for a game provider in the presence of heterogeneous players and a competitor.

2 - Advertising Role Of Recommender Systems In Electronic Marketplaces: Is It A Boon Or A Bane For Competing Sellers?

Lusi Li, University of Texas at Dallas, Lusi.Li@utdallas.edu

This paper examines the intricate interaction between competing sellers' advertising and pricing strategies in the presence of a recommender system in an electronic marketplace.

3 - Competition And Efficiency In Express Service Industry

Yihong Hu, Assistant Professor, Tongji University, 1293, Siping Road, Tongji University, Shanghai, 200092, China, yhhu@tongji.edu.cn, Ruixia Shi

We consider service firms competing for customers sensitive to price and congestion and operating through a platform which charges a transaction fee. We establish upper and lower bounds of efficiency loss. With linear inverse demand and homogeneous firms, the platform's charge make the worst case increase from 1/4 to 9/16, additionally losing more than one half of social welfare compared to free competition. When heterogeneous, it raise the bound to over 9/16, depending on the largest gap between cost coefficients of firms and the maximum ratio of volume-to-investment. For concave inverse demand and homogeneous firms, the bound increases from 1/3 without the charge to 2/3 with the charge.

4 - The Centrality Of Ict In Network Structures Of Innovation And Impact On R&D

Rajib L Saha, Assistant Professor, Indian School of Business, Room 6123, AC6, Level 1, Hyderabad, 500032, India, Rajib_Saha@isb.edu, Aditya Karanam, Deepa Mani

We document the centrality of Information and Communication Technology (ICT) industries in network structures of innovation and its subsequent impact on R&D processes and outcomes across diverse industries. We find strong evidence for the impact of technology centricity of an industry's innovations, as measured by the industry's position in the network relative to the ICT industries, on its R&D productivity, new product creations, and recombinant intensity. Performance volatility, spread and market returns of an industry also increase with the technology centricity of its innovations.

MB57

Music Row 5- Omni

Queues and Customer Behavior

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Mirko Kremer, Frankfurt School of Finance and Management gGmbh, Sonnemannstrasse 9-11, Frankfurt, 60314, Germany, m.kremer@fs.de

1 - Last Place Aversion In Queues

Ryan Buell, Assistant Professor, Harvard Business School, Morgan Hall 429, Boston, MA, 02163, United States, rbuell@hbs.edu
Michael Norton, Jay Chakraborty

Since customers dislike waiting, much of the existing queuing research concentrates on what's taking place ahead of the customer in line (service rates, queue length, etc.). We examine whether what's taking place behind the customer - specifically, whether they are last in line - influences their perceptions and behaviors. Through a combination of lab and field studies, we document how being in "last place" diminishes wait time satisfaction, and increases the probability of leaving the queue. We also test several interventions aimed at reducing last place aversion and improving queue performance.

2 - Behavioral Drivers Of Routing Decisions: Evidence From Restaurant Table Assignment

Bradley R Staats, University of North Carolina at Chapel Hill, Campus Box 3490, McColl 4721, Chapel Hill, NC, 27599-3490, United States, bstaats@unc.edu, Fangyun Tan

In many settings, humans make routing decisions dynamically, either because algorithms don't exist, decision support tools have not been implemented, or existing rules are not enforced. Understanding how individuals make decisions creates the opportunity to identify both positive deviances, as well as suboptimal decision making that can be improved. In this paper we theoretically identify the factors that may impact decision making before empirically examining a large operational data set in a casual restaurant setting to research whether and how hosts deviate from their predefined round-robin rule to seat customers to servers.

3 - The Impact Of Delay Announcements: An Experimental Approach

Gad Allon, Northwestern University, Evanston, IN, United States, g-allon@kellogg.northwestern.edu, Achal Bassamboo, Mirko Kremer

We explore the impact of delay announcements by studying the data from a lab experiment, where customers are provided with anticipated delay.

4 - Diagnostic Accuracy In Congested Environment

Mirko Kremer, Frankfurt School of Finance and Management gGmbh, m.kremer@fs.de, Francis E DeVericourt

The trade-off between diagnostic accuracy and congestion characterizes many manufacturing and service settings, where the gathering of additional information is likely to improve the diagnosis but may also increase congestion in the system. For example, medical staff often needs to weigh the benefit of running additional tests against the cost of delaying the provision of services to other patients. We present the results from a set of controlled laboratory experiments designed to test the predictions of a formal sequential testing model that captures this trade-off.

■ MB58

Music Row 6- Omni

Energy VI

Contributed Session

Chair: Luis Baringo, Universidad de Castilla-La Mancha, Av. Camilo José Cela s/n, E.T.S.I.Industriales, Ciudad Real, 13071, Spain, Luis.Baringo@uclm.es

1 - Resilient Based Power System Restoration On Sectionalized Grid

Saeedeh Abbasi, Research and Teaching Assistant, University of Houston, 9000 Braesmont Dr, Apt #4, Houston, TX, 77096, United States, sabbasi5@uh.edu, Masoud Barati, Gino J Lim

Several catastrophic experiences of extreme events increased the criticality of the power grid restoration. This paper discusses a novel resilience-based restoration and sectionalizing model. This restoration approach aims to restore the de-energized power grids to the normal state after cascading outages that may occur during severe conditions. The problem is formulated as a bi-level programming model and solved by the pre-emptive programming method. The proposed approach is illustrated using an IEEE six-bus and 118 bus test systems, with focus on assessing and improving its resilience during the restoration process to severe disasters.

2 - A Generation Capacity Expansion Planning Model Considering Capacity Markets With High Wind Power Penetrations

Jonghwan Kwon, Arizona State University, 10410 N Cave Creek Rd, Tempe, AZ, 85020, United States, Jonghwan.Kwon@asu.edu, Zhi Zhou, Todd Levin, Fernando de Sisternes, Kory W Hedman, Audun Botterud

This work aims to develop a modeling framework for simulating generation capacity expansion planning, considering long-term capacity markets and short-term energy and operating reserve markets with increasing levels of wind power. The framework will provide the ability to analyze the impact of high wind penetrations on the economics and reliability of the grid in a more realistic market environment. System operators and regulators can obtain new and important insights into how wind resources can be efficiently and effectively integrated into electricity markets under various rules and policies.

3 - Electricity Pooling Markets With Inelastic Demand

Mohammad Rasouli, PhD Candidate, University of Michigan, 430 S Fourth Ave, Ann Arbor, MI, 48104, United States, rasouli@umich.edu, Demosthenis Teneketzis

In the restructured electricity industry, electricity pooling markets are an oligopoly with strategic producers possessing private information. We focus on pooling markets where aggregate demand is represented by a non-strategic agent and is inelastic.
Inelasticity of demand is a main difficulty in electricity markets. It can potentially result in market failure and high prices.
We propose a market mechanism that has the following features. (F1)It is individually rational.(F2)It is budget balanced.(F3)It is price efficient(F4)The energy production profile corresponding to every non-zero Nash equilibrium of the game induced by the mechanism is a solution maximizes the social welfare.

4 - Offering Strategy Of A Virtual Power Plant: A Stochastic Adaptive Robust Optimization Approach

Luis Baringo, Universidad de Castilla-La Mancha, Av. Camilo José Cela s/n, E.T.S.I. Industriales, Ciudad Real, 13071, Spain, Luis.Baringo@uclm.es, Ana Baringo

We propose a stochastic adaptive robust optimization model for the offering strategy of a virtual power plant (VPP) that participates in the day-ahead and the real-time energy markets. The VPP comprises a conventional power plant, a wind-power unit, a storage facility, and flexible demands, which participate in the markets as a single entity in order to optimize their energy resources. Uncertainties in the wind-power production and in the market prices are modeled using confidence bounds and scenarios, respectively.

■ MB59

Cumberland 1- Omni

Connected and Automated Vehicles

Sponsored: Transportation Science & Logistics

Sponsored Session

Chair: Michael Levin, University of Texas, Austin, TX, United States, michaellevin@utexas.edu

1 - Modeling Spatiotemporal Propagation Of Information In a Connected Vehicle System With The Consideration Of Communication Capacity

Jian Wang, Purdue University, Lyles School of Civil Engineering, West Lafayette, IN, United States, wang2084@purdue.edu Xiaozheng He, Yong Hoon kim, Srinivas Peeta

This study proposes integro-differential equations to model the spatiotemporal propagation of information under vehicle-to-vehicle communications while factoring communication capacity and traffic dynamics. We also derive closed form solutions for the asymptotic speeds of information propagation wave under different densities of equipped vehicles. Numerical experiments demonstrate the effectiveness of the proposed model in various traffic conditions.

2 - Road In Transition: Autonomous Vehicle Manufacturer Strategies And Transportation Systems Performance

Mohamadhossein Noruzoliaee, University of Illinois at Chicago, Chicago, IL, United States, h.noruzoliaee@gmail.com, Bo Zou, Yang Liu

This study explores the impacts of autonomous vehicles (AVs) on transportation system equilibrium and AV manufacturer pricing strategies. A mathematical program with equilibrium constraints (MPEC) is formulated, where the upper level determines pricing strategy of an AV manufacturer and the lower-level computes system equilibrium as a variational inequality (VI). Besides, the competition among multiple AV manufacturers is formulated as an equilibrium problem with equilibrium constraints (EPEC). Solving the MPEC and EPEC helps gauge the impact of market-driven AV pricing on system performance.

3 - A Cell Transmission Model For Dynamic Lane Reversal With AutonomousVehicles

Michael Levin, University of Texas, Austin, TX, United States, michaellevin@utexas.edu

Autonomous vehicles admit consideration of novel traffic behaviors such as reservation-based intersection controls and dynamic lane reversal. We present a cell transmission model formulation for dynamic lane reversal. For deterministic demand, we formulate the dynamic lane reversal control problem for a single link as an integer program and derive theoretical results. In reality, demand is not known perfectly at arbitrary times in the future. To address stochastic demand, we present a Markov decision process formulation. Due to the large state size, the Markov decision process is intractable. However, based on theoretical results from the integer program, we derive an effective heuristic. We demonstrate significant improvements over a fixed lane configuration both on a single bottleneck link with varying demands, and on the downtown Austin network.

4 - Integrated Mode Choice And Assignment-simulation Framework With Automated Transit Vehicles

Omer Verbas, Northwestern University, Transportation Center, Evanston, IL, 60208, United States, omer@northwestern.edu
Hani S Mahmassani, Michael F. Hyland

With the advent of automated and connected transportation systems, car and bike sharing, ride sourcing, and on-demand transit services, as well as the increasing availability of real-time traffic and transit information; travelers have the opportunity to evaluate their multiple routing options and make better-informed decisions. This study proposes an integrated mode-choice and a path finding-assignment-simulation framework that evaluates the system performance and traveler behavior under the existence of automated transit vehicles.

■ MB60

Cumberland 2- Omni

Latest Advances in Last Mile Distribution

Sponsored: TSL, Urban Transportation

Sponsored Session

Chair: Mathias A Klapp, PhD Candidate, Georgia Institute of Technology, 765 Ferst Dr NW, Atlanta, GA, 30318, United States, maklapp@gatech.edu

1 - Complexity Of Dynamic Delivery Problems With Release Dates And Deadlines

Damian Reyes, Georgia Institute Of Technology, Atlanta, GA, United States, ldrr3@gatech.edu, Alan Erera, Martin W P Savelsbergh

Motivated by a case-study in food delivery operations, we investigate the complexity of dynamic delivery problems with release times and service guarantees. At the heart of these problems, there is a trade-off between waiting to consolidate more orders - enabling cost-effective delivery routes - and dispatching a vehicle earlier - in order to complete some orders while preserving capacity for others released later in the operating period. We introduce polynomial-time algorithms for some deterministic variants on a 1-dimensional geometry.

2 - Consolidating Last-mile Delivery Flows

Niels Agatz, Erasmus University, Rotterdam, Netherlands, nagatz@rsm.nl, Joydeep Paul, Remy Spliet

Most multi-channel retailers offer in-store pickup to their online customers. Pickup orders are typically shipped from a dedicated e-fulfilment warehouse while store replenishment takes place from another warehouse. In this contribution, we study the opportunity to use the excess capacity in the replenishment routes to accommodate some of the in-store pickup demand. We develop a heuristic to support the consolidation decisions and present numerical experiments based on artificial and real-world data.

3 - Branch-and-Price For Probabilistic VRP

Felipe Lagos, Georgia Institute Of Technology, falg3@gatech.edu

We study a probabilistic VRP in which a customer’s appearance is uncertain. Customers are divided into routes within which the vehicle may skip customers that do not appear, and the objective is minimizing expected routing cost. We propose a column generation algorithm that uses successively tighter cost approximations to solve the problem within any given numerical tolerance. We also provide an a priori guarantee on the number of iterations needed to satisfy any tolerance, which can be calculated from problem parameters. We embed the column generation framework into an exact branch-and-price algorithm, and test our methods on instances adapted from the literature.

4 - Cost Efficiency Versus Customer Service In The Dynamic Dispatch Waves Problem

Mathias A Klapp, PhD Candidate, Georgia Institute of Technology, 755 Ferst Drive NW, Atlanta, GA, 30332, United States, maklapp@gatech.edu, Mathias A Klapp, PhD Candidate, Pontificia Universidad Católica de Chile, Vicuña Mackenna 4860, Macul, Santiago, Chile, maklapp@gatech.edu, Alan Erera, Alejandro Toriello

We study the Dynamic Dispatch Waves Problem that models the trade-offs between vehicle dispatch, route sequencing, and request selection in same-day delivery systems with dynamic disclosure of orders. The objective is to minimize vehicle travel time (efficiency) and penalties for unserved requests (service). We provide an optimal solution to the deterministic and a priori problems, and design two heuristic dynamic policies. Our computational experiments indicate that in the efficient frontier there is a decreasing marginal rate of substitution between efficiency and service, and that frequency and structure of vehicle dispatches significantly change between these two objectives.

■ MB61

Cumberland 3- Omni

Practical Steps Towards Shipment & Network Capacity Management

Sponsored: Railway Applications

Sponsored Session

Chair: Carl D Van Dyke, TransNetOpt, 6 Snowbird Ct, West Windsor, NJ, 08550, United States, carl@cvdzone.com

1 - Managing Train Scheduling To Optimize Network Capacity

Dharma Acharya, Transport Consultant, acharya.dharma@gmail.com

To move North American rail freight efficiently and reliably, an option for the railroads is to lock down on running of all scheduled and unscheduled trains over their rail network at least a few days in advance. This way railways will be able to line up resources at the right place at right time and avoid/minimize any resource waste and train delays. Railroads will also be able to better plan when trains could meet and pass on their predominantly single track corridors and be able to better predict train/shipment ETAs. We will also discuss what kind of changes in railroad’s operational practice will be needed from their traditional philosophy of running trains whenever there is enough tonnage/shipments.

2 - Managing Intermodal Capacity Through Differentiated Service Products And Load Acceptance

Carl Van Dyke, TransNetOpt, carl@cvdzone.com

As intermodal grows in sophistication and volume, it becomes important to employ effective means to manage capacity to ensure customer service expectations are met, and total revenue & profits are maximized. Currently this is being done by providing differentiated service, and adjusting the underlying terminal and train operations to both match the promised service and better balance variations of traffic volumes between services. An attitude of unlimited capacity is giving way to adopting specific constraints on capacity & the introduction of load acceptance processes. These capacity management strategies, plus some potential new ones that could be adopted in the near future, will be explored.

3 - Unit Train Management System

Bob Golbasi, CSX Transportation, Jacksonville, FL, United States, Hakan_Golbasi@csx.com, Robert Gutman

Unit Train Management System (UTMS) is a comprehensive system that was developed at CSX Transportation to bring all the relevant unit trains information together into one planning tool. A unit train is a special order train of only one commodity type that is not on a fixed scheduled. Shippers, Receivers and CSXT Unit Train Managers all work together in UTMS to ensure full visibility and alignment of upcoming trains. UTMS includes an optimization model to accept, modify or reject reservations in the selected time period based present business conditions and current and predicted availability of right cars at the right place at the right time.

4 - Connected Driver Advisory System: Cost Efficient Way For Improving Rail Traffic Management

Per Leander, Transrail Sweden AB, per.leander@transrail.se

Trains and Traffic Management in co-operation. The presentation will explain the concepts of C-DAS (Connected Driver Advisory System) and C-Cruise (Connected Cruise) for punctual and eco-efficient operation of trains and improved Traffic Management at low cost. These are concepts currently developed and deployed in Europe in order to improve punctuality, capacity and sustainability and to reduce costs. The algorithm developed by Transrail Sweden AB may be used in all types rail operations and the cost function be tuned to the specific needs of the operation. The algorithm may also be used as a powerful engine for future eco-efficient and interoperable ATO.

■ MB62

Cumberland 4- Omni

Data Mining in Air Transportation

Sponsored: Aviation Applications

Sponsored Session

Chair: Yi Liu, University of California, 107 McLaughlin Hall, Berkeley, CA, 94720, United States, liuyi.feier@gmail.com

1 - Using Historical Data To Support Traffic Management Initiative Decisions

Alexander Estes, University of Maryland-College Park, 3117 A.V. Williams, University of Maryland-College Park, College Park, MD, United States, aestes@math.umd.edu, David J Lovell, Michael O Ball

There is a large amount of data collected about traffic management initiatives that have been taken in the past by the Federal Aviation Administration. While this information could be helpful to decision-makers that are attempting to plan traffic management initiatives, this data is currently not very accessible. We propose unsupervised learning methods that identify relevant data and present it to the decision-makers.

2 - Identifying Similar Days To Guide Traffic Management Decision Making

Sreeta Gorripaty, UC Berkeley, Berkeley, CA, 94703, United States, gorripaty@berkeley.edu, Mark M Hansen

The experience of traffic flow management specialists is crucial in managing airport operations efficiently. Historical airport operations data can assist decision-making by augmenting controller experience with a systematic record of past traffic management actions under similar conditions and their consequences. A decision-support tool that finds historical days similar to a query day can guide day-of-operation decisions and assess past performance. Using machine-learning algorithms, we learn a similarity measure between two days based on weather and demand data. This measure is assessed for accuracy using airport operational outcomes and traffic management initiatives (TMI) data.

3 - Impacts Of Airline Mergers On Consumer Welfare

Vikrant Vaze, Assistant Professor, Dartmouth College, 14 Engineering Drive, Hanover, NH, 03755, United States, Vikrant.S.Vaze@dartmouth.edu, Tian Luo

We used publicly available passenger flows data and a discrete choice modeling framework to examine welfare changes due to the five major airline mergers in the past decade in the United States. We found that consolidations of legacy airlines with significantly overlapping markets generally increased the passenger welfare. However, overall passenger welfare in small communities declined after the two mergers whose small community markets data sets are sufficiently large for our analyses. We also found that welfare of passengers, traveling to or from hub airports of the primary merging airline, increased significantly.

4 - Hourly Ground Delay Program Prediction With Local And Convective Weather Variables

Mark M Hansen, University of California - Berkeley, 114 McLaughlin Hall, Berkeley, CA, 94720, United States, mhansen@ce.berkeley.edu, Yi Liu, Danqing Zhang, Alexey Pozdnukhov

We propose a method to predict ground delay program status for each hour using data mining techniques. We use local and convective weather variables as our predictors. We apply the method to 5 top-traffic US airports. The results include prediction performance, variable importance analysis and convective weather weight map.

■ MB63

Cumberland 5- Omni

HUB Location

Sponsored: Location Analysis

Sponsored Session

Chair: Sibel Alumur Alev, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, sibel.alumur@uwaterloo.ca

1 - Modeling Congestion And Service Time In Hub Location Problems

Stefan Nickel, Karlsruhe Institute of Technology, stefan.nickel@kit.edu, Sibel Alumur Alev, Brita Rohrbeck, Francisco Saldanha-da-Gama

In this paper, we present a modeling framework for hub location problems with a service time limit considering congestion at hubs. Service time is modeled taking the traveling time on the hub network as well as the handling time and the delay caused by congestion at hubs into account. We develop mixed-integer linear programming formulations for the single and multiple allocation versions of this problem. We further extend the multiple allocation model with a possibility of direct shipments. We test our models on the well-known AP data set and analyze the effects of congestion and service time on costs and hub network design.

2 - An Enhanced Milp Model For Stochastic Multi-period Multiple Allocation Hub Location

Francisco Saldanha-da-Gama, University of Lisbon, Lisbon, Portugal, fsgama@ciencias.ulisboa.pt Isabel Correia, Stefan Nickel

A two-stage stochastic programming modeling framework is proposed for a pure phase-in multi-period multiple allocation hub location problem. Stochasticity is associated with the demands. Assuming a finite support for the underlying random vector, a compact formulation can be derived for the extensive form of the deterministic equivalent, which leads to a large-scale mixed-integer linear optimization problem. By considering 4 sets of valid inequalities, the model is enhanced, which makes it possible to solve to optimality by means of a general solver, instances that could not be tackled when the original formulation was considered. Results obtained using the CAB data set are reported.

3 - Modeling Hub Location Problems

James F Campbell, University of Missouri-St Louis, campbell@umsl.edu, Sibel Alumur Alev

In this talk, we focus on some of the key features of hub location models such as demands, costs, economies of scale, capacity and service level constraints, and network topologies including single and multiple allocation and complete and incomplete inter-hub networks. We discuss some of the possible implications of how these features are modeled on the hub locations, network design and performance measures, and emphasize the characteristics within the context of different applications. Additionally, we identify some distinguishing properties of the CAB, AP, and TR data sets commonly used in hub location studies. We aim to provide a road map for future hub location research.

■ MB64

Cumberland 6- Omni

MCDM for System Design: No Camels Allowed

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Stephen Henry, Sandia National Laboratories, P.O. Box 5800, Albuquerque, NM, 87185, United States, smhenry@sandia.gov

1 - Multiple Criteria Decision Making For The United States Army's Robotic Pack Mule Design

Lucas Waddell, Sandia National Laboratories, lawadde@sandia.gov Stephen Henry

The U.S. Army has a strong interest in the development and deployment of unmanned ground systems (UGSs) to provide soldiers with many unique battlefield advantages. As with any new, complex system, UGSs present a vast array of design tradeoffs, interdependencies, and competing stakeholder goals. There is an extremely fine line between design solutions that represent fair compromises, and solutions that nobody is willing to accept. We present lessons learned from an in-depth trade study performed for the U.S. Army on the Squad Multipurpose Equipment Transport (SMET) UGS.

2 - Infrastructure Equipment Optimization For United States Military Contingency Base Designs

Alexander Dessanti, Sandia National Laboratories, Albuquerque, NM, United States, adessan@sandia.gov

Contingency bases provide temporary facilities from which deployed forces can operate overseas. These bases are large-scale complex systems with many interrelated functions, making it difficult to identify the best equipment to utilize when designing a new one without an optimization approach. The Whole System Trades Analysis Tool (WSTAT), a multi-objective optimization capability, is being applied to this problem for the U.S. Army to enable more efficient and affordable future contingency base designs. Focus will be on the unique technical challenges presented by a problem of this magnitude.

3 - Ultra-high Dimensional Optimization For Military Systems Requirements Negotiation

Stephen Henry, Sandia National Laboratories, smhenry@sandia.gov

Complex military system design begins long before the welding of metal. A key early step is the development of a set of requirements - performance levels in various categories that must be achieved by the new system. These requirements are typically drafted by separate communities of experts and lack an analytic mechanism to address incompatibilities between the individual requirements - often leading to program cancellation due to unmet requirements. In this talk, we present a new tool for ensuring holistically feasible requirements. We discuss the mathematical challenges of high-dimensional optimization (>30 objectives) as well as the human challenges of real-time requirements negotiation.

4 - A Preference-Based Evolutionary Algorithm For Bi-Objective UAV Route Planning In Continuous Space

Erdi Da demir, Hacettepe University, Ankara, Turkey, dasdemir.erdi@metu.edu.tr, Murat Köksalan, Diclehan Tezcaner Öztürk

We address the bi-objective route planning problem for unmanned air vehicles that move in a continuous terrain. We develop a preference-based evolutionary algorithm that converge the desired regions of the Pareto front using the route planner's preferences. The algorithm determines both the visiting order of the targets and the specific trajectory between targets. Experiments show that the algorithm works well.

■ MB65

Mockingbird 1- Omni

Field Experiment Research on Mobile and Social Applications

Sponsored: Information Systems

Sponsored Session

Chair: Tianshu Sun, University of Southern California, 3670 Trousdale Pkwy, Los Angeles, CA, 90089, United States, tianshu.sun@gmail.com

1 - Evaluating Consumer m-Health Services For User Engagement And Health Promotion

Vibhanshu Abhishek, Carnegie Mellon University, vibs@andrew.cmu.edu, Rema Padman, Yi-Chin Lin

Mobile apps have great potential to deliver promising health-related interventions to engage consumers and change their behaviors such as healthy eating. This study proposes and evaluates three mobile-enabled interventions to address these challenges: a mobile-based visual diary, image-based dietitian support, and peer engagement. We examined their effects on user engagement and food choices via a 4-month randomized field experiment and show a positive impact of the mobile diary and dietitian support on improving customer engagement. Specifically, the mobile-based visual diary and dietitian support each increases the log-odds ratio of user engagement by 43.8% and 50.7%, respectively.

2 - The Effect Of Product Placement On Shopping Behavior At The Point Of Purchase: Evidence From A Randomized Experiment Using Video Tracking In A Physical Bookstore

Pedro Ferreira, Carnegie Mellon University, pedrof@cmu.edu, Qiwei Han, João Paulo Costeira

Physical retailers are increasingly trying to understand in-store shopping behavior in order to increase sales. However, measuring and analyzing shopper behavior at the point of purchase in physical retailing remains challenging. In this paper, we implement an in-vivo randomized field experiment in a physical bookstore. We leverage video tracking technologies to monitor how shoppers respond to random book placement, which induces random search costs. More specifically, we randomize the position of newly released books on the top of a large table with several rows and columns such that each book's search cost becomes independent of the book's characteristics. We use advanced 3D cameras and vision-understanding algorithms that can track human motions in real-time to overcome the large costs associated to large-scale video data. This way we are able to significantly reduce the cost of encoding shopper activities by more than 80%. Our experimental results show that on an average day books placed at the edge of the table are both picked and taken more often by consumers than books placed in the center of the table. However, the likelihood of taking a book that was picked is on average similar for books placed at the edge and at the center of the table, that is, books at the edge of the table sell more only because they are, on average, picked more often. Armed with this knowledge, the bookstore manager may maximize profit by placing books with higher margins at the edge of the table.

3 - Stimulating UGC Contribution Via Performance Feedback: A Randomized Mobile Field Experiment

Yili Hong, Arizona State University, 832 W Wagner Dr, Gilbert, AZ, 85233, United States, hong@asu.edu, Bin Gu, Chen Liang, Gordon Burtch, Nina Huang

This study analyzes the effect of performance feedback on user content generation through a randomized mobile experiment. We find heterogeneous treatment effects that depend upon a subject's gender and the framing of the feedback supplied (altruistic vs. competitive). Specifically, we found that female users are more responsive to altruism-framed performance feedback, whereas male users are more responsive to competitively-framed performance feedback.

4 - Motivating Mobile App Adoption: Evidence From A Large-scale Field Experiment

Tianshu Sun, University of Southern California, Los Angeles, CA, United States, tianshu.sun@gmail.com, Lanfei Shi, Siva Viswanathan, Elena Zheleva

Using a randomized field experiment involving 250,000 customers, we investigate 1) whether and how a platform can motivate customers' app adoption and 2) the causal effect of induced mobile app adoptions on customer engagement. We find that 1) providing information or incentives can both significantly increase customers' app adoption; 2) the effect of app adoption varies greatly depending on how customers are motivated. Providing incentives increases adoption but not engagement. In contrast, providing information leads to effective mobile app adoptions that sustainably increase customers' engagement. We further look into multi-channel browsing data to understand the effect of app adoption.

■ MB66

Mockingbird 2- Omni

Data Visualization

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Fadel Mounir Megahed, Auburn University, 3301 L Shelby Center Auburn University, Auburn, AL, 36849, United States, fmegahed@auburn.edu

1 - Stock Market Exploration And Prediction Through Visualization

Xing Wang, Auburn University, Auburn, AL, 36849, United States, xzw0005@auburn.edu, Bin Weng, Fadel Mounir Megahed

Stock Market prediction has attracted much attention from both business and academia. To explore the insight from the stock market history data could help investors to make their decision more efficiently. The purpose of this study is to develop a tool for visualizing and predicting the stock market through data mining methods. In this study, the tool is developed using Shiny R, which gives users useful information via visualizing related data from disparate data sources to assist investors to make decisions. By introducing our application, we focus on two things, one is the data visualization system design, and the other is reactive programming, both are emphasized in our development process.

2 - What We Learned From Visualizing 25 Years Of Statistics Research?

Fadel Megahed, Miami University, fmegahed@miamioh.edu Theyab Alhwiti, Mohammad Alamdar Yazdi, Maria Weese, L. Allison Jones-Farmer

The size and scope of the literature on statistics can be overwhelming, which makes it difficult to identify emerging trends and see the relationships between different developments. Visualization techniques, coupled with statistical and data mining methods, have been found effective in achieving these goals in a number of application domains including healthcare and manufacturing research. In this paper, we apply these concepts to the field of statistical sciences. Our dataset is based on bibliographic information, including: authors, keywords, abstracts, citations, and funding information, extracted from 10,030 papers published in the 17 ASA journals in the period of 1991-2015.

■ MB67

Mockingbird 3- Omni

Advances in Degradation Modeling and Operations Management

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Xiao Liu, IBM T.J. Watson Research Center, 1101 Kitchwan Road, Yorktown Heights, NY, 10598, United States, liuxiao@us.ibm.com

1 - Kalman Filter Based Logistic Regression For Degradation Analysis

Erotokritos Skordilis, University of Miami, Miami, FL, United States, sge12@miami.edu, Ramin Moghaddass

We propose a new stochastic approach for degradation analysis using a combination of Bayesian Filtering and Binary Classification that can transform real-time condition monitoring signals to actionable insights. Analytical results for important reliability measures (e.g. RUL) will be given and a closed-form solution for the marginal log-likelihood function will be developed. Finally, a dynamic cost-effective predictive maintenance policy based on the proposed degradation structure will be introduced and its benefit over time-based preventive maintenance and corrective maintenance policies will be presented with a set of numerical experiments.

2 - Degradation Prediction Of Printed Images

Ziyi Wang, Rutgers University, Piscataway, NJ, 08854, United States, ziyiwangcumtb@gmail.com, Elsayed A. Elsayed

Today, a great number of images are produced by digital color printers, especially inkjet printers. Many factors lead to the degradation of such images and accurate prediction modeling of the degradation is of interest. Previous research that addresses image degradation usually measures the density loss or color change of the prints. In this presentation, the area coverage of the Neugebauer primaries for the basic four-colors (CMYK) ink-set is estimated from the spectral information of the print. A degradation model is developed to predict the area coverage loss over time. A numerical example is used to illustrate the proposed approach.

3 - Modeling Spatio-temporal Degradation Data

Xiao Liu, IBM T.J. Watson Research Center, liuxiaodnn_1@hotmail.com

This talk presents a modeling approach for an important type of degradation data, i.e., the degradation data collected over time and from a spatial domain. The connection between the proposed model and traditional pure time-dependent univariate stochastic degradation models is discussed, and an application example is provided.

■ MB68

Mockingbird 4 - Omni

Joint Session QSR/DM: Data analytics for system improvement I

Sponsored: Quality, Statistics and Reliability/Data Mining

Sponsored Session

Chair: Kaibo Liu, University of Wisconsin-Madison, WI, kliu8@wisc.edu

Co-chair: Haitao Liao, University of Arkansas, Fayetteville, AR, liao@uark.edu

1 - Kernel Fisher Discriminant Analysis For Uncertain Data Objects

Behnam Tavakkol, Rutgers University, Piscataway, NJ, btavakkol66@gmail.com, Myong K Jeong, Susan Albin

Uncertain data problems have features represented by multiple observations or their fitted PDFs. We propose measures of scatter for uncertain data objects which include covariance matrix along with within and between scatter matrices. We also propose Fisher linear discriminant and kernel Fisher discriminant for classifying uncertain data objects.

2 - An Efficient Statistical Quality Control Scheme For High-dimensional Process

Sangahn Kim1, Rutgers University, Piscatawy, Piscataway, NJ, sk1389@scarletmail.rutgers.edu, Myong K Jeong, Elsayed A. Elsayed

As the number of quality characteristics to be monitored increases in those complex processes, the simultaneous monitoring becomes less sensitive to the out-of-control signals especially when only a few variables are responsible for abnormal situation. We introduce a new process control chart for monitoring high-dimensional processes based on the ridge penalizing likelihood. The accurate probability distributions under null and alternative hypotheses are obtained. In addition, we find out several theoretical properties of the proposed method, and finally demonstrate the proposed chart performs well in monitoring high dimensional processes.

3 - A Nonparametric Adaptive Sampling Strategy For Online Monitoring Of Big Data Streams

Xiaochen Xian, UW-Madison, Madison, WI, xxian@wisc.edu, Andi Wang, Kaibo Liu

Modern and rapid advancement in sensor technology generates huge amount of data, posing unique challenges for Statistical Process Control. We propose a Nonparametric Adaptive Sampling (NAS) strategy to online monitor non-normal big data streams in the context of limited resources, such that only partial observations are available. In particular, this proposed method integrates a rank-based CUSUM scheme that corrects with the anti-rank statistics due to partial observations, which can effectively detect a wide range of possible mean shifts in all directions when each data stream follows arbitrary distribution. Two theoretical properties of the NAS algorithm are investigated.

■ MB69

Old Hickory- Omni

Military Operations Research II

Sponsored: Military Applications

Sponsored Session

Chair: Natalie M Scala, Towson University, 8000 York Road, Towson, MD, 21252, United States, nscala@towson.edu

1 - A Value Model For Cybersecurity Metrics

Natalie M Scala, Assistant Professor, Towson University, 8000 York Road, Towson, MD, 21252, United States, nscala@towson.edu, Paul L Goethals

This research applies decision analysis perspectives to cybersecurity and creates a value model for performance metrics and best practices that is supported by industry data and interviews with subject matter experts. The utility-theory based value model will include attributes and values, score metrics on their contribution to value, and provide a rank ordered list of important metrics and best practices for implementation. We illustrate the value model but contribute an overall framework that can be customized for any organization. Results will enable organizations to assess the performance of cyber systems.

2 - Efficient Benchmarking Tool Regarding Optimal Detection Of Critical Components In A Network

Gokhan Karakose, University of Missouri, gkz7c@mail.missouri.edu, Ronald McGarvey

Many mathematical and heuristic approaches have been provided to assess critical components of the network based on the network connectivity metric. Since examined objectives through this metric (e.g. minimum connectivity) have important values in many areas (e.g. immunization), proposing an effective solution framework to determine optimal values of such objectives is crucial. In this regard, we provide efficient mathematical models along with new valid inequality constraints to further decrease computational complexity compare to the most recent best models. With this improvement, we broaden the application scope of the exact solution method for the determination of critical component.

3 - OMEGA: Evaluating Effectiveness Of Proposed Systems Using Bayesian Networks

Freeman Marvin, Innovative Decisions, 5848 Hunton Wood Drive, Broad Run, VA, 20137, United States, ffmarvin@innovativedecisions.com, Amanda Hepler

OMEGA is a new approach for designing affordable systems architectures that meet user needs. OMEGA uses a Bayesian network of probability distributions that describes functional needs, system capabilities and customer satisfaction. Measures of Effectiveness (MOE) are combined to estimate the probability that a proposed system will meet mission needs. Additionally, OMEGA can "back cast" the system requirements necessary to achieve alternative levels of mission effectiveness. This innovative approach was developed by a collaborative team of requirements engineers and decision analysts. OMEGA is a flexible, low cost approach for conducting architecture trades and developing requirements for any kind of system.

4 - Designing An Objective Metric For Evaluating Army Unit Readiness

Paul Goethals, United States Military Academy, West Point, NY, United States, paul.goethals@usma.edu, Natalie M Scala

Perhaps one of the most difficult assessments to make with some level of accuracy is military readiness - it is a frequent topic of interest in defense news both in times of combat and peace. This research proposes a readiness index tailored to objectively evaluate units based upon their current status and future mission, using quality engineering tools as a foundation for measurement. A simulated comparison of the current and proposed readiness indices is provided to illustrate their differences in assessing Army units.

■ MB70

Acoustic- Omni

Transportation, Maritime II

Contributed Session

Chair: Kazuhiko Ishiguro, Kobe University, 5-1-1, Fukae-minami, Higashi-nada, Kobe, 658-0022, Japan, ishiguro@maritime.kobe-u.ac.jp

1 - Container Vessel Capacity Allocation In Liner Shipping

Michele Acciaro, Kuehne Logistics University, Grosser Grassbrook 17, Hamburg, 20457, Germany, michele.acciaro@the-klu.org, Jan Frahnert

The paper deals with the problem of vessel capacity allocation, taking into consideration priority, cargo type and time of the booking. The approach used is based on a a single leg slot allocation model based on the capacity allocation problem solved by Littlewood s Rule and the enhanced version of the EMSRa-heuristic. Protection classes for cargo types are calculated taking into account cancellations and no-shows and allowing for overbooking. The paper shows that the allocation criteria used by major container carriers are sub-optimal. An application on an existing liner shipping service illustrates the practical and economic benefits of the proposed approach in contrast to current practices.

2 - Optimization System At ENAP For Distributing Refined Petroleum Products By Tanker

Martin Quinteros, Head of Operations Research, Empresa Nacional del Petroleo, San Jose de la Sierra 50 depto 1202, Lo Barnechea, Santiago, 7710088, Chile, martinq46@gmail.com
Andres P Weintraub, Monique Guignard-Spielberg, Marc Llambias

ENAP is a petroleum state-owned company in Chile and plays a key role on the national energy matrix. A critical function on its complex supply chain is the maritime distribution to clients. We present a practical approach for determining an optimal schedule for the fleet of tankers delivering petroleum products. This process takes care of satisfying the demand for multiple end-products by multiple clients with different storage capacities and locations. The optimization model is a large scale MIP problem that was unsolvable on CPLEX but through a generation scheme in routes we were able to solve it to optimality. Our approach is currently saving 10 to 12 percent of the total operational cost

3 - Determinant Of Shippers' Port Choice In Rural Areas In Japan

Kazuhiko Ishiguro, Kobe University, 5-1-1, Fukae-minami, Higashi-nada, Kobe, 658-0022, Japan, ishiguro@maritime.kobe-u.ac.jp

This study discusses factors of shipper's port choice in rural areas in Japan by using a logit model considering "average waiting time at port" and four type of "seaborne transportation time." Average waiting time at port is derived by the calling schedule at each port. Results show that, a shippers care the average transit time in export and the longest transit time in import. It turned out that shippers consider transshipment time in case of export and it doesn't consider transshipment time in case of import. Shippers considers a sum of average waiting time at port and seaborne transportation time as a total transit time.

■ MB71

Electric- Omni

Supply Chain, Shipping II

Contributed Session

Chair: Yuen Ying Lam, Research Assistant, Hang Seng Management College, Hang Shin Link, Siu Lek Yuen, Shatin, N.T., Hong Kong, avislam@hsmc.edu.hk

1 - Benders Decomposition For Inventory Routing Problem With Perishable Product In Cold Supply Chain

Faisal M Alkaabneh, PhD Student, Cornell University, Ithaca, NY, 14850, United States, fma34@cornell.edu, Huaizhu Gao

We consider Inventory Routing Problem of perishable products. The developed mathematical model takes into account cost of CO2 emissions during the distribution process. The problem is modeled as a nonlinear mixed integer mathematical model that is difficult to solve directly. To this end, we propose a set of linearization schemes to simplify nonlinearity terms and developed Benders decomposition to solve the model. Furthermore, we provide extensive numerical analysis for Vendor Managed Inventory system taking into consideration different classes of perishable products.

2 - A Bi-level Programming Approach For Optimizing Resilience Of Port-hinterland Container Transportation Networks

Nan Liu, Professor, Zhejiang University, School of Management, Zijingang Campus, Yuhangtang Road, Hangzhou, 310058, China, nliu@zju.edu.cn, Song Gao

In this paper, we employ a bi-level programming model to optimize the resilience of the port-hinterland container transportation network when suffered from natural or human-caused disasters. At the upper level problem, the transportation network planner, i.e. the government, make recovery decision to optimize the resilience of the transportation network when facing the disasters within given budgets constraint such as money and time. At the lower level problem, the transportation network users, i.e. third party logistics companies, make decisions about the transport modes, routes and freight volume to maximize its own profit according to the recovered transportation network.

3 - Effects Of Time Incentives On Container Port Operations

Yuen Ying Lam, Research Assistant, Hang Seng Management College, Hang Shin Link, Siu Lek Yuen, Shatin, N.T., Hong Kong, Hong Kong, avislam@hsmc.edu.hk, Karolina J. Glowacka, Yin Cheung, Eugene Wong

This paper presents a simulation model of Hong Kong container port ship-to-shore operations with inclusion of time incentives and penalties for early/late work completion. The presented method allows for detailed container-level modelling. Assuming continuous berth assignment and variable-in-time crane allocation, we measure the impact of the incentives and penalties on the ship lines and port operators. We present the results for various levels of incentives and penalties, as well as contract incentive adoption rate.

■ MB72

Bass- Omni

Supply Chain Mgt VI

Contributed Session

Chair: Jie Tan, Huazhong University of Science and Technology, Wuhan, China, jietan@hust.edu.cn

1 - Supply Chain Configuration And Financial Performance: An Empirical Investigation

Marouen Ben Jebara, University of South Carolina Aiken, 471 University Parkway, School of Business, Aiken, SC, 29801, United States, marouenB@usca.edu, Sachin Modi

Disintermediation is gaining attention in pharmaceutical industry: drug companies have the opportunity to sell their products directly to the end consumers as well as to intermediaries. We conceptualize the influence of supply chain disintermediation and product portfolio on financial performance. Using secondary data collected from pharmaceutical industry, we empirically investigate the proposed hypotheses and present results.

2 - Configurations Of Distribution Strategies: An Integrated Analysis Of Quantitative And Qualitative Data In Retailing Industry

Dongtao Xu, Huazhong University of Science and Technology, 1037 Luoyu Road, Wuhan, 430074, China, xudongtao@hust.edu.cn

This paper develops a theoretical framework of distribution strategy and provides empirical evidence onthe configurations of distribution strategies and their strategic fit. To achieve this goal, we identified the configurations of distribution strategies and operational competencies with conducting an integrated analysis of quantitative and qualitative data in retailing industry.

4 - Applications Of Open Innovation To Improve Supply Chain

Tianqin Shi, San Jose State University, One Washington Square, Business Tower 465, San Jose, CA, 95192-0164, United States, tianqin.shi@sjsu.edu, Taeho Park

The concept of open innovation has changed the paradigm of R&D practices by advocating firms' efforts to use external ideas beyond their internal R&D resources. Previous studies have mainly focused on the application of open innovation on the development of new technology and products. However, the concepts and practices of open innovation are not limited to R&D management. Thus, this research provides insights into the current and potential applications of open innovation in a supply chain system. It also identifies the current practices of open innovation in supply chain management, and presents further potentials of applications of open innovation in the supply chain system.

5 - Procurement Strategy In Decentralized Supply Chains Under Supply Disruptions And Uncertain Demand

Jie Tan, Huazhong University of Science and Technology, Wuhan, China, jietan@hust.edu.cn, Haijun Wang

This paper considers a decentralized supply chain consisting of one retailer and one unreliable supplier under single-period setting. The retailer (buyer) has a chance of complete supply disruption and faces uncertain demand simultaneously. She (buyer) offers a contract (q, w), and upon it the supplier then chooses the optimal reliability level and pays for the corresponding cost of technology investment, to maximize his expected profit. Also the interaction between supplier's reliability and production cost has been considered. We finally conduct a numerical analysis with the purpose of providing several managerial suggestions for order size and purchase price as well as reliability level.

■ MB79

Legends G- Omni

Health Care, Modeling VI

Contributed Session

Chair: David J Robb, Professor of Operations and Supply Chain Managemen, University of Auckland, Graduate School of Management, The University of Auckland Business School, Auckland, 1142, New Zealand, d.robb@auckland.ac.nz

1 - A Model For Diabetes Clinical Pathway Scheduling

Hossein Badri, PhD Student, Wayne State University, 4185 4th Street, Manufacturing Building, Detroit, MI, 48202, United States, fq2529@wayne.edu, Kai Yang

Clinical Pathway is a very efficient method to improve patient care, to manage clinical risks, and to improve resource efficiency. In this research we develop a model for the scheduling of the diabetes clinical pathway. The proposed model is tested using a real data set and the performance of the proposed model is analyzed.

2 - Modeling The Screening Of Post-traumatic Stress Disorder: A Criticism Of The Current Dichotomous Categorization Of Patients

Navid Ghaffarzadegan, Virginia Tech, 1145 Perry Street, 231 Durham Hall, Blacksburg, VA, 24061, United States, navidg@vt.edu, Mohammad S. Jalali, Alireza Ebrahimvandi, Richard C Larson

Post-traumatic stress disorder (PTSD) stands out as a major mental illness and screening policies have played a critical role in mitigating the effects of PTSD; however, little agreement exists on the optimal cutoff value—a threshold above which screening scores should be considered as PTSD positive. We develop a simulation model of PTSD screening which includes social forces that inhibit accurate screening. Our analysis shows that the results of long-term optimal policies are different than their myopic short-term results. With the presence of public stigma, current dichotomous screening policies are not much effective to minimize the number of false positive and false negative.

3 - Robust Multi Product Network Design For Blood Chain A Priority Queuing System

Mohammad Abdollahi, PhD Candidate, Wayne State University, 4815 Fourth Street, Room 1067, Detroit, MI, 48202, United States, fq6861@wayne.edu, Kai Yang

This study tries to investigate best network configuration in constructing a smooth and cost effective network considering all the modification corresponding to blood supply. Some highly important blood specific considerations such as blood type priority and lateral transshipment and perishability is considered in the proposed model. To cope with the existent uncertainty related to the blood processing and traveling times, a prioritized M/M/C and M/M/C models are considered for laboratories and blood banks, respectively. Moreover, an interval robust counterpart is proposed to deal with the uncertainty in the model corresponding to demand and cost and etc.

5 - Association Between Accident Rates And Daylight Saving Time Transitions

David J Robb, Professor of Operations and Supply Chain Managemen, University of Auckland, Graduate School of Management, The University of Auckland Business School, Auckland, 1142, New Zealand, d.robb@auckland.ac.nz, Thomas P Barnes

A third of nations have adopted Daylight Saving Time, presumably hoping that benefits exceed costs. Studies have found changes in accident rates associated with DST. Using data from 21 million New Zealand accidents during 2003-2015, we model accident rates as a function of various date-based predictors including days before/after the start and end of DST, day of week, and month of year. This is the first study to consider multiple accident categories (work, home, falls, sport, & road), and the first in the southern hemisphere. We find evidence of accident rates impacted in the week prior to the start and end of DST, i.e.,anticipation effects. Our results have implications for implementation and policy.

■ MB86

Gibson Board Room-Omni

Marketing II

Contributed Session

1 - Why Do Web Retailers And P&G Use "Postage Stamp" Pricing?

Phillip J Lederer, Professor, University of Rochester, Simon School of Bus. Admin., Rochester, NY, 14627, United States, Lederer@simon.rochester.edu

First, this talk explains why some web retailers/mail order firms use zero or postage stamp type delivery charges but others set distance charges. A game theoretic model demonstrates the equilibrium decisions of a web retailer competing against reactive local retailers. I can show why Lands' End and web furniture stores set flat prices but other specialty retailers charge by distance. Second, unrecognized in the literature is that P&G and other consumer products firms set location independent delivery charges to retailers. I present an economic model explaining this pattern.

2 - Marketing Strategies And Empirical Comparisons Between Agricultural Producer Community Structures

Brian A. Bourquard, Purdue University, 403 W State Street, West Lafayette, IN, 47907, United States, bbourqua@purdue.edu, Allan W. Gray

We study agricultural community structures and how influencers relate to information channel preferences. We use 1,300 agricultural producers' ratings of information-source preferences and outside influencers from a nationally delivered survey to determine community structures with sociodemographic characteristics. We develop an empirical comparison of the producer communities' purchasing and management behaviors. We also develop a methodology to predict the most effective marketing channels for input suppliers that accounts for the changing characteristics of agricultural producers.

3 - Modeling The Exposure Effect Of Customized Promotions On Shopping Frequency: A Quasi-experimental Analysis

Russell Zaretzki, Associate Professor, University of Tennessee, 246 Stokely Management Center, Knoxville, TN, 37996, United States, rzaretzk@utk.edu, Amil Williamson, Mary Leitnaker

Modern customer relationship management frequently involves the use of customized direct-to-consumer promotions. How well do such promotions work? We focus on the impact promotions have on the frequency of visits and analyze an unbalanced quasi-experimental crossover design that provides several varieties of customized and non-customized coupons to shoppers. Differences in trip frequency among consumers during periods with and without coupons are modeled. Carryover effects of promotion, decay rates of these effects, and positive feedback in the coupon allocation mechanism are also analyzed.

■ MB94

5th Avenue Lobby-MCC

Technology Tutorial: Optimization Direct/IBM Analytics

Technology Tutorial

1 - Optimization Direct: Recent Advancements In Linear And Mixed Programing Give us The Capability To Solve Larger Optimization Problems

Dr. Robert Ashford, Optimization Direct, Inc., 202 Parkway, Harrington Park, NJ, 07640, United States, rwa@optimizationdirect.com, Alkis Vazacopoulos

CPLEX Optimization Studio solves large-scale optimization problems and enables better business decisions and resulting financial benefits in areas such as supply chain management, operations, healthcare, retail, transportation, logistics and asset management. In this tutorial using CPLEX Optimization Studio we will discuss modeling practices, case studies and demonstrate good practices for solving Hard Optimization Problems. We will also discuss recent CPLEX performance improvements and recently added features.

2 - IBM Analytics - 11:45am-12:30pm

Xavier Nodet, IBM Decision Optimization, xavier.nodet@fr.ibm.com

In this tutorial, you will learn about the new CPLEX and CP Optimizer engine features in the upcoming IBM CPLEX Optimization Studio release, including how to use the new features, how they can help you during the development of your model, and how they can speed up the resolution of your models.

Monday, 12:30PM - 2:30PM

■ Poster Session

Exhibit Hall

Monday Poster

Poster Session

Mature Oil Fields And Real Options Valuation: Simulation In The Brazilian Oil Industry

Carlos Abreu, Adjunct Professor, Federal University of Rio Grande do Norte State (UFRN), Avenida das Brancas Dunas, Natal, 59064720, Brazil, calexandreabreu@ect.ufrn.br

Real Option Valuation in the Oil industry is an important tool for decision-making valuating a potential flexibility caused by the uncertainties in oil projects. Mature fields are a considerable portion of producing oil fields around the world. These oil fields production projects need positive future expectations regarding oil prices to get a positive investing decision. The Real Options models valuates the decision to wait for better expectation in prices. In this paper we have a Real Options analysis in two simulations for mature oil field in the northeastern of Brazil applying a decision-making rule using Real Options Valuation, net present value and return on investment indicator.

Class-based Warehouse Location Allocation For Textile Products

Esra Agca Aktunc, Kadir Has University, Faculty of Engineering and Natural Sciences, Kadir Has Caddesi Cibali, Istanbul, 34083, Turkey, esra.agca@khas.edu.tr, Halil Argun, Erkin Gokce

This study focuses on building a layout plan by allocating storage space to products in a warehouse of a textile company (English Home) which allows for the minimum total travel distance of operators for order picking or placing. The study is carried out by (1) performing regression analysis for sales forecasting for each product class, (2) applying Analytical Hierarchy Process for determining product class weights, and (3) formulating and solving a linear program to minimize the weighted total distance between storage locations, collecting area, and loading dock using GAMS. Optimal solution results in 26.8% less distance required for order picking than the previous layout.

Application Of Advanced Analytics In Banking Big Data

Mou Dutta, Genpact Analytics & Reserach, Danbury, CT, mou.dutta@genpact.com

Data is meaningful when it delivers insights. Data analysis is smart when insights are actionable. In today's world big data and analytics is transforming the business end to end with smart intelligent insights challenging the conventional thought process and enabling the marketers to optimize strategies to build a genuine customer connect and cultivate a positive relationship. This presentation aims to highlight how marketers are shifting their attention to the application of cutting edge advanced analytics solutions to gain in-depth knowledge of consumer buying preferences and product affinity and hence optimize existing cross selling and up selling marketing strategies.

Efficient Algorithm To Improve Scheduling Problem Solutions

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Any choice-free manufacturing system can be represented by a directed acyclic graph (DAG) where the nodes and edges represent the operations, the sequence of the operations, and with the scheduling of the jobs respectively. Graphical wise, perturbation may occur over structure of the graph denoting scheduling or sequencing of operations. The goal of current research is to find the efficient algorithms to calculate changes to the makespan in a system under multiple structural perturbations. The paper will show that there will be savings in the complexity of the calculations if the perturbations are not extensive. As an example, a buffered job shop system is considered.

Comparing Two Goods-to-person Order Picking Systems For Online Retailing

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Using simulation modeling and an on-line retail setting, we compare the performance of two types of goods-to-person order picking (OP) systems, namely, the Kiva system and the Miniload-AS/RS with a conveyor loop (to connect the pick stations). The two systems are compared on the basis of quantitative factors such as expected throughput (line items picked per hour), expected picker and material handling equipment utilizations, and order completion times. We also compare the two systems in terms of qualitative factors that are relevant for OP systems.

Two-dimensional Cutting Problem And Pallet Loading Problem Using Industrial Robots

David Alvarez Martinez, Los Andes University, Colombia, Bogotá, Colombia; d.alvarezm@uniandes.edu.co, Guillermo A. Camacho Muñoz

We developed an automatic cutting and palletizing system, solving the two-dimensional single knapsack problem and the distributor's pallet loading problem. The system is composed by: optimization stage, code-generator, manipulator and plasma cutter (vacuum gripper). At the optimization we use a GRASP algorithm; at the code generation we use the forward kinematic model (FKM) of the manipulator. The GRASP was validated by using the classical benchmarks. The FKM was validated using the simulator and the controller provided by the Robot vendor. Finally, we enhanced the cutting procedure through a post-processing. It reduces the time and keeps the accuracy, but increases particulate generation.

Meaningful Use Of Health Information Technology And Process Quality Of Care At Hospitals: A Patient Safety Culture Perspective

Ajit Appari, University of Texas Health Science Center at Houston, 1200 Pressler Street, RAS W-310, School of Public Health, Houston, TX, 77030, United States, ajit.appari@uth.tmc.edu
Xin (David) Ding, Rajendar R Aparasu

Based on the Resource Based View and Sociotechnical System Theory, we examined the synergetic effect of meaningful use of health information technology (IT) and patient safety culture on hospital quality of care performance. Hospital safety culture was measured using composite score derived from confirmatory factor analysis. Health IT meaningful use was measured as composite index of nine meaningful use criteria with patient days as weights. We analyzed data from 305 nonfederal acute care hospitals using two-step Heckman estimation approach and adjusting for autocorrelation in performance outcomes. Our results show empirical support for the hypothesized relationship.

Gait Assessment: Correlation Of Gait Parameters With Falls Among Patients With Cognitive Impairment

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Pinar Keskinocak, Joe Nocera, Gregory J Esper

In aging, alteration in the customarily stable gait pattern is one of the most consistent predictors of falls. Adults with cognitive impairment fall 5x more than their cognitive intact peers. In this study, we assess the correlation between gait characteristics captured by gait mat technology and history of falls among patients with Mild Cognitive Impairment and Alzheimer's Disease diagnoses.

On Optimization Of Carbon Capture, Utilization, And Storage Supply Chains Under Uncertainty

Mahnaz Asghari Khankandi, Virginia Tech, Blacksburg, VA, 24060, United States, mahnaz@vt.edu

Carbon capture, utilization, and storage (CCUS) is a crucial technology to mitigate climate change. Due to the high costs of the technology, a great deal of attention has been focused on how the captured Co2 can be optimally utilized or stored. We study optimizing CCUS supply chains under an uncertain environment. In this poster, we present an algorithm to generate a candidate network for Co2 transportation and a model for optimizing the utilization and storage of the captured Co2 in CCUS systems.

Ethanol Risk Management Modeling

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A theoretical model is developed including margins and risk is measured using value at risk (VaR). An empirical model is developed and extended to VaR using copulas to analyze the marginal distribution and dependence structure for input and output prices on margins. Efficient frontier curves analyzing VaR with and without copula are discussed. The results compare varying risk-strategy measures for long corn, short corn, and combining short and long corn. Sensitivity analyses are conducted for functional changes in the margin as a result of ethanol price changes.

A Location Allocation Model For Facility Planning To Minimize The Operational Cost

Damitha Bandara, Dr., Albany State University, 2805, Albany, GA, 31721, United States, damithb@g.clemson.edu

Locating and allocating distribution centers optimally is a crucial and systematic task for decision-makers. Optimally located distribution centers can significantly improve the logistics system's efficiency and reduce its operational costs. In this research, we develop a mathematical model to determine the optimal locations and allocations for distribution centers that minimizes the operational cost. The model is used to find the optimal location and allocation of distributions centers for a leading company in the USA. Computational results show that the company can reduce their operational cost significantly by implementing new optimal distribution locations.

Inference For The Progressively Type-I Censored Step-stress ALT Under Interval Monitoring

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Tianyu Bai

A step-stress ALT under progressive Type-I censoring was considered when a continuous monitoring of failures is infeasible but inspections at certain time points is possible. In addition to the accelerated failure time model, a general scale family of distributions was considered for flexible modeling. The MLE of scale parameters and their conditional densities could be derived explicitly. Using the exact distributions of the estimators, confidence intervals for the parameters were obtained and numerically assessed.

A Probabilistic Unit Commitment Model

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Stochastic unit commitment models allow calculating an optimal trade-off between the cost of scheduling and activating reserves, load shedding and curtailment, but may become computationally intractable for real-life power systems. Therefore, we develop a probabilistic unit commitment (PUC) formulation, which allows internalizing the reserve sizing and allocation in a deterministic unit commitment problem, considering the full cost of reserve allocation and activation. This PUC formulation yields UC schedules that are nearly as cost-effective as the theoretical optimal solution of the stochastic model in calculation times similar to that of a deterministic equivalent.

Understanding Vehicle Movement Patterns With Artificial Neural Networks

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This research evaluates the question if we can understand the vehicle movement patterns depending o their (Geographic Identification Systems)GIS data. The research propose to classify the vehicle movements as the work they are doing with machine learning algorithms. The results label the vehicle movement states and make it possible to evaluate the performance of the vehicles which is an essential need for work vehicles, personal devices and vehicles, and vessels. The poster also explains the data preparation and the algorithms such as decision tree, random forest, and neural networks to classify the geospatial data.

Algorithms For Identifying Optimal Inspection Paths In Pipe Networks

Thomas Ying-Jeh Chen, University of Michigan, 1780 Broadway Street, Apt S128, Ann Arbor, MI, 48105, United States, tyjchen@umich.edu, Seth Guikema

The inspection of aging water distribution pipes is an important process for utilities. Due to limitations on inspection capabilities (~2% length of system is typically inspected annually), an optimization process is needed to suggest inspection paths. This paper examines the use of 3 algorithms (Genetic Algorithm, Simulated Annealing, Greedy Search) in finding paths that maximizes high risk pipes being inspected while reducing the number of pipe feature changes (material, diameter etc.). The algorithms were applied to a grid network and a virtual water distribution network. Both cases demonstrated genetic algorithms were the most effective in identifying strong candidates for inspection.

Properties Of Location Based Social Networks And Travelers Destination Choice

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The aim of this study is to investigate the relationship between friendship and distance, the possible influence of friendship in travelers' destination choices, and the importance of this factor in choosing a destination. By analyzing social network properties of two Location based Social Networks (LBSNs), the characteristics of LBSNs are identified. Results show that in general, the distance has the strongest influence on travelers' destination choices, followed by personal preference and social influence from their friends on-line. For users whose friends are in geographical proximity to each other, a possible synchronization characteristic amongst individuals is investigated.

Stadiums And Contraband: A Study On Metal Detectors In The Field

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Sports stadiums are increasingly using walk-through metal detectors for patron screening. We utilized experimental design to understand detection rates of real contraband items. These items were identified through interviews of various subject matter experts. Experiments were carried out on machines borrowed from stadium venues. We also created a testing scheme for the metal detectors to ensure functionality prior to events.

Assessing Uncertainty: A Model-output Oriented Approach

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Erik T. Verhoef, Anming Zhang

The present paper develops the concept of continuous uncertainty types, which are defined by the extent to which uncertainty affects the firm's optimized price markups and quantities (i.e., "model outputs"). We show that this model-output orientation can cover scenarios where additive, multiplicative and many more stochastic structures all occur with positive probabilities. This approach allows a compact assessment of the impacts of uncertainty. We further show that the optimal inventory level, and the composition of inventory in terms of the number and size of production units, depend strongly on the type of uncertainty and its distribution as defined according to our theory.

Explaining Energy Bonds' Option-adjusted Spread (OAS) Using Multiple Exponential Regression Models

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In order to explain the OAS of corporate energy bond, we developed exponential regression models for prediction. We found that as the oil prices drop, the OAS of energy bonds widen significantly. The sensitivity of OAS to oil price varied among energy subsectors in line with leverage. In addition, adding treasuries yield predictor could significantly increase the predicting accuracy. In particular, these two variables can explain 87.4%, 75.6%, 86.5%, 64% and 84.4% of credit spread changes for independent, integrated, midstream, oil field, and refining energy bonds respectively. Our predictive model provided a tool to monitor risk and signal rich or cheap bonds as potential buy/sell candidates.

Deep Learning For Sleep Assessment

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Based on the physiological and neurological features, sleep is divided into two main types: Rapid Eye Movement, and non-rapid eye movement. NREM sleep consists of three stages, stages 1-3. Brain activity during sleep stochastically alternates between stages. In order to judge sleep, clinicians record the electrical activity of the brain through an electroencephalogram, and visually inspect the results to classify them into the three stages. This process is referred to as "sleep scoring". We apply a deep learning algorithm to automatically score sleep and provide monitoring of sleep quality.

Inventory Placement Supply Chain With Two Competing Retailers

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This study examines service time competition in the context of inventory and environmental constraints. We first discuss the case of a downstream duopoly market without regulator, and then we extend the model by including a regulator that is dedicated to carbon emission abatement. We analyse how service time can be affected internally through inventory placement and externally through market competition as well as government regulation of carbon emissions. The results suggest that although expedited service requires higher safety stock, increasing unit inventory holding cost does not seem to slow down service, nor does imposing higher carbon tax.

Decision Support Model To Planning A Mobility Scheme For Critical System Services In Urban Networks With Natural Interruptions

Andrea Margarita Ditta, Universidad del Norte, km 5 Antigua vía Puerto Colombia, Barranquilla, Colombia, dittaa@uninorte.edu.co, Ruben Yie, Gina Galindo

This work aims to design a Decision Support Model (DSM) to planning a mobility scheme in emergency scenarios in urban networks. The DSM seeks to evaluate the transportation between points of incidents and points of care. The research is focused in the area of humanitarian logistics considering natural interruptions like streams, storms, downpours, among others. We undertake emergency response systems with critical services. Fire brigade, police force requirements or urgent medical attention, are examples of critical services.We hope to increase the efficiency in dealing with emergencies, by decreasing attention times and risk of accidents.

Supermarket Optimization: Simulation Modeling And Analysis Of A Grocery Store Layout

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This is a study on how to optimize the layout of a supermarket in order to increase its gross profit via the maximization of impulse sales. In most supermarkets many items often get unnoticed because on average customers only walk one-third of the store. Recent advances in marketing research reveal that encouraging customers to walk longer paths can often increase spending because they are exposed to more products. Retailers can then increase their sales by using the store layout—i.e., the design of the aisles and the product location—to extend the customers' shopping paths and thus indirectly motivate them to purchase items that are not originally on their shopping list.

Allocation Of Organization's Resource Using Data Envelopment Analysis & Topsis Method: A Case Of Capital Medical University

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We proposes a DEA-TOPSIS combined method for the problem of organization's resource allocation. This method, firstly, measures the DMUs'relative efficiency using DEA model, and determines the organization's efficiency objectives and alternatives. In the second stage, we ranks the alternatives using TOPSIS method for organization making decision. DEA measures the DMUs' relative efficiency about multiple-input and multiple-output index, so it is theoretically possible to the decision matrix for the TOPSIS method. Taking the 10 affiliation hospitals of capital medical university for example, results show DEA-TOPSIS combined method can sequence alternatives effectively.

Spent Microbial Biomass As An Alternative Fertilizer: A Spatial Cost And Optimal Product Mix Analysis

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High commercial fertilizer costs have necessitated further investigation into alternative sources of N, P, and K to meet the fertility requirements of crops grown in East Tennessee. The objective of this analysis is to determine the optimal fertilizer mix strategy and minimum cost threshold for utilizing spent microbial biomass as an alternative to commercial fertilizer in Loudon County, Tennessee using a linear programming model. Additionally, the analysis will examine the optimal spatial distribution of the spent microbial biomass across typical crops and crop rotations.

A Cyber-physical Vulnerabilities Framework For Manufacturing Systems: A Quality Control Perspective

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With recent technological advancements, manufacturing systems have become more susceptible to cyber-attacks that can maliciously affect the physical world. Moreover, such cyber-physical attacks can be designed to avoid detection by traditional Quality Control (QC) tools. Hence, this work proposes a framework that allows for understanding the relationships between QC systems, manufacturing systems, and cyber-physical attacks; in order to develop better QC tools minimizing the chances of such attacks being effective in manufacturing systems. The proposed framework analyzes the different levels involved in cyber-physical attacks and explores potential QC tools exploitation mechanisms.

Analysis Of Competition And Cooperation Strategy Of Railway Inland Port And Seaport

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China government has constructed a number of inland ports to narrow the economic development gap between coastal developed areas and inland area. The function of inland port is similar to seaport; especially to those inland ports possess an international express railway could transport cargoes by freight train directly from inland region to abroad. Given that, there is a new decision problem urgent to solving for urban policy maker and related enterprises: what is the optimal strategy (competition /cooperation) for the inland port and seaport? In this sense, we aim to construct a competition-cooperation model to support the port operators and local government to make decisions on strategy level.

Optimal Number Of Choices In Rating Contexts

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In many settings people give numerical scores to entities from a small discrete set, e.g., attractiveness from 1-5 on dating sites and papers from 1-10 for conferences. We study the problem of understanding when using a different number of options is optimal. We study several natural processes for score generation. One may expect that using more options always improves performance, but we show that this is not the case, and that using fewer choices—even just two—can surprisingly be optimal. Our results suggest that using fewer options than typical could be optimal in certain situations. This would have many potential applications, as settings requiring entities to be ranked by humans are ubiquitous.

Information Technology Investment And Logistics Outsourcing Contract

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Third party logistics (3PL) providers have invested a lot in information technologies (IT) to improve its logistics service quality. We compare four different contracts for logistics outsourcing and consider a 3PL's investment in IT. We find that the performance of contracts is related to the 3PL's IT investment.

Comparing The Impact Of Park And Ride, Non-park And Ride, And Terminals On Schedule Time For The Hudson-Bergen Light Rail

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The Hudson-Bergen Light Rail transportation service provides commuters accessible ways to travel throughout Hudson and Bergen Counties in New Jersey. In addition, commuters have the option to use a "Park and Ride" service adjacent to several light rail stations. Hence, this study investigates the service quality with respect to the efficiency and reliability of train arrival and departure time.

The Effect Of High Socioeconomic Inequalities On The Educational Efficiency

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This study constructs a two-stage model that takes into account the link between educational efficiency and socioeconomic indicators, using DEA methodology followed by the tobit regression. These aims are achieved using data from 5,020 municipalities in Brazil. The results suggest that for less wealthy municipalities other factors than expenditure per capita have much more influence on IDEB, but for the richest municipalities the expenditure per capita is considered an efficient determinant of education. The tobit regression results strongly confirm that municipalities with high inequality are inclined to have lower educational efficiency.

Obtaining Lower Bounds For Conditional Value-at-risk Optimization In Stochastic Mixed-integer Programs

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Recently, optimization of risk measures has attracted attention in stochastic mixed-integer programs. Computational issues regarding lower bound for Conditional Value-at-Risk (CVaR) models, however, are largely unexplored. We present a method to obtain convergent and tight lower bounds from the Progressive Hedging Algorithm (PHA) for CVaR-based stochastic mixed-integer programs. This method can assess solution quality for PHA and also integrate with exact algorithms that rely on lower bounds. We report computational results on stochastic server location and manufacturing instances.

Evaluation Of Traffic Management Strategies At The Swedish Emeregency Call Center

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The Swedish emergency call center fail in achieving government agreement regarding availability. In this project we evaluate different traffic management strategies using our designed discrete event simulation model, also supposed to apply as a traffic planning tool assisting daily issues. Outputs from the study has so far contributed to the managerial decision of implementing a new strategy, currently being evaluated. The result from this evaluation is statistical significant. As a result of our evaluation we have pinpointed some challenges of great value for the management team. For instance, if they measure sociological parameters, the model performance will be significantly improved.

The Growing Role Of Analytics In Management Education

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Business schools are under growing pressure to engage in significant programmatic reforms in light of the business community's call for web-savvy, problem solving graduates. The increase use of Analytics represents one approach for helping addressing these challenges. The purpose of this presentation is to highlight best practices in the use of Analytics throughout the management

VHA Supply Chain Enterprise System Benchmarking Analysis

Julie Lynn Hammett, Texas A&M University, 301 Holleman Dr E, Apt 728, College Station, TX, 77840, United States, jhammett@tamu.edu

We present the final outcome of a benchmarking analysis of supply chain enterprise systems conducted by Texas A&M University for the Veterans Health Administration and the Veterans Affairs Center for Applied Systems Engineering. This project entailed market research, stakeholder analysis, functionality requirements definition and prioritization, and benchmarking analysis using SWOT and Data Envelopment Analysis. The use of dual benchmarking methodologies was beneficial for representing the alternatives to the varied perspectives of the decision making units.

Non-convex Problems For Long-term Hydropower Scheduling

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With its large operational flexibility, hydropower may provide spinning reserves at a low cost. With the introduction of a market for providing capacity in the scheduling, the unit commitment problem in the stochastic multistage hydropower scheduling problem becomes essential. This is mainly due to the minimum generation restriction for a hydropower station that should be enforced to ensure a practicable dispatch. This work will focus on methods to solve these kinds of problems, and evaluate its importance for the hydropower scheduling problem. Methods that will be applied are Stochastic Dynamic Programming (SDP) and Stochastic Dual Dynamic Programming (SDDP) with possible extensions.

A Two-echelon Decomposition Method On Fresh Product Distribution Problem

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Refrigerator cars are widely used for fresh product distribution. The energy consumption of these vehicles is sensitive to the environment temperature. To reduce operation costs of third-party transportation providers (TPTP), the refrigerator car scheduling problem is addressed in this research. A time-dependent mixed-integer programming model is established to reduce total operation costs. An adaptive heuristic method is proposed by combining the variable neighborhood search and particle swarm optimization.Numerical experiments are conducted to demonstrate the effectiveness of the proposed time-dependent decision model.

Modeling Capacity Planning Projects In The Automotive Industry Using A Markov Decision Process

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To support automotive OEMs in time-phased decision making during capacity planning projects connected to new vehicle introductions, we present a dynamic programming approach based on a Markov Decision Process. We employ Bayesian updating to anticipate forecast updates and adapt standard risk measures. Our methodology is superior over alternative stochastic approaches.

Assessment Of Clustering Algorithms Based On A Data Mining Technique

Youngseon Jeong, Assistant Professor, Chonnam National University, 77 Yongbong-ro, Buk-gu, Gwangju, 61186, Korea, Republic of, youngseonjeong@gmail.com

This research presents a novel performance assessment of clustering compactness based on one-class classification algorithms. The proposed method evaluates the compactness of each cluster by using support vector data description (SVDD) and Bayesian support vector data description (BSVDD), which is robust to arbitrary shapes of a clustering. In addition, the proposed approach can accurately evaluate a clustering compactness in kernel space. The experimental results show that the proposed method can evaluate the accurate compactness for arbitrary shapes of a clustering.

The Status, Development Potential Prediction And Policy Recommendations Of New Energy In China

HongDian Jiang, Master Degree Candidate, China University of Petroleum, No.18, Fuxue Road, Changping District,, Beijing, 102249, China, cupjhd@163.com, KangYin Dong, RenJin Sun

By combining the GM (1, 1) grey model with BP neural network model and establishing a combined Grey-BP modelling tool, future the development potential of China's new energy is forecasted. In addition, the ranking of the development potential for the different new energy fuel types is performed, from both the development scale and growth rate perspective. According to our estimation, China's total new energy consumption will increase to 690.5 Mtoe in 2020, accounting for 19.7% of the domestic energy need. Besides, according to the rank results, nuclear and solar energy will be considered as future oriented composition of the new energy, as well as hydropower considered as the key element in China.

Predictive Maintenance From Analysis Of Airplane Sensor Data

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Unscheduled maintenance drives 10% of the annual operational cost to airlines worldwide. Predictive Maintenance could reduce those costs, particularly when synchronized with airline's operations. By using engineering expertise, statistics and machine learning on aircraft sensor and fault data, as well as analysis of an airline's flight and maintenance schedule, we detect impending issues on the aircraft and suggest maintenance tasks in accordance with the prediction and an airline's working rhythm. These predictive maintenance tasks will increase reliability and reduce unscheduled maintenance.

Eliminating Preventable Motor Vehicle Accidents Through Simulation Scenarios Of Vehicle Modifications

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Facilitator for express work out initiative to determine ways to improve driving performance in enterprise divisions. Developed SharePoint team site. Supported effort with Jack 7.1 simulation tool model to evaluate statistical significance of vehicle improvements with extended graduate student team resulted in optimized scenarios where the certain vehicle modification resulted in an improved visibility measured by simulation software. Consequently, the study led to proved solutions in order to eliminate preventable accidents.

Building A Luxury Products Evaluation Model

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Considering the market size and history of luxury product, it is very surprising that there is no holistic model to evaluate luxury product market. In this study we try to propose comprehensive perspectives and policy considerations on existing research about the evaluation of luxury products in terms of both product characteristics and value. It has been focused on the brand value. Even though it needs the verification process of proposed evaluation model, this research indicates that it considers the new viewpoint of the evaluation of luxury products. Therefore, the following study will be substantiated based on case study and focused expert group interview.

Strengthening Keystroke Dynamics Based User Authentication Based On User Adaptive Feature Construction For One Class Classification

Junhong Kim, Korea University, Seoul, Korea, Republic of, junhongkim@korea.ac.kr, Haedong Kim, Boseop Kim

This study present a new KDA method based on one-class classification(OCC) with user-adaptive feature construction scheme. Since users have their own typing patterns, the average typing speeds of digraphs are also different between users. Hence, we construct eight features by considering the rank of the typing speed of digraph for four typing speed measures for each user. A total of five OCC is then trained for a valid user is applied to classify a new keystroke data. We collected more than 10,000 keystrokes from 150 participant. Based on the experiment with 25 combinations of training and test keystroke size, the proposed model yielded lower EER than the conventional feature construction method.

Evaluating Information Quality For News Articles Based On Topic Modeling

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We propose two topic model-based information quality evaluation measures for news articles: Relevance and Uniqueness. Relevance of an article is assessed by the weighted sum of the average per-topic posterior probabilities of user-provided keywords and the per-document topic distributions. Uniqueness of an article is assessed by the score of a novelty detection algorithm based on per-document topic distributions. The proposed model is applied to Korean economic news articles and qualitatively verified by domain experts.

Why Firms Disappear: Bankruptcy In The Thoroughbred Horse Industry's Social Network

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I look at how social influence in the Thoroughbred Horse Industry network can influence the value for goods at auction. Firms going through a bankruptcy are forced to sell off their goods while the network of social connections is affected by the news of their impending bankruptcy. I analyze whether the network takes into account that these firms will not exist in the future. I use clustering analysis to find network patterns in which account for the differences in network structures related to the node deletion from 2010-2014.

Nondestructive Quality Inspection Using Piezoelectric Transducers Affixed To A Fixture

Tomilayo Komolafe, PhD Candidate, Virginia Polytechnic Institute and State University, 1145 Perry Street, Blacksburg, VA, 24061, United States, tomilayo@vt.edu

Product change detection is of utmost importance in any manufacturing environment and it is one of the major goals in quality control practices. Some changes could be due to a malicious cyber-physical attack which is inherently very difficult to detect by traditional inspection schemes. This study proposes to use piezoelectric transducers (PZT) affixed to a fixture to perform nondestructive quality inspection. Mechanical impedance information is obtained through exciting the PZT bonded to the fixture-part combination and signal processing is used to identify presence of an alteration.

Demand-driven Movie Scheduling In A Multiplex

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A cinema chain is confronted with the weekly problem of creating a movie schedule. Decisions need to be taken about the set of movies, the assignment to screens and the start times. The proposed model improves this decision-making process with possible objectives like the increase of total attendance or revenue.

Unittracker: Enhancing Conventional Generation Modeling Resolution In The Regional Energy Deployment System (ReEDS) Model

Venkat Krishnan, Engineer, National Renewable Energy Laboratory, 15013 Denver West Parkway, Golden, CO, 80401, United States, Venkat.Krishnan@nrel.gov, Jonathan Ho, Kelly Eurek

The Regional Energy Deployment System (ReEDS) model is the National Renewable Energy Laboratory's flagship planning model for projecting the long-term build-out and operation of the U.S. electric power generation and transmission system. In this poster, we explore the effects of model resolution on solution quality and tractability. Specifically, for each of 134 load balancing areas in ReEDS, we increase the resolution of conventional plant thermal efficiencies and examine the consequent impacts on the planning results from ReEDS.

Network Simplex Based Algorithm For The Minimum Cost Flow Problem With Linear Interdependencies

Adam Rumpf, Illinois Institute of Technology, 10 West 32nd Street, Room 208, Chicago, IL, 60616, United States, arumpf@hawk.iit.edu

We consider a generalization of the minimum cost network flow problem in which the flows through certain arcs are bounded by linear functions of the flows through other arcs. This formulation can be used to model interdependent infrastructure systems, for example a subway system whose components require delivery of electrical power from a separate system. We characterize the basis of this problem as a spanning forest plus some supplementary structures, and use these to develop an efficient solution algorithm based on the well-known network simplex algorithm. This is joint work with H. Kaul.

Modelling Competitive Equilibrium Prices For Energy And Balancing Capacity In Electricity Markets Involving Non-convexities

Andre Ortner, Researcher, Technical University of Vienna, Gusshausstraße 25-29, Vienna, 1040, Austria, ortner@eeg.tuwien.ac.at, Daniel Huppmann

In economic analyses of markets often the dual variables of market clearing equations derived from the optimal solution of cost-benefit optimization models are interpreted as efficient market prices. Whereas in convex (linear) problems the validity of this approach is undisputed it cannot be generalized to problem formulations containing non-convexities. The withholding of spinning reserves in electricity markets are a good example of such cases as costs in these markets are essentially driven by indivisibilities. In this paper we present a novel modelling approach designed to find equilibria in binary games to derive equilibrium prices of self-committed electricity market models.

Multi-period Matching Under Relaxed Stability

Zihao Li, Georgia Institute of Technology, 765 Ferst Drive, School of ISyE, Atlanta, GA, 30332-0225, United States, zli66@gatech.edu, Özlem Ergun, Julie L Swann

Organizations sometimes face challenges in producing assignments of staff to jobs that are good (in the sense that preferences are met), and stable (which promotes high morale and less turnover in staff). In some situations, assignments have to be made more than once, allowing organizations to be more flexible in making assignments and negotiate with workers more efficiently. We extend the stable matching problem to a multi-period setting and consider stability as measured over all periods. We consider notions of relaxed stability to improve the quality of matching by analyzing stability over the entire horizon of the assignment.

Stochastic Optimal Power Flow With Forecast Errors And Failures In Communication

Basel Alnajjab, Lehigh University, 19 Memorial Drive, West, Bethlehem, PA, 18015, United States, bra212@lehigh.edu, Alberto J Lamadrid, Rick S Blum, Shalinee Kishore, Lawrence V Snyder

The role of communication networks in supporting the operation of power grids will become increasingly more critical as we continue to integrate renewable energy sources into power grids, We present a stochastic optimal power flow formulation in which we account for errors in forecasting future load and renewable generation while also considering random failures in the communication network employed to communicate the realized values of the quantities for which we have forecasts. The communication network is also assumed to be employed for the control of loads and generators in the power system. We present results comparing different topologies for the communication network.

Reducing Response Categories In Multinomial Regression

Brad Price, West Virginia University, College of Business and Economics, PO Box 6025, Morgantown, WV, 26506, United States, brad.price@mail.wvu.edu, Adam Rothman, Charles Geyer

In this work we propose penalized likelihood estimators to reduce the number of response categories in multinomial regression. Typically the multinomial model is made simpler by trying to reduce the number of covariates in the model. We instead approach it by combining response categories in situations where a set of covariates does a poor job of differentiating between these categories. An ADMM algorithm is proposed, and convergence properties presented. Tuning parameter selection is also addressed.

Reliability And Economic Criteria To Determine Management Policies Of Wind Energy Systems With Storage

Cristina M Azcarate, Universidad Publica de Navarra, Dep of Statistics & OR, Campus Arrosadia, Pamplona, Navarra, 31006, Spain, cazcarate@unavarra.es, Fermin Mallor, Pedro Mateo

Electrical energy storage systems integrated into a renewable generation system reduce the effects of forecasting errors and enable the determination of management policies. In this work, we propose a management strategy for a wind energy system with storage capacity that integrates tactical and operational decisions in a single stochastic mathematical model. The mathematical model includes economical and reliability criteria, and an updated probabilistic wind speed forecast. A simulation model inspired on a real wind-hydrogen energy system is built to assess the performance of this strategy.

Electric Transmission Expansion Considering Property Value Reduction On Routing

Juan Andrade, University of Texas at Austin, 4405 Avenue A, Apt 11, Austin, TX, 78751, United States, jandraderam@utexas.edu, Ross Baldick

The development of utility scale renewable generation requires new transmission infrastructure, whose proximity to urban areas produces social opposition. This opposition can be quantified as a social cost produced in property value reduction by transmission proximity to population. It is presented a MILP formulation that minimizes costs for generation, and investment and social impact for transmission considering an electrical and a routing networks. An implementation that uses geographical information was developed, and tested with typical IEEE test systems.

Detection Of Copyrightable Images From Social Media Feeds

Manoj Pooleery, Scopio LLC, 175 Varick St, New York, NY, United States, manoj@scopio.io, Binu Josephi, Jinjin Qin

Finding ``original" images-those that can be potentially protected by copyright laws-from social media channels is a challenging problem. The images may contain objectionable/unusable content (spam) and are often modified by users by addition of text, change of texture and color. This paper presents a framework for detection of original images by first filtering out spam, then identifying presence of user generated text and finally augmenting the decision making process by manual curation & verification. Empirical results obtained from Twitter & Instagram feeds suggest that an automated technique for identification of original images with minimal manual intervention can be developed.

Application Of Data-driven Analytics To Optimal Decisions

Meng-Chen Hsieh, Assistant Professor I, Rider University, 2083 Lawrenceville Rd, SWG 313, Lawrence Township, NJ, 08648, United States, mehsieh@rider.edu, Jeffrey Simonoff, Clifford Hurvich, Avi H Giloni

In operation research and management science problems, a traditional approach in deriving optimal decision rules under uncertainty has been to optimize an univariate target quantity while ignoring the presence of auxiliary variables. These auxiliary variables, if used wisely, can provide valuable information on their association with the target variable and thus substantially reduce the target variable's prediction uncertainty. This work provides guidelines on applying statistical learning to leverage the association between target and auxiliary variables thereby enhancing the efficiency of optimal decisions.

Modeling In-Process Machining Data as Spatial Point Clouds vs. Time Series: Research Challenges and Opportunities

Mohammed Shafae, PhD Candidate, Virginia Tech, Blacksburg, VA, United States, shafae1@vt.edu, Lee Wells, Jaime Camelio

Traditional approaches for analyzing machining process data revolve around representing them as time-series. What tends to be missing is the relationship between the time-series and the part physical dimensions. This research discusses the concept of a novel representation of machining data as spatial point clouds and the corresponding practical advantages.

Using Anom Slicing For Multiway Models With Binomial Or Poisson Data

peter wludyka, CEO, Wludykaandassociates, 4285 Baltic Street, Jacksonville, FL, 32210, United States, pwludyka@unf.edu, John Noguera

Results from "Using ANOM Slicing for Multi-Way Models with Significant Interaction" (Wludyka, JQT 2015) are extended to binomial and Poisson data. Analysis of Means (ANOM) slice charts using an overall estimate for the proportion/rate (which will often have more power than by analysis charts) are presented.

Data-driven Decision Making In The Sharing Economy

Qiaochu He, Assistant Professor, University of North Carolina, Charlotte, 9201 University City Blvd., Univ. North Carolina, Charlotte, NC, 28223, United States, qhe4@uncc.edu
Yun Yang

In this presentation, we propose several new models related to the sharing economy. We investigate this industry from a data-driven perspective, and focus on the following issues: (1) Delayed matching mechanism in a two-sided market; (2) The value of forecasting in matching with uncertainty; (3) Emerging service mechanism in the sharing economy.

Optimization Problems In The Design And Control Of Internet Fulfillment Warehouses

Sevilay Onal, PhD Candidate, New Jersey Institute of Technology, 323 Dr Martin Luther King Jr Blvd, Newark, NJ, 07102, United States, so59@njit.edu, Jingran Zhang, Sanchoy Das

Internet Fulfillment Warehouses (IFWs) are facilities that have been designed and built exclusively to process online retail orders. The nature of e-commerce is described with a high number of transactions in small quantities. Therefore, human controlled systems are being replaced with total digital control. Thus, a revision is required for existing methodology such as adoption of pick and storage policies, resource allocation strategies, warehouse design and control. We aim to introduce the operational and design environment of IFWs and summarize associated emerging optimization problems

Container Port Selection In West Africa A Multicriteria Decision Analysis

Rivelino De Icaza, PhD Candidate, University of Arkansas, 1301 N Prairie Dunes Trail, Apt 305, Fayetteville, AR, 72704, United States, rdeicaza@uark.edu

West Africa gross domestic product is expected to grow to 6.2 percent in 2016 and port capacity will increase by over 12 million TEUs by 2020. Despite the region economic potential and the steady grow of container traffic over the years, port selection decision by shipping lines is complex because the region still has poor shipping infrastructure and political instability that impact transportation security, and consequently the logistics and supply chain services. This research applies a multiattribute value theory (MAVT) with valued-focused thinking (VFT) and an alternative-focused thinking (AFT) methodologies to develop a shipping lines' container port selection decision models.

Dynamic Data-driven Physician Rostering Under Variable Availability

Monique Bakker, City University of Hong Kong, Hong Kong SAR, Hong Kong. mbakker2-c@my.cityu.edu.hk, Kwok L. Tsui

Efficient staff rostering and patient scheduling to meet outpatient demand is a very complex and dynamic task. Medical specialists are typically restricted in sub-specialization, serve several patient groups and are the key resource in a chain of patient appointments at the outpatient clinic, endoscopy unit, and surgical unit. We present a new, data-driven algorithmic approach to automatic allocation of specialists to activities and patient groups. This approach minimizes variability in specialist activity rosters. It outperforms traditional cyclic scheduling with increased patient service level (% patients served in time) and capacity utilization, and decreased patient wait time (days).

How Can Mathematical Modelling Quantify Future Fishing Risks Under Climate Change Scenarios?

Sara Rezaee, Dalhousie University, Halifax, NS, Canada, BC, Canada. sara.rezaee@dal.ca, Ronald P. Pelot, Christian Seiler, Alireza Ghasemi

Studies have shown that extreme weather factors can affect fishing safety significantly. Changes in weather patterns due to climate change effects will add uncertainty to fishing safety systems. This study proposes a framework to quantify fishing incident risks in the future due to changes in weather conditions. The framework builds relationships between fishing incidents and weather conditions based on historical data using mathematical modelling and data mining techniques and then predicts future risks according to these relationships with respect to potential changes in weather patterns.

Evaluation Of Low Carbon Level Of Enterprise Logistics Based On Improved Entropy Law And Cloud Model

Mi Gan, Southwest Jiaotong University, Chengdu, China. migan@swjtu.cn, Xiaofan Guo, Shuai Yang, Lei Wang

To evaluate the low-carbon level of logistics enterprise, we construct corresponding evaluation index system and introduce the concept of centrality in DEMATEL method to improve the entropy method, use data variability to do objective weighting of evaluation index. Then combine with cloud model theory, use reverse cloud generator to convert evaluation data into cloud parameters, and use index approximation method to construct evaluation cloud, reflect and obtain the evaluation results in the form of normal cloud chart, to solve fuzziness and randomness quantification in the evaluation process.

■ Poster Competition

Exhibit Hall

Monday Poster Competitition

Competition Poster Session

A Simple Classification Framework For Discrimination Of Antipsychotic Treatment Resistant And Treatment Responsive Schizophrenia Patients

Farnaz Zamani Esfahlani, PHD Candidate, SUNY Binghamton, 4400 Vestal Parkway East, Binghamton, NY, 13902-6000, United States, fzamani1@binghamton.edu, Katherine Frost, Gregory Strauss, Hiroki Sayama

Predicting the outcome of different treatment options for patients is essential for effective treatment planning. However, this is a challenging task especially in mental disorders such as schizophrenia where the treatment outcome of patients depends on the complex interaction of various symptoms. In this study, we used analytical tools of network science to study the interaction of the symptoms in schizophrenia and identify symptoms that best discriminate antipsychotic treatment resistant and treatment responsive schizophrenia patients. The features selected based on network analysis provided better classification accuracy when compared to traditional feature selection methods.

Anticipatory Dynamic Traffic Sensor Location Problems with Connected Vehicle Technologies

John (Hyoshin) Park, Research Associate, University of Massachusetts Amherst, 370 Northampton Rd. Apt B, Amherst, MA, 01002, United States, hyoshin0724@gmail.com, Song Gao, Ali Haghani

Despite the potential benefits of sensor technologies, the challenges associated with identifying optimal sensor locations for multiple time stages throughout a day with uncertain demand patterns has received little attention. In this paper, we focus on proactively reducing the network delay by controlling traffic signals through an optimized sensor deployment. The framework is based upon portable sensors that may be repositioned within the day to new locations such that delay savings over multiple time stages will be maximized. To tackle this multi-period stochastic problem, dynamic models are proposed, considering the future sensor locations given budget constraints on the sensor costs and relocation costs. A subproblem decomposed by Lagrangian relaxation enhanced with valid cuts has a better bound and a variable neighborhood search algorithm quickly finds solutions. Two dynamic models that constrain a flexible or restricted relocation present higher savings compared to the stationary model without sensor relocation. The flexible relocation model guarantees higher savings than restricted model by achieving the same maximum savings with fewer number of sensors.

Resilient Offgrid Microgrids – Capacity Planning And N-1 Security

Sreenath Chalil Madathil, Clemson University, 324 Village Walk Ln, Clemson, SC, 29631, United States, schalil@g.clemson.edu
Scott J. Mason, Russell Bent, Harsha Nagarajan, Emre Yamangil, Scott Backhaus, Arthur Barnes, Salman Mashayekh, Michael Stadler

Despite the long distance power transmission capabilities, there are some remote communities in Alaska and Hawaii that are not connected to these systems. These communities rely on small, disconnected microgrids to deliver power. These microgrids are not held to same reliability standards as transmission grids and can place many communities at risk for extended black-outs. To address this issue, we develop an optimization model and algorithm for capacity planning and operations of microgrids that includes N-1 security and other modeling features. The effectiveness of the approach is demonstrated using the IEEE 13 node test feeder and a model of the Nome, Alaska distribution system.

Two-stage Game Theoretic Modeling Of Airline Frequency And Fare Competition

Reed Harder, Dartmouth College, 14 Engineering Drive, Hanover, NH, 03755, United States, reed.haseltine.harder.TH@dartmouth.edu, Vikrant Vaze

We develop a 2-stage game-theoretic model of airline competition, with flight frequency decisions followed by fare decisions. For a simple 2-player model, we show that this game has properties that ensure a tractable and credible equilibrium solution. We then use quadratic approximations of payoffs to extend these results to more realistic scenarios. Finally, we calibrate model parameters on a real-world network and validate out-of-sample predicted frequencies against observed airline behavior.

Identification And Allocation Of Increased-risk Encephalitis Organs

Pinar Keskinocak, Georgia Institute of Technology, School of Indust/System Eng, 765 Ferst Drive, Atlanta, GA, 30332, United States, pinar@isye.gatech.edu, Hannah Smalley, Nishi Anand, Dylan Buczek, Nicholas Buczek, Tim Lin, Tanay Rajore, Muriel Wacker, Brian Gurbaxani, Matthew Kuehnert, Sridhar Basavaraju, Teresa Hammett

We developed decision-support tools to aid organ transplant physicians (and patients) in the identification and allocation of organs that carry the risk of infectious encephalitis. The Infectious Encephalitis Risk Calculator assesses whether a donor (and his/her organs) may have infectious versus non-infectious encephalitis. The Liver Transplant Decision Aid helps patients and physicians evaluate the trade-offs between accepting and rejecting an increased-risk encephalitis liver, thus potentially enabling a better allocation of high-risk organs and reducing deaths on the waitlist. The tool provides wait time estimates for liver transplants based on patient characteristics.

Evaluation Of Google's Voice Recognition And Sentence Classification For Health Care Applications

M. Majbah Uddin, University of South Carolina, 300 Main Street, Civil and Environmental Engineering, Columbia, SC, 29208, United States, muddin@cec.sc.edu, Nathan Huynh, Jose M Vidal, Kevin M Taaffe, Lawrence Fredendall, Joel S Greenstein

This study examined the use of voice recognition (VR) technology in perioperative services (Periop) to enable Periop staff to record workflow milestones using mobile technology. The use of mobile technology to improve patient flow and quality of care could be facilitated if such VR technology could be made robust. The goal of this experiment was to allow the Periop staff to provide care without being interrupted with data entry and querying tasks. This study enhanced Google's VR capability by using post-processing classifiers (i.e., bag-of-sentences, support vector machine, and maximum entropy), which would facilitate its use in health care and other applications.

A Heuristic Algorithm Assigning Optimal Tolls

Vyacheslav V. Kalashnikov, Tecnologico de Monterrey, ITESM, Campus Monterrey, Ave. Eugenio Garza Sada 2501 Sur, Monterrey, 64849, Mexico, kalash@itesm.mx, Nataliya I. Kalashnykova, Arturo García-Martínez

The problem of assigning optimal tolls to the arcs of a multi-commodity transportation network is formulated as a bilevel mathematical program. We describe an algorithm based on the allowable ranges to stay optimal (ARSO) resulting from sensitivity analysis applied to the lower level problem. In this way, one can analyze possible changes in the coefficients of some variables in the objective function within these allowed ranges without affecting the optimal solution. In addition, when stuck to a local maximum solution, the "filled function" technique helps one "jump" to another local maximum (if such does exist) or stop the search. Numerical experiments confirm the robustness of our heuristics.

Developing A Novel Inventory Classification Approach For Large Scale Multi Echelon Inventory Systems

Alireza Sheikhzadeh, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States, asheikhz@uark.edu, Manuel D Rossetti

The purpose of this research is to create a new inventory classification approach for large-scale multi-echelon repairable item provisioning systems. In this research, we develop a new concept for defining the classification criteria which is the artificial stocking policy (ASP). We also propose a new partitioning approach which takes into the account the characteristics of the (aggregated) pseudo-items. The proposed technique is evaluated and compared with complete enumeration and eight alternative clustering and classification methods via 36 different problem instances. The results indicate that the proposed methods significantly outperform the alternative techniques.

The Value Of Aggregation Under Minimax Pricing Scheme In The Electricity Retail Market

Alberto J Lamadrid, Associate Professor, Lehigh University, 621 Taylor Street, R451, Bethlehem, PA, 18015-3120, United States, ajl259@cornell.edu, Kwami Senam Sedzro, Mooi Choo Chuah

We explore both economic and technical benefits of demand responsive load aggregation under a specific retail pricing scheme we call Minimax. It is a 3-rate scheme with a threshold level. Each region is applied a differentiated rate. To assess how adopting Minimax would impact both end-users and distribution system operators (DSO), we model consumers' optimal response to Minimax as an MILP and evaluated the DSO's operating conditions and costs. A case study with different aggregation scenarios implemented on the IEEE 33-bus system reveals that larger aggregate groups achieve lower energy bills and help the DSO lower generation cost and aggregate peak demand, and achieve better voltage profiles.

Designing A Space-efficient Warehouse Layout

Shahab Derhami, PhD Candidate, Auburn University, 3301 Shelby Center, Auburn, AL, 36849, United States, shahab.derhami@hotmail.comJeffrey Smith, Kevin Gue

In this research, we analyze the factors that impact the space utilization in a warehouse. We develop mathematical models to maximize space utilization in the warehouse and depict the trade-off exist between space utilization and transportation cost in the warehouse layout.

Optimizing Decisions In Prenatal Integrated Screening For Down Syndrome

Jia Yan, Georgia Institute of Technology, 710 Peachtree Street NE, Apt 1612, Atlanta, GA, 30308, United States, jyan40@gatech.edu, Turgay Ayer, Pinar Keskinocak, Aaron Caughey

Down syndrome (DS) is a common type of chromosomal abnormality. Currently a one-size-fits-all type of risk-cutoff value of 1/270 is commonly used in DS screening to identify high-risk women and recommend an invasive confirmatory test, such as amniocentesis. In this study, we construct modeling frameworks to determine the optimal cutoffs from two practical perspectives of DS screening: one is the fairness across ages, and the other is the heterogeneity in women's preferences about adverse pregnancy outcomes. We have shown the potential to improve health outcomes and patient satisfaction.

Identification Of Optimal Partition For Semidefinite Optimization

Ali Mohammad Nezhad, PhD Candidate, Lehigh University, 200 West Packer Ave, Bethlehem, PA, 18015, United States, alm413@lehigh.edu, Tamas Terlaky

The concept of optimal partition was originally introduced for linear optimization and linear complementary problems and subsequently extended to semidefinite optimization. In this paper, under no assumption on strict complementarity, we formalize the optimal partition concept for semidefinite optimization. The magnitude of the eigenvalues belonging to each partition is quantified using a condition number and the degree of singularity of the problem.

Wasserstein Distance And The Distributionally Robust Tsp

Mehdi Behroozi, Assistant Professor, Northeastern University, 334 Snell Engineering Center, 360 Huntington Avenue, Boston, MA, 02115, United States, m.behroozi@neu.edu

Recent research on the robust and stochastic Euclidean travelling salesman problem has seen many different approaches for describing the region of uncertainty, such as taking convex combinations of observed demand vectors or imposing constraints on the moments of the spatial demand distribution. In this paper, we consider a distributionally robust version of the Euclidean travelling salesman problem in which we compute the worst-case spatial distribution of demand against all distributions whose Wasserstein distance to an observed demand distribution is bounded from above. This constraint allows us to circumvent common overestimation that arises when other procedures are used.

Reformulating The Disjunctive Cut Generating Linear Program

Thiago Serra, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA, 15213, United States, tserra@cmu.edu, Egon Balas, Francois Margot

In lift-and-project, CGLP optima may yield dominated cuts due to distortions caused by normalization. This work proposes the Reverse Polar CGLP, a reformulation where normalization defines separability and the resulting cut minimizes the slack for a point in the disjunctive hull. Cuts derived from RP-CGLP optima define supporting hyperplanes of the disjunctive hull, hence never being strongly dominated. For a point in the interior of the disjunctive hull, the cutting plane is a combination of facets separating the fractional solution. We show equivalent CGLP formulations, explain the benefits of RP-CGLP, and present computational experiments where a larger gap can be closed after two rounds.

Acceleration Of A Communication Efficient Distributed Dual Block Descent Algorithm

Chenxin Ma, Lehigh University, 200 West Packer Avenue, Bethlehem, PA, 08801, United States, chm514@lehigh.edu

Distributed optimization algorithms for very large-scale machine learning suffer from communication bottlenecks. Confronting this issue, a communication-efficient primal-dual coordinate ascent framework (CoCoA) and its improved variant CoCoA+ have been proposed, achieving a convergence rate of O(1/t) for solving empirical risk minimization problems with Lipschitz losses. In this paper, we propose an accelerated variant of CoCoA+ and show that it has a rate of O(1/t2) in terms of reducing dual suboptimality. Our analysis is also notable in that our convergence rate bounds involve constants that, except in extreme cases, are significantly reduced.

Primal-dual Interior-point Methods With Domain-driven Barriers

Mehdi Karimi, PhD Student, University of Waterloo, 200 University Avenue West, Department of Combinatorics and Optimization, University of Waterloo, Waterloo, ON, N2L 3G1, Canada, m7karimi@uwaterloo.ca, Levent Tuncel

While primal-dual algorithms have yielded efficient solvers for convex optimization problems in conic form over symmetric cones, many other highly demanded convex optimization problems lack comparable solvers. To close this gap, we develop infeasible-start primal-dual interior-point algorithms for convex optimization problems in “domain-driven” formulation, which we show covers many interesting optimization problems including the conic ones. After presenting our techniques, we introduce our Matlab-based code that solves a large class of problems including LP, SOCP, SDP, QCQP, Geometric programming, and Entropy programming among others, and mention some numerical challenges.

Upward Reward Perturbation For Reinforcement Learning

LATE CANCELLATION

Zhengyuan Zhou, Stanford University, 160 Comstock Circle, Unit 306D2, Stanford, CA, 94305, United States, zyzhou@stanford.edu, Ling Zhu, Benjamin Van Roy, Nicholas Bambos

Late Cancellation

Applying Case Queries To Network Clusters: Identifying The Intussusception Signal In Rotashield Adverse Event Reports

Matthew Foster, ORISE Fellow, FDA, 10903 New Hampshire Ave, Silver Spring, MD, 20993, United States, matthew.foster@fda.hhs.gov

We constructed a network of Medical Dictionary for Regulatory Activities (MedDRA) Preferred Terms (PTs) from RotaShield adverse event reports and calculated the eigenvector, betweenness, and closeness centrality metrics. We used these metrics to cluster PTs and assessed the sensitivity of clusters using an intussusception (IS) case definition and a variety of Standardized MedDRA Queries. Clustering using eigenvector vs closeness centrality was superior to other combinations, although all identified the IS signal before the July 1999 CDC recommendation for discontinuation. The early detection of this safety signal supports the potential use of our methodology for safety surveillance.

Neighborhood-based Reductions And Cuts For Signed Graphs

Christopher Muir, University of Tennessee - Knoxville, 2044 Wilkerson Road, Knoxville, TN, 37922, United States, cmuir1@vols.utk.edu

This research is concerned with improving solve times for instances of the Balanced Subgraph problem. We discuss various data reduction techniques based on the neighborhoods of vertices and on cut vertices. Additionally, we show that certain structures often present in signed graphs can be exploited to allow for faster solve times. Computational test results are also presented for previously explored problems, including the toll-like problem from the MIPLIB 2010 instance library.

Monday, 1:30PM - 3:00PM

■ MC01

101A-MCC

Image and Shape Data Analysis

Sponsored: Data Mining

Sponsored Session

Chair: Chiwoo Park, Florida State University, 2525 Pottsdamer Street, Tallahassee, FL, 32310-6046, United States, cpark5@fsu.edu

Co-Chair: Kamran Paynabar, Assistant Professor, Georgia Institute of Technology, 755 Ferst Drive, NW, Atlanta, GA, 30332, United States, kamran.paynabar@isye.gatech.edu

1 - State Space Model For Time-varying Density Estimation

Yanjun Qian, Texas A&M University, College Station, TX, 77840, United States, qianyanjun09@gmail.com, Yu Ding, Jianhua Huang

In both scientific and industrial fields, estimating the time-varying density can provide an important tool for the monitoring or research purpose. In our work, we propose a new method for the time-varying density estimation based on the state space model. Our method can learn the system parameters off-line, and provides an on-line density curve updating from the observed histogram data. By adding a spatial penalty term, we can guarantee the smoothness of the estimated curves and prevent the over-fitting. At last, we show the application of our method on the study of the nanocrystal growth process.

2 - Dynamic Network Modeling Of In-situ Image Profiles For Statistical Process Control – Applications In Ultraprecision Machining And Biomanufacturing Process

Chen Kan, Pennsylvania State University, PSU, University Park, PA, 16802, United States, CJK5654@psu.edu, Hui Yang

Modern industries are investing in advanced imaging technology to increase information visibility, cope with system complexity, and improve the quality and integrity of system operations. Realizing the full potential of advanced imaging technology for process monitoring and control hinges on the development of new SPC methodologies. This paper presents a novel dynamic network methodology for monitoring and control of high-dimensional imaging streams.

3 - Structured Point Cloud Data Modeling Via Regularized Tensor Decomposition And Regression

Hao Yan, Georgia Institute of Technology, yanhao@gatech.edu, Massimo Pacella, Kamran Paynabar

Due to the easy accessibility of the 3D metrology tools such as Coordinate Measuring Machine or scanning tools, structured point cloud data is becoming more and more popular. Therefore, modeling the structured point cloud is an important task in many application domains. We model the structure point cloud as tensor and propose regularized tucker decomposition and regularized tensor regression to detect the variation patterns in the data and link these patterns to the process variables. Furthermore, the performance of the proposed method is evaluated through simulation and a real case study in the point cloud data in the turning process.

4 - Statistical Analysis Of Preferential Orientations Of Two Shapes In Their Aggregate

Ali Esmaieeli, Florida State University, Tallahassee, FL, 32304, United States, ae13e@my.fsu.edu, Chiwoo Park, David Welch, Roland Faller, Taylor Woehl, James Evans, Nigel Browning

Nanoscientists believe that adjacent nanoparticles aggregate with each other in specific preferential directions. This phenomenon is known as oriented attachment and can be studied by direct observations using dynamic electron microscopy. These studies relied on manual and qualitative analysis up to now; therefore, in this research we are proposing a statistical approach to study the oriented attachment believing that certain geometries have specific preferential orientation when they aggregate. We use multiple aggregation examples collected from dynamic microscope data in order to examine the performance of our approach.

■ MC02

101B-MCC

Data Mining Innovations in Healthcare

Sponsored: Data Mining

Sponsored Session

Chair: Michael Lash, University of Iowa, S210 John Pappajohn Business Building, Iowa City, IA, 52242-1000, United States, michael-lash@uiowa.edu

1 - Multi-site Evidence-based Best Practice Discovery – Finding Factors That Influence Treatment Outcome

Eva Lee, Georgia Tech, evakylee@isye.gatech.edu
Cody Wang

This work is joint with Care Coordination Institute. The work focuses on establishing inter-operability among electronic-medical-records(EMRs) from 737 providers for large-scale data mining to identify discriminatory characteristics that can predict the quality of treatment outcome. We demonstrate the system usability by analyzing Type II diabetic patients. DAMIP establishes a classification rule on a training set that results in greater than 80% predictive accuracy on a blind set of patients. This facilitates evidence-based treatment and optimization of site performance through best practice dissemination and knowledge transfer.

2 - Scalable Support Vector Machines For Massive Healthcare Datasets

Talayeh Razzaghi, Clemson University, trazzag@g.clemson.edu

Solving the optimization model of support vector machines is often an expensive computational task for massive healthcare training sets. We propose an efficient, effective, multilevel algorithmic framework that scales to very large data sets. Our multilevel framework substantially improves the computational time without loosing the quality of classifiers for balanced and imbalanced datasets.

3 - Exploring Feasibility To Early Detect Alzheimer's Disease (AD) And Dementia Progression Using Big Data + Machine Learning Approach

Chih-Lin Chi, University of Minnesota, Minneapolis, MN, United States, cchi@umn.edu, Wenjun Zeng, Wonsuk Oh, Soo Borson

We aim to develop a 3-step data strategy to develop a model to predict long-term cognitive changes for AD. We show results from the first step: exploring feasibility of long-term prediction by optimizing time-varying risk factors. The developed model predicts cognitive scores and annual changes in up to 8 years when most subjects were cognitive normal or mild cognitive impairment. This model demonstrates accurate prediction of how dementia progress for cognitive stable, mild deterioration, moderate deterioration, and sharp deterioration subgroups. The presentation will also discuss the next steps that aim at converting the data-research results into informatics tools.

■ MC03

101C-MCC

Health Care, Modeling I

Contributed Session

Chair: Sina Faridimehr, PhD Student, Wayne State University, 4815 Fourth Street, Detroit, MI, 48202, United States, sina.faridimehr@wayne.edu

1 - Measure And Predict Medication Adherence Behavior Using Administrative Data

Shan Xie, Purdue University, 315 N Grant Street, W Lafayette, IN, 47907, United States, xie34@purdue.edu, Yuehwern Yih

For patients with diabetes, poor adherence to medication has been associated with suboptimal glycemic control, increased health care costs and adverse health outcomes. Thus, improving medication adherence is important to realize the full benefit of medication therapies. The existing measures of medication adherence based on administrative data only provide an aggregate number, which lack the ability to distinguish between different adherence behaviors. This study will develop an analytic framework to quantify and predict medication adherence patterns, and provide useful information to efficiently target patients at high risk and customize adherence improvement interventions.

2 - Improving Access To Healthcare By Minimizing Appointment Delays

Ashley N. Anhalt, PhD Student, University of Pittsburgh, 525 S. Aiken Avenue, APT #3, Pittsburgh, PA, 15232, United States, ana88@pitt.edu, Jeffrey P. Kharoufeh

Providing patients with timely access to healthcare is an important issue for major healthcare providers. One major problem is that patients are often unable to schedule appointments with specialists in a reasonable time. We present queueing models and decision tools to find effective appointment scheduling strategies with the objective of maximizing the likelihood that a majority of patients can be seen within a time threshold.

3 - Managing Access To Primary Care Through Advanced Scheduling

Sina Faridimehr, PhD Student, Wayne State University, 4815 Fourth Street, Detroit, MI, 48202, United States, sina.faridimehr@wayne.edu, Ratna Babu Chinnam, Saravanan Venkatachalam

In this research, we develop a scheduling framework that employs stochastic programming to improve access to care within primary care clinics. The model leverages correlations between scheduling practice, continuity of care, appointment utilization and access performance. Results from testing the models at VA facilities are promising.

■ MC04

101D-MCC

Optimal Procurement, Tariff, and Cybersecurity in Smart Grid

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Lawrence V Snyder, Lehigh University, 200 West Packer Avenue, Bethlehem, PA, 18015, United States, lvs2@lehigh.edu

1 - Optimal Day-ahead Power Procurement With Renewable Energy, Storage, And Demand Response

Soongeol Kwon, Texas A&M University, College Station, TX, United States, soongeol@tamu.edu, Natarajan Gautam, Lewis Ntaimo

Motivation of this research stems from pressing issues related to reducing energy cost, specifically focused on demand-side. From energy consumers perspective, there exist opportunities to reduce energy cost by adjusting purchase and consumption of energy in responding to time-varying electricity prices while utilizing renewable energy with energy storage. Considering this scenario, the main research objective is to develop a decision model to determine optimal day-ahead purchase commitment while considering real-time adjustments in response to variability and uncertainty in actual power demand, renewable supply, and electricity price.

2 - A Game Theoretic Analysis Of Electricity Time-of-use (TOU) Tariff For Residential Customers

Dong Gu Choi, Pohang University of Science and Technology, Pohang, Korea, Republic of, dgchoi@postech.ac.kr, Valerie Thomas

We properly formulate a game-theoretic model for analyzing not only the optimal behaviors of both an electric utility and residential customers but also their monetary gains or losses under a TOU tariff. With two heterogeneous customer types in terms of consumption pattern, we identify that a win-win situation is not possible. Also, we emphasize our analytic results by describing a numerical example, and we discuss the implications of our results for electric utilities and regulatory agencies.

3 - Risk Assessment And Network Optimization For Smart Grid Cybersecurity

Lawrence V Snyder, Lehigh University, lvs2@lehigh.edu, Jiyun Yao, Parv Venkitasubramaniam, Shalinee Kishore, Rick Blum

Mesh communication networks are widely used to facilitate communication to and between smart grid sensors such as advanced meters and demand response devices. Despite this wide use, a comprehensive risk assessment of cyber attacks on distributed networks has not been fully explored. In this work, we propose a framework for connectivity analysis of smart grid sensor networks to ensure robust communication when a given number of communication nodes are compromised. We also propose an efficient algorithm to construct a graph to meet given connectivity criteria by augmentation of communication links or strong authentication on certain nodes.

4 - Electricity Market Clearing With Enhanced Dispatch Of Wind Producers: Market Design And Environmental Implications

Ali Daraeepour, Duke University, Durham, NC, 27708, United States, a.daraeepour@duke.edu, Dalia Patino-Echeverri

This study explores the market design, operational, and environmental effects of the stochastic electricity market clearing. We propose a framework that allows a robust assessment of the relative advantages of the stochastic market clearing with respect to the conventional deterministic mechanism under wind production uncertainty. Using a stylized version of PJM, the two mechanisms are compared in terms of air emissions, wind integration, prices and supply-side revenue adequacy, and out-of-market adjustments.

■ MC06

102A-MCC

Text Analytics for Quality Management

Sponsored: Data Mining

Sponsored Session

Chair: Alan Abrahams, Virginia Tech, Pamplin 1007, Blacksburg, VA, 24061, United States, abra@vt.edu

1 - Human Intelligence In Keyword Query Formulation: Comparing The Recall Performance Of Computer- And Human-generated Smoke Word Lists

Richard Gruss, Pamplin College of Business, Virginia Tech, Blacksburg, VA, United States, rgruss@vt.edu
Alan Abrahams, Siriporn Srisawas

Are humans better at producing safety concern keyword searches than computers? 72 subjects annotated 263 reviews of over-the-counter medicines, half of which contained known safety concerns. Subjects then compiled a list of words and phrases that might be effective filter terms in finding reviews with safety concerns. Subjects then collaborated in groups of 2, 3 or 4 to assemble a group list. Lists were scored on how many of the known safety concerns they were able to recall in a separate test set. Preliminary results indicate that human-generated lists frequently outperform computer-generated lists.

2 - Let'S Not Get Too Sentimental: A Critical Analysis Of Sentiment Analysis For Quality Surveillance

Nohel Zaman, Virginia Tech, Blacksburg, VA, 24060, United States, znohel@vt.edu, Alan Abrahams, Richard James Gruss, Siriporn Srisawas

Our study will be beneficial for quality management (QM) professionals analyzing unstructured user-generated-content in social media. The goal is to determine whether and to what extent negative sentiment and defect existence are associated, in different products across multiple industries. With product defects being expensive, this paper could help manufacturers more rapidly discover defects. This paper aims to assess which sentiment and non-sentiment scoring methods are most effective at finding product defects in each industry, and which methods generalize well across industries.

3 - Online Reviews To Revenue: Contributory Factors And Moderating Effects In The Airline Industry

Zachary Davis, Virginia Tech, zached1@vt.edu
Alan S. Abrahams, Lara Z Khansa

In this study, online reviews of airlines are examined with respect to company revenue. Though previous studies have examined online reviews' effect on product sales, the relationship has not been elicited in service industries, including the airline industry. Using passengers' reviews of the 7 airline groups with the highest revenue we consider the impact of these reviews on the quarterly revenue of each of these companies. Compared with other major industries, the airline industry has the highest defect rate in their online reviews. Our findings suggest that online reviews do have an impact on company revenue, however this impact is dampened by offline maneuvers.

4 - Identifying Product Defects From User Complaints: A Probabilistic Defect Model

Alan Wang, Associate Professor, Virginia Tech, 2070 Pamplin Hall, Virginia Tech, Blacksburg, VA, 24060, United States, alanwang@vt.edu, Xuan Zhang, Zhilei Qiao, Weiguo Fan, Edward A Fox

Discovering potential product defects from large amounts of user complaints is a challenging task. In this research, we develop a probabilistic defect model (PDM) that identifies the most critical product issues and corresponding product attributes (e.g., product model-year, defective components, symptoms, etc.), simultaneously. We conduct comprehensive evaluations to ensure the quality of discovered information. Our research has significant managerial implications for managers, manufacturers, and policy makers.

■ MC07

102B-MCC

Data Analytics in Renewable Energy

Sponsored: Data Mining

Sponsored Session

Chair: Zijun Zhang, City University of Hong Kong, 83 Tat Chee Avenue, Kowloon Tong, Hong Kong, zijzhang@cityu.edu.hk

1 - Exploratory Data Analytics For Temporal Lighting Energy Usage In Commercial Buildings

Mingyang Li, University of South Florida, Tampa, FL, United States, mingyangli@usf.edu, Kara C Heuer, Dina Villalba-Sanchez, Zhe Song

Lighting energy usage accounts for a major proportion of building energy consumption. A better understanding of lighting energy data will facilitate building energy management. Conventional studies mainly focused on aggregate-level energy usage, ignoring the temporal usage patterns featured in stochasticity, nonlinearity and intermittency. In this study, an exploratory data analytics approach is proposed to extract, cluster and visualize temporal patterns of lighting energy usage in commercial buildings. A real data study is further provided to illustrate the proposed work and demonstrate its validity.

2 - Characterization Of Air Traffic Network Using Ads-b Data

Lishuai Li, City University of Hong Kong, P6606, AC1, Tat Chee Avenue, Kowloon, Hong Kong, lishuai.li@cityu.edu.hk
Pan Ren

Airspace capacity has been credited as a major factor for air traffic congestion and flight delays. However, few studies provided measures of airspace capacity and efficiency for a large air traffic network. This research aims at evaluating whether airspace capacity is a significant factor in relation to recent air traffic delays in China. We developed a novel method to characterize flow patterns in the airspace and construct an air traffic network using cluster analysis on historical flight trajectories. Findings will be useful in evaluating the efficiency and robustness of an air traffic network in relation to its actual operation and management.

3 - Image-based Wind Turbine Blade Surface Crack Detection And Analysis

Zijun Zhang, City University of Hong Kong, zijzhang@cityu.edu.hk
Long Wang

A data-driven framework for automatically detecting wind turbine (WT) blade surface cracks based on images taken by unmanned aerial vehicles (UAVs) is proposed in this paper. Haar-like features are applied to depict crack regions and train a cascading classifier. The computational results demonstrate that the proposed framework can successfully provide the number of cracks and locate them in original images.

■ MC08

103A-MCC

Innovation in Product and Service Development

Invited: Business Model Innovation

Invited Session

Chair: Morvarid Rahmani, Georgia Institute of Technology, Atlanta, GA, United States, morvarid.rahmani@scheller.gatech.edu

1 - An Economic Analysis Of Customer Codesign

Sreekumar R Bhaskaran, Southern Methodist University, sbhaskar@mail.cox.smu.edu, Amit Basu

A key barrier to companies successfully engaging customers in the design of new products is customers fearing that they will be forced to pay much more for the custom products they help design. We show how a firm can motivate its customers to engage in co-design through its product line choices. The effect of market and firm characteristics on the value of engaging customers in the co-design process is also examined. In addition, we analyze the effects of (a) information asymmetry about the firm's co-design capability, and (b) competition, on the firm's decisions regarding co-design.

2 - Allocating Customer Control In Service Processes

Ioannis Bellos, George Mason University, ibellos@gmu.edu, Stylianos Kavadias

In most services customers actively participate in the service deliver process. In practice we observe services that require varying degrees of customer involvement. Motivated by this, we develop an analytical model to determine which parts of a service process should be performed by the service provider and which parts should be delegated to the customers.

3 - Sourcing Innovation: Private And Public Feedback In Contests

Jurgen Mihm, Insead, Fontainebleau, France, jurgen.mihm@insead.edu, Jochen Schlapp

Contests, in which contestants compete for a prize offered by a contest holder, have become a popular way to source innovation. Despite great interest from the academic community, many important managerial aspects of contests have received very little formal inquiry. The most important of these is feedback from the contest holder to the contestants while the contest unfolds. This paper sets out to establish a comprehensive understanding of how to give feedback in a contest by answering the questions of when to give feedback and when not to give feedback and which type of feedback to give, public (which all solvers can observe) or private (which only the concerned party can observe).

4 - Balancing Diagnostic And Resolution Efforts In A Nonprofit Service Delivery Organization

Priyank Arora, Georgia Institute of Technology, 800 W Peachtree St NW, Atlanta, GA, 30308, United States, Priyank.Arora@scheller.gatech.edu, Morvarid Rahmani, Karthik Ramachandran

This paper studies service design of a nonprofit organization (NPO) that aims to maximize overall utility delivered to its clients. We examine how the NPO should balance levels of effort between diagnostic and resolution stages of its service delivery, in the presence of client heterogeneity and resource constraint. Our analytical model is based on secondary data collected from an NPO working towards empowerment of victims of domestic violence.

■ MC09

103B-MCC

Nonlinear Optimization Problems for Power Systems

Invited: Energy Systems Management

Invited Session

Chair: Javad Lavaei, University of California, Berkeley, 4121 Etcheverry, Berkeley, CA, 94720, United States, lavaei@berkeley.edu

1 - Power System State Estimation With A Limited Number Of Measurements

Ramtin Madani, University of California, Berkeley, Berkeley, CA, United States, ramtin.madani@berkeley.edu, Javad Lavaei, Ross Baldick

This work is concerned with the power system state estimation (PSSE) problem, which aims to find the unknown operating point of a power network based on a given set of measurements. We develop a set of convex programs with the property that they all solve the non-convex PSSE problem in the case of noiseless measurements if the voltage angles are relatively small. This result is then extended to a general PSSE problem with noisy measurements, and an upper bound on the estimation error is derived. The objective function of each convex program has two terms to account for the non-convexity of the power flow equations and estimate the noise levels. The proposed technique is demonstrated on a 9000-bus network.

2 - Stochastic Unit Commitment With Topology Control Recourse For Renewables Integration

Jiaying Shi, University of California, Berkeley, Berkeley, CA, 94720, United States, shijy07@berkeley.edu, Shmuel S Oren

We propose a two-stage stochastic unit commitment formulation with topology control recourse decisions for power systems with renewables integration. We investigate applying progressive hedging algorithm to solve this problem. Preliminary test results on both IEEE 118 system and central European system show that such capability of controlling the system configuration actively through switching transmission lines can help improve the efficiency of unit commitment.

3 - A Strong Semidefinite Programming Relaxation Of The Unit Commitment Problem

Javad Lavaei, University of California-Berkeley, Berkeley, CA, United States, lavaei@berkeley.edu, Morteza Ashraphijuo, Salar Fattahi, Alper Atamturk

The unit commitment (UC) problem aims to find an optimal schedule of generating units subject to the demand and operating constraints for an electricity grid. We develop a strengthened semidefinite program (SDP) based on first deriving certain valid quadratic constraints and then relaxing them to linear matrix inequalities. These valid inequalities are obtained by the multiplication of the linear constraints of the UC problem. The performance of the proposed convex relaxation is evaluated on several hard instances of the UC problem. By solving a single convex problem, globally optimal integer solutions are obtained in most of the experiments that we have conducted.

4 - Optimal Distributed Control Of Power Systems

Salar Fattahi, University of California, Berkeley, Berkeley, CA, United States, fattahi@berkeley.edu, Abdulrahman Kalbat, Javad Lavaei

This talk is concerned with the optimal distributed control of power systems under input disturbance and measurement noise. This optimal control problem is highly nonlinear and NP-hard. In this work, we design an efficient computational method that transforms the optimal centralized controller to a near-optimal distributed controller. We also study how the connectivity of its underlying communication network affects the optimal performance of the stochastic power system under control. As a case study, the proposed technique is used to design a distributed primary frequency controller for the IEEE 39-Bus New England test System.

■ MC10

103C-MCC

Food, Energy, Water and Extreme Events

Sponsored: Energy, Natural Res & the Environment, Energy II Other

Sponsored Session

Chair: Sauleh Ahmad Siddiqui, Johns Hopkins University, 3400 N. Charles St., Latrobe Hall 205, Baltimore, MD, 21218, United States, siddiqui@jhu.edu

Co-Chair: Craig Bakkar, Johns Hopkins University, 3400 N. Charles St., Baltimore, MD, 21218, United States, cbakker2@jhu.edu

1 - Mixed Complementarity Modelling In Food Systems

Sauleh Ahmad Siddiqui, Johns Hopkins University, 3400 N. Charles St., Latrobe Hall 205, Baltimore, MD, 21218, United States, siddiqui@jhu.edu, Craig Bakkar

We are developing a new food systems model investigate the impacts of climate change. This model is designed to build upon past climate-food research by modelling the entire food supply chain, connecting more fully with energy and water sector models, and capturing shock propagation. Our model uses a microeconomic Mixed Complementarity Problem (MCP) formulation and a new MCP decomposition method that both reduces wall clock time to solution and increases the size of solvable problems.

2 - Post-disaster Distribution Systems Restoration

Yushi Tan, University of Washington, 185 Stevens Way, Seattle, WA, 98195, United States, ystan@uw.edu, Feng Qiu

We investigate the problem of repairing a distribution network after a natural disaster. Such a post-disaster restoration is identified as an NP-hard variant of a job scheduling problem, in which crew are dispatched to repair the damaged lines in a way that minimizes the total harm caused by the outages. We implement a time-indexed ILP formulation with valid inequalities as a benchmark. Two practical methods are also proposed to solve the problem: a conversion algorithm and a linear-relaxation-based list scheduling algorithm. Worst case bounds are analyzed for both algorithms. Numerical results validate the effectiveness of the proposed methods.

3 - Nonlinear Optimization Of Water Supply Network Pumping Plans In A Deregulated Electricity Market

Maxime Fender, Optimization Consultant, Artelys, 2001 Boulevard Robert-Bourassa, Suite 1700, Montreal, QC, H3A 2A6, Canada, maxime.fender@artelys.com

Within the context of deregulated electricity markets, electro-intensive companies are encouraged to optimize their electricity consumption patterns. This talk presents a study led by Artelys showing how a water distribution network operator, facing varying electricity wholesale market prices, can minimize its water pumping costs. This MINLP (nonlinear pressure loss constraints in pipes / OnOff pumps binary variables) has been solved using an iterative process composed of a linear relaxation and a continuous nonlinear optimization solved respectively by FICO Xpress-Optimizer and Artelys Knitro.

■ MC11

104A-MCC

Network Vulnerability and Criticality

Sponsored: Optimization, Network Optimization

Sponsored Session

Chair: Chrysafis Vogiatzis, Assistant Professor, North Dakota State University, CIE 202K, P.O. Box 6050, Fargo, ND, 58108, United States, chrysafis.vogiatzis@ndsu.edu

1 - Critical Arcs Detection In Influence Networks

Colin P. Gillen, University of Pittsburgh, Pittsburgh, PA, 15261, United States, cpg12@pitt.edu, Alexander Veremyev, Oleg A Prokopyev, Eduardo Pasiliao

The influence maximization (MAXINF) problem chooses an optimal set of seed nodes to maximize the propagation of influence (cascading behavior) in a network. Given a set of seed nodes and the linear threshold model, our work proposes to determine which edges - e.g. relationships in a social network - are most critical to the influence propagation process. NP-completeness of the problem is proved. Naïve time-dependent and time-independent mixed-integer programming (MIP) models are stated. An improved MIP-based exact algorithm and a heuristic are proposed, and computational results presented.

2 - Randomized Network Inspection For Security Against Link Disruption Attacks

Mathieu Dahan, Massachusetts Institute of Technology, Cambridge, MA, United States, mdahan@mit.edu, Polina Sela Perelman, Saurabh Amin

We consider a network inspection game, in which a defender collects state measurements at few nodes of the network to detect simultaneous link disruptions by an attacker. The defender's objective is to maximize the detection score and the attacker's objective is to maximize the missed detection rate. Both players face budget constraints. We study the mixed Nash equilibria of this game in terms of the defender's inspection capabilities and the network structure. We characterize the player strategies using a generalization of the minimum vertex cover and the maximum matching of the network.

3 - A Stochastic Programming Unified Framework For Travel Demand Estimation Problems With Multiple Observation Sets

Yudi Yang, University of California, Davis, Davis, CA, United States, ydyang@ucdavis.edu, Yueyue Fan, Roger J-B Wets

This paper proposes a unied framework of modeling Origin-Destination (O-D) demand estimation problems in transportation networks using multiple observation sets. Unlike traditional approaches that aim at either parameter estimation or reconstruction, our approach employs a hierarchical structure to integrate both problems. This proposed framework has a great flexibility to incorporate various data input and domain knowledge.

■ MC12

104B-MCC

Mixed Integer Polynomial Optimization

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Robert Hildebrand, IBM T.J. Watson Research Cente r, 206 Chateau Rive, Peekskill, NY, 10566, United States, robdhildebrand@gmail.com

1 - New Certificates For Nonnegativity Via Circuit Polynomials And Geometric Programming

Timo de Wolff, Texas A&M University, dewolff@math.tamu.edu

Deciding nonnegativity of real polynomials is a fundamental problem in polynomial optimization. In practice, one uses semidefinite programming (SDP), which is based on sums of squares (SOS) certificates, the standard certificates since the 19th century.

We introduce an entirely new class of nonnegativity certificate based on circuit polynomials, which are independent of SOS. Similar as SOS correspond to SDP our certificates correspond to geometric programming (GP). Our certificates yield GPs which compute lower bounds both for unconstrained and constrained polynomial optimization problems efficiently. Our approach is significantly faster and often provides better bounds than SDPs.

2 - Analysis Of Strength Of Convex Relaxations Of Monomials

Akshay Gupte, Clemson University, Clemson, SC, 29634, United States, agupte@clemson.edu, Warren P Adams, Yibo Xu

Convexifying each monomial in a polynomial optimization problem yields a lower bound on the global optimum. The quality of this lower bound and the additive error on the global optimum can be quantified by analyzing the approximation error produced by the closure convex hull of each monomial. For any monomial whose domain is a subset of [0,1]^n, we give degree-dependent upper bounds on this approximation error. Special structures of the domain for which our bounds are tight are also analyzed. For a multilinear monomial, we refine this bound for the [1,r]^n case and also give a formula for the [-1,1]^n case.

3 - Optimal Power Flow Problem

Santanu Dey, Georgia Institute of Technology, santanu.dey@isye.gatech.edu

The AC optimal power flow (OPF) problem is a key polynomial optimization problem in the area of electrical power systems operations. We present a few families of cutting-planes to strengthen the standard SOCP relaxation of this problem. Extensive computational experiments show that these relaxations have numerous advantages over existing convex relaxations.

■ MC13

104C-MCC

New Algorithms for Global Optimization and MINLP II

Sponsored: Optimization, Global Optimization

Sponsored Session

Chair: John W Chinneck, Carleton University, 1125 Colonel By Drive, Ottawa, ON, K1S 5B6, Canada, chinneck@sce.carleton.ca

1 - Coordination Between Constraint Filtering Techniques And Reduced RLT Representations In RLT-POS

Evrim Dalkiran, Wayne State University, evrimd@wayne.edu Hanif D. Sherali

RLT-POS is a Reformulation-Linearization Technique (RLT)-based open-source optimization software for solving polynomial optimization problems. RLT-POS theoretically filters standard bound-factor constraints to obtain tractable relaxations. Using linear equality subsystem, RLT-POS generates reduced sized LP relaxations. In this talk, we discuss the coordination between constraint filtering techniques and reduced RLT representations for sparse polynomial programming problems.

2 - A Global Optimization Algorithm For Routing Heterogeneous Jobs To Heterogeneous Servers

Vahid Nourbakhsh, PhD Candidate, University of California - Irvine, Irvine, CA, 92617, United States, vahidn@uci.edu, John G Turner

The problem of routing heterogeneous jobs to heterogeneous servers with job-server dependent service rates arises in different applications. We formulate the problem as a math problem which allows us to use the general framework of math programming to embed the problem into planning problems. For the objective functions of maximizing service level and minimizing average waiting time, the problem is non-convex. We develop an optimization algorithm called fixed-ratio shifting envelopes (FSE) to find the global optimal solution and compare its performance against the global solver BARON.

3 - Tuning Baron Using Derivative-free Optimization Algorithms

Nikolaos Ploskas, Carnegie Mellon University, Pittsburgh, PA, United States, nploskas@andrew.cmu.edu, Jianfeng Liu, Nikolaos Sahinidis

Optimization solvers include many options that allow users to control different aspects of them. All previous proposed methods for tuning optimization solvers options have focused on MILP and local NLP solvers. A total of 27 derivative-free optimization algorithms are used on a set of 126 benchmark problems to find the optimal values for the options of the global optimization solver BARON. Detailed computational results will be presented.

4 - Recent Advances In Baron

Mustafa Kilinc, Carnegie Mellon University, Pittsburgh, PA, United States, mkilinc@cmu.edu, Nikolaos Sahinidis

In this talk, we provide a brief account of key software engineering and algorithmic developments in BARON and discuss recent advances that result in dynamic solution strategies aimed to provide tight relaxations for solving difficult problems, and present extensive computational results on a collection of benchmarks.

■ MC14

104D-MCC

Emerging Applications of Optimization in Industry

Sponsored: Analytics

Sponsored Session

Chair: Juan Ma, Turner Broadcasting Systems, 1050 Techwood Drive NW, Atlanta, GA, 30318, United States, juan.ma@turner.com

1 - Scheduling Television Programs Optimally

Juan Ma, Turner Broadcasting System, Inc., Atlanta, GA, 30318, United States, juan.ma@turner.com, Jose Antonio Carbajal Orozco, Peter Williams, Wassim (Wes) Chaar

Deciding a television program schedule that generates the highest viewer ratings is critical and challenging for professionals in the media industry. In this study, we developed a novel analytical model for optimal television program scheduling. Our model combines program rating predictions during different time slots of a scheduling window with a shortest path problem under resource constraints. Solution techniques and preliminary experiment results will also be discussed.

2 - Scheduling Commercial Spots Using Mixed Integer Programming

Vivek Vasudeva, Turner Broadcasting System, Inc., Atlanta, GA, United States, vivek.vasudeva@turner.com, Jose Antonio Carbajal Orozco, Wassim (Wes) Chaar

A broadcasting company sells airtime to advertisers to air their commercial spots in accordance with certain agreed-upon rules. We examine a mixed integer programming-based formulation that can be used to schedule spots such that a desired measure can be optimized while honoring the deal rules. We also analyze how the measure changes as we relax different sets of constraints, to gain insights into the relative impact of these constraints on the optimization measure.

■ MC15

104E-MCC

Disaster and Emergency Management I

Contributed Session

1 - Apropos Resilient System Design

Henry Lester, University of South Alabama, P.O. Box 8172, Mobile, AL, 36689, United States, hlester@southalabama.edu

System resiliency signifies the ability to resist and recover from an extreme event. Critical measures of this resiliency are extreme event damages and disaster recovery time. This paper presents an analytical approach to capturing extreme event system behaviors with respect to system resiliency in order to predict disaster recovery time. The approach isolates significant system factors to estimate recovery function parameters to enhance a resilient system design. The resultant resilient system design can provide situational awareness for future decision analysis pertaining system deployment and operations while subject to extreme events.

2 - A Follow-Up Sharing Method For Post-Event Response Resource Distribution With Group Information Updates

Yong Ye, Wenzhou Medical University, Chashan Street, Ouhai District, Wenzhou, 325035, China, yong_ye@foxmail.com, Guiling Liu, Lingle Pan

This paper addresses a Follow-up Sharing Character (FSC), which coordinates resources between different phases. Based on FSC, this paper proposes a general model by minimizing the RAEL (the losses caused by the mismatch between supply and demand in impacted areas) of all phases, the RAEL of all affected areas in the present phase, and the ELTL of the distribution plan in the present phase. We also apply the Bayesian information updates approach to deal with uncertainties of demand and traffic condition, by using historical and sample information. Then, a solution algorithm is proposed to solve the model; and a simulation study is presented. Insights derived from the model are provided in the conclusion.

■ MC16

105A-MCC

Data-Driven Optimization Methods

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Vishal Gupta, University of Southern California, University Park Campus, Los Angeles, CA, 90089, United States, guptavis@usc.edu

1 - Machine Learning & Portfolio Optimization

Gah-Yi Ban, London Business School, gban@london.edu, Noureddine El Karoui, Andrew Lim

We adapt two machine learning methods, regularization and cross-validation, for portfolio optimization. First, we introduce performance-based regularization (PBR), where the idea is to constrain the sample variances of the estimated portfolio risk and return. We consider PBR for both mean-variance and mean-CVaR problems. We show that the PBR models can be cast as robust optimization problems with novel uncertainty sets and establish asymptotic optimality of both Sample Average Approximation (SAA) and PBR solutions and the corresponding efficient frontiers. We also develop new, performance-based k-fold cross-validation algorithms.

2 - Smart Predict Then Optimize

Paul Grigas, UC Berkeley, 4177 Etcheverry Hall, University of California, Berkeley, CA, 94720-1777, United States, pgrigas@berkeley.edu, Adam Elmachtoub

We consider a class of optimization problems where the objective function is not explicitly provided, but contextual information can be used to predict the objective based on historical data. A traditional approach would be to simply predict the objective based on minimizing prediction error, and then solve the corresponding optimization problem. Instead, we propose a prediction framework that leverages the structure of the optimization problem that will be solved given the prediction. We provide theoretical, algorithmic, and computational results to show the validity and practicality of our framework.

3 - Distribution Sensitivities For Quantile, Distortion Risk Measure, And Inference

Yijie Peng, Fudan University, pengy10@fudan.edu.cn Michael Fu

We treat quantile sensitivity, sensitivity of distortion risk measure, and statistical inference under a single umbrella of distribution sensitivities. A new stochastic derivative estimation technique called generalized likelihood ratio method is proposed to address three applications in a uniform manner. We illustrate advantages of the proposed method over existing stochastic derivative estimation techniques for distribution sensitivities estimation, and provide supporting numerical evidences.

4 - Small Data Optimization

Vishal Gupta, University of Southern California, guptavis@usc.edu, Paat Rusmevichientong

Notwithstanding press about “Big Data,” many real-world problems exhibit both a large number of uncertain parameters and a small amount of data per parameter. We propose a novel approach to linear optimization in this “small-data regime” inspired by empirical Bayes methods. Our approach uses the large-scale structure to circumvent the insufficient data; as the size of the optimization tends to infinity while the amount of data remains fixed, our approach performs comparably to an oracle best-in-class policy. Other popular methods do NOT enjoy this property. Empirical evidence confirms that our approach significantly outperforms state-of-the-art data-driven methods in this small-data regime.

■ MC17

105B-MCC

Robust Optimization

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Anirudh Subramanyam, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, asubramanyam@cmu.edu

1 - Exploiting The Structure Of Two-stage Robust Optimization Models With Integer Adversarial Variables

Seyed Hossein Hashemi Doulabi, Polytechnique Montréal, Montreal, QC, Canada, hashemi.doulabi@polymtl.ca Patrick Jaillet, Gilles Pesant, Louis-Martin Rousseau

This paper addresses a class of two-stage robust optimization models with integer variables in the adversary’s problem. We apply Dantzig-Wolfe decomposition to exploit the structure of these models and show that the original problem reduces to a single-stage robust problem. We propose a Benders algorithm for the reformulated problem. Since the master problem and subproblem in the Benders algorithm are mixed integer programs it is computationally burdensome to optimally solve them in each iteration of the algorithm. Therefore, we develop novel stopping conditions for these mixed integer. Some computational experiments are performed on a two-stage nurse planning problem.

2 - A New Algorithmic Framework For Two-stage K-adaptable Robust Optimization Problems With Mixed-integer Recourse

Anirudh Subramanyam, Carnegie Mellon University, Pittsburgh, PA, 15213, United States, asubramanyam@cmu.edu Wolfram Wiesemann, Chrysanthos Gounaris

We present a new algorithm for solving K-adaptability versions of two-stage robust mixed-integer linear programs (MILPs), in which we commit to K recourse policies here-and-now and implement the best policy once the uncertain parameters are observed. Viewing such problems as semi-infinite disjunctive MILPs, our framework is able to address mixed-integer and random recourse in K-adaptability problems for the first time. It is also able to incorporate tailored solution approaches for the corresponding deterministic problems and decomposition techniques widely used in stochastic programming. We conduct extensive numerical experiments on benchmark data from a number of popular applications.

3 - Weekly Two Stage Robust Generation Scheduling For Hydrothermal Power Systems

Hossein Dashti, University of Arizona, hdashti@email.arizona.edu, Antonio J. Conejo, Ruiwei Jiang, Jianhui Wang

As compared to short-term forecasting, it is challenging to accurately forecast the volume of precipitation in a medium-term horizon. As a result, fluctuations in water inflow can trigger generation shortage and electricity price spikes in a power system with major hydro resources. In this work, we study a two-stage robust scheduling approach for a hydrothermal power system. We consider water inflow uncertainty and employ a vector autoregressive (VAR) model to represent its seasonality and construct an uncertainty set in the robust optimization approach. We design a Benders’ decomposition algorithm to solve the problem. Results are presented for the proposed approach on a real-world case study.

■ MC18

106A-MCC

Recent Developments in Integer Programming

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Diego A Moran, Universidad Adolfo Ibañez, Diagonal Las Torres 2640, Santiago, 7941169, Chile, damr@vt.edu

1 - An Algorithm To Exploit Diversification And Exploration For Solving Mixed-integer Linear Programs

Rodolfo Carvajal, Universidad Adolfo Ibáñez, Viña del Mar, Chile, rodolfo.carvajal@uai.cl, Shabbir Ahmed, George L Nemhauser

Mixed-Integer Linear Programming solvers are known to exhibit performance variability. We present an algorithm that takes advantage of this variability by using diversification together with exploration during the tree search. Preliminary computational results are presented.

2 - On Multi-row Chvatal- Gomory Cuts

Babak Badri Koohi, PhD Candidate, Virginia Tech, Blacksburg, VA, United States, babakbk@vt.edu, Diego A Moran

In recent years, cutting planes obtained from multi-row relaxations of polyhedra have been widely studied in the integer programming community, both from a theoretical and computational point of view. In this talk, we study k-row Chvatal-Gomory (k-CG) cuts, that are obtained by computing integer hulls of k-row relaxations of a polyhedron. This is a generalization of Chvatal-Gomory (CG) cuts (k=1), a very important class of cuts that is well-understood. Here, we present some basic properties of k-CG cuts for the case $k \geq 2$.

3 - Extended Formulations For Vertex Cover

Austin Buchanan, Oklahoma State University, buchanan@okstate.edu

The vertex cover polytopes of graphs do not admit polynomial-size extended formulations. This motivates the search for polyhedral analogues to approximation algorithms and fixed-parameter tractable (FPT) algorithms. In this paper, we take the FPT approach and study the k-vertex cover polytope (the convex hull of vertex covers of size k). Our main result is that there are extended formulations of size O(kn+1.47^k). We also provide FPT extended formulations for solutions of size k to instances of d-hitting set.

4 - Complete Efficient Frontier Of Multidimensional Nonlinear Knapsack Problems With Multiple Objectives

Yuji Nakagawa, Kansai University, nakagawa@res.kutc.kansai-u.ac.jp, Yoshiko Hanada, Chanaka Edirisinghe

We propose a technique for finding all efficient solutions of multi-objective nonlinear separable discrete optimization problems using a unique enumeration approach, termed the Target Method, based on the surrogate constraint technique. The Target Method is superior to the existing algorithms, in both speed and accuracy, on 0-1 separable discrete problems with a single constraint. Comparative results of the proposed method and metaheuristic are presented.

■ MC19

106B-MCC

Multilevel Optimization Models and Applications

Sponsored: Computing

Sponsored Session

Chair: Jorge A Sefair, Arizona State Univerity, 699 S. Mill Ave., BYENG 330, Tempe, AZ, 85281, United States, jorge.sefair@asu.edu

1 - A Backward Sampling Framework For Interdiction Problems With Fortification

Cole Smith, Clemson University, 110 Freeman Hall, Clemson, SC, 29634, United States, jcsmith@clemson.edu, Leonardo Lozano

We examine three-stage sequential defender-attacker-defender problems that are notoriously difficult to optimize, and almost always require the third-stage (recourse) problem to be convex. We propose an approach in which we allow the recourse problem to take any form. The proposed framework restricts the defender to select a recourse decision from a sample of feasible vectors and iteratively refines the sample to force finite convergence to an optimal solution. We provide computational experiments on different interdiction problems with fortification to demonstrate that our algorithm solves problems involving NP-hard recourse problems within reasonable computational limits.

2 - Interdicting Layered Information And Physical Flow Networks

Orkun Baycik, Rensselaer Polytechnic Institute, Troy, NY, United States, baycin@rpi.edu, Thomas Sharkey, Chase Rainwater

We study the interdiction of layered networks that involve a physical flow network and an information flow network. The objective of the defender is to maximize the physical flow and the objective of the attacker is to minimize this maximum amount. There exist interdependencies between the networks which lead to a network interdiction problem with a discrete inner problem. We reformulate the problem by using duality and obtain a single-level model. We apply this technique to the applications of combating illegal drug trafficking and protecting cyber infrastructures, and present computational results.

3 - Integer Programming Formulations For Minimum Spanning Tree Interdiction

Ningji Wei, University at Buffalo, Buffalo, NY, United States, ningjiwe@buffalo.edu, Jose Luis Walteros, Foad Mahdavi Pajouh

We solve the problem of removing a set of edges with minimized removal cost in a weighted graph so that the weight of any spanning tree in the remaining graph is bounded below by a value r. We developed several formulations and compare their strength analytically. We also study the convex hull of feasible solutions and identify several facets, as well as other polyhedral properties. Finally we present the computational results for three algorithms.

4 - Assortment Optimization Under Worst-case In-store Consumer Shopping Behavior

Saharnaz Mehrani, Arizona State University, Tempe, AZ, United States, smehrani@asu.edu, Jorge A. Sefair

We study an assortment problem that incorporates in-store customer response to product unavailability. In this approach, each customer has a list of products to be purchased in a given sequence. If at some point of the sequence a product is not available, the customer either chooses a substitute product or leaves the store. We propose a multi-level optimization approach to find a robust assortment under a worst-case customer's shopping list and purchasing sequence. Our approach includes a probabilistic model of the customer in-store behavior embedded into an integer program.

■ MC20

106C-MCC

Systemic Risk, Policies, and Data Needs

Invited: Tutorial

Invited Session

Chair: Agostino Capponi, Columbia University, 500 West 120th street, New York, NY, 10027, United States, ac3827@columbia.edu

1 - Systemic Risk, Policies, And Data Needs

Agostino Capponi, Columbia University, 500 West 120th Street, New York, NY, 10027, United States, ac3827@columbia.edu

The study of financial system stability is of fundamental importance in modern economies. The failure or distress experienced by systemically important financial institutions can have contagious effects on the rest of the financial system. This may in turn result in deteriorating macroeconomic conditions and price instability, with negative consequences and spillover effects to other sectors of the real economy. This tutorial surveys the different approaches put forward by academic and practitioner literature to systemic risk modeling and measurement. We analyze the relevant economic forces in play, the mechanisms leading systemic instabilities, and discuss the methodologies used in the analysis. We discuss macroprudential, monetary and resolution policies targeting financial stability. We highlight the supervisory authorities of the different financial institutions, as well as barriers to data sharing.

■ MC21

107A-MCC

Applications Supporting Clinical and Public Health Decision Making

Sponsored: Health Applications

Sponsored Session

Chair: Hussein Ezzeldin, ORISE, 10903 New Hampshire Ave, Bldg 71 Rm 1009C, Silver Spring, MD, 20993, United States, hussein.ezzeldin@fda.hhs.gov

1 - On The Application Of Big Data To Microbial Risk Assessment

Mark Walderhaug, FDA/CBER/OBE, mark.walderhaug@fda.hhs.gov, Steven Anderson

"Big Data" is a term that seems to be currently inescapable. New hardware, software, and data sources are transforming the nature and size of risk assessment models. Each component of microbial risk assessment is impacted by big data. Hazard Identification is becoming knowledge discovery. Dose-Response is being refined by both microbial and human variability on the genetic level. Exposure assessment is gaining depth through data made available by the evolving Internet of Things. The use of big data and sophisticated software models creates a highly complex risk characterization that is a challenge to manage, to process, and to meaningfully communicate results to risk managers and to stakeholders.

2 - Supporting The Decision Making Process In Safety Review

Taxiarchis Botsis, FDA/CBER/OBE, Taxiarchis.Botsis@fda.hhs.gov

Medical experts at the US Food and Drug Administration (FDA) conduct surveillance of licensed medical products to assure continued safety. The review process requires the thorough evaluation of multiple parameters and can be time-consuming for the end users. To assist them in this process, the FDA has developed a Decision Support Environment that extracts key clinical (and time) information from the texts, normalizes it to medical codes, and visualizes it in meaningful manners. It also allows for other analysis, case management and report generation.

3 - The Impact Of Transfusing Newer Blood Versus Current Practice On The US Blood Supply

Hussein Ezzeldin, FDA/CBER/OBE, Silver Spring, MD, United States, hussein.ezzeldin@fda.hhs.gov, Richard Forshee, Arianna Simonetti

The prolonged storage of red blood cells (RBCs) may be associated with transfusion adverse events. Mixed findings between observational and clinical studies demand larger and better-designed studies. We enhanced the US blood supply model by implementing an adaptive feedback-control mechanism, where blood collection is dynamically adjusted, to maintain inventory collector's levels and overcome potential shocks. If any benefits in transfusion outcomes of younger RBCs are proven, an increase in their demand may be expected. We evaluate the impact of such changes on the US blood system with respect to current blood transfusion practice.

4 - Optimal Resource Allocation For Adaptive Clinical Trials

Alba Rojas-Cordova, Virginia Tech, Blacksburg, VA, 24060, United States, albarc@vt.edu, Ebru Korular Bish

Certain adaptive designs allow decision-makers to alter the course of a clinical trial based on revised estimates of a drug's probability of technical success. We develop a stochastic dynamic programming model to analyze the resource allocation decision, of continuing or stopping a trial, based on frequent data updates. We determine the structure of the optimal resource allocation strategy and support our findings with a numerical analysis.

■ MC22

107B-MCC

Cost, Safety and Resource Allocation In Health Systems

Invited: ORinformed Healthcare Policies

Invited Session

Chair: Retsef Levi, MIT, Cambridge, MA, United States, retsef@mit.edu

1 - Data-driven Approaches To Improve The U.S. Kidney Allocation System

Nikolaos Trichakis, MIT, Cambridge, MA, United States, ntrichakis@mit.edu, Chaithanya Bandi, Phebe Vayanos

We present a data-driven optimization approach to estimate wait times for individual patients in the U.S. Kidney Allocation System, based on the very limited system information that they possess in practice. To deal with this information incompleteness, we develop a novel robust optimization analytical framework for wait time estimation in multiclass, multiserver queuing systems. We calibrate our model with highly detailed historical data and illustrate how it can be used to inform medical decision making and improve patient welfare.

2 - Optimization-driven Framework To Understand Healthcare Networks Cost And Resource Allocation

Fernanda Bravo, UCLA Anderson School of Management, Los Angeles, CA, United States, fernanda.bravo@anderson.ucla.edu Marcus Braun, Vivek Farias, Retsef Levi

Consolidation in the US healthcare industry has resulted in the formation of large delivery networks. However, integration remains uncertain. In order for large care providers to best utilize their growing networks, it will be critical to understand not only system-wide demand and capacity, but also how the deployment of limited resources can be improved. We develop an optimization-driven framework, inspired by revenue management, to understand network costs and provide solutions to strategic problems, such as access, resource deployment, and case-mix in multi-site networks. In collaboration with a network of hospitals, we demonstrate our framework applicability.

3 - New Data-driven Approach To Safety And Risk Management In Health Systems

Retsef Levi, Professor of Operations Management, MIT, 100 Main Street, BDG E62-562, Cambridge, MA, 02142, United States, retsef@mit.edu, Patricia Folcarelli, Yiqun Hu, Daniel Talmor, Jeffrey Adam Traina

We present an innovative system approach to safety in Health Systems. The approach is based on the innovative concept of risk drivers, which are states of the System, its environment and its staff that affect the likelihood of harms, as well as an innovative aggregated measure of the 'burden of harm'. Using large scale data we develop statistical models that identify predictive risky states.

■ MC23

108-MCC

Healthcare Delivery Modeling

Sponsored: Health Applications

Sponsored Session

Chair: Bryan A Norman, University of Pittsburgh, 1006 Benedum Hall, Pittsburgh, PA, 15261, United States, banorman@pitt.edu

1 - Modeling To Enhance The Nurse Handoff Process

Anna Svirsko, University of Pittsburgh, ACS167@pitt.edu Bryan A Norman, David Rausch, Emily Shawley

Nurses in emergency departments often rotate between different zones during their 12 hour shift to balance nurse workload. However, this rotation significantly increases the number of nurse handoffs which reduces the amount of available nurse-patient time and can result in errors in patient care. This model reduces the number of nurse handoffs while still allowing nurses to rotate during their shift and balancing workload among nurses. Furthermore, we look to reduce long chains and cycles that can occur that hinder the rotation and handoff processes. The effectiveness of the model is demonstrated by applying the model to the nursing schedule from a local hospital.

2 - Closed-Form Solutions For Periodic Review Inventory Systemsin Healthcare

Nazanin Esmaili, University of Pittsburgh, Pittsburgh, PA, United States, nae22@pitt.edu, Bryan A Norman, Jayant Rajgopal

Most inventory management systems at points of use in hospitals are characterized by stochastic demand, periodic reviews, fractional lead time, expedited delivery, limited storage capacity, and service level requirements. We develop discrete time Markov chain models for such systems to minimize the total expected replenishment effort. We derive closed form expressions and propose an exact algorithm to calculate the limiting probability distribution by locally decomposing the state space. We investigate the structural results and the tradeoffs of performance measures of interest for different policies and show that the computational effort is less than other algorithms from the literature.

3 - Considering No-shows And Procedure Time Variability When Scheduling Endoscopy Patients

Karmel Shehadeh, University of Michigan, Ann Arbor, MI, United States, ksheha@umich.edu, Amy Cohn, Sameer Saini, Jacob Kurlander

We consider the problem of how to schedule patients for colonoscopy appointments, recognizing both the high frequency of no-shows and the significant variability in procedure time. We review the clinic process flow, identify metrics for evaluating schedule quality, and simulate different scheduling approaches.

4 - Improving Healthcare Resource Management Through Demand Prediction And Staff Scheduling

Nazanin Zinouri, Clemson University, 269 Freeman Hall, Clemson, SC, 29634, United States, nzinour@g.clemson.edu, Kevin Taffe

Staff scheduling in healthcare is very challenging. Hospitals typically operate 24 hours a day, 7 days a week, and are faced with high fluctuations in demand. We developed an ARIMA model to forecast daily patient volumes a month in advance. This information was used to compute workload and solve staff scheduling problems. We used a risk adverse approach to find a feasible nurse assignment that minimizes labor costs and to avoid risky cases, i.e., highly overstaffed or understaffed. The liabilities of overstaffing and understaffing are many. Overstaffing increases payrolls and results in excessive idle times, while understaffing will negatively impact patient outcomes and results in loss of revenue.

■ MC24

109-MCC

Personalizing Healthcare Decision-Making

Sponsored: Health Applications

Sponsored Session

Chair: Anil Aswani, UC Berkeley, 1, San Francisco, CA, United States, aaswani@berkeley.edu

1 - Incentive Design In The Medicare Shared Savings Program

Auyon Siddiq, UC Berkeley, Berkeley, CA, United States, auyon@berkeley.edu, Anil Aswani, Zuo-Jun (Max) Shen

The Medicare Shared Savings Program (MSSP) was created to control rising healthcare costs by offering Medicare providers financial incentives to reduce spending on healthcare delivery. We place the MSSP within a principal-agent framework and investigate the impact of directly subsidizing investments made by a provider to improve operational efficiency. We then estimate parameters of the principal-agent model using financial performance data of Medicare providers participating in the MSSP. Our analytical and empirical results both suggest that a direct subsidy can yield net reductions in total Medicare spending, despite the additional payments made to providers.

2 - Approximation Algorithms For Population-scale Personal Dietary Management

Pedro Hespanhol, UC Berkeley, pedrohespanhol@berkeley.edu Anil Aswani

Diet is an important component of wellness and health; however, various fiscal, geographic, and time constraints can make it difficult for families to healthfully manage dietary decisions and purchases. This talk describes a novel mixed-integer formulation for personal management of dietary decisions, and this formulation can be generalized to a new class of knapsack-like problems. We design an approximation algorithm to solve these problems, and such an approximation algorithm enables scaling the use of our personal dietary management formulation to the broader population.

3 - A Decision Analytics Approach For Clinical Intervention Design

Yonatan Mintz, UC Berkeley, ymintz@berkeley.edu, Anil Aswani, Philip Kaminsky, Yoshimi Fukuoka, Elena Flowers

When designing behavioral interventions it is crucial to take into account the inherent tradeoff between quality of care and intervention cost. In this paper, we develop an algorithm which uses patient data to resolve this tradeoff effectively in the context of weight loss interventions. We expand on a previously developed utility maximization model for patient behavior by utilizing integer programming and Bayesian prediction to evaluate the efficacy of various weight loss interventions and combine them into a weight loss program. We then present simulation results which show that our method maintains efficacy while potentially reducing the associated person hours and cost of the intervention.

4 - A Correlation-preserving Method To Estimate Risk Factor Trajectories From Cross-sectional Data

Sze-chuan Suen, USC, Los Angeles, CA, United States, suensze@gmail.com, Jeremy D. Goldhaber-Fiebert, Sanjay Basu

How should we approximate individual risk factors (i.e., cholesterol levels, BMI, etc.) over time when we only have information about the distributions over the whole population at each time period? We use a shortest-distance algorithm which preserves correlation to approximate risk factor trajectories for use in microsimulation models of disease when only cross-sectional data is available. We compare the treatment implications of using this algorithm with other commonly used methods.

■ MC25

110A-MCC

Project Related SCM I

Invited: Project Management and Scheduling

Invited Session

Chair: Xiaoqiang Cai, The Chinese University of Hong Kong, Shatin, Hong Kong, Hong Kong, xqcai@se.cuhk.edu.hk

1 - Capacity Control Policies For Leasing Industry Based On Customers' Behavior

Lifeng Zhang, University of Electronic Science and Technology of China, Chengdu, China, anny78@163.com, Yinping Mu, Shiming Li

The paper studies the capacity control strategy for multiperiod and multiproduct leasing based on customers' behavior pricing strategy. Considering that the customers' behavior will affect the value of the products in the process of using rental products, and then affect the benefit of the industry. We regard product prices as a function of customers' behavior, and build a model to analyze how to solve the mismatching problem between capacity and demand with upgrades. We present the stochastic dynamic programming formulation for customers' behavior, and propose a new product upgrade mechanism.Finally, we perform computational expeiments to testify the qualities of the model.

2 - Downstream Firm's Investment With Equity Holding In Decentralized Assembly Systems

Hong Fu, University of Electronic Science and Technology of China, Chengdu, China, hongfu@uestc.edu.cn Yongkai Ma, Xiaoqiang Cai

We consider a decentralized assembly system in which n upstream firms sell complementary components to a downstream firm facing a stochastic and price-sensitive demand. The downstream firm may make an investment to hold equity in an upstream firm. This not only enables the downstream firm to share the profit of the upstream firm as determined by the equity held, but also provides the needed resources for the upstream firm to improve its production efficiency and consequently benefits the entire system. We consider two distinct decision settings: upstream Stackelberg and downstream Stackelberg. We characterize the optimal decisions of the chain members, and obtain some useful insights.

3 - Ex-ante Transfer Pricing Decision In a Multinational Firm

Lianmin Zhang, Nanjing University, Nanjing, China, zhanglm@nju.edu.cn, Xiaopeng Zhang

This paper focus on the practice observed recently that MNFs do not only produce for themselves but also for the local competitors. TP decision has ex-ante feature in the analytical model and the arm's length principle is applied also.

4 - Optimal Policies For Two-products Supply Chain With Free Gift Cards Promotion

Yuefeng Li, University of Electronic Science and Technology of China, Chengdu, China, yuefengliuestc@yahoo.com Jingming Pan, Xiaowo Tang

Many retailers offer free gift cards for attracting more consumers. These gift cards are rewarded to consumers and can be redeemed on the purchase of other products at the retailer. In this paper, we consider a supply chain system with two independent manufacturers (M1 and M2) and one retailer. The retailer sells two products, product 1 from the manufacturer 1 and product 2 from the manufacturer 2. And she offers a specific "free" gift cards promotion, i.e., the consumer who buy the product 1 can get a gift card then redeem gift card only to buy product 2. Based on the above assumptions, we develop a decision model and get the optimal strategies for the retailer.

■ MC26

110B-MCC

Optimal Auctions

Invited: Auctions

Invited Session

Chair: Ian Kash, Microsoft, Cambridge, United Kingdom, iankash@microsoft.com

1 - A Continuous Approximation Method For Optimal Auction Design

Eiichiro Kazumori, SUNY, Buffalo, NY, United States, eiichiro.kazumori@gmail.com

This paper propose a new method to analyze the optimal auction design problem. The starting point is an observation that seller's profit function is Baire class 1 that can be derived as a pointwise limit of a sequence of continuous functions. Thus the optimal auction mechanism is a limit of the nonlinear pricing problems. This continuous approximation method can be regarded as an application of the path-following method to the optimal auction design problem. Using this novel method, we characterize the optimal auction mechanism with heterogeneous objects and multidimensional types with continuous distributions by unifying Myerson(1981), Mussa and Rosen(1978), and Rochet and Choné (1998).

2 - Strong Duality For A Multiple Good Monopolist

Christos Tzamos, MIT, tzamos@csail.mit.edu

We provide a duality-based framework for revenue maximization in a multiple-good monopoly. Our framework shows that every optimal mechanism has a certificate of optimality, taking the form of an optimal transportation map between measures. Using our framework, we characterize optimal mechanisms showing that a mechanism is optimal if and only if stochastic dominance conditions hold between specific measures induced by the buyer's type distribution. As a corollary, we consider the case of n independent uniform items each supported on [c,c+1] and show that grand bundling is optimal if and only if c is sufficiently large compared to n. This extends Pavlov's result for 2 items [Pavlov11].

3 - Optimal Auctions With Restricted Allocations

Ian Kash, Microsoft, iankash@microsoft.com

We study the design of optimal auctions under restrictions on the set of allocations. In addition to allowing us to restrict to deterministic mechanisms, we can also indirectly model non-additive valuations. We prove a strong duality result, extending a result due to Daskalakis et al. [2015], that guarantees the existence of a certificate of optimality for optimal restricted mechanisms. As a corollary, we provide a new characterization of the allocations that the optimal mechanism may use. We find and certify optimal mechanisms for four settings where previous frameworks do not apply and provide new economic intuition about some of the tools that have previously been used to find optimal mechanisms.

4 - Sample Complexity Of Revenue Maximization In The Hierarchy Of Deterministic Combinatorial Auctions

Tuomas Sandholm, Carnegie Mellon University, sandholm@cs.cmu.edu, Nina Balcan, Ellen Vitercik

Designing revenue-maximizing combinatorial auctions (CAs) is elusive. It is typically assumed that the designer knows the prior distribution over valuations, which is unrealistic because the prior is doubly exponential. Sandholm and Likhodedov introduced automated mechanism design that takes as input samples from the prior, and searches for a high-revenue CA within rich auction classes. There was no formal characterization of the number of samples required to guarantee that the CA revenue on the samples is close to its revenue on the underlying prior. We fill that gap, providing tight sample complexity bounds over the hierarchy of deterministic CA classes, and uncover structural properties.

■ MC27

201A-MCC

Organizational Learning and Problem Solving Strategies in Service Organizations

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Anita L Tucker, Brandeis, 415 South Street, MS 032, Waltham, MA, 02453-2728, United States, altucker@bu.edu

1 - Checklists In Aviation And Healthcare

Roger E Bohn, University of California-San Diego, rbohn@ucsd.edu

Checklists in health care are often motivated by citing their use in aviation. But aviation struggled with checklists and standardization for decades. Craft-based pilots were often better than pilots who used standard procedures. Combining the benefits of both centralized explicit knowledge and individual tacit knowledge is still not fully solved. Medicine will have similar tradeoffs, and needs a flexible and learning-centered approach to checklists and other procedural knowledge.

2 - The Moderating Role Of Organizational Context On Learning-by-doing

Bradley R Staats, University of North Carolina at Chapel Hill, bstaats@unc.edu

In this paper, we examine relatedness from a strategic perspective. We consider one aspect of strategic relatedness that is particularly salient at all levels of analysis: goals. In doing so, we argue that even where otherwise diverse activities are knowledge-related, if they are not goal-related, learning-by-doing is likely to suffer. Using data from the hospital industry our findings suggest that goal-relatedness is an important consideration when it comes to learning. Although goal-related teaching aids learning-by-doing in clinical care, we find that strong academic affiliations (and the research-oriented tasks and goals they bring with them) may detract from it.

3 - Impact Of Tightly-coupled Team Familiarity And Learning-curve Heterogeneity On Orthopedic Procedure Times

Michael A Lapre, Vanderbilt University, michael.lapre@owen.vanderbilt.edu, David W Moore

We study team familiarity and learning-curve heterogeneity in the context of orthopedic surgery times. We find that learning from team experience depends on familiarity between team members who have to closely coordinate their tasks. When we allow for learning-curve heterogeneity for individual and tightly-coupled team experience, organizational experience is no longer significant. This finding suggests that organizational experience could be a proxy for individuals and teams learning at different rates.

4 - Integration And Quality Performance In Hospitals

Eitan Naveh, Technion – Israel Institute of Technology, Haifa, Israel, naveh@ie.technion.ac.il, Wiljeana Glover, Qing Li, Michael Gross

While many studies suggest that integration is positively associated with improved quality of care, others assert that integration may not necessarily result in better quality of care. The inconsistent success of integration to improve performance is not limited to healthcare operations, but in operations and engineering management in general. We suggest that this inconsistency exists due to the predominant view that does not consider that systems integration requires consideration of both technical and human components. We use the theory of Human Systems Integration (HSI) to explain how the technical component and the human component of a system interact to influence quality performance.

■ MC28

201B-MCC

New Supply Chain Inventory Problems Motivated by Practice

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Jeannette Song, Duke University, NC, United States, jingsheng.song@duke.edu

Co-Chair: Yue Zhang, Duke University, Durham, NC, United States, yueyue.zhang@duke.edu

1 - Online-retail Inventory Replenishment: A Dynamic Programming Approach

Stephen C Graves, Massachusetts Institute of Technology, Cambridge, MA, United States, sgraves@mit.edu
Annie I-An Chen

An online-retail inventory system consists of fulfillment centers where items are stored and shipped. Demand can be satisfied by any fulfillment center carrying the item, but a system-wide stockout results in lost sales. Assuming myopic fulfillment and joint periodic review, we formulate the online-retail inventory replenishment problem as a dynamic program. We study the optimal solution structure and propose near-optimal heuristic policies of tractable complexity, including base-stock and constant-basestock hybrid policies, which can be found by simulation optimization methods. Numerical examples demonstrate that our approach outperforms the status-quo base-stock policy.

2 - Robust Inventory Allocation Under Process Flexibility

He Wang, Massachusetts Institute of Technology, 77 Massachusetts Avenue, E40-130, Cambridge, MA, 02139, United States, hewang150@gmail.com, David Simchi-Levi, Yehua Wei

We consider a hybrid strategy that combines process flexibility and inventory to help firms meet uncertain supply with uncertain demand. We propose a robust optimization framework to model this hybrid strategy, and show that the problem can be efficiently solved using a cutting-plane algorithm. We then demonstrate the benefit of this method in practical applications such as supply chain risk mitigation and production postponement.

3 - Stock Or Print? Impact Of 3D Printing On Critical Spare Parts Logistics

Yue Zhang, Duke University, Durham, NC, United States, yueyue.zhang@duke.edu, Jing-Sheng Jeannette Song

In this paper, we construct a general framework to analyze the impact of 3D printing in spare part sourcing. Our results provide guidance in how to partition the spare part service among an oversea supplier and a local 3D printer.

■ MC29

202A-MCC

Issues in Energy Efficiency and Renewable Energy

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Mili Mehrotra, University Of Minnesota, 321 19th Ave South, Minneapolis, MN, 55455, United States, milim@umn.edu

1 - Operational Response To Climate Change: Do Profitable Carbon Abatement Opportunities Decrease Over Time?

Christian Blanco, UCLA Anderson School of Management, Los Angeles, CA, United States, cblanco@anderson.ucla.edu
Felipe Caro, Charles J Corbett

We explore data collected by CDP (formerly the Carbon Disclosure Project) on over 11,000 projects implemented by 956 firms. We find that the average payback period is increasing by about one month for each reporting period, but less so for firms that pursue opportunities that are directly related to core company operations.

2 - Closing A Supplier's Energy Efficiency Gap: The Role Of Assessment Assistance And Procurement Commitment

Quang Dang Nguyen, University of Minnesota, Minneapolis, MN, 55455, United States, nguy1762@umn.edu
Karen Donohue, Mili Mehrotra

This paper analyzes the Energy Efficiency (EE) investment decisions of a capital-constrained manufacturer that competes with an alternate supplier for the business of a large industrial buyer. Through a series of game theoretic models, we analyze the impact of EE assessment assistance and procurement commitment on the supplier's EE investment.

3 - Mind The Gap: Coordinating Energy Efficiency And Demand Response

Eric Webb, Kelley School of Business, Indiana University, Bloomington, IN, 47405, United States, ermwebb@indiana.edu
Owen Wu, Kyle D Cattani

Traditionally, energy demand-side management techniques, such as energy efficiency (EE) and demand response (DR), are evaluated in isolation. We examine the interactions between long-term EE upgrades and daily DR participation at an industrial firm. We find that EE and DR act as substitutes in terms of reduction of peak electricity demand, and the long-studied energy efficiency gap between firm-optimal and societal-optimal levels of EE is smaller when DR is considered. We suggest three approaches to reducing the energy efficiency gap, including an original suggestion that relies upon the interactions between EE and DR.

■ MC30

202B-MCC

New Business Models In Transportation

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Karan Girotra, INSEAD, Fontainebleau, France, karan.girotra@insead.edu

1 - Service Region Design For Urban Electric Vehicle Systems

Long He, National University of Singapore, longhe@nus.edu.sg,
Ho-Yin Mak, Ying Rong, Zuo-Jun Max Shen

We consider the service region design problem for electric vehicle sharing systems. We then develop a model that incorporates both customer adoption behavior and fleet operations under spatially-imbalanced and time-varying travel patterns. To address the uncertainty in adoption patterns, we employ a distributionally-robust optimization framework. Applying this approach to the case of Car2Go's service, with real operations data, we address a number of planning questions.

2 - Dynamic Type Matching

Ming Hu, University of Toronto, Toronto, ON, Canada, ming.hu@rotman.utoronto.ca, Yun Zhou

We study a dynamic multi-period assignment/transportation problem, in which an intermediary dynamically matches demand and supply of heterogeneous types and the unmatched will incur waiting or holding costs, and be carried over to the next period with abandonments. This problem also applies to many emerging settings in the sharing economy. The Monge sequence discovered by Gaspard Monge in 1781 was introduced to solve a deterministic, balanced transportation problem in a greedy fashion. We propose modified Monge conditions that are sufficient and robustly necessary for structural priority properties for the dynamic, stochastic and unbalanced transportation problem.

3 - Algorithmic Support For Bike-sharing System Operations At Motivate

David B Shmoys, Cornell University, david.shmoys@cornell.edu
Daniel Freund, Shane Henderson, Nanjing Jian

Bike-sharing systems (BSSs) have become increasinglly prevalent as part of the urban landscape, and are common even in smaller towns. For larger cities, these systems give rise to a number of interesting logistical problems to support their operations. A group at Cornell has been embedded within the support structure for Motivate, which operates BSSs in several major US cities. We will give an update on a number of the models and algorithmic advances that have been implemented to support operations at Motivate, and in particular, for Citibike in NYC.

4 - Maximizing Ridership In Bike Sharing Systems Using Empirical Data And Stochastic Models

Vinayak Deshpande, University of North Carolina, Chapel Hill, NC, 27599, United States, Vinayak_Deshpande@kenan-flagler.unc.edu
Pradeep Kumar Pendem

We analyze the optimal allocation of bikes in a network of stations to improve ridership under non-stationarity demand and station substitution. We utilize large datasets on trips, real time inventory information at stations, and distances between stations. Our demand model captures both bike pickups and dropffs, as well as demand non-stationarity and substitution under stockouts. The optimal allocation of bikes across stations to maximize ridership is determined using a dynamic program. Our study provides insights on the relationship between the allocation of bikes and ridership, and the value of incorporating non-stationarity, real-time inventory information, and station substitution.

■ MC31

202C-MCC

Operational Issues in Agriculture

Sponsored: Manufacturing & Service Oper Mgmt, iFORM

Sponsored Session

Chair: Onur Boyabatli, Singapore Management University, 50 Stamford Road 04-01, Singapore, 178899, Singapore, oboyabatli@smu.edu.sg

1 - Designing Contracts And Sourcing Channels To Create Shared Value

Joann de Zegher, Stanford University, jfdezegher@stanford.edu,
Hau Leung Lee, Dan Andrei Iancu

We study contract and channel design to create mutual benefit in decentralized agricultural value chains, where suppliers bear costs of new technologies while benefits accrue primarily to buyers. We provide insights to companies seeking to incorporate responsible sourcing strategies while also creating economic value - a concept called creating shared value. We identify that the technology's cost elasticity drives whether switching sourcing channel, changing contract structure, or adopting an integrated change is necessary. Using a dataset of farms in Argentina we estimate that the our mechanism could increase average supply chain profit by 6.9% while realizing environmental benefits.

2 - Third-wave Coffee: Sourcing And Pricing A Specialty Product Under Uncertainty

Shahryar Gheibi, Siena College, Loudonville, NY, United States, sgheibi@siena.edu, Burak Kazaz, Scott Webster

Motivated by an emerging phenomenon in the coffee industry—third-wave coffee—we study an agricultural supply chain where a firm sells a finished product which requires processing an agricultural product as input. In order to target the quality-sensitive segment of consumers, the firm (processor) offers specialty coffee by engaging in Direct Trade which in turn leads to exposure to supply risk. Our study provides insights into the main driving forces that influence the sourcing and pricing decisions of the processor in a specialty-coffee supply chain.

3 - New Results For Bounds In Newsvendor Problems

Saurabh Bansal, Penn State University, sub32@psu.edu

We discuss new results for the bounds on the newsvendor problem in the agribusiness context and quantify the value of decisions based on these bounds over some commonly used approaches.

■ MC32

203A-MCC

Scheduling VI

Contributed Session

Chair: Matthew J Liberatore, Villanova University, 800 Lancaster Avenue, Villanova, PA, 19085, United States, matthew.liberatore@villanova.edu

1 - Job Shop Scheduling With Convex Costs

Reinhard Burgy, GERAD and Polytechnique Montreal, GERAD – HEC Montréal, 3000, ch. de la Côte-Sainte-Catherine, Montreal, QC, H3T 2A7, Canada, reinhard.burgy@gerad.ca

We address an extension of the classical job shop scheduling problem with a generic convex cost objective. This objective makes it possible to model, for example, convex tardiness costs and convex (intermediate) holding costs. It is, to the best of our knowledge, the first time such a generic nonlinear and nonregular objective is considered in job shop scheduling. We give a disjunctive graph formulation and develop a local search heuristic. Numerical results support the validity of our approach.

2 - Heuristics For Lot Streaming In Flow Shop Scheduling

Anurag Agarwal, Professor, University of South Florida, Information Systems and Decision Sciences, Coll of Business, Sarasota, FL, 34243, United States, agarwala@usf.edu,
Ramakrishna Govindu

We develop heuristic solutions to generate efficient schedules for a lot streaming scheduling problem within the flowshop environment. We formulate this problem as a multiobjective problem that attempts to strike a balance between makespan and cost of handling the sublots. We consider transfer times, sequence dependent lot setup times, as well as sublot setup times.

3 - A Multistart Algorithm For The Parallel Machine Scheduling Problem With Dependent Setup Times And Preventive Maintenance

Oliver Avalos-Rosales, Profesor Investigador de Tiempo Completo, Universidad Autónoma de Coahuila, orion 338, Satelite Norte, Saltillo, 25115, Mexico, aoliver84@gmail.com, Ada M. Álvarez, Francisco Angel-Bello

We address an unrelated parallel machine scheduling problem minimizing the makespan. We consider dependent setup times and periodic preventive maintenance. These aspects have not been jointly studied in parallel machine environment. The problem is NP-hard. We consider the structure of feasible solutions and the structure of the objective function to design each component of the multistart proposed algorithm. We present computational experiments to compare the algorithm with exact solutions in small an medium size instances, and validate the contribution of each part of the algorithm in large instances.

4 - Operating Room Scheduling Under Hybrid Demand

Hamed Yarmand, University of Massachusetts Boston, 2 Fatima Rd, Stoneham, MA, 02180, United States, hamed.yarmand@umb.edu, Amirreza Shojaeifard, Babak Rezaee

We present a novel model for the elective surgery scheduling problem for multiple operating rooms to improve the efficiency of ORs with the intent of maximizing the profit (considering revenue of surgeries, fixed cost, and overtime cost). We develop an integer linear programming model for this scheduling problem. The developed model is a four dimensional assignment problem that determines the weekly schedule (day, surgeon, operating room, and type of surgery) considering three types of surgery demands simultaneously (pre-scheduled, pre-assigned, and other). It also considers surgeons' availabilities for performing surgeries. Two heuristic algorithms are proposed and investigated.

5 - Project Planning And Scheduling To Maximize Expected Quality In The Presence Of Stochastic Time Delays

Matthew J Liberatore, Villanova University, 800 Lancaster Avenue, Villanova, PA, 19085, United States, matthew.liberatore@villanova.edu, Bruce Pollack-Johnson

We present research designed to help deal with probabilistic time delays and cost overruns which endanger project quality. We present strategies to find the planned durations for tasks and the scheduling protocol that maximize the expected overall project quality by applying our previously developed notion of a continuous quality function for a task (and the project overall) in terms of the time and investment put into it.

■ MC33

203B-MCC

Simulation I

Contributed Session

Chair: Barret Pengyuan Shao, Crabel Capital Management, 414 East Market Street Second Floor, Charlottesville, VA, 22903, United States, barretshao@gmail.com

1 - Simulation-based Optimization For Layout-based Grafting Resource Allocation

Sara Masoud, University of Arizona, 1300 E Fort Lowell Road, # A214, Tucson, AZ, 85719, United States, saramasoud@email.arizona.edu, Young-Jun Son, Chieri Kubota, Russell Tronstad

Optimal resource planning in vegetable seedling propagation facilities is complicated due to the dynamicity of workers' performance. In addition, the negative impact of an inefficient layout on workers' performance reduces the productivity in grafting facilities substantially. In this work, a simulation-based optimization model is devised to achieve the optimal layout-based resource allocation. The proposed model is customized based on workers' individual performance and managerial design preferences. The optimal solution is expected to reduce the production cost of grafting systems. systems.

2 - Interfirm Imitation Under Relational And Institutional Influences

Kyun Kim, Doctoral Student, University of Texas at Dallas, 800 West Campbell Road, SM43, Richardson, TX, 75080, United States, kyun.kim@utdallas.edu, Zhiang (John) Lin

In the interfirm imitation research, the role of imitation targets is often underexplored since imitators have received the most attention. Also, the connection between macro and micro constructs related to imitation has not been clearly discussed. We endeavor to shed light on imitation targets and to connect macro and micro factors. We develop a status based approach and introduce how status (macro and micro) of a firm lets imitators reduce uncertainty and gain legitimacy. We also examine performance (micro) and institutional environment (macro) of an imitation target. We conduct empirical tests and computational analyses regarding firms' resource acquisition activities: M&As and Alliances.

3 - Climate Prediction Markets And Investor Beliefs: An Agent-based Simulation

Jonathan Gilligan, Associate Professor, Vanderbilt University, 2301 Vanderbilt Place, PMB 351805, Nashville, TN, 37235-1805, United States, jonathan.gilligan@vanderbilt.edu, John J. Nay, Martin Van der Linden

A large fraction of the American public doubts the scientific consensus that human activity is causing global warming. Climate prediction markets might influence beliefs in people who distrust scientists but trust free markets. We present an agent-based computational test-bed to examine prediction market dynamics. Traders with different beliefs about climate bet on future temperatures and adapt their beliefs based on the profits of other traders. Traders believe that global climate is primarily controlled by carbon dioxide or by solar irradiance. Market participation causes traders' beliefs to converge rapidly, suggesting that a climate market could be useful for building public consensus.

4 - Agent-Based Simulation Of Production And Seeding Strategies For Innovations

Ashkan Negahban, Assistant Professor, Pennsylvania State University, 30 E Swedesford Rd, Malvern, PA, 19355, United States, anegahban@psu.edu, Jeffrey Smith

We develop an agent-based simulation model of new technology diffusion to evaluate different viral marketing and inventory build-up policies under various social network structures. We show that determining seeding and build-up policies sequentially may lead to suboptimal decisions. We show how the optimal joint policy varies for different product categories and that the seeding strategy that maximizes demand rate is not necessarily optimal under supply constraints. We also investigate the role of high-degree nodes and long-range connections in scale-free and small-world networks.

5 - Approximation Of Long Memory Process With Short Memory Process And Some Numerical Experiments

Barret Pengyuan Shao, Crabel Capital Management, 414 East Market Street Second Floor, Charlottesville, VA, 22903, United States, barretshao@gmail.com

Taking FARIMA(p,d,q) process with $d > 0$ as an example for long memory process, we use information distance to prove that stationary ARMA processes are dense in all FARIMA processes in the total variation distance. As a consequence, statistical tests with finite sample size fail to distinguish a FARIMA process from ARMA processes. We provide Monte Carlo experiments that confirm that long memory processes are not easily distinguished from our approximate ARMA processes with finite sample sizes using a variety of well known statistical tests.

■ MC34

204-MCC

Empirical Studies in Healthcare OM

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Song-Hee Kim, USC Marshall School of Business, 3670 Trousdale Parkway, Los Angeles, CA, 90089, United States, songheek@marshall.usc.edu

1 - Nursing Shift Assignment And Its Influence On Medical Outcomes: First Insights Of A Multicenter Study

Ludwig Kuntz, University of Cologne, Cologne, Germany, kuntz@wiso.uni-koeln.de, Felix Miedaner, Stefan Scholtes

Low staffing levels are known to be a risk factor for medical outcomes. However, it is important not only to consider the right staffing levels but also to assign the available staff in the most sensible manner. Based on data from a multicenter study of 66 neonatal intensive care units, we analyze variation in staffing allocation decisions and present the first insights into their association with outcomes.

2 - The Impact Of Internal Service Quality On Nurse Inefficiency And Medical Errors

Xin(Sarah) Zheng, Boston University, Boston, MA, United States, xinzheng@bu.edu, Anita L Tucker, Z Justin Ren, Janelle Heineke, Amy McLaughlin, Aubrey Podell

Drawing on the theories of swift, even flow and conservation of resources, we propose a new avenue for addressing medical errors—improving internal service quality (ISQ), which is the quality of service provided by support departments such as housekeeping, and materials management. Using 13 months of panel data from five nursing units that gather weekly data on ISQ delivered by 11 support departments, we find that a one standard deviation increase in ISQ is associated with near elimination of hospital-acquired pressure ulcer and patient fall. The one standard deviation increase in ISQ is further associated with a 5% reduction in nurse inefficiency and a financial benefit as high as $7 million.

3 - Using Patient-centric Quality Information To Unlock Hidden Health Care Capabilities

Guihua Wang, Ross School of Business, University of Michigan, Ann Arbor, MI, 48105, United States, guihuaw@umich.edu
Jun Li, Wallace J Hopp

We document a wide variation in quality among 188 surgeons at 35 hospitals in New York state that perform mitral valve surgery. Our analysis shows that patients of different demographics and levels of acuity benefit differently from elite surgeons. In this paper, we develop an approach for computing patient-centric information from outcome data and evaluate the potential health benefits from using such information to guide patients to surgeons. We estimate that the total societal benefits from using patient-centric information are comparable to those achievable by enabling the best surgeons to treat 40% more patients under population-average information.

4 - Evidence Of Upcoding In Pay-for-Performance Programs

Hamsa Sridhar Bastani, Stanford University, Stanford, CA, United States, hsridhar@stanford.edu, Joel Goh, Mohsen Bayati

Medicare has sought to improve patient care by penalizing providers for hospital-acquired infections (HAIs). However, these efforts may be undermined if providers upcode, i.e. mis-report HAIs (possibly unintentionally) to increase reimbursement. Identifying upcoding is challenging due to unobservable confounders. We exploit state-level variations in adverse event regulation and instrumental variables to estimate that over 10,000 infections (nearly 15%) are upcoded each year, resulting in an added cost of $200 million. Our findings suggest that increasing financial penalties alone may not reduce HAI incidence. We make several policy recommendations accordingly.

■ MC35

205A-MCC"

Empirical Research in Services

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Qiuping Yu, Indiana University, Kelley School of Business, Bloomington, IN, 47405, United States, qiupyu@indiana.edu

Co-Chair: Gad Allon, Professor, Kellogg School of Management, 2001 Sheridan Rd, Evanston, IL, 60208, United States, g-allon@kellogg.northwestern.edu

1 - Understanding Customers Retrial In Call Centers: Preference Of Service Quality And Service Speed

Kejia Hu, Kellogg School of Management, Northwestern University, k-hu@kellogg.northwestern.edu
Gad Allon, Achal Bassamboo

In this paper we want to understand retrial by connecting customers decisions with their preferences on service aspects: the speed in service access and the quality in service delivered. We use a dynamic random-coefficient structural model along with observations in a call center to capture customers behavior. Our results suggest different preferences for service speed and service quality exist across different customer segments. Using counterfactual analysis, we suggest two cost-effective strategies to reduce retrial. Our new service system design increases private customer welfare by 8.91% and business customer welfare by 37.6%.

2 - The Reference Effect Of Delay Announcements: A Field Experiment

Qiuping Yu, Assistant Professor, Kelley School of Business, Indiana University, Bloomington, IN, 47405, United States, qiupyu@indiana.edu, Gad Allon, Achal Bassamboo

We empirically explore whether delay announcements induce the reference effect and customers' loss aversion in a field experiment approach. We find that customers exhibit loss aversion, whether they are provided with announcements or not. Moreover, providing delay announcements appears to impact customers' reference points and may reduce customers' per unit waiting cost compared to the case when announcements are not provided.

3 - When You Work With A Super Man, Will You Also Fly? An Empirical Study Of The Impact Of The Coworkers On Workers' Performance

Tom Tan, Cox School of Business, Southern Methodist University, ttan@smu.edu, Serguei Netessine

We examine a large operational data set in a casual restaurant setting to study how coworkers' sales ability (measured as servers' sales premium) affects workers' performance in terms of service speed and service quality. We find that servers react non-linearly to their coworkers' ability. Our empirical findings imply that managers should mix servers having heterogeneous ability levels during the same shift. Through a counterfactual analysis, we find that considering the inverted-U-shaped peer effects to optimize current servers' schedules without changing their capacity may increase total sales by 2.7%.

4 - Responsiveness And Learning In The Medical Device Product Recall Process

George Ball, Kelley School of Business, Indiana University, gpball@indiana.edu, Rachna Shah

Product recalls move through multiple steps in a firm. Deciphering the impact of moving fast or slow can help unravel the complexities associated with product recalls and reveal the impact of learning on future recalls. We investigate recall responsiveness with unique data obtained from the Food and Drug Administration consisting of over 4,000 medical device recalls from 2003 to 2013. We find that moving too quickly to identify root cause and corrective action may hamper learning, and lead to additional future recalls. We also find that the speed at which the firm opens a recall is not associated with future recalls, supporting the view that firms should move quickly to recall risky products.

■ MC36

205B-MCC

Incentive Design in Marketing and Operations

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: Tinglong Dai, Johns Hopkins University, Baltimore, MD, United States, dai@jhu.edu

Co-Chair: Kinshuk Jerath, Columbia University, 3022 Broadway, New York, NY, 10027, United States, jerath@columbia.edu

1 - Salesforce Compensation With Network Effects

Hemant Bhargava, University of California, Davis, hemantb@ucdavis.edu, Olivier J Rubel

This paper examines the management problem of "selling" platforms, i.e., designing appropriate salesforce management and incentives schemes to obtain participation by paying customers. The paper shows that network effects increase not only the mean, but also the variance of the performance metrics used to compensate sales agents.

2 - Salesforce Contracting Under Yield Uncertainty

Tinglong Dai, Assistant Professor, Johns Hopkins University, 100 International Drive, Baltimore, MD, 21202, United States, dai@jhu.edu, Kinshuk Jerath

We consider a scenario in which a firm hires a salesperson to market a product with uncertainty in both demand and supply. We build a principal-agent model of the above situation and study the optimal structure and timing of the contracts, and obtain a number of interesting results. We find that bonus contracts are optimal in both cases, and the bonus may be higher if the yield is lower. Our paper also provides interesting insights into optimal timing of salesforce contracting. For example, we find that when it is difficult to infer marketing effort from observing the sales outcome, it may be in the best interests of the firm to contract with the salesperson before the inventory information becomes available.

3 - Long-term Versus Short-term Contracting With Effort Shifting

Fei Long, Columbia University, New York, NY, United States, FLong18@gsb.columbia.edu, Kinshuk Jerath, Fangruo Chen

We investigate multi-period contracts to understand agents' gaming in terms of effort shifting, and what is a firm's best response. We model a risk-neutral principal employs a risk-neutral agent with limited liability to exert unobservable effort to increase demand over two periods. We find that the principal may find it optimal to use either a short-term plan paying at each period, or a long-term plan paying at the end that concentrates rewards at a single output level. Under limited liability, the latter one provides larger incentives compared to the former, but it suffers from agents' effort shifting. We extend to a case when the inventory is limited and find it makes the short-term plan more preferred.

4 - Who Compensates The Sales Agent?

Duo Shi, PhD Student, Washington University in St. Louis, KH 401, Olin Business School, 1 Brookings Drive, Saint Louis, MO, 63130, United States, dshi@wustl.edu, Panos Kouvelis

We analytically study a value chain consisting of three segments: a manufacturer, a retailer, and a sales agent. Five distinct value-chain structures are considered: an integrated value chain, an integrated distribution channel (the manufacturer and the retailer) compensating the sales agent, non-integrated channels with the manufacturer compensating the sales agent, with the retailer compensating the sales agent, and with joint compensation. We compare the strategic implications across all these value-chain structures.

■ MC37

205C-MCC

Socially Responsible Business Models

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Serguei Netessine, INSEAD, Singapore, Singapore, serguei.netessine@insead.edu

1 - To Sell And To Provide? The Economic And Environmental Implications Of The Auto Manufacturer's Involvement In The Car Sharing Business

Ioannis Bellos, George Mason University, ibellos@gmu.edu Mark Ferguson, Beril L Toktay

Motivated by the involvement of Daimler and BMW in the car sharing business we consider an OEM who contemplates introducing a car sharing program. The OEM designs its product line by accounting for the trade-off between driving performance and fuel efficiency. We determine the efficiency of the vehicles offered and we characterize the effect on the OEM's Corporate Average Fuel Economy (CAFE) along with the economic and environmental implications.

2 - Optimal Allocation Rules With Waste Considerations

Sara Rezaee Vessal, HEC Paris, Jouy en josas, France, sara.rezaee-vessal@hec.edu, Sam Aflaki, Dimitrios Andritsos

We study capacity allocation of a scarce and perishable product among stockout-averse retailers that face stochastic demand. We focus on two commonly practiced allocation mechanisms and using a dynamic model characterize the conditions under which each allocation mechanism performs superior from a waste and profit point of view.

3 - Child Labor In Supply Chains: An Empirical Investigation

Sameer Hasija, INSEAD, sameer.hasija@insead.edu, Hsiao-Hui Lee, Niyazi Taneri

Due to increasing globalization, labor malpractices at upstream positions in supply chains directly or indirectly impact many organizations. Moreover, from a social/moral perspective poor labor conditions may have long term adverse effects on society. Lack of visibility in long supply chains hinders our capability in overcoming such issues. In this paper, we generate empirical insights on the drivers of labor malpractices, and child labor in particular.

4 - Philanthropic Campaigns And Customer Behavior: Field Experiments In An Online Taxi Booking Company

Serguei Netessine, INSEAD, 1 Ayer Rajah Avenue, Singapore, 138676, Singapore, serguei.netessine@insead.edu Jasjit Singh, Nina Teng

Companies commonly use philanthropic campaigns to attract and retain customers in the form of charity-linked promotions, where a company donates money to a cause when a customer makes a purchase. Customer-related effects of such promotions remain under-studied, an issue this study investigates using field experiments in an online taxi booking company. Take-up rates for charity-linked promotions were smaller than for discount-based promotions, and also less sensitive to the monetary amount. Although promotion take-up did represent new bookings rather than substitution of non-promotional bookings, there is little evidence of an increase in subsequent purchase frequency.

■ MC38

206A-MCC

Social Media Analysis V

Invited: Social Media Analytics

Invited Session

Chair: Chris Smith, Air Force Institute of Technology, 2950 Hobson Way, 2950 Hobson Way, Wright-Patterson AFB, OH, 45433, United States, cms3am@virginia.edu

1 - App Developers' Product Offering Strategies In Multi-platform Markets

Degan Yu, PhD Candidate, University of Rhode Island, Ballentine Hall, 7 Lippitt Road, Kingston, RI, 02881, United States, yudegan@gmail.com

Mobile application (app) developers usually face challenges in deciding product offering choices. In this research we construct an analytical model for product offering problem that app and software developers face in a two-platform environment and the developers offer paid or free app (free app offers advertisement) in each platform. Our findings shed light on some insights into the business practices in industries including mobile apps, computer software, and social media games.

2 - Positive Impact Of Graphical Visualization Of Discussion Forums On Collaborative Learning

Jacqueline Ng, Northwestern University, 2145 Sheridan Road, C-230, Evanston, IL, 60208, United States, jacqueline.ng@u.northwestern.edu, Seyed Iravani

Widespread internet connectivity has increased the popularity of online delivery of course content. With the rise of online courses, e.g., MOOCs, there is an increasing need to create opportunities for learners to interact and exchange ideas. Dynamic online discussion forums can accomplish these goals. We use visualization techniques to design a novel graphical interface for discussion forums that presents posts as nodes and replies as edges connecting nodes. By comparing the effectiveness of graphical and text-based discussion forums, we find that the graphical interface promotes higher levels of both activity and interactivity, creating increased engagement in online discussions.

3 - Public Reactions To Supply Chain Events: A Twitter Sentimental Analysis Event Study

David Wuttke, EBS University, Burgstr. 5, Oestrich-Winkel, 65375, Germany, david.wuttke@ebs.edu, Christoph Schmidt, H. Sebastian Heese

We conduct sentiment analysis on Twitter data to evaluate public reactions to supply chain events.

4 - Effectiveness Of Network-Based Evacuation Warning Dissemination: An Experimental Investigation

Sulian Wang, Tsinghua University, 30 Shuangqing Road, Haidian, Beijing, 100084, China, wangsulian13@mails.tsinghua.edu.cn, Chen Wang

Effective risk communication with the general public plays a vital role in emergency preparedness and response. Spontaneous dissemination of warning messages in the decentralized channel (e.g., through online social network) is shown to be an efficient way of complementing the traditional channels such as television and radio. We model the individual willingness to spread warning messages as a function of their past experiences and trust of the information source, which is determined by both the false positive and false negative rates of historical warnings. We validate our model by lab experiments and simulation.

■ MC39

207A-MCC

Applied Probability and Optimization II

Sponsored: Applied Probability

Sponsored Session

Chair: Jiaming Xu, The Wharton School of the University of Pennsylvania, jiamingx@wharton.upenn.edu

1 - Low-rank Estimation: Why Non-convex Gradient Descent Works

Yudong Chen, Cornell University, Ithaca, NY, United States, yudong.chen@cornell.edu

Many problems in statistics involve fitting a low-rank matrix to noisy data. A popular approach to the resulting rank-constrained optimization is SDP relaxation, which does not scale to large problems. We instead consider gradient descent over the low-rank space. This approach is scalable, but convergence was unclear due to non-convexity. We develop a unified framework characterizing its convergence and statistical properties. Our results provide insights to why we expect non-convex methods to work in general, and yield global guarantees for linear convergence in various concrete problems. Our framework handles arbitrary ranks, noise and constraints, and does not require sample splitting.

2 - Scaled Least Squares Estimator For Glms

Murat A. Erdogdu, Stanford University, erdogdu@stanford.edu

We study the problem of efficiently estimating the coefficients of generalized linear models (GLMs) in the large-scale setting where the number of observations n is much larger than the number of predictors p, i.e. n>>p>>1. We show that in GLMs with random design, the GLM coefficients are approximately proportional to the corresponding ordinary least squares (OLS) coefficients.Using this relation, we design an algorithm that achieves the same accuracy as the maximum likelihood estimator through iterations that attain up to a cubic convergence rate, and that are cheaper than any batch optimization algorithm by at least a factor of O(p).

3 - Reinforcement With Fading Memories

Se-Young Yun, Los Alamos National Lab, Los Alamos, NM, United States, yunseyoung@gmail.com, Kuang Xu

Can one make good decisions despite having a faulty memory? We study a continuous-time action-rewards process, where an agent is to select a sequence of actions from a finite set of alternative, and during the period when action k is selected, she accrues discrete rewards according to a Poisson process of rate λ_k. However, each unit of reward randomly "fades" from the agent's memory at rate n^{-1}. We analyse a simple reward matching rule: the new action is sampled from a distribution proportional to the recallable rewards associated with actions chosen in the past.

4 - Social Learning In The Presence Of Adversaries

Lili Su, University of Illinois at Urbana-Champaign, lilisu3@illinois.edu

We focus on the impact of the adversarial agents on the performance of consensus-based non-Bayesian learning. We propose an update rule wherein each agent updates its local beliefs as (up to normalization) the product of (1) the likelihood of the cumulative private signals and (2) the weighted geometric average of the beliefs of its incoming neighbors and itself (using Byzantine consensus). Under mild assumptions on the underlying network structure and the global identifiability of the network, we show that all the non-faulty agents asymptotically agree on the true state almost surely.

■ MC40

207B-MCC

Target Setting in Efficiency Analysis

Invited: Data Envelopment Analysis

Invited Session

Chair: Dong Joon Lim, Portland State University, Engineering & Technology Management - Engineering & Computer Science, Maseeh College of (ETM), Portland, OR, 97207, United States, dongjoon@pdx.edu

1 - Study Of Capital Requirement And Bank Operating Efficiency

Yang Li, National University of Kaohsiung, Kaohsiung, Taiwan, yangli@nuk.edu.tw

Following the 2008 financial tsunami, the Bank of International Settlements proposed Basel III in 2010, in which banks need to raise their capital adequacy ratio in order to make them sound and safe. This study employs the two-stage bootstrapped truncated regression model, proposed by Simar and Wilson (2007), and takes into account undesirable outputs to investigate how the increases in core, tier I, and total capital adequacy ratios influence the efficiency of Chinese commercial banks. The data set is obtained from Bankscope for the period 2012-2014. Empirical results are consistent with the schedule and intention set by Basel III.

2 - Inverse DEA With Frontier Changes For New Product Target Setting

Timothy Anderson, Portland State University, Portland, OR, 97201, United States, tim.anderson@pdx.edu, Dong-Joon Lim

Inverse DEA can serve as a useful planning tool by providing information such as how much resources should be invested to achieve a desired level of efficiency. Inverse DEA studies however are based on an assumption that the PPS will not change within the period of interest, which in fact confines the use of inverse DEA to a sensitivity analysis by simply addressing what alternative levels of input/output would have been possible to result in the same efficiency score obtained. In this study, we discuss an inverse DEA problem considering expected changes of the production frontier in the future so that it can be an ex-ante decision support tool for the new product target setting practices.

3 - Evaluating Banker Et Al (2007) Allocative Efficiency Method

Paul Rouse, University of Auckland, p.rouse@auckland.ac.nz

When price information is unavailable, Banker, Chang, & Natarajan (2007) proposed a method to estimate technical and allocative inefficiency using aggregate cost or revenue data. This research replicates their analysis using the same data but supplemented by simulated data. The results show that when using individual firm prices, the Banker et al. (2007) method produces upwardly biased inefficiency measures and appears to misclassify some allocative inefficiency as technical inefficiency. The method does work, however, if uniform prices are known but in that situation, the quantities can then be derived and allocative efficiency calculated in the usual fashion.

4 - Measuring The Efficiency Of Suffolk County School Districts

Diana Hagedorn, Stony Brook University, 14 Orleans Court, Commack, NY, 11725, United States, diana.hagedorn@stonybrook.edu, Herbert F. Lewis, Thomas R Sexton

In this paper, we use an input oriented DEA model to evaluate the performance of 69 school districts in Suffolk County, New York. We then consider merging adjacent school districts to potentially improve efficiency due to economies of scale.

■ MC41

207C-MCC

Option Pricing and Estimation of Greeks

Sponsored: Financial Services

Sponsored Session

Chair: Xuewei Yang, Nanjing University, 22 Hankou Road, Gulou District, Nanjing, 210093, China, xwyang@nju.edu.cn

1 - Optimal Portfolio Deleveraging With Cross Asset Price Pressure

Jingnan Chen, Singapore University of Technology and Design, jingnan_chen@sutd.edu.sg, Yufei Yang, Jie Zhang

We study an optimal portfolio deleveraging problem, where the objective is to meet specified debt/equity requirements at the minimal execution cost. During the course of trading, permanent and temporary price impact is taken into account. In particular, we include the cross-asset price pressure which measures the impact on an asset caused by the trading of other assets. Mathematically, the optimal deleveraging problem is formulated as a non-convex quadratic program with quadratic and box constraints. We develop a successive convex optimization algorithm to obtain the optimal deleveraging strategy.

2 - A New Smooth Perturbation Analysis Approach To Sensitivity Analysis For Options With Discontinuous Payoffs

Yanchu Liu, Sun Yat-sen University, liuych26@mail.sysu.edu.cn, Zhijian He, Guangwu Liu

Greeks estimation is one of the most important procedures in financial risk management. Pathwise and likelihood ratio (LR) methods are two classical ways generating unbiased estimates to Greeks. The pathwise method usually has a smaller variance than the LR method. But it typically requires the payoff functions to be (Lipschitz) continuous. This paper proposes a new smooth perturbation analysis (SPA) method that can liberate the Lipschitz continuity requirement on the payoff functions. Our estimator is unbiased and can be easily implemented. Extensive numerical experiments illustrate the advantage of our method.

3 - Catastrophe Option Pricing With Auto-correlated And Catastrophe-dependent Intensity

Guanying Wang, Tianjin University, Tianjin, 300072, China, wangguanyingnk@163.com

A discrete-time pricing model is proposed to investigate catastrophe equity put options with auto-correlated and catastrophe-dependent intensity. Catastrophic events are assumed to occur according to a Poisson process and the intensity is affected by the numbers of catastrophic events that occurred in the past. Stochastic volatility of
the underlying asset is captured by a GARCH process. We derive a pricing formula for catastrophe equity put options and then illustrate effects of the catastrophe intensity on catastrophe equity put option prices.

4 - Option Pricing Under The Price Limits Mechanism: Evidence From China

Xuewei Yang, Nanjing University, xwyang@nju.edu.cn
Ning Cai

We study the effects of the so-called price limits mechnism (PLM) on option pricing. Our setting considers options written on 50-ETF (510050.SH) traded in Shanghai Stock Exchange of China, which is subject to the PLM. Numerical results reveal the implications of PLM on option pricing and hedging.

■ MC42

207D-MCC

Revenue Management in the Social Environment

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Ming Hu, University of Toronto, Toronto, ON, Canada, ming.hu@rotman.utoronto.ca

1 - Optimal Pricing In Networks With Latent Agents

Ozan Candogan, Chicago Booth, Ozan.Candogan@chicagobooth.edu, Baris Ata, Alexandre Belloni

We analyze the question of targeted pricing/advertising in social networks, in settings where the platform does not have full information about the underlying network. In particular, we assume that certain agents are latent, and characterize the optimal pricing rule of the platform. We establish that unlike the case with full information, in the presence of latent agents even with symmetric influence structure, using network information can significantly improve the profits of the platform. We then explore how the platform can efficiently learn the optimal prices when the latent component is small when compared to the observable part.

2 - When Do Bidders Anticipate Regret During Auctions? Empirical Evidence From Ebay

A. Serdar Simsek, The University of Texas at Dallas, Richardson, TX, United States, Serdar.Simsek@utdallas.edu, Ozalp Ozer, Meisam Hejazi Nia

We developed a structural model that accounts for bidders' learning and their anticipation of winner and loser regrets in auctions. Using a large data set from eBay, we quantify in which product categories bidders anticipate regret and show how our results can be used to increase eBay's revenue significantly

3 - Optimal Pricing In Social Networks Under Asymmetric Information

Yang Zhang, Tsinghua University, yangzhanguser@mail.tsinghua.edu.cn, Ying-ju Chen

We study the optimal pricing of products / services in social networks, where customers are strategic and their consumptions exhibit local externality. Our model concerns the information asymmetry — Consumers know about their local network characteristics while the selling firm has only knowledge of global network. The network model we employ embeds random network and scale free network as special cases. We characterize the optimal menu for the firm, the induced sales, and their properties with regard to the network structure.

■ MC43

208A-MCC

Decision Analysis Arcade I

Sponsored: Decision Analysis

Sponsored Session

Chair: Joshua Woodruff, University of Texas, Austin, TX, United States, joshua.woodruff@utexas.edu

1 - Assessment Of Drug Development Options: If, When And How Much?

Ozgur Ozkan, Decision Science Director, Astrazeneca Pharmaceuticals, Gaithersburg, MD, United States, Ozgur.Ozkan@astrazeneca.com

New approaches in clinical trial design and changing regulatory and payer environment make it a challenging task to compare different drug development paths. We will describe a modeling approach to assess different options in time, risk and value dimensions. This will cover uncertainties around success measures, clinical trial timelines and market share expectations. Ideas of eliciting information from subject matter experts as well as combining expert opinion with statistical estimates will be shared. The talk will also reflect on our experience of utilizing different metrics and visualizations to communicate with stakeholders.

2 - Optimal Discretization For Decision Analysis

Joshua Woodruff, University of Texas, joshua.woodruff@utexas.edu

Optimal discretization is a new method to discretize uncertainties. By using optimization techniques to discretize uncertainties, it is possible to create robust discretizations that are more accurate. Our method produces more accurate project certain equivalents which will improve decision quality. We use non-linear optimization to select and assign probabilities to candidate percentiles for each model uncertainty. With optimal discretization we found we can use the model information and potential distributions of the uncertainties to find discretizations that yield certain equivalent errors that can be orders of magnitude better than other discretization methods we tested.

3 - Network Interdiction In Competitive Market Entry And Product Design

Benjamin Harris, Northeastern University, 360 Huntington Avenue, Boston, MA, 02115, United States, harris.be@husky.neu.edu, Sagar S Kamarthi

Optimal strategy for product design in the Internet of Things (IoT) must consider input beyond that of stakeholders and customers and include the highly connected infrastructure on which the product will be released. Firms involved in the IoT need to develop strategy and risk mitigation techniques and remain competitive. This research will enable firms to identify optimal strategies under current requirement and market conditions, as well as analyze changes in strategy if a requirements space is changed. As a result, product designers and firm leadership can anticipate and respond to market and industrial changes with increased fidelity and predictive power through network model insights.

■ MC44

208B-MCC

Panel: Howard Raiffa: Celebration of His Life and Achievement

Sponsored: Decision Analysis

Sponsored Session

Moderator: Jeffrey Keisler, University of Massachusetts - Boston, 100 Morrissey Boulevard, Boston, MA, 02125, United States, jeff.keisler@umb.edu

1 - Howard Raiffa: Celebration Of His Life And Achievement

Jeffrey Keisler, University of Massachusetts, Boston, MA, United States, jeff.keisler@umb.edu

Colleagues of Howard Raiffa will discuss aspects of his life, contributions and legacy.

2 - Panelist

David Bell, Harvard Business School, Morgan Hall 171, Boston, MA, 02163, United States, dbell@hbs.edu

3 - Panelist

Ralph Keeney, Duke University, Fuqua School of Business, San Francisco, CA, 94111, United States, keeneyr@aol.com

4 - Panelist

Detlof Von Winterfeldt, University of Southern California, USC, Los angeles, CA, 90089, United States, winterfe@usc.edu

■ MC45

209A-MCC

Optimization via Simulation under Input Uncertainty

Sponsored: Simulation

Sponsored Session

Chair: Eunhye Song, Northwestern University, 2145 Sheridan Road, Evanston, IL, 60208, United States, eunhyesong2016@u.northwestern.edu

1 - Data-driven Construction Of Uncertainty Sets For Joint Chance-constrained Programs

Jeff Hong, City University of Hong Kong, jeffhong@cityu.edu.hk Henry Lam, Zhiyuan Huang

We study the use of robust optimization (RO) in approximating joint chance-constrained programs (CCP), in situations where only limited data, or Monte Carlo samples, are available in inferring the underlying probability distributions. We introduce a procedure to construct uncertainty set in the RO problem that translates into provable statistical guarantees for the joint CCP. This procedure relies on learning the high probability region of the data and controlling the region's size via a reformulation as quantile estimation. We show some encouraging numerical results.

2 - Asymptotics Of Risk Formulations For Simulation Optimization Under Input Uncertainty

Di Wu, Georgia Institute of Technology, Atlanta, GA, United States, dwu80@gatech.edu, Enlu Zhou

Input distributions are the distributions (of stochastic uncertainty) that drive a simulation process. Since input distributions are usually estimated from finite data, optimizing the model may yield solutions that perform poorly under the true input distributions. To hedge against the risk of input uncertainty, we minimize the risk measures of mean output with respect to the unknown parameters' posterior distribution. We establish the consistency and the asymptotic normality of risk formulations, and show that when the input data has a small size, the risk formulations are essentially seeking a tradeoff between average performance and the risk of actual performance.

3 - An Optimization-based Approach To Input Uncertainty Via The Empirical Likelihood

Henry Lam, University of Michigan, khlam@umich.edu Huajie Qian

We study a simulation-optimization-based approach in constructing statistically accurate confidence bounds for stochastic simulation under nonparametric input uncertainty. This approach utilizes the empirical likelihood method that converts the computation of confidence bounds into a pair of optimizations over the uncertain input distributions, with a suitable weighted-average divergence constraint calibrated with a chi-square quantile. We present the theory giving rise to the constraint and the calibration, and compare the performance of our optimization algorithm with existing standard methods such as the bootstrap.

4 - Leveraging The Common Input Data In Comparisons Of Systems Under Input Uncertainty

Eunhye Song, Northwestern University, Evanston, IL, United States, eunhyesong2016@u.northwestern.edu, Barry L Nelson

This talk focuses on a discrete optimization via simulation problem when all systems share the same input models estimated from common input data. Standard methods that are conditional on the estimated input models may not provide the target correct-selection inference, exposing the user to unmeasured model risk. We define the common-input-data (CID) effect as the joint impact of input uncertainty due to the common distribution on each system's outputs. The proposed procedure incorporates input uncertainty by leveraging the CID effect and is proven to provide the desired inference asymptotically under mild conditions.

■ MC46

209B-MCC

Revenue Management in e-Commerce

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Joline Uichanco, University of Michigan, Ross School of Business, Ann Arbor, MI, United States, jolineu@umich.edu

1 - Minimum Advertised Pricing Policy: An Economic Analysis

Ozge Sahin, Johns Hopkins University, ozge.sahin@jhu.edu
Liang Ding, Roman Kapuscinski

During last twenty years, many brick-and-mortar retailers face competition from online retailers and local discounters. Customers are able to experience products in a brick-and-mortar store but purchase online for lower prices. As a result, brick-and-mortar retailers' sales decrease and they stop promoting or carrying such products. For manufacturers, however, brick-and-mortar retailers play a crucial role by showcasing and advertising products to customers. In this paper, we build a stylized model to study and compare the performance of common price restraining policies.

2 - Omni-channel Revenue Management Through Pricing And Fulfillment Planning

Joline Uichanco, University of Michigan, Ann Arbor, MI, United States, jolineu@umich.edu
Pavithra Harsha, Shivaram Subramanian

In an omni-channel environment, inventory is shared across channels through multiple fulfillment options. We present a tractable optimization model to determine optimal lifecycle channel prices, inventory allocations and partitions across channels that maximizes the total chain level profit. This solution was tested in a production pilot setting and demonstrated a 6% increase in markdown revenue over current practices across the categories analyzed.

3 - Cash-on-delivery In Emerging Markets: An Empirical Study

Richard Zhiji Xu, Kellogg School of Management, Northwestern University, Evanston, IL, United States, zhiji-xu@kellogg.northwestern.edu, Antonio Moreno-Garcia, Chaithanya Bandi

Cash-on-delivery (COD), the payment method where customers pay for the products in cash at the time of delivery, is widely used in online retailing in developing countries. Using a unique data set from a leading online fashion retailer in India, we study the impacts of COD on pricing strategies, firm revenue, and other operational consequences.

4 - Inventory Optimization For Fulfillment Integration In Omnichannel Retailing

Aravind Govindarajan, University of Michigan, 701 Tappan Street, Ann Arbor, MI, 48109, United States, arav@umich.edu, Amitabh Sinha, Joline Uichanco

Omnichannel refers to the seamless integration of a retailer's channels such as brick-and-mortar and e-commerce. Using analytical models, we study three basic omnichannel fulfillment models varying in the level of integration between in-store and online demands. We obtain optimal order-up-to quantities for the single period, two-store problem, and extend our analyses to the multi-store setting, developing an asymptotically optimal heuristic which provides significant cost savings over current practice. We then numerically study the effects of cost and demand parameters on the choice of fulfillment structures. Finally, we discuss extensions to the multi-period setting under lost sales.

■ MC47

209C-MCC

New Revenue Management Practices in Airline and Hotel Industries

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Ovunc Yilmaz, University of South Carolina, Columbia, SC, United States, oyilmaz@email.sc.edu

Co-Chair: Mark Ferguson, University of South Carolina, Columbia, SC, United States, mark.ferguson@moore.sc.edu

1 - Dynamic Pricing With A Fare-lock Option

Zhi-Long Chen, University of Maryland, Robert H Smith School of Business, Dept of Decision, Operations & Info Tech, College Park, MD, 20742-1815, United States, zchen@rhsmith.umd.edu
Ming Chen

We study a relatively new revenue management practice frequently seen in the airlines industry where customers have the option to lock a fare at a small fee for a certain period of time. The free 24 hour cancellation policy enforced by DOT can be viewed as a special case of this problem. This provides a valuable option for those undecided travelers when finalizing their travel plans. We investigate the implications of such practice on both the airlines and the passengers, as well as the resulting pricing policies.

2 - You Are Eligible For An Upgrade: A Critical Look At Hotel Standby Upgrades

Ovunc Yilmaz, PhD Student, University of South Carolina, Columbia, SC, United States, oyilmaz@email.sc.edu
Mark Ferguson, Pelin Pekgun

Standby upgrades, where the guest is only charged if the upgrade is available at the time of arrival, is one technique that has become increasingly popular in the hotel industry. Working on a data set from a major hotel chain, we analyze the guest decision-making process for these upgrades.

3 - The Rise Of The Sharing Economy: Estimating The Impact Of Air BnB On The Hotel Industry

Davide Proserpio, Boston University, dproserp@cs.bu.edu

In this paper we study Air BnB and its entry into the short-term accommodation market in Texas. We first explore Air BnB's impact on hotel room revenue, and show that in Austin, where Air BnB supply is highest, the impact on hotel revenue is in the 8-10% range; moreover, the impact is non-uniformly distributed, with lower-priced hotels and those hotels not catering to business travelers being the most affected. We then examine seasonal effects and provide evidence that the flexibility of Airbnb supply impacts hotels disproportionately during high season, limiting their pricing power.

4 - Price Volatility And Market Performance Measure: The Case Of Revenue Managed Goods

Benny Mantin, University of Waterloo, benny.mantin@uwaterloo.ca, Eran Rubin

The airline industry has embraced revenue management practices which are manifested through frequent updates to posted airfares. When shopping for the lowest available fare, consumers are exposed to volatile prices. Different routes exhibit substantially different volatility levels of the lowest available fare. We quantify the relation between these volatility levels and performance metrics such as sales and revenue at the route level using US domestic aviation markets.

■ MC48

210-MCC

New Insights from Social Media: Empirical Study, Field Experiment, and Algorithm Development

Invited: Social Media Analytics

Invited Session

Chair: Yen-Yao Wang, Michigan State University, 632 Bogue Street, Room N204, Okemos, MI, 48824, United States, wangyen@broad.msu.edu

1 - Social Media Engagement, Product Evaluations, And Demand Spillover In The Automobile Industry

Yen-Yao Wang, Michigan State University, wangyen@broad.msu.edu, Anjana Susarla, Roger Calantone, Yingda Lu

Online Word of Mouth (WOM) is an important aspect of consumer-firm relationship and a leading indicator of product performance. However, prior research focuses considerably on the static view of it. This paper examines the dynamics of the spillover effects in online WOM in the US automobile industry. To measure online WOM, we focus specifically on customers' test drive experience. We collected data from around 1000 different social media platforms for 32 car brands from 2009 to 2015. We used a Bayesian modeling framework and estimated the model using Markov Chain Monte Carlo (MCMC) methods.

2 - The Dark Side Of Positive Social Influence

Che-Wei Liu, University of Maryland, College Park, MD, Un ited States, cwliu@rhsmith.umd.edu, Ritu Agarwal, Guodong (Gordon) Gao

Social influence has been widely used to transform behaviors. However, when individuals are pressured to conform to behavior of the majority, would it lead to an unexpected backfire effect? We conducted a randomized field experiment of more than 10,000 individuals for a two-month period on an online physical activity community to examine the dark side of social influence. We studied the effect of social norms on users' goal setting and goal achievement behavior. While social influence increased the rate of goal setting, strikingly, we also observe the dark side of social influence. Our findings have important implications for the design of interventions in the context of mHealth technologies.

3 - Influencers In Social Media – An Assessment Of Algorithmic Approaches In Big Data Environments

Shih-Hui Hsiao, Lawrence Technological University, Southfield, MI, United States, suade0904@msn.com, Ram Pakath

Growing social media usage, accompanied by explosive growth in related Big Data, has resulted in increasing interest in finding automated ways of discovering influencers (i.e., opinion leaders) in online social interactions. Beginning 2008, about two dozen variants of six basic approaches have been proposed. Yet, there is no comprehensive study investigating the relative efficacy of these methods in specific settings. We investigate and report on the relative performances of 15 methods on 9 twitter data sets ranging in size from tens of thousands to hundreds of thousands of tweets.

4 - Natural Language Processing: From Text Mining To Social Media Analysis

Chih-Hao Ku, Assistant Professor, Lawrence Technological University, 21000 W 10 Mile Rd, M309A, Southfield, MI, 48331, United States, cku@ltu.edu, Yung-Chun Chang

Today, the number of digital reports, e.g., crime reports and social media data derived from Twitter, LinkedIn, and Facebook are growing rapidly. However, this immerse amount of digital data post challenges and opportunities for data analysis. The rise of social media has drawn interest on text mining and social media analysis, e.g., sentiment analysis. Natural language processing (NLP) is an important component for those analyses. We report here on research work on text mining, sentiment analysis, and future trend using NLP techniques.

■ MC49

211-MCC

Estimating Sentiments Using Social Media

Invited: Social Media Analytics

Invited Session

Chair: Subodha Kumar, Mays Business School, Texas A&M University, 301-F, Wehner, 4217 TAMU, Mays Business School, College Station, TX, 77843, United States, skumar@mays.tamu.edu

1 - The Effects Of Social Media Sentiment On Engagement

Rakesh Reddy Mallipeddi, Mays Business School, Texas A&M University, College Station, TX, United States, rmallipeddi@mays.tamu.edu, Ramkumar Janakiraman, Subodha Kumar, Seema Gupta

In this study, we propose an econometric model to examine the drivers of social media engagement. Set in the context of national elections, we examine the impacts of tweeting behavior of the candidates contesting in an election on the social media engagement with their constituents. To meet our objectives, we assemble a novel candidate-level data of social media engagement.

2 - The Effect Of "online following" On Contributions To Open Source Communities

Xiaowei Mei, University of Florida, xiaowei.mei@warrington.ufl.edu, Mahdi Moqri, Liangfei Qiu, Subhajyoti Bandyopadhyay

We estimate the effect of "online following," a basic form of online social interaction, on members' contributions in open source software (OSS) communities. We employ a panel vector autoregression model using individual level data across time in GitHub to achieve identification of causal effects, while controlling for individual heterogeneity and time effects. We find that the following behavior of others has a significant positive effect on users' contribution level to the platform even after controlling for the aforementioned factors. On the other hand, users' contribution level also has a significant positive effect on their following behavior.

3 - Manipulation For Competition: An Empirical Investigation Of Click Farming

Jingchuan Pu, University of Florida, jingchuan@ufl.edu Liangfei Qiu, Hsing K Cheng

Anytime there's a monetary value added to clicks, there's going to be people going to the dark side. This research focuses on the economic incentive of the click farming, a popular form of click fraud which is widely conducted by sellers or content generators. We cooperate with a website that uses an algorithm to detect the robot or unreal viewing activity, a black list is built for the suspicious user account which may be used as click farming. Using the detection results as a proxy of the content generators' click farming activity, we test the impact of potential incentive, like the status of this content, content generator and the competition environment on the content generators' click farming activity.

■ MC51

213-MCC

Pricing and Revenue Management Applications

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: N. Bora Keskin, Duke University, Durham, NC, United States, bora.keskin@duke.edu

1 - Pricing Reservations: Dealing With No-shows

Jaelynn Oh, University of Utah, jaelynn.oh@business.utah.edu

We study two remedies to deal with reservation no-shows: charging no-show fees and price discrimination. We also study how to allocate capacity between reservations and walk-ins.

2 - Trade Credit And Lifetime Value Of A Newsvendor Buyer

Meisam Soltani-koopa, Queen's University, Kingston, ON, Canada, 15msk3@queensu.ca, Yuri Levin, Mikhail Nediak, Anton Ovchinnikov

Trade credit typically appears as a grace period for invoice payment. It helps retailers overcome temporary cash shortages as an alternative to seeking financing from banks. We consider a supply chain with one supplier and one repeated newsvendor retailer where the supplier maximizes its long-term profit by offering the retailer a financing and wholesale price contract. In each period, the retailer decides about the quantity to order and the amount of money to borrow from the supplier or a bank. We study the lifetime value of the retailer using a dynamic Stackelberg game, from the perspective of the supplier who, as a leader, takes into account the long-term view of its relationship with the retailer.

3 - Asymptotically Optimal Markdown Policies For Demand Learning

Hongfan Chen, University of Chicago, hongfan.chen@chicagobooth.edu, N. Bora Keskin

Consider a firm selling a product to a population of customers with heterogeneous valuations. In this setting, we develop guidelines for designing markdown policies and derive asymptotically optimal performance guarantees. (Joint work with Bora Keskin)

■ MC52

214-MCC

Panel: Pro Bono Analytics

Sponsored: Public Sector OR

Sponsored Session

Moderator: David T. Hunt, Oliver Wyman, One University Square, Princeton, NJ, 08540, United States, david.hunt@oliverwyman.com

1 - Pro Bono Analytics

David T. Hunt, Oliver Wyman, One University Square, Princeton, NJ, 08540, United States, david.hunt@oliverwyman.com

Pro Bono Analytics is an initiative within INFORMS to match members willing to volunteer their OR and analytical skills with non-profit organizations working in underserved and developing communities. Panelists include Nashville area non-profit organizations and Pro Bono Analytics volunteers discussing how analytics can provide positive impacts for topics ranging from improving operations at a homeless shelter to understanding the inventory needs for supplies in a low-income school district.

2 - Panelist:

Matthew Brondum, US Army Corps of Engineers, Vicksburg, MS, United States, mcb345@cornell.edu

3 - Panelist:

Joel Wright, PENCIL Foundation, Nashville, TN, United States, jwright@pencilfd.org

4 - Panelist:

Cindy Corona Rivera, Hands On Nashville, Nashville, TN, Cindy@hon.org

5 – Panelist:

Anna Danandeh, Verizon, Waltham, MA, annadanandeh@mail.usf.edu

■ MC53

Music Row 1- Omni

Panel: Emerging Themes in Startup Product, Supply Chain & Technology Management

Sponsored: Technology, Innovation Management & Entrepreneurship

Sponsored Session

Moderator: Nitin Joglekar, Boston University Questrom School of Business, 595 Commonwealth Avenue, Boston, MA, 02215, United States, joglekar@bu.edu

1 - Panelist:

Nitin Joglekar, Boston University Questrom School of Business, joglekar@bu.edu

This panel showcases alternative themes and research approaches being pursued by a select set of emerging scholars in the startup product, supply chain & technology management research domain.

2 - Panelist:

Jennifer Bailey, Babson College, jbailey@babson.edu

3 - Panelist:

Jianxi Luo, Singapore University of Technology & Design, luo@sutd.edu.sg

4 - Panelist:

Joel Wooten, University of South Carolina, joel.wooten@moore.sc.edu

5 - Panelist:

Onesun Steve Yoo, University College London, onesun.yoo@ucl.ac.uk

6 - Panelist:

Meyyappan Narayanan, Lakehead University, Thunder Bay, ON, Canada, meyyappan.narayanan@lakeheadu.ca

■ MC54

Music Row 2- Omni

Service Innovation in the Cognitive Era

Invited: Service Science

Invited Session

Chair: Changrui Ren, IBM Research - China, IBM Research - China, Beijing, 100193, China, rencr@cn.ibm.com

1 - Enterprise Cloud Garbage Collector

Sai Zeng, IBM T.J. Watson Research Center, Yorktown Heights, NY, United States, saizeng@us.ibm.com, Christopher Young, Karin Murthy

Infrastructure as a Service (IaaS) clouds empowers the agility to provision servers. Recent findings indicate that this agility led to a situation where 1 in 3 data center servers is a zombie server, aka server is running but does not do any useful work. In this paper, we present Enterprise Cloud Garbage Collector, a tool that detects zombie severs. It establishes dependency between users/clients and servers by constructing a weighted reference model based on application knowledge. In the situation of insufficient application knowledge, it supplements its dependency results with a machine learning model trained on resource utilization data.

2 - Big Data Fueled Supply Risk Management: Sensing, Prediction, Evaluation And Mitigation

Changrui Ren, IBM Research - China, Beijing, China, rencr@cn.ibm.com, Miao He, Qinhua Wang

Supplier risks jeopardize on-time or complete delivery of supply in a supply chain. This talk will introduce a big data fueled approach to monitor and manage supply risks, which includes a big data analytics component, a simulation component and an optimization component. The big data analytics component senses and predicts supply disruptions with internally (operational) and external (environmental) data. The simulation component supports risk evaluation to convert predicted risk severity to key performance indices (KPIs) such as cost and stockout percentage. The optimization component assists the risk-hedging decision-making.

■ MC55

Music Row 3- Omni

Inventory Management II

Contributed Session

Chair: Heinrich Kuhn, Catholic University of Eichstaett-Ingolstadt, Auf der Schanz 49, Ingolstadt, 85049, Germany, heinrich.kuhn@ku.de

1 - Base-stock Models For Lost Sales - A Markovian Approach

Sang-Phil Kim, Assistant Professor, Winona State University, 175 W. Mark st., Somsen 406, Winona, MN, 55987, United States, Ksphil@me.com, Yanyi Xu, Maqbool Dada, Arnab Bisi, Suresh Chand

We consider the lost sales model with discrete demand. The inventory is reviewed every T periods and an order is placed to bring the inventory position back to the target base-stock level R, and is received after a lead time of L periods. Based on the outstanding orders in the pipeline, we represent the state of the system as a Markov chain. We show that the structure of the transition probability matrix is recursive in R and L. This special structure is used to facilitate computation of the stationary distribution. Analytical results complemented by numerical examples reveal that neither the optimal base-stock nor the expected cost is monotone in L for a given T.

2 - Capacity Usage Estimation Methodology For Inventory Management

Ahmet Nuroglu, Yildiz Technical University, Barbaros Bulvari, Yildiz-Istanbul, 34349, Turkey, envernuroglu@gmail.com, Fahrettin Eldemir

New analytical capacity usage estimation methodology for economic order quantity (EOQ) model is proposed. In multiple item warehouse-space capacity constrained EOQ model, by applying the randomized storage concept, capacity usage is estimated from expected inventory occurrences instead of order quantities. In joint replenishment problem under power of two (PoT) policy, the capacity usage is estimated from average inventory occurrences which are the function of PoT parameter of each item. The feasible optimal solutions are simulated and validated.

3 - An Inventory Model With Fuzzy Demand In a Two-echelon Supply Chain Management: Drug Distribution In Hospital Pharmacy

Parisa Jannatifard, graduate Student and teacher assistant, Southern Illinoise University Edwardsville, Edwardsville, IL, 62026, United States, pjannat@siue.edu, Javad Sadeghi

This paper develops an inventory model with fuzzy demand regarding the vendor managed inventory (VMI) policy. In recent past few decades, VMI policies have been used in modeling inventory problems. The vendor's warehouse has a capacity constraint while a vendor supplies several products to retailers. This policy reduces total costs in healthcare system like drug distribution in hospital pharmacy. The aim of this paper is to find a near optimal solution including order quantities for vendor and retailer and replenishment frequencies to minimize the total cost with a metaheuristic algorithm.

4 - Inventory Pooling And Transshipment Under Correlated Fat-Tail Demands

Zhen Liu, Numerix LLC, 1237 Bristol Ln, Buffalo Grove, IL, 60089, United States, zhenliu@alum.northwestern.edu

We study the classic inventory pooling problem by Eppen (1979) under a special class of multivariate fat-tail distribution: Normal Inverse Gaussian (NIG) demands to better fit real-world demand data. We obtain the optimal inventory level in a closed form by employing standardized NIG density function, and express the optimal expected costs in terms of unit NIG loss function. Rather than independent and identically distributed demands, our results complement Bimpikis and Markakis (2015) by considering correlated demands. We further discuss the transshipment problem of Dong and Rudi (2004) under NIG demands.

5 - Cyclic Vs. Static Inventory Policy Assumptions When Optimizing Case-pack Sizes In Grocery Retailing

Heinrich Kuhn, Catholic University of Eichstaett-Ingolstadt, Auf der Schanz 49, Ingolstadt, 85049, Germany, heinrich.kuhn@ku.de, Thomas Wensing, Michael Sternbeck

We analyze two possible approaches quantifying the optimal case-pack (CP) size in retail distribution systems. One approach assumes a cyclic inventory policy taking into account the weekly seasonality of product demands. The other approach assumes an equal demand distribution on each day of the week, i.e., assuming a stationary inventory policy. The general assumptions of a periodic review reorder inventory policy, i.e., (r, s, nq) policy, are assumed. We conduct several experiments analyzing the question under what circumstances both approaches achieve equal results.

■ MC56

Music Row 4- Omni

IT and Services

Sponsored: EBusiness

Sponsored Session

Chair: Atanu Lahiri, University of Texas at Dallas, Richardson, TX, United States, atanu.lahiri@utdallas.edu

1 - Data-driven Optimization: Revenue Analytics For A Supply-side Network Via Traffic-stream Mixing

Zhen Sun, University of Texas-Dallas, 800 west campbell rd, Richardson, TX, United States, zhen.sun@utdallas.edu, Milind Dawande, Ganesh Janakiraman, Vijay S Mookerjee

This study develops a data-driven approach to solve constrained optimization problems in which the decision maker does not have an analytic form for the objective function, but knows what decision variables affect the function. Our approach comes with a worst-case performance guarantee that improves with the characteristics (size, pervasiveness) of the available data. We apply our technique to a traffic-stream mixing problem encountered by a supply-side internet advertising network that wishes to optimize the click revenue earned from ads.

2 - Cardinality Bundles With Complex Costs

Jianqing Wu, Foster School of Business, University of Washington, Seattle, WA, United States, fisherwu@uw.edu, Mohit Tawarmalani, Karthik Kannan

This paper studies pricing of cardinality bundles (CB) when bundling involves complex costs. When implementing CB, a firm set prices on the sizes of bundle and lets consumers choose specific products based on bundle sizes. The basic model of CB is analyzed in Wu et al. (2016). In this paper, we first extend the existing CB model to allow fixed costs in adding additional bundles. We show that CB problem with fixed costs can be solved as a shortest-path problem. We then extend the CB model in another way to solve CB problem with submodular cost structure. Such analysis is especially useful when there exists economies of scale in production.

4 - An Economic Analysis Of The Impact Of Recommender Systems On Product Search

Abhijeet Ghoshal, University of Louisville, abhijeet.ghoshal@louisville.edu, Vijay M. Mookerjee, Sumit Sarkar

We perform an economic analysis of firms providing recommendation services considering the influence of recommendations on the search process of customers. We determine the price and recommendation system effectiveness equilibrium and analyze how the equilibrium shifts when costs of recommendations change.

■ MC57

Music Row 5- Omni

Experiments in Supply Chain Management

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Andrew M. Davis, Cornell University, Ithaca, NY, United States, adavis@cornell.edu

1 - Experimental Evidence On Post-choice Forecasting Bias: Do Optimizers Know They're Cursed?

Jordan Tong, University of Wisconsin, jtong@bus.wisc.edu

Choose the best alternative and predict its outcome. We find that people tend to be too optimistic in such post-choice forecasting tasks. This tendency has important implications. For example, it suggests that managers who pick products to include in assortments tend to forecast higher demand and order more inventory than managers who don't pick. We develop a behavioral model to help explain the phenomenon and provide supporting experimental evidence in three settings: guessing the number of pennies in jars, forecasting and making inventory decisions for products, and estimating sales prices of houses. Finally, we study factors that exacerbate the bias and possible ways to mitigate it.

2 - Firm Objectives And Managers' Pricing Decisions: Theory And Experiments

Rashmi Sharma, Penn State University, rashmi.sharma@psu.edu, Saurabh Bansal, Elena Katok

In this paper we develop a model to determine what compensation plan a firm should offer to managers who make pricing decisions under price-responsive, uncertain demand. We show that the structure of the compensation plan depends on the firm's objective function. We then report the results of a behavioral experiment to test the model's predictions.

3 - Multidimensional Bargaining In Supply Chains: An Experimental Study

Kyle Hyndman, University of Texas at Dallas, kyleb.hyndman@utdallas.edu, Andrew M. Davis

We experimentally investigate the impact of bargaining and the allocation of inventory risk on the performance of a two-stage supply chain. We show that when allowing the parties to bargain over all contract terms simultaneously, observed supply chain efficiencies are at least 90%, which are considerably higher than those seen in past studies. Second, contrary to the theoretical prediction, the party incurring the inventory risk always earns a substantially lower profit than the other party. Third, a win-win situation is created when all contract terms are simultaneously negotiated.

4 - Group Identity To Manipulate Social Preferences In Sales And Operations Planning

Felix Papier, Associate Professor, ESSEC Business School, 3 Av Bernhard Hirsch BP 50105, Cergy Pontoise Cedex, France, papier@essec.edu, Ulrich Thonemann, Torsten Gully

We analyze a supply chain in which a demand planner provides demand forecasts to a production planner. The production planner needs information about the forecast accuracy. If the actual effort of the demand planner and the belief of the production planner are not aligned, the supply chain performance suffers. We develop a game theoretic model to show how social preferences affect the alignment between the two supply chain actors. Using lab experiments we find that some demand planners invest effort, and that production planners anticipate this effort. We further show that group identity can increase social preferences, which ultimately leads to higher supply chain profit.

■ MC58

Music Row 6- Omni

Energy VII

Contributed Session

Chair: Par Holmberg, Associate Professor, Research Insitute of Industrial Economics (IFN), Grevgatan 34, Stockholm, SE10215, Sweden, par.holmberg@ifn.se

1 - Electricity Resource Capacity Expansion With Distributed Energy Resources: A New MILP Formulation

Jesse D Jenkins, PhD Candidate, Massachusetts Institute of Technology, Cambridge, MA, 02139, United States, jessedj@mit.edu

Conventional electricity capacity expansion models do not properly consider distributed energy resources (DERs), including distributed generation, storage and demand response. DERs provide locational benefits—e.g. loss mitigation, congestion relief, network capacity deferral—which must be considered along with the costs of different unit scales. In this new MILP formulation, conventional generation and DER investments are made across several transmission zones and distribution voltage levels subject to power flow constraints, network reinforcement costs, losses, and operational constraints capturing reserves, ramp rates, and unit commitment constraints for thermal generators.

2 - Price Projections For Ancillary Services Markets Under Hypothetical Future Scenarios

Todd Levin, Energy Systems Engineer, Argonne National Laboratory, 9700 S. Cass Ave, Bldg 362, Lemont, IL, 60439, United States, tlevin@anl.gov, Zhi Zhou

We forecast broad future ancillary service price trends in U.S. power markets by first identifying a set of key parameters that influence prices. Baseline models are then developed and calibrated based on historical data and current regional characteristics. We then utilize AURORAxmp to model hourly dispatch in each region and forecast the impact of changes in these inputs, such as electricity demand, fuel prices, renewable penetration levels, and availability of AS supply. Finally, we identify correlations to broadly project price trends under hypothetical future scenarios, e.g. increased wind penetration, decreased natural gas prices, and increased supply of flexible generation resources.

3 - An Efficient Integer L-shaped Method For A Two-stage Self-healing Power Grid Problem

Amir Golshani, PhD Candidate, University of Central Florida, Orlando, FL, United States, amir.golshani@knights.ucf.edu, Wei Sun, Qipeng Zheng

When a power system enters an emergency state, the self-healing process is initiated by system operators to bring the system back to its normal condition. This presentation proposes a two-stage self-healing optimization problem with a set of practical constraints containing integer variables in both stages. To solve the proposed problem, the integer L-shaped algorithm together with an efficient optimality cut based on the physical characteristics of power system will be presented. Standard IEEE test system is used to demonstrate the effectiveness of the proposed algorithm and optimality cut.

4 - Toward Cost-efficient And Reliable Unit Commitment Under Uncertainty

Hrvoje Pandzic, Faculty of Electrical Engineering and Computing University of Zagreb, Unska 3, Zagreb, 10000, Croatia, hrvoje.pandzic@fer.hr, Yury Dvorkin, Ting Qiu, Yishen Wang, Daniel Kirschen

This presentation will describe a new improved interval unit commitment formulation that combines some aspects of stochastic and interval formulations. A systematic and rigorous assessment of the cost and reliability performance of the improved interval, interval, stochastic and robust unit commitment will be demonstrated as well.

5 - Price Instability In Multi-unit Auctions

Par Holmberg, Associate Professor, Research Insitute of Industrial Economics (IFN), Grevgatan 34, Stockholm, SE10215, Sweden, par.holmberg@ifn.se, Edward James Anderson

We consider a uniform-price procurement auction with indivisible units and private costs. We solve for a Bayesian Nash equilibrium and show that the equilibrium has a price instability in the sense that a minor change in a supplier's realized cost can result in a drastic change in the market price. The price instability is reduced as the size of indivisible units decreases for a given total production capacity. In the limit, where the size of units approaches zero and costs are almost surely common knowledge, the Bayesian equilibrium converges to a pure-strategy NE without price instability, the Supply Function Equilibrium (SFE).

■ MC59

Cumberland 1- Omni

Freight Network Design

General Session

Chair: James F Campbell, University of Missouri-St Louis, Saint Louis, MO, TBD, United States, campbell@umsl.edu

1 - Strategic Design For Delivery With Drones And Trucks

James F Campbell, University of Missouri-St Louis, St. Louis, MO, United States, campbell@umsl.edu, Donald C. Sweeney II, Juan Zhang

Our research develops continuous approximation models for the strategic design of drone and hybrid truck-drone delivery systems. We consider aerial and ground-based drones that can be launched from fixed or relocatable facilities, or from trucks. In contrast to discrete VRP-based optimization models, we treat the demand for deliveries as a continuous spatial density over a region. Analytical results and illustrations assess the economic and service performance from using the best mix of drones and trucks, and provide strategic managerial insights. Results show how using drones in conjunction with trucks alters the optimal delivery strategy and can facilitate lower cost and faster deliveries.

2 - A Quantitative Model For Truck Parking And Hours Of Service Regulations

Sarah G Nurre, University of Arkansas, 425 W. Louise Street, Fayetteville, AR, 72701, United States, snurre@uark.edu

Truck parking and hours-of-service (HOS) regulations are consistently reported as two of the top concerns in the trucking industry. Parking shortages are a function of inadequate capacity and changes to HOS regulations requiring drivers to stop frequently and for longer periods. We develop a network-based optimization model which determines the best times and locations for stopping along a set of truck routes while adhering to system-wide HOS regulations, network, and scheduling constraints. We present the results and insights deduced from experiments run using historical truck route data.

■ MC60

Cumberland 2- Omni

Methodological Advances and Empirical Discoveries in Travel and Activity Choice Modeling

Sponsored: TSL, Urban Transportation

Sponsored Session

Chair: Sayeeda B. Ayaz, UMass Amherst, UMass Amherst, Amherst, MA, 01003, United States, sbayaz@engin.umass.edu

1 - Bike Route Choice Modeling Without Choice Sets Of Paths: Estimation, Prediction And Accessibility Measure

Maelle Zimmermann, Université de Montreal, maelle.zimmermann@gmail.com

We estimate a link-based bike route choice model in a real network which does not require to sample any choice set of paths, similar to the recursive logit (RL) model formulated by Fosgerau (2013). We provide numerical estimation results, and we show the advantages of this approach in the context of prediction by focusing on two applications of the model: i) simulation of bike traffic flows; ii) measuring bike accessibility. Compared to the path-based approach which requires to generate choice sets, the RL model proves to make significant gains in computational time and to avoid paradoxical results discussed in previous works, e.g. in Nassir (2014).

2 - A Random Utility Based Estimation Framework For The Household Activity Pattern Problem

Zhiheng Xu, University at Buffalo, Buffalo, NY, United States, zhihengx@buffalo.edu, Jee Eun Kang, Roger Chen

We develop an estimation framework for the Household Activity Pattern Problem (HAPP) based on random utility theory. The estimation procedure is based on the realization that travelers' complex activity-travel pattern decisions form a continuous path in space-time. The proposed framework is comprised of choice set generation, choice set individualization, and multinomial logit estimation procedures.

3 - Looking-ahead Route Choice Behavior Based On Driving Simulator And Pc-based Experiments

Sayeeda B. Ayaz, University of Massachusetts Amherst, Marston 139, 130 Natural Resources Rd, Amherst, MA, 01003, United States, sbayaz@engin.umass.edu, Hengliang Tian, Song Gao, Donald Fisher

We study drivers' route choice behavior with real-time traffic information based on driving simulator and PC-based experiments. A looking-ahead route choice refers to a decision taking into account future diversion possibilities at downstream nodes based on real-time information not yet available at the time of decision-making. A mixed Logit model with two latent classes, myopic and looking-ahead route choice, is specified and estimated. Factors influencing looking-ahead behaviors such as information bias, experience, network complexity, and cognitive load are studied.

4 - The Initial Condition Problem With Complete History Dependency In Learning Models For Travel Choice

Yue Tang, UMass Amherst, yuet@umass.edu

Missing initial observations in longitudinal data can lead to inconsistent parameter estimates in learning models for travel choice due to the complete history dependency of choices of such models. This study proposes the maximum simulated likelihood (MSL) and multiple imputation (MI) methods to address this problem, and examines their efficacy and efficiency using an instance-based learning (IBL) model. Monte Carlo simulations with synthetic data are carried out to verify that the true parameter values are retrieved. An experimental dataset of repeated binary route choice is used to illustrate the empirical applicability of the methods.

■ MC61

Cumberland 3- Omni

Rail Safety and Risk

Sponsored: Railway Applications

Sponsored Session

Chair: Xiang Liu, Rutgers, The State University of New Jersey, Piscataway, NJ, United States, xiang.liu@rutgers.edu

1 - Analysis Of Railroad Accident Investigation Reports Using Probabilistic Topic Models And K-means Clustering

Trefor Williams, Rutgers University, New Brunswick, NJ, United States, tpw@rci.rutgers.edu, John Betak

Railroad accident investigation reports from the National Transportation Safety Board in the United States and the Transportation Safety Board of Canada were analyzed using Latent Dirichlet Allocation (LDA) and k-means clustering. The analysis suggests that recurring accident themes are track defects, wheel defects, grade crossing accidents, signaling issues, train crew fatigue and switching accidents. The Canadian analysis additionally highlighted accidents related to bridges and track drainage. The LDA analysis of the accident reports will also be contrasted with the results from an LDA analysis of the text fields of the FRA Railroad Equipment Accident database.

2 - Statistical Modeling Of Freight Train Accident Estimation

Zhao Wang, University of Illinois at Urbana - Champaign, Urbana, IL, United States, zwang144@illinois.edu

Accurate train accident rate estimation is critical in railway safety and risk management. In current methodology, the accident rate estimation methodology is based on a single exposure variable and could be improved. Utilizing statistical distribution modeling methods, a new train rate predictive model is build that accounts for more complex factors.

3 - Simulation-based Risk Analysis Model For Optimizing Rail Flaw Inspection Frequency

Xiang Liu, Rutgers University, xiang.liu@rutgers.edu

A simulation based risk analysis model is developed to quantify broken rail caused derailment risk on U.S. freight railroads. The model can be used to determine optimal inspection and maintenance scheduling.

■ MC62

Cumberland 4- Omni

Market Structure, Competition and Constraints in the Airline Industry

Sponsored: Aviation Applications

Sponsored Session

Chair: Martin E Dresner, University of Maryland-College Park, R H Smith School of Business, College Park, MD, 20742, United States, mdresner@rhsmith.umd.edu

1 - Excess Inventory As A Market Entry Deterrence Mechanism: Evidence From The Us Airline Markets

Chen Zhou, University of South Carolina, chen.zhou@moore.sc.edu

Inventory may have strategic value because it is necessary for production and consumer satisfaction that are crucial for firms to achieve competitive advantage. In service industries, inventory is often a result of extra capacity, which play a critical role in customer service. In this research, we examine the strategic role of inventory beyond cost efficiency and customer service, using data on the domestic airline industry in the United States. We find that extra inventory discourage market entry on major routes and the intensity of market competition strengthens the relationship between inventory and market entry.

2 - Modeling Multimodal Network Equilibrium For Unregulated Intercity Travel: An Equilibrium Problem With Equilibrium Constraints Approach

Bo Zou, University of Illinois at Chicago, Chicago, IL, United States, bzou@uic.edu, Mohamadhossein Noruzoliaee, Lili Du

This paper proposes a new approach to modeling network competition for multimodal intercity transportation. We view the interactions of transportation operators and travelers as a Multi-Leader-Multi-Follower game, which is modeled as an Equilibrium Problem with Equilibrium Constraints characterized by a series of transportation operators' profit maximization problems. To solve the EPEC, we propose an algorithm that combines the Gauss-Seidel diagonalization method and the relaxation method. The validity of the EPEC model and the algorithm is demonstrated by applying them to a small network as well as a large network representing the US Midwest.

3 - Costs And Benefits Of 'Open Skies' In The East African Community (EAC)

Megersa Abate, Swedish National Road and Transport Research Institute, megersa.abate@vti.se

This paper investigates the economic effects of open skies in the East African Community (EAC) member countries. We find two important results. Firstly, fare levels are lower and departure frequencies are higher for countries with the most liberal air services agreements (ASA). Secondly, our welfare estimate shows that liberal ASAs have had significant economic impact in the order of $400 gain per passenger. The paper also makes normative analysis of the role of liberal policies on the long-term supply side responses in the EAC's air transport market with respect to airline output, market structure, fares and the position of national airlines.

4 - The Impacts Of Merging And Acquisition On Route Entry Behavior: An Empirical Test Of The Contingency Framework In The US Domestic Airline Industry

Li Zou, Embry-Riddle Aeronautical University, zoul@erau.edu, Janani Thiagarajan

This paper examines the impacts on route structure development of the merger and acquisition (M&A) within the airline industry. Several contingent factors considered include the timing of the M&A in the economic cycle, the financial strength of the merging airlines, and their inclination toward merger activities, and similarity in terms of cost structure, operation scale, market strategy, and network structure. The estimation of the model is based on data drawn from the US domestic airline industry over the 1993-2011 period. A total of 14 airline mergers are covered in the analysis using data collected from Form 41, DB1B Market Data, T100 Domestic Segment Data, and other supplemental sources.

■ MC63

Cumberland 5- Omni

Robust Planning in Air Transportation Systems

Sponsored: Aviation Applications

Sponsored Session

Chair: Adan Vela, Technical Staff, MIT Lincoln Laboratory, 244 Wood Street, Lexington, MA, 02420-9108, United States, adan.vela@ll.mit.edu

Co-Chair: James Jones, Technical Staff, MIT Lincoln Laboratory, 244 Wood St., Arlington, MA, 02420, United States, James.Jones@ll.mit.edu

1 - Inferring The State Of The Air Transportation System Using Mobile Phone Data

Eric Feron, Georgia Institute of Technology, Atlanta, GA, United States, feron@gatech.edu, Aude Marzuoli, Emmanuel Boidot, Helene Piquet

The Air Transportation system is becoming increasingly congested, leading to perturbations that propagate through the entire airspace, disproportionately impacting passengers. Most performance metrics in aviation are flight-centric, simply because passenger data belongs to airlines. Yet, using anonymized mobile phone location data, we can analyze passenger flow movements between airports, under nominal and degraded conditions. Once passengers are identified amongst mobile phone users, a matrix representing passenger flow movements between airports is extracted. We study the impact of a bad weather event on passenger flow movements, connections and wait times at airports.

2 - An Integrated Framework For Military Airlift Planning

James Jones, MIT Lincoln Laboratory, James.Jones@ll.mit.edu

As the sole manager of the United States' global defense resources USTRANSCOM is charged with the mission of routing military cargo and passengers across the world. In this presentation we propose a simulation that integrates multiple interacting airlift algorithms to enhance their scheduling and routing process at the strategic and tactical levels.

This material is based upon work supported by USTRANSCOM under Air Force Contract No. FA8721-05-C-0002 and/or FA8702-15-D-0001. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of USTRANSCOM.

■ MC64

Cumberland 6- Omni

MCDM in Infrastructure Network Resilience Planning

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Kash Barker, Associate Professor, University of Oklahoma, 202 W Boyd St, Rm. 124, Norman, OK, 73019, United States, kashbarker@ou.edu

1 - Multiple Criteria Multidimensional Resilience Framework For Disaster Evaluation

Dante Gama Dessavre, Stevens Institute of Technology, Castle Point on Hudson, Hoboken, NJ, 07030, United States, dgamades@stevens.edu, Jose Emmanuel Ramirez-Marquez, Andrea Garcia Tapia

System resilience refers to the ability to cope with adversities and be restored back to a pre-disruption state. Resilience is a global concept that encompasses reliability, vulnerability and restorability. This works presents a multiple criteria system resilience formulation regarding this components, using a multi-event resilience model. Showing preliminary results for a group of Mexican hydro-meteorological disaster events, we show how this approach can enhance the understanding of disaster consequences, therefore improving future decision making in similar situations.

2 - Multi-criteria Formulation For Defending Multi-commodity Networks

Matthew McCarter, University of Oklahoma, Norman, OK, United States, mattm@ou.edu, Kash Barker

The vulnerability of a multi-commodity network to disruption is defined by the extent to which commodities can no longer flow through the network to satisfy demand. A multiobjective formulation and heuristic-driven decision support environment is developed to find defense strategies that balance minimal cost with an ability to maintain a high level of demand satisfaction across all commodities. The solution approach is applied to a Swedish railway dataset.

3 - Component Criticality Analysis Of A Multi-commodity Network

Mackenzie G Whitman, University of Oklahoma, Norman, OK, United States, mgwhitman@ou.edu, Kash Barker

Preparedness planning for critical infrastructure networks requires evaluating the impact to the network when its components are disrupted. We extend the well-studied problem of component importance measures in single-commodity networks to multi-commodity networks by integrating a multi-commodity optimization model with a multi-criteria decision analysis tool to evaluate the impact of one-at-a-time component disruptions. We analyze commodity-specific impacts on network performance of a Swedish railway system application to rank critical links.

4 - Multi-criteria Formulation For Network Recovery Decision Making

Nazanin Morshedlou, University of Oklahoma, nazanin.morshedlou@ou.edu

Recent work has offered optimization formulations for optimal recovery of infrastructure networks after a disruption. Building upon this literature, we introduce a dynamic network component recovery rate, recognizing that recovery speed may change (i) over time after recovery commences, and (ii) with the assignment of different spatial work crews. Enhancing resilience, as well as other objectives, is considered.

■ MC65

Mockingbird 1- Omni

Economics of Health Information Technology

Sponsored: Information Systems

Sponsored Session

Chair: Hilal Atasoy, Temple University, Fox School of Business, Philadelphia, PA, 19122, United States, hilal.atasoy@temple.edu

1 - Antecedents And Consequences Of Electronic Medical Record System Changes

Kartik Krishna Ganju, Temple University, tuc67632@temple.edu

The adoption of EMR systems has been found to have a number of organization wide changes and is often met with resistance from users. Additionally, EMR systems often do not meet all the requirements over time. Due to these reasons, EMR systems are occasionally switched or abandoned. In this paper, we examine the phenomenon of switching and abandoning EMR systems and identify the impact of policy and hospital characteristics on EMR system switching and abandonment. We first examine the role of the HITECH Act on changes of EMR systems. We also examine the choices that hospitals make and if they choose to adopt the market leader and the impact of these changes both during and outside the purview of the HITEH Act.

2 - Impact Of Organizational Usage Experience On Service Operation Efficiency: A Study Of Online Care Delivery

Changmi Jung, Johns Hopkins University, changmi@jhu.edu

Advanced online medical services are regarded as visiting physicians virtually in an asynchronous way. If patients' wait time in online is longer than what patients experience in office visits, the service's merit becomes undermined, and thus, the organizations need to consider redesigning the service processes or the way they integrate the service into their current operation. Also, if the newly introduced service acquires high efficiency at the cost of the existing operation, the efficiency gain might be offset. We examine the operational aspect of the online service, specifically patients' waiting time and work coordination among the members in practices.

3 - Is Technology Eating Nurses? Staffing Decisions In Nursing Homes

Abraham Seidmann, University of Rochester, Simon Business School, Dir of OR Dept, Rochester, NY, 14627, United States, avi.seidmann@simon.rochester.edu, Lu Feng, Huaxia Rui

We study the effect of IT-enabled automation on staffing decisions in healthcare facilities. Our findings suggest that the impact of automation technology on staffing decisions depends crucially on a facility's strategic position in the local marketplace.

■ MC66

Mockingbird 2- Omni

IEEE T-ASE Invited Session I

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Jingshan Li, University of Wisconsin-Madison, 1513 University Ave, Madison, WI, 53706, United States, Jingshan.li@wisc.edu

1 - A Decentralized Stay-time Based Occupant Distribution Estimation Method For Buildings

Qing-Shan Jia, Tsinghua University, jiaqs@mail.tsinghua.edu.cn

Zonal occupant level is of great practical interest for building energy saving and fast evacuation. The problem is challenging due to the privacy concerns, the random human movement, and the accumulative error. We consider this important problem and focus on infrared beam systems that monitor the zonal arrival and departure events. We make three contributions. First, a rule based on the stay time is developed to reduce the accumulated estimation error in each zone. Second, another rule is designed to coordinate the estimation among neighboring zones. A decentralized estimation method is then developed. Third, the advantage of this method is demonstrated through simulation results and field tests.

2 - Collaborative Energy And Thermal Comfort Management Through Distributed Consensus Algorithms

John Wen, RPI, wenj@rpi.edu

Buildings with shared spaces are occupied by multiple occupants typically with have different temperature preferences. Using occupant-differentiated dynamically-adjusted penalty factor as feedback signals, we propose a distributed solution which ensures that a consensus is attained among all occupants upon convergence, irrespective of their ideal temperature preferences being in coherence or conflicting. We establish the convergence of the proposed algorithm to the optimal temperature set-point that minimizes the sum of the energy cost and the aggregate discomfort of all occupants in a multizone building.

3 - Analysis on Energy Efficient Switching Of Machine Tool With Stochastic Arrivals And Buffer Information

Andrea Matta, Shanghai Jiaotong University, matta@sjtu.edu.cn

Energy saving in production plants is becoming more and more relevant due to the pressure from governments to contain the environmental impact of manufacturing, and from companies to reduce costs. One of the measures for saving energy is the implementation of control strategies that reduce energy consumption during the machine idle periods. This talk will deal with switching policies that turn the machine off when production is not critical, and on when the part flow has to be resumed. A general policy is formalized by modelling explicitly the energy consumed at each machine state.

■ MC67

Mockingbird 3- Omni

Panel Discussion on Publishing in Quality and Reliability: The Editors' Perspective

Panel Session

Moderator: Kaibo Wang, Tsinghua University, Beijing, China, kbwang@tsinghua.edu.cn

1 - Panel Discussion on Publishing In Quality And Reliability: The Editors' Perspective

Kaibo Wang, Tsinghua University, kbwang@tsinghua.edu.cn

This panel brings journal editors to share their perspectives and experiences with the audience and answer questions pertaining to publication in Quality, Reliability and Data Sciences. Panelists are: Dr. Jianjun Shi, IIE Transactions; Dr. Fugee Tsung, Journal of Quality Technology; Dr. Peihua Qiu, Technometrics; Dr. Murat Caner Testik, Quality Engineering; Dr. Jing Li, Quality Technology and Quantitative Management.

2 - Panelist: IIE Transactions

Jianjun Shi, Georgia Institute of Technology, jianjun.shi@isye.gatech.edu

3 - Panelist: QTQM

Jing Li, Arizona State University, jing.li.8@asu.edu

4 - Panelist: Quality Engineering

Murat Caner Testik, Hacettepe University, mtestik@hacettepe.edu.tr

5 - Panelist: Technometrics

Peihua Qiu, University of Florida, pqiu@phhp.ufl.edu

6 - Panelist: Journal Of Quality Technology

Fugee Tsung, HKUST, season@ust.hk

■ MC68

Mockingbird 4- Omni

Reliability Evaluation and Optimization from Complex Systems I

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Eunshin Byon, University of Michigan, College Station, MI, United States, ebyon@umich.edu

Co-Chair: Qingyu Yang, Wayne State University, Detroit, MI, United States, qyang@wayne.edu

1 - A Space-time Autoregressive Model For Radar Images Under A Lagrangian Integration Scheme

Xiao Liu, IBM T.J. Watson Research Center, Yorktown Heights, NY, United States, liuxiaodnn_1@hotmail.com

This paper is concerned with the spatio-temporal modeling of two dimensional radar echo fields from a sequence of radar images. The method is useful for many environment- and energy-related problems. For example, the precipitation forecast, and the prediction of solar power production.

2 - Reliability Modeling For Continuous-state Systems

Xinying Wu, Ohio University, wuxinying2009@gmail.com, Tao Yuan

This talk presents a Bayesian hierarchical modeling framework for modeling the reliability and degradation of continuous-state systems composed of continuous-state components. Degradation modeling, degradation data analysis, system reliability prediction, and component important measures will be discussed.

3 - On The Probabilistic Site Selection Problem

Yiwen Xu, North Dakota State University, Fargo, ND, 58102, United States, yiwen.xu6@gmail.com, Haitao Liao

In this research, we study a site-selection problem in probabilistic networks where both nodes and edges are prone to be failed. To enhance the probability of connectivity from one node to another, options for adding multiple edges (i.e., edge-level redundancy) are considered. We formulate the mathematical programming problem and develop a method to solve the problem. Numerical examples are provided to demonstrate the problem and the use of the proposed solution methodology.

4 - A Physical-statistical Hybrid Model For Li-ion Battery Prognosis

Nan Chen, National University of Singapore, isecn@nus.edu.sg

The traditional PHM approaches for Li-Ion batteries relied on the experimental data, like battery capacity or impedance. We proposed a physical-statistical model to take full use of operational data, which are readily available, to model and predict the performance and reliability of Li-Ion batteries. Both numerical and case studies are constructed to demonstrate the effectiveness and promising futures of this physical-statistical model in the real applications.

■ MC69

Old Hickory- Omni

Military Resource Management

Sponsored: Military Applications

Sponsored Session

Chair: Brian J Lunday, Air Force Institute of Technology, P.O. WPAFB, OH, 1, United States, brian.lunday@afit.edu

1 - Discrete Event Simulation-based Analysis Of Personnel Evaluation Policy

Lee A. Evans, University of Louisville, Louisville, KY, United States, laevan04@louisville.edu, Prajwal Khadgi

The United States Army uses a forced ranking appraisal system, a practice largely abandoned in the private sector, in evaluating its officer corps. The psychological aspects of forced ranking evaluation systems have been well documented, but this study examines the mathematical aspects of how these systems can lead to misidentification of high-performing individuals. We show how the binomial distribution can explain many of the challenges, analyze human behavior in such a system, and create a discrete event simulation to analyze the effects of policy-driven constraints.

2 - Modeling And Forecasting Army Enlistments With Geographic Data Weighting, Principal Components Analysis, And Linear Regression

Joshua McDonald, U.S. Army, Aberdeen Proving Ground, MD, United States, joshua.l.mcdonald10.mil@mail.mil

Using ordinary least squares regression applied to geographically weighted panel data we forecast the production of Regular U.S. Army enlistments in 38 recruiting markets. We find that a set of five continuous independent variables obtained through principal components analysis plus categorical variables for markets and quarters of the fiscal year achieves effective 15-month forecasts; when forecasting independent variables, the models explain between 63% and 73% of the variation between actual and predicted data at the highest level of aggregation, depending on enlistment contract type.

3 - Optimal Design Of Piezoelectric Materials For Maximal Energy Harvesting

Russell Nelson, United States Military Academy, West Point, NY, 10996, United States, russell.nelson@usma.edu, Hong Zhou, Susan Sanchez

The DoD seeks alternative methods to produce electricity, thus decreasing dependence on fossil fuels and increasing combat power. Piezoelectric generators can produce alternative electrical power in isolated and austere conditions. We use three and six variable mathematical models to analyze piezoelectric generator power capabilities. Using mk factorial sampling, nearly orthogonal and balanced Latin hypercube (NOBLH) design, and NOBLH iterative methods, we find solutions to maximize piezoelectric generator power output. We further analyze our optimal results using robustness analysis techniques. Our results provide optimal material parameter and environmental designs.

4 - Risk Assessment In Robust Goal Programming

Robert Hanks, Air Force Institute of Technology, robert.hanks@afit.edu

We investigate interval-based and norm-based uncertainty sets using cardinality-constrained robustness in the Robust Goal Programming (RGP) construct in addition to strict robustness using ellipsoidal uncertainty sets. Then, using utility theory, a decision maker's (DM) view of risk is quantified via a utility function, which will be mapped back to relevant parameters of the varying uncertainty sets to model the DM's risk attitude toward a robust solution. The findings offer theoretical contributions to the RGP framework and will be applied in a future endeavor to setting shipping rates for the United States Transportation Command's customers as it pertains to revenue management.

■ MC70

Acoustic- Omni

Transportation, Maritime III

Contributed Session

Chair: Liliana Delgado Hidalgo, Doctoral Candidate, University of Arkansas and Universidad del Valle, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States, ld002@uark.edu

1 - A Constraint Programming Approach For A Parallel Machine Scheduling Problem With Time Intervals And Sequence Dependent Setup Times

Ridvan Gedik, University of New Haven, 300 Boston Post Rd, Buckman Hall 223 F, West Haven, CT, 06516, United States, rgedik@newhaven.edu, Chase Rainwater

In this study, we introduce a scheduling problem that aims to minimize the makespan of jobs on unrelated machines subject to time availability intervals and sequence dependent setup times in a fixed planning horizon. Computational tests on a real-life case study prepared in collaboration with the U.S. Army Corps of Engineers (USACE) show that the constraint programming model outperforms the mixed integer programming model in terms of solution time and quality. In addition, sensitivity analysis conducted on time interval restrictions provide decision makers with quantitative insights into how much savings might be obtained if these were relaxed.

2 - A Rolling Horizon Approach For Integrated Yard Crane Scheduling And Container Handling In A Stochastic Environment

Filip Covic, PhD Student, Institute for Operations Research, University of Hamburg, Von-Melle-Park 5, Hamburg, 20146, Germany, filip.covic@uni-hamburg.de, Mehdi Karimi-Nasab

A container terminal with multiple blocks, each operated by a yard crane is considered. A mixed-integer model is developed for integrating following operational sub-problems: crane scheduling, container storage allocation, relocation and re-marshaling. The objective function is to minimize the total weighted number of shuffle and re-marshaling moves. A rolling horizon framework is used to deal with uncertainty of container arrival and retrieval times. Within this framework, these data are periodically updated according to available berthing and truck arrival times. In each period the time capacity of the crane is limited. A solution approach to exploit the decompsoable sturcture is applied.

3 - Simulation Approach For A Container Terminal, A Case Study

Nabil Nehme, Assistant Professor, Lebanese American University, Ramlet El- Baida, Thomas Edison Street, Beirut, Lebanon, nehme_nabil@hotmail.com, Faten Abou Shakra, Clovis Francis

This research investigates the tactical operations inside a container terminal. The case of Beirut Container Terminal (BCT) is considered. A simulation model is developed to reflect the current state of BCT and existing berthing problems. Both qualitative and quantitative data are collected. Several scenarios are tested to minimize the queue for berthing vessels. A strategic work policy is suggested to leverage competition taking into consideration financial and operational constraints.

4 - Barge Assignment And Scheduling During Inland Waterway Disruption Response

Liliana Delgado Hidalgo, Doctoral Candidate, University of Arkansas and Universidad del Valle, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States, ld002@uark.edu, Heather Nachtmann

We study the problem of assigning and scheduling barges to terminals during inland waterway disruption response. The problem is formulated as a heterogeneous vehicle routing problem with time windows that minimizes total value loss. We present an improvement to the initial formulation by adding valid inequalities. Several disruption instances are solved, comparing our approach with prior work in this area and resulting in improved results.

■ MC71

Electric- Omni

Supply Chain, Shipping III

Contributed Session

Chair: Umit Saglam, Assistant Professor, East Tennessee State University, East Tennessee State University, PO Box 70625, Johnson City, TN, 37614, United States, saglam@etsu.edu

1 - Application Of Service Industry In Port Management

Maryam Hamidi, University of Arizona, 3121 E Bellevue Street, Unit 2, Tucson, AZ, 85716, United States, mhamidi@email.arizona.edu

In this presentation, we will study the port management and supply chain in maritime.

2 - Centralized And Decentralized Warehouse Logistics With Stochastic Demand Collaboration

Shiman Ding, University of California Berkeley, Berkeley, CA, 94706, United States, shiman@berkeley.edu, Philip Kaminsky

An emerging paradigm for horizontal logistics collaboration in the grocery industry involves the use of large third-party warehouses used by suppliers as outbound warehouses, and by retailers as distribution centers. We model a setting where safety stock is maintained at both the warehouse and retailers, and build on our previous work for a deterministic version of this problem to develop a heuristic for this model with a worst-case bound of 1.19. We also develop effective heuristics for decentralized versions of this model, and finally, we characterize the "cost of anarchy" in this system - the loss due to decentralized operation.

3 - A Change Of Gear: Managing Modal Split Transport (mst)

Chuanwen Dong, Kuehne Logistics University, Grosser Grasbrook 17, Hamburg, 20457, Germany, chuanwen.dong@the-klu.org, Sandra Transchel, Stefan Minner

The truck driver shortage rises freight cost and erodes firms' SC margins. We study a MST policy to shift volume to trains. We model the two modes differently based on their nature: a train has a fixed schedule over a long period and requires stable deliveries. The economics of scale in rail freight cost and inventory mismatch cost is also incorporated. The model is solved via Stochastic DP optimally for: the fixed load and delivery frequency of the train, and the delivery policy of the truck. Real data application shows considerably modal shift into trains, and suggests the firm the favorable products for MST.

4 - Multiproduct Batch Production And Truck Shipment Scheduling Under Different Shipping Policies

Umit Saglam, Assistant Professor, East Tennessee State University, East Tennessee State University Department of Management and Marketing, PO Box 70625, Johnson City, TN, 37614, United States, saglam@etsu.edu

In this paper, we formulate mathematical models that attempt to integrate the production lot scheduling problem with outbound shipment decisions. The optimization objective is to minimize the total relevant costs of a manufacturer, which distributes a set of products to multiple retailers. In making the production/distribution decisions, the common cycle approach is employed to solve the ELSP, for simplicity. The resulting mixed-integer, non-linear programming models (MINLPs) are solved by the BONMIN solver. Finally, a set of numerical examples illustrate and evaluate the relative efficacies of these policies.

■ MC72

Bass- Omni

Supply Chain Mgt VII

Contributed Session

Chair: Turgut Aykin, Managing Member, Aykin Associates, 136 Buckmanville Rd., New Hope, PA, 18938, United States, taykin@aykinassociates.com

1 - Robust Supply Chain System Under Yield Uncertainty

Samir A Alsobhi, Assistant Professor, Yanbu University College, Yanbu Alsinaiyah, 51000, Saudi Arabia, Alsobhis@rcyci.edu.sa, Krishna Krishnan

Products are often damaged in transit.These damages are stochastic in nature.To minimize the impact of damage,the selection of routes should consider not only the expected damage but also the variability of damage.In this research,the first model is of the supply chain network in order to minimize total cost,which consists of product cost and transportation cost while considering multiple routes and products.In the second model,the concept of robust design has been applied to minimize damage.

2 - A Location Allocation Model For Facility Planning To Minimize The Operational Cost

Damitha Bandara, Assistant Professor, Albany State University, 504 College Dr, Albany, GA, 31705, United States, damitha.bandara@asurams.edu

Locating and allocating distribution centers optimally is a crucial and systematic task for decision-makers. Optimally located distribution centers can significantly improve the logistics system's efficiency and reduce its operational costs. In this research, we develop a mathematical model to determine the optimal locations and allocations for distribution centers that minimizes the operational cost. The model is used to find the optimal location and allocation of distributions centers for a leading company in the USA. Computational results show that the company can reduce their operational cost significantly by implementing new optimal distribution locations.

3 - Project Management Inventory And Due Date Study In Push And Pull Contracts

Xingxing Chen, Washington University- St. Louis, Campus Box 1156, One Brookings Drive, Saint Louis, MO, 63130, United States, xingxing.chen@wustl.edu, Panos Kouvelis, Yu Xia

This research studies the inventory management and project cycle in project management. We investigate a supply chain with one manufacturer and one supplier. The manufacturer replenishes a critical part from the supplier to meet the stochastic demand during the project cycle time. Both the manufacturer and the supplier target at optimizing their profits respectively. The games between the manufacturer and the supplier are studied under different contract formats: push, pull and push-pull contracts. Optimal inventory policy and project cycle time are found indifferent cases.

4 - Product Recalls In The Consumer Products Industry: Evidence Of A Silver Lining

Carolyn Queenan, Assistant Professor, University of South Carolina, Darla Moore School of Business, 1014 Greene St, Columbia, SC, 29208, United States, carrie.queenan@moore.sc.edu, Adams Steven, Yan Dong, Manus Rungtusanatham

Research shows us that recalls generally harm firm performance and intuition confirms this. We, however, investigate if recalls universally harm firm performance. After analyzing seven years of consumer products recall data and corresponding firm performance, we find certain circumstances mitigate some of the potential negative impacts of recalls on firm performance. Results suggest new ways to consider recalls and ways to mitigate their effects.

5 - Demand And Supply Planning In Configure-to-order Supply Chains

Turgut Aykin, Managing Member, Aykin Associates, 136 Buckmanville Rd., New Hope, PA, 18938, United States, taykin@aykinassociates.com

Configure-to-order (CTO) products involve variable bills of materials (BOM), which may vary from one order to another in SKU's and quantities required, and customers who are sensitive to the promised delivery times. In this presentation, we review the approaches available for CTO supply chains and present a new approach to model variable BOM's, as well as link supply levels to the targeted delivery performance, forecasts, forecast accuracy and lead times.

■ MC79

Legends G- Omni

Health Care, Modeling VII

Contributed Session

Chair: Jacqueline Griffin, Northeastern University, 360 Huntington Ave., 334 Snell Engineering Center, Boston, MA, 2115, United States, ja.griffin@neu.edu

1 - Optimizing Chemoradiotherapy To Target Multi-Site Metastatic Disease And Tumor Growth

Hamidreza Badri, PhD Student, University of Minnesota, IsyE University of Minnesota, 111 Church Street S.E., Minneapolis, MN, 55455, United States, badri019@umn.edu, Kevin Leder, Ehsan Salari

We introduce a model to obtain optimal drug and radiation protocols in a chemoradiotherapy scheduling problem with the objective of minimizing metastatic cancer cell populations at multiple sites while maintaining a minimum level of damage to the primary tumor site. We derive closed-form expressions for an optimal chemotherapy fractionation regimen. A dynamic programming framework is used to determine the optimal radiotherapy fractionation regimen. We quantify the trade-off between the new and traditional objectives of minimizing the metastatic population size and maximizing the tumor control probability, respectively, for a cervical cancer case.

2 - Integrated Physician And Clinic Scheduling Problem In an Ambulatory Cancer Treatment Polyclinic

Mohammad Tohidi, PhD Candidate, Concordia University, 7400 Sherbrooke West, Apt 218, Montreal, QC, H4B 1R8, Canada, m_tohidi@encs.concordia.ca, Masoumeh Kazemi Zanjani, Ivan Contreras

In this presentation, we present an extension of physician scheduling problems which arises in hospitals with polyclinic centers. In these centers, a patient can be assessed by multiple clinics in a single visit. The clinics share available resources, and interdisciplinary clinics have to be scheduled together on simultaneous shifts. This work is inspired by a case study in a hospital in Montreal. We integrate clinic session scheduling with physician scheduling and formulate the problem as a multi-objective mathematical program. For some problem instances that the exact method is not able to find the optimal solution, we present an iterated variable neighborhood search mathheuristic.

3 - Does Specialization Of Hospitals Increase Operational Efficiency?

Saied Samiedaluie, Postdoctoral Fellow, The University of British Columbia, Vancouver, BC, Canada, saied.samiedaluie@gmail.com, Vedat Verter

We study a health care network configuration problem considering two scenarios: specialization versus generalization. We characterize the situations in which each scenario is preferred in terms of accessibility to care. Our results show that the decision of system configuration for a multi-hospital network requires careful consideration of patient mix among arrivals, relative length of stay of patients, and distribution of patient load between hospitals.

5 - Multi Attribute Balanced Scheduling In An Integrated Outpatient Clinic

Jacqueline Griffin, Northeastern University, 360 Huntington Ave., 334 Snell Engineering Center, Boston, MA, 02115, United States, ja.griffin@neu.edu, Vahab Vahdatzad, Sarah Burns

Using a discrete event simulation modelling approach, we examine new policies for the design and operation of a new integrated orthopedic, rheumatology, and radiology healthcare facility. With interdependent flows and shared resources between these units, the importance of balancing workload across the facility, and strategies for accomplishing this are examined. Specifically, we quantify the impact of various patient and provider scheduling policies, both independently and simultaneously, to identify the cost effectiveness of implementation.

■ MC86

Glbson Board Room-Omni

Marketing III

Contributed Session

Chair: Nithya Shankar, Rensselaer Polytechnic Institute, Troy, NY, nithya.shankar21@gmail.com

1 - Nonlinear Customer Satisfaction Index Model

Nobuhiko Terui, Professor, Tohoku University, Faculty of Economics, Kawauchi Aoba-Ku, Sendai, 980-8576, Japan, terui@econ.tohoku.ac.jp, Xing Aijing, PK Kannan

We extend the relationship proposed by the customer satisfaction index (CSI) model to include a nonlinear functional form between satisfaction and loyalty. We examine different functional forms on how satisfaction affects loyalty and propose a model that reflects intrinsic characteristics of nonlinear effects, such as saturation-attainable limit of effectiveness, non-constant marginal return, and asymmetric response between satisfied and dissatisfied customers, in a parsimonious way. The model is estimated via a hierarchical Bayes model to accommodate structural heterogeneity of companies surveyed in the analysis by proposing an efficient multi-move sampler.

2 - When Better Product Quality Imply More Advertising

Regis Chenavaz, KEDGE Business School, Marseille Cedex 9, France. r.chenavaz@gmail.com, Sajjad Jasimuddin

This article examines when does better quality lead to more advertising. It models the advertising-quality relationship in an optimal control setting. This article proposes a rule for the advertising-quality relationship generating both positive and negative relationships: Advertising increases with quality if the demand effects (quality and advertising effects on demand) outweigh the supply effect (quality effect on cost); alternatively, advertising decreases with quality if the demand effects are lower than the supply effect. Consequently, despite consumer awareness of quality, to maximize profit the firm may advertise a product of lower quality more.

3 - Intimacy And Loyalty In Parasocial Relationships

Lenita Davis, Professor, University of Arkansas-Little Rock, 1200 Brookwood Drive, Apt 463, Little Rock, AR, 72202, United States, lmdavis@ualr.edu, Elizabeth Micahel

This research seeks to identify how negative information affects the loyalty and commitment of fans engaged in a parasocial relationship that is established or strengthened through social media. This research will use multiple methods including social media ethnography, qualitative comparative analysis of celebrity and fan social media and empirical analysis. This research will be conducted in the context of the presidential election, social media data will be collected on the front runners' social media in the Presidential campaign during the primaries up to a week post their respective national conventions.

4 - Managerial Overconfidence And Brand Capital

Nithya Shankar, Assistant Professor of Marketing, State University of New York at Plattsburgh, Plattsburgh, NY, United States, nithya.shankar21@gmail.com, Staceyann Sharpe, Bill Francis

A growing area of research in marketing focuses on the impact of firm-level factors on brand capital. Largely lacking in the marketing literature is the impact of managerial behavioral traits on firms' brand capital. Our research investigates this relationship by examining the impact of managerial overconfidence on brand capital. Preliminary results indicate a negative relationship between managerial overconfidence and brand capital. Further analysis will evaluate the impact of managerial overconfidence on change in brand capital, as well as the impact of industry factors on this relationship.

■ MC94

5th Avenue Lobby-MCC

Technology Tutorial: GAMS/LINDO

Technology Tutorial

1 - GAMS: Introduction To Modeling In GAMS

Steven P Dirkse, GAMS Development Corporation, Washington, DC, United States, sdirkse@gams.com

We demonstrate many of the capabilities of the GAMS software as we start with a simple optimization model and build it out by adding nonlinear and integer variables to the model and connecting it with a GUI in a sample application.

2 - LINDO: Optimization Modeling Made Easy

Mark A Wiley, LINDO Systems Inc, 1415 No Dayton Street, Chicago, IL, 60622, United States, mwiley@lindo.com, Gautier Laude

Monday, 3:10PM - 4:00PM

■ Monday Plenary

Davidson Ballroom-MCC

Omega Rho – 40th Year Anniversary Panel

Plenary Session

Chair: Graham Rand, Lancaster University, United Kingdom, Lancaster, LA1 4YX

1 - Omega Rho - 40th Year Anniversary Panel

Graham Rand, Lancaster University, Lancaster, United Kingdom, g.rand@lancaster.ac.uk

After a brief introduction to Omega Rho, International Honor Society for Operations Research and Management Science, as it celebrates its 40th birthday, four of its distinguished lecturers will revisit their lectures. All four were in the first group of INFORMS Fellows, created in 2002

2 - Panelist

John R. Birge, Jerry W. and Carol Lee Levin Professor of Operatio, University of Chicago, Booth School of Business, Chicago, IL, United States, John.Birge@ChicagoBooth.edu

3 - Panelist

John D. Little, Massachusetts Institute of Technology, M.I.T. Sloan School Of Management, Room E62-534, Cambridge, MA, 02142, United States, jlittle@mit.edu

4 - Panelist

Ralph Keeney, Duke University, San Francisco, CA, United States, keeneyr@aol.com

5 - Panelist

Alfred Blumstein, Carnegie Mellon University, Heinz College - Hamburg Hall, Pittsburgh, PA, United States, ab0q@andrew.cmu.edu

Monday, 4:30PM - 6:00PM

■ MD01

101A-MCC

Data Mining for State Transition Modeling

Sponsored: Data Mining

Sponsored Session

Chair: Victoria C. P. Chen, The University of Texas at Arlington, Dept. of Ind., Manuf., & Sys. Engr., Campus Box 19017, Arlington, TX, 76019, United States, vchen@uta.edu

1 - A High-dimensional State Transition Development Framework For Deicing Activities At Dallas-fort Worth International Airport

Zirun Zhang, FedEx, zhang.zirun@gmail.com

For high-dimensional and complex systems, state transitions can be empirically represented from data to enable system simulation or optimization. This paper presents a data-driven framework for state transition development in the context of deicing/anti-icing activities at Dallas-Fort Worth (D/FW) International Airport. From study of the framework, the D/FW deicing system is stochastic, finite horizon and discrete-time, non-stationary, and non-convex with mostly continuous state variables.

2 - State Transition Modeling For An Interdisciplinary Pain Management Program

Nilabh Ohol, The University of Texas at Arlington, nilabh.ohol@mavs.uta.edu

We discuss state transition modeling for an adaptive interdisciplinary pain management program at the University of Texas Southwestern Medical Center at Dallas. Challenges include data collection and preparation, endogeneity, and statistical modeling for optimization. Different modeling approaches will be presented, including linear and piecewise linear regression, piecewise linear networks, and regression splines models.

3 - Challenges In State Transition Modeling For A System Of Electric Vehicle Charging Stations

Ying Chen, The University of Texas at Arlington, ying.chen@mavs.uta.edu

In order to supervise the running of plug-in hybrid electric vehicle (PHEV) charging station intelligently, approximated dynamic programming (ADP) algorithm is proposed to control this system, which is equipped with a distributed energy storage system charged by solar power, wind power and electricity from the power grid. The sampling of state space and state transition model are the critical parts to build a converged future value function (FVF) in ADP considering the dimension of state space and multicollinearity issue between state variables. In PHEV charging station control problem, the objective is to minimize the operational cost.

4 - Multicollinearity In State Transition Modeling

Victoria C. P. Chen, University of Texas, 701 S. Nedderman Drive, Arlington, TX, 76019, United States, vchen@uta.edu, Bancha Ariyajunya, Ying Chen, Seoung Bum Kim

Multicollinearity is known to have a negative impact on statistical modeling, specifically with respect to variance inflation. A state transition modeling approach based on orthogonalization of the state space is presented. Results are shown for a ground-level ozone pollution stochastic dynamic program.

■ MD02

101B-MCC

Panel: Funding Issues at NSF

Invited: NSF

Invited Session

Moderator: Sheldon H Jacobson, University of Illinois, 201 N. Goodwin Avenue (MC258), Urbana, IL, 61801, United States, shj@illinois.edu

1 - Funding Issues At NSF: Broader Impact Changes

Panelist: Sheldon H Jacobson, University of Illinois, shj@illinois.edu

Discuss outcomes of recent NSF-sponsored workshop on Broader Impact, and its impact on future funding decisions.

2 - Funding Opportunities At The National Science Foundation

Panelist: Diwakar Gupta, University of Minnesota and National Science Foundation, guptad@umn.edu

3 - Broader Impact at NSF

Panelist: Sheldon Jacobson, University of Illinois, shj@illinois.edu

■ MD03

101C-MCC

Daniel H. Wagner Prize Competition III

Award Session

Chair: C. Allen Butler, Daniel H Wagner Associates, Inc., 2 Eaton Street, Hampton, VA, 23669, United States, Allen.Butler@va.wagner.com

1 - IBM Cognitive Technology Helps Aqualia Reduce Costs And Save Resources In Wastewater Treatment

Alexander Zadorojniy, IBM Research, IBM Haifa Research Lab, Haifa, Israel, Zalex@il.ibm.com, Segev Wasserkrug, Sergey Zeltyn, Vladimir Lipets

This work takes a deep dive into operational management optimization problems in wastewater treatment plants. We used a constrained Markov Decision Process as the key optimization framework. Our technology was tested in a one-year pilot at a plant in Lleida, Spain, operated by Aqualia, the world's 3rd-largest water company. The results showed a dramatic 13.5 percent general reduction in the plant's electricity consumption, a 14 percent reduction in the amount of chemicals needed to remove phosphorus from the water, and a 17 percent reduction in sludge production.

2 - Implementationof The Genetic Gain Performance Metric Accelerates Agricultural Productivity

Joseph Byrum, Syngenta, West Des Moines, IA, 50265, United States, joseph.byrum@syngenta.com, Craig Davis, Greg Doonan, Tracy Doubler, Bill Beavis, Von Kaster, Sam Parry, Ronald Mowers

Yield is the most important metric for a farmer, as crop output directly impacts profitability. We now refer to the rate of increase in the genetic potential for yield in cultivars as “genetic gain,” and it is measured in bushels per acre (bu/ac). The challenge was to develop models and methods that provide unbiased estimates of the genetic components of yield for unbalanced field trials conducted across years. An algorithm was implemented that minimizes the confounding influence of unpredictable environmental contributions to estimated yields of varieties enabling real-time unbiased estimation of performance metrics that are used in operational decision making and optimization.

■ MD04

101D-MCC

Optimization for Enhancing Critical Infrastructure Resilience

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Feng Qiu, Argonne National Laboratory, 9700 S. Cass Avenue, Lemont, IL, 60439, United States, fqiu@anl.gov

Co-Chair: Matteo Spada, Paul Scherrer Institut, OHSA/D19, 5232 Villigen PSI, Villigen PSI, Switzerland, matteo.spada@psi.ch

1 - A Framework For Measuring Infrastructure Resilience Of Energy Systems Taking Natural Hazards And Technical Failures As Disruption Triggers

Peter Lustenberger, Paul Scherrer Institut/ETH Zurich, Singapore, Singapore, lustenberger@frs.ethz.ch, Tianyin Sun, Patrick Gasser, Wansub Kim, Peter Burgherr, Matteo Spada, Stefan Hirschberg

This work first provides a quantifiable and feasible technical resilience definition and measure specifically for energy systems. Following this definition, we propose a framework for measuring the technical resilience of both the components (power plants, substations, refineries, compressor stations etc.) and the network topology of power grid and oil/gas supply systems by considering probabilistic disruption triggers of both natural hazards and technical failures as well as recovery dynamics.

2 - Prioritization Of Infrastructure Resilience Investments

Julia Phillips, Argonne National Laboratory, phillipsj@anl.gov

Recent events emphasize the importance of the protection and resilience of systems of critical infrastructure. This talk explores initial research on prioritization of infrastructure investments for resilience through optimization considering owner risk profiles. It is hypothesized that owners of different types of critical infrastructure systems may let their risk tendencies influence how to allocate funds as opposed to what investments are “optimal” considering monetary value only. The research community has struggled with the measurement of resilience. We use a technique of perceived value to assist in measurement of resilience and prioritization of investment funds.

3 - Wind-participated Power System Restoration

Feng Qiu, Argonne National Laboratory, fqiu@anl.gov

Black-start resources, electric generators that can start on their own without power supply from the grid, are critical initial power sources for power system restoration. Wind generation, with black-start capability, however, has not been considered as black-start resources due to its unreliability (variable and uncertain). As the wind integration continues to grow, wind-participated system restoration becomes not only a viable but also a valuable solution. In this talk, we will present an optimization model to incorporate wind in the system restoration. Wind uncertainty and variability will be addressed to ensure the success of system restoration.

4 - Repair, Rebuild, Or Replace? Protecting Aging Infrastructure From Hazards And Threats

David L. Alderson, Naval Postgraduate School, dlalders@nps.edu, Jan Brendecke, Kyle Y Lin

We consider an infrastructure system whose function depends on a number of components that fail randomly according to known rates. Components that are “new” have a small failure rate and components that are “old” have a larger failure rate. When a component fails it can be replaced to “new” status or repaired to “old” status. An “old” component can also be proactively replaced to “new” status. We formulate and solve a Markov decision process to identify the optimal replace/repair policies for given system operating costs and discuss implications for real infrastructure systems.

■ MD05

101E-MCC

Power System Generation and Transmission Expansion

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Enzo E Sauma, Pontificia Universidad Catolica de Chile, Vicuña Mackenna 4860, Macul., Santiago, 7820436, Chile, esauma@ing.puc.cl

1 - Risk-averse Transmission And Generation Planning: Wecc Case Study

Francisco Munoz, Universidad Adolfo Ibáñez, elpanchomunoz@gmail.com, Harry van der Weijde, Benjamin Field Hobbs, Jean-Paul Watson

We investigate the effects of risk aversion on optimal transmission and generation expansion planning in a competitive market. To do so, we formulate a stochastic model which minimizes a weighted average of expected transmission and generation costs and their conditional value at risk (CVaR), and which can be shown to have an equivalent solution to a perfectly competitive risk-averse Stackelberg equilibrium in which a risk-averse transmission planner maximizes welfare after which risk-averse generators maximize profits.

2 - How Technical Operational Details Affect Generation Expansion In Oligopolist Markets

Efraim Centeno, Universidad Pontificia Comillas - IIT, Efraim.Centeno@iit.comillas.edu, Sonja Wogrin, Adelaida Nogales

We propose a generation expansion model including an oligopolistic market representation based on an equilibrium approach. We incorporate the system states methodology into this generation expansion model allowing us to recover some chronological information in a LDC framework, thereby more accurately accounting for start-up and shut-down costs without making use of an hourly representation of demand. We find that when operational details are considered, flexible technologies are preferred by the companies in the optimal mix. We also observe that under perfect competition in comparison with oligopolistic markets, more base-load plants are built as well as more peaking plants.

3 - Sustainable Transmission Planning In Imperfectly Competitive Electricity Industries: Balancing Economic Efficiency And Environmental Outcomes

Afzal S. Siddiqui, Stockholm University, Stockholm, Sweden, Afzal S. Siddiqui, HEC Montréal, Montréal, QC, H3T 2A7, Canada, afzal.siddiqui@ucl.ac.uk, Makoto Tanaka, Yihsu Chen

We address the problem of a TSO that builds a transmission line in order to maximise social welfare inclusive of the cost of emissions. A TSO in a deregulated industry can only indirectly influence outcomes via its choice of the transmission line capacity. Via a bi-level model, we show that this results in less transmission capacity with limited emissions control if industry is perfectly competitive. A carbon tax on industry leads to perfect alignment of incentives and maximised social welfare only under perfect competition. By contrast, a carbon tax actually lowers social welfare under a Cournot oligopoly as the resulting reduction in consumption facilitates the further exercise of market power.

4 - Power Capacity Expansion Planning And The Influence Of Network Payment Schemes

Enzo Sauma, Pontificia Universidad Católica de Chile, esauma@ing.puc.cl, Diego Bravo, Javier Contreras, Sebastián de la Torre, José Aguado, David Pozo

We propose a multi-annual transmission expansion planning model seeking to reduce the total system costs and considering different network payment schemes. The proposed models are reformulated as Mixed Integer Linear Programming (MILP) problems. A realistic case study based on the main power system in Chile is analyzed to illustrate the proposed models. It is shown that integrating line cost-recovering equations into the Transmission Expansion Planning model may result into a more realistic and less congested power network. Also, total system cost is highly related with transmission tariff discrimination.

■ MD06

102A-MCC

Business Analytics and Text Mining

Sponsored: Data Mining

Sponsored Session

Chair: Xiao Liu, University of Arizona, 1130 E. Helen St., Tucson, AZ, 85721, United States, xiaoliu@email.arizona.edu

1 - A Network-based Inference Model For Estimating Missing Attributes

Da Xu, University of Utah, da.xu@eccles.utah.edu

The attribute information, which is critical for recommendations, search engines, and advertising targeting, is valuable for business intelligence. While, all the aforementioned machine learning based applications are only capable of optimal performance when the data utilized are of high quality. And in many cases, the attribute information is incomplete, which makes a big obstacle in targeting products, businesses, or promotions effectively. In this paper, we utilized both networks and content information to infer missing business attributes, which could benefit business recommendations, help validate online business information, and provide better personalized offerings.

2 - Extracting Signals From Social Media Text With Natural Language Processing, Machine Learning And Domain Adaptation

Wenli Zhang, University of Arizona, Tucson, AZ, United States, wenlizhang@email.arizona.edu, Sudha Ram

There has been increasing interest in using social media data for predictive analytics in different domains. Although significant promise has been shown, mounting evidence suggests many of the results can be misrepresented because of the loosely structured text and noise caused by media spikes and use of misleading phases. We introduce efficient techniques combining Natural Language Processing and Machine Learning to extract signal from social media text. Sophisticated domain adaptation method is introduced to address multi-domain adaptation problem. The methodology can be used for extracting signals in health care and other domains with a view to enabling improved predictions.

3 - The Effect Of Rating System Design On Emotion Sharing

Ying Liu, Arizona State University, yingliu_is@asu.edu

How do ratings and reviews reflect consumers' overall evaluations toward the product? Does the overall evaluation reflect average experience or is it biased? In this study, we focus on evaluating the integration bias in consumers' rating behavior through rating system design. Analysis of data from two leading restaurant review websites with different rating systems suggests that the overall ratings tend to reflect consumers' extreme experiences in a single-dimensional rating system, however, their average experience by taking all dimensions into consideration in multi-dimensional rating systems. The results are confirmed by information from text reviews through text mining skills.

4 - Webcasting Game Or Sharing Experience? Exploring The Role Of Team-created Word-of-mouth In Football Game Attendance

Yang Wang, University of Utah, yang.wang@eccles.utah.edu, Nick Sullivan, Shyam Gopinath

A 2015 NCAA report shows that college football attendance drops to the lowest in 15 years. To help generate demand, the 128 FBS teams develop different strategies and use social media as a tool to attract fans. Among them, those schools with top game attendance usually tweet a lot about game ambiance which shows the unique game experience at the stadium, while the others only webcast the team performance on the pitch. This study aims to examine the differential impacts of the two types of team-created word-of-mouth on the future game attendance versus the TV viewership. We find the unique role of each type of the content and provide relevant business implications.

■ MD07

102B-MCC

Urban Data Analytics and Mining

Sponsored: Data Mining

Sponsored Session

Chair: Xun Zhou, University of Iowa, S210 PBB 21 East Market Street, Iowa City, IA, 52242, United States, xun-zhou@uiowa.edu

1 - A Traffic Flow Approach To Early Detection Of Gathering Events

Amin Vahedian, University of Iowa, Iowa City, IA, United States, amin-vahediankhezerlou@uiowa.edu, Xun Zhou

Given traffic flows in a spatial field, early detection of gathering events problem aims to discover the most likely gathering events. It is important for city planners to identify emerging gathering events which might cause public safety or sustainability issues. Here, we model the footprint of a gathering event as a directed acyclic Graph, which captures routes of the flows to an event and their most likely destination. We also propose an efficient algorithm to discover the most likely events. Our analysis shows that the proposed model and algorithm efficiently and effectively capture important gathering events from real-world mobility data while saving 50% time over the baseline algorithm.

2 - Mapping The Structure Of China'S Cities Network

Xiaolong Xue, Harbin Institute of Technology, xlxue@hit.edu.cn

The structure of China's cities network is dramatical changing with the rapid urbanization process. This paper analyzes the research status of cities network theory, and constructs China's cities network model using China's transportation infrastructure data. The structure of China's cities network is described through network characteristics, and China's cities network is divided into different network communities by clustering analysis. We find the center city, traffic hub and regional centers by calculating cities nodes' effectiveness. The calculating of network effectiveness provides a reference for improving the efficiency of China's cities network.

3 - A Markov Decision Process Approach To Optimizing Taxi Driver Business Efficiency

Xun Zhou, University of Iowa, xun-zhou@uiowa.edu

Improving taxi business efficiency is an important societal problem. This work investigates how to increase the revenue efficiency (revenue per unit time) of taxi drivers. To solve this problem we model the passenger seeking process as a Markov Decision Process(MDP) and learn necessary parameters from historical taxi data. A case study and several experimental evaluation on a real dataset from a major city in China show that our proposed approach improve the revenue efficiency of inexperienced drivers by up to 15%.

4 - Operation Strategies And Algorithms For Minibus Systems In Hong Kong

Jacky Pak Ki Li, PhD Student, VU University Amsterdam, De Boelelaan 1081a, Amsterdam, 1081 HV, Netherlands, jacky.li@kpu.ca

In Hong Kong, the spatial distribution of Minibuses within the public transportation system is self-organized, lacking a clearly defined operation strategy. There is no optimization based on current demand. Within this paper several operation strategies are introduced. A new integrated algorithm for optimal strategy is described in detail, including two approaches: a user-based approach, outlining a strategy to capture and optimize consumer demand, and an operation-based approach, outlining a strategy to balance revenue and consumer satisfaction.

■ MD08

103A-MCC

Tutorial: Data-Driven Research in Revenue Management

Invited: Business Model Innovation

Invited Session

Chair: David Simchi-Levi, Massachusetts Institute of Technology, Masachusetts Avenue, Cambridge, MA, 0, United States, dslevi@mit.edu

1 - Data-Driven Research In Revenue Management

David Simchi-Levi, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA, United States, dslevi@mit.edu

We present a pricing optimization problem for the data plans of a big satellite firm. First we address the problem of missing data (as reservation prices are not directly observed especially for those who are not current customers). We formulate the price optimization problem as a MIP and develop properties and heuristics in order to solve realistic instances providing analytical lower bounds of their performance. We conclude that with our method the company can increase its profits by more than 10% and outperform the current plans' prices even under misspecifications of the assumptions.

■ MD09

103B-MCC

Management of Stochastic Resources, Demand, and Energy Efficiency

Invited: Energy Systems Management

Invited Session

Chair: Lindsay Anderson, Cornell University, 316 Riley Robb Hall, Ithaca, NY, 14853, United States, landerson@cornell.edu

1 - The Value Of Transmission Lines And Its Implications For Electricity Systems With Stochastic Resources

Alberto J Lamadrid, Lehigh University, ajlamadrid@Lehigh.EDU

We demonstrate an analytical method for determining the economic value of individual transmission lines in a meshed network by calculating the total welfare effects for the system. We show that the uncertainty in system conditions breaks down the congestion rents paradigm. The results show that a substantial portion of the economic benefits for an individual line may come from maintaining system reliability when equipment failures occur.

2 - Optimal Offering Of Wind Power In Energy And Primary Reserve Markets

Tue Vissing Jensen, Technical University of Denmark, Kgs Lyngby, Denmark, tvjens@elektro.dtu.dk, Pierre Pinson, Tiago Soares, Hugo Morais, Hugo Morais

As wind power generation comes to dominate electricity systems, wind turbines may be needed to provide reserves. To allow for this, the reserve market must accept and price that the wind turbine can fail to deliver reserves when called on. For such a market, we give analytical results on the optimal energy and reserve bids for a wind generator under its day-ahead forecast.

3 - Integrating Roof-top Solar PV And Residential Energy Efficiency In The Carolinas: Feasibility And Impacts On Costs, Reliability And Emissions

Dalia Patino Echeverri, Duke University, dp52@duke.edu, Bandar Alqahtani

We estimate the reliability, environmental, and economic effects of large levels of roof-top Photovoltaic (PV), and residential energy efficiency penetration within the services areas of the Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP). A PV production model based on household density and a gridded hourly global horizontal irradiance dataset simulates hourly PV power output from roof-top installations; a demand adjustment model simulates the effects of residential energy efficiency investments, and a unit commitment and real time economic dispatch (UC/ED) model simulates hourly system operations.

4 - Energy Efficiency Of Data Center Operating Practices: Server Clustering, Powering On/off And Bang-bang Control

Young Myoung Ko, Pohang University of Science and Technology, Pohang, 37673, Korea, Republic of, youngko@postech.ac.kr, Yongkyu Cho

We examine common data center operating practices such as server clustering, powering on/off, and the bang-bang control in terms of energy efficiency. We add new constraints reflecting the operating practices to the existing MIP model and propose an algorithm for constructing energy efficient clusters of servers from the two upper bounds of the maximum cluster size. Numerical experiments show that server clustering and the bang-bang control can be used in an energy-efficient way, but powering on/off alone may not be sufficient.

■ MD10

103C-MCC

Managing Transitions in Regulated Energy Markets

Sponsored: Energy, Natural Res & the Environment, Energy II Other

Sponsored Session

Chair: Bertrand Williams-Rioux, KAPSARC, Riyadh, 11672, Saudi Arabia, bertrand.rioux@kapsarc.org

Co-Chair: Frederic H Murphy, Temple University, Temple University, Philadelphia, PA, 19121, United States, fmurphy@temple.edu

1 - A Hybrid Top-down, Bottom-up Approach For Saudi Arabia

Hossa Al-Mutairi, King Abdullah Petroleum Studies and Research Center, P.O. Box 88550, Riyadh, Saudi Arabia, hossa.mutairi@kapsarc.org

We show how to combine a CGE-like top-down model with a technology-rich bottom-up energy model in a single Mixed Complementarity Problem (MCP). Calibrated on Saudi Arabia's data, this hybrid model will be used to study the interaction between energy and non-energy sectors and to get insights on the effects of energy policies on the whole Saudi economy.

2 - North America Natural Gas Model: Impacts Of Market Deregulation In Mexico

Felipe Feijoo, Pacific Northwest National Laboratory, College Park, MD, 2, United States, felipe.feijoo@pnnl.gov

Mexico has recently launched a new energy regulation, with its focus on increasing Natural Gas consumption form the electricity sector. It is expected that the U.S. will serve as the main exporter to Mexico to satisfy their demand. We use both, the North American Natural Gas Model (NANGAM) and the Global Assessment Model (GCAM) to assess the short term impacts of the Mexican energy regulation.

3 - US Biofuel Market And Policy Model – A GAMS/EMP Approach

Adam Christensen, University of Wisconsin - Madison, Madison, WI, 4, United States, adam.christensen@wisc.edu

In this work we discuss the landscape of US biofuel policies (both federal and state level) and highlight market challenges and opportunities. A policy modeling tool was developed using the Extended Mathematical Programming (EMP) framework within GAMS to analyze the complicated network of overlapping policies, in particular the Renewable Fuel Standard as well as the California Low Carbon Fuel Standard. The EMP framework is utilized in order to speed the development of different market models which can help identify effects of market power for policymakers.

4 - How do Price Caps In China's Electricity Sector Impact The Economics Of Coal, Power And Wind? Potential Gains From Reforms

Bertrand Williams-Rioux, King Abdullah Petroleum Studies And Research Center, P.O. Box 88550, Riyadh, Saudi Arabia, Bertrand.rioux@kapsarc.org

China imposes maximum prices by plant type and region on the electricity that generators sell to utilities. We examine the impact of the price caps on the electricity sector and on the economics of wind power. We model this sector as a Stackelberg game formulated as a mixed complementarity problem, calibrated to 2012 data.

■ MD11

104A-MCC

Network Vulnerability Analysis and its Applications

Sponsored: Optimization, Network Optimization

Sponsored Session

Chair: Neng Fan, University of Arizona, Tucson, AZ, United States, nfan@email.arizona.edu

1 - Subgraph Identification With Connectivity Requirements

Ou Sun, University of Arizona, suno@email.arizona.edu

Many combinatorial optimization problems, such as the maximum leaf spanning tree problem and the connected dominating set problem, involve finding a connected subgraph embedded in a larger graph while satisfying other problem-specific constraints. These structures appear in many applications, such as wildlife conservation, forest planning, and power grid islanding. In this talk, we review some existed approaches by mixed integer constraints for subgraph connectivity, and also propose some mixed integer constraints and valid inequalities. Some numerical experiments are performed to compare these approaches.

2 - Reliable Power Grid Expansion With Renewable Integration And Storage System

Bader Alsuhaim, University of Arizona, alsuhaib@email.arizona.edu

A reliable power grid system is important to ensure the delivery of power to consumers while minimizing the cost of new technologies. A plan of a power grid expansion is going to be proposed with different type of renewable energies to meet the demand and minimize the cost of installation; as well as, different type of storage systems that would be compared to come up with an optimal solution of a reliable power grid. The NERC contingency criteria are also considered in the optimization model, such as line failures, generator failures, loss-of-load, and etc. Also, numerical experiments and results will be presented.

3 - Multilevel Optimization For Resilient Planning Of Interdependent Water And Energy System

Shanshan Hou, University of Arizona, shanshanh@email.arizona.edu

Water is used for energy generation, and the energy network supply power for water distribution and extraction. They two could be modeled as an interdependent network. In this talk, we not only consider their operations and management, but also the planning stage, which contains analysis of the possible failures to ensure the system resiliency. We build the optimization model to simulate the water and energy relevant flow network. This model consists of the facilities that could be built in water network and different generation stations in energy network.

4 - Diameter-constrained Lambda-edge-connected K-subgraph Problem

Yongying Zhou, University of Arizona, yongyingz@email.arizona.edu

In this talk, we study the diameter-constrained lambda-edge-connected k-subgraph problem, or the DC (k, lambda)-subgraph problem. Besides the requirements on the number of the vertices and edge connectivity, the subgraph has a diameter limit. This problem is a generalization of (k, lambda)-subgraph problem and diameter constrained minimum spanning tree. Commodity flow-based and hop constrained formulations are established, which are both integer programming (IP) formulation. Additionally, numerical experiments are performed to compare all proposed IP formulation.

■ MD12

104B-MCC

Mixed Integer Programming Formulations and Applications

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Juan Pablo Vielma, Massachusetts Institute of Technology, Cambridge, MA, United States, jvielma@mit.edu

1 - Small Independent Branching Formulations For Unions Of V-polyhedra

Joey Huchette, Massachusetts Institute of Technology, Cambridge, MA, United States, huchette@mit.edu, Juan Pablo Vielma

We present a framework for constructing small, strong mixed-integer formulations for disjunctive constraints. Our approach is a generalization of the logarithmically-sized formulations of Vielma and Nemhauser for SOS2 constraints, and we offer a complete characterization of its expressive power. We apply the framework to a variety of disjunctive constraints, producing novel, small, and strong formulations for outer approximations of multilinear terms, generalizations of special ordered sets, piecewise linear functions over a variety of domains, and collision avoidance constraints.

2 - Embedding Formulations For Unions Of Convex Bodies

Juan Pablo Vielma, MIT, jvielma@mit.edu

In this talk we extend to the non-polyhedral setting a systematic procedure to construct non-extended ideal formulations for unions of polyhedral introduced in Vielma (2015). Using geometric tools from the study of Minkoswki sums we show that the procedure can be used to recover and extend several special purpose non-extended ideal formulations. We also illustrate how the tools can be used to prove that no polynomially constrained non-extended ideal formulation can be obtained for some simple convex quadratic sets.

3 - Winning Daily Fantasy Sports Hockey Contests Using Integer Programming

Scott Hunter, MIT, dshunter@mit.edu, Juan Pablo Vielma, Tauhid Zaman

We present an integer programming (IP) approach to winning daily fantasy sports hockey contests which have top heavy payoff structures. Our approach incorporates publicly available predictions into a series of IPs that compute optimal lineups. We find that the produced lineups perform well in practice and are able to come in first place in contests with thousands of entries. We also show through simulations how the profit margin varies with various parameters. Our approach can easily be extended to other sports, such as American football and baseball.

4 - Smart Grids Observability Using Bilevel Programming

Claudia D'Ambrosio, Ecole Polytechnique, LIX CNRS (UMR7161), Palaiseau, France, dambrosio@lix.polytechnique.fr

Monitoring an electrical network is an important and challenging task. Phasor measurement units (PMU) are devices that can be used for a state estimation of this network. We consider a PMU placement problem and propose two new approaches to model this problem, which take into account a propagation rule based on Ohm's and Kirchoff's laws. First, we describe the natural binary linear programming model based on an iterative observability process. Then, we remove the iteration by reformulating its fixed point conditions to a bilevel program, which we solve with a tailored cutting plane algorithm. Finally, we show computational evidence of the effectiveness of our method.

■ MD13

104C-MCC

Project and Resource Planning

Sponsored: Optimization, Computational Optimization and Software

Sponsored Session

Chair: Haitao Li, Univ. of Missouri - St Louis, St Louis, MO, United States, lihait@umsl.edu

Co-Chair: Cipriano A. Santos, Distinguished Technologist, HPe-IT Center of Excellence, Virtual Office, Palo Alto, CA, 94304, United States, cipriano.santos@hpe.com

1 - An Optimization Approach To Workforce Planning In Professional Service Firms

Vincent Hargaden, Assistant Professor, University College Dublin, 209 Engineering & Materials Science Centre, Belfield, Dublin 4, Ireland, vincent.hargaden@ucd.ie, Jennifer K. Ryan, Amir Azaron

We develop a comprehensive mixed integer programming model for the workforce planning process in professional service firms. We will present results from the model which show the impact of skill mix, skill capability levels and cross training on key performance metrics such as project completion rates, staff utilization and profit. We show how extensions to our base model can incorporate issues such as a rolling planning horizon approach and variable project start dates.

2 - Simulation -Optimization For Strategic Workforce Planning

Manuel Laguna, University of Colorado Boulder, laguna@colorado.edu

OptForce is a data analytics tool for workforce planning. We describe how company data is used to build a simulation model of a workforce. This model is then used for what-if analysis and optimization. The techniques associated with this application of simulation-optimization are also discussed.

3 - Talent Optimization For The Knowledge Economy

Cipriano A. Santos, HP Enterprise, cipriano.santos@hpe.com

Allocating the right talent for the right job at the right time, location, and cost is critical for the operational efficiency of Professional Services Organizations. In this talk we present a hierarchical planning approach for labor resources allocations

■ MD14

104D-MCC

IAAA and Sygenta Reprise

Sponsored: Analytics

Sponsored Session

Chair: Tarun Mohan Lal, Mayo Clinic, 1, Rochester, MN, 12345, United States, mohanlal.tarun@mayo.edu

■ MD15

104E-MCC

Network Modeling and Inference

Sponsored: Artificial Intelligence

Sponsored Session

Chair: Adel Javanmard, Assistant Professor, University of Southern California, Bridge Hall, 3670 Trousdale Parkway, Los Angeles, CA, 90089, United States, ajavanma@marshall.usc.edu

1 - Co-clustering Of Non-smooth Graphons

David Sungjun Choi, Carnegie Mellon University, davidch@andrew.cmu.edu

Theory is becoming known for community detection and network clustering; however, the results assume an idealized model that is unlikely to hold in many settings. Here we consider exploratory co-clustering of a bipartite network whose nodes are sampled from an arbitrary population. This is equivalent to assuming a nonparametric generative model known as a graphon. We show that clusters found in the data by any method will extend to the population, or equivalently that the estimated blockmodel approximates a blocked version of the generative graphon, with error bounded by n^{-1/2}. Analogous results are also shown for degree-corrected and random dot product graph models.

2 - Aggregate Variation Under Network Perturbation

Azarakhsh Malekian, Rotman School of management, azarakhsh.malekian@rotman.utoronto.ca

We consider a game among agents represented by nodes of a graph in which the utility of each agent depends on the externalities from his neighbors. We study the sensitivity of equilibrium actions of agents with respect to the strengths of the network structure and its connections in both random and deterministic settings.

3 - Diffusion Disparities In Competitive Settings

Yotam Shmargad, School of Information, University of Arizona, yotam@email.arizona.edu

In many settings, competing groups have different resources at their disposal, resulting in imbalances in their abilities to seed messages. We conduct an experimental study to investigate the effect of network structure on diffusion in a setting with asymmetric seeding. We manipulate network structure by randomly assigning participants to social networks that vary in clustering (i.e. the extent to which individuals' ties are connected to each other). We then seed competing messages in these networks and model their diffusion over the course of eight days. We find that clustering perpetuates the disparities in exposure to asymmetrically-seeded messages.

■ MD16

105A-MCC

Distributionally Robust Optimization

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Angelos Georghiou, Swiss Federal Institute of Technology, Zurich, Zurich, 00000, Switzerland, angelosg@control.ee.ethz.ch

Co-Chair: Grani Adiwena Hanasusanto, University of Texas at Austin, Austin, TX, 1015, United States, grani.hanasusanto@utexas.edu

1 - Robust Control With Adjustable Uncertainty Sets: Providing Frequency Reserves To The Power Grid Via Demand Response

Angelos Georghiou, Dr, Swiss Federal Institute of Technology, Zurich, Switzerland, angelosg@control.ee.ethz.ch, Xiaojing Zhang, Maryam Kamgarpour, John Lygeros

Given a fixed uncertainty set, robust control finds a policy that minimizes a given cost while satisfying the system's constraints for all uncertainty realizations. In this work, we extend the robust control setup by allowing both the policies and the uncertainty sets to be decision-dependent, which we refer to as adjustable uncertainty sets. By restricting the set of admissible policies, we can cast the problem as a tractable convex optimization problem. We showcase the effectiveness of our approach on a demand response problem, providing frequency reserves to the power grid.

2 - Two-stage Distributionally Robust Linear Programming Over Wasserstein Balls

Grani Adiwena Hanasusanto, Assistant Professor, The University of Texas at Austin, Austin, TX, United States, grani.hanasusanto@utexas.edu, Daniel Kuhn

We study two-stage stochastic linear programming problems where the distribution of the uncertain parameters is ambiguous and is only known to belong to a family of all distributions that are close to the empirical distribution with respect to the Wasserstein metric. We derive an exact copositive program for the generic problems and formulate a tractable linear program for instances with only right-hand side uncertainty. We illustrate the effectiveness of our reformulations in numerical experiments and demonstrate their superiority over the classical sample average approximation scheme and the state-of-the-art moment-based model.

3 - Bounds On Random Binary Quadratic Programs

Karthik Natarajan, Singapore University of Technology and Design, karthik_natarajan@sutd.edu.sg

In this paper, we consider a binary quadratic program (BQP) with random objective coefficients. Given information on the marginal distributions of the objective coefficients, we propose new bounds on the expected optimal value of the random BQP. Preliminary computational results on random quadratic unconstrained binary optimization problems and random quadratic knapsack problems provides evidence of the quality of the bounds.

4 - Multi-objective Robust Optimization

Aurelie Thiele, Associate Professor, Southern Methodist University, Dallas, TX, United States, aurelie@alum.mit.edu

We investigate robust optimization frameworks for decision-making under high uncertainty when the decision maker has multiple, possibly conflicting objectives. Of particular interest is a situation with competitors seeking to either maintain or gain the lead in some of the markets the decision maker operates in. The decision maker must decide whether to use his budget defending his current positions or trying to take the lead in others. We investigate distributionally robust paradigms in those cases.

■ MD17

105B-MCC

Robust Optimization and Learning

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Xi Chen, Assistant Professor, New York University, 44 West 4th Street, New York, NY, 10012, United States, xchen3@stern.nyu.edu

Co-Chair: Qihang Lin, The University of Iowa, 101 Jessup Hall, Iowa City, IA, 52242, United States, qihang-lin@uiowa.edu

1 - Piecewise Affine Policies For Two-stage Optimization Under Demand Uncertainty

Vineet Goyal, Columbia University, vgoyal@ieor.columbia.edu, Aharon Ben-Tal, Omar El Housni

We consider the problem of designing piecewise affine policies for two-stage robust linear optimization under right hand side uncertainty. Such problems arise in many settings with demand uncertainty. One of the main challenges for piecewise affine policy is designing the pieces of the uncertainty set. We introduce a new framework where we approximate the set by a simplex and construct a piecewise affine policy from a map between the uncertainty set and simplex. Our policy can be computed efficiently and performs significantly better than affine policy for many interesting uncertainty sets.

2 - Distributional Robust Analysis For Log-concave And IFR Distributions

Simai He, Shanghai University of Finance and Economics, simaihe@mail.shufe.edu.cn

Distributional free robust optimization have raised attention for a long time, however it has been criticized as too over-conservative. Especially, the bounds yield from the so-called moment problems corresponds to few points discrete distributions, which are usually considered too extreme in practice. Increasing failure rate (IFR) and log-concave distribution assumptions are too widely accepted and applied distribution assumptions in many area. We develop general distributional free robust optimization theory with such distribution assumptions, based on optimum solution structure of a particular class of non-convex optimization problems.

3 - Recovering Statistical Guarantees Via The Empirical Robust Optimization

Henry Lam, University of Michigan, khlam@umich.edu

We investigate the use of distributionally robust optimization (DRO) in recovering the statistical guarantees provided by the best benchmark that is in line with the central limit theorem, for the feasibility of expected value constraints. We show that the divergence ball, suitably empirically defined, and with its size calibrated by the quantile of a chi-square process excursion, amounts to such guarantees. The construction of this ball deviates from the standard mechanism of DRO in that the ball can have low, or even zero probability of covering the true distribution. Rather its performance is explained by connecting the dual of the DRO with a generalization of the empirical likelihood method.

4 - Optimal Regret In Multi Armed Bandits Under Heavy Tailed And Correlated Reward Processes

Alexej Proskynitopoulos, Northwestern University, Evanston, IL, United States, alexej.proskynitopoulos@kellogg.northwestern.edu, Chaithanya Bandi

It is well known that Thomson Sampling and UCB based algorithms achieve the optimal regret for Bandits with light tailed reward processes. In this talk, we present a new framework for deriving these optimal algorithms which achieves optimal regret for heavy tailed reward processes as well as a bound for correlated arms. We also derive the order of the optimal regret as a function of the heavy tail coefficient and correlation.

■ MD18

106A-MCC

Statistical Learning under a Modern Optimization Lens

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Dimitris Bertsimas, Operations Research Center, MIT, MIT, E40-111, Cambridge, MA, 02139, United States, dbertsim@mit.edu

Co-Chair: Dimitris Bertsimas, Operations Research Center, MIT, MIT, E40-111, Cambridge, MA, 02139, United States, dbertsim@mit.edu

1 - Missing Data Imputation Via A Modern Optimization Lens

Colin Pawlowski, Massachusetts Institute of Technology, Cambridge, MA, United States, cpawlows@mit.edu, Dimitris Bertsimas, Ying Zhuo

We propose an optimization framework for missing data imputation. The formulation imputes missing values to minimize the total distance to the K-nearest neighbors of each data point. Because the problem is non-convex, we derive a fast first-order method opt.impute to find high-quality solutions. On a sample of 64 data sets with 25% hidden values, opt.impute produces the best overall imputation in 40 data sets benchmarked against state-of-the-art methods. Further, the relative performance of opt.impute improves as the percentage of missing data increases, and for problems with the highest percentage of missing data, the mean absolute deviation from true values is lowered by 2.4%.

2 - Multi-target Tracking Via Mixed Integer Optimization

Shimrit Shtern, Operations Research Center, MIT, sshtern@mit.edu, Zachary C. Saunders

The Multi-target tracking problem combines the problems of assigning sensor detections to targets and estimating the target trajectory. Inaccuracies in the detection process make this a difficult problem. The literature is abundant with probability based models, but few optimization based models have been suggested, which mostly focus on model accuracy rather than interoperability or solvability. In our work we develop a simple and interpretable mixed integer optimization model, which is warm started by an appropriate heuristic, and yields high quality solutions in a reasonable time.

3 - Optimal Sparse Inverse Covariance Estimation

Jourdain Bernard Lamperski, Operations Research Center, MIT, jourdain@mit.edu

We consider the maximum likelihood estimation of sparse inverse covariance matrices. We formulate the estimation problem as a nonlinear MIP and develop a novel decomposition approach that solves the formulation to optimality. Using a variety of datasets, we demonstrate that the approach scales to problem sizes of interest and yields sparser solutions than existing methods, while maintaining desirable statistical properties.

4 - Optimal Low Rank Factor Analysis

Martin S. Copenhaver, Operations Research Center, MIT, Cambridge, MA, United States, mcopen@mit.edu, Dimitris Bertsimas, Rahul Mazumder

Factor Analysis (FA) is a technique that is widely used to obtain a parsimonious representation of correlation structure among a set of variables in terms of a smaller number of common hidden factors. In this talk we revisit the classical rank-constrained FA problem and propose a flexible family of exact, smooth reformulations for this task. By coupling state-of-the-art techniques from nonlinear optimization with methods from discrete and global optimization, we show that our approach often finds certifiably optimal solutions and significantly outperforms existing publicly available methods across a variety of real and synthetic examples.

■ MD19

106B-MCC

Networks and Geography in Optimization

Sponsored: Computing

Sponsored Session

Chair: John Gunnar Carlsson, University of Southern California, University of Southern California, Los Angeles, CA United States, jcarlsso@usc.edu

1 - A Decomposition Heuristic For The One-warehouse Multi-retailer Problem With Batch Costs

Alejandro Toriello, Georgia Institute of Technology, Atlanta, GA, United States, atoriello@isye.gatech.edu, Weihong Hu

We consider a one-warehouse, multi-retailer system with deterministic dynamic demand over a discrete finite horizon, where orders placed by any facility incur batched fixed costs. We propose a decomposition heuristic that solves the warehouse's and retailers' problems separately and then judiciously converts the separate solutions into a globally feasible solution with worst-case approximation guarantee of 2; this improves the previously best-known ratio of 3.6. Time permitting, we will discuss the extension to concave batch costs.

2 - Bounds For The Euclidean Generalized Travelling Salesman Problem

John Gunnar Carlsson, University of Southern California, jcarlsso@usc.edu

We study the Euclidean generalized travelling salesman problem (GTSP), in which the goal is to find a tour that visits one element from each of a collection of point sets. Our results characterize the long-term, asymptotic behavior of the tour length when a large number of points are sampled, and give rise to a number of counterintuitive managerial insights.

3 - Distributionally Robust Travelling Salesman Problem With Wasserstein Distance

Mehdi Behroozi, Visiting Scholar, University of Southern California, Los Angeles, CA, United States, mehdi.behroozi@usc.edu, John Gunnar Carlsson

Recent research on the robust and stochastic Euclidean travelling salesman problem has seen many different approaches for describing the region of uncertainty, such as taking convex combinations of observed demand vectors or imposing constraints on the moments of the spatial demand distribution. In this paper, we consider a distributionally robust version of the Euclidean travelling salesman problem in which we compute the worst-case spatial distribution of demand against all distributions whose Wasserstein distance to an observed demand distribution is bounded from above. This constraint allows us to circumvent common overestimation that arises when other procedures are used.

■ MD20

106C-MCC

Recent Developments in Multistage Stochastic Programming

Invited: Tutorial

Invited Session

Chair: Alan King, IBM Research, 1, Yorktown Heights, NY, 15, United States, kingaj@us.ibm.com

1 - Recent Developments In Multistage Stochastic Programming

Alan King, IBM Research, Yorktown Heights, NY, 10, United States, kingaj@us.ibm.com

Multistage stochastic programming is a framework for applying large scale optimization technologies to multiperiod decision making under uncertainty. This talk will review the past decade and a half's developments in multistage stochastic programming, including risk functionals, Stochastic Dual Dynamic Programming, time-consistent risk measures, and quantization of scenario trees.

■ MD21

107A-MCC

Healthcare Information Systems

Sponsored: Health Applications

Sponsored Session

Chair: Yi-Chin Lin, Hofstra University, Hempstead, Weller Hall 032, Hempstead, NY, 11549-1000, United States, yichin.kl@gmail.com

Co-Chair: Rema Padman, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, rpadman@cmu.edu

1 - Physician Quality And Online Reviews

Danish Saifee, PhD Student, Naveen Jindal School of Management/The University of Texas at Dallas, 800 West Campbell Road, Richardson, TX, 75080, United States, dxs121230@utdallas.edu, Indranil Bardhan, Eric Zheng

We investigate how online reviews and physician competence differ in terms of their impact on clinical outcomes. Using a panel of COPD patients, we find that physicians with higher competence exhibit better patient outcomes.

2 - Patient Experience And The Adoption And Use Of Hospital Health Information Technology

Yunfeng Shi, Assistant Professor, The Pennsylvania State University, 504E Ford Building, University Park, PA, 16802, United States, yus16@psu.edu, Verónica Fuentes Cáceres

This study evaluates the impact of EHR capability on Patient Experience. Using information from the Hospital Compare and HIMSS, we constructed a longitudinal sample (2007 -2013) of 2808 hospitals and estimated the impact with a linear fixed effects model. In particular, we examined how the 5 different levels of EHR capabilities, as defined in previous research, were related to the 10 HCAHPS outcomes reported in Hospital Compare, including patient satisfaction, patient-provider communication, and discharge information. Our findings suggest that having the highest level of EHR capability may have a positive impact on patient experience, although the magnitude of the impact is generally small.

3 - The Evidence On Chronic Kidney Disease Patient Education: A Review Of The Literature And A Case Study

Hilary Wolfendale, Doctoral Student, Carnegie Mellon University, Hamburg Hall, 4800 Forbes Avenue, Pittsburgh, PA, 15213, United States, hwolfend@andrew.cmu.edu, Rema Padman, Amelia M Haviland

The prevalence of chronic kidney disease (CKD) is rising in the United States. While CKD cannot be reversed, CKD health education may delay the progression of the disease. Consequently, Medicare began offering a series of education sessions promoting behaviors that can postpone the need for dialysis or transplant in CKD patients. This study 1) evaluates the current state of evidence supporting education-based interventions for CKD patients and 2) examines electronic health record data from a community nephrology practice for preliminary evidence of any impact of Medicare's education sessions.

4 - Designing M-health Services For User Engagement And Health Promotion: An App For Healthy Eating

Yi-Chin Kato-Lin, Hofstra University, Hempstead, NY, United States, yichin.lin@hofstra.edu

Mobile technologies have the potential to engage patients in managing their healthy behaviors, such as healthy eating. However, few advanced functionalities have been employed in practice for promoting healthy eating. This study proposes novel mobile-enabled interventions by upgrading three interventions commonly used in practice: self-monitoring, professional support, and peer support. Surveys reveal user satisfaction and heterogeneous preferences among subpopulations. This study provides strategic insights that are generalizable to other healthy behaviors.

■ MD22

107B-MCC

Policy Modeling and Analysis in Healthcare

Sponsored: ORinformed Healthcare Policies

Sponsored Session

Chair: Turgay Ayer, Georgia Institute of Technology, Atlanta, GA, United States, ayer@isye.gatech.edu

1 - Evaluating Diversion Programs For Drug Offenders

Margaret Brandeau, Stanford University, Stanford, CA, United States, brandeau@stanford.edu, Cora Bernard, Konner Robison

Jails in the US process more than 11 million people each year, and the prevalence of communicable diseases such as HIV, hepatitis C and tuberculosis is much higher in jails than in the general population. We investigate the costs and health impact of a jail-diversion program for low-level drug offenders which is currently being pioneered in Seattle. We simulate the flow of at-risk people through the criminal justice system and drug treatment programs, comparing outcomes for those who get into the diversion program with those who do not. The goal is to estimate the costs and health benefits of the diversion program, and its impact on public health as well as on the criminal justice system.

2 - Carrot Or Stick? The Role Of Incentives In Achieving Meaningful Health It Security

M Eric Johnson, Professor, Vanderbilt Universtity, Nashville, TN, 37205, United States, eric.johnson@owen.vanderbilt.edu, Juhee Kwon

The U.S. HITECH Act provided healthcare providers with both financial incentives and penalties linked to an EHR certification process, referred to as "meaningful-use" attestation. We consider the impact of these incentive on information security. We find that both carrot and stick strategies are required for mitigating different information security risks.

3 - Prioritizing Hepatitis C Treatment In US Prisons

Turgay Ayer, Georgia Tech, ayer@isye.gatech.edu, Can Zhang, Anthony Bonifonte, Anne Spaulding, Jagpreet Chhatwal

Prisons, which represent approximately 30% of the national HCV prevalence, offer a great opportunity to control the epidemic of HCV. However, state prison systems typically have very tight budgets and cannot bear the cost burden of HCV treatment. Therefore, in current practice, only a small portion of HCV-infected inmates are treated based on some prioritization rules. In this study, we propose a restless bandit model framework to support HCV treatment decisions in prisons. We propose a capacity-adjusted closed-form index-based prioritization policy and show that our policy performs much better than the myopic policy and the well-known Whittle's index.

■ MD23

108-MCC

Healthcare Delivery with New Technology Development and Patient Choice

Sponsored: Health Applications

Sponsored Session

Chair: Mabel Chou, National University of Singapore, Mochtar Riady Building, 15 Kent Ridge Drive, BIZ1 #8-66, Singapore, Singapore, mabelchou@nus.edu.sg

1 - Optimal Mobile Health Clinic Delivery Aimed At Minimizing Long-run Average Healthcare Costs

Fang Liu, Nanyang Technological University, liu_fang@ntu.edu.sg, Pengfei Guo, Song Jiu, Yulan Wang

People in remote area have poor access to health care services. Mobile health clinics (MHC) provides a solution to this problem by delivering health care services to them. We first develop a discrete-time Markov model to capture the progression of a chronic disease and then characterise the optimal delivery policy that minimizes the long-run average healthcare cost. we find that when the disease is fast progressive, MHC should be delivered in every period or two periods.

2 - Appointment Scheduling With Time-dependent Patient No-show

Qingxia Kong, Assistant Professor, Erasmus University, Rotterdam, Netherlands, qingxia.kong@gmail.com, Shan Li, Nan Liu, Chung-Piaw Teo, Zhenzhen Yan

We study independent data sets from countries on two continents which identify a significant time-of-day effect on patient arrival probabilities. We deploy a distributionally robust model to find the optimal scheduled arrival times for patients.

3 - Hospital Portering Service Delivery Analysis And Design

Mabel Chou, National University of Singapore, Singapore, Singapore, mabelchou@nus.edu.sg

This paper aims to improve the overall performance of the porter system at a hospital in Singapore. We focus on reducing the response times of porters and therefore reducing the patient waiting times. Our analysis reveals that the performance of porter stations is in general better than the performance of central pool station with respect to response and completion times for jobs. We discover three main reasons for the performance differences, which are an understaffed central pool, an overstaffed emergency department and possibly other stations, and differences in distances travelled between central pool and stations. We then discuss how to redesign the system to improve the overall performance.

■ MD24

109-MCC

Decision Models in Healthcare/Clinical Settings.

Sponsored: Health Applications

Sponsored Session

Chair: Vishal Ahuja, Southern Methodist University, 12, Dallas, TX, United States, vahuja@smu.edu

1 - Issuing Policies For Hospital Blood Inventory

Alireza Sabouri, Haskayne School of Business, University of Calgary, alireza.sabouri@haskayne.ucalgary.ca, Steven Shechter, Woonghee Tim Huh

We propose a model for allocating red blood cells for transfusion to patients, which is motivated by recent evidence suggesting that transfusing older blood is associated with increased mortality rate. We study the properties of blood issuance policies that balance the trade-off between "quality" measured in average age of blood transfused and "efficiency" measured in the amount of shortage. Based on our analysis, we design efficient issuance policies and evaluate their performance.

2 - Quantitative Approaches For Measuring And Relieving Congestion In A Dialysis Unit At A Hospital: The Case Of Compassionate Dialysis

Olga Bountali, Southern Methodist University, 3145 Dyer street, Dallas, TX, United States, obountali@smu.edu, Sila Çetinkaya, Vishal Ahuja

We examine a congested healthcare delivery setting due to emergency treatment of a chronic disease. A prominent example of the problem of interest is congestion in the emergency room due to arrival of unfunded ESRD patients needing dialysis (a.k.a., compassionate dialysis). Unfortunately, this is the only treatment option for undocumented immigrants with ESRD., i.e., when their clinical condition is deemed as life-threatening. We model the problem as a queueing network with recurrent arrivals and service and examine various performance metrics impacting patient welfare and social cost.

3 - Efficient Sampling From Large Databases For Controlled Trials

Sanjay Mehrotra, Professor, Northwestern University, Evanston, IL, 60208, United States, mehrotra@northwestern.edu, Daniel Apley, Liwen Ouyang

Controlled trials are ubiquitously used to investigate the effect of a medical treatment. The trial outcome can be dependent on a set of patient covariates. Traditional approaches have relied primarily on randomized patient sampling and allocation to treatment and control groups. We will present an approach that uses optimal design of experiments (DOE) concepts to select the patients for the treatment and control groups, based on their covariate values, in a manner that optimizes the information content in the data.

4 - Optimal Stopping For Response-guided Dosing

Jakob Kotas, PhD, University of Portland, Portland, OR, 37221, United States, kotas@up.edu

One important decision in response-guided dosing is when to stop treatment. In practice, stopping often occurs for patients in remission, or due to a finding of futility or a desire to switch to a different drug. We have previously developed a stochastic dynamic programming framework for response-guided dosing which tailors dose to a patient's stochastic evolution of disease state. In this talk we present an extension of that model that allows for stopping before the scheduled end time. Our numerical simulations show optimality of stopping below a threshold state. We also outline structural properties of the stopping formulation, including monotonicity of the threshold state with respect to time.

■ MD25

110A-MCC

Project Related SCM II

Invited: Project Management and Scheduling

Invited Session

Chair: Xiaoqiang Cai, The Chinese University of Hong Kong, Shatin NT, xqcai@se.cuhk.edu.hk

1 - Procurement Strategies With Asymmetric Yield Information

Houcai Shen, Nanjing University, hcshen@nju.edu.cn

In this paper, we study firm purchase behavior when her supplier has private information about his yield rate.

2 - Optimal Design Of Omnichannel

Xiaolin Xu, Nanjing University, xuxl@nju.edu.cn

Nowadays omnichannel has received much attention in retail industry. However, how to design an appropriate omnichannel strategy is a challenge facing the retailers. For example, retailer can provide BOPS (buy online and pickup at store) or STOP (shipment to store for consumers to pickup at store), in addtion to the traditional O2O (online vs. offline) channels. The channel BOPS shares the store inventory with the offline channel, while the channel STOP shares the DC (distribution center) inventory with the online channel. We investigate how these two omnichannel strateties affect the market segmentation, fill rates at store and the retailer's profit.

3 - Pricing And Ordering Strategies Of Supply Chain With Selling Gift Cards

Wenqing Shi, University of Electronic Science and Technology of China, Chengdu, China, shiwenqing1218@163.com, Jingming Pan, Xiaowo Tang

Gift cards is one popular promotion way in market, which is widely used to replace traditional gift cash and gift products, especially when gift givers do not know gift receivers' performances. Basing on this phenomenon, we develop a Stackelberg model to analyze the supplier's and retailer's optimal strategies with selling gift cards. We also exam the influences of different parameters on the optimal decisions and the supply chain performance.

4 - Product Quality Choice In Two-echelon Supply Chains Under Post-sale Liability: Insights From Wholesale Price Contracts

Jianchang Fan, Doctor, University of Electronic Science and Technology of China, Qingshuihe Campus: No.2006, Xiyuan Ave, West Hi-Tech Zone, Chengdu, 611731, China, love.andyfan@163.com, Debing Ni

A two-stage game model in a supply chain consisting of a manufacturer (M) and a Retailer (R) is built via a wholesale price contract. M is liable for the harm caused by its low-quality products. In the equilibrium, we find that (1) in spite that product liability positively affects the wholesale price, M's quality level, the contracted quantity and the supply chain members' profitability are independent of it; (2) in response to changes in liability-related factors, the product quality is in conflict with the profits for both M and R, but the quality and the profit increase in quality improvement efficiency; (3) the wholesale price serves as a medium for M to share its ex ante expected liability cost with R.

■ MD26

110B-MCC

Auctions, Markets, and Mechanism Design

Invited: Auctions

Invited Session

Chair: Brian Baisa, Amherst College, Amherst, MA, United States, bbaisa@amherst.edu

1 - Mechanism Design For Team Formation

Greg Leo, Vanderbilt University, Nashville, TN, United States, g.leo@vanderbilt.edu, Martin van der Linden, Jian Lou, Yevgeniy Vorobeychik, Myrna Wonders

Team, or coalition, formation is a fundamental problem in AI and game theory. While there has been extensive research on coalitional stability, especially in hedonic games, the problem of designing mechanisms for coalition formation has received relatively little attention. Theoretically, most of what is known about such design problems is negative; for example, no mechanism that always matches soulmates (individuals who prefer to be matched together) is strategyproof in general. We describe some of our recent positive results about achieving efficiency, incentive compatibility, individual rationality, and coalitional stability in important restricted classes of hedonic preferences.

2 - Equilibrium In a Uniform-Price Auction withPrivate Values

Justin Burkett, Wake Forest University, burketje@wfu.edu

In a model incorporating bidders with private information bidding for multiple units of a homogeneous good, I show that the equilibrium bid functions can be completely characterized, sometimes in closed form. The equilibrium bid functions can be considered aggregated bid functions from first-price single unit bidders. This property allows one to extend results from the single-unit auction literature to this multi-unit setting.

3 - Strategic Ironing In Pay-as-bid Auctions: Equilibrium Existence With Private Information

Kyle Woodward, University of North Carolina at Chapel Hill, Gardner Hall, CB 3305, Chapel Hill, NC, 27599-3305, United States, kyle.woodward@unc.edu

I establish the existence of pure-strategy Bayesian-Nash equilibria in divisible-good pay-as-bid auctions with private information, and show that such equilibria can approximate equilibria in nearby multi-unit auctions. I show that equilibrium strategies exhibit strategic ironing, a reduction of bids below what might be expected. Strategic ironing has implications for the tractability of equilibrium strategies.

4 - Efficient Multi-unit Auction Design Without Quasilinear Preferences

Brian Baisa, Amherst College, bbaisa@amherst.edu

I study efficient multi-unit auction design when bidders have private values, multi-unit demands, and non-quasilinear preferences. Without quasilinearity, the Vickrey auction loses it desired incentive and efficiency properties. I construct a novel mechanism that retains the desirable properties of Vickrey auction, even in cases when bidders have non-quasilinear preferences. When bidders have single dimensional types, the mechanism (1) is dominant strategy incentive compatible, (2) is Pareto efficient, and (3) provides no subsidies. If bidders types are multi-dimensional, I show that there is no mechanism that satisfies these three properties.

■ MD27

201A-MCC

New Frontiers in Operations Management

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Retsef Levi, Sloan School of Management, 100 Main Street, Building E62-562, Cambridge, MA, 02142, United States, retsef@mit.edu

1 - Exploration Vs. Exploitation: Reducing Uncertainty In Operational Problems

Yaron Shaposhnik, MIT, Cambridge, MA, 02139, United States, shap@mit.edu, Chen Attias, Robert Krauthgamer, Retsef Levi

We study a broad class of multistage stochastic combinatorial optimization models that capture a fundamental tradeoff between performing work and making decisions under uncertainty (exploitation) and investing capacity to reduce the uncertainty in the decision making (exploration). Unlike existing models that take a Bayesian approach to learning (through sampling), we study a learning mechanism called testing (also known as probing or querying), in which exact realizations from known distributions are observed. We derive insightful structural results on the optimal policies that include the optimality of local decision rules.

2 - Competitive Analysis Of Online Scheduling Algorithms For Infusion Center Appointments

Michael Hu, MIT, Cambridge, MA, United States, hum@mit.edu, Kimia Ghobadi, Retsef Levi

We study the problem of minimizing resource requirements of infusion centers through the use of optimized appointment scheduling. We do this by developing a modeling framework that generalizes online bin packing. We then describe 3 different online scheduling algorithms for the problem and analyze their performance via competitive analysis. Our main result in this work is an online algorithm that is 2-competitive under certain assumptions on the appointment requests. We also establish lower bounds on the competitive ratios for all 3 online algorithms in both the most general setting and when assumptions are made on the appointment data.

3 - Incentivized Actions In Freemium Games

Lifei Sheng, PhD Candidate, UBC, 2053 Main Mall, Vancouver, BC, Canada, fay.sheng@sauder.ubc.ca, Christopher Ryan, Mahesh Nagarajan

We study the common phenomena of mobile game companies offering users “virtual” benefits to take actions in-game that earn the game company revenue from third parties. Examples of “incentivized actions” include paying users in “gold coins” to watch video advertising or to fill out a survey. We explore the costs and benefits of offering incentivized actions as users progress in their engagement with the game. We find sufficient conditions for when it is optimal to follow a threshold strategy of offering incentivized actions to low-engaged users and then remove them once a user is sufficiently engaged. We also provide insights into what types of games benefit most from offering incentivized actions.

4 - Process Capacity: Exact Analysis And The Bottleneck Formula

Yang Bo, Naveen Jindal School of Management, The University of Texas at Dallas, 2200 Waterview Pkwy, Apt. 27304, Richardson, TX, 75080, United States, yxb120630@utdallas.edu, Milind Dawande, Tim Huh, Ganesh Janakiraman, Mahesh Nagarajan

We offer a rigorous understanding of process capacity for a single-product process, culminating in a precise expression for this quantity. We also contrast this with the widely used formula based on bottle-neck capacity.

■ MD28

201B-MCC

Operations Management for Fashion Goods

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Robert Swinney, Duke University, Durham, NC, United States, robert.swinney@duke.edu

1 - Attribute-based Modeling Of Product Recommendations

Sajad Modaresi, Duke University, Durham, NC, United States, sajad.modaresi@duke.edu, Fernando Bernstein

We study product recommendations through data analytics in the context of fashion retailing. Using a Bayesian semi-parametric approach, we identify customers with similar preferences for products, which is the basis for the product recommendation system. We test our results using a dataset from a large European clothing manufacturer.

2 - Managing Online Content To Build A Follower Base

Felipe Caro, UCLA Anderson School of Management, felipe.caro@anderson.ucla.edu, Victor Martínez-de-Albéniz

Content providers typically manage a dual objective of generating interest for current followers and at the same time reaching out to new audiences that may become repeat visitors. The pace at which content is created must thus take into account how much it contributes to maintain the follower base. We formulate a simple model to study follower base build-up dynamics under the assumption that the attractiveness of past content decays over time. Using stochastic dynamic programming we develop heuristics for content release and an upper bound to assess performance. We then apply our model to the case of blogs.

3 - Inventory And Channel Integration In The Presence Of Strategic Consumers

Arian Aflaki, Duke University, Durham, NC, United States, aa251@duke.edu, Robert Swinney

We study the impact of inventory and channel integration on a firm that sells a product to consumers that are strategic in two dimensions: they decide “whether” and “when” to visit the firm based on the availability risk, cost to visit, and price of the product. The firm decides whether to operate in a multichannel setting and dedicate separate inventory to multiple markets, or to integrate the system and combine the inventory between the markets. We show that integration can be much less valuable in the presence of strategic consumers and may even possess a negative value.

4 - Fast And Furious? The Impact Of Delivery Lead-times In Online Buyer Behavior

Eduard Calvo, Assistant Professor, IESE, Barcelona, Spain, ecalvo@iese.edu, Víctor Martínez-de-Albéniz, Alex Thiele

Many e-commerce firms implement efforts to reduce their lead-times believing that faster deliveries make online buyers “happier” and thus more likely to buy more. However, the specific mechanisms through which lead-time reductions connect with sales growth are still not well understood. In this work, we leverage user and click-level activity data from an e-commerce player to find evidence of this connection. The data spans a period of time during which the firm undertook several lead-time cutting initiatives, and we build a structural model that allows us to study the impact of those on online buyer behaviour as described by traffic, conversion rates, and average ticket values.

■ MD29

202A-MCC

Innovative Models in CLSC: Returns, Remanufacturing, Recycling, and Servicization

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Gal Raz, Ivey Business School, 1255 Western Rd., London, ON, N6G 0N1, Canada, graz@ivey.ca

1 - Recycling As A Strategic Supply Source

Gal Raz, Ivey Business School, Western Unversity, graz@ivey.ca

We investigate how recycling can be used as a strategic source of supply in the presence of competition and a powerful material supplier. We examine the economic and environmental impact of a manufacturer’s decision to recycle its products and the implications for its customers, supplier, and society. We show that the result depends on the type of recycling the manufacturer does as well as on the market dynamics and price of recycling.

2 - Servicizing Business Models: A Supply Chain Perspective

Jeremy John Kovach, Assistant Professor, Texas Christian University, TCU Box 298530, Fort Worth, TX, 76129, United States, j.j.kovach@tcu.edu, Ioannis Bellos

In recent years we have observed several auto manufacturers introducing car sharing programs. In this paper we study the different types of supply chain structures that manufacturers can use to sell cars and provide car sharing services.

3 - The Effect Of Regulation on DfE Innovation

Cheryl Druehl, George Mason University, cdruehl@gmu.edu, Gal Raz, Vered Blass

We examine the DfE innovations, use stage and refurbishing, of a firm selling new primary market products and refurbished products in a secondary market. The firm determines innovations, prices, and fraction collected. Using LCA data from cell phones, we compare EPR and Use stage regulations on profits and environmental impact.

4 - Drivers And Benefits Of Return Policies For Online Retailers

Guangzhi Shang, Florida State University, gshang@business.fsu.edu

The common retail practice of full refunds is inconsistent with the recommendations of many analyticalmodels of returns, which almost always show that a partial refund is optimal. We use data collected from eBay to analyze both the return policy drivers from the seller's perspective and the return policy value from the consumer's perspective, providing insights to two potential explanations for the gap between theory and practice.

■ MD30

202B-MCC

Retail Operations II

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Santiago Gallino, Dartmouth College, Hanover, NH, United States, santiago.gallino@tuck.dartmouth.edu

1 - Optimizing Customer Pick-up Locations Using An Empirical Model

Chloe Kim, The Whaton School, chloekim@wharton.upenn.edu, Marshall L Fisher, Xuanming Su

We empirically study the determinants of pick-up location success for an online grocery retailer. We consider various aspects of individual locations, including local competition, local consumer attributes, and the potential for cannibalizing sales from other locations. We suggest an algorithm for optimizing pick-up locations and measure its impact on revenue.

2 - Prioritizing Outbound Calls In A Sales Contact Center

Marcelo Olivares, Universidad de Chile, molivares@u.uchile.cl

We study an outbound call center that provides sales support to an online platform selling auto insurance. When setting priorities among which customers to contact, it is necessary to identify which calls are more likely to convert into sales. We develop an econometric approach to conduct this segmentation using detailed customer-level transaction data. A key factor in our analysis is the customer elapsed time since receiving the quote, which has a significant negative effect in sales conversion. This approach can be used to implement an automated priority system to manage outbound calls and can be adapted to other types of contact centers.

3 - Management And Effects Of In-store Promotional Displays

Oguz Cetin, UNC Kenan-Flagler Business School, Oguz_Cetin@kenan-flagler.unc.edu, Adam J Mersereau, Ali Kemal Parlakturk

Promoting a product via an in-store display can increase demand for it by making it more visible to customers, but it may also impact demand for other products by changing customer traffic patterns in the store. We characterize the optimal choice of product to promote in a nested multinomial logit formulation, and we examine the impact on product, category, and store profits.

4 - Spatial Competition And Preemptive Entry In The Discount Retail Industry

Fanyin Zheng, Columbia Business School, fz2225@gsb.columbia.edu

This paper studies how discount retailers make store location decisions by estimating a dynamic game model. It extends the empirical models of dynamic oligopoly entry by allowing for spatially interdependent entry and introducing machine learning tools to infer market divisions from data. The results suggest that preemptive incentives are important in chain stores' location decisions and that they lead to loss of production efficiency.

■ MD31

202C-MCC

Operations and Financing Interface

Sponsored: Manufacturing & Service Oper Mgmt, iFORM

Sponsored Session

Chair: Guoming Lai, Univ. of Texas Austin, 2110 Speedway Stop B6500, Austin, TX, 78712, United States, laiguoming@gmail.com

Co-Chair: Qi Wu, Case Western Reserve University, Cleveland, OH, 44106, United States, qxw132@case.edu

1 - Capital Structure With Asset Flexibility

Qi Wu, CWRU, Cleveland, OH, United States, qxw132@case.edu, Peter Ritchken

We study the impact of asset flexibility on the design of an optimal capital structure in a dynamic model in which the firm has multiple debt issues and equityholders choose the timing and financing of future growth options as well as the operating policy for assets in place. We show that, all things being equal, profitable firms with flexible assets exercise their growth options earlier, use less debt, and will typically be less leveraged than otherwise identical firms with no asset flexibility. When asset flexibility allows risk-shifting possibilities, firms exercise growth options even earlier.

2 - Operational And Financial Interactions In Supply Chain Network Structure

John R Birge, University of Chicago, John.Birge@ChicagoBooth.edu

3 - Competitive Risk Management

Danko Turcic, Washington Univ. in St. Louis, turcic@wustl.edu, Guang Xiao, Panos Kouvelis

This paper provides a new rationale for hedging that is based, in part, on non-competitive behavior in product markets. We identify a set of conditions, which imply that a firm may want to hedge. Both operational and financial hedging strategies are considered.

4 - Inventory Operations Under The Shadow Of Company Stock Price

Guoming Lai, UT-Austin, laiguoming@gmail.com

Inventory management is one central problem of operations. The classical inventory theories typically focus on the operational tradeoffs to optimize the inventory decisions. In practice, however, many firms are public that often have short-term interests in their market value. Our analysis reveals that public firms may install more inventory in equilibrium to influence their earnings. We discuss the determinants of such an effect as well as the empirical evidence.

■ MD32

203A-MCC

Scheduling

Contributed Session

Chair: Med Labidi, Assistant professor, King Saud University, IED, Riyadh, 11421, Saudi Arabia, mlabidi@ksu.edu.sa

1 - A Mathematical Model And A Heuristic For The Capacitated Lot Sizing Problem In Process Industries

Chandrasekharan Rajendran, Professor, IIT Madras, DoMS, IIT Madras, Chennai, 600036, India, crajiitm@gmail.com, Ramya Ravi, Hans Ziegler

In this work, we consider the capacitated lot sizing problem (CLSP) with production carryover and setup carryover across multiple periods in process industries. This CLSP is characterized by the commencement of production immediately after the setup of the product, and without any interruption in production. Mathematical and heuristic models are specifically developed for this class of CLSP. Also, the proposed heuristic exploits the Fixed-and-Relaxed principle. The computational effectiveness of both the models are evaluated using problem instances of various sizes, and are also reported. It is possibly the first time that such a CLSP is presented.

2 - Scheduling When You Don't Know The Number Of Machines

Mingxian Zhong, Columbia University, 528 Riverside Drive, Apt 4A, New York, NY, 10027, United States, mz2325@columbia.edu, Clifford Stein

We study scheduling environments in which you have to make some decisions before learning the number of machines. Specifically, we introduce a model in which you first need to group jobs into some sets, next you learn the number of machines and then you need to schedule sets of jobs on machines without separating them. We give a 9/5(1+epsilon)-approximation algorithm for minimizing makespan in this environment and show some hardness results.

3 - Facility Recovery Plan Under Resource Constraints

Gang Li, Bentley University, Management Department, 175 Forest Street, Waltham, MA, 02452-4705, United States, gli@bentley.edu, Xiangtong Qi

We address a facility recovery plan problem after disruption. The disruption has damaged some of the existing facilities while the resources used to repair these facilities are limited. This plan entails supply adjustment among customers and resource allocation among damaged facilities in order to minimize the total supply and shortage cost during the recovery period. In this talk, we present the problem formulation and discuss efficient algorithms to solve.

4 - Energy Conscious Robot Scheduling In Robotic Cell Manufacturing

Vahid Eghbal Akhlaghi, Research Assistant, Middle East Technical University, Cankaya, METU, Yurt. 2, room 112-1, Ankara, 06800, Turkey, vahid.akhlaghi@metu.edu.tr, Hakan Gultekin, Sinan Gurel

Robotic cells usually operate under time pressure to minimize time related objectives such as cycle time. Besides, robots consume significant amount of energy determined by the speeds and distances of their moves. We study the tradeoff between cycle time and energy consumption of a robot in a two machine flexible robotic cell. There are alternative cyclic schedules for such a cell and each cycle involves a number of different robot moves. Energy consumption of a robot is formulated as a convex function of its speed. Given a cycle time, we find optimal speeds for different robot moves in robotic cell cycles. We determine the best cyclic schedule and optimal robot speeds that minimize energy consumption.

■ MD33

203B-MCC

Simulation II

Contributed Session

Chair: Geonsik Yu, Yonsei University, Seoul, Korea, Republic of, geonsik.yu@gmail.com

1 - Siting A Geological Disposal Facility – A Discrete Event Simulation Approach.

Matthew Gilbert, Mr, University of Warwick, Statistics, University of Warwick, Coventry, CV4 7ES, United Kingdom, m.g.gilbert@warwick.ac.uk, Simon French, Jim Q Smith

Disposal of nuclear waste has become an increasing concern for the UK government over the past few decades. We present a discrete event simulation modelling changes in public opinion for their previous failed geological disposal siting attempt in Cumbria between 2009 and 2013. Using this we explore potential bias that could have been introduced at the end of the process.

2 - Estimating Cumulative Mean Behavior Using Standardized Time Series

Dashi Singham, Naval Postgraduate School, 1411 Cunningham Road, Operations Research Department, Monterey, CA, 93943, United States, dsingham@nps.edu, Michael Atkinson

We present an alternative to confidence intervals that evaluates the probability a sequentially updated sample mean stays within a given distance from the true mean of a process after a given initial sample size. This measure of reliability relies on properties of standardized time series, which we explore in relation to Brownian bridges.

3 - Managing The Delays Caused By Slow Groups In Golf

MoonSoo Choi, Columbia University, 500 West 120th Street, S.W. Mudd Building, New York, NY, 10027, United States, moonsoo.choi@columbia.edu, Qi Fu, Ward Whitt

We use simulation to study various models of slow groups and their significant impact on the pace of play in golf. We also compare different remedies to reduce the delays caused by slow groups. The golf course model is a series of eighteen queues in which multiple groups can play simultaneously with random stage playing times and precedence constraints.

4 - Simulation Metamodeling In The Presence Of Model Inadequacy

Xiaowei Zhang, Hong Kong University of Science and Technology-HKUST, Room 5559B, Academic Building, HKUST, Clear Water Bay, Hong Kong, NA, China, xiaoweiz@ust.hk, Lu Zou

A simulation model is often used as a proxy for the real system of interest in a decision-making process. However, no simulation model is totally representative of the reality. The impact of the model inadequacy on the prediction of system performance should be carefully assessed. We propose a new metamodeling approach to simultaneously characterize both the simulation model and its model inadequacy. Our approach utilizes both simulation outputs and real data to predict system performance, and accounts for four types of uncertainty that arise from unknown performance measure of the simulation model, simulation errors, unknown model inadequacy, and observation errors of the real system.

5 - When The Diversified Organization Prevails: A Simulation Approach

Geonsik Yu, Yonsei University, Seoul, Korea, Republic of, geonsik.yu@gmail.com

This research investigates through simulation the mechanism under which diversity improves the performance of a company. In experiments, we focus on the settings where the organization consisting of dissimilar members and try to explain the reported reality-instances where diversity is ineffective. Analyzing the characteristics of those settings, we identify that under what conditions the organizational diversity is more or less effective. The simulation model newly formulated in this study extends the existing methods that use discrete vectors and genetic algorithm and is able to include market needs and product paradigm shifts.

■ MD34

204-MCC

Joint Session HAS/MSOM: Healthcare Operations

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Mahboubeh Madadi, Louisiana Tech University, 123, Ruston, LA, 71272, United States, madadi@latech.edu

1 - Team Primary Care Practice Scheduling Problem

Ekin Koker, University of Massachusetts-Amherst, Amherst, MA, United States, ekoker@umass.edu, Hyun Jung Oh, Hari Balasubramanian, Ana Muriel

We consider the team primary care practice scheduling problem where each patient is seen by one of many available nurses before seeing her provider. In other words, the nurse step is flexible while the provider step is dedicated. Both steps have uncertain durations and these durations further depend on the type of patient — some patients require a longer service duration than others. The patients can also crossover in schedule, so the order of patients seen by the nurse might not be the same as the order in which the provider sees patients. We develop a two-stage stochastic integer programming model to solve this challenging scheduling problem and present computational results.

2 - Optimal Decision Making In The Processing Of Human Breast Milk

Ruichen Sun, University of Pittsburgh, Pittsburgh, PA, United States, rus19@pitt.edu, Lisa M Maillart, Andrew J Schaefer

Donated breast milk - collected, processed and dispensed via milk banks - is the standard of care for premature and unhealthy infants whose mothers cannot provide adequate supply. We formulate a multi-criteria mixed-integer program to optimize the daily decisions involved in the pooling of milk from different donors to meet macronutrient requirements across different product types, and the batching of pooled milk for efficient pasteurization. Our numerical results demonstrate significant improvements compared to historical decisions at our partner milk bank.

3 - A Stochastic Programming Approach For Surgery Scheduling Under Limited Availability Of Turnover Teams

Serhat Gul, TED University, serhat.gul@tedu.edu.tr

The number and availability of turnover teams may significantly affect the performance of a surgery schedule. We propose a two-stage stochastic integer programming formulation for setting the patient appointment times under limited availability of turnover teams. We consider the duration of surgical operation and turnover to be random variables. The objective is to minimize the competing criteria of patient waiting time and operating room idle time. We present a heuristic to solve the problem. We conduct numerical experiments using data from a large hospital.

■ MD35

205A-MCC

Empirical Service Operations

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Robert Louis Bray, Kellogg School of Management, 830 Hinman Ave, Apt 2S, Evanston, IL, 60202, United States, robertlbray@gmail.com

1 - Modeling Growth In Service Operations: Evidence From The App Economy

Ken Moon, The Wharton School, Philadelphia, PA, United States, kenmoon@wharton.upenn.edu, Haim Mendelson

The best service firms expand and sustain their customer bases and profits organically through word of mouth and customer retention. We propose a customer-flow model fashioned after classical service operations models that focuses on the effects of customer retention, usage frequency, and growth (RFG). Using daily, weekly, and monthly usership data for services in the app economy, our results empirically demonstrate the importance of RFG, including that new apps score increasingly higher in growth by improving in service quality. Finally, we present evidence of an experience curve, analogous to that in manufacturing, whereby service events drive advances in service quality and RFG.

2 - Managing Product Quality In The Face Of Field Failures

Ahmet Colak, Northwestern University, Evanston, IL, United States, a-colak@kellogg.northwestern.edu

We model a manufacturer's and regulator's joint recall decisions as a dynamic discrete choice game. We estimate our model with 14,124 U.S. auto recalls and 976,062 defect reports over the period 1994—2015. We find that (i) automakers initiate recalls mainly to avoid field failure costs, and (ii) automakers don't preempt the regulator's interventions in 86% of our sample.

3 - Impact Of Callers' History On Abandonment: Model And Implications

Seyed Emadi, UNC - Kenan Flagler Business School, Chapel Hill, NC, 27599, United States, Seyed_Emadi@kenan-flagler.unc.edu, Jayashankar M Swaminathan

Caller abandonment could depend on their past waiting experiences. To tease out the impact of callers' waiting experiences on their abandonment behavior from the impact of their heterogeneity, we use a structural estimation approach in a Bayesian learning setting. Our framework has managerial implications at both tactical and operational levels such as managing customer expectation about their delays in the system, and implementation of patience-based priority policies such as Least-Patience-First and Most-Patience-First scheduling.

4 - Multitasking, Multi-armed Bandits, And The Italian Judiciary

Robert Louis Bray, Kellogg School of Management, robertlbray@gmail.com

We model how a judge schedules cases as a multi-armed bandit problem. The model indicates that a first-in-first-out (FIFO) scheduling policy is optimal when the case completion hazard rate function is monotonic. But there are two ways to implement FIFO in this context: at the hearing level or at the case level. Our model indicates the latter policy, prioritizing the oldest case, is optimal when the case completion hazard rate function increases. This result convinced six judges of the Roman Labor Court of Appeals—-a court that exhibits increasing hazard rates—-to switch from hearing-level FIFO to case-level FIFO. We estimate that our intervention decreased the average case duration by 12%.

■ MD36

205B-MCC

Control, Learning, and Strategic Behavior in Queueing Models

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Philipp Afeche, University of Toronto, 105 St. George Street, Toronto, ON, M5S 3E6, Canada, afeche@rotman.utoronto.ca

1 - Dynamic Control Of A Call Center With The Callback Option

Xiaoshan Peng, University of Chicago Booth School of Business, x-peng@chicagobooth.edu, Baris Ata

We investigate a call center with the callback option. An incoming customer is routed to an online queue or to an offline queue where she needs to hang up the phone and waits for the system to call her back. We characterize the optimal routing policy and service policy when the forecast of the arrival rate is available.

2 - Learning And Impatience In Queues

Senthil Veeraraghavan, Wharton School of the University of Pennsylvania, senthilv@upenn.edu, Li Xiao, Hanqin Zhang

We study the abandonment behavior of customers in M/M/1+G by the Bayesian learning approach. An arriving impatient customer knows the average arrival rate but does not know the average service rate. To have a rational abandonment, the arriving impatient customer has to learn the service rate. Two Bayesian learning ways are discussed in accordance with what kind information of the queueing system is available to the arriving impatient customer. Based on the learned service rate, the abandonment behavior is quantitatively characterized by the utility of the arriving impatient customer.

3 - Jumping The Line, Charitably: Analysis And Remedy Of The Donor Priority Rule

Tinglong Dai, Assistant Professor, Johns Hopkins University, 100 International Drive, Baltimore, MD, 21202, United States, dai@jhu.edu, Ronghuo Zheng, Katia P. Sycara

In the United States, the growth of the organ transplantation waiting list significantly outpaces the supply of donated cadaveric organs. Among a myriad of initiatives aiming to boost the supply, the donor priority rule, under which a registered organ donor, in case of needing a transplant, is given priority to receive a donated organ, has been weighed by U.S. policy makers. In this paper, we model the U.S. organ donation and allocation system using the strategic queueing theoretic framework. We propose a simple freeze-period mechanism, and prove that in conjunction with the donor priority rule, it can increase the supply of donated organs without compromising the average quality of the donor pool.

4 - Learning And Earning For Congestion-prone Service Systems

N. Bora Keskin, Duke University, Durham, NC, United States, bora.keskin@duke.edu, Philipp Afeche

Consider a firm selling a service in a congestion-prone system to price- and delay-sensitive customers. The firm faces Bayesian uncertainty about the consumer demand for its service and can dynamically make noisy observations on the demand. We characterize the structure and performance of the myopic Bayesian policy and well-performing variants.

■ MD37

205C-MCC

Sustainability in Supply Chains

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Georgia Perakis, Massachusetts Institute of Technology, Cambridge, MA, United States, georgiap@mit.edu

Co-Chair: Maxime Cohen, Google NYC, New York, NY, United States, maxccohen@gmail.com

1 - Optimal Stopping Of Subsidies To Products With Network Externality

Ningyuan Chen, HKUST, Hong Kong, Hong Kong, nychen@ust.hk, Saed Alizamir, Vahideh Manshadi

Many products exhibit network externality: a customer who has purchased the product makes his/her neighbors or friends more likely to buy the same product. This includes eco-friendly products such as electronic cars and solar panels. The government subsidizes customers to promote such products. We find that it is optimal for the government to stop the subsidy when the total externality of the owners reaches a threshold, which depends on the spectrum of the externality matrix. The optimal stopping time is not monotone in the strength of the externality between customers. We investigate how the structure of the network affects the stopping time and the optimal reward of the government.

2 - A Unifying Framework For Consumer Surplus Under Demand Uncertainty

Charles Thraves, MIT, cthraves@mit.edu, Maxime Cohen, Georgia Perakis

We present a general framework for consumer surplus when demand is stochastic and there are multiple items. We take a utility maximization approach in order to study the impact of demand uncertainty on consumers in several interesting settings. We show how the impact of uncertainty on consumers depends on the demand shape (convexity) and the allocation rule. In many settings we show that it can in fact hurt consumers.

3 - Price Competition Based On Relative Prices Or Subsidies

Awi Federgruen, Columbia University, New York, NY, United States, af7@gsb.columbia.edu, Lijian Lu

We consider price competition models for oligopolistic markets in which the consumer reacts to relative rather than absolute prices. The relative price is defined as the difference between the absolute price and a reference value., either a third party subsidy or a prospect theoretical reference price. Application areas We review five different application areas. We then characterize the equilibrium behavior under general reference value scheme , assuming the consumer choice model is of the general MultiNomial Logit type. We also derive comparison results for the price equilibria that arise under alternative Subsidy schemes. These have important applications for the design of subsidy schemes.

4 - Risk-aware Demand Management Of Aggregators Participating In Energy Programs With Utilities

Ana Radovanovic, Google, anaradovanovic@google.com

We present a methodology for modeling and optimally managing the demand of an aggregator with deferrable (flexible) loads (e.g., electric vehicles and HVACs) under uncertainty. We propose a unified framework for treating different types of flexible loads, that captures uncertainties in their parameters, and environmental conditions they are exposed to. Our optimization formulation minimizes the total expected cost, whose goal is to optimally balance two terms: user discomfort cost (regret), and cost paid to the utility. We propose a cost-efficient procedure for risk estimation, and provide guidelines for its consideration in cost-effective program selection.

■ MD38

206A-MCC

Reliability

Contributed Session

Chair: Zhimin Xi, University of Michigan-Dearborn, 4901 Evergreen Road, 2240 HPEC, Dearborn, MI, 48128, United States, zxi@umich.edu

1 - Estimation Of Field Reliability Based On Aggregate Lifetime Data

Piao Chen, National University of Singapore, Singapore, Singapore, cp@u.nus.edu

Because of the exponential distribution assumption, many reliability databases recorded data in an aggregate way. The data format is different from traditional lifetime data and the statistical inference is challenging. In this study, we model the aggregate data by gamma distribution and inverse Gaussian (IG) distribution. Statistical inference methods are proposed.

2 - ALT With Exponentially Changing Stress Durations Under Cost Constraint

David Han, University of Texas at San Antonio, Management Science & Statistics, College of Business, San Antonio, TX, 78249-0632, United States, david.han@utsa.edu

When designing ALT, several variables such as the allocation proportions and stress durations must be determined carefully because of constrained resources. This talk discusses the optimal decision variables based on the popular optimality criteria under the constraint that the total cost does not exceed a pre-specified budget. A general scale family of distributions is considered to accommodate different lifetime models for flexible modeling with exponentially decreasing stress durations.

3 - Fault Localization Of A Series System When Tests Are Imperfect

Tonguc Unluyurt, Sabanci University, Orhanli Tuzla, Istanbul, 34956, Turkey, tonguc@sabanciuniv.edu, Zahed Shahmoradi

We consider a failed series system. The goal is to find the component that caused the failure with the minimum expected cost. In order to do this, we conduct costly tests and we know the probability that a certain component is the reason of the failure. The complicating factor is the fact that tests are imperfect and this is described by type I and type II error probabilities. In addition to the testing costs, we also consider misclassification costs. In order to decrease the total cost we develop a model that allows repetition of the tests in a certain way. We compute the expected cost of such a solution and we demonstrate the potential savings resulting from repetition of tests.

4 - Model Uncertainty Approximation Using A Copula-based Approach For Reliability Based Design Optimization

Zhimin Xi, University of Michigan-Dearborn, 4901 Evergreen Road, 2240 HPEC, Dearborn, MI, 48128, United States, zxi@umich.edu

Reliability-based design optimization (RBDO) has been widely used to design engineering products with minimum cost function while meeting reliability constraints. Model uncertainty, i.e., the uncertainty of model bias indicating the inherent model inadequacy for representing the real physical system, is typically overlooked in RBDO. This paper addresses model uncertainty approximation in a product design space and further integrates the model uncertainty into RBDO. In particular, a copula-based bias modeling approach is proposed and results are demonstrated by two vehicle design problems.

■ MD39

207A-MCC

Markov Lecture

Sponsored: Applied Probability

Sponsored Session

Chair: David Goldberg, GA Institute of Technology, Atlanta, GA 30332-0205, dgoldberg9@isye.gatech.edu

Co-Chair: Rouba Ibrahim, University College London, rouba.ibrahim@ucl.ac.uk

1 - Piecewise Deterministic Markov Processes For Monte Carlo

Gareth Roberts, University of Warwick, Coventry, United Kingdom, Gareth.O.Roberts@warwick.ac.uk

Traditional MCMC approaches for sampling complex distributions are almost all based on the Metropolis-Hastings framework, which, although versatile, restrict algorithms to be reversible, discrete time, and to require target density evaluation at each iteration. All of these features can sometimes be significant disadvantages. To overcome these difficulties, new algorithms are being developed which are non-reversible and continuous in time, for example the Zigzag, Bouncy Particle sampler, and the SCALE and CIS algorithms. The first two of these are pure MCMC algorithms whereas the latter two involve combination with sequential Monte Carlo methods. They all share the property that they can be couched in terms of Piecewise Deterministic Markov processes. The presentation will also touch on the impressive theoretical and empirical properties of these methods, including the super-efficiency properties of the zigzag algorithm, the unbiased subsampling properties of the SCALE approach and the stability of the CIS importance sampling approach, and is based on joint work with Joris Bierkens, Paul Fearnhead, Adam Johansen, and Krys Latuszynski.

2 - Adaptive MCMC For Everyone

Jeffrey Rosenthal, University of Toronto, Toronto, ON, Canada, rosenthal, jeff@math.toronto.edu

In this discussion, we shall briefly discuss the theory behind “adaptive” Markov chain Monte Carlo (MCMC), which automatically modify the algorithm while it runs in an effort to improve its performance “on the fly”. Adaptation can greatly improve convergence, but it can also destroy the ergodicity properties necessary for the algorithm to be valid. We shall present some examples and theorems concerning the ergodicity and efficiency of adaptive MCMC, with an aim towards making it more widely applicable in broader contexts

3 - Optimal Scaling Of MCMC Algorithms

Natesh Pillai, Harvard University, Cambridge, MA, United States, nateshspillai@gmail.com

In this discussion, we will give a brief overview of optimal scaling of MCMC algorithms. Optimal scaling offers a new perspective for studying the efficiency of MCMC algorithms in high dimensions. The key idea is to study the properties of the proposal distribution as a function of the dimension. This point of view gives us new insights on the behavior of the algorithm, such as precise estimates of the number of steps required to explore the target measure as a function of the dimension of the state space. After reviewing the original results, we will mention some recent progress as well.

■ MD40

207B-MCC

Theoretical Development in Estimation

Invited: Data Envelopment Analysis

Invited Session

Chair: Ole Olesen, Southern Denmark University, Campusvej 55, Odense, 5230, Denmark, ole@sam.sdu.dk

1 - An Improved Afriat-Diewert-Parkan Nonparametric Production Function Estimator

Ole Olesen, Southern Denmark University, ole@sam.sdu.dk, John Ruggiero

Nonparametric regression estimators with shape constraints have recently been extended based on the Afriat inequalities. Overfitting of the ADP estimator suggests that estimators based on a weighted average of restricted estimators may provide an equally unbiased estimator but an estimator with lower variance. Both an Average Random k-Hinge estimator, a Jackknife Model Average (JMA) or a slightly modified JMA are considered. Small sample properties of the estimators are presented

2 - Production Of Schooling

John Ruggiero, University of Dayton, jruggiero1@udayton.edu

In this paper we analyze the production of schooling using stochastic DEA. Using Banker's stochastic DEA model, we estimate frontier production allowing for measurement error while controlling for the socioeconomic environment. We derive useful policy measures related to costs to help guide school funding.

3 - Insights From Machine Learning For Evaluating Production Function Estimators On Manufacturing Survey Data

Andrew Johnson, Texas A & M University-College Station, ajohnson@tamu.edu, José Luis Preciado Arreola

Organizations like census bureaus rely on non-exhaustive surveys to estimate industry population-level production functions. In this paper we propose selecting an estimator based on a weighting of its in-sample and predictive performance on actual application datasets. We compare Cobb-Douglas functional assumptions to nonparametric shape constrained estimators. For simulated data, we find that our proposed estimator has the lowest weighted errors. For actual data, specifically the 2010 Chilean Annual National Industrial Survey, a Cobb-Douglas specification describes at least 90% as much variance as the best alternative estimators in practically all cases considered.

4 - Endogenous Environmental Variables In Stochastic Frontier Models

Artem Prokhorov, University of Sydney Business School, Sydney, Australia, artem.b.prokhorov@gmail.com, Christine Amsler, Peter Schmidt

We consider an SFA model with errors e=v+uoexp(q'd), where v is normally distributed noise, uo generates technical inefficiency and q are the environmental variables that influence the level of technical inefficiency. In a previous paper we looked at the case that the input variables are correlated with v and u but q are exogenous. Here we allow q to be endogenous in the sense that they are not independent of v and/or uo. We consider estimation by IV and by MLE. MLE requires specification of reduced form equations. The case that q and uo are dependent is difficult because we need to assume a copula and so there are computational issues.

■ MD41

207C-MCC

Quantitative Methods for Finance and Energy

Sponsored: Financial Services

Sponsored Session

Chair: Mendoza Rafael, rafamendoza1977@gmail.com

1 - Modeling Dependent Outages Of Electricity Generators

Vishwakant Malladi, McCombs School of Business, vishwakant@gmail.com

We present a framework where the electricity plants in a region are modeled as subordinated Markov Chains. We also develop a factor model for Markov chain generators to separate both the idiosyncratic and correlated behavior of the plants. Calibration shows that supply curves are bent resulting in lower generation capacity available at higher reliability levels.

2 - Dynamic Mean-variance Under Predictable Criteria

Xiao Han, University of Texas-Austin, xhan581@gmail.com

While mean-variance analysis has been widely adopted by investment professional as a basic asset allocation tool, its dynamic counterpart was rarely studied in academic literature. We aim to fill this gap by proposing a type of mean-variance criteria that is predictable, self-generating and consistent over time. The framework partially resolves the dilemma when searching for dynamic optimal portfolio strategies while facing uncertainties about model parameters and investment horizons. As an example, we solve the forward mean-variance problem when the investor only has partial information regarding the dynamics of asset returns.

3 - Static Hedging And Pricing Under The JDCEV Model Via Integral Equations

Dong-Young Lim, Korea Advanced Institute of Science & Technology, DaeJeon, Korea, Republic of, ldy1848@kaist.ac.kr, Kyoung-Kuk Kim

We provide a systematic approach to construct an exact static hedge for exotic options under the JDCEV model, using the theory of integral equations. We show the existence and uniqueness of an exact static hedging portfolio which consists of continuum of vanilla or binary options. Under suitable conditions, such a hedging portfolio can be explicitly found in terms of generalized hypergeometric functions. Also, we work on constructing a robust static hedge with finitely many hedging instruments, together with an efficient method of evaluating hedge errors. The effectiveness of the proposed method is demonstrated by several examples, including double barrier options and step up(down) options.

■ MD42

207D-MCC

Pricing and Information Provision of Services

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Gad Allon, Northwestern University, Evanston, IL, United States, g-allon@kellogg.northwestern.edu

1 - Managing Customer Expectations And Priorities With Delay Announcements

Gad Allon, Northwestern University, g-allon@kellogg.northwestern.edu, Achal Bassamboo, Qiuping Yu

We study in a service environment, how to manage customers' expectations and to prioritize customers appropriately to maximize the firm's profits. Specifically, we focus on a setting where the firm uses only delay announcements and study the opportunities and limitations of this mechanism. We are particularly interested in when and how the customers can be influenced by delay announcements.

2 - Trading Time In A Congested Environment

Luyi Yang, The University of Chicago, Chicago, IL, United States, luyi.yang@chicagobooth.edu, Laurens Debo, Varun Gupta

We propose time trading mechanisms, in which customers who are privately informed about their waiting costs mutually agree on the ordering in the queue by trading positions. We design optimal mechanisms for the social planner, the service provider, and an intermediary who might mediate the trading platform. Both the social planner's and the service provider's optimal mechanisms involve a flat admission fee and an auction that implements strict priority. If a revenue-maximizing intermediary operates the trading platform, it should charge a trade participation fee and implement an auction with some restrictions on customer trade.

3 - Learning To Bid In Sequential Auctions With Budgets Without Market Information

Yonatan Gur, Stanford University, ygur@stanford.edu, Santiago Balseiro

We consider the of bidding in sequential auctions with budget constraints under incomplete information, where bidders do not know the valuation distributions and the budgets of their competitors. We present a general adaptive strategy consisting of an approximation scheme in the dual space, in which bidders adjust their multipliers (and accordingly, their bid functions) through the campaign according to their expenditures. When adopted by all bidders, we show that the long-run average payoffs of the strategy asymptotically converge to those under a fluid mean-field equilibrium. We also analyze off-equilibrium performance under arbitrary and utility maximizing deviations.

4 - Impact Of Uncertainty About Co-workers Capability On Server Behavior In Queueing Systems

Masha Shunko, University of Washington, mshunko@gmail.com, Yaroslav Rosokha, Saurabh Bansal

We study business environment in which multiple servers process individual orders, but receive payment based on the team performance. Specifically, we are interested in the case when there is uncertainty about each other's capability, such as when teams are newly formed or when new members join the group. What impact does this uncertainty have on the productivity of workers? Do workers perform better or worse if they know what the co-workers are capable of? Can the productivity be manipulated (impacted) by provision of relevant information regarding others' capability? We answer these questions using a behavioral lab experiment.

■ MD43

208A-MCC

Simulation for Supply Chain

Sponsored: Simulation

Sponsored Session

Chair: Abdullah A Alabdulkarim, Dean, College of Engineering, Majmaah University, university campus, Majmaah, Majmaah, 1176, Saudi Arabia, aalabdulkarim2010@gmail.com

1 - Statistical Selection Of The Best Path In A Supply Chain

David Goldsman, Georgia Institute of Technology, sman@gatech.edu

We study statistical formulations of problems involving the selection of the best path from an origin to a destination through a network such as a supply chain. The term "best" can take a variety of meanings, e.g., the path having the (i) smallest expected travel time, (ii) highest probability of meeting a deadline, and

(iii) highest probability of yielding the shortest travel time. In each case, the goal is to determine the number of experiments that one has to perform in order to satisfy a certain indifference-zone requirement on the probability of correctly selecting the best path. The experiments can involve actual observed travel times or simulated realizations of travel times.

2 - Production Scheduling Of Jobs Limited By The Number Of Machines And Workers With Setup Times And Route Flexibility

Alejandro Garcia del Valle, University of A Coruna, Head Modeling & Simulation UMI Navantia, Ferrol, Spain, alejandro.garcia.delvalle@udc.es, Javier Faulin, Jose Antonio Muina Dono

Planning in dual resource constrained job shops like shipyards, is a very difficult task, due to the large number of tasks and limited resources and the setup times. In this paper, we develop a methodology using discrete event simulation models, together with efficient and robust dispatching rules. This models are going to be applied in the Navantia shipyard (Ferrol, Spain) in the context of a virtual shipyard following the concept of Industry 4.0. Results will be presented explaining the influence of jobs priority, assignation of workers to machines, and the reduction of setup times.

3 - Stress Testing For Supply Chain Risk Management Using Simulation Modeling

Harrison Luvai, University of Missouri - St. Louis, Saint Louis, MO, 63005, United States, hl6d9@umsl.edu, L. Douglas Smith”

We employ a discrete-event simulation model with embedded MILP and heuristics to test the resilience of a three-tier supply network when a blend of strategies is used for mitigating risk. Production and material flows are adjusted in response to daily simulated events. We investigate supply-network vulnerability to system contagion by adjusting correlations in demands downstream and in material deliveries upstream.

4 - MetaSimLab: A Laboratory For Validating And Calibrating Agent-based Simulation For Business Analytics

Janina Knepper, Research Group Advanced Analytics, Janina.knepper@ada.rwth-aachen.de

Agent-based simulations are frequently used to develop and evaluate new and improved approaches for business analytics and decision support. To be reliable, they have to be empirically calibrated and validated. Existing calibration approaches are rarely automated; however, manual calibration is costly in terms of time and effort. Therefore, this contribution introduces the laboratory environment MetaSimLab, which is designed to evaluate the efficiency and effectiveness of alternative calibration approaches. We present numerical examples to illustrate MetaSimLab’s functionality, novel calibration methods, and an outlook on further research.

■ MD44

208B-MCC

DAS Awards Session

Sponsored: Decision Analysis

Sponsored Session

Chair: Eric Bickel, Associate Professor & Director, The University of Texas at Austin, 204 E Dean Keeton St, Stop C2200, Austin, TX, 78712, United States, ebickel@utexas.edu

1 - DAS Student Paper Award

Emanuele Borgonovo, Bocconi University, Milano, Italy, emanuele.borgonovo@unibocconi.it, Robert Hammond

The Student Paper Award is given annually to the best decision analysis paper by a student author, as judged by a panel of the Decision Analysis Society of INFORMS. Students who did not complete their Ph.D. prior to May 1, 2015 are eligible for this year’s competition.

2 - DAS Publication Award

Kenneth Charles Lichtendahl, University of Virginia, lichtendahlc@darden.virginia.edu

This award is given annually to the best decision analysis article or book published in the second preceding calendar year (i.e. calendar year 2014 for consideration in 2016). The intent of the award is to recognize the best publication in “decision analysis, broadly defined.” This includes, but is not limited to, theoretical work on decision analysis methodology (including behavioral decision making and non-expected utility theory), descriptions of applications, and experimental studies.

3 - DAS Practice Award

Franklyn Koch, Koch Decision Consulting, kochfg@gmail.com

The Decision Analysis Practice Award is awarded to the best example of decision analysis practice as judged by the Decision Analysis Practice Award Committee. The purpose of the award is to publicize and encourage outstanding applications of decision analysis practice. We will present the finalists and this year’s winner.

4 - DAS Ramsey Medal

Jeffrey M Keisler, University of Massachusetts - Boston, jeff.keisler@umb.edu

The Ramsey Medal of the Decision Analysis Society is awarded for distinguished contributions in decision analysis. Distinguished contributions can be internal, such as theoretical and procedural advances in decision analysis, or external, such as developing or spreading decision analysis in new fields. We will introduce the 2016 Ramsey Medal winner, followed by a presentation by the winner.

■ MD45

209A-MCC

Simulation-based Optimization

Sponsored: Simulation

Sponsored Session

Chair: Tahir Ekin, Texas State University, San Marcos, TX, United States, tahirekin@gmail.com

1 - Nested Augmented Simulation For Stochastic Optimization

Tahir Ekin, Texas State University, t_e18@txstate.edu, Refik Soyer, Nick Polson

This talk presents nested augmented probability simulation to solve for decision making problems with uncertainty. The focus will be on stochastic programs with recourse under decision dependent (endogenous) uncertainty. Augmented probability simulation is based on the idea of treating the decision variable as random and investigating the optimal decision in the joint space of decision and random variables. We present the use of Nested Sampling for simulation from this joint distribution. An illustration is provided on a two stage news-vendor problem. We provide performance comparisons with traditional Monte Carlo simulation and present computational insights.

2 - Bayesian Inference And Augmented Probability Simulation In Call Center Staffing

Tevfik Aktekin, University of New Hampshire, Tevfik.Aktekin@unh.edu

We consider the issue of short term staffing in a queuing system such as a call center where the system rates are dependent random variables. We consider their estimation using Bayesian inference and the well-known Erlang A queueing model. We formulate the optimization model such that both the objective function and the constraints are random due to the uncertainty in the system rates and propose the use of an augmented probability simulation approach. In our numerical illustration, we consider both real and simulated data examples. In each case, we divide the day into discrete time intervals to determine staffing levels and discuss further implications of our approach.

3 - A Simulation Optimization Framework For Scheduling Preventive Maintenance In Wind Energy Systems

Eduardo Perez, Texas State University, eduardopr@txstate.edu

Because of the continuously escalating costs of wind farms O&M in the United States, determining methods for using available data in conditioning-monitoring systems is critical to decreasing wind farms operational costs. To accomplish this objective, we have developed a data-driven integrated stochastic online optimization and discrete event simulation methodology that takes into account data uncertainties in turbines status, weather conditions, and resources availability in scheduling maintenance and resources. Discrete event simulation coupled with optimization provides a powerful instrument for assessing and revising schedules prior to actual implementation.

4 - On The Sample Average Approximation Of The Two Stage Chance Constrained Staffing Problem In Call Centers With Arrival Rate Uncertainty

Anh Thuy Ta, PhD Student, University of Montreal, CP 6128 Succursale Centre-Ville, Montreal, QC, H3W1C5, Canada, tathuyanh1989@gmail.com, Wyean Chan, Pierre L’ecuyer, Fabian Bastin

We consider a chance constrained two stage stochastic staffing problem for multi-skill call centers with arrival rate uncertainty. The aim is to minimize the total cost of agents under some chance constraints, defined over the randomness of the service level in a given time period. We use the Monte Carlo method to generate M scenarios of arrival rates and we perform N simulation runs to get the estimates of probabilities that the service level is satisfied. We then obtain a sample average approximation (SAA) of the problem. We investigate the convergence of the optimal solution of the SAA to that of the original one when the sample size increases and present numerical illustrations on the sample sizes M and N.

■ MD46

209B-MCC

Customer Choice Estimation and Assortment Optimization

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Vineet Goyal, Columbia University, New York, NY, United States, vgoyal@ieor.columbia.edu

1 - Rationalizing Empirical Choice Counts

Srikanth Jagabathula, NYU Stern School of Business, sjagabat@stern.nyu.edu, Paat Rusmevichientong

We consider the rank-aggregation problem where the objective is to find the ranking over n items that minimizes the number of conflicts with the given choice observations. A ranking has a conflict with a choice observation (i, S) if i is not the most preferred item in the subset S according to the ranking. This problem appears in many practical applications. This a known NP-hard problem with almost no algorithms that provide theoretical guarantees. We propose a graphical model approach and show that the complexity scales in the tree-width of the graph, defined on the choice sets. Numerically, our algorithm out-performs existing heuristics for important sub-classes of problems of interest in operations.

2 - The Impact Of Consumer Search Cost On Assortment Planning And Pricing

Ozge Sahin, Johns Hopkins University, ozge.sahin@jhu.edu, Ruxian Wang

Consumers search for product information to resolve valuation uncertainties before purchase. Under the consider-then-choose policy: a consumer forms her consideration set by balancing utility uncertainty and search cost, then she evaluates all products in her consideration set and chooses the one with the highest net utility. The choice behavior within consideration sets is governed by the multinomial logit model. The assortment problems are NP-hard. For the joint assortment planning and pricing problem, we show that the intrinsic-utility-ordered assortment and the quasi-same-price policy, which charges a same price for all products except at most one, are optimal for the joint problem.

3 - Waste Reduction Of Perishable Products Using Dynamic Pricing

Arnoud V. den Boer, University of amsterdam, KdVI, science park 904, room F3.33, amsterdam, Netherlands, A.V.denBoer@uva.nl, Jieying Jiao

According to the 2013 UN Food Wastage Footprint study, “approximately one-third of all food produced for human consumption in the world is lost or wasted”. The impact of this waste can hardly be overstated. Some Dutch supermarkets try to mitigate food loss by discounting products sold on their expiry date. This measure reduces the expected waste, but its effect on profit is an open question. In this talk we show how to optimize the discount percentage in a Markovian framework, and we discuss the effect on profit and waste in a diffusion limit of the inventory process.

■ MD47

209C-MCC

Pricing, Promotion Planning, and Revenue Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: N. Bora Keskin, Duke University, Durham, NC, United States, bora.keskin@duke.edu

1 - Multiple Equilibria In Pricing Problems With Network Effects

William L Cooper, University of Minnesota, 111 Church Street S.E., University of Minnesota, Minneapolis, MN, 55455, United States, billcoop@umn.edu, Chenhao Du, Zizhuo Wang

We consider multi-product price-optimization problems with network effects wherein the expected utility each individual customer obtains from a product is increasing in the number of other customers who buy that product. Such network effects give rise to equilibrium constraints that describe how sales depend upon prices. In some cases there may be multiple different vectors of sales quantities that satisfy the equilibrium constraint for a given vector of prices. Moreover, the seller’s revenue may be quite different at those different equilibria. In this talk, we compare the seller’s revenue-maximizing prices under differing assumptions about which of the multiple equilibria will prevail.

2 - Value Of Targeted Promotions: Evidence From A Large Department Store

Bharadwaj Kadiyala, PhD Candidate, The University of Texas at Dallas, Richardson, TX, 75080, United States, bharadwaj.kadiyala@utdallas.edu, Ozalp Ozer, A Serdar Simsek

Gift cards have become a popular vehicle for promotional campaigns run by many departmental, consumer electronic, and online retail stores. Using a proprietary data set from a large department store, we investigate the value of targeted marketing efforts via emails in the context of gift-card promotional campaigns. We estimate the effects of online gift card promotions on customer purchase behavior and then discuss how to use these estimates to plan for targeted promotional events, a step towards one-to-one marketing.

3 - Pricing From Observational Data

Nathan Kallus, Assistant Professor, Cornell University and Cornell Tech, 111 8th Avenue #302, New York, NY, 10011, United States, kallus@cornell.edu, Dimitris Bertsimas

Given price-demand data, pricing is often addressed by a predictive approach: fit a model to predict demand given price observation, substitute into profit, and optimize price. Predictive approaches fail to find the optimal price, which is not generally identifiable from observational data. We bound suboptimality. We provide identifiability conditions and corresponding methods for pricing and prove consistency, asymptotic normality, and convergence rates. We develop a hypothesis test for optimality of pricing from observational data and demonstrate predictive approaches lose significant profit while our parametric method is indistinguishable from optimal and recovers 36-70% of losses.

4 - Using Contingent Markdown With Reservation To Deter Strategic Consumer Behavior

Gustavo Vulcano, NYU/UTDT, New York, NY, United States, gvulcano@stern.nyu.edu, Navaporn Surasvadi, Christopher S Tang

We examine a contingent price markdown (CM) mechanism with guaranteed reservations under which a retailer sells multiple units to forward-looking consumers who arrive over time according to a Poisson process. We study the consumer purchasing behavior in equilibrium, and numercially compare the performance of our mechanism against two benchmarks: Fixed Price (FP) and Pre-announced Discount (PD). Using extensive numerics, we identify market conditions under which CM dominates both FP and PD in terms of the retailer’s revenue and consumer’s surplus. Finally, through a fluid approximation to the stochastic model, we analytically show that CM weakly dominates the other two mechanisms.

■ MD48

210-MCC

Peeling Back the Onion in Social Media Analysis

Invited: Social Media Analytics

Invited Session

Chair: Chris Smith, Air Force Institute of Technology, 2950 Hobson Way, Wright-Patterson AFB, OH, 45433, United States, cms3am@virginia.edu

1 - Assessing Bias Correction For Social Media Samples

Christopher Wienberg, USC Institute for Creative Technologies, cwienberg@ict.usc.edu

While social media has made it possible to quickly and cheaply gather the opinions and experiences of large numbers of people, it is unclear how well social media users represent broader real-world populations, introducing the possibility of serious estimation bias. We investigate the applicability of traditional sample reweighting techniques for estimating real world population characteristics from a sample of social media users, with an eye towards using automatic attribute inference from social media profiles to make predictions about real-world populations.

2 - Who’s In Charge: Looking At Hierarchy And Heterarchy On Social Media

Robert Schroeder, Naval Postgraduate School, rcschroe@nps.edu, Sean Everton

Depending on the context of the information being passed on social media, conversations can seem to be fairly flat with no-one in charge, or highly centralized with a few main accounts key to the flow of information. With networks of different size, this paper compares various network measures of hierarchy in order to better classify social media conversations.

3 - Communication And Conflict: Analyzing Homophily On Social Media During Conflict

Sean Everton, Associate Professor, Naval Postgraduate School, Monterey, CA, 93943, United States, sfeverto@nps.edu, Robert Schroeder

Social media is used as a way to spread news-related messages. Research suggests that such messages tend to be transmitted between like-minded individuals. This paper examines whether during the conflict in Ukraine Twitter users shared messages primarily with similar users, thereby (possibly) contributing to the fragmentation of Ukrainian society, or with a heterophilous cross-section of users, thereby (possibly) contributing to societal cohesion.

4 - Determinants Of Social Media Privacy Protection Behaviors

Shalini Wunnava, Assistant Professor, State University of New York at Potsdam, 44 Pierrepont Avenue, Potsdam, NY, 13676, United States, wunnavss@potsdam.edu

Despite the growing availability of tools and options to ensure greater privacy on social media, not many people seem to actually utilize and benefit from them. Why? This research question will be examined under the lens of the Protection Motivation Theory (PMT). The goal of this project is to draw upon previous research on information privacy and PMT in order to develop a research model that could potentially identify and explain the determinants/motivators of privacy protection behaviors on social media.

■ MD49

211-MCC

Social Media User Behavior

Invited: Social Media Analytics

Invited Session

Chair: Donghyun Kim, Delta State University, Cleveland, MS, 11111, United States, dkim@deltastate.edu

1 - Social Relativeness

Eyad Youssef, Delta State University, eyoussef@deltastate.edu

This research seeks to gain a better understanding of how the social connectedness of a community can influence and affect health outcomes. Social connectedness can be defined as the structure for which social support is provided. The goal is to understand how individuals interact within their communities and how that interaction can play a role, either directly or indirectly, affecting their health outcomes.

2 - Social Media Analytics Using IBM SPSS Modeler's Text Analytics

Lakisha Simmons, Belmont University, lakisha.simmons@belmont.edu, Sumali Conlon, Chris Simmons

IBM SPSS Modeler empowers marketers to import data from multiple sources for fast decision making. For example, merge data from a sales database and text from a social media account to make predictions about future customer behavior. This session will demonstrate the ease of use and usefulness of IBM SPSS Modeler to analyze text from social media accounts to improve traditional quantitative based decision making.

3 - Analyzing User-it Artifact Interaction And Technology Implementation Using Mobile Social Capital

Donghyun Kim, Delta State University, dkim@deltastate.edu

This paper has two objectives. First, it introduces and tests a richer theoretical model than has been examined previously in order to explain the drivers of mobile social networking (MSN) and outcomes derived from MSN. To do so, the study develops a research model utilizing social network theories to examine the impact of "mobile social capital" on IT usage and social cognitive theory to investigate the outcomes from IT usage.

■ MD51

213-MCC

Humanitarian & Disaster Relief Logistics

Sponsored: Public Sector OR

Sponsored Session

Chair: Christopher W Zobel, Virginia Tech, Pamplin Hall, Room 1007, 880 West Campus Drive, Blacksburg, VA, 24061, United States, czobel@vt.edu

Co-Chair: Andrew N Arnette, University of Wyoming, 1000 E. University Avenue, Laramie, WY, 82071, United States, aarnette@uwyo.edu

1 - An Optimization Model For Disaster Relief Asset Pre-positioning

Andrew Arnette, University of Wyoming, aarnette@uwyo.edu, Christopher Zobel

This research extends previous work on improving the pre-positioning of assets used for disaster relief. It is founded on an evidence-based analytical model that utilizes multiple factors for analytically characterizing risk. This, in turn, is used to determine the potential need for the sheltering of impacted populations in the face of multiple possible natural disasters. By explicitly considering risk, the model is able to consider overall effectiveness at the same time that it ensures equity in the resource allocations.

2 - Empirical Analysis Of Volunteer Convergence At A Disaster Relief Center

Lauren Davis, North Carolina A&T University, lbdavis@ncat.edu, Emmett J Lodree

Volunteer convergence refers to the mass movement of volunteers toward affected areas following disaster events. This study explores volunteer convergence following the April 2011 tornado disaster in Tuscaloosa, Alabama. Specifically, we characterize selected stochastic variables that are relevant to volunteer task assignment within the context of a disaster relief warehouse environment using data collected during tornado relief efforts. We also discuss the implications of our findings with respect to modeling relief center convergence as a queuing system.

3 - Collaborative Emergency Supply-chains For Essential Goods And Services

Marcus Wiens, Dr., Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, marcus.wiens@kit.edu, Frank Schätter, Christopher Zobel, Frank Schultmann

We outline the scope of a Public-Private-Emergency Collaboration (PPEC) with a focus on the provision of essential goods and services which are urgently needed in a disaster situation. We evaluate the potential for such cooperation for each phase of a disaster from an economic perspective. The best chance for synergies and improvements for crisis management depend - among others - on two critical requirements: Public and private actors need to coordinate on critical stages of a relief supply chain and private actors need sufficient incentives to engage in a PPEC on a sustainable basis instead of launching a fast-paced PR-campaign.

4 - Models For The Needs Assessment Routing Problem

Burcu Balcik, Ozyegin University, Istanbul, Turkey, burcu.balcik@ozyegin.edu.tr, Duygu Pamukcu

We focus on site selection and routing decisions of rapid needs assessment teams, which aim to collect adequate information about the post-disaster conditions of affected communities in a short period of time. We develop alternative mathematical models, which facilitate completing assessments quickly while meeting coverage targets. We present a heuristic, which decomposes the problem into site selection and routing components. We present computational results to show the efficiency of our heuristic.

■ MD52

214-MCC

Routing Models for Public Safety

Sponsored: Public Sector OR

Sponsored Session

Chair: Burcu B Keskin, The University of Alabama, The University of Alabama, Tuscaloosa, AL, 35487, United States, bkeskin@cba.ua.edu

Co-Chair: Ibrahim Capar, The University of Alabama, The University of Alabama, Tuscaloosa, AL, 35487, United States, icapar@cba.ua.edu

1 - Drone Routing Models With Applications To Disaster Relief

Stefan Poikonen, University of Maryland - College Park, MD, spoikone@math.umd.edu, Xingyin Wang, Bruce L Golden

The Vehicle Routing Problem with Drones (VRPD) is a model that allows the range and carrying capacity of trucks to be complemented by the ability of drones to operate on the as-the-crow-flies metric. Trucks act as mobile recharging stations for the drones. Applications include efficient delivery of medical supplies and communications equipment to remote regions (potentially after a disaster) where traversal of road networks may be slow or non-direct. VRPD will be compared to other models of vehicle routing. Bounds and computational results will be presented, as times allows.

2 - Online Patrol Routing Problem

Ibrahim Capar, Bowling Green State University, icapar@bgsu.edu, Burcu B Keskin

In this research, we consider online patrol routing problem (OPRP). The objective of OPRP is to maximize the visibility of state troopers at pre-determined hot spots while responding to accidents. We develop several scenarios to explore different reoptimization strategies after responding to an accident. In addition, we evaluate diversification strategies to improve coverage while responding to accidents.

■ MD53

Music Row 1- Omni

TIMES Distinguished Speaker

Sponsored: Technology, Innovation Management & Entrepreneurship

Sponsored Session

Chair: Sinan Erzurumlu, Babson College, 231 Forest St, Babson Park, MA, 02457, United States, serzurumlu@babson.edu

1 - Processes In Entrepreneurship

Moren Levesque, York University, mlevesque@schulich.yorku.ca

Phenomena in the scholarly field of entrepreneurship must often be studied as processes that involve assumptions of dynamism, nonlinearity, complexity, ambiguity, with multi-theoretical and multi-level analyses. While acknowledging these properties in the conceptual, formal or empirical framing of my research, I go over some findings from investigating the business investment process and entrepreneurial market process. I also offer some thoughts on research opportunities to further our understanding of such processes and their practical implications. I conclude with real-life examples where the knowledge of these practical implications has resulted in entrepreneurial achievements.

■ MD54

Music Row 2- Omni

Service Optimization, Design and Measure in Emerging Market

Sponsored: Service Science

Sponsored Session

Chair: Yihong Hu, Tongji University, 1239, Siping Road, Shanghai, 200092, China, yhhu@tongji.edu.cn

1 - Benefiting From Seasonal Overloading Problem Of Delivery Service: A Strategic Analysis Of Dual Channel Business

Xiang Ji, School of Management, University of Science and Technology of China, Hefei, China, xxj150630@utdallas.edu, Jie Wu, Jiasen Sun

The tension between limited delivery service capacity and concentrated enormous orders in online hot selling seasons is one of the most serious problems that troubles nowadays e-commerce. To tackle this issue, we present a strategic analysis for the retailer who is involved in both online sales channel and bricks-and-mortar retail channel. A series optimal decisions on pricing, inventory and service level in different scenarios of consumer segments are derived. We also propose several contractual methods for the retailer to coordinate with its upstream manufacturer and its delivery supplier.

2 - Risk Measure Of Automobile Supply Chain Based On Conditional Value At Risk Approximation To Value At Risk Constrained Program

Shiting Zhang, Tongji University, Shanghai, China, 1531159@tongji.edu.cn, Jiantong Zhang, Xiaodong Chen

VaR and CVaR are time-honored risk measures in the field of finance. We apply them to construct a three-hierarchical quantitative risk measure model for automobile supply chain. VaR does not necessarily preserve the convexity and thus leads to difficulties of accurate computation. We first construct a tight binding with the CVaR approximation, which is known as the best CCA of VaR, then remedy the gap between VaR and CVaR by deriving the formulation of Hong et al., and finally obtain the accurate solution of VaR. We select fifteen public automobile companies, input their stock prices into the model, and finally explain its feasibility and practicality for risk assessment and risk orientation hunting.

3 - Path-Based Model And Algorithm For Emergency Evacuation

Tianhu Deng, Tsinghua University, Beijing, China, deng13@mail.tsinghua.edu.cn., Jianghua Zhang

Natural disasters such as earthquake or tsunami can easily take the lives of thousands of people and millions worth of property in a fleeting moment. A successful emergency evacuation plan is critical in response to disasters. In this paper, we seek to investigate the multi-source, multi-destination evacuation problem. First, we build a mixed integer linear programming model. Second, based on K shortest paths and User Equilibrium, we propose a novel algorithm (hereafter KPUE), whose complexity is polynomial in the numbers of nodes and evacuees. We prove that the algorithm is exact when there is only one source node. Finally, we demonstrate the effectiveness of Algorithm KPUE by a real evacuation network in Shanghai, China. The numerical examples show that the average computation time of the proposed algorithm is 93% less than that of IBM ILOG CPLEX solver and the optimality gap is no more than 5%.

■ MD55

Music Row 3- Omni

CPMS Isolated Practioner

Sponsored: CPMS, The Practice Section

Sponsored Session

Chair: Jack Theurer, G Theurer Associates, Inc., 215 West 92nd Street, New York, NY, 10025, United States, theurer@aol.com

1 - Isolated Practitioner Workshop

Jack Theurer, G Theurer Associates, Inc., 215 West 92nd Street, New York, NY, 10025, United States, theurer@aol.com

Topics in this series address timely issues of interest to the isolated practitioner community of Analytics/OR/MS ("Lone Ranger" practicing the profession independently or within a large organization) while also having a universal appeal to a broader audience of practitioners from all walks of life in the profession. This is the 33rd in the series of workshops sponsored by the Practice Section of INFORMS since the first one at the 1992 fall meeting in San Francisco.

■ MD56

Music Row 4- Omni

IOT: Technology Innovation and Business Impact

Sponsored: EBusiness

Sponsored Session

Chair: Zhe Shan, Assistant Professor, University of Cincinnati, 2925 Campus Green Dr, 317 Lindner Hall, Cincinnati, OH, 45221, United States, zhe.shan@uc.edu

1 - Internet Of Things Business Innovations And Opportunities

Michael Chuang, State University of New York at New Paltz, New Paltz, NY, 1, United States, huangm@newpaltz.edu

: Internet of Things (IoT), a global infrastructure enabling services by interconnecting physical and virtual things based on interoperable information and communication technologies, has emerged in business applications in various industrial areas. However, there is lack of holistic research that explores business opportunities enabled by IoT and related analytics. In this preliminary study, to build a needed foundation for IoT research, we review literature focusing on IoT-enabled business scenarios, and delineate related issues such as innovation for future research. .

2 - Network Analysis Of Supply Chain Adaptation For Disruption Recovery: An Empirically Grounded Complex Adaptive Systems Approach

Kang Zhao, University of Iowa, kang-zhao@uiowa.edu

This study investigates adaptive decisions and strategies in a real-world large-scale supply chain network in the face of a disruption in the network through the development and usage of an agent-based model. With real-world data, we show the supply chain network has structures similar to scale-free networks, and how the model of adaptive behaviors can leverage competition relationships within a supply chain network. We also illustrate how disruptions propagate in the supply chain network through cascading failures and develop metrics to predict such propagation. Finally, we test strategies an individual firm can trigger to reduce the negative effects of a supply chain network disruption.

3 - A Spatial Adaptive Sampling Procedure For Monitoring High-dimensional Data Streams

Xiaochen Xian, University of Wisconsin, 500 Lincoln Drive, Madison, WI, 53706, United States, xxian@wisc.edu

High dimensional (HD) data streams frequently appear in modern engineering applications and provide challenges for process monitoring. A spatial adaptive sampling and monitoring (SASAM) procedure is proposed under the limited resource constraint for detecting clustered out-of-control variables. Numerical studies show that the proposed method significantly outperforms the adaptive sampling strategy taking no consideration of the variables' spatial distribution.

3 - Consumer's Preferences Modeling For Rail Transportation In Qatar

Rana Sobh, Qatar University, Doha, Qatar; r.sobh@qu.edu.qa, Belaid Aouni

The increase in traffic congestion, road safety and pollution have led Qatar to improve the existing public transportation system and introduce Doha Metro. This shift in public transportation requires changes in consumers' perceptions about rail transportation. The aim of our paper is to predict the factors that may impact consumers' behavior and their preferences in choosing transportation systems. Moreover, our study aims to develop a better understanding of the rail transportation mode adoption in Qatar and provides some recommendations to the policy makers in Qatar Rail.

4 - Optimal Process Adaptation For Robust Iot Collaboration

Zhe Shan, University of Cincinnati, Cincinnati, OH, Contact: zhe.shan@uc.edu

The purpose of process adaptation is to mediate the communication between several independent IoT processes to overcome their mismatches and incompatibilities. In this work, we propose a new framework and efficient algorithms for creating optimal adapters for IoT process collaboration. This solution integrates message adaptation patterns with control flow adapters to create a complete adapter for multiple processes. The comparisons against existing methods show that our approach produces remarkable improvements.

■ MD57

Music Row 5- Omni

Influencing Behavior in Aircraft Operations

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Kenneth Schultz, Air Force Institute of Technology, 2950 Hobson Way, WPAFB, OH, 45433, United States, kschultz@afit.edu

1 - Antecedents Of Fuel Efficiency

James Cotton, AFIT, James.cotton@afit.edu

The United States Air Force (USAF) uses $15B of fuel each year, more than all other Department of Defense agencies combined (USAF 2014, 30). USAF data show that certain pilots fly more efficiently than their peers; however, current literature has little research on discretionary pro-environmental professional behaviors. We use the Theory of Planned Behavior as a starting point (Ajzen, 1985, 2011), and incorporate theory as proposed by Lülfs and Hahn (2013, 2014) and McDonald (2014), including additional factors to more accurately capture the behavior and context of USAF cargo pilots. The results should help us understand pilot motivation and help us encourage more efficient vehicle operation.

2 - The Effects Of Public Versus Private Feedback On Autonomous Motivation

Kenneth Schultz, Air Force Institute of Technology, WPAFB, OH, Kenneth.Schultz@afit.edu, Cory Sanders

Research has shown public feedback increases work performance compared to private feedback (Song, Tucker, Murrell, and Vinson, 2015). What motivates employees to perform differently in the two conditions is an open question. To answer this, we can investigate the motivation type differential between the two (Ryan and Deci, 2000). Motivation type is important because controlled motivation can result in unethical behavior (Welsh and Ordonez, 2014), lower quality of life (Gagne, 2014), and lower task persistence (Ryan and Deci, 2000) compared to autonomous motivation. We will investigate this question in a longitudinal field experiment using Boeing C-17 pilots' fuel efficiency performance.

■ MD58

Music Row 6- Omni

Energy VIII

Contributed Session

Chair: Carlos Abreu, Adjunct Professor, Federal University of Rio Grande do Norte State (UFRN), Natal, Brazil, calexandreabreu@ect.ufrn.br

1 - Optimal Multi-Period Energy Procurement Policies With The Integration Of Wind Energy

Tian Wang, Huazhong University of Science and Technology, School of Management, Hongshan Distrct, Wuhan, 430074, China, wangtian3261@gmail.com

The changes of electricity market are envisioned to be revolutionary in power generation and consumption. How to manage the increasing potential of adjustable demand with the increasing penetration of renewable sources is one of the most significant problems. We investigate a multi-period energy procurement model for a smart grid community. Multiple periods of harvesting (renewable energy) and purchasing (traditional energy) are required for satisfying demand. Demand can be delayed if any energy shortfall. At the end, all demand must be fulfilled. We obtain dynamic solutions and provide numerical studies.

2 - Energy Flow Network Stochastic Optimization Through Predictive Analytics Of Energy Demand

Ebisa Wollega, Assistant Professor, Colorado State University-Pueblo, 2200 Bonforte Blvd, Pueblo, CO, 81001, United States, ebisa.wollega@csupueblo.edu, Hiba Baroud, Vitor Winckler

Modeling energy flow depends on a number of uncertain factors that are related to economic development, extreme weather, and renewable energy sources availability, among many others. In order to improve decision making under uncertainty in the energy sector, we present a stochastic non-linear mixed integer energy flow network model under supply uncertainty where the energy demand is determined through data-driven statistical models. Computational results that compare the performance of different predictive models for energy demand and the efficiency of the solution approach will be presented.

3 - Real Time Pricing Strategies And Dynamic Load Scheduling In Smart Communities

Vignesh Subramanian, University of South Florida, 5006, Bordeaux Village pl, Apt #201, Tampa, FL, 33617, United States, vigneshs@mail.usf.edu, Tapas K. Das

Real Time pricing will actively engage the electricity consumers, having an advanced metering infrastructure (AMI), in a centralized demand side management (CDSM), a key to price stability and network reliability. We propose a Quadratic Binary Programming model for a centralized controller to schedule the consumer load. The numerical result demonstrates how CDSM can lower the price peaks, reduce the reserve capacity of the generator and minimize the consumer's hourly tariff.

4 - The Effects Of Low Prices And Higher Uncertainty On Enhanced Oil Recovery Projects: A Real Options Valuation Perspective

Carlos Abreu, Adjunct Professor, Federal University of Rio Grande do Norte State (UFRN), Natal, Brazil, calexandreabreu@ect.ufrn.br, Lielson Santos, Juli Sergine, Nayara Nagly

Real Option Valuation main objective is the financial analysis of projects under uncertainty conditions. The Oil and Gas industry is full of uncertainties starting with its main economic variable, oil prices. Using a Real Options model to evaluate the potential return of an oil project captures the flexibility of a decision-maker to capture possible prices oscillations. Enhanced oil recovery projects are developed to try to elevate mature oil field production using injection technology. We focus on the injection of natural gas to boost the oil production analyzing uncertainty scenarios involving oil and gas markets to estimate a decision - making rule for investment in a Real Option perspective.

■ MD60

Cumberland 2- Omni

Modeling and Analysis of Innovative Mobility Services I

Sponsored: TSL, Urban Transportation

Sponsored Session

Chair: Yafeng Yin, University of Florida, University of Florida, Gainesville, FL, 32611, United States, yafeng@ce.ufl.edu

1 - A Stable Matching Paradigm For Transport Service Allocation, User Assignment, And Pricing

Joseph Y J Chow, New York University, joseph.chow@nyu.edu

Assignment in a generic transportation system (including shared mobility options) is modeled as a many-to-one stable matching problem of passengers to tour sets. The result allows joint assignment of flows and mechanism design for allocation of costs, with implications for designing fare pricing and incentives for shared mobility, and designing for partnerships between operators in this setting.

2 - Modeling Surge Pricing In Ride Sourcing Markets

Yafeng Yin, University of Florida, Civil and Coastal Engineering, 365 Weil Hall Box 116580, Gainesville, FL, 32611, United States, yafeng@ce.ufl.edu, Liteng Zha

This study proposes an equilibrium model to quantitatively investigate the effects of surge pricing on the ride-sourcing market (e.g., Uber and Lyft). The proposed model explicitly captures the behaviors of agents at both demand and supply sides. Equilibrium outcomes under surging strategies with different control objectives are compared and discussed.

3 - Is Ride-sourcing Services Worsening Traffic Congestion?

Hongyu Chen, Northwestern University, chyy1989@gmail.com, Yu Nie

Ride-sourcing services which allow private car owners to provide taxi-like services for profit, have offered passengers a convenient choice of transportation but also created controversies. It has been argued that they might have worsened traffic congestion by both attracting more demand for mobility services and inducing more empty-loaded vehicles on the road network. This research aims to analyze the personal mobility services market with both traditional taxi and ride-sourcing services using an aggregate economic model. Various impacts of the emerging services on the market, especially on traffic congestion, will be the focus of this research.

4 - Design And Modeling Of A Crowdsource-enabled System For Urban Parcel Delivery

Bo Zou, University of Illinois at Chicago, Chicago, IL, United States, bzou@uic.edu, Nabin Kafle, Jane Lin

We consider cyclists and pedestrians close to customers as crowdsources to relay parcels with a truck carrier and undertake last-leg parcel delivery. The crowdsources express their interests in doing so by submitting bids to the truck carrier. The truck carrier then selects bids and coordinate crowdsources' last-leg delivery with its truck operations. A Tabu Search based algorithm is proposed to solve the truck carrier problem. Results show that truck VMT and total cost can be considerably reduced compared to pure-truck delivery.

■ MD61

Cumberland 3- Omni

Advances in Blocking and Trip Planning

Sponsored: Railway Applications

Sponsored Session

Chair: Shrikant Jarugumilli, BNSF Railway, Fort Worth, TX, United States, shrikant.jarugumilli@bnsf.com

1 - Arc Costing Approaches For Railroad Algorithmic Blocking

Erick D Wikum, TCS, erick.wikum@tcs.com

Algorithmic blocking provides a way to generate travel routes for freight rail car movements by computing shortest paths in a network of blocks. Traditionally, the cost of a block (arc) has been a function of two components—the distance between the block's origin and destination yards in the railroad's physical track network and the relative cost of classifying a rail car at the block's origin yard. We explore alternative cost structures which take into account time as well as incremental operating cost. We compare and contrast the various approaches and draw analogies to airline passenger itineraries to arrive at a promising approach.

2 - Next Generation Blocking And Trip Planning Systems

Carl D Van Dyke, TransNetOpt, carl@cvdzone.com

Algorithmic blocking has now been in production for close to 20 years, and is slowly spreading to more railroads. The basic trip planning logic used by railways is even older, having been in wide use for about 35 years. As railroads think about the future, the obvious question is how blocking and trip planning should evolve to meet current and future needs, due to both changes in technology and changes in the fundamental business mix. Are the current technologies still relevant given the rise of intermodal and unit trains? How should these technologies be adapted to support these lines of business? What changes should be considered in how traditional carload traffic is blocked and trip planned?

3 - Modernizing Blocking And Trip Planning

Pooja Dewan, BNSF Railway, pooja.dewan@bnsf.com

In this talk, we present the various challenges and opportunities that need to be considered and carefully evaluated as railroads modernize various information

■ MD62

Cumberland 4- Omni

Aviation Applications Section: Keynote Presentation

Sponsored: Aviation Applications

Sponsored Session

Chair: Senay Solak, University of Massachusetts Amherst, Isenberg 318, 121 Presidents Drive, Amherst, MA, 01003, United States, solak2@isenberg.umass.edu

1 - Operations Research at FedEx: Looking Back, Looking Forward

William Payson, Staff Vice President, FedEx Corporation, 1000 Ridgeway Loop, Memphis, TN, 38120, United States, william.payson@fedex.com

This keynote talk will describe a history and overview of the use of operations research at FedEx, and how this usage is expected to evolve in the future. While overall logistics applications will be discussed, special emphasis will be given on FedEx air cargo operations.

■ MD63

Cumberland 5- Omni

UAS Traffic Management and Low-altitude Airspace Operations

Sponsored: Aviation Applications

Sponsored Session

Chair: Peng Wei, Iowa State University, 2312 Howe Hall, 537 Bissell Road, Ames, IA, 50011, United States, pwei@iastate.edu

1 - Deliver Or Not?: Revenue Management For Future Delivery Service Operations Using Unmanned Aerial Vehicles

Heng Chen, Assistant Professor, University of Nebraska–Lincoln, Lincoln, NE, 68588, United States, heng@unl.edu, Senay Solak

Unmanned Aerial Vehicles (UAVs) are expected to fulfill commercial delivery services for retailers and courier companies in the near future. We study certain capacity and revenue management decisions that these companies will face in UAV based delivery operations, and use currently available data to develop models for guiding such decisions.

2 - On Routing Unmanned Aerial Vehicles For Surveillance And Reconnaissance Activities

Cai Gao, University at Buffalo, Buffalo, NY, 14260, United States, caigao@buffalo.edu, Jose Luis Walteros

We tackle a variation of the close-enough traveling salesman problem in which the salesman is accounted of visiting a node if he traverses a predefined distance through a circular area surrounding the node. This variation arises in the context of unmanned aerial vehicle routing, where a vehicle must cross an area collecting information form a set of targets, while minimizing the detection risks. We consider two approaches for modeling the tradeoff between the amount of collected information and the observed risk and test them by solving a collection of instances adapted from the literature.

3 - Mission Planning For Unmanned Aerial Vehicles And Human Operators

Chase Murray, University at Buffalo, Dept of Industrial & Systems Engineering, 309 Bell Hall, Amherst, NY, 14260-2050, United States, cmurray3@buffalo.edu

Advances in autonomy promise to enable human operators to manage multiple UAVs simultaneously. This talk presents a new algorithm to optimally allocate complex tasks to operators and machines. This algorithm mitigates the impacts of increased operator multitasking, and considers the degree to which each operator "trusts" the automated system. Operator stress caused by multitasking overload or lack of trust can compromise task performance and increase the likelihood of a mishap or mission failure.

4 - Routing Problems For Unmanned Surface Vehicles With Limited Battery Life

Joshua Margolis, Clemson University, Clemson, SC, 29634, United States, jtmargo@clemson.edu, Lawrence V Snyder

Given a set of locations that must be inspected and a set of waypoints, we design and implement a model to construct the optimal set of routes for at most K unmanned surface vehicles that minimizes the fleet's total distance, subject to distance, battery life, and site number constraints, while ensuring that a set of sites are covered during the tours. The model also determines the velocity of each vehicle along each arc of the tour, where the velocity is dependent upon the importance of the sites that are covered along that arc. Lastly, we modify, design, and implement heuristics to construct feasible solutions.

■ MD64

Cumberland 6- Omni

Multicriteria Applications in the Public Section

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Richard Forrester, Associate Professor, Dickinson College, P.O. Box 1773, Carlisle, PA, 17013, United States, forrestr@dickinson.edu

1 - The Protest Casino; A Procurement Policy Simulation

Steven D Roemerman, Lone Star Analysis, 4555 Excel Pkwy, Ste 500, Addison, TX, 75001-5691, United States, sroemerman@lone-star.com, Randal Allen

Protests are a controversial component of public procurement. Governments and agencies use a range of approaches to contested awards of funds from the public treasury. This paper examines policy questions facing the House Armed Services Committee of the U. S. Congress. A policy simulation examined economic rationality of three agents; government setting protest rules, and two CEOs, one who always protests and one never does. The model helped inform lawmakers who drafted the National Defense Authorization Act. The approach to modeling and supporting research is presented, along with results and progress toward improved protest policy. A survey of prior work is provided.

2 - Assigning Students To Schools To Minimize Socioeconomic Variation Between Schools

Richard Forrester, Associate Professor of Mathematics, Dickinson College, College and Louther Streets, Carlisle, PA, 17013, United States, forrestr@dickinson.edu, Kevin Hutson, Elizabeth Bouzarth

Numerous studies have found that a student's academic achievement is as much determined by the socioeconomic composition of their school as their own socioeconomic status. In this talk we provide a methodology for assigning students to schools so as to balance the socioeconomic compositions of the schools while taking into consideration the total travel distance. Our technique utilizes a bi-objective general 0-1 fractional program that is linearized into a mixed 0-1 linear program which can be submitted directly to a standard optimization package. As a test case for our approach we analyze data from the Greenville County School District in Greenville, South Carolina.

3 - Consumer's Preferences Modeling For Rail Transportation In Qatar

Rana Sobh, Qatar University, Doha, Qatar; r.sobh@qu.edu.qa, Belaid Aouni

The increase in traffic congestion, road safety and pollution have led Qatar to improve the existing public transportation system and introduce Doha Metro. This shift in public transportation requires changes in consumers' perceptions about rail transportation. The aim of our paper is to predict the factors that may impact consumers' behavior and their preferences in choosing transportation systems. Moreover, our study aims to develop a better understanding of the rail transportation mode adoption in Qatar and provides some recommendations to the policy makers in Qatar Rail.

■ MD65

Mockingbird 1- Omni

Data Analytics and Machine Learning

Sponsored: Information Systems

Sponsored Session

Chair: Sriram Somanchi, University of Notre Dame, 344 Mendoza College of Business, Notre Dame, IN, 46556, United States, somanchi.1@nd.edu

1 - Analytical And Empirical Modeling Of Complementarities In An Online Advertising Supply Chain

Changseung Yoo, The University of Texas at Austin, Austin, TX, United States, csyoo@utexas.edu, Anitesh Barua, Genaro Gutierrez

We examine channel structures and pricing models in an online advertising supply chain using a proprietary dataset. We develop analytic as well as structural econometric models that enable us to model interactions between the channel structures/pricing models, and quantify synergy effects between them. To the best of our knowledge, our study takes the first step of analyzing details of an online advertising supply chain. Moreover, while the extant literature emphasizes choosing between pricing models, we demonstrate that using multiple models in concert yields higher overall profitability due to spillover effects and strategic complementarities among the pricing schemes.

2 - Predicting Hotel Revenue Using Hotel Latent Quality

Uttara Madurai Ananthakrishnan, Carnegie Mellon University, umadurai@andrew.cmu.edu

Online reviews have become a major source of information for consumers in the past decade and influence various aspects of e-commerce such as purchase decisions and product sales in a variety of settings. Most of the work in this field has focused on numerical ratings to understand the impact of online reviews on sales. In our paper, we use a novel topic-modeling technique on a large dataset of online reviews of hotels and study if topics obtained from this technique provide a better representation of a hotel's quality. We then analyze how each hotel's quality evolves over time and predict the changes in hotel revenue using such topics.

3 - SkillR: Personalized Skill Recommendations Using Joint Bayesian Member-job Clustering

Abhinav Maurya, Carnegie Mellon University, Pittsburgh, PA, United States, ahmaurya@cmu.edu, Rahul Telang, Sai Sundar

Skill gaps in various sectors of the economy are considered to be major problems facing economies today. Increasing the productivity of a member of the workforce depends on recommending skills whose acquisition will yield the highest utility gains for the member. We present SkillR - a skill recommendation algorithm that employs a joint Bayesian clustering model to match members to other similar members as well as relevant jobs, and to identify the top skills that provide the maximum utility gains to a member. Our evaluation suggests that SkillR leads to orders of magnitude improvement in the job propensity of recommended skills compared to a traditional collaborative filtering system.

4 - Does Government Surveillance Give Twitter The Chills?

Sriram Somanchi, University of Notre Dame, somanchi.1@nd.edu, Laura Brandimarte, Edward McFowland, Uttara Madurai Ananthakrishnan

Since Snowden's revelations regarding mass surveillance programs implemented by the NSA, Government surveillance has garnered huge attention. The research community has attempted to estimate the "chilling effects" of surveillance, the tendency to self-censor. Until now, such effects have been estimated using either the search terms, Wikipedia articles, or survey data. In this work, we propose a new method in order to test for chilling effects in online social media. We use large Twitter dataset and propose the use of new statistical machine learning method in order to detect anomalous trends in user behavior after Snowden's revelations made users aware of existing surveillance programs.

■ MD66

Mockingbird 2- Omni

Computer Experiments and Uncertainty Quantification

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Ying Hung, Rutgers State University of New Jersey, Piscataway, NJ, United States, yhung@stat.rutgers.edu

1 - Robust Parameter Design Using Computer Experiments

Roshan Vengazhiyil, Georgia Institute of Technology, roshan@gatech.edu

Space-filling designs, commonly used in computer experiments, try to spread out points uniformly in the experimental region. However, when the objective is to achieve robustness against noise factors, uniformity is no longer needed in the space of noise factors. This is because noise factors usually follow nonuniform distributions such as normal distribution. It makes more sense to place points in the high probability regions where more "actions" take place. Unfortunately, nonuniform points in the experimental region can lead to problems in model fitting. In this article we propose novel design and modeling strategies to deal with these issues.

2 - Invariance-preserving Emulation For Computer Models, With Application To Structural Energy Prediction

Peter Qian, University of Wisconsin - Madison, peter.qian@wisc.edu

Simulation models with invariance properties appear in material science, physics, biology and other fields. Standard emulation methods such as Gaussian process regression cannot accommodate input invariance and thus do not work for this new problem. We will propose a kernel-based emulation method to preserve invariance in inputs. The method employs a direct graph representation and equivalence relations to characterize relabeling invariance. The effectiveness of the proposed method is illustrated by using several examples from material science.

3 - A Sequential Maximum Projection Design Framework For Computer Experiments With Inert Factors

Shan Ba, The Procter & Gamble Company, Cincinnati, OH, United States, ba.s@pg.com

Many computer experiments involve a large number of input factors, but many of them are inert and only a subset are important. In this talk we present a new sequential design framework which can accommodate multiple responses and quickly screen out inert factors so that the final space-filling design is close to optimal with respect to the active factors. The new approach does not require prescribing the total sample size, and under the presence of inert factors, it can lead to substantial savings in simulation resources. Even if all the factors are important, the proposed sequential design can still achieve similar overall space-filling property compared to a maximin LHD optimized in a single stage.

■ MD67

Mockingbird 3- Omni

IEEE T-ASE Invited Session II

General Session

Chair: Jingshan Li, University of Wisconsin - Madison, jli252@wisc.edu

1 - Sparse Modeling And Recursive Prediction Of Space-time Dynamics In Stochastic Sensor Networks

Hui Yang, Penn State University, huy25@engr.psu.edu

Wireless sensor network has emerged as a key technology for monitoring space-time dynamics of complex systems, e.g., and body area sensor network. However, sensor failures are not uncommon in traditional sensing systems. As such, we propose the design of stochastic sensor networks to allow a subset of sensors at varying locations within the network to transmit dynamic information intermittently. Experimental results on real-world data and different scenarios of stochastic sensor networks demonstrated the effectiveness of sparse particle filtering to support the stochastic design and harness the uncertain information for modeling space-time dynamics of complex systems.

2 - Integration Of Data Fusion Methodology And Degradation Modeling Process To Improve Prognostics

Kaibo Liu, UW-Madison, 1513 University Avenue, Madison, WI, 53706, United States, kliu8@wisc.edu, Shuai Huang

The rapid development of sensing and computing technologies has enabled multiple sensors embedded in a system to simultaneously monitor the degradation status of an operation unit. Unlike other existing data fusion methodologies that treat the fusion procedure and the degradation modeling as two separate tasks, this paper aims at solving these two challenging problems in a unified manner. A case study that involves a degradation dataset of an aircraft gas turbine engine is implemented to numerically evaluate and compare the prognostic performance of the developed health index with existing literature.

3 - Bottleneck Analysis To Reduce Surgical Flow Disruptions: Theory And Application

Xiang Zhong, UW-Madison, xzhong4@wisc.edu, Jingshan Li

The work flow of surgical operations in emergency department and operating rooms can be interrupted due to various disruptions. Reducing such disruptions is of significant importance to ensure successful operations. In this paper, we introduce a continuous-time Markov chain model to analyze the disruptions and their impacts. A continuous improvement method is developed to identify the bottleneck disruption, so that reducing the interruption time and frequency of the bottleneck can lead to the largest improvement. An application of the method at an emergency department of a large academic medical center is presented to illustrate the effectiveness of the model and the improvement approach.

4 - Integrating Optimal Simulation Budget Allocation And Genetic Algorithm To Find The Approximate Pareto Patient Flow Distribution

Zekun Liu, Washington University, liu.zekun@wustl.edu

The imbalanced development among different levels of hospitals caused by the irrational patient flow distribution has become a major social issue in China's urban healthcare system. In this work, we propose a methodology framework integrating discrete-event simulation, multi-objective optimization and multi-objective optimal computing budget allocation to find the optimal macro-level patient flow distribution. A case study validating the optimization framework shows the Pareto optimal patient flow distribution can improve overall system performances.

■ MD68

Mockingbird 4- Omni

Quality Engineering Invited Session

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Murat Caner Testik, Prof.Dr., Hacettepe University, Hacettepe Universitesi, Muhendislik Fakultesi Endustri Muhendisligi Bolumu, Ankara, 06800, Turkey, mtestik@hacettepe.edu.tr

1 - Metamodel Based Method For Optimization Of Multilayer Thin Film Architecture

Srikant Nekkanty, Intel Corporation, nekkanty2001@gmail.com, Danel Draguljic, Thomas Santner, Angela Dean, Rajiv Shivpuri

The application of thin, hard coatings is one of the most effective ways to protect engineering components operating under heavy contact. We describe a metamodel based approach for improving the performance of a multilayer coating architecture using finite element models. From finite element models, the stresses in the coating material were evaluated and used to build the metamodel for optimizing the multilayer system. The complexity of this engineering application involved (1) a nonrectangular input region of coating designs and (2) opposing objectives to be minimized simultaneously.

2 - Measurement Error Of Binary Quality Inspections In Industry

Thomas Akkerhuis, University of Amsterdam, T.S.Akkerhuis@uva.nl

The evaluation of the reliability of binary measurements, such as quality inspections in industry, is challenging. This especially holds in gold standard unavailable situations, where the true conditions of the inspected items are unobservable. Our studies show that methods in literature for such evaluation perform poorly. We found that binary measurement error can be decomposed in a random and a systematic part. Although this is a well-known decomposition for numerical measurement, it is a new insight for binary measurement. It turns out that, in a gold standard unavailable situation, generally only the random component is identifiable. We have developed a robust and efficient method to do so.

3 - Qfd Customer-requirement Prioritization Based On The Law Of Comparative Judgments

Domenico Augusto Maisano, Associate Professor, Politecnico di Torino, Corso Duca degli Abruzzi 24, Turin, 10129, Italy, domenico.maisano@polito.it, Fiorenzo Franceschini

Quality Function Deployment (QFD) is a structured process to design and develop products/services that better fulfill customers' requirements (CRs). The initial collection and analysis of the CRs is particularly critical, as any distortion can propagate to the whole process results. The focus of this article is on the prioritization of CRs, which can be improved by introducing a new prioritization technique based on the Thurstone's Law of Comparative Judgment. The greatest strength of this technique is combining a refined theoretical model with a simple and user-friendly data collection process. The description is supported by a realistic application example.

■ MD69

Old Hickory- Omni

Routing and Allocation in Military Operations

Sponsored: Military Applications

Sponsored Session

Chair: Alexandra M Newman, Colorado School of Mines, 1104 Maple Street, Golden, CO, 80401, United States, anewman@mines.edu

1 - Minimum Risk Routing Through A Mapped Mine Field

Chris Richards, Colorado School of Mines, chrichar@mymail.mines.edu

A typical risk-additive routing model in a network or network representation of continuous space may be unrealistic. We present an alternative ``threat-additive model" formulated as an integer program. We then develop a specialized, shortest-path approximation to this model. In a realistic model of a ship seeking to traverse a mapped minefield with minimum risk, we show that the approximation provides ``true risk" while constraining computation time via implicit enumeration.

2 - Building An Optimization-based, Decision Support System For Routing Vehicles For Randomized Inspections

Doug Altner, MITRE Corporation, daltner@mitre.org, Justin Nave, Abby Ng

Suppose we want to maximize the number of 500,000+ sites that 60+ vehicles can visit subject to constraints on time, area covered, overnight travel, and the mix of sites selected, while also ensuring selections are "sufficiently random" and vehicle territories are "well defined". This talk discusses how we heuristically solved this problem, and how we turned our methods into an optimization-based, decision support system for our customer.

3 - Daily Aircraft Routing For Amphibious Ready Groups

Robert Dell, Professor of Operations Research, Naval Postgraduate School, Monterey, CA, United States, dell@nps.edu, Travis Hartman, Connor McLemore, Ertan Yakici

An Amphibious Ready Group (ARG) consists of ships capable of conducting flight operations that routinely require the transport of personnel and cargo (PMC) to remain operationally viable. Planning PMC transport for an ARG and nearby airfields is a unique vehicle routing problem (VRP) characterized by a heterogeneous capacitated fleet, two cargo types, multiple depots, disjoint time windows, and synchronized routing of two aircraft required between some but not all node pairs. We solve most realistic instances optimally but solution time can become excessive so we also solve instances using a metaheuristic. This talk describes this unique VRP, our metaheuristic and our computational experience.

4 - Robust Allocation Of Testing Resources In Reliability Growth
MohammadHossein Heydari, University of Arkansas, Fayetteville, AR, United States, mhheydar@uark.edu, Kelly Sullivan

Reliability growth testing seeks to improve system reliability by identifying and removing failure modes. Recent models maximize system reliability by allocating limited testing resources across the system's components, each of which exhibits reliability growth according to the AMSAA model (Crow, 1974) with known parameters. We extend this research to solve a robust version of this problem in which AMSAA parameters are uncertain but assumed to lie within a budget-restricted uncertainty set.

■ MD70

Acoustic- Omni

Transportation, Rail I

Contributed Session

Chair: Ginger Yi Ke, Memorial University of Newfoundland, Faculty of Business Administration, Memorial University of Newfoundland, St. John's, NL, A1B 3X5, Canada, gke@mun.ca

1 - Passenger Centric Railway Planning
Yousef Maknoon, EPFL, Lausanne, Switzerland, Yousef.maknoon@epfl.ch, Tomas Robenek, Stefan Binder, Michel Bierlaire

Traditional railway systems use operations research techniques to optimize their system. Most of the time such mathematical models take only operators' cost and benefit into account. However, passengers' decision as the main users of such systems play an important role in the performance of such networks. We introduce a state of the art methodology that takes both sides (demand and supply) into account in timetable design as well as recovery plans for trains.

2 - The Locomotive Planning Problem With Alternative Train Speeds An Integrative Environmental Perspective
Ginger Yi Ke, Memorial University of Newfoundland, Faculty of Business Administration, Memorial University of Newfoundland, St. John's, NL, A1B 3X5, Canada, gke@mun.ca, Kan Fang, Manish Verma

We develop multi-objective models for the locomotive planning problem to minimize the GHG emissions and the operational costs. The amount of GHG emitted by a locomotive depends on the train speed, train load, and the locomotive type, etc. We determine the assignment of locomotives to each train, so that sufficient power can be provided to pull the trains; we generate train schedules that meet customer demands within different time windows, and determine the number of active, deadheading, light traveling locomotives, and the train-to-train connections (e.g. consist busting) for each train. Real-life railway systems are used for numerical experiments to provide additional managerial insights.

■ MD71

Electric- Omni

Vehicle Routing I

Contributed Session

Chair: Michael F Gorman, Professor, University of Dayton, 300 College Park, Dayton, OH, 45469, United States, michael.gorman@udayton.edu

1 - An Optimization Method Of Petrol Distribution Considering Drivers' Workload Balance
Lijun Sun, Associate Professor, Dalian University of Technology, 2 Linggong Road, Ganjingzi District, Dalian City, 116023, China, slj@dlut.edu.cn, Haiyang Shi

We present a multi-objective optimization model of petrol distribution considering drivers' workload balance based on Adams's equity theory. A heuristic algorithm is designed based on the NSGA-II algorithm. Computational results show that the proposed algorithm can generate a non-dominated solution set corresponding to distribution plans that perform well both in the total distribution cost and drivers' workload balance.

2 - Two Level Logic-based Benders Decomposition For Optimal Service NetworkDesign
Amin Hosseininasab, Carnegie Mellon University, Pittsburgh, PA, United States, aminhosseininasab@gmail.com, Fatma Gzara

We present a new continuous time network and model for the service network design problem (SNDP). SNDP addresses the planning of operations for freight transportation carriers. Given a set of requests to transport commodities from specific origins to specific destinations with given availability and delivery times, SNDP determines a continuous movement of vehicles. We propose a two-stage Logic-based Benders decomposition and develop several valid cuts for SNDP. Numerical results show the benefits of the continuous time approach and the effectiveness of the solution methodology.

3 - A Multi Stage Heuristic Solution For A Consultant Assignment And Routing Problem
Andrew Junfang Yu, Associate Professor, The University of Tennessee - Knoxville, 411 B. H. Goethert Pkwy., MS 19, Tullahoma, TN, 37388-9700, United States, ajyu@utk.edu, Brett Shields

In this study, a heuristic algorithm is developed for a novel Vehicle Routing Problem (VRP), namely the Heterogeneous Fleet Vehicle Routing Problem with Multiple Depots, Fixed Visits, and Priority Matching. The heuristic is four stage, in which the first stage is a conversion of skills and priorities to one set, second a listing of consultants is constructed based on the items in step one, third a fixed visit based assignment is given considering the availability of consultants and clustered demand, and lastly an optimal routing for each consultant is determined.

4 - Two Echelon Location Routing Problem In The Presence Of Third Party Logistics
Khosro Pichka, PhD Student, S. B. Lubar School of Business, 3202 N. Maryland Ave., Milwaukee, WI, 53211, United States, kpichka@uwm.edu, Amirsaman Hamzeh Bajgiran, Xiaohang Yue, Jaejin Jang, Matthew Petering

This paper addresses a two echelon location routing problem (2E-LRP) considering third party logistics. A 2E-LRP is a variant of the classical LRP; however, it seeks to find a set of vehicle routs in two echelons. First, from a single depot to a set of possible satelites and second, from the opened satelites to customers. In spite of the large amount of research on LRPs, the 2E-LRP has received very little attention from researchers. A mixed integer program (MIP) formulation is proposed, and a hybrid heuristic algorithm is developed to solve its medium and large size problems.

5 - Inventory-based Delivery Scheduling And Routing
Michael F Gorman, Professor, University of Dayton, 300 College Park, Dayton, OH, 45469, United States, michael.gorman@udayton.edu

Milk-run deliveries of product to customers depend on both inventory levels and customer proximity to one another. We describe a system designed to improve delivery economies through careful assessment of the trade-offs between stopping costs and mileage costs. We use k-means clustering to great groups of "like" customer in both geography and inventory depletion dates. We use a novel "furtherst neighbor" heuristic to then sequence deliveries. We discuss the application of this approach at a US manufacturer.

■ MD72

Bass- Omni

Supply Chain Mgt VIII

Contributed Session

Chair: Nathalia Hernandez, Universidad del Norte, Km 5 Vía Puerto Colombia, Barranquilla, AA1569, Colombia, inhernandez@uninorte.edu.co

1 - An Econometric Analysis Of Omnichannel Retailing Using Data Analytics
Serkan M. Akturk, Texas A&M University, 4217 TAMU, Wehner 320 M, College Station, TX, 77843-4217, United States, makturk@mays.tamu.edu, Michael Ketzenberg

The advent of omnichannel technologies, like ship-to-store capability, enable integration of both physical and electronic marketplaces and thereby offer consumers shopping flexibility and enhanced services. For a retailer, these capabilities require significant investment in order to deliver a seemless shopping experience, yet hold the promise of greater customer loyalty, higher marketshare, and increased competitiveness. We assess this promise by analyzing the impact of ship-to-store capability on a retailer's performance using transactional data from a national retailer.

2 - Determining The Optimal Level Of Supply Chain Forecast Coordination With Bidirectional Option Contracts
Seong-Hyun Nam, Professor, University of North Dakota, 2517 Sand Hills Avenue, Grand Forks, ND, 58201, United States, snam@business.und.edu

We have studied bidirectional option contracts associated to demand uncertainty. By analyzing how the buyer's procurement and supplier's production decisions are affected by the level of the coordination/collaboration of demand forecast under bidirectional option contracts, we have found that the optimal procurement for buyer and optimal production strategy for supplier to maximize supply chain surplus is associated with the level of forecast collaboration under bidirectional option contracts.

3 - The Impact Of Manufactures Comptition To Pay Incentive Funds On Supply Chain

Neda Khanjari, Assistant Professor, Rutgers University, 227 Penn St, BSB 260, Camden, PA, 08102, United States, neda.khanjari@rutgers.edu

In many industries manufacturers pay incentive funds to retailer hired sales agents to boost the demand for the manufacturers' products. In this paper, we study a supply chain in which two manufactures are competing to get the attention of the retailer hired sales agent to boost their own product.

4 - Partial Outsourcing And Linked Learning Processes

Burcu Tan, Tulane University, A. B. Freeman School Of Business, 7 Mcalister Dr., New Orleans, LA, 70118, United States, btan@tulane.edu, Edward Anderson, Geoffrey Parker, Xiaoyue Jiang

Firms are increasingly outsourcing software and technology development as well as other knowledge work. Standard economic models predict that firms should outsource either all or none of a particular activity; however, recent evidence contradicts that. We develop a dynamic optimization model to provide a rational explanation for partial outsourcing. Our explanation hinges upon the linked learning processes at the subsystem development level and the systems integration level.

5 - A Hybrid Stochastic Fuzzy Approach For Inventory Control In Multi Item Job Shop Processes With Unsteady Lead Time

Alcides Santander, Universidad del Norte, Barranquilla, Colombia, asantand@uninorte.edu.co, Kevin Melendez, Nathalia Hernandez, Diego Guillen, Marco E. Sanjuan

Uncertainties inherent in customer demands and variable lead times make difficult for supply chains to achieve either just-in-time inventory replenishment or economic optimal process. This results in a low service level among the different echelons of the supply chain. A hybrid stochastic-fuzzy approach for inventory control is proposed in order to guarantee production rate despite fluctuations in demand and process lead time to minimize the work in process. Demand forecast and probabilistic depiction of lead times, along with the process variables, are the inputs of a fuzzy inference system designed to determine whether it is profitable to generate a purchase order in a given period of time.

■ MD79

Legends G- Omni

Health Care, Modeling VIII

Contributed Session

1 - Multi-period Appointment Scheduling In Outpatient Procedure Centers

Utku Tarik Bilgic, Middle East Technical University, Department of Industrial Engineering, Middle East Technical University, Ankara, 06800, Turkey, utbilgic@metu.edu.tr, Sakine Batun

Single-period appointment scheduling for a given sequence of outpatient procedures is a well-studied problem. We consider the problem determining the sequence of and the appointment times for a given set of surgeries to be operated over a multi-period planning horizon in the presence of patient no-shows and uncertainty in surgery durations. We formulate and solve the problem as a two-stage stochastic program to estimate the value of capturing uncertainty.

2 - Robust Design Of A Stroke Hospital Network

Amir Ardestani Jaafari, McGill University, 1001 Rue Sherbrooke West, Montreal, QC, H3A 1G5, Canada, amir.ardestani-jaafari@hec.ca, Beste Kucukyazici

With advances in the diagnosis and treatment of acute stroke, timely medical intention is increasingly critical; however, simply transporting the patients to the closest stroke hospital may cause congestions in some hospitals, while the stroke beds are underutilized in other hospitals. In this research, we study the trade-off between minimizing transportation time to the hospital and minimizing the congestion experiences by the patient at the hospital using robust optimization.

3 - Method To Assign Specialties To Timetable Slots In Surgery Units To Smooth Postoperative Inward Bed Demand

Flavio S Fogliatto, Prof., Federal Univ of Rio Grande do Sul, Av. Osvaldo Aranha, 99/5o andar, Porto Alegre, RS, 90040020, Brazil, ffogliatto@producao.ufrgs.br, Marcos Gerchman, Jeruza Neyeloff, Michel J Anzanello, Beatriz D Schaan

Peaks in patients' demand for inward hospitalization usually lead to disruptions in the provision of healthcare, having negative effects on patient and staff satisfaction. A main source of inward bed demand is the surgical theater. This paper proposes a method to determine the best assignment of specialties to timetable slots in surgical theaters, such that the variance of inward bed demand is minimized. For that, we use integer programming heuristics. Our propositions are tested in the surgical unit of a large public University hospital located in the south of Brazil. We were able to reduce the inward bed demand variability by 90%, smoothing the flow of post-surgical patients to hospital wards.

■ MD94

5th Avenue Lobby-MCC

Technology Tutorial: Gurobi/AMPL

Technology Tutorial

1 - Gurobi Optimization

Dr. Greg Glockner, Vice President of Engineering, Bellevue, WA, glockner@gurobi.com

Advanced Python Modeling with Gurobi Are you looking for an environment that combines the expressiveness of a modeling language with the power and flexibility of a programming language? The Gurobi Python interface allows you to build concise and efficient optimization a model using high-level modeling constructs. This tutorial will provide an overview of these capabilities, including an introduction to new modeling features that significantly enhance the expressiveness of our environment.

2 - AMPL In The Cloud: Using Online Services To Develop And Deploy Optimization Applications Through Algebraic Modeling

Robert Fourer, AMPL Optimization Inc., 2521 Asbury Ave, Evanston, IL, 60201, United States, 4er@ampl.com

Optimization modeling systems first appeared online almost 20 years ago, not long after web browsers came into widespread use. This presentation describes the evolution of optimization alternatives in what has come to be known as cloud computing, with emphasis on the role of the AMPL modeling language in making models easy to develop and deploy. We start with the pioneering free NEOS Server, and then compare more recent commercial offerings such as Gurobi Instant Cloud; the benefits of these solver services are readily leveraged through their use with the AMPL modeling tools. We conclude by introducing QuanDec, which creates web-based collaborative applications from an AMPL models. Robert Fourer, an authority on the design and implementation of computer software to support large-scale optimization, studied at M.I.T. and Stanford and was a professor of Industrial Engineering and Management Sciences for over 30 years. He is a founder and is currently President of AMPL Optimization Inc. and is co-author of a popular book on modeling in the AMPL language.

Tuesday, 8:00AM - 9:30AM

■ TA01

101A-MCC

Machine Learning II

Sponsored: Data Mining

Sponsored Session

Chair: Hamidreza Ahady Dolatsara, MD, United States, hamid@auburn.edu

1 - Expectation Maximization For Finite Mixture Of Linear Regression Models With Group Structure Data

Haidar Almohri, PhD Candidate, Wayne State University, 2833 Catalpa Circle, Ann Arbor, MI, 48108, United States, almohrih@yahoo.com, Ratna Babu Chinnam, Arash Ali Amini

One of the limitations with the available methods for fitting Finite Mixture of Linear Regression (FMR) models is that they do not explicitly account for group structure within the datasets during modeling. It is sometimes desirable to force the algorithm to allocate groups/blocks of observations to individual models, instead of individual observations. We propose an Expectation Maximization (EM) approach to fit FMR to data with group structure.

2 - A Comparison Method For Association Rule Mining Algorithms

Gulser Koksal, Prof. Dr., Middle East Technical University, Industrial Engineering Department, Ankara, 06800, Turkey, koksal@metu.edu.tr, Sanam Azadiamin

Association rule mining algorithms are helpful in extracting useful information from large amount of data. In literature, these algorithms are compared using data sets for which interesting association rules are unknown. A novel comparison method is developed to perform the comparison using designed data sets containing interesting rules generated by logistic regression. Several comparison measures are defined. Statistical analyses and multi-criteria decision making approaches are applied to find the best algorithm considering the selected measures.

3 - Productivity Assessment Through Knowledge Generation In Automotive Manufacturing Sector, Utilizing Statistical Methods

Amir Abolhassani, West Virginia University, 1233 Pineview Drive, Apt 14, Morgantown, WV, 26505, United States, Amirabolhassani@gmail.com, Bhaskaran Gopalakrishnan

The research investigates current strategies that help automobile manufacturers to enhance their productivity. The study utilizes statistical methods to define the most important effective factors on the most well-known productivity measurement, Hours per Vehicle (HPV), in the automotive industry in North American manufacturing plants.

4 - A Machine Learning Approach For Developing Intersection Safety Performance Function

Hamidreza Ahady Dolatsara, Auburn University, Suite 3301, 345 West Magnolia Ave., Auburn, AL, 36849, United States, hamid@auburn.edu, Fadel Mounir Megahed

This study introduces a non-subjective method for identifying intersection related crashes based on their distance to the center of intersection. Then utilizes data of those crashes for developing Safety Performance Functions (SPFs). This study utilizes machine learning algorithm to investigate histogram of crashes' distance to the center of intersections. The histogram classified to intersection and non-intersection related parts. After classifying the crashes, intersection SPFs are developed.

■ TA02

101B-MCC

Predictive Modeling for Wind Power

Sponsored: Data Mining

Sponsored Session

Chair: Seth Guikema, University of Michigan, 1205 Beal Ave., Ann Arbor, MI, 48109-2117, United States, sguikema@umich.edu

1 - Adverse Event Prediction: Forecasting Wind Power Ramps

Andrea Staid, Sandia National Labs, Albuquerque, NM, United States, astaid@sandia.gov

Wind power ramp events (large changes in output over a short period of time) are of particular concern in power systems with high wind penetration. They are also often difficult to predict. We present statistical methods for combining multi-source data to better predict the adverse ramp events that are typically not captured in a standard weather forecast. We present a case study using data from the Bonneville Power Administration and focus on farm-specific ramps.

2 - Predicting Low-wind Events To Inform Planning And Policy Incentives

Kristen R. Schell, University of Michigan, Ann Arbor, MI, United States, krschell@umich.edu, Seth Guikema

Wind power is currently the most cost-effective source of renewable energy, from the perspective of life-cycle cost estimates. Given major government backing to support the general expansion of renewable energy, wind power continues to be the investment of choice for developers, largely due to its generally higher resource potential and capacity factors. Hence, as wind power becomes increasingly integrated into the electric grid, the power system in turn becomes increasingly vulnerable to "wind droughts", or periods of low-to-no wind power. This study uses large-scale wind data to predict low-wind events, to better inform system planning and renewable policy incentives.

3 - Learning Of Imbalanced Data For Predicting The Power Outage

Elnaz Kabir, PhD Student, University of Michigan, 1205 Beal Avenue, Ann Arbor, MI, 48109-2117, United States, ekabir@umich.edu, Seth Guikema

In this article we want to model the number of power outages during the hurricanes. Making accurate prediction of power outage can be really valuable for the utility companies as well as customers and public agencies to make better response planning. Our data-set is highly zero inflated and imbalanced because power outages occur rarely. Since no techniques for dealing with imbalanced data sets are consistently better for all conditions, we investigate several methods to find the most appropriate strategy for our data set.

■ TA03

101C-MCC

Entertainment Analytics

Invited: Entertainment Analytics

Invited Session

Chair: Christian Peukert, University of Zurich, Rämistrasse 71, Zurich, 8006, Switzerland, christian.peukert@uzh.ch

1 - Freemium Pricing: A Stylized Framework And Evidence From A Large-scale Field Experiment

Jörg Claussen, LMU Munich, Munich, Germany, j.claussen@lmu.de, Jörg Claussen, Copenhagen Business School, Frederiksberg, Denmark, j.claussen@lmu.de, Julian Runge, Julian Runge, Stefan Wagner

Marketers struggle to find optimal designs for their freemium offerings. We present a stylized framework of freemium pricing that systematizes key choice variables and identifies their interaction with relevant outcome variables. Firms set the share of free product features and the price of premium content and implement viral mechanisms. These choices affect monetization not only via their effect on users' conversion to paying customers, but also via their effects on usage behavior and viral activities. We apply our framework to a large-scale field experiment and show that a reduction of free product features increases conversion rates and viral activities, and has ambivalent effects on usage.

2 - Building An Online Reputation With Free Content: Evidence From The E-book Market

Dainis Zegners, LMU Munich, d.zegners@lmu.de

An important strategy to build a reputation is to offer products for free to induce buyers to provide feedback. I argue that giving away free products to build a reputation can be a double-edged strategy. It does not only attract buyers with a high preference, but also buyers with a low preference, who give worse feedback. I test the strength of this negative effect on reputation using data from an online platform where I observe self-published authors either selling their e-books at a positive price or giving them away as free content. Consistent with a negative selection effect on reputation, I observe that buyers who receive an e-book as free content rate it worse than buyers who buy it at a positive price.

■ TA04

101D-MCC

Advances in Using Market Models for Power Transmission Planning

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: David Pozo, Pontificia Universidad Catolica, Avendia Vicuna Mackenna #4860, Puebla del Principe, 7820436, Chile, davidpozocamara@gmail.com

1 - Non-cooperative Multi-regional Transmission Planning

Saamrat Kasina, Johns Hopkins University, Ames 214, Baltimore, MD, 21218, United States, bkasina1@jhu.edu, Benjamin Field Hobbs

Traditional transmission planning methods overlook the political boundaries within which planning entities operate. However, in reality, there are multiple regional transmission planning agencies with limited coordination with each other during planning. We develop a bi-level model that defines the relationship between multiple non-cooperating transmission planners, generation investors, and the energy market equilibrium. We ask how the transmission plans from such a process differ from those from a cooperative planning process and what the value of cooperation is, if any.

2 - Bi-level Network Planning Model Considering Generation-market Equilibria Subject To Inefficient Network Pricing

Pengcheng Ding, Johns Hopkins University, Baltimore, MD, United States, pangchingting@gmail.com, Benjamin Hobbs

We consider proactive planning of transmission subject to the response of a generation market with imperfect long-run transmission pricing based on a MW-km charging system, similar to that of the UK and elsewhere. MW-km-based charging distorts siting decisions of both thermal and renewable plants relative to the social optimum because (1) congestion and locations of needed reinforcements are ignored and (2) all generation types at a location pay the same charge, no matter how they use the grid.

3 - Reliable Renewable Generation And Transmission Expansion Planning: Co-optimizing System's Resources For Meeting Renewable Targets

David Pozo, Pontificia Universidad Católica de Chile, Santiago, Chile, davidpozocamara@gmail.com, Alexandre Moreira, Alexandre Street, Enzo E Sauma

We propose a two-stage renewable generation and transmission expansion planning model that jointly finds the best subset of new transmission assets and renewable sites to be developed. The main goal of this co-optimization planning model is to address renewable targets while accounting for the least-cost reserve scheduling to ensure reserve deliverability under generation and transmission outages and renewable variability. A case study with realistic data from the Chilean system is presented and solutions obtained with different level of security are tested against a set of 10,000 simulated scenarios of renewable injections and system component outages.

■ TA05

101E-MCC

Short-term Operation, Maintenance, and Long-term Planning for Power Systems

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Murat Yildirim, Georgia Institute of Technology, 755 Ferst Dr, Atlanta, GA, 30312, United States, murat.v.yildirim@gmail.com

1 - Topics On Optimal Power Flow

Richard O'Neill, FERC, Richard.O'Neill@ferc.gov

2 - Load-dependent Sensor-driven Maintenance And Operations In Power Systems

Murat Yildirim, Georgia Institute of Technology, Atlanta, GA, 30332, United States, murat@gatech.edu, Andy Sun, Nagi Gebraeel

The operational loads on the generating units have a significant impact on how fast they degrade. For instance, the frequency of start-up and shut-down cycles can change the lifetime of combined-cycle power plants by an order of magnitude. In this talk, we use in-situ sensor based signals to provide i) an accurate load-dependent degradation model for generating units, and ii) a flexible framework whereby the scheduler gains some control on how fast the generating units are degrading. The proposed framework achieves significant improvements in cost and reliability.

3 - Impact Of Short-term Variability And Uncertainty On Long-term Planning Problems

Henrik Bylling, University of Copenhagen, Universitetsparken 5, Copenhagen, DK-2100, Denmark, bylling@math.ku.dk, Salvador Pineda, Trine Krogh Boomsma

Considering a detailed representation of short-term system operations turns long-term planning problems, such as generation expansion, computationally intractable. Simplified models reduce the computational burden by focusing on a particular aspect of the short-term operation. We compare existing simplified models in terms of i) their ability to capture the impact of both short-term variability and short-term uncertainty on long-term planning decisions and ii) their computational complexity. We also propose a new procedure that outperforms existing ones in these two aspects.

■ TA06

102A-MCC

Optimization Models in Data Mining

Sponsored: Data Mining

Sponsored Session

Chair: Petros Xanthopoulos, University of Central Florida, 4000 Central Florida Blvd., P.O. BOX 162993, Orlando, FL, United States, petrosx@ucf.edu

1 - Relaxing Support Vector Machines

Orestis P. Panagopoulos, California State University, Stanislaus, Turlock, CA, United States, orepana@gmail.com, Talayeh Razzaghi, Petros Xanthopoulos, Onur Seref

In this paper, we extend Relaxed Support Vector Machines (RSVM) to perform regression as well as one-class classification tasks. Our models, Relaxed Support Vector Regression (RSVR) and One-Class Relaxed Support Vector Machines (ORSVM) are formulated using both linear and quadratic loss functions and are solved with sequential minimal optimization. Their performance is measured on several publicly available datasets and are compared to other state-of-the-art regression and classification methods.

2 - Online Feature Importance Ranking Based On Sensitivity Analysis

Alaleh Razmjoo, University of Central Florida, Orlando, FL, 32765, United States, alaleh.razmjoo@Knights.ucf.edu, Petros Xanthopoulos

In this paper, we present a fast and efficient incremental online feature ranking and feature selection. We employ the concept of global sensitivity and rank features based on their impact on the outcome of classification model. In the feature selection part, we use a two stage filtering method to first eliminate highly correlated and redundant features and then eliminating irrelevant features in the second stage. It can be implemented along with any online classification method. The proposed method is primarily developed for online tasks, however, significant experimental results in comparison with popular feature selection methods suggest that it can be also used in batch learning tasks.

3 - A Novel Weighting Policy For Unsupervised Ensemble Learning Based On Mean-variance Portfolio Optimization Method.

Ramazan Unlu, UCF, ramazanunlu@gmail.com

Unsupervised ensemble learning is an optimal combination strategy of individual clustering methods to create a model that fits to data better. Determining proper weights for clustering methods is a crucial step to build a well-combined partition. Recently, an approach was proposed based on concept of internal validity measures that has profound advantages over traditional ensemble learning. Despite its robust properties this approach consider only index values itself, but not variation of them. In this paper, we propose a better weighting policy for this problem that is based on mean-variance portfolio optimization method and compare against other popular approaches.

4 - Nonlinear Dimensionality Reduction For Analysis Ofelectroencephalography Records

Anton Kocheturov, University of Florida, Gainesville, FL, United States, antrubler@gmail.com

We suggest using nonlinear dimensionality reduction technique called the Local Linear Embedding for analysis of EEG records. This approach enabled us to distinguish between different states of the brain in a more efficient way comparing to the existing machine learning techniques since it is faster and doesn't require training of the algorithm. We also detected evidence for local linearity of the brain in the resting state and introduced a new model of the brain based on it.

■ TA07

102B-MCC

Retail Analytics

Sponsored: Data Mining

Sponsored Session

Chair: Matthew Lanham, Virginia Tech, Pamplin 1007, Blacksburg, VA, 24061, United States, lanham@vt.edu

1 - Analytics on The Edge Of Retail

Aaron Burciaga, Accenture, adburciaga@gmail.com

The fervor of big data and business analytics have led to a bumper crop of education, training, tools, and methods. It's has become increasingly difficult to detect the signal from the noise of those same people, processes, and tools that purportedly exist to distinguish signals from noise. This presentation will review several case studies of how commercial and national government programs are developing (or stumbling) in their analytics programs. Emergent technologies and methods, including the application of Machine Learning and Artificial Intelligence on edge devices will be presented, showing how the last mile and last dollar can be closed in both new and traditional challenges.

2 - An Investigation Of Cluster Analysis Of Retail Stores To Improve Predictive Modeling Of Sales

Linda Schumacher, Merchandise Scientist, Raleigh, NC, 27604, United States, schumachers@bellsouth.net

Data mining clustering algorithms are used to identify similar groups of retail stores for segmenting data to improve predictive modeling results. Clustering methods including centroid-based, hierarchical, two-step and probabilistic clustering are considered. The performance of these clustering methods is evaluated and compared with calculated metrics. Using data from a national retailer, the impact of segmenting the data to improve overall predictive performance is reported.

3 - Investigating Sparse Demand Models To Support The Assortment Planning Decision

Matthew Lanham, Clinical Assistant Professor, Purdue University, West Lafayette, IN, United States, malanham@gmail.com

We present research examining the performance of substitution-based multi-classification models currently being researched and employed in practice by major retailers, versus more naïve binary classification models to understand purchase propensity. We discuss how these models would yield different assortments for sparse demand products.

■ TA08

103A-MCC

Collaborative Innovation and Project Supply Chain Management Interfaces

Invited: Business Model Innovation

Invited Session

Chair: Yao Zhao, Rutgers University, Newark, NJ, United States, yaozhao@andromeda.rutgers.edu

Co-Chair: Onesun Steve Yoo, University College London, School of Management, Gower Street, London, WC1E 6BT, United Kingdom, onesun.yoo@ucl.ac.uk

1 - Investment In Shared Suppliers

Youngsoo Kim, University of Illinois, Champaign, IL, WC1E 6BT, United States, mailto:ykim180@illinois.edu, Anupam Agrawal, Dharma Kwon, Suresh Muthulingam

Motivated by an auto maker's supplier quality management, we study the investment time game of firms in a shared supplier when investment can spillover to the other. In our model, each firm decides when to invest by observing continuous flow of supplier performance with incomplete information on the type of supplier. We first characterize equilibria by a region of preemption and war of attrition. Then, we examine the interactive effects of spillover, competition, and learning on investment strategies and time to invest. We identify the simple conditions under which competition delays or hastens the first investment in a shared supplier.

2 - Project Management Contracts Under Information Asymmetry

Ju Myung Song, Rutgers University, jumyung.song@rutgers.edu

Collaboration and partnership are essential for development projects many industries. We develop game theoretical models to show how firms behave on behalf of their best interest in collaboration and how it affects the project performance under information asymmetry.

3 - On-demand Delivery Via On-demand Drivers

Michael Wagner, University of Washington, mrwagner@uw.edu, Soraya Fatehi

Controlling shipping costs has always been a challenge for most retailers. With the consumer trend towards more on-demand orders and the expectation of fast shipping times, some retailers have decided to crowdsource their deliveries (e.g., Amazon Flex, Uber Rush). This delivery method uses an on-demand work force to deliver orders. Retailers typically pay drivers hourly wages whereas couriers such as UPS charge retailers per package. The use of an on-demand crowd for logistics creates new challenges such as crowd availability, service level constraints, and liability. In this presentation, we evaluate the crowdsourcing delivery method and derive optimal strategies for firms.

4 - Managing Risks In Major Defense Acquisition Programs From The Supply Chain Perspective.

Olena Rudna, Rutgers University, omr20@scarletmail.rutgers.edu

The Major Defense Acquisition Programs (MDAP) cost overrun problem was on the high-profile issues list of the U.S. Government Accountability Office since 1990s. Drawing on organizational theory, this work develops a series of proposals explaining MDAP cost overrun from a supply chain management perspective. Using data mining techniques, we combined two independent publicly available data sources related to the MDAP performance and contracting activities over the past twenty years. Then we conducted a three-tier analysis—strategic, operational and tactical—to detect data patterns related to risks related to the MDAP project performance from the supply chain point of view.

■ TA09

103B-MCC

Panel Discussion: Open Challenges in Internet of Things & Agriculture Analytics

Invited: Agricultural Analytics

Invited Session

Moderator: Robin Lougee, IBM Research, IBM TJ Watson Research Center, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States, rlougee@us.ibm.com

1 - Panel Discussion: Open Challenges In Internet Of Things & Agriculture Analytics

Robin Lougee, IBM Research, IBM TJ Watson Research Center, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States, rlougee@us.ibm.com

The Internet-of-Things is expected to enable a second Green Revolution in agriculture with the potential to feed and sustain the growing world population. What are the important problems, application areas, and future research directions needed to realize the vision of digital agriculture? This panel will explore the state-of-the-art and discuss the open challenges for analytics and operations research experts.

2 - Panelist

Joseph Byrum, Syngenta, des Moines, IA, 50235, United States, joseph.byrum@syngenta.com

3 - Panelist

Melissa Moore, INFORMS, Catonsville, MD, 21228, United States, Melissa.Moore@informs.org

■ TA10

103C-MCC

Renewable Energy Systems and Grid Integration

Sponsored: Energy, Natural Res & the Environment, Energy II Other

Sponsored Session

Chair: Alexandra M Newman, Colorado School of Mines, newman@mines.edu

1 - Optimization Of Stored Energy Dispatch For Concentrating Solar Power Systems

Michael J Wagner, National Renewable Energy Laboratory, mike.wagner@nrel.gov

2 - Optimal Design Of Concentrating Solar Power Systems

Will Hamilton, Colorado School of Mines, whamilton@mines.edu

In 2011, the United States Department of Energy launched the SunShot Initiative, the mission of which is to make solar energy technologies more affordable and accessible to citizens by 2020. With the use of thermal storage devices, concentrated solar power (CSP) technologies store solar energy in the form of thermal energy which can be used to supply electrical power during hours of little to no solar resource. In order to make CSP systems competitive with current technologies, we optimize design to minimize system, operation, and maintenance costs for the lifetime of the plant, providing preliminary numerical results.

3 - ROC-ing The Grid: The Unintended Consequences Of Northern Ireland's Renewable Obligation Credit

Destenie Supreece Nock, University of Massachusetts - Amherst, Amherst, MA, 01002, United States, dnock@umass.edu, Erin Baker

In 2005 Northern Ireland introduced the renewable obligation certificate (ROC) policy, which was designed to increase the levels of renewable generation in the country. While the ROC was successful in encouraging the uptake of renewable generation technology, the amount of small- and micro-generation incorporated into the power system was much larger than anticipated. We use this case study as an illustration of specific opportunities for IEOR research in power system reliability and cost optimization. We discuss reliability metrics useful for evaluating potential responses to Northern Ireland's challenges.

4 - Siting And Sizing Of Merchant Energy Storage

Yury Dvorkin, University of Washington, Seattle, WA, United States, dvorkin@uw.edu, Yury Dvorkin, New York University, New York, NY, United States, dvorkin@uw.edu, Ricardo Fernandez-Blanco, Jean-Paul Watson, Cesar A Silva-Monroy, Cesar A Silva-Monroy, Hrvoje Pandzic, Daniel Kirschen

A high capital cost of battery energy storage systems (BESSs) raises concerns over whether merchant BESSs are economically viable within a market environment. This presentation will describe two multi-level optimization models that explicitly guarantee the profitability of merchant investment decisions on BESSs siting and sizing. The presentation will also demonstrate how these decisions are affected by a co-optimization with transmission expansion plans. Numerical simulations carried out on test-beds of the ISO New England and WECC systems demonstrate that considering the profitability of merchant BESSs also leads to improvements in market efficiency.

■ TA11

104A-MCC

Novel Applications of Network Optimization

Sponsored: Optimization, Network Optimization

Sponsored Session

Chair: Anna Nagurney, John F. Smith Memorial Professor, Isenberg School of Management, University of Massachuseets, Amherst, MA, 01003, United States, nagurney@isenberg.umass.edu

1 - A General Multitiered Supply Chain Network Model Of Quality Competition With Suppliers

Dong Li, Arkansas State University, dli@astate.edu, Anna B Nagurney

In this paper, we develop a general multitiered supply chain network equilibrium model consisting of competing suppliers and competing firms who purchase components from suppliers. The competitive behavior of each tier of decision-makers is described along with their strategic variables, which include quality of the components and, in the case of the firms, the quality of the assembly process itself. The governing equilibrium conditions of the supply chain network are formulated as a variational inequality and qualitative properties are presented. The algorithm, accompanied with convergence results, is then applied to numerical supply chain network examples along with sensitivity analysis.

2 - Supply Chain Network Equilibrium With Strategic Financial Hedging Using Futures Contracts

Zugang Liu, Pennsylvania State University - Hazleton, Hazleton, PA, United States, zxl23@psu.edu, Jia Wang

We develop a modeling and computational framework for supply chain networks with strategic financial hedging. We consider multiple competing firms that purchase multiple materials to manufacture their products. The supply chain firms' procurement activities are exposed to several risk factors such as commodity price uncertainty and exchange rate volatility. The firms can use futures contracts to hedge the risks. Our research studies the equilibrium of the entire network where each firm optimizes its own operation and hedging decisions.

3 - A Time-space Network Model For Medical Resources Allocation In An Epidemic Outbreak

Ding Zhang, SUNY Oswego, New York, NY, United States, ding.zhang@oswego.edu

This paper presents a dynamic logistics model for medical resources allocation that can be used in the control of an epidemic diffusion. It couples a forecasting mechanism, constructed for the demand of a medicine in the course of such epidemic diffusion, and a logistic planning system to satisfy the forecasted demand and minimize the total cost. The model is built as a closed-loop cycle, comprises of forecast phase, planning phase, execution phase, and adjustment phase. The parameters of the forecast mechanism are adjusted in reflection of the real data collected in the execution phase by solving a quadratic programming problem. A numerical example is presented to illustrate the model.

4 - A Generalized Nash Equilibrium Network Model For Post-disaster Humanitarian Relief

Anna Nagurney, John F. Smith Memorial Professor, University of Massachusetts Amherst, Amherst, MA, 01003, United States, nagurney@isenberg.umass.edu, Emilio Alvarez Flores, Ceren Soylu

We develop a Generalized Nash Equilibrium network model for post-disaster humanitarian relief by nongovernmental organizations (NGOs). NGOs derive utility from providing relief supplies to the victims of the disasters at multiple demand points in a supply chain context while competing with each other for financial funds provided by donations. The shared constraints consist of the lower and upper bounds for demand for relief items at the demand points and can be imposed by the regulatory body or higher level coordinating NGO to reduce materiel convergence and congestion. We provide an effective computational scheme and numerical examples plus solutions under the Nash Equilibrium counterpart.

■ TA12

104B-MCC

Mixed-Integer Programming with Applications

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Minjiao Zhang, Kennesaw State University, 560 Parliament Garden Way, Kennesaw, GA, 30144, United States, mzhang16@kennesaw.edu

1 - Coordinated Capacitated Lot-sizing For Multiple Product Families With Setup Times

Tiffany Bayley, University of Waterloo, Waterloo, ON, Canada, tiffany.bayley@uwaterloo.ca, Haldun Sural, James H Bookbinder

We examine a coordinated capacitated lot-sizing problem for multiple product families, where demand is deterministic and time-varying. The problem considers only holding costs, where capacity constraints limit the number of item and family setups and the amount of production in each period. Using a strong reformulation and relaxing the demand constraint, we improve both the upper and lower bounds using Benders decomposition and a cutting plane procedure. Through computational experiments, we show that our method consistently achieves better bounds, reducing the duality gap compared to other single-family methods studied in the literature.

2 - A Polyhedral Study On Lot-sizing Problem With Capacity Acquisition

Jia Guo, The University of Alabama, Tuscaloosa, AL, 35487, United States, jguo23@crimson.ua.edu, Minjiao Zhang

Determining the optimal capacity level to invest is one of the fundamental problems for an enterprise's operation. In this study, we consider a single-echelon lot-sizing problem with capacity acquisition (CALS). Two families of the so-called capacity definition and demand satisfying inequalities are proposed to describe the convex hull of CALS. Our computational results show that the proposed inequalities are very effective in solving CALS.

3 - The Slim Branch And Price Method With An Application To The Hamiltonian P-median Problem

Ahmed Marzouk, Texas A&M University, College Station, TX, 77840, United States, ambadr@email.tamu.edu, Erick Moreno-Centeno, Halit Uster

We present the Slim Branch and Price (SBP) method which is an improvement over traditional Branch and Price in the case of binary master problems. The main advantage in SBP is that the branching tree has only one main branch with several leaves. We illustrate the computational advantage of SBP over Branch and Price on the Hamiltonian p-median problem. In particular, under one hour limit, SBP can solve to optimality instances with up to 200 nodes; whereas Branch and Price can solve to optimality instances with up to 127 nodes.

4 - Multiechelon Lot Sizing With Intermediate Demands

Ming Zhao, Assistant Professor, University of Houston, Houston, TX, 77204, United States, mzhao@bauer.uh.edu, Minjiao Zhang

We prove that multiechelon lot sizing with intermediate demands is NP-hard. However, in the case of fixed number of echelons, we are able to derive polynomial time algorithms for both capacitated and uncapacitated models.

■ TA13

104C-MCC

Computational Linear Optimization

General Session

Chair: Nikolaos Ploskas, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, ploskasn@gmail.com

1 - Vector Space Decomposition For Solving Linear Programs

Marco Lübbecke, RWTH Aachen University, marco.luebbecke@rwth-aachen.de, Jean Bertrand Gauthier, Jacques Desrosiers

We propose a general algorithmic framework for solving linear programs. An iteration moves from one solution to the next in a direction with a certain step size. Part of the direction is determined by a pricing problem that is interesting in its primal and dual form: the dual fixes part of the dual variables and optimizes the rest; the primal selects a convex combinations of variables. Several known algorithms are unified by our view, in particular the primal simplex method, the minimum mean cycle canceling algorithm, and the improved primal simplex method. The framework allows us to precisely characterize when degenerate iterations can occur, and how to avoid them (of course, at a computational cost).

2 - Some Thoughts On Implementing Linear Optimization Algorithms

Tamás Terlaky, Lehigh University, terlaky@lehigh.edu

We discuss some aspects of implementing simplex and interior point algorithms for LO. Among others, we discuss the role of duality in algorithms design, in preprocessing, in choosing the most promising algorithm, in choosing if the given problem should be considered as primal or dual. The provocative question naturally arises: Do we indeed have both primal and dual simplex algorithms? Another question is if an optimal basis is always needed? Then, the algorithmic and practical consequences of choosing either crossover or optimal basis identification procedure are discussed.

3 - An Advanced Starting Basis For The Simplex Algorithm

Nikolaos Ploskas, Carnegie Mellon University, Pittsburgh, PA, United States, nploskas@andrew.cmu.edu, Nikolaos Samaras, Nikolaos Sahinidis

The computation of a starting basis for the simplex algorithm is of great importance. We propose six algorithms for constructing an initial basis using various ordering methods in order to generate a nearly-triangular and sparse initial basis. We give the initial bases as input to the CPLEX solver and compare the performance of the primal and dual simplex algorithm using the proposed algorithms against CPLEX advanced starting basis and crash procedures. The best algorithm results in 95% and 87% reduction of the execution time of the primal and the dual simplex algorithm, respectively.

4 - A Planning Approach And a Decision Support System For Wine Bottling Operations

Alfredo R. Squadritto, Pontificia Universidad Católica de Valparaíso, School of Industrial Engineering, Valparaíso, Chile, squadritto@ucv.cl, Ernesto Vásquez, Ricardo A. Gatica, Sergio G. Flores, Ricardo Gatica

We will describe a MIP-heuristic based decision support system (DSS) for production planning and scheduling at wine bottling plants. The production system involves several complicating features such as the coexistence of items made-to-order with items made-to-inventory, a complex structure, several constraints on wine supply, and a variety of company's policies. The DSS offers tools for easily modifying and analyzing the production schedule using a friendly graphic user interface. It's been implemented in 3 plants. The largest plant handles about 2400 SKUs, 400 intermediate products, and 3500 types of raw material, and it processes, on average, 250 production orders per week on 2 parallel production lines.

■ TA14

104D-MCC

Data Mining in Genetics and Genomics

Sponsored: Data Mining

Sponsored Session

Chair: Michael M Hoffman, Princess Margaret Cancer Centre/University of Toronto, Toronto Medical Discovery Tower 11-311, 101 College Street, Toronto, ON, M5G 1L7, Canada, michael.hoffman@utoronto.ca

1 - Modeling Methyl-sensitive Transcription Factor Motifs With An Expanded Epigenetic Alphabet

Michael M Hoffman, Scientist, Princess Margaret Cancer Centre, Toronto Medical Discovery Tower 11-311, 101 College St, Toronto, ON, M5G 1L7, Canada, michael.hoffman@utoronto.ca
Michael M Hoffman, Scientist, University of Toronto, Toronto Medical Discovery Tower 15-701, 101 College St, Toronto, ON, M5G 1L7, Canada, michael.hoffman@utoronto.ca

To understand the effect of DNA methylation on gene regulation, we developed methods to discover motifs and identify TF binding sites (TFBS) in DNA with covalent modifications. Our models expand the standard A/C/G/T alphabet, adding m for 5-methylcytosine. We adapted the position weight matrix model of TFBS affinity to an expanded alphabet. Using ChIP-seq data from Mouse ENCODE and others, we identified modification-sensitive cis-regulatory modules. We elucidated various known methylation binding preferences, including the methylation preferences of ZFP57, C/EBP , and c-Myc.

2 - Data, Informatics, And Analytical Challenges In Genomic Medicine

Elizabeth A. Worthey, Faculty Investigator & Director, HudsonAlpha Institute for Biotechnology, 601 Genome Way, Huntsville, AL, United States, lworthey@hudsonalpha.org

Application of Next Generation Sequencing has transformed genomic research. It is also transforming medicine through use as a molecular diagnostic test in both rare disease and oncology. It can also identify much (though not all) of the variation associated with more common and polygenic disease. To support such clinical and translational advances investment in computational applications, hardware, and methodologies has been necessary. Informatics environments, tools, and processes supporting medical genomics have been developed or refined and validated for clinical use. This talk will highlight various successes and will discuss potential solutions to some of the challenges that remain.

3 - Machine Learning For Predicting Vaccine Immunity

Eva K. Lee, Georgia Institute of Technology, eva.lee@isye.gatech.edu

This work is joint with Emory Vaccine Center and CDC. The ability to better predict how different individuals will respond to vaccination and to understand what best protects individuals from infection greatly facilitates developing next-generation vaccines. It facilitates both the rapid design and evaluation of new and emerging vaccines as well as identifies individuals unlikely to be protected by vaccine. We describe a general-purpose machine learning framework, DAMIP, for discovering gene signatures that can predict vaccine immunity and efficacy.

■ TA15

104E-MCC

Academic Job Search Panel

Invited: INFORMS Career Center

Invited Session

Chair: Wedad Jasmine Elmaghraby, University of Maryland, College Park, MD, United States, welmaghr@rhsmith.umd.edu

1 - Academic Job Search Panel

Wedad Jasmine Elmaghraby, University of Maryland, welmaghr@rhsmith.umd.edu

The panel will discuss the academic interview process and do's and don'ts associated with the job search. In addition to comments by current and former search chairs, time will be provided for questions and answers.

2 - Panelist

Volodymyr O Babich, Georgetown University, vob2@georgetown.edu

3 - Panelist

Candace Arai Yano, University of California-Berkeley, yano@ieor.berkeley.edu

4 - Panelist

Brian Tomlin, Tuck School of Business, brian.tomlin@tuck.dartmouth.edu

5 - Panelist

Ken Moon, Univeristy of Pennsylvania, Wharton School, Philadelphia, PA, 19104, United States, kenmoon@wharton.upenn.edu

6 - Panelist

Ken Moon, Univeristy of Pennsylvania, Philadelphia, PA, United States, kenmoon@wharton.upenn.edu

■ TA16

105A-MCC

Energy Systems

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Bruno Fanzeres, Visiting PhD Student, Georgia Institute of Technology, 755 Ferst Drive, NW, Atlanta, GA, 30332, United States, santosbruno85@gmail.com

1 - The Information-collecting Vehicle Routing Problem For Emergency Storm Response

Lina Al-Kanj, Postdoctoral Research Associate, Princeton University, Olden Street, Sherrerd Hall, room 119, Princeton, NJ, 08544, United States, lalkanj@princeton.edu, Warren B Powell"

This talk presents a new policy that routes a utility truck to restore outages in the power grid using trouble calls and the truck's route as a mechanism for collecting information to create beliefs about outages. This means that routing decisions change our belief about the network, creating the first stochastic vehicle routing problem that explicitly models information collection. The problem is formulated as a sequential stochastic optimization program. Then, a stochastic lookahead policy is presented that uses Monte Carlo tree search (MCTS) to produce a practical policy that is asymptotically optimal. Simulation results show that the developed policy has a close-to-optimal performance.

2 - Sampling Based Optimization Algorithms For Power Systems Application

Harsha Gangammanavar, Clemson University, harsha@clemson.edu

We present sampling-based approaches for addressing a class of stochastic optimization problems arising in power systems with significant renewable penetration, including economic dispatch and distributed storage control. These approaches provide a distribution-free alternative to methods based on Benders decomposition. This allows them to directly operate with external state-of-the-art simulators accessible to power systems operators. We will demonstrate their advantages in two-stage and multistage setups through computational experiments on real-scale power systems.

3 - Robust Strategic Bidding In Day Ahead Electricity Markets

Bruno Fanzeres, Georgia Institute of Technology, 765 Ferst Drive NW, Atlanta, GA, United States, santosbruno85@gmail.com, Shabbir Ahmed, Alexandre Street

The standard approach to devise bidding strategies in day-ahead electricity markets assumes available a joint probability distribution that drives the probabilistic nature of rival players' behavior. Nevertheless, construct such probabilistic description is a challenging task due to its complex nature. In this talk, robust optimization techniques are adapted to the bidding strategy problem to characterize the uncertainty on rival players' bids. A Column-and-Constraint Generation algorithm is constructed to solve the bidding problem. An illustrative example is presented to highlight the applicability of the proposed model as well as to provide intuition behind the algorithm.

4 - Modeling Power Markets With Multi-stage Stochastic Nash Equilibrium

Joaquim Dias Garcia, PSR-Inc., Praia de Botafogo, 228, Botafogo, Rio de Janiero, Brazil, joaquimgarcia@psr-inc.com

The modeling of modern power markets requires the representation of the following main features: (i) a stochastic dynamic decision process, with uncertainties related to renewable production and fuel costs, and (ii) a game-theoretic framework that represents the strategic behaviour of multiple agents., These features can be in theory represented as a stochastic dynamic programming recursion, where we have a Nash equilibrium for multiple agents. This work presents an iterative process to solve the above problem for realistic power systems. The proposed algorithm consists of a fixed point algorithm, in which, each step is solved via stochastic dual dynamic programming method.

■ TA17

105B-MCC

Stochastic Programming for Long Term Planning

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Anderson Rodrigo de Queiroz, NCSU, n, 1, NC, 12, United States, arqueiroz@ncsu.edu

Co-Chair: Joseph F DeCarolis, North Carolina State University, Raleigh, NC, United States, jdecarolis@ncsu.edu

1 - The Value Of Stochastic Programming For Energy Systems Planning

Anderson Rodrigo de Queiroz, North Carolina State University, Raleigh, NC, United States, arqueiroz@ncsu.edu, Joseph F DeCarolis

Energy system models should reflect the reality that planners must make decisions prior to the realization of future uncertainties. Multi-stage stochastic programs, which embed uncertainty in the decision process, optimize over future possibilities to yield a near-term decision strategy. We use the expected value of perfect information and the value of the stochastic solution as metrics to quantify the value of such strategies for long-term capacity expansion of energy systems.

2 - Stochastic Optimization Of Design Under Heuristic Operation In Mixed Integer Programs

Alexander Zolan, The University of Texas at Austin, alex.zolan@utexas.edu, David Morton, Alexandra M Newman

We present a framework for optimizing system design in the face of a restricted class of policies governing system operation, which aim to model realistic operation for stochastic integer programs with a long operating time horizon. This leads to a natural decomposition of the problem yielding upper and lower bounds, which we can compute quickly. We illustrate application of these ideas using a model that seeks to design and operate a microgrid to support a forward-operating base under load and photovoltaic (PV) uncertainty, as well as other examples from the literature.

4 - Power System Planning In Fragile States: A Case Study Of South Sudan

Evangelia Spyrou, Johns Hopkins University, Baltimore, MD, United States, elina.spirou@gmail.com, Morgan Bazilian, Debabrata Chattopadhyay, Benjamin Field Hobbs

In countries suffering from fragility, conflict and violence, power system planning and investment is essential for development and economic growth. However, the sector has to contend with deep uncertainty that may impact on an already vulnerable power system. We propose the application of a multi-stage stochastic program that explicitly considers probability of conflict and its consequences on power system infrastructure. Results for the power system in South Sudan are provided and discussed.

■ TA18

106A-MCC

Finance, Portfolio I

Contributed Session

Chair: Markku Kallio, Professor, Aalto Univertsity, Runeberginkatu 22-24, Helsinki, FIN-00200, Finland, markku.kallio@aalto.fi

1 - Trade Space Exploration Tools And Methods With Applications To Capital Investments And Portfolio Management Decisions For Optimality

Simon Miller, Applied Research Laboratory, The Pennsylvania State University, 411 Waupelani Drive, D-221, State College, PA, 16801, United States, swm154@psu.edu, Christopher M. Farrell, Michael A. Yukish, Gary M Stump

Faced with constrained portfolio conditions, senior leaders must often make strategic choices and fiscal trades with implications on capabilities, capacities, and system attributes to maximize value, manage risk, and satisfy stakeholder requirements. Researchers have developed robust tools and methods to explore large scale, complex, multi-objective problems for portfolio analyses, where data visualization techniques and optimization algorithms are simultaneously applied to support decision processes in a binary combinatorial space. The tools and methods may be applied to a wide range of financial management and resource allocation problems to provide flexibility and options.

2 - Forth Order Stochastic Dominance Efficiency Test And An Empirical Evaluation

Nasim Dehghan Hardoroudi, PhD Candidate, Aalto University School of Business, Runeberginkatu 22-24, Chydenia (4th floor), Helsinki, 00100, Finland, nasim.dehghan.hardoroudi@aalto.fi

Stochastic dominance is an important tool in aiding decisions under uncertainty when the decision maker's utility function is unknown. In this study, we propose a novel forth order stochastic dominance (FOSD) efficiency test. We derive the necessary and sufficient conditions for such test, which is based on nonlinear convex optimization problem. For comparison, we provide numerical illustrations for second and third order stochastic dominance (SSD, TSD) as well as decreasing absolute risk aversion stochastic dominance (DSD) besides the FOSD test, using stock market data of the US. The market index as benchmark is found inefficient and dominated under the all types of stochastic dominance.

3 - Some Tests For Stochastic Dominance Efficiency

Markku Kallio, Professor, Aalto Univertsity, Runeberginkatu 22-24, Helsinki, FIN-00200, Finland, markku.kallio@aalto.fi

We consider third order stochastic dominance (TSD), decreasing absolute risk aversion (DARA) stochastic dominance (DSD) as well as stochastic dominance (ESD) based on the family negative exponential utility functions. These concepts are of interest because the respective classes of utility functions convey observed properties of individual preferences. Using the efficiency concept introduced by Post, we derive necessary and sufficient tests for efficiency under the three types of stochastic dominance. Our DSD efficiency test is new, it relies on our argument for the TSD test, and it circumvents shortcomings in recent literature.

■ TA19

106B-MCC

Optimization Modeling and Beyond with a Focus on Practice

Sponsored: Computing

Sponsored Session

Chair: Leo Lopes, SAS, SAS Campus Drive, Cary, NC, 27513, United States, Leo.Lopes@sas.com

1 - Optimization Modeling With Python Using Pandas

Irv Lustig, Princeton Consulting, irv@princeton.com

The Python library pandas (http://pandas.pydata.org/) is a popular library used by data scientists to carry out an entire data analysis workflow in Python. When building optimization models, we often work with data in tables that are sourced from databases, CSV files, and spreadsheets. pandas provides a uniform environment for working with data tables with a large number of methods for manipulating tabular data, many of which are directly applicable for building large scale optimization models. In this talk, we will illustrate some of these powerful features that can accelerate optimization model development and deployment.

2 - SAS/OR Value Beyond the Model

Leo Lopes, SAS Institute, Leo.Lopes@sas.com

We focus on uses of SAS/OR that go beyond modeling and solving, but are are just as essential to deliver production quality prescriptive analytics models quickly. The tasks we describe support testing, instance generation, access to alternative solvers, data manipulation, algorithmic control, and visualization.

3 - Building Optimization-enabled Applications Using AMPL Api

Robert Fourer, AMPL Optimization Inc., 2521 Asbury Ave, Evanston, IL, 60201, United States, 4er@ampl.com

We describe how to combine the power of the AMPL modeling system and a general-purpose programming language to build rich optimization-enabled client applications. Having an optimization model expressed in a high-level declarative form with model and data separation facilitates its evolution and maintenance, and makes switching between different solvers and data sources easy. At the same time it is possible to use a familiar development environment and have access to a wide variety of programming libraries for data management and interface development.

4 - Decision Optimizer 7.0: Combinatorial Optimization For Business Analysts

Susanne Heipcke, FICO, San Jose, CA, United States, SusanneHeipcke@fico.com, Livio Bertacco, Sebastien Lannez

With Decision Optimizer a strategy analyst can define and optimize complex decision problems using an intuitive graphical workflow. By designing the interactions between decisions and constrained metrics, it is possible to create models for optimizing the assignment of actions, such as investment options or transaction authorization, for large-scale datasets of input elements leveraging analytic techniques for sampling and segmentation. In the new version 7.0, DO has been integrated with FICO Optimization Modeler to provide a more collaborative, web and cloud based experience, improved scenario management, distributed execution and Tableau based reporting.

■ TA20

106C-MCC

Mathematical Finance, Models, Simulation and Today's Pressing Problem

Invited: Tutorial

Invited Session

Chair: Joseph M. Pimbley, Maxwell Consulting, LLC, 1, Croton-on-Hudson, NY, 10520, United States, pimbley@maxwell-consulting.com

1 - Mathematical Finance, Models, Simulation And Today's Pressing Problem

Joseph M. Pimbley, Maxwell Consulting, LLC, a, Croton-on-Hudson, NY, 10520, United States, pimbley@maxwell-consulting.com

Financial markets are awash in information ranging in form from numerical data to unstructured news reports to nebulous narratives of executives and regulators. Investors, fiduciaries, intermediaries and other "market actors" apply an exceedingly broad spectrum of human skill and ingenuity to the interpretation of this streaming information. Mathematical techniques and analysis, in particular, are notable tools in which mathematical advances and discoveries may improve markets' liquidity, efficiency and pace. This article outlines the origin and techniques of mathematical finance and associated models and simulations. We note strengths and shortcomings of these mathematical tools. The greatest challenge today is to learn and teach to the financial world the necessary judgment to avoid and rescind destructive deployment of financial models.

■ TA21

107A-MCC

Beyond Predictive Analytics

Sponsored: Health Applications

Sponsored Session

Chair: Margret Bjarnadottir, University of Maryland, 4324 Van Munching Hall, College Park, MD, 20742, margret@rhsmith.umd.edu

1 - Data-driven Specification Of Cyclical Arrival Processes

Donald Lee, Yale University, 165 Whitney Ave, Box 208200, New Haven, CT, 06520, United States, donald.lee@yale.edu, Ningyuan Chen, Sahand Negahban

The arrival processes of real-world systems usually exhibit cyclical behaviour. For example, patient arrivals to emergency departments often peak around midday and drops off at night. In this talk we show how this periodic structure can be exploited to obtain a compact and analytic description of the underlying arrival process from data. Such a model is clearly useful for both simulation and modeling purposes. We demonstrate the method on arrivals data from an Emergency Department in southern Connecticut.

2 - Incorporating Dose-prediction Within A Personalized Treatment Paradigm

Eva Lee, Georgia Institute of Technology, eva.lee@gatech.edu, Xin Wei

This work is joint with Grady Health Systems and Atlanta VA Medical Center. We design an outcome-based decision support tool that couples a predictive treatment-effect model with a planning optimization model. The predictive model uncovers treatment effect analysis of anti-diabetic drug dosage and the blood glucose level recorded in the titration period of each patient. This evidence is then incorporated within a personalized planning model for optimal treatment design. The decision support tool allows continuous learning of evidence for each patient as new treatment outcomes are recorded.

3 - Optimal Selection Of Health Care Providers

Jerry Kung, MIT, jkung@mit.edu

Given electronic health claims data for employees of a company, we propose a mixed integer optimization approach to select a collection of providers that optimizes over total cost, while maintaining quality and respecting travel distance for employees. We demonstrate that our formulation is tractable for large datasets and present the computational results on a real claims dataset. By following the prescriptions generated by our optimization model, we estimate that cost reductions of up to 10% can be achieved by reassigning patients for a small number of different types of procedures. We demonstrate that these cost reductions are robust to changes in a variety of parameters.

■ TA22

107B-MCC

Joint Session MSOM-HC/HAS: Modeling and Optimization for Chronic and End-Stage Renal Disease Patients

Sponsored: Health Applications

Sponsored Session

Chair: Murat Kurt, Merck, Merck, Philadelphia, PA, 07033, United States, murat.kurt7@gmail.com

Co-Chair: David Kaufman, University of Michigan-Dearborn, 19000 Hubbard Dr, Dearborn, MI, 48126, United States, davidlk@umich.edu

1 - Optimal Decision Making In A Markov Model With Parameter Uncertainty: The Case Of Chronic Kidney Disease

Reza Skandari, University of British Columbia, Reza.Skandari@sauder.ubc.ca, Steven Shechter

We investigate a Markov decision process whose unknown transition parameters are revealed partially through state observation. Decisions are made as the state evolves. We use the model to study the optimal time to start preparing a type of vascular access for chronic kidney disease patients who will need dialysis.

2 - Optimal Integration Of Kidney Exchange Programs With Antibody Reduction Therapy To Increase Successful Transplant In Difficult To Match Recipients

Naoru Koizumi, George Mason University, nkoizumi@gmu.edu, Monica Gentili

Kidney paired donation (KPD) allows incompatible pairs to exchange kidneys with other incompatible pairs. However, evidence suggests there stills exist barriers to KPD utilization, especially among difficult-to-match transplant candidates and positive actual or virtual crossmatches. We use optimization and simulation analyses to optimally integrate antibody reduction therapy in KPD matching runs to increase the overall number of transplants. The proposed mathematical model matches incompatible pairs taking into consideration the possibility that some of the recipients could undergo a desensitization protocol to improve compatibility with the matched donor.

3 - Position-indexed Formulations For Kidney Exchange

Tuomas Sandholm, Carnegie Mellon University, sandholm@cs.cmu.edu, John Dickerson, David Manlove, Benjamin Plaut, James Trimble

We address the tractable clearing of kidney exchanges with short cycles and practical (long, but not unbounded) chains. We introduce three compact integer programming formulations with linear programming relaxations that are at least as tight as the previous tightest formulation (which was not compact) for instances in which each donor has a paired patient. Then, on real data from the UNOS US-wide exchange and the NHS UK-wide exchange, as well as on generated data, we show that our models dramatically outperform all prior solvers. We also present models that are more scalable than the state-of-the-art models for failure-aware kidney exchange.

■ TA23

108-MCC

Modelling Care and Treatment of Chronic Diseases

Sponsored: Health Applications

Sponsored Session

Chair: Michael W Carter, University of Toronto, 5 King's College Rd., Toronto, ON, M5S 3G8, Canada, carter@mie.utoronto.ca

1 - Chronic Care Disease Management Through Operations Research & Analytics – Lessons From Ontario

Ali Vahit Esensoy, Manager, Strategic Analytics, CCO, Toronto, ON, Canada, AliVahit.Esensoy@cancercare.on.ca, Kiren Handa

CCO acts as a key Ontario government advisor on cancer care, renal, palliative and access to care. Part of CCO's mandate is to drive improvement through developing multi-year system plans, setting standards and guidelines, developing and deploying information systems, and measuring performance. Since 2010, CCO has actively tested and deployed numerous operational research methodologies as part of their advanced analytics work. This session will review the evolution of CCO's OR practice within the advanced analytics group and discuss successes and challenges of applying OR for system planning and policy decisions within Ontario's healthcare system.

2 - An Analytics Approach To Dementia Capacity Planning

Tannaz Mahootchi, Cancer Care Ontario, Tannaz.Mahootchi@cancercare.on.ca, Azadeh Mostaghel, Ali Vahit Esensoy

We use a data-driven approach to identify and project capacity issues in Ontario for the persons living with dementia (PLwD). Evidence suggests that while PLwD prefer to stay at home for as long as possible. Lack of appropriate community-care could lead to hospitalization and residential long-term care (LTC) placements. Using the person-level care trajectory data and evidence from literature, we develop a simulation model to predict the effect of augmented home and community care options on the patient flow and LTC placements for the future dementia incidence cases.

3 - Nurse Scheduling And Risk Analysis Of Hemodialysis Patients

Michael W Carter, University of Toronto, carter@mie.utoronto.ca, Mahsa Shateri

Kidney failure patients require dialysis treatment three times a week until a suitable donor is found. During dialysis, nurses monitor several patients at once, but when complications occur, a nurse must be available quickly to attend to the problem and restart dialysis. This paper provides a model to determine the minimum staffing levels required in order to deliver safe, effective care.

4 - Two-stage Stochastic Programming For Adaptive Interdisciplinary Pain Management With PIN Transition Models

Gazi Md Daud Iqbal, The University of Texas at Arlington, gazimddaud.iqbal@mavs.uta.edu, Jay Michael Rosenberger, Victoria C. P. Chen, Robert Gatchel

This research uses a two-stage stochastic programming approach to optimize personal adaptive treatment strategies for pain management. Transition models are represented by Piecewise Linear Networks. A multi-objective mixed integer linear program is developed to optimize treatment strategies for patients based upon on these transition models.

■ TA24

109-MCC

Practice-Based Research in Healthcare OM

Sponsored: Health Applications

Sponsored Session

Chair: Jónas Oddur Jónasson, London School of Business, Regent's Park, NW1 4SA, London, TX, 00000, United Kingdom, jjonasson@london.edu

1 - Staff Planning For Anesthesiologists

Sandeep Rath, University of California-Los Angeles, sandeep.rath.1@anderson.ucla.edu, Kumar Rajaram

Staff planning for human resources like anesthesiologists at hospitals takes place sequentially, where planning is done for regular staffing as well as reserve capacity. The staff planners balance the expected overtime, under-utilization costs as well as the cost of keeping staff on reserve. Some of these costs are not explicitly known. We employ a structural estimation model to infer these implicit costs and subsequently find heuristic solution for the medium term staff planning. We apply this approach to staff planning for anesthesiologists.

2 - Separate & Concentrate: Accounting For Patient Complexity In General Hospitals

Sandra Sülz, Assistant Professor, Erasmus University Rotterdam, Rotterdam, Netherlands, sulz@bmg.eur.nl, Ludwig M Kuntz, Stefan Scholtes

We show that the positive association between patient volume, focus and service quality is worse for complex patients, and that hospitals that route the majority patients in a disease segment to the same department have fewer department allocation errors and better outcomes, particularly for complex patients. These findings suggest a redesign of general hospitals: Separate out routine patients and route them away from general hospitals into high-volume and focused value-adding process clinics and concentrate disease segments in the clinical departments of solution shop hospitals rather than scattering patients across several departments.

3 - Towards An Equitable Allocation Of Organs Among End-stage Liver Disease Patients

Mustafa Akan, Associate Professor of Operations Management, Carnegie Mellon University, Tepper School of Business, Posner Hall 381C, Pittsburgh, PA, 15213, United States, akan@andrew.cmu.edu, Ngai-Hang Z Leung, James F. Markmann, Sridhar R Tayur, Heidi Yeh

Patients on the waiting list for liver transplants receive priority based on their MELD scores, which reflect the severity of liver disease. Recent studies have shown that Hepatocellular Carcinoma (HCC) patients have significantly higher liver transplant rates than non-HCC patients due to non-individualized MELD calculation of the former. By using clinical data from SRTR we calibrate Markov Models and build a new simulator (MYATLAS). We then compute alternative MELD scores for the HCC patients that are a function of the candidate's tumor biology and its progression.

4 - Ambulance Emergency Response Optimization In Developing Urban Centers

Justin J. Boutilier, University of Toronto, Toronto, ON, Canada, j.boutilier@mail.utoronto.ca, Timothy Chan

Time sensitive medical emergencies are a major health concern comprising over 33% of all deaths in low and middle income countries (LMICs). Despite evidence that ambulance services can save lives, poor access and availability of emergency medical care in LMICs continues to be a widespread problem. In this work, we develop a novel ambulance location-routing model, tailored to address the challenges faced by urban areas in LMICs. We use extensive field data from Dhaka, the capital of Bangladesh and one of the most densely populated cities on earth, to develop and validate our modelling framework.

■ TA25

110A-MCC

Project Related SCM III

Invited: Project Management and Scheduling

Invited Session

Chair: Xiaoqiang Cai, The Chinese University of Hong Kong, Shatin, Hong Kong, 000, Hong Kong, xqcai@se.cuhk.edu.hk

1 - An Iterative Capacity Sharing Mechanism For Freight Forwarders

Minghui Lai, Southeast University, Nanjing, China, laimh@seu.edu.cn, Weili Xue

We consider the collaboration problem of forwarders in transportation capacity sharing over a general logistics network. As competition for capacity is intensive and usually carriers reserve more capacity for big customers, small forwarders can form an alliance to jointly book allotment capacity before the freight season. During the season, forwarders observe their private demand realization and then share the capacity to deliver their services. Capacity sharing also reduces cost, due to economies of scale from fixed cost. We propose a strategy-proof iterative mechanism, and prove that the mechanism is finitely convergent and individually rational.

2 - Value Of Category Captainship With Shelf-space Dependent Demand

Weili Xue, Southeast University, wlxue1981@gmail.com, Minghui Xu

We consider a supply chain with one retailer and two manufacturers, who sell his product through the retailer to the consumer market. We consider two category management scenarios. In the retailer category management scenario, the retailer makes decisions on how to allocate the total shelfspace to all his products, and what is the selling price for each product. In the captain category management scenario, the retailer delegates the pricing and allocation decisions to one of the supplier (the captain). In both scenarios, the retailer will decide the total shelf-space allocated to this category. We analyze these two scenarios when the selling prices for both products are exogenously given.

3 - A Noncooperative Game Model And Algorithm For a Utility Computing System

Pengyu Yan, Associate professor, University of Electronic Science and Technology of China, Chengdu, China, yanpy@uestc.edu.cn, Hongru Miao, Nicholas G Hall, Guanhua Wang

Selfish behaviors of resource users and providers can damage the performance of utility computing systems. Existing market-based approaches effectively allocate resources and schedule tasks to minimize the costs for users. Using a noncooperative sequencing game model, we study the providers' decisions about the computing resources they allocate to the system to complete tasks. To find a Nash equilibrium strategy, the model is transformed into a directed bi-valued cyclic graph, and a polynomial time algorithm is proposed. The price of anarchy and incentive contract design are also discussed.

4 - Principal-agent vs Revenue Sharing Contracts In The Optimal Supplier Switching Model With Learning Effect

Qian Wei, Tianjin University, qwei@tju.edu.cn, Jianxiong Zhang

This paper examines two contracts (Principal-agent and Revenue sharing) in a supplier switching model with considering learning effect. Our analysis reveals that both contracts can be optimal under different parameter settings. Furthermore, we compare the two contracts from an ex-post perspective. We find the switching strategy on the basis of the principal-agent theory dominates that based on the revenue sharing contract when the learning rate lies in an intermediate region, while the result is reversed with a relatively large or small learning rate.

■ TA26

110B-MCC

Auctions and Econometrics

Invited: Auctions

Invited Session

Chair: Robert Day, University of Connecticut, Storrs, CT, United States, Bob.Day@business.uconn.edu

1 - Dynamic Demand Estimation In Auction Markets

Greg Lewis, Microsoft Research New England, glewis@microsoft.com, Matthew Backus

Auction mechanisms play an important part in allocating goods, yet existing empirical auction techniques treat each auction in isolation, obscuring market interactions. We provide a framework for estimating demand in a large auction market with a dynamic population of buyers with unit demand and heterogeneous preferences over a finite set of differentiated products. We offer an empirically tractable equilibrium concept, characterize bidding and prove existence of equilibrium. Having developed a demand system, we show that it is non-parametrically identified from panel data. We apply the model to measure consumer surplus in the market for compact cameras on eBay.

2 - Identification And Estimation Of Affiliated Private Values Auctions With Unobserved Heterogeneity

Jorge Balat, Johns Hopkins, jorge.balat@jhu.edu

I consider a first-price auction model with affiliated private values and unobserved heterogeneity. Both affiliation and unobserved heterogeneity manifest in bids that are correlated and it is hard to disentangle these two sources apart from bid data alone. I show that the model is nonparametrically identified once we allow for endogenous participation and leverage entry data combining ideas from the control function and measurement error literatures. I propose a nonparametric estimator and show how one can test for different information structures. I then take the model to data from highway procurement auctions from California. I find evidence of both unobserved heterogeneity and affiliation.

3 - Simultaneous First-price Auctions With Preferences Over Combinations

Matthew Gentry, LSE, United Kingdom, M.L.Gentry@lse.ac.uk, Tatiana Komarova, Pasquale Schiraldi

We develop a structural model of strategic bidding in simultaneous first-price auctions when objects are heterogeneous and bidders have preferences over combinations. We then apply this model using data on Michigan Department of Transportation (MDOT) highway procurement auctions. Our results suggest that the simultaneous first-price mechanism performs very well relative to theoretically attractive but practically costly alternatives such as combinatorial proxy auctions, helping to rationalize the widespread use of simultaneous auctions in practice.

4 - Robust Data-driven Welfare Guarantees In Auctions

Vasilis Syrgkanis, Microsoft Research, vasy@microsoft.com, Darrell Hoy, Denis Nekipelov

Analysis of welfare in auctions comes traditionally via one of two approaches: precise but fragile inference of the exact details of a setting from data or robust but coarse theoretical price of anarchy bounds that hold in any setting. As markets get more and more dynamic and bidders become more and more sophisticated, the weaknesses of each approach are magnified.In this paper, we provide tools for analyzing and estimating the empirical price of anarchy of an auction. The empirical price of anarchy is the worst case efficiency loss of any auction that could have produced the observed data.

■ TA27

201A-MCC

New Developments in Sourcing and Selling Strategies

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Basak Kalkanci, Georgia Institute of Technology, Atlanta, GA, United States, basak.kalkanci@scheller.gatech.edu

Co-Chair: Necati Tereyagoglu, Scheller College of Business, Georgia Institute of Technology, Atlanta, GA, United States, necati.tereyagoglu@scheller.gatech.edu

1 - Strategic Sourcing Under Competition And Asymmetric Cost Information

Lusheng Shao, The University of Melbourne, Level 10, 198 Berkeley Street, Melbourne, 3010, Australia, lusheng.shao@unimelb.edu.au, Xiaole Wu, Fuqiang Zhang

We study a sourcing game where competing firms choose between a supplier with certain cost (C-supplier) and a supplier with potentially lower, but uncertain cost (U-supplier). We find that with a larger market potential, the firms would more likely choose a C-supplier despite its higher average cost. The higher cost uncertainty of a U-supplier may either improve or reduce its attractiveness to the sourcing firms, depending on its current uncertainty level. The increasing cost of C-supplier may lead to a new sourcing equilibrium and thus make both sourcing firms better off.

2 - Money-back Guarantees In A Distribution Channel: Bargaining Power & Downstream Competition

Yufei Huang, Assistant Professor, University of Bath, Bath, United Kingdom, y.huang@bath.ac.uk, Tingliang Huang, Ying-Ju Chen

Although existing literature emphasizes the usefulness of Money-back Guarantees (MBG), little is known about why retailers may adopt different MBG choices in practice. To understand this, we examine two competing retailers' MBG decisions, who also simultaneously bargain for wholesale prices with a wholesaler in a distribution channel. We show that, retailers' asymmetric bargaining power may lead to asymmetric MBG choices. We provide economic rationales for all possible MBG outcomes.

3 - Selling To Socially Connected Customers

Ruslan Momot, INSEAD, Fontainebleau, France, ruslan.momot@insead.edu, Elena Belavina, Karan Girotra

We study the value of different kinds of social network information and illustrate its use. We build a model of a social network of strategically interacting customers who value exclusive ownership of the product and are heterogeneous in the number of friends (degree) and proclivity for social comparisons (conspicuity). We find that high-conspicuity customers within intermediate-degree segments are the firm's best targets. Our analysis reveals how they should be selectively targeted by the firms with information on either (or both) of the customer traits. We find that information about degree is more valuable than information about conspicuity and that the two are substitutes.

4 - Subscription Box Business Models: Pricing And Quality Decisions

Basak Kalkanci, Georgia Institute of Technology, basak.kalkanci@scheller.gatech.edu, Necati Tereyagoglu

We model the value of online subscription box business model for a consumer who chooses the replenishment frequency (or timing) of a frequently used durable good. We explore the seller's pricing and quality decisions under the online subscription box business model, and evaluate the performance of such a model in comparison to selling through an offline retail channel.

■ TA28

201B-MCC

Sequential Sampling and Optimization

Sponsored: Applied Probability

Sponsored Session

Chair: Raghu Pasupathy, Purdue University, West Lafayette, IN, United States, pasupath@purdue.edu

1 - Sequential Stopping Rules For Simulation Problems Where Variance Estimation Is Difficult

Jing Dong, Northwestern University, jing.dong@northwestern.edu, Peter W Glynn

We solve the sequential stopping problem for a class of simulation problems in which variance estimation is difficult. In particular, we establish the asymptotic validity of sequential stopping procedures for estimators constructed using various cancellation methods. We characterize the limiting distribution of the estimators at stopping times as the error size (the absolute error or the relative error) goes to 0, which is different from the limiting distribution of the estimator constructed based on a fixed size of samples as the sample size goes to infinity.

2 - Probabilistic Bisection Converges Almost As Quickly As Stochastic Approximation

Shane Henderson, Professor, Cornell University, 230 Rhodes Hall, Ithaca, NY, 14853, United States, sgh9@cornell.edu, Peter Frazier, Rolf Waeber

The probabilistic bisection algorithm (PBA) can be applied to stochastic root finding problems in one dimension. The PBA successively updates a Bayesian prior on the location of the root after using a power-one test at the median of the posterior to estimate the direction of the root from the median. The power-one test has a variable sample size. The PBA has features that we believe make it attractive relative to stochastic approximation for such problems. I will discuss the algorithm and sketch a proof that it converges at a rate arbitrarily close to the canonical "square root" rate of stochastic approximation.

3 - Fixed-Step, Line Search, And Trust-Region Adaptive Sampling Recursions for Simulation Optimization

Raghu Pasupathy, Purdue University, pasupath@purdue.edu

We present a sequential sampling framework for recursively solving stochastic optimization problems. The framework consists of embedding a globally convergent numerical optimization search routine, e.g., line search, trust region, with Monte Carlo sampled estimators of the objective function and gradient. Global convergence to a stationary point depends crucially on a result characterizing the sample size at each iteration. We will outline the conditions that guarantee the attainment of the Monte Carlo canonical rate.

■ TA29

202A-MCC

Managing Capacity in Energy Markets Through Demand and Supply-side Interventions

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Charles J Corbett, University of California - Los Angeles, Los Angeles, CA, United States, charles.corbett@anderson.ucla.edu

1 - Energy Efficiency Contracting In Supply Chains Under Asymmetric Bargaining Power

Ali Shantia, HEC Paris, 1 rue de la Liberation, Jouy-en-Josas, 78350, France, ali.shantia@hec.edu, Sam Aflaki, Andrea Masini

Evidence shows that suppliers refrain from investing in energy efficiency (EE) measures because they fear that a buyer with greater bargaining power will use the EE-related cost reductions to push prices down, in the purchase bargaining process, and thereby further reduce the supplier's profit margin. In a supply chain consisting of a buyer and a supplier, this study analyses the effect of relative bargaining power and technology uncertainty on the supplier's decision to invest in energy efficiency measures. We analyse price commitment and shared investment contracts as potential coordination mechanisms and compare them in their ability to boost EE investment by the supplier.

2 - An Analysis Of Time-based Pricing In Electricity Supply Chains

Asligul Serasu Duran, Kellogg School of Management, 2001 Sheridan Road, 5th floor, Evanston, IL, 60208, United States, a-duran@kellogg.northwestern.edu, Baris Ata, Ozge Islegen

This study builds a framework for the retail electricity market to empirically evaluate the impact of time-based tariffs on the electricity supply chain. We find that optimal time-based tariffs reduce peak demand, but do not change consumers' electricity bills significantly. Time-of-use tariffs with predetermined rates can capture most of the benefits of real-time prices. The environmental impact of time-based tariffs depends on the characteristics of the electricity market under study.

3 - Investments In Renewable And Conventional Energy: The Role Of Operational Flexibility

Kevin Shang, Duke University, Durham, NC, United States, khshang@duke.edu, Gurhan Kok, Safak Yucel

We study capacity investments of a utility firm in renewable and conventional energy sources with different levels of operational flexibility, i.e., the ability to quickly ramp up or down the output of a generator. We consider supply characteristics of conventional and renewable sources and derive the optimal capacity investment portfolio. We find that inflexible sources (e.g., nuclear energy) and renewables are substitutes; flexible sources (e.g., natural gas) and renewables are complements.

4 - Explaining The Variation In Progress In The Us Nuclear Industry

Christian Blanco, University of California - Los Angeles, Los Angeles, CA, United States, cblanco@anderson.ucla.edu, Felipe Caro, Charles J Corbett

We examine the factors that influenced the US nuclear power production efficiency and safety over time.

■ TA30

202B-MCC

Studies in Service Operations

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Robert Batt, Wisconsin School of Business, UW - Madison, Madison, WI, United States, rbatt@bus.wisc.edu

1 - Heart Failure transitions: Staffing Follow-up Clinics To Reduce Readmissions

Itai Gurvich, Kellogg School of Management, i-gurvich@kellogg.northwestern.edu, Benjamin Grant, Jan A Van Mieghem, Kannan Mutharasan

Heart failure (HF) readmissions are a major driver of cost and health care utilization. Timely follow-up of patients post-discharge represents an evidence-based intervention proven to reduce readmission rates. Patients discharged after HF hospitalization are scheduled to meet a cardiologist in the outpatient clinic. Meeting targets for timely follow-up requires appropriate capacity planning for these clinics that takes into account the inpatient-discharge variability. An intervention based on simple safety capacity rules and more aggressive utilization of existing capacity resulted in more than doubling the fraction of patients seen within one week of discharge.

2 - Question-and-answer Forums For Product Support: Crowdsourcing Service To Customers

Konstantinos Stouras, INSEAD, konstantinos.stouras@insead.edu

Online product support forums where customers can post complaints and questions, or report issues about a product or service of a firm abound. A large number of companies choose to crowdsource their product and service support back to their customers, employing a few dedicated service operators. We characterize the equilibrium behavior of such a novel business model for service and compare it with a call center model.

3 - Scale, Scope And Hospital Productivity: An Empirical Study Of Volume Spillovers Across Hospital Services

Michael Freeman, Judge Business School, University of Cambridge, Cambridge, United Kingdom, mef35@cam.ac.uk, Nicos Savva, Stefan Scholtes

Demand pressures mean that hospitals are increasingly getting bigger (i.e. treat more patients per year) and also more complex (i.e. see patients with more diverse care needs). Although prior work has shown that increased volume is positively associated with patient outcomes, the relationship between volume, complexity, and costs is less-well understood. This paper uses a detailed panel of 130 hospitals in England over a period of nine years to examine the relationship between scale and costs in hospitals by investigating spillovers between treating together related (e.g. same service line, same degree of urgency) and unrelated (e.g. different service lines, different urgency) activity.

4 - Finding A Needle In A Haystack: The Effects Of Searching And Learning On Pick-worker Performance

Robert Batt, Assistant Professor, Wisconsin School of Business, UW-Madison, Madison, WI, United States, bob.batt@wisc.edu, Santiago Gallino

We use a unique dataset from an online apparel retailer to estimate the magnitude of intra-bin search time and what operational and behavioral factors affect it. We find that intra-bin search time increases with both the number of items in the bin and the density of items in the bin (i.e., items per foot). Further, we find that the deleterious effects of bin load and density are attenuated by worker experience. More experienced workers are less impacted by bin load and density than are less experienced workers. We use simulation to show that incorporating these bin load and experience effects into pick assignments and routing can lead to meaningful improvements in pick times.

■ TA31

202C-MCC

Supply Chain Finance and Risk Management

Sponsored: Manufacturing & Service Oper Mgmt, iFORM

Sponsored Session

Chair: Wei Luo, IESE Business School, Av. Pearson 21, Barcelona, n/a, Spain, wluo@iese.edu

1 - The Effectiveness Of Supplier Buy Back Finance: Evidence From Chinese Automobile Industry

Weiming Zhu, University of Maryland, weimingzhu@rhsmith.umd.edu

Facing a budget-constrained buyer, a novel approach for large suppliers is adopting buy-back financing schemes to relieve their downstream partners and reduce channel costs. Through counterfactual analysis, we analyze the efficiency of these financing schemes. We find that such contract agreements can improve channel efficiency over traditional financing methods.

2 - Suppliers As Liquidity Providers

Panos Markou, IE Business School, pmarkou.phd2016@Student.ie.edu, Daniel S Corsten, Reint Gropp

Using a data set of private and public French firms and their suppliers, we examine how supplier financial constraint affects buyer cash holdings. When external financing is costly or unavailable, firms rely on their suppliers for backup liquidity, freeing up cash. Using matching estimators, we show that constrained buyers with unconstrained suppliers hold less cash than buyers with constrained suppliers. This effect persists during the financial crisis, highlighting that suppliers may be viable liquidity sources when banks are not. Finally, not only do buyers with unconstrained suppliers hold less cash, but they adjust cash holdings downwards following a supplier IPO.

3 - Financial Fluctuations Through Dynamic Networks

Stefano Nasini, IESEG School of Management, Paris/Lille, France, s.nasini@ieseg.fr, Mireia Giné, Miguel Antón

Decisions and outcomes of listed enterprises are strongly related by different types of associations, such as supply-chain, competition and partnership. In the context of financial stock markets, we introduce a network-based econometric framework to explain cross-section dependencies of stock prices. After a detailed analysis of the proposed methodology, estimation and forecast are carried out, based on the COMPUSTAT data set (with information about supply-chain, competition and partnership between U.S. listed companies). The inclusion of these pairwise dependencies results in a substantial improvement of the predictive power, in comparison with the standard auto-regressive approach.

4 - Financing Sellers Via E-commerce Platform In The Presence Of Seller Competition

Long Ren, Tsinghua University, renl.12@sem.tsinghua.edu.cn, Lingxiu Dong

Small-business sellers selling products via e-retailing platforms (e.g., Amazon.com, eBay, Taobao) operate under consignment-revenue-sharing (commission) contracts, under which the seller decides his product portfolio, inventory, and selling price. Many of those sellers face capital constraints that limit their ability to build inventory, expand product offerings. We investigate the effect of e-commerce platform backed financing on sellers' operational decisions and the competition landscape.

■ TA32

203A-MCC

Revenue Mgt, Pricing I

Contributed Session

Chair: Syed Asif Raza, Qatar University, College of Business and Economics, Doha, 2713, Qatar, syedar@qu.edu.qa

1 - Reputation-based Pricing In E-commerce Retailing

Renato E de Matta, Associate Professor, University of Iowa, 2360 Mulberry Street, Coralville, IA, 52241, United States, renato-dematta@uiowa.edu, Timothy Joe Lowe, Dengfeng Zhang

We examine a revenue management problem involving an online seller of a seasonal product in an e-commerce setting where consumers are sensitive to both price and seller service rating. This rating is the aggregated consumer perception of service quality and is used as a reputation indicator in setting prices. Using a Markov decision process to model the problem over a finite horizon, we examine the impact of changes in seller service rating and consumer heterogeneity on the seller's optimal pricing policy and expected revenues. Using simulated market settings, we validate our model and compare our pricing policy with two other competing policies.

2 - Research On Pricing Decision Of Remanufacturing Considering Product Disassemblability And Recycling Quality Uncertainty

Juhong Gao, Dr., College of Management and Economics, Tianjin University, Building 25-A No.92 Weijin Road, Nankai, Tianjin, 300072, China, gaojuhong@tju.edu.cn, Mengmeng Li

In this paper, the target of CLSC is to realize the members' profit maximization considering product disassemblability and recycling quality uncertainty. The four different remanufacturing models have been analyzed and the coordination mechanism has been introduced, in which the separation and cooperation model of OEM and IO. Research shows the members obtain less profit when both of OEM and IO are involved into remanufacturing. And OEM's profit is higher in centralized decision; IO still prefers to give up part of the profit and to participate in the cooperation model considering that IO is more easily to be driven out of remanufacturing market by OEM in decentralized decision.

3 - Dynamic Pricing In China's Largest E-retailer JD.com

Dongdong Ge, Professor, Shanghai University of Finance and Economics, School of Information management and eng, 777 Guoding Road, Shanghai, 200433, China, dongdong@gmail.com

In China's largest E-Retailer JingDong(JD.com), there are 20 millions SKUs on sale and 3 million orders made every day. Dynamic pricing in this gigantic system has been recognized a vital issue in company's revenue management operations. In this talk, we briefly introduce our data-driven optimization models and findings with JD.com. We also report our A/B test result, which shows a great improvement in GMV/GP.

4 - Economic Order Quantity Models For Joint Pricing And Greening Effort Decisions With Discounts

Syed Asif Raza, Qatar University, College of Business and Economics, Doha, 2713, Qatar, syedar@qu.edu.qa

Environmental protection and greening concerns have gained greatly emphasis both at the procedures and consumers alike. Nowadays, customers are often willing to pay a premium for environmentally friendly products, however, the investment in greening effort by a firm must yield profitability to a firm. This required the use of contemporary tools from Revenue Management (RM) and pricing. Economic order quantity (EOQ) models are among the most studied in inventory management context. This paper develops EOQ models with joint pricing, greening effort (investment) decision in an RM context. Efficient solution procedure is also proposed to consider the quantity discount in the EOQ models analysis.

■ TA33

203B-MCC

Queueing Models

Contributed Session

Chair: Pedro Cesar Lopes Gerum, PhD Student, Rutgers University, 96 Frelinghuysen Road, CoRE Building, Room 201, piscataway, NJ, 8854, United States, pedro.gerum@rutgers.edu

1 - Mean Value Analysis Of Mixed Queuing Networks

Ivo Adan, Eindhoven University of Technology, Den Dolech 2, Eindhoven, 5600 MB, Netherlands, I.Adan@tue.nl, Vidyadhar Kulkarni

We study a mixed queuing network with multi-server stations. The mixed network has both closed and open network components: it has a fixed number of customers (called permanent customers) that circulate among the service stations indefinitely, and it also serves customers (called transient customers) who enter from outside, visit the stations in a random order and leave. We develop novel mean-value equations for recursively computing the mean queue lengths and mean waiting waiting times, and we study the asymptotic behavior of these quantities in the presence of multiple bottle-neck stations as the number of permanent customers tends to infinity.

2 - Simple And Efficient Ways For Discrete GI/G/1 Queues

Winfried K Grassmann, Professor emeritus, University of Saskatchewan, 110 Science Place, 176 Thorvaldson Building, Saskatoon, SK, S7N 5C9, Canada, grassman@cs.usask.ca

We present a number of simple and not so simple methods to find the distribution of the number of elements in a GI/G/1 queue and related problems. As it turns out, many methods described in literature are mathematically challenging, but this does not imply that they are numerically efficient numerically. In fact, it is our experience that the simpler methods tend to be the most efficient ones, while also easy to understand. This leads to the suspicion that criteria for publication typically favor mathematical elegance over practical usefulness.

3 - A Queueing System With On-demand Servers: Local Stability Of Fluid Limits

Lam M Nguyen, PhD Student, Lehigh University, 200 West Packer Avenue, Room 362, Bethlehem, PA, 18015, United States, lmn214@lehigh.edu, Alexander Stolyar

We consider a system, where a random flow of customers is served by agents invited on-demand. Each invited agent arrives into the system after a random time, and leaves it with some probability after each service completion. Customers and/or agents may be impatient. The objective is to design a real-time adaptive invitation scheme that minimizes customer and agent waiting times. We consider a queue-length-based feedback scheme; study it in the asymptotic regime where the customer arrival rate goes to infinity; and derive a variety of sufficient conditions for the system local stability at the desired equilibrium point. Under these conditions, simulations show good overall performance of the scheme.

4 - Traffic Density Analytical Model Validation And Applications

Pedro Cesar Lopes Gerum, PhD Student, Rutgers University, 96 Frelinghuysen Road, CoRE Building, Room 201, piscataway, NJ, 08854, United States, pedro.gerum@rutgers.edu, Melike Baykal-Gursoy, Marcelo Ricardo Figueroa

This paper compares a general equation for the probability generating function of density for a general road system, discovered by W. Xiao and Baykal-Gursoy, with real data from Milwaukee, Wisconsin. Furthermore, once shown the analytical model is valid, this paper presents some insights in possible applications taken from these formulations. These insights include improving efficiency of evacuation in extreme scenarios, such as flooding or other weather conditions; providing useful information to decision-makers on how to better invest their money in infrastructure; allowing the end-user of a routing system to choose between routes according to the risk of delay he is willing to take.

■ TA34

204-MCC

Provider Staffing and its Impact on Patient Flow

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Retsef Levi, MIT, 100 Main Street, Building E62-562, Cambridge, MA, 02142, United States, retsef@mit.edu

Co-Chair: Cecilia Zenteno, Massachusetts General Hospital, 55 Fruit Street, White 400, Boston, MA, 02114, United States, azentenolangle@mgh.harvard.edu

1 - Ed Physician Staffing Via Multi-stage Multi-class Network

Caglar Caglayan, Georgia Institute of Technology, Atlanta, GA, 30318, United States, ccaglayan6@gatech.edu, Mustafa Y Sir, Kalyan Pasupathy, Turgay Ayer, Yunan Liu

We propose an “intuitive”, “realistic” and “tractable” model of the emergency department (ED) by a multi-class multi-stage queuing network with multiple targeted service levels. Based on infinite-server approximation and offered load analysis, we employ a modified version of square-root safety principle to determine the right number of physicians in the ED. Our model is detailed enough to capture the key dynamics of the ED but simple enough to understand, infer results and implement in a clinical setting.

2 - Discrete Event Simulation Of Outpatient Flow In A Phlebotomy Clinic

Elizabeth Olin, University of Michigan, 1205 Beal, Ann Arbor, MI, 48109, United States, genehkim@umich.edu, Amy Cohn, Ajaay Chandrasekaran

The University of Michigan Comprehensive Cancer Center handles approximately 97,000 outpatient visits annually, with most including a blood draw, clinic appointment, preparation of infusion drugs, and an infusion appointment. The goal of our project is to reduce patient waiting times at the phlebotomy (blood draw) clinic, which appears to be a primary bottleneck in the patient experience. In order to accomplish this goal, we developed a discrete-event simulation of the clinic’s patient and work flow. By adjusting the various simulation parameters, we can evaluate alternative methods to improve turnaround time, patient wait time, and phlebotomist utilization.

3 - Quantifying Provider’s Schedule Effects On Patient’s Length-of-Stay

Kimia Ghobadi, MIT, Cambridge, MA, United States, kimiag@mit.edu, Andrew Johnston, Retsef Levi, Walter O’Donnell

We identify a natural randomized control setting between providers’ schedule and patients arrival in a congested Department of Medicine in a large academic hospital. We use this setting to build a predictive model and quantify the impact of care team handoff on patients’ length-of-stay.

■ TA35

205A-MCC

Online Services: Learning and Pricing

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Yash Kanoria, Columbia University, Graduate School of Business, New York, NY, 10027, United States, ykanoria@columbia.edu

Co-Chair: Vijay Kamble, Stanford University, Stanford, CA, 9, United States, vijaykamble.iitkgp@gmail.com

1 - Efficiency And Performance Guarantees For Network Revenue Management Problems With Customer Choice

David Simchi-Levi, Massachusetts Institute of Technology, Dept of Civil and Environmental Engineering, 77 Massachusetts Avenue Rm 1-171, Cambridge, MA, 02139, United States, dslevi@mit.edu, Wang Chi Cheung

We consider the network revenue management problem with customer choice. While the solution to the Choice-based Deterministic Linear Program (CDLP) can be used to design a near-optimal policy, CDLP has an exponential size. We propose algorithms that solves CDLP with polynomially many elementary operations and invocations to an oracle that solves the underlying single period problems. Next, we design an efficient online algorithm for the problem with MNL choice models, where the parameters are unknown. The algorithm achieves a regret of O(T2/3), where T is the length of the time horizon.

2 - Optimal Version Updates

Gad Allon, Northwestern University, g-allon@kellogg.northwestern.edu

Mobile apps have become an economy with a market size of $25 Billion in 2013 and with a projected market size of $77 Billion by 2017. One of the key features that distinguishes mobile apps from other types of digital goods (such as movies, songs or books) is the they have versions. A developer can release an app into a mobile app store, and can then keep adding, removing or editing features of the app with subsequent version updates. We study empirically and theoretically the optimal strategy for such updates.

3 - Service Systems With Coarse Priorities: The Social Cost Of Revenue Maximization

Martin Lariviere, Northwestern University,
2001 Sheridan Rd, Evanston, IL, 60208, United States,
m-lariviere@kellogg.northwestern.edu, Itai Gurvich, Can Ozkan

We consider how social maximization differs from revenue maximization in a queuing system in which a continuum of customer types is mapped to a finite number of priority classes. The decision maker controls coverage (how many customers to serve), coarseness (how many priority levels to offer), and classification (how types are assigned to classes). We show that both types of decision makers provide similar coverage and coarseness. They differ in how they split customers between classes. Relative to the social planner, the revenue maximizer may have the highest priority class over- or undersubscribed depending on the behavior of the distribution of customer values.

4 - Learning In Online Matching Platforms: Multi-armed Bandits With Capacity Constraints

Vijay Kamble, Stanford University, Stanford, CA, 9, United States,
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We consider the interaction between two central operational challenges for almost any matching platform: on the one hand, new users are continuously arriving, and the platform's goal is to learn the attributes of these users quickly enough to ensure satisfactory matches. On the other hand, learning these attributes typically requires experimenting with matches and observing the outcomes, which is difficult since the supply of entities to be matched to is limited. In this paper we address the correct balance between these activities in such two-sided matching platforms, in the presence of supply constraints.

■ TA36

205B-MCC

Operations and Supply Chains for Innovative Goods

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: Robert Swinney, Duke University, Durham, NC, United States,
robert.swinney@duke.edu

1 - Promoting Innovative Technology In Developing Countries Through Solution-based Contracts

Guangrui Ma, Tianjin University, Tianjin, China,
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Limited knowledge and lack of proper skills make potential users reluctant to purchase innovative technology, e.g., drip irrigation systems, even though it can improve yields incredibly. We show that through solution-based service, firms can help farmers, especially in developing countries, overcome the above knowledge barrier of using the technology, thus leading to higher market adoption and profitability. Besides, a yield-based payment structure can facilitate efficient financial cost saving when farmers face financial constraint, and hence incentivises farmers' adoption further more.

2 - Designing Supply Chains For Substitutable Digital And Physical Goods

Zhenhuan Lei, Duke University, zhenhuan.lei@duke.edu,
Robert Swinney

We consider a firm selling two partially substitutable goods, one digital and one physical, e.g., a downloadable and DVD version of the same movie. The physical good is characterized by non-zero marginal production cost, positive production leadtime, and, potentially, a mismatch between supply and demand. The digital good is characterized by zero marginal cost and no inventory constraints. We consider how market and product characteristics drive the firm to price each product, determine inventory, choose a selling strategy involving one or both goods, and design its supply chain.

3 - Dynamic Stimulus In Crowdfunding

Longyuan Du, University of Toronto, Toronto, ON, Canada,
Longyuan.Du14@rotman.utoronto.ca, Ming Hu, Jiahua Wu

We study the dynamics of online crowdfunding in which a campaign would fail unless a predetermined funding goal is achieved within a given duration. We demonstrate empirically using KickStarter data the significant benefit of dynamically offering stimulus. Motivated by the empirical results, we build a theoretical model to analyze several policies, such as seeding, feature upgrade and promotional discount, and provide the optimal timing of stimulus offerings depending on time- and pledge-to-go. We then illustrate the stimulus policies' benefits using failed projects from Kickstarter.

4 - Food Wastage In Commercial Kitchens

Varun Karamshetty, INSEAD, Fontainebleau, 77300, France,
varun.karamshetty@insead.edu, Elena Belavina, Karan Girotra

Kitchens are wasting as much on food waste as they make in profits. With an estimated $1 trillion in food being wasted every year, food waste is not only a huge economic loss, but also has a major impact on our environment accounting for nearly 15% of global GHG emissions. We analyze proprietary data to understand key drivers of food wastage in commercial kitchens. We identify the controllable factors, and quantify the impact of each of them. We then propose changes in their operations that minimize wastage while maintaining their service quality and bottom-line.

■ TA37

205C-MCC

Sustainability Issues in Supply Chains I

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Saed Alizamir, Yale University, 165 Whitney Ave,
New Haven, CT, 06511, United States, saed.alizamir@yale.edu

1 - Should Brands Tighten Certification Standards

Li Chen, Cornell University, Ithaca, NY, United States,
li.chen@cornell.edu, Shiqing Yao, Kaijie Zhu

Global brands are increasingly relying on third-party certification to screen out low-quality suppliers. However, an unethical certifier may collude with a low-quality supplier to produce a false certification. In this study, we investigate the buyer's equilibrium strategy in setting certification standard under the risk of supplier-certifier collusion.

2 - Can Brands Claim Ignorance? Unauthorized Subcontracting In Apparel Supply Chains

Anna Saez de Tejada Cuenca, PhD Student, UCLA Anderson School of Management, Los Angeles, CA, United States,
anna.sdtc.1@anderson.ucla.edu, Felipe Caro

The collapse of the Rana Plaza building in Bangladesh brought into focus the poor safety conditions faced by many workers in the apparel industry. A common way in which safety and environmental standards are violated is through unauthorized subcontracting. We analyze empirically some factors that can lead suppliers to outsource their production to third parties without their retailers' knowledge. We use data provided by a supply chain manager that consists of over 30,000 orders, including 36% of subcontracted ones. Our results provide managerial insights to retailers on what factory and order characteristics increase the probability of unauthorized subcontracting, and how it can be prevented.

3 - Optimal Production Planing In Agricultural Supply Chains

Utku Serhatli, PhD Student, INSEAD, Constance de le Boulevard,
Fontainebleau, 77590, France, utku.serhatli@insead.edu,
Enver Yucesan, Andre Du Pin Calmon

We model the production decisions of a corn seed manufacturer who faces supply and demand uncertainties, product returns, and quality problems over a finite horizon. More specifically, we build an N-period model to capture the inherent complexities and solve the two-period scenario where we prove the optimality of a base stock policy and show the impact of operational agility on profit. We also investigate the impact of yield variability and return rates on the optimal production quantities. We complement our theory using numerical results with data from a major European agro-chemical company.

4 - Managing A Responsible Supply Chain Under Threat Of Public Disclosure

Saed Alizamir, Yale University, saed.alizamir@yale.edu, Sang Kim

We analyze a game-theoretic model in which a downstream supply chain member ("buyer") is penalized disproportionately due to a compliance violation by an upstream member ("supplier"). Buyer's ability to audit the supplier is limited, and she faces a risk of being publicly blamed after the supplier's violation is caught by a third party. Supplier exerts effort to enhance compliance in each period, but risks having his relationship terminated due to a stochastic compliance outcome.

TA38

206A-MCC

Reliability II

Contributed Session

Chair: Mengmeng Zhu, Rutgers University, Piscataway, NJ, 8854, United States, mengmeng.zhu@rutgers.edu

1 - Optimal Design Of Hybrid Sequential Testing For A System With Mixture Of One-shot Units

Elsayed A Elsayed, Distinguished Professor, Rutgers University, 96 Frelinghuysen Rd, Piscataway, NJ, 08854-8018, United States, elsayed@rci.rutgers.edu

Non Destructive Testing is conducted to determine the functionality of the units without permanent damage in order to estimate the units' reliability. In this presentation, we investigate a system composed of non-identical units with different characteristics and subjected to hybrid reliability testing (Destructive and NDT). It is of interest to optimally design the hybrid sequential reliability testing. After conducting a number of hybrid testing, we decrease the sample size of the destructive testing as the accuracy of reliability metrics estimation improves. Eventually, we only need to conduct NDT only. The efficiency and accuracy of the proposed methods are validated.

2 - Transportation Network Fragility And Economic Losses

Narges Kaveshgar, University of South Carolina, 300 Main Street, Department of Civil and Environmental Engineering, Columbia, SC, 29208, United States, kaveshga@email.sc.edu, Nathan Huynh, Joseph Von Nessen

Interdependencies between the transportation system and other critical infrastructures necessitate the need to protect it to achieve system resiliency. Current study develops a methodology to quantify the robustness and investigate the reliability of transport network under extreme events. To this end, perishable field data is collected to determine the impact of the recent road and bridge closures caused by historic rainfall event in South Carolina to the traveling public and businesses.

3 - Analyzing Coastal Highway Network Reliability In Hurricane Flooding Surge Through Geographic Information System

Lei Bu, Institute for Multimodal Transportation, Jackson, MS, United States, leibu04168@gmail.com, Feng Wang

Reliability is related to the ability of a network to carry out desire traffic flow which includes node to node blocking or delay. Based on the history data of hurricane flooding surge in Gulf coastal region, coastal highway network reliability is analyzed using a geographic information system. Spatial statistics and analyst methods based on density, geographic distribution and bilinear interpolation are used to calculate point density, Z score and hot spots for the hurricane flooding surge data. Based on the spatial statistics and analyst results, the blocking or delay links, namely, nodes to nodes, on highway network are found to determine the network reliability.

4 - Two Phase Imperfect Debugging And Imperfect Fault Removal Software Reliability Modeling

Mengmeng Zhu, Rutgers University, Piscataway, NJ, 08854, United States, mengmeng.zhu@rutgers.edu, Hoang Pham

A software reliability modeling considering software fault type and multi-phase debugging process is proposed in this paper. Type I fault and Type II fault represent independent and dependent software fault during debugging, respectively. Two-Phase debugging process are discussed in the model development. Additionally, a small portion of software faults that software testers are not able to remove is included in this study due to the limitation of resource and knowledge.

TA39

207A-MCC

Artificial Intelligence in Big Data

General Session

Chair: Xiao Liu, University of Arizona, 1300 E. Fort Lowell Road G109, Tucson, AZ, 85719, United States, xiaoliu@email.arizona.edu

1 - Does Interim Winner's Performance Information Playa Role? An Empirical Investigation Of The Rank-order Newsvendor Contests

Abraham Seidmann, Simon Business School, University of Rochester, Simon Business School, Dir of OR Dept, Rochester, NY, 14627, United States, avi.seidmann@simon.rochester.edu, Tong Wu

Many firms award bonuses to their employees based on their relative performance. When facing newsvendor-type decisions under this type of inter-worker competition, firms need to consider what type of information to disclose to the employees from period to period in order to achieve better outcomes in the long run. Using a laboratory experiment, we find that publicly displaying the winner's performance information every period can significantly improve individuals' overall newsvendor decision making compared to the control group, although the pull-to-center effect is observed. Using another experiment, we find that impulsivity can explain the observed pull-to-center bias.

2 - Big Data In The Healthcare And Wellness Industry

Stephen J Stoyan, Director, Business Analytics and Strategy, Abbott Laboratories, 100 Abbort Park Road, Chicago, IL, 60064, United States, stephen.stoyan@abbott.com

Today's healthcare and wellness industry is dynamic, competitive, and global demands require extremely high volume. Keeping your supply chain lean and efficient is imperative to driving cost savings. Staying competitive requires a sales campaign that is connected to customers at new levels. Big data and advanced analytics are integral parts of the business that provide supply chain efficiencies and top line growth through strategic and operational initiatives. Analytically tuned tools are discovering new opportunities, making connections, and creating business value streams in areas not well understood. We present big data initiatives at Abbott Laboratories and their impact on the business.

3 - Sales Assistance Search And Purchase Decisions An Analysis Using Retail Video Data

Aditya Jain, Baruch College, Zicklin School of Business, 55 Lexington Ave, Suite 9-240, New York, NY, 10010, United States, aditya.jain@baruch.cuny.edu, Sanjog Misra, Nils Rudi

We investigate the roles of sales assistance and search in driving customer's purchase decision using unique observational video data from retail stores. Our analysis reveals that both sales assistance and search play substantial roles which differ based on the context of specific decisions—search has a more dominant role in purchase incidence, whereas the latter in conditional expenditure.

4 - Mining E-cigarette Adverse Events Using The LSTM-based RNN Model With Word Embeddings Features

Jiaheng Xie, University of Arizona, Department of Management Information Systems, Tucson, AZ, 6, United States, xiej@email.arizona.edu

The past years have witnessed increased popularity of e-cigarette use across the world. However, the risk of cartridge fluids and emissions is relatively under-examined due to limited user sample size. Social media provide a large corpus that contains e-cigarette related information. In order to study the e-cigarette adverse effects in a more comprehensive manner, we propose to study the adverse events of e-cigarette with a large volume of health social media data. The challenges in e-cigarette safety social media monitoring lie in identifying relevant adverse events reported by consumers in noisy social media content with high accuracy. The current automatic entity recognition methods have unsatisfying performance due to consumer vocabulary used in social media. To address this issue, we developed a Long Short Term Memory (LSTM) based Recurrent Neural Network (RNN) model to extract the medical entities. Based on our results, our proposed LSTM-based RNN model with word embeddings achieved better entity extraction performance, with a precision of 90.58%, recall of 82.43% and f-score of 86.31%. We identified 1,212 adverse event entities, 397 e-cigarette component entities (chemicals, flavors, and brands) and the corresponding component-event relationships. Since certain e-liquid chemicals, flavors and e-cigarette brands are significantly associated with adverse events, regulatory actions are in need. Certain flavors and brands should also be controlled due to their adverse events.

TA40

207B-MCC

Markov Decision Processes: Applications

Sponsored: Applied Probability

Sponsored Session

Chair: Jie Ning, Case Western Reserve University, 11119 Bellflower Rd, Case Western Reserve University, Cleveland, OH, 44106, United States, jie.ning@case.edu

Co-Chair: Matthew J Sobel, Case Western Reserve University - Retired, 11119 Bellflower Rd, Case Western Reserve University, Cleveland, OH, 44106, United States, matthew.sobel@case.edu

1 - Optimal Policies For Risk-averse Electric Vehicle Charging With Spot Purchases

Daniel Jiang, University of Pittsburgh, Pittsburgh, PA, 15261, United States, drjiang@pitt.edu, Warren B Powell

We consider the sequential decision problem faced by the manager of an electric vehicle (EV) charging station, who aims to satisfy the charging demand of the customer while minimizing cost. We formulate the problem as a finite horizon Markov decision process (MDP) and provide an analysis of the effect that risk parameters, e.g., the risk-level used in CVaR, have on the structure of the optimal policy. We show that becoming more risk-averse in the dynamic risk measure sense corresponds to the intuitively appealing notion of becoming more risk-averse in the order thresholds of the optimal policy.

2 - On The Optimal Timing Of Meld Score Updates In The Liver Transplantation System

Sepehr Nemati, Ivey School of Business, 1255 Western Road, Ivey Business School, London, ON, N6G 0N1, Canada, sproon@ivey.uwo.ca, Zeynep Icten, Lisa N Maillart, Andrew J Schaefer, Mark Roberts

Patients on the waiting list for liver transplants have opportunities to game the system by concealing changes in their health status. We formulate a model that determines, as a function of the last reported health status, current health status, days until the next required update and the quality of the current liver offer, whether the patient should do nothing, report her current health status, or accept the current liver offer (if any) to maximize expected lifetime. We analyze the degree to which a patient can benefit from the flexibility inherent to the current reporting requirements.

3 - Operational And Financial Decisions Within Proportional Investment Cooperatives

Xiaoyan Qian, PhD Student, University of Auckland, 12 Grafton Road, Auckland, 1010, New Zealand, x.qian@auckland.ac.nz, Tava Olsen

In a proportional investment co-op, operational and financial decisions are inseparable because members' capital investment is required to be in proportion to their economic transactions with the co-op. In agriculture where yield and market are uncertain, we propose a Markov decision process wherein the decisions of processing quantity interact with the financial decisions of retained earnings and short term loans. The results include: (1) characterization of the value function and the optimal policy; (2) explicit expressions for the deterministic-yield dynamic program; and (3) identification of financial risks. Keywords: cooperative; finance and operations; coordination.

4 - Easy Affine Markov Decision Processes: Applications And Algorithms

Jie Ning, Case Western Reserve University, jie.ning@case.edu, Matthew J Sobel

Affine Markov decision processes (MDPs) with continuous state and action vectors and decomposable constraints on actions have unique features that free them from the curse of dimensionality. Exploiting the properties of affine MDPs (a companion paper presented in another session), we present algorithms that efficiently compute an optimal policy and the value function. We show that affine MDPs are applicable in a variety of decision-making contexts such as fishery management and advertising, and that the optimal policies generate qualitative insights.

■ TA41

207C-MCC

Quantitative Methods in Finance VI

Sponsored: Financial Services

Sponsored Session

Chair: Xuefeng Gao, The Chinese University of Hong Kong, William MWM Engineering Building, Shatin, NA, Hong Kong, xfgao@se.cuhk.edu.hk

1 - A Primal-dual Iterative Method For Stochastic Dynamic Programming And Its Applications

Nan Chen, Chinese University of Hong Kong, nchen@se.cuhk.edu.hk

Due to the curse of dimensionality, people often rely on computationally tractable, but suboptimal, heustric policies to solve stochastic dynamic programs (SDP). Our work develops a recursive approach from the technique of information relaxation to obtain a sequence of confidence intervals for SDP optimal value. The width of the confidence interval can be used to measure the quality of currently used heuristics. We also show the resulting intervals converge in a finite number of iterations to the true value. Thereby our approach presents a systematic way to improve the quality of control polices. Two applications in optimal trading execution and network revenue management are discussed.

2 - Operational Risk Management: Coordinating Capital Investment And Firm Growth

Lingjiong Zhu, Florida State University, zhu@math.fsu.edu

We consider a jump-diffusion model to analyze the impact on a firm's value of small shocks caused by market risk events and large shocks caused by operational risk events. We consider the investments in the infrastructure of a firm that aims at mitigating the impact of operational risk events through changes in the stochastic nature of the large shocks. We study the investment strategies in two settings: the maximization the firm's value over a fixed investment horizon and the minimization of the ruin probability over an infinite horizon. This is based on the joint work with Yuqian Xu and Mike Pinedo.

3 - Limit Theorems For Hawkes Processes With A Large Initial Intensity

Xuefeng Gao, The Chinese University of Hong Kong, xfgao@se.cuhk.edu.hk

Hawkes process is a class of simple point processes that is self-exciting and has clustering effect. The intensity of this point process depends on its entire past history. It has wide applications in finance, neuroscience, social networks, criminology, seismology, and many other fields. In this paper, we study the linear Hawkes process with an exponential kernel in the asymptotic regime where the initial intensity of the Hawkes process is large. We derive limit theorems for this asymptotic regime as well as the regime when both the initial intensity and the time are large. The limit theorems could be useful for approximating the transient behavior of Hawkes processes.

4 - Testing The Capital Asset Pricing Model Under Economic Regime Shifts

Yonggan Zhao, Professor, Dalhousie University, 6100 University Avenue, Suite 2010, Halifax, NS, B3H 4R2, Canada, yonggan.zhao@dal.ca

We present a dynamic version of the Capital Asset Pricing Model (CAPM) with economic regime shifts. Assuming the equilibrium security returns are characterized by economic indicators, we test the hypotheses that risk premiums on financial securities are asymmetric across economic regimes with positive risk premium in the expansion regimes and negative risk premium in the contraction regimes. Using a sector rotation investment strategy, the superiority of the dynamic CAPM to the traditional CAPM in predicting stock returns is shown.

■ TA42

207D-MCC

Choice Models and Assortment Optimization

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Sumit Kunnumkal, Indian School of Business, Hyderabad, India, sumit_kunnumkal@isb.edu

1 - Assortment, Pricing And Market Expansion

Ruxian Wang, Johns Hopkins Carey Business School, Baltimore, MD, 21202, United States, ruxian.wang@jhu.edu

We incorporate market expansion into consumer choice models and investigate the revenue management problems. We characterize the structure of the optimal policies for the problems under the consumer choice models with various market expansion effects, and develop efficient algorithms.

2 - Assortment Planning Decision In Two-sided Market

Ying Cao, University of Texas at Dallas, Ying.Cao@utdallas.edu, Dorothee Honhon, Sridhar Seshadri

We consider a firm which makes product assortment decisions when facing a two-sided market, which means it receives revenues from two distinct groups. We obtain structural properties of the optimal assortment and theoretical bounds on the performance of heuristic policies, showing the value of considering both sides of the market.

3 - A Near-optimal Exploration-exploitation Approach For Assortment Selection

Vashist Avadhanula, Columbia University, New York, NY, 10027, United States, va2297@columbia.edu, Shipra Agrawal, Vineet Goyal, Assaf Zeevi

We consider a dynamic assortment optimization problem where customers choose according to an unknown MNL choice model. In each period, we offer an assortment of at most K products out of N and observe the customer's choice to learn the model parameters. We present an exploration-exploitation policy that achieves a near-optimal worst case regret of $\tilde {O}(\sqrt{NT})$. Our policy is based on the principle of optimism under uncertainty and does not require any separability assumption on the parameters. We also present a nearly matching lower bound of $\Omega(\sqrt{NT/K})$ for this problem.

4 - New Bounds For Assortment Optimization Under The Nested Logit Model

Sumit Kunnumkal, Indian School of Business, sumit_kunnumkal@isb.edu

We consider the assortment optimization problem under the nested logit choice model. We establish new bounds on the quality of revenue ordered assortments.

■ TA43

208A-MCC

Data-Driven Decision Making

Sponsored: Decision Analysis

Sponsored Session

Chair: Hiba Baroud, Assistant Professor, Vanderbilt University, 2301 Vanderbilt Place, PMB# 351831, Nashville, TN, 37212, United States, hiba.baroud@vanderbilt.edu

1 - Combining Data And Weakly Informative Priors To Make Better Decisions Faster

Adam Jason Fleischhacker, University of Delaware, ajf@udel.edu

In tackling decision problems, a decision maker must choose how to represent uncertainty using techniques that may be classified on a spectrum; on one end you have fully specified distributions which make strong assumptions, and on the other end, completely non-parametric and robust approaches which minimize assumptions. In this work, we develop and use an analytically tractable model of uncertainty that can model mild assumptions and which can more rapidly extract value from data than non-parametric approaches.

2 - Projection Of Drought Risk For Thermoelectric Power Plants Using Downscaled Climate Scenarios

Royce Francis, Assistant Professor, George Washington University, Washington, DC, 20052, United States, seed@email.gwu.edu

Many climate researchers have studied a number of climate forcing scenarios to determine how the coupled oceanic-atmospheric systems will respond. At the same time, these responses will be part of a complex feedback loop with infrastructure systems. Thus, it is important to help infrastructure decision makers incorporate climate scenarios into risk and reliability assessments. This presentation demonstrates a Copula Bayesian Network for projecting thermoelectric power plant drought risk over CMIP5 downscaled climate scenarios.

3 - Data-driven Decision Analysis Model For Planning And Management Of Multiple Purpose Reservoir Cascade Systems

Thushara De Silva, Vanderbilt University, 400 24th Avenue South, 267 Jacobs Hall, Nashville, TN, 37212, United States, thushara.k.de.silva@vanderbilt.edu, George Hornberger, Hiba Baroud

The objective of this study is to develop a decision analysis model for the planning and management of water resources that maximizes multiple objectives such as economic viability, environmental sustainability, and social development. The model is deployed to the Mahaweli water resources development which is the largest multipurpose project of Sri Lanka. A multicriteria decision analysis model is considered and several data sources are used to assess the multiple attributes in the model. The utility function incorporates the preferences of multiple decision makers to assess the weights on the attributes.

4 - Using Data In Decision Making: Big Data, Little Data, No Data

Hiba Baroud, Vanderbilt University, hiba.baroud@vanderbilt.edu

The role of data analytics in decision making has evolved as the volume of data changed and the tools and technologies to handle such data improved. Are decision makers overwhelmed with data or do they still lack the amount of data they need to improve their decision models? This work is a review of the current state of the art of the use of data-driven tools in decision analysis techniques in practice and theory. The objective is to identify gaps between data and decisions while highlighting opportunities and challenges in research.

■ TA44

208B-MCC

Investment Analysis and Financial Applications

Sponsored: Decision Analysis

Sponsored Session

Chair: Manel Baucells, University of Virginia Darden School of Business, 100 Darden Blvd, Charlottesville, VA, 22903, United States, baucellsm@darden.virginia.edu

1 - Net Present Value Analysis And Individual Utility

Manel Baucells, University of Virginia Darden School of Business, baucellsm@darden.virginia.edu, Sam Bodily

Standard investment analysis employs expected Net Present Value discounting at a risk-adjusted market return. Such prescription takes the viewpoint of the capital market, but neglects the risk aversion of the project owner or the individual investor. We develop an approach that is consistent with expected utility, and requires the integration of project and market returns. The approach recommends the use of the certainty equivalent discount rate, which depends on both the market and the risk aversion of the individual. We explore conditions in which market returns can be omitted from the analysis; or in which our approach particularizes into the standard analysis.

2 - An Expected Utility Approach For The Mean-variance Portfolio Problem

Felipe Macedo de Morais Pinto, Universidade Federal de Pernambuco, Caixa Postal 7471, Recife, 50630971, Brazil, felipe_mmp94@hotmail.com, Adiel T de Almeida Filho

This paper presents an expected utility approach for decision makers with exponential utility behavior as an alternative to the mean-variance approach when considering a financial portfolio. The DA framework is used for modeling the classical Markowitz's portfolio decision problem incorporating a Bayesian perspective, which allows to include aspects such as the evaluation of macroeconomic environment and minimizing the Bayes Risk. A numerical application is presented based on financial data for an investment decision evaluating a portfolio of DOW 30, FTSE 100 and NASDAQ 100.

3 - A Bayesian Approach For Consumer Credit Debt Collections Process

Adiel T de Almeida Filho, Assistant Professor, Universidade Federal de Pernambuco, Caixa Postal 7471, Recife, 50630971, Brazil, adieltaf@cdsid.org.br, Mee Chi So, Christophe Mues, Lyn C Thomas

After a borrower defaults on their repayment obligations, collectors of unsecured consumer credit debt have a number of actions they can take to secure some repayment of the debt. The operations management challenge in this setting is to decide which of these actions to take, how long to take them, and in what sequence to take them. In this paper, a Bayesian Markov Decision Process (MDP) model is used to find an optimal policy of what action to undertake in the next period given the current information on the individual debtor's repayment performance thus far.

4 - An Analytic Method For Investment Analysis In Mulichannel Retailing

Somayeh Yasamin Salmani, Drexel University, 2007 Chestnut Street, Apt D2, Philadelphia, PA, 19103, United States, ss3858@drexel.edu, Fariborz Partovi

We propose a two-stage stylized model to help firms in making a major strategic decision in distribution channels investment. Our study is motivated by firms that provide multiple channels for customers. We develop an analytic model using customer input and operating costs for specific channel structures to find optimal investing allocation across different distribution channels.

■ TA45

209A-MCC

Efficient Learning in Stochastic Optimization

Sponsored: Simulation

Sponsored Session

Chair: Ilya O. Ryzhov, University of Maryland, 4322 Van Munching Hall, College Park, MD, 20742-1815, United States, iryzhov@rhsmith.umd.edu

1 - Continuous Learning For Contextual Bandits With Nonstationary Rewards

John G Turner, University of California Irvine, Irvine, CA, United States, john.turner@uci.edu, Amelia C Regan, Tianbing Xu, Yaming Yu

We study how best to match ads to viewers using high-dimensional contextual features (demographic, browsing behavior) to predict click-through probability. Using Thompson Sampling in a Bayesian framework, our model learns the importance of contextual features while adapting/forgetting over time, capturing changing individuals' tastes and shifts in the viewing population's composition.

2 - Bayesian Bandits For Sequential Clinical Trials Of Multiple Technologies

Ozge Yapar, University of Pennsylvania, Philadelphia, PA, United States, yapar@wharton.upenn.edu, Stephen E Chick, Noah Gans

We extend recent work on fully sequential trials for health technologies that explore the potential benefits of linking Phase III trials with health technology assessments for market access. We take a bandit perspective that uses Bayesian learning about multiple health technologies.

3 - Vssa – A Variable Sample-size Stochastic Approximation Schemes For Stochastic Convex Optimization

Uday V. Shanbhag, Pennsylvania State University, udaybag@engr.psu.edu, Afrooz Jalilzadeh, Jose Blanchet, Peter W Glynn

Traditional stochastic approximation (SA) schemes employ a single gradient or a fixed batch of noisy gradients in computing a new iterate. We consider SA schemes in which Nk samples are utilized at step k and the total simulation budget is M. This paper derives error bounds in this budget-constrained regime in both strongly convex and convex regimes with constant and increasing sample-sizes. Notably, trade-offs between sample-complexity and computational complexity are examined. Preliminary numerics suggest that such avenues provide approximate solutions in less than a hundredth of the time taken by standard SA schemes with modest drops in accuracy.

4 - A New Consistency Theory For Approximate Bayesian Inference

Ye Chen, University of Maryland, yechen@math.umd.edu, Ilya O Ryzhov

Approximate Bayesian inference is a powerful methodology for constructing statistical learning mechanisms in problems where incomplete information is collected sequentially. Approximate Bayesian models have been widely applied, but the convergence or consistency results for approximate Bayesian estimators are largely unavailable. We develop a new consistency theory for these learning schemes by interpreting them as stochastic approximation (SA) algorithms with additional "bias" terms. We prove the convergence of a general SA algorithm of this type, and through this, for the first time, show the consistency of several approximate Bayesian methods from the recent literature.

■ TA46

209B-MCC

Dynamic Games and Applications to Revenue Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Konstantinos Bimpikis, Stanford, Stanford, Palo Alto, CA, 94305, United States, kostasb@stanford.edu

1 - Dynamic Selling Mechanisms For Product Differentiation And Learning

N. Bora Keskin, Duke University, Durham, NC, United States, bora.keskin@duke.edu, John R Birge

We consider a firm that designs a menu of vertically differentiated products for a population of customers with heterogeneous quality sensitivities. The firm faces an uncertainty about production costs. We characterize the structure of the firm's optimal dynamic learning policy and construct simple and practically implementable policies that are near-optimal.

2 - When Fixed Price Meets Priority Auctions: Service Systems With Dual Modes

Krishnamurthy Iyer, Cornell University, kriyer@cornell.edu, Jiayang Gao, Huseyin Topaloglu

We consider a service system where service is offered via two modes. The first mode charges a fixed price, and the service discipline is FIFO. In the second mode, called the bid-based priority mode, customers submit a bid, obtain service in the descending order of their bids, and make payments equal to their bids. We assume the customers have heterogeneous waiting costs, and choose the service mode strategically on arrival. We establish the existence and uniqueness of a symmetric equilibrium, which has a simple threshold structure: customers with either high or low waiting cost obtain service from the bid-based priority mode, whereas those with moderate waiting cost obtain service from the FIFO mode.

3 - Customizing Marketing Decisions Using Field Experiments

Spyros Zoumpoulis, INSEAD, spyros.zoumpoulis@insead.edu, Theodoros Evgeniou, Duncan I Simester, Artem Timoshenko

We investigate how firms can use the results of field experiments to optimize marketing decisions, and in particular allocating different promotional offers to different customer segments for the customer acquisition problem of a large retailer. In the first stand of the work, we solve the problem of finding the optimal one-shot promotion policy: what promotional offer should be sent to what customer segment? In the second strand of the work, we solve the problem of optimally retargeting nonrespondents through promotions in multiple waves: what customer segment should we stop mailing to, and for what segment would we benefit from repeated promotions?

■ TA47

209C-MCC

Personalized E-commerce

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Van Anh Truong, Cornell University, Ithaca, NY, United States, vat3@cornell.edu

1 - Distribution-free Pricing

Ming Hu, University of Toronto, Toronto, ON, Canada, Ming.Hu@rotman.utoronto.ca, Hongqiao Chen

We study a monopoly robust pricing problem in which the seller does not know the customers' valuation distribution but knows its mean and variance. Such minimum requirement of information is nothing but asking two questions: How much your targeted customers are going to pay on average? And how sure are you? We obtain the best robust price heuristic in closed form and provide its distribution-free, worst-case performance bound. We then provide easily verifiable distribution-free sufficient conditions to guarantee the pure bundle to be more profitable than separately sales. We illustrate the benefit of bundling by a couple of practical examples such as subscription services of digital music.

2 - Revenue Management With Consumer Search Cost

Zizhuo Wang, University of Minnesota, Minneapolis, MN, United States, zwang@umn.edu, Yan Liu, William L Cooper

We consider a pricing problem in which the product valuations are uncertain to the consumers. The consumers can find the valuation of the product by incurring a search cost. We study the seller's problems of whether it should lower the search costs of the products, and what prices it should charge. We find that when there are two products, lowering the search cost of one product while maintaining a high search cost for the other product may be optimal. We also show how our results vary depending on the correlation between the uncertainty of the products.

3 - Approximation Algorithms For Product Framing And Pricing

Anran Li, Columbia University, al2942@columbia.edu

We propose one of the first models of "product framing" and pricing. Product framing refers to the way consumer choice is influenced by how the products are displayed. We present a model where consumers consider only products in a random number of top web pages. Consumers select a product from these pages following a general choice model. We show that the product framing problem is NP-hard. We derive algorithms with guaranteed performance relative to an optimal algorithm under reasonable assumptions. We also present structural results for pricing under framing effects. At optimality, products are sorted in descending order of quality, and prices are shown to be page dependent.

■ TA48

210-MCC

Social Media Analysis II

Invited: Social Media Analytics

Invited Session

Chair: Yen-Yao Wang, Michigan State University, 5211 Madison Avenue, Apartment A5, Okemos, MI, 48864, United States, wangyen@broad.msu.edu

1 - A Unified Framework For Credit Evaluation For Internet Finance Companies

Meheli Basu, Graduate Research Assistant, University of Pittsburgh, 5820 Elwood Street, APT 33, Pittsburgh, PA, 15232, United States, meb209@pitt.edu

We developed and detailed a multi-criteria decision-making framework based on interface of the subjective approach of analytical hierarchical process (AHP) and validated by comparative analysis using the objective approach of data envelopment analysis (DEA) to evaluate credit index. Our framework identifies and weighs the most important characteristics of SMEs and start-ups which contribute to overall credit rating. Although our target implementation group is the internet finance industry, our framework for credit evaluation will also give start-ups and SMEs an insight into favorable criteria for a good credit standing.

3 - Advances In Social Media Analytics For Ultra-low Latency Fintech Applications

Martin M Spollen, Queen's University, Belfast, BT9 5JX, United Kingdom, m.spollen@qub.ac.uk

This presentation will discuss some recent advances in adaptive machine learning designed to extract more reliable capital markets foresight from streaming social media firehose data. Such techniques must keep pace with the rapidly evolving human language used on social media and deliver outputs with a minimum of latency for real time applications for Hedge Funds and High Frequency Algorithmic Traders.

4 - Momentum In Social Media And Sale Performance After Automobile Recalls

Yen-Yao Wang, Michigan State University, N204 Business College Complex, East Lansing, MI, United States, wangyen@broad.msu.edu, Tawei Wang, Roger Calantone

Due to the unique nature of social media, many firms have turned their attentions to social media to manage their recall campaigns. However, the role of social media before and after recalls has not received a more detailed examination. The purpose of this paper is to (1) assess the impact of social media on customers' attentions to US mid-size vehicle recalls, and (2) examine the role of momentum in social media before and after the recall process. We obtained all mid-size automobile recall events and supplemented with social media data on customers' discussions on defected vehicles and firms' recall process from around 1,000 different social media platforms from 2010 to 2015.

■ TA49

211-MCC

Classroom Activities

Sponsored: Education (INFORMED)

Sponsored Session

Chair: Vincent Hargaden, Assistant Professor, University College Dublin, 209 Engineering & Materials Science Centre,, Belfield, 00000, Ireland, vincent.hargaden@ucd.ie

1 - An Interactive Spreadsheet Based Game For Teaching Design Of Experiments And Response Surface Methodology

Anthony Bonifonte, Georgia Institute of Technology, ABonifon@gatech.edu

Experimentation is a key feature of many scientific and engineering disciplines. This presentation describes an interactive spreadsheet based game implemented in a quality control course. The game is designed to simulate an industrial or laboratory experimentation process and develops skills in design of experiments, response surface methodology, optimization, and statistical analysis. The game is appropriate for the undergraduate or masters level and relevant for any course that teaches experimentation.

2 - Using Jupyter Notebook In The Operations Research Classroom

Nelson A Uhan, United States Naval Academy, uhan@usna.edu

Jupyter Notebook is an interactive computational environment that allows you to create documents that contain live code, text, equations, and visualizations. As a result, Jupyter Notebook can be a very useful teaching and learning tool for classes with a considerable emphasis on programming and computation. In this talk, I will share my experience with using Jupyter Notebook in undergraduate operations research classes, and discuss some of my plans for using it in the future.

3 - Analysis And Design Of Discrete Material Flow Systems: A Virtual Industrial Engineering Systems Pilot Laboratory

United States, dima.nazzal@isye.gatech.edu, Leon McGinnis, Timothy Sprock, George Thiers

In this project we redesigned a core undergraduate course that focuses on the analysis and design of discrete material flow systems. We partnered with MathWorks to use Matlab and created a virtual Industrial Engineering systems lab; a suite of computational components that enable students to "experiment" not just with the kinds of analytic models we routinely teach, but also with computational models of versions of the systems they represent where the simplifying assumptions are relaxed. This talk will illustrate samples of the computational tools we developed and how they were integrated into the course and utilized to enhance students' understanding of the key concepts covered in this course.

4 - Teaching Earned Value Analysis Using A Classroom-based Dice Game

Vincent Hargaden, Assistant Professor, University College Dublin, 209 Engineering & Materials Science Centre, Belfield, Ireland, vincent.hargaden@ucd.ie, Virpi Turkulainen

We describe the use and evaluation of a classroom based dice game to teach the concept of Earned Value Analysis. A summary of the game and teaching materials will be outlined. We describe how the perceived effectiveness of the game as a teaching tool was measured among different cohorts of students.

■ TA50

212-MCC

SpORts: Sports Analytics Education

Sponsored: SpORts

Sponsored Session

Chair: Keith A Willoughby, University of Saskatchewan, 25 Campus Drive, Saskatoon, SK, S7N 5A7, Canada, willoughby@edwards.usask.ca

1 - Bracketology: How Business Analytics Can Help You Fill Out Your Bracket

Michael Magazine, University of Cincinnati, mike.magazine@uc.edu

This course is open to advanced undergraduates/graduate students with at least one course in probability and statistics. It meets over three Saturdays -one each in February, March and April. The course covers research papers that both determine the probability that one team beats another and also how brackets should be formed and filled out. One class is devoted to student teams acting as the selection committee and justifying how they form brackets. Students and instructors (I co-teach this with Paul Bessire, an ex-student who is founder of Predictionmachine.com) compete in a bracket challenge and prizes awarded to the best performers. The last class has included visitors, like Joe Lunardi of ESPN.

2 - When Is It Ok Not To Score? Teaching Decision Analysis With The Sport Of Curling

Keith A Willoughby, University of Saskatchewan, Saskatoon, SK, Canada, willoughby@edwards.usask.ca, Kent J. Kostuk

The object of sports is to outscore your opponent. Curling is a winter team sport popular in Canada, Europe, the northern United States and the Pacific Rim. In the sport of curling, teams may encounter a crucial decision in the latter stages of the game; namely, should they score a point (thereby providing last-shot advantage to the opposition in subsequent stages of the game) or deliberately fail to score a point (thus retaining last-shot opportunity in the next part of the match)? We develop a model for this particular scenario that can be used to teach introductory decision analysis.

3 - A Playbook For Teaching Sports Analytics To Undergraduate Business And MBA Students

Scott Nestler, University of Notre Dame, snestler@nd.edu

Last year, the presenter taught a half-semester length course (2 credits for MBA students, 1.5 credits for undergraduates) in Sports Analytics for the first time at the University of Notre Dame. Offensive plays — reaching out to faculty members at other schools who had taught a similar course yielded many great examples; allowing students freedom to use whatever tool or coding language they were comfortable with for the course project. Defensive plays — selecting Excel as a common language for class examples to account for difference in technical preparation (may revisit for next semester with a more pro-style scheme that incorporates R); using a known but somewhat dated text (Winston's "Mathletics"). Please come listen and your experiences in teaching quantitative techniques using a subject matter that students are truly excited about.

■ TA51

213-MCC

Lifting up Populations

Sponsored: Public Sector OR

Sponsored Session

Chair: Feyza Guliz Sahinyazan, McGill University, Desautels Faculty of Management, Montreal, QC, HA 1G5, Canada, feyza.sahinyazan@mail.mcgill.ca

1 - Resilience-based Post-disaster Recovery Strategies For Community Road-bridge Networks

Weili Zhang, University of Oklahoma, 202 W. Boyd St., Room 116, Norman, OK, 73019, United States, weili.zhang-1@ou.edu, Naiyu Wang, Charles Nicholson

This paper presents a novel resilience-based framework to optimize the scheduling of the post-disaster recovery actions for community road-bridge transportation networks. Two metrics are proposed for measuring rapidity and efficiency of the network recovery: the TRT is the time required for the network to be restored to its pre-hazard functionality level, while the SRT is a metric defined for the first time in this study to capture the characteristics of the recovery trajectory that relate to the efficiency of those restoration strategies considered. Based on this two-dimensional metric, we propose a restoration scheduling method for optimal post-disaster recovery planning.

2 - A Multi-objective Optimization Model For Mitigating Community Economic Loss And Population Dislocation

Weili Zhang, University of Oklahoma, 202 W. Boyd St., Room 116, Norman, OK, 73019, United States, weili.zhang-1@ou.edu, Charles Nicholson

Decisions regarding allocation of limited resources to improve the infrastructure components are complex and involve various tradeoffs. In this study we develop a mathematical model that incorporates expected building damage from an earthquake, an estimate of the value of monetary loss from damaged buildings, and a likelihood of families to be dislocated based on the damage to the housing stock to determine which types of buildings should be prioritized for code level improvements given a variety of external constraints. The model is applied to the well-developed virtual city, Centerville, designed collaboratively by a team of engineering experts, economists, and social scientists.

3 - A Data-driven Approach On Training Set Optimizaton For Genomic Selection In Plant Breeding

Guiping Hu, Iowa State University, guiping.hu.2011@gmail.com, Shiyang Huang

We propose a data-driven approach for training set optimization in genomic selection for plant breeding. To deal with the enormous scaled genetic data, we extract specific information according to the stages of decision making. The data are processed and analyzed with different tools, including data mining and stochastic process analysis. With the analytic tool, the plant breeding process is expected to accelerate with high throughput.

4 - How To Provide Food Aid In Kenya: In Kind, Cash Or Voucher?

Feyza Guliz Sahinyazan, PhD Candidate, McGill University, 1001 Sherbrooke Street West, Montreal, QC, H3A 1G5, Canada, feyza.sahinyazan@mail.mcgill.ca, Marie-Ève Rancourt, Vedat Verter

As of 2016, there are still more than 800 million people dealing with hunger who are mostly located in Sub-Saharan Africa. Recently, relief efforts of humanitarian organizations are shifting from in-kind food aid to different food assistance programs. There are multiple reports suggesting that providing cash or vouchers can be significantly more effective compared to in-kind food distribution. However, our study is the first attempt to mathematically formulate the aid modality selection problem. We develop a flexible methodology that can adjust to the ever-changing dynamics of the food assistance environment using real data from Kenya.

■ TA52

214-MCC

Transportation Issues in Smart Cities

Sponsored: Public Sector OR

Sponsored Session

Chair: Leila Hajibabai, WSU, 405 Spokane St, Pullman, WA, 99163, United States, leila.hajibabai@wsu.edu

1 - Development Of An Optimal Control Logic For Autonomous Intersection Management

Amir Mirheli, Washington State University, Pullman, WA, 99163, United States, amir.mirheli@wsu.edu, Clayton Cline, Leila Hajibabai, Ali Hajbabaie

Reliable coordination between connected-autonomous vehicles (CAVs) and transportation infrastructure offers the possibility of eliminating existing traffic signals in smart cities. This research develops an intersection control system (ICS) that obtains advance information on CAVs' arrivals, locations, and speeds over time. ICS models an optimal logic to simultaneously maximize intersection throughput and minimize delay while upholding safety constraints on vehicle maneuvers to prevent collisions. Numerical results confirm that the proposed technique can solve the problem efficiently.

2 - Variable Speed Limit Optimization In Urban Street Networks

Mehrdad Tajalli, Graduate Research Assistant, Washington State University, Pullman, WA, United States, mehrdad.tajalli@wsu.edu, Sattar Sattarov, Ali Hajbabaie

Emergence of connected vehicle technology provides the opportunity to facilitate the movement of vehicles in smart transportation networks and reduce their travel time. Dynamic speed limit on different links of the network helps efficiently utilize the roadway capacity and facilitates network-wide vehicular movements. This study develops a novel formulation and an efficient solution technique for variable speed limit optimization based on cell transmission model.

3 - Dynamic Traffic Metering In Urban Street Networks

Rasool Mohebifard, Washington State University, Pullman, WA, United States, rasool.mohebifard@wsu.edu, Andrew Stephenson, Ali Hajbabaie

Traffic metering offers great potential to reduce congestion in oversaturated urban street networks. This research presents a linear program for traffic metering in smart urban street networks. We also present a Mixed-Integer Linear Program (MILP) to address the flow holding-back problem of the linear program. We propose a novel solution algorithm and show that it converts the MILP to a linear program and several simulation runs.

4 - Distributed-coordinated Signal Timing Optimization In Connected Transportation Networks

S.M.A Bin Al Islam, Graduate Research Assistant, Washington State University, 545 NE Morton Street, Apt 202, Pullman, WA, 99163, United States, smabinal.islam@wsu.edu, James Amundsen, Ali Hajbabaie

This research presents a Distributed-Coordinated methodology for signal timing optimization in connected urban street networks. The novelty of the work arises from reformulating the signal timing optimization problem from a central to a distributed architecture, where a mathematical program controls the timing of only a single intersection. The distribution, reduces the complexity of the problem. Furthermore, distributed mathematical programs continuously coordinate with each other to avoid finding locally optimal solutions and to move towards global optimality.

5 - Strategic Design Of Station Location And Patrol Routing For Incident Response Programs

Debashis Saha, Washington State University, Pullman, WA, 1, United States, debashis.saha@wsu.edu, Leila Hajibabai

Transportation and enforcement agencies aim to clear traffic accidents in a timely manner to mitigate congestion and improve traffic safety. This research develops a set of mathematical programs to determine the optimal patrol routing scheme for connected response teams under strategic dispatching station location decisions in smart cities. The proposed models minimize the expected maximum response time to all possible hotspots on transportation networks. A hybrid solution algorithm including Lagrangian relaxation and column generation techniques is developed. Numerical tests are conducted to evaluate the efficiency of the proposed algorithm.

■ TA53

Music Row 1- Omni

Organizational Learning, Innovation and Knowledge Creation

Sponsored: Technology, Innovation Management & Entrepreneurship

Sponsored Session

Chair: Leonardo Santiago, Copenhagen Business School, Department of Operations Management, Solbjerg Plads 3, Blok B 5. sal, Frederiksberg, 2000, Denmark, ls.om@cbs.dk

1 - Why Scale Matters In Social Network Analysis: The Case Of Twitter Conversations about YouTube Product Categories

Charles Weber, Portland State University, Portland, OR, United States, webercm@gmail.com, Nitin Mayande

2 - Role Of Firm Knowledge, Quality Conformance And Lean Practices On Product Development

Vashkar Ghosh, University of Florida, Warrington College of Business, Gainesville, FL, United States, vashkar.ghosh@warrington.ufl.edu, Janice E Carrillo

We investigate the implementation of lean principles which constitutes value creation and waste elimination in a product development setting. We view a firm's design knowledge creation and quality development as value creation and study its impact on product development. We also investigate a goal level of quality performance.

3 - The Impact Of Learning On Cumulative Innovation

Leonardo Santiago, Copenhagen Business School, ls.om@cbs.dk, Julia Couto, Nitin Joglekar

The ability to continuously innovate is a key asset to maintain a competitive advantage. A sequence of successful innovations can render a company not only a new product or technique but also a platform which could be used in future. This work investigates how knowledge is accumulated over time as a function of managerial decisions and the dynamics of firm's knowledge. Our results show that an organization can actively select pivoting points to appropriately balance exploration and exploitation initiatives and successfully learn. Moreover, we show how companies improve their performance by reacting to environmental shocks or to turbulent environments.

■ TA54

Music Row 2- Omni

Service Science in Electricity Supply

Sponsored: Service Science

Sponsored Session

Chair: Zhi Zhou, Argonne National Laboratory, Energy Systems Division, Argonne, IL, 60439, United States, zzhou@anl.gov

1 - Guided Particle Swarm Optimizer For Transactive Operation Of Interconnected Micro-grids

Yang Chen, University of Illinois at Chicago, Chicago, IL, 60607, United States, ychen429@uic.edu, Mengqi Hu

Existing research has demonstrated that micro-grid clusters can freely share energy to achieve more cost savings. However, few solution approaches are developed to realize transactive operation for micro-grid clusters, not to mention large scale application. To this end, we develop a scalable distributed decision approach to study the transcative operation of micro-grid clusters where a virtual transaction center is introduced to coordinate all the micro-grids using a particle swarm optimizer (PSO). The dual price of local transactive energy is employed to guide the convergence of PSO. The effectiveness of the proposed dual-price guided PSO is demonstrated using a cluster of 256 micro-grids.

2 - Coordinated Multi-area Dispatch For Wholesale Electricity Markets

Feng Zhao, ISO New England, Holyoke, MA, United States, fzhao@iso-ne.com, Dane Andrew Schiro, Eugene Litvinov

Wholesale regional electricity markets in the U.S. are managed by Independent System Operators (ISOs) through tools such as Security Constrained Economic Dispatch (SCED). The disconnection between the regional markets contradicts the interconnected nature of the corresponding regional power systems. This entails coordination between regional markets. This presentation describes a novel coordination method for the multi-area SCED problem by exchanging critical information of free variables and binding constraints. The method is also extended to solving general large-scale linear programs with demonstrated computational efficiency.

3 - Nuclear Plants Market Competitiveness With Flexible Operational Capability

Zhi Zhou, Argonne National Laboratory, zzhou@anl.gov, Jesse D Jenkins, Audun Botterud

The economic viability of nuclear energy is increasingly challenged in the U.S. deregulated electricity markets due to large availability of cheap natural gas and increased penetration of renewables. It is critical to improve the competitiveness of nuclear energy to maintain energy supply diversity. In this study, we investigate the economic impact of flexible operations of a nuclear plant on its profitability, considering reliability issues on both plant and reactor levels, under the context of a deregulated electricity market. Case study results on a utility scale system show that operational flexibility can not only increase a nuclear plant's profit, but also have benefit to the whole system.

■ TA55

Music Row 3- Omni

Inventory Management III

Contributed Session

Chair: Naser Nikandish, California State University Fullerton, 800 N State College Blvd, Anaheim, CA, 92806, United States, nnikandish@fullerton.edu

1 - A Queueing Service Problem With MDP In Steel Slab Yard

Yanhe Jia, Student, Northeastern University, Heping Street, Shenyang,Liaoning, 110819, China, yhejia@126.com, Lixin Tang

The paper analyzes a serving storage problem of slab yard in iron and steel enterprises. Slabs from a continuous casting stage are stored in a slab yard (as a buffer) for further processing in a hot rolling stage. The coming slabs well be carried by some servers-cranes, these slabs come randomly. In this paper, we consider the slab serving storage problem to minimize the service cost. We give a queueing model and propose a dynamic programming algorithm to present a staffing policy.

2 - Integrating Inventory Classification And Control Decisions To Maximize Order Fulfillment Measures

Liu Yang, Assistant Professor, Purdue University, 3000 Technology Ave, New Albany, IN, 47150, United States, LYang@purdue.edu, Haitao Li, James F Campbell, Donald C. Sweeney

This study presents a linear optimization model that integrates inventory classification and control decisions to maximize the order fulfillment performance, subject to inventory budget constraint and minimum profit requirement. The focus of the research is the order-based performance measures, rather than the commonly used item fill rate. With the proposed models, companies have the ability to arrange the inventory in a way to meet customer segmentation strategy, to evaluate the tradeoff of two order-based measures and profitability, and to simulate the impact of different levels of inventory investment.

3 - A Partially Observed Inventory Control Problem

Satya Sarvani Malladi, PhD Student, Georgia Institute of Technology, 2209 Briarcliff Rd NE, Apt 17, Atlanta, GA, 30329, United States, mss@gatech.edu, Alan Erera, Chelsea C. White

We consider the inventory control problem with backlogging and partially observed discrete demands. We prove the optimality of a myopic policy under a key assumption. We present upper and lower bounds on the optimal expected cost and a bound on the difference between the bounds.

4 - Dynamic Inventory Management Of Hybrid Manufacturing/Remanufacturing Systems With Different Lead Times

Tong Wang, PhD Student, The Chinese University of Hong Kong, 511D William M Engineering Building, Hong Kong, twang@se.cuhk.edu.hk, Xiting Gong, Xiuli Chao

In this paper, we consider an inventory management problem where a firm replenishes its inventory from both manufacturing and remanufacturing processes in finite periods. Production lead time for manufacturing is different from that for remanufacturing. Besides the complete characterization of the optimal replenishment policy, we provide some managerial insights on results as well.

5 - Inventory Management Under Labor Constraints On Restocking

Naser Nikandish, California State University Fullerton, 800 N State College Blvd, Anaheim, CA, 92806, United States, nnikandish@fullerton.edu, Lawrence W Robinson

we present a linear programming model for determining inventory replenishment policies under limited restocking labor. We use this model to solve the restocking problem facing a specific European supermarket. We discuss three inventory replenishment policies and report impact of limiting labor on retailer's profitability. We also develop a Lagrangian Relaxation based algorithm for finding inventory replenishment policies under one of these policies.

■ TA56

Music Row 4- Omni

Economics of Information Technology and Social Media

Sponsored: EBusiness

Sponsored Session

Chair: Liangfei Qiu, Gainesville, FL, United States, liangfei.qiu@warrington.ufl.edu

1 - Sponsored Data: Smarter Data Pricing In The Age Of Data Cap

Xiaowei Mei, University of Florida, xmei@ufl.edu

We investigate a recent phenomenon whereby network service providers are encouraging content providers to sponsor data for consumers. We analyze this phenomenon using game theory within a setting of one monopoly mobile network operator (MNO) and two competing content providers (CPs). Consumers are heterogeneous in both data usage and in their preference for the CPs. We find the optimal pricing scheme for MNO is a two-part tariff without any data caps. The CPs are in a Prisoner's Dilemma regarding sponsored data in the sense that they would prefer not to subsidize the consumers' data consumption but doing so unilaterally would put them in a relatively inferior position.

2 - Please Share! Online Word Of Mouth And Charitable Crowdfunding

Mahdi Moqri, University of Florida, Gainesville, FL, United States, mahdi.moqri@warrington.ufl.edu

While online WOM is commonly used to share information about crowdfunding campaigns, there is hitherto limited understanding as to whether or how this information sharing affect individuals' contribution behavior or the outcome of crowdfunding campaigns. In this study, using a unique dataset from 590 crowdfunding campaigns observed over 12 days, we examine to what extent, and how quickly online WOM affect the rate of contributions. In addition, we explore the effect of different phases of fundraising (over time or as they approach their target goals) and of the coverage of the campaigns in major online news websites.

3 - "Hidden Profiles" In Corporate Prediction Markets: The Impact Of Public Information Precision And Social Interactions

Jingchuan Pu, University of Florida, Gainesville, FL, United States, jingchuan@ufl.edu, Liangfei Qiu, Hsing K Cheng

Recently, large companies are experimenting with corporate prediction markets run among their employees. we develop an analytical model to analyze the effects of information precision and social interactions on prediction market performance. But increased precision of public information is not always beneficial to prediction market accuracy because of the "hidden profiles" effect: participants place a larger than efficient weight on existing public information. A socially embedded prediction market with information sharing mechanism may help correct such inefficiency. We also identify conditions under which increased precision of public information is detrimental in both cases.

4 - Credit Card Companies And Is-integrated Marketing Platforms: A Comparison Of Social Network Promotions And Targeted Promotions

Soohyun Cho, University of Florida, Gainesville, FL, United States, soohyun.cho@warrington.ufl.edu, Liangfei Qiu, Subhajyoti Bandyopadhyay

In this paper, we investigate two types of marketing promotions that credit card companies have recently been featuring in collaboration with partnered retailers: public promotions through social networking services and targeted promotions through companies' websites. To analyze the strategic impacts on the promotion's participants (including companies/retailers and consumers), we develop a game theoretical model and then determine the best strategies for different participants. The study is extended by considering the advertising effect of social network services as well as security issues involving targeted promotions.

■ TA57

Music Row 5- Omni

Insights from Relaxing Traditional Modeling Assumptions about Human Behavior in OM Settings

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Jordan Tong, Wisconsin School of Business, 4293 Grainger Hall, Madison, WI, 53706, United States, jtong@bus.wisc.edu

1 - Utility Based Queueing: Predicting Delay When Servers Are Strategic

Amy Ward, University of Southern California, amyward@marshall.usc.edu, Sherwin Doroudi, Ragavendran Gopalakrishnan, Adam Wierman, Dongyuan Zhan

Most common queueing models used for service system design assume the servers work at fixed (possibly heterogeneous) rates. However, real-life service systems are staffed by people, and people may change their service speed in response to incentives. To model this, we assume each server selfishly chooses his service speed in order to maximize his expected utility. Under various assumptions on the utility function, we characterize the equilibrium service speed, which can then be used to estimate system performance.

2 - Service Systems With Unknown Quality & Customer Anecdotal Reasoning

Tingliang Huang, Carroll School of Management, Boston College, 140 Commonwealth Avenue, Chestnut Hill, MA, 02467, United States, tingliang.huang@bc.edu, Hang Ren, Kenan Arifoglu

We consider a service system where customers do not know the distribution of uncertain service quality and cannot estimate it fully rationally; instead, they form beliefs by taking sample averages of anecdotes. The number of anecdotes can be used to measure to what extent customers are boundedly rational. We characterize customers' joining behavior and the server's pricing and quality decisions.

3 - The Effect Of Social Information On Demand In Quality Competition

Dayoung Kim, Cornell University, dk668@cornell.edu

We investigate the impact of different types of social information on the demand characteristics of firms competing through service quality. We develop a Hidden Markov model to understand the choice mechanism of a consumer under social information. We then conduct a lab experiment where a consumer chooses to visit one of two firms, each with unknown service quality. In the experiment, a consumer may have access to (1) no information, (2) market "share-based" social information, or (3) "quality-based" social information. Our results show that different types of information have dramatically different effects on firms' market shares and demand uncertainty.

4 - Selling To Experience-sampling Customers: Quality Conformance, Pricing, And Promotions

Gregory A DeCroix, University of Wisconsin - Madison, greg.decroix@wisc.edu, Jordan Tong

We consider a firm that sells a service, the quality of which is stationary but stochastic. Customers cannot directly observe mean quality, but instead base their estimate of quality on their own past purchases. Customers are risk neutral but boundedly rational - their purchase decisions are described by a logit model based on customer surplus (estimated quality minus price). We explore several phenomena that arise in such a setting. For example, poor quality conformance (high service variability) leads to reduced sales revenues, even though customers are risk neutral. In addition, under certain circumstances occasional promotions can help counter this erosion in revenues.

■ TA58

Music Row 6- Omni

Energy VX

Contributed Session

Chair: Ruediger Schultz, University of Duisburg Essen, Thea-Leymann-Str. 9, Essen, D-45127, Germany, ruediger.schultz@uni-due.de

1 - Managing Stored Energy In Microgrids Via Multistage Stochastic Programming

Arnab Bhattacharya, PhD Candidate, University of Pittsburgh, 1031 Benedum Hall, 3700 O'Hara Street, Pittsburgh, PA, 15261, United States, cfcarnabiitkgp@gmail.com, Jeffrey P. Kharoufeh, Bo Zeng

Energy storage systems are used to mitigate adverse effects of renewable sources in a microgrid where procurement and storage decisions are made under uncertain demand, renewable supply and prices. A multistage stochastic programming (SP) model is formulated to minimize the expected total costs in a microgrid. To improve computational tractability of the SP model, a customized stochastic dual-dynamic programming (SDDP) algorithm is employed to obtain high-quality solutions within reasonable time bounds. A numerical study highlights significant cost reductions and computational benefits.

2 - A Crowdfunding Model For Green Energy Investment

Ying Xu, Assistant Professor, Singapore University of Technology and Design, Singapore, Singapore, xu_ying@sutd.edu.sg, Ronghuo Zheng, Nilanjan. Chakraborty, Katia P. Sycara

Motivated by emerging community solar farms, this paper studies a new renewable energy investment model through crowdfunding. We develop a sequential game theory model to capture the interactions among crowdfunders, the solar farm owner, and an electricity company in a multi-period framework. We find that under crowdfunding although the farm owner reduces its investment level, the overall green energy investment level is increased due to the contribution of crowdfunders. We also find that crowdfunding can increase the penetration of green energy in consumption. Finally, the numerical results based on real data indicates crowdfunding is a simple but effective way to boost green generation.

3 - Incentive-based Coordination Mechanism For Backup Renewable Energy Investment

Sadra Babaei, Oklahoma State University, Stillwater, OK, United States, sadra.babaei@okstate.edu, Chaoyue Zhao

Due to the intermittent nature of renewable energy, the renewable energy producers are exposed to high risks in delivering what they have already committed to the energy market. Cooperating with other market participants like conventional energy producers poses a possibility to mitigate this issue. Using stochastic modeling formulation, this paper aims to find optimal bidding strategies that provide incentive for both renewable and conventional power producers to cooperate with each other. Additionally, the trading volume and price between the participants are determined by using Nash game framework. Numerical experiments have been conducted to verify the effectiveness of the model.

4 - Nomination Validation In Gas Grids Under Uncertainty

Ruediger Schultz, University of Duisburg Essen, Thea-Leymann-Str. 9, Essen, D-45127, Germany, ruediger.schultz@uni-due.de

Gas flows in the pipes and pressures at the nodes, both under uncertainty of gas withdrawals from the network (loads) at exit (delivery) nodes are studied. Assuming the uncertainty of withdrawals is stochastic with known distributions, methods for calculating probabilities for the feasibility of load coverage are presented. Emphasis is placed on mildly meshed networks.

■ TA59

Cumberland 1- Omni

Modeling Interdependent Infrastructure Networks

Sponsored: Transportation Science & Logistics

Sponsored Session

Chair: Xiaozhang He, Perdue University, West Lafayette, IN, United States, seanhe@purdue.edu

1 - Algorithm To Identify Intermodal Project Prioritization

Irina Benedyk, Purdue University, West Lafayette, IN, United States, birina@purdue.edu, Srinivas Peeta

We propose intermodal connectivity measures for freight intermodal facilities and develop an algorithm to assist the system-level intermodal facility investment planning process. The intermodal connectivity measures combine spatial data, characteristics of the intermodal facilities and potential demand for intermodal freight transportation. The proposed algorithm helps to identify regions that require intermodal facility development, and can be used for intermodal project prioritization.

2 - Multi-objective Spare Parts Location-inventory Optimization

Hector Vergara, Oregon State University, School of Mechanical, Industrial and, Manufacturing Engineering, Corvallis, OR, 97331, United States, hector.vergara@oregonstate.edu, Prasanna Venkatesh Rajaraman

Facility location-allocation decisions and inventory stocking decisions are very important in spare parts logistics. Both sets of decisions affect service levels by establishing distances between customers and warehouses in facility location-allocation, and by determining the availability of parts in inventory stocking. Integrating location-inventory decisions and considering multiple objectives can help to overcome the sub-optimality of solutions obtained separately. This research formulated this problem as a nonlinear multi-objective model where the objectives are to minimize cost and maximize the service level. An NSGA-II approach is used to obtain Pareto optimal solutions.

3 - Interdiction And Restoration Of Interdependent Infrastructure Systems In Military Operations

Liqun Lu, University of Illinois, Normal, IL, United States, liqunlu2@illinois.edu, Zhaodong Wang, Yanfeng Ouyang

In the modern world with complicated politics and humanitarian concerns, military landpower in the war game is demonstrated by the interdiction on the urban infrastructure systems, which enables the offense .force to take control, as well as the restoration of the systems afterwards. An infrastructure interdependency model is integrated into interdiction-restoration decision-making framework as a two-stage optimization problem.

4 - Critical Component Strengthening Strategies To Enhance The Resilience Of Interdependent Infrastructure Systems

Xiaozheng He, Purdue University, 3000 Kent Ave., West Lafayette, IN, 47906, United States, seanhe@purdue.edu, Chao Zhang, Srinivas Peeta

This study proposes three component strengthening strategies to enhance the resilience of interdependent infrastructure systems, considering the failure propagation within and across the systems. These strategies are developed from structural, functional, and synergistic effect perspectives. Numerical examples are used to investigate the effectiveness of the proposed strategies and provide insights into enhancing the resilience of interdependent infrastructure systems.

5 - Identifying Critical Components Of The Public Transit Network To Mitigate Contagion Episodes

Lauren Gardner, UNSW Australia, Sydney, Australia, l.gardner@unsw.edu.au, András Bota, Alireza Khani

We explore the risk posed by a regional public transit system in the event of an epidemic outbreak. We use metro transit data from Twin Cities, MN, and present a novel network structure to represent the contacts and movement of individuals using the transit system, which can be used to model outbreak behaviour within the region. The model developed is used to identify critical components of the system (e.g., super spreading vehicle-trips), which can be prioritized for monitoring and control during an emerging outbreak.

■ TA60

Cumberland 2- Omni

Modeling and Analysis of Innovative Mobility Services II

Sponsored: TSL, Urban Transportation

Sponsored Session

Chair: Yu Nie, Northwestern University, 633 Clark Street, Evanston, IL, 60208, United States, y-nie@northwestern.edu

1 - Green Same Day Package Delivery Service With Real-time Demand

Lin Jane, University of Illinois - Chicago, janelin@uic.edu, Wei Zhou, Lili Du

This study evaluates a green same day delivery (green-SDDS) paradigm for its cost performance by comparing three delivery paradigms: hub-and-spoke, green-SDDS with a commercial fleet, and green-SDDS by crowdsourcing. Hub-and-spoke proves to be cost-effective for traditional distribution service provided by commercial carriers but ill suited for providing same day delivery service. Crowdsourcing provides low cost same day delivery service. Regardless of the delivery paradigm, total cost goes down as the economy of scale increases; and green-SDDS by crowdsourcing would become even more competitive when the demand ratio is very high; however, its fuel consumption and emissions tend to go up.

2 - Distributed Computation Based Car-following Control Integrating Optimal System Performance For A Platoon Of Autonomous Vehicles

Siyuan Gong, PhD Candidate, Illinois Institute of Technology, 3201 South Dearborn Street, Chicago, IL, United States, sgong1@hawk.iit.edu, Jinglai Shen, Lili Du

This research develops car-following control algorithms for a platoon of autonomous vehicles on a straight highway. The platoon is modeled as an interconnected multi-agent dynamic system subject to physical and safety constraints. A constrained optimization based control algorithm is developed to improve transient traffic smoothness and asymptotic dynamic performance. Distributed algorithms are proposed to compute optimal solutions, and stability analysis is carried out for the linear dynamics. Simulations are conducted to illustrate the efficiency of the proposed algorithms.

3 - Demand Adaptive Paired-line Hybrid Transit System In Radial Transit Network

Yu Nie, Northwestern University, A328 Technological Institute, 2145 Sheridan Road, Evanston, IL, 60208, United States, y-nie@northwestern.edu, Peng Chen

This paper proposes and analyzes a hybrid transit system in the radial transit network with both circular and radial transit lines. The hybrid transit system integrates the traditional fixed-route service with a demand adaptive service (DAS). The optimal design problem is formulated and solved. Both numerical experiments and simulation experiments are conducted to compare the performance of the proposed system with the same kind of hybrid transit system in the grid transit network.

4 - Shared-use Mobility And Parking Provision

Zhengtian Xu, University of Florida, Gainesville, FL, United States, zhengtianxu@ufl.edu, Yafeng Yin, Liteng Zha

Shared-use mobility services become increasingly important in meeting travel needs in metropolitan areas. The cruising of ride-sharing vehicles for customers generates additional traffic demand that may worsen the traffic condition. This study develops a parsimonious framework to investigate the allocation of a certain portion of road space to on-street parking for vacant ride-sharing vehicles. Various market competition situations, business models, and vehicle technologies are considered.

■ TA61

Cumberland 3 – Omni

TSL Prize Winners

Sponsored: Transportation Science & Logistics

Sponsored Session

Chair: Maciek Nowak, Loyola University Chicago, Chicago, IL, mnowak4@luc.edu

■ TA62

Cumberland 3- Omni

Distributed Control of Multi-Agent Networks

Sponsored: Aviation Applications

Sponsored Session

Chair: Shaoshuai Mou, Purdue University, 701 W. Stadium Ave., West Lafayette, IN, 47907-2045, United States, mous@purdue.edu

1 - A Distributed Algorithm For Solving Linear Algebraic Equations

Shaoshuai Mou, Purdue University, mous@purdue.edu

Solving linear algebraic equations is perhaps one of the most fundamental problems in all fields. Besides allowing decomposing a large linear equations into smaller ones to be cooperatively solved by a mutli-agent network, distributed algorithms for solving large linear equations only require each agent to know part of the linear equation, and can only communicate with its nearby neighbors. The distributed algorithm to presented (1.) is applicable to all linear equations; (2) converges exponentially fast; (3) works for time-varying networks; (4) allows asynchronous operations; (5) does not involve any time-varying step size.

2 - Control And Coordination Of Quadrotors

Wenlong Zhang, Arizona State University, Wenlong.Zhang@asu.edu

Quadrotors have attracted a lot of attentions in recent years due to its low cost and wide range of applications in product delivery, mapping, and surveillance. This talk will cover the estimation and control techniques to enable smooth operation of individual quadrotors. Moreover, design and coordination algorithms of a multi-quadcopter team will be introduced for enhanced capabilities and resilience.

3 - Stochastic Scheduling Estimation Of Multiple Discrete-time Linear Time Invariant Systems

Chong Li, Staff Research Engineer, Qualcomm Research & Development, Bridgewater, NJ, United States, lichong0436213@gmail.com

We proposed a stochastic scheduling strategy for estimating the states of multiple discrete-time linear time invariant dynamic systems, where only one system can be observed by the sensor at each time instant due to practical resource constraints. The idea of our stochastic strategy is that a system is randomly selected for observation at each time instant according to a pre-assigned probability distribution. We find the optimal pre-assigned probability in order to minimize the maximal estimate error covariance among dynamic systems. Finally, for scheduling implementation, we propose centralized and distributed deterministic scheduling strategies based on the optimal stochastic solution.

■ TA63

Cumberland 5- Omni

Alternative Fuel Refueling Location Problems

Sponsored: Location Analysis

Sponsored Session

Chair: Ismail Capar, Texas A&M University, TAMU 3367, College Station, TX, 77843, United States, capar@tamu.edu

1 - Community-aware Charging Station Network Design For Electrified Vehicles In Urban Areas: Improving Accessibility, Reducing Emissions, And Promoting Walking

Sina Faridimehr, Wayne State University, sina.faridimehr@wayne.edu, Saravanan Venkatachalam, Ratna Babu Chinnam

Advantages of electric vehicles (EVs) include reduction of greenhouse gas and other emissions, energy security, and fuel economy. The societal benefits of large-scale adoption of EVs cannot be realized without adequate deployment of publicly accessible charging stations. In our research, we develop stochastic programming models to determine optimal infrastructure of charging stations for a community considering the uncertainties in state of charge for vehicles, arrival data based on origin-destination pairs, and walkable range within a community. We conducted computational experiments using various publicly available data sources.

2 - Capacitated Hydrogen Refueling Station Location Problem With Traffic Deviations Over Multiple Time Periods

Burcu Keskin, The University of Alabama at Tuscaloosa, bkeskin@cba.ua.edu, Mohammad Miralinaghi, Yingyan Lou, Arash M. Roshandeh

Construction of refueling stations is a major step toward the promotion of hydrogen fuel vehicles. In this study, we consider the problem of locating hydrogen refueling stations in a traffic network for intra-city trips via mathematical programming. The central planner aims to minimize the total system travel cost, including construction costs, operational costs and total system travel time cost. It is formulated as a mixed-integer linear model which is solved using Lagrangian relaxation and branch-and-bound algorithms. Numerical results demonstrate that refueling station location pattern can change with considering multi-period travel demand.

3 - Transnational Infrastructure Planning For Natural Gas Trucking

Ismail Capar, Texas A&M University, capar@tamu.edu, Michael J Kuby, Jong-Geun Kim

The European Union relies on oil for over 90% of its transportation fuels and spends one billion Euros a day on imported oil. To reduce this dependency, the EU is developing an integrated market for compressed (CNG) and liquefied (LNG) natural gas as alternatives to diesel for long-haul trucking. Motivated by this objective, we use forecasted road freight data from EU TransTools, and introduce several new side constraints for the flow-refueling location model to produce a more equitable distribution of covered flows across EU members.

■ TA64

Cumberland 6- Omni

Multi-Criteria Decision Making in Agriculture

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Jay Parsons, University of Nebraska-Lincoln, Lincoln, NE, United States, jparsons4@unl.edu

1 - Flexible Stocking Strategies In A Variable Climate: From Research To Reality

John Ritten, University of Wyoming, Laramie, WY, United States, john.ritten@uwyo.edu, Justin Derner, Christopher Bastian, John Tanaka, David Agustine, Lauren Porensky, Mark Eisele, Kendall Roberts

Livestock producers must make decisions in a rapidly changing world. Precipitation-induced variability on forage production often makes it difficult to effectively match animal demand with forage availability. Weather events interact with price cycle dynamics creating additional difficulty for producers to react optimally to changing conditions. Further complicating the process is carry-over effects such as residual forage and soil moisture that can impact production. Consideration needs to be given to minimizing degradation of range resources, while also ensuring long-term economic viability.

2 - A Network Comparison Of Competing Institutions For Managing Water Against Hydropower And Irrigation Demands

Patrick O’Reilly, PhD Candidate, Mineral and Energy Economics, Colorado School of Mines, Golden, CO, United States, poreilly@mines.edu

Using a variational inequality approach, this paper investigates transaction cost consequences of choosing between alternative water institutions in light of their respective network structure, uncertain supply, and competing demands. Network formulation can reflect spatial, precedence, and institutional features associated with the flow of water through rivers, hydropower stations, and irrigated farmland. Preliminary boundary case results reflect what transaction cost theory suggests: where water rights can be made sufficiently complete, a centrally-planned approach does not fare better than a decentralized market equilibrium.

■ TA65

Mockingbird 1- Omni

Analytical and Empirical Analyses of Digital Markets

Sponsored: Information Systems

Sponsored Session

Chair: Yi-Jen Ho, Pennsylvania State University, Pennsylvania State University, University Park, PA, 16801, United States, hoy1@uci.edu

1 - Mobile App Analytics: Impact Of Popularity, Quality And Rank on Click And Conversion Performance

Shengjun Mao, University of California - Irvine, shengjum@uci.edu

The explosion in number and variety of mobile apps makes finding desirable ones a challenge, which in turn brings the significance for apps distributers to effectively display the apps. To understand users’ response to the listings of posted apps, we study the role of apps’ quality, popularity and positions in handsets screens on users’ click and download decisions based on a panel date set from an app recommendation engine. We found that when users make decisions to click an app, there are positive quality and popularity effects and negative position effect. However, when users decide whether or not to download apps, quality and popularity effects disappear and position effects becomes positive.

2 - An Empirical Analysis Of Price Dispersion In Electronic Markets

Jin Sik Kim, University of California-Irvine, Irvine, CA, 92617, United States, jinsk6@uci.edu, Vijay C Gurbaxani

Theory predicts that the price of homogeneous products at online retailers will exhibit low price dispersion; yet, there is empirical evidence to the contrary. This paper investigates price dispersion in homogeneous product markets based on uncertainty theory. We examine two types of uncertainty: seller and product uncertainty. We collect data in three product categories: search, experience, and credence goods. Our results show higher product uncertainty is consistent with higher price dispersion. Sellers with stronger reputations can set higher prices in product markets with higher uncertainty, resulting in price dispersion, but not otherwise.

3 - Product Upgrades With Innovation Uncertainty

Yiwei Wang, University of California-Irvine, derekw7@uci.edu

Firms usually upgrade their products by introducing an innovative attribute. This article looks at how a profit-maximizing firm design and position such upgraded versions, when products with traditional attribute has been supplied in the market. We specifically study the quality design and configuration strategy in the presence of innovation uncertainty, based on a product line selection framework.

4 - The Impact Of Digitization On Optimal Content Pricing Strategy

Ran Zhang, University of California-Irvine, ranz2@uci.edu

The widespread adoption of the Internet and digital technologies has transformed the distribution and consumption of information goods. We develop a parsimonious model to study pricing strategies of a publisher who offers information good in dual medium and in bundled medium. We develop optimal pricing strategies and show that while offering bundle of mediums and digital medium only (partial mixed bundling) is optimal under a wider range of market conditions, offering digital medium only is optimal under other market conditions. Offering information good or content in physical medium and in digital medium is not optimal as long as the two mediums are partial substitutes.

■ TA66

Mockingbird 2- Omni

Data Analytics and Reliability in Energy/Smart Grids

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Ramin Moghaddass, University of Miami, McArthur Engineering Building, Miami, FL, 33146, United States, raminm@mit.edu

1 - Wind Turbine Wake Effects: Characteristics And Impacts On Wind Power Generation

Hoon Hwangbo, Texas A&M University, Dept. of Industrial & Systems Engineering, 3131 TAMU, College Station, TX, 77843-3131, United States, hhwangbo@tamu.edu, Andrew L Johnson, Yu Ding

When a wind turbine operates, rotating blades not only consume energy available in wind but also generate some turbulence, both changing characteristics of downstream wind thereby affecting power generation of downstream wind turbines. This phenomenon is referred to as wind turbine wake, and its effect on power performance is known to be significant. In this study, we observe characteristics of the wake effects from actual wind turbine data and quantify the effects on power performance of wind turbines.

2 - Statistical Monitoring Of Data Attacjs In Smartgrids

George Michailidis, University of Florida, gmichail@ufl.edu

Data attacks on the distribution network in SmartGrids have the potential to destabilize the power network, as well as impact the consumption patterns of electricity consumers.In this work, we provide an overview of such attacks and develop a statistical framework for their detection. The developed methodology is illustrated on synthetic and real data traces.

3 - Opportunistic Condition Based Maintenance Optimization For Offshore Wind Farm

Sanling Song, Postdoc, Rutgers University, 33 Livingston Ave, Room 250, New Brunswick, NJ, 08901, United States, lamusesi38sanling@gmail.com, Frank A Felder, David W Coit

Operation and maintenance cost for offshore wind farm can be 5-10 times higher than the cost for on-land wind farm. In this paper, opportunistic condition-based maintenance optimization model is developed. Two objectives we are interested in are wind farm maintenance cost and wind turbine availability or uptime. Genetic algorithm considering uncertainty is conducted, which is especially challenging because life experience for each component in the wind turbine is uncertain. Probabilistic Pareto frontier rather than deterministic Pareto front is obtained.

4 - Robust Optimization Based Power System Restoration For Incorporating Large-scale Wind Farms

Amir Golshani, University of Central Florida, Orlando, FL, United States, amir.golshani@knights.ucf.edu, Wei Sun, Qipeng Zheng

This presentation provides a novel two-stage optimization model for a faster and reliable power system restoration. The robust optimization approach is employed to immunize the solution against all possible realizations of wind uncertainties. With mixed-integer optimization in the inner-level problem the KKT condition cannot be directly applied. Thus, we adopt the column-and-constraint generation (C&CG) algorithm to solve the two-stage robust optimization problem. The proposed strategy can assist system operators to accomplish the restoration tasks accurately and harness wind energy more efficiently.

■ TA67

Mockingbird 3- Omni

IEEE T-ASE Invited Session III

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Jingshan Li, University of Wisconsin-Madison, 1513 University Ave, Madison, WI, 53706, United States, Jingshan.li@wisc.edu

1 - A Spatial Calibration Model For Quality Prediction

Kaibo Wang, Tsinghua University, kbwang@tsinghua.edu.cn

The anisotropy of a carbon nanotube (CNT) film, which is a spatially distributed quality index, is difficult to measure in practice due to metrology and cost constraints. However, the anisotropy is highly correlated with the height of the CNT array, which can be measured in a much easier and more cost-effective way. In this talk, we propose a spatial model for predicting the anisotropy using the height. The model takes the spatially distributed two-dimensional (2D) height as an input and provides a predicted anisotropy distribution in a 2D space. If the anisotropy measures are obtained, the model can provide a more accurate prediction.

2 - Estimating Clearing Functions For Production Resources Using Simulation Optimization

Reha Uzsoy, NC State University, ruzsoy@ncsu.edu, Baris Kacar

We implement the Simultaneous Perturbation Stochastic Approximation (SPSA) algorithm, to estimate clearing functions (CFs) that describe the expected output of a production resource as a function of its expected workload from empirical data. A simulation model of a scaled-down wafer fabrication facility is used to generate the data and evaluate the performance of the CFs obtained from the SPSA.

3 - A BDD-based Approach For Designing Maximally Permissive Deadlock Avoidance Policies For Complex Resource Allocation Systems

Spyros Reveliotis, Georgia Tech, Atlanta, GA, United States, spyros.reveliotis@isye.gatech.edu, Zhennan Fei, Sajed Miremadi, Knut Akesson

The maximally permissive deadlock avoidance policy (DAP) for complex resource allocation systems (RAS) can be implemented through the identification and storage of a set of critical states of the underlying RAS state-space, known as minimal boundary unsafe states. This paper presents a symbolic approach, based on binary decision diagrams (BDDs), for efficiently retrieving the (minimal) boundary unsafe states from the underlying RAS state- space. Numerical experimentation demonstrates that the proposed method enables the deployment of the maximally permissive DAP for RAS with complex structure and large state-spaces with limited time and memory requirements.

4 - A Dynamic Control Algorithm For Distributed Feedback Control For Manufacturing Production, Capacity, And Maintenance

Seokgi Lee, Assistant Professor, University of Miami, 1251 Memorial Drive 281, Coral Gables, FL, 33146, United States, sgl14@miami.edu, Vittaldas V. Prabhu

We propose a dynamic algorithm for distributed feedback control which unifies the functions of production and maintenance scheduling at the shop floor level, and machinery capacity control at the CNC level, which are usually considered in isolation in practice. A continuous-time control theoretic approach is used to model dynamics of these three functions in a unified manner, considering stochastic machine failures and a corresponding maintenance interval. Theories of nonlinear control and discontinuous differential equations are used to analytically predict the system dynamics including the resulting discontinuous dynamics.

■ TA68

Mockingbird 4- Omni

Graph Analytics for Complex Systems

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Hoang Tran, Texas A&M University, College Station, TX, United States, tran@tamu.edu

Co-Chair: Satish Bukkapatnam, Texas A&M University, College Station, TX, United States, satish@tamu.edu

1 - Predicting Community Structure In Dynamic Networks: A Case Of Online Educational Networks

Yi-Shan Sung, Penn State University, yqs5097@psu.edu, Soundar Kumara

Community structure points to structural patterns in a network and reflects functional associations between entities. However, it is challenging to obtain timely updates of communities in a dynamic network in which changes are frequently introduced over time. We develop a model to predict community structure by integrating link prediction with community detection algorithms. We test the model efficacy using the data from nanoHUB.org, which is an online educational platform for science and engineering in nanotechnology. Predicting community structure in nanoHUB networks will help in developing an efficient recommendation system for the nanoHUB users and optimizing the resource allocation.

2 - Detecting Changes In Complex Systems Via Network Inference

Hoang M Tran, Texas A&M University, College Station, TX, United States, tran@tamu.eud, Satish Bukkapatnam

We propose a network based method to do change detection in transient complex systems. This is based on our approach to infer spurious-link-free network structures from time series. A spectral graph based method is used to detect process changes from these networks.

3 - Graph Reconstruction From High-dimensional Systems Of Additive Differential Equations

Ali Shojaie, University of Washington, Seattle, WA, United States, ashojaie@uw.edu, Shizhe Chen, Daniela Witten

We consider the task of learning a dynamical system from high-dimensional time-course data. We model the dynamical system non-parametrically as a system of additive ordinary differential equations. Most existing methods for parameter estimation in ordinary differential equations estimate the derivatives from noisy observations. This is known to be challenging and inefficient. We propose a novel approach that does not involve derivative estimation. We show that the proposed method can consistently recover the true network structure even in high dimensions, and we demonstrate empirical improvement over competing approaches.

4 - Modeling And Change Detection Of Dynamic Network Data By A Network State Space Model

Na Zou, Texas A&M University, College Station, TX, 77845, United States, nzou1@tamu.edu, Jing Li

Dynamic network data widely exist in social, biological, and engineering domains. There are two types of variability in dynamic network data: variability of natural evolution and variability due to assignable causes. Accurate and timely change detection from dynamic network data is important. Change detection is a classic research area in Statistical Process Control (SPC) and various approaches have been developed for dynamic data in the form of univariate or multivariate time series, but not in the form of networks. We propose a Network State Space Model (NSSM) to characterize the natural evolution of dynamic networks and integrate the NSSM with SPC for change detection.

■ TA69

Old Hickory- Omni

Economics IV

Contributed Session

Chair: Fouad El Ouardighi, Professor, ESSEC Business School, Avenue B Hirsch BP 105, Cergy Pontoise, 95021, France, elouardighi@essec.fr

1 - A Note On Real Estate Pricing With Exogenous Variables

Hiroshi Ishijima, Professor, Chuo University, 1-18 Ichigaya-tamachi Shinjuku, Tokyo, 1628478, Japan, hiroshi.ishijima.jp@gmail.com, Akira Maeda

We develop a pricing model of real estate that incorporates conventional hedonic attribute variables of real estate as well as exogenous variables, namely financial asset prices; this model is based on a theoretical pricing model that we, fundamentally develop. Specifically, our model features a pricing kernel expressed as the product of a cash-flow pricing kernel (stochastic discount factor) and a hedonic pricing kernel. Furthermore, we conduct an empirical analysis to understand Japanese real estate prices comprehensively. Our analysis reveals that the financial asset prices and conventional hedonic variables serve as the major determinants of Japanese real estate prices.

2 - Ensemble Model For U. S. Stock Major Index Prediction Using Economic Factors With Interactive Visualization

Yao-Te Tsai, Post-Doctoral Fellow, Auburn University, Auburn, AL, 36849, United States, yzt0007@auburn.edu, Bin Weng, Fadel Megahed, James Barth

The accuracy of the stock market prediction has been an attractive topic for researchers and public. However, it has still been remaining one of the most challenging tasks due to the non-linearity and non-stationary of the time series data. Our objective is to discover information and trends from macroeconomic perspectives to provide a foundation for the future stock market predictive model development. we investigate how macroeconomic factors that drive the U.S. major stock market index by applying the ensemble model. We also determine if the index of each sector would be driven from different factors. The last task is to predict the stock market index based on our variable selection.

3 - Capital Growth With Recycling And The Environmental Kuznets Curve

Fouad El Ouardighi, Professor, ESSEC Business School, Avenue B Hirsch BP 105, Cergy Pontoise, 95021, France, elouardighi@essec.fr

We investigate how the relationship between capital growth and pollution accumulation is affected by the source of pollution, that is, either production or consumption. We are interested in polluting waste that cannot be naturally absorbed, but for which recycling efforts are made to avoid massive accumulation with harmful consequences in the long run. We distinguish the cases where recycling efforts are capital-improving or capital-neutral. Based on both environmental and social welfare perspectives, we determine how the influence of the pollution source on capital growth and polluting waste accumulation is affected by the fact that recycling is capital-improving or capital-neutral.

■ TA70

Acoustic- Omni

Transportation, Rail II

Contributed Session

Chair: Yalda Khashe, University of Southern California, 3230 Overland Ave. APT 312, Los Angeles, CA, 90034, United States, khashe@usc.edu

1 - Train Timetable Based Integer Programming Model For Passenger Assignment Problem In Congest Urban Rail Line

Si Ma, Associate Professor, Southwest Jiaotong University, Chengdu, China, masi@home.swjtu.edu.cn, Gongyuan Lu, Lin Wang

We optimized passenger assignment problem (PAP) considering passenger waiting time, platform and car capacity to maximize transportation capacity in congest urban rail line. Using passenger_flow-Train_path network to integrate passenger behavior and timetable based train movement in space and time dimension, the PAP is modeled as a maximum flow problem with multi-sources and multi-sinks. In the real-world case of Chengdu urban rail line 1, the integer programming model is solved efficiently by commercial solver.

2 - Face Recognition Based Ticket Checking Solution In Speeding Train

Kui Yang, PH.D. Candidate, Southwest Jiaotong University, Chendu, 610031, China, ykylw@my.swjtu.edu.cn, Gongyuan Lu, Haifeng Yan

It is a big challenge to check rail ticket in almost every passenger section, due to great workload and passenger inconvenience. Integrated with ticket section, a face recognition based ticket checking solution is presented for strict and efficient checking. This visual-aided solution can automatically identify checking candidate in different section, avoid missing or multiple checking in the whole journey.

3 - Critical Systems Management Issues Of Implementing The Positive Train Control Technology In A Regional Railroad

Yalda Khashe, University of Southern California, 3230 Overland Ave. Apt 312, Los Angeles, CA, 90034, United States, khashe@usc.edu

Positive Train Control (PTC) is a generic term referring to a range of fully integrated technologies that overlay existing safety systems to prevent train-to-train collision and improve worker safety. One of the challenges that railroad industry is facing for implementing PTC is the complications of introducing this new technology to an already existing system and its effect on the technological, organizational and human subsystems and their interactions.

■ TA71

Electric- Omni

Vehicle Routing I

Contributed Session

Chair: Mehdi Behroozi, University of Southern California, 3120 Bagley Ave, Apt 5, Los Angeles, CA, 90034-2930, United States, behro040@umn.edu

1 - Optimal And Heuristic Models For School Bus Fleet Size Problem

Jiayuan Zhang, Stony Brook University, 24 malvern lane, stony brook, NY, 11790, United States, jiayuan.zhang01@gmail.com, Herbert F. Lewis, Thomas Raymond Sexton, Sreekanth Mallikarjun

We present a new algorithm to minimize the number of school buses that a district must own to serve morning and afternoon routes subject to constraints on school bell times and pickup and delivery time windows. We compare our results to those produced by known optimal and heuristic models. Our proposed heuristic algorithm produces very good solutions in reasonable time.

2 - Combined Maintenance And Routing Optimization For Large-scale Problems

John Fontecha-García, Instructor, Universidad de los Andes, Cra 1 Este No 19A - 40, Bogotá, Colombia, je.fontecha10@uniandes.edu.co, Raha Akhavan-Tabatabaei, Daniel Duque, Juan Pablo Rodríguez, Andres L Medaglia

We tackle the problem of planning and scheduling maintenance operations of a set of geographically distributed sites that are subject to non-deterministic failures. We extended a combined maintenance and routing optimization approach that is based on two components: a maintenance model that is used to determine the optimal time to serve a site; and an MIP-based split (route-first, cluster-second) procedure that routes the crews who conduct maintenance operations. We applied our method on a case study for the sewer system in the city of Bogotá.

4 - Simultaneous Production And Transportation Problem: A Case Of Additive Manufacturing

Gourav Dwivedi, Doctoral Student, Indian Institute of Management, Indian Institute of Management, IIM Road, Off Sitapur Road, Lucknow, 226013, India, fpm14013@iiml.ac.in, Yogesh K Agarwal, Rajiv K Srivastava

We present a new situation of simultaneous production and transportation problem arising in additive manufacturing (AM) application. A vehicle with AM machine produces parts while approaching the customers' location, saving the production time while transporting. Thus, delivery time depends on the travel time and the production completion time. This presents a unique operational decision problem to optimize delivery routes under different decision settings. A mixed-integer linear programming formulation is presented to decide the sequence of deliveries for the minimum total trip time. Tighter formulation is demonstrated through valid inequalities and their effect on lower bounds.

5 - Geometric Partitioning And Robust Ad-hoc Network Design

Mehdi Behroozi, University of Southern California, 3120 Bagley Ave, Apt 5, Los Angeles, CA, 90034-2930, United States, mehdi.behroozi@usc.edu, John Gunnar Carlsson, Xiang Li

We present fast approximation algorithms for the problem of dividing a given convex geographic region into smaller sub-regions so as to distribute the workloads of a set of vehicles. Our objective is to partition the region in such a fashion as to ensure that vehicles are capable of communicating with one another under limited communication radii. We consider variations of this problem in which sub-regions are constrained to have equal area or be convex, and as a side consequence, our approach yields a factor 1.99 approximation algorithm for the continuous k-centers problem on a convex polygon.

■ TA72

Bass- Omni

Supply Chain Mgt IX

Contributed Session

Chair: Tugce Vural, Smeal College of Business, Pennsylvania State University, Smeal College of Business, 454 Business Building, University Park, PA, 16802, United States, tugcevural@psu.edu

1 - How Do Countries' Direct Manufacturing Costs And Hidden Costs Affect Manufacturers' Performance? An Empirical Study

Zhexiong Tao, McGill University, 1001 Rue Sherbrooke O, Montreal, QC, H3A1G5, Canada, zhexiong.tao@mail.mcgill.ca

In this study, we attempt to investigate the relationship between countries' direct manufacturing costs and hidden costs and local manufacturers' performance. A research model is proposed and then tested by an international dataset.

2 - Joint Pricing And Production Decisions With Yield Uncertainty And Downconversion

Fen Lu, Huazhong University of Science and Technology, 1037 Luoyu Road,Hongshan District, Wuhan, China, Wuhan, 430074, China, lufen@hust.edu.cn

We consider a firm who supplies two types of products: high-end and low-end. Because of the uncertainty in the production process, the yield rate of the high-end product is uncertain.The substandard high-end products caused by the yield uncertainty can be transformed into the low-end product with a certain cost. We characterize the optimal pricing and production decisions and develop an algorithm to compute the optimal solution. We also investigate the impact of the yield uncertainty on the firm's performance, and how stability of market demand, emergent fulfillment costs and downconversion cost influence this effect.

3 - Supply Chain Strategies And International Tax Arbitrage

Hung Tuan Do, Assistant Professor, University of Vermont, 55 Colchester Avenue, Burlington, VT, 05405, United States, hdo@uvm.edu, Masha Shunko, Andy A Tsay

Our model and analysis demonstrate that the MNF's preferences regarding the operating structures are not necessarily an obvious ordering based on the amount of risk and decision authority transferred to the division. We derive and analyze threshold values of the performance parameters that describe the main tradeoffs involved.

4 - Dynamic Substitution Policy For Selling Multiple Products

Chengzhang Li, Purdue University, West Lafayette, IN, United States, li1392@purdue.edu, Qi Feng, J. George Shanthikumar

We study a firm selling multiple substitutable products over a selling horizon. In each period, when the random demands materializes, the firm may choose one product to meet the demand for another at a cost. We design an efficient algorithm that delivers close-to-optimal performance. We also show that restricting substitutions between products with adjacent characteristics can yield a benefit close to allowing full substitution among all products. Moreover, with an efficient dynamic substitution policy, the value of optimizing initial stock level becomes negligible.

5 - Shipment Consolidation Under Different Delivery Date Options For E-tailing

Tugce Vural, Smeal College of Business, Pennsylvania State University, Smeal College of Business Department of Supply Chain and Information Systems, 454 Business Building, University Park, PA, 16802, United States, tugcevural@psu.edu, Nesim K Erkip

We consider a shipment consolidation problem for an e-retailer that provides two types of services. In regular service, the e-retailer guarantees a maximum delivery time to its customers, whereas in premium service customers receive their items in negligible time. The consolidation operation is analyzed under deterministic demand structure. With the objective of maximizing average profit, a non-linear program with linear constraints is devised. Decision variables are durations for satisfying different service combinations. The structure of optimal policy is derived by using KKT conditions.

■ TA73

Legends A- Omni

Operations Management I

Contributed Session

Chair: Jingqi Wang, The University of Hong Kong, room 806, K.K.Leung Building, The University of Hong Kong, Hong Kong, Hong Kong, jingqi@hku.hk

1 - Equilibria Of Decision Signalling Problem In A Time Sensitive Market

Sheng Zhao, NUS, 14-255D UTwon Residence South Tower, Singapore, 138600, Singapore, zhaosheng@u.nus.edu

A timely launch of new products is crucial for their success/failure.Time is a source of competitive advantage and time-based competition has been recognized as a key feature in different industries such as smartphones, video games, personal computers, automobiles etc. While releasing a product earlier is helpful from the marketing perspective because customers are usually time-sensitive, operational constraints, primarily due to limited production rate, imply that less inventory will be available for sale. We explore this trade-o both under monopoly and competition.

2 - Disruption Management For Outbound Baggage Handling With Worker Assignment

Christian Ruf, TU Muenchen, Arcisstr. 33, Munich, 80333, Germany, christian.ruf@tum.de

Outbound baggage is transferred to departing airplanes. Flights have to be assigned to handling facilities, the handling has to be scheduled and workers have to be staffed to the flights. We propose a model and a solution procedure to plan the outbound baggage handling rolling planning fashion which allows for considering disruptions and updates of problem parameters at each decision epoch. In a computational study we show that the procedure is capable of giving a good solution in a reasonable amount of time even under severe disruptions.

3 - Demand Learning And Agreement Delay In Technology Adoption

Wei Zhang, University of Hong Kong, Pokfulam Road, Hong Kong, China, zhangw.03@gmail.com

Delay of price agreement is common when new technologies are being adopted. Existing theories attribute agreement delay in bilateral negotiations to either asymmetric information or behavioral constraints. We discover that incentives to learn about the uncertain demand drive delay of agreements, even when information is symmetric. Contrary to most existing theories, costly delay can benefit both negotiators.

■ TA74

Legends B- Omni

Optimization Methodology I

Contributed Session

Chair: Abdulaziz Saud Alkabaa, Ph.D. Candidate, University of Tennesee, 1001 Cain Oak Place, Apt 1001, Knoxville, TN, 37909, United States, aalkabaa@vols.utk.edu

1 - Constraint Programming Models For The Irregular Cutting And Packing Problems

Luiz Henrique Cherri, University of São Paulo, São Carlos, 13566-590, Brazil, luizcherri@gmail.com,
Maria Antonia Carravilla, Cristina Ribeiro, Franklina M Toledo

We propose new constraint programming models for variants of the two-dimensional irregular cutting and packing problem. In the literature, several heuristics were proposed for some problem variants, however there is no exact method or mathematical model for many of them. Using the constraint programming models we can represent and solve the irregular cutting and packing variants by exact methods. Since the enforcement of the no overlap among the pieces are the core constraints of all the problem variants, the formulations are built around this basis.

2 - An Iterative Method For Biobjective Mixed Integer Linear Programming Models

Hadi Farhangi, Research Assistant, Missouri University of Science and Technology, 1870 Miner Circle, 236, Engineering Mgmt & Systems Eng, Rolla, MO, 65409, United States, hfrhc@mst.edu, Dincer Konur

In this study, we propose an iterative method to generate the complete set of Pareto efficient solutions for biobjective mixed integer linear programming models. The Pareto efficient set is obtained by sequentially solving mixed integer linear programming models and utilizing the properties of the feasible search space. A numerical study demonstrates the performance of the solution method.

3 - Ensuring Scalability And Re-Usability Of Spreadsheet Analytical And Optimization Models

Larry J LeBlanc, Professor, Vanderbilt University, Owen Graduate School of Mgmt, 401 21st Ave South, Nashville, TN, 37203, United States, larry.leblanc@owen.vanderbilt.edu, Thomas A Grossman

Spreadsheet optimization models are harder than their algebraic counterparts to scale up and down in size. We show how to overcome this spreadsheet scalability disadvantage—We show how to program an optimization model in a spreadsheet that can easily be scaled up or down in size and re-optimized using the Excel Solver as easily as algebraic models. We give examples involving supply chain optimization.

4 - A Novel Branching Rule For Branch And Bound Based on Mahalanobis Distance

Abdulaziz Saud Alkabaa, PhD Candidate, University of Tennesee, 1001 Cain Oak Place, Apt 1001, Knoxville, TN, 37909, United States, aalkabaa@vols.utk.edu, Alberto Garcia-Diaz

The critical rules affecting the Branch-and-Bound (B&B) algorithm's solution performances are mostly regarded to the selection strategies of the search trees' variables and nodes. These strategies can significantly impact on the algorithms' efficiency. The available branching strategies in the literature, however, are not reliable in large problems (Linear Integer problems). In this research, we propose a novel branching strategy that is based on the concept of Mahalanobis Distance. Our analytical and numerical results show that the purposed strategy can effectively improve the B&B solution performances and works capably in a range of problem sizes.

■ TA75

Legends C- Omni

Behavioral Operations I

Contributed Session

Chair: Nazaré Rego, Escola de Economia e Gestão, Universidade do Minho, Braga, Portugal, nazare@eeg.uminho.pt

1 - Study Of Patient Satisfaction Perception Based On Medical Experience And Health Cognition

Jianjie Zhang, Beijing Institute of Technology, Beijing, China, zhjj_2013@163.com, Jinlin LI, Rong Zhang, Jian Xue

This paper examines patient experience and health cognition in outpatient from nine cities of China.By conducting discrete choice experiments,we identify discrepant patients in several attributes and the individual-difference about the health cognition that can explain such discrepancy.For the high degree of the health cognition patients,medical environment and waiting time affection is not significant.however,for the low degree of group,both two attributes affect significantly.In addition to providing the empirical description in China's healthcare market,our study offers patient behavioral optimization suggestions to improve patient satisfaction perception.

2 - Detecting Market Irrationality Using News Sentiment Transfer Entropy

Anqi Liu, PhD Candidate, Stevens Institute of Technology, Hoboken, NJ, 07030, United States, aliu@stevens.edu, Steve Y Yang

Studies in behavioral finance have shown that investors are not rational, and market sentiment and returns have complex interactions. In this study we explore the non-linear relationship between news sentiment and market returns according to the transfer entropy statistic which identifies the amount of directional information flow. We identify two market regimes: sentiment dominance and market dominance. Further analysis suggests that the sentiment dominance indicates more irrational market activities contributing to elevated mispricing and high volatility, while market dominance reflects informational market efficiency.

3 - The Dark Side Of The Singularity: Can OR/MS Help?

John D C Little, Institute Professor, Massachusetts Institute of Technology, M.I.T. Sloan School Of Management, Room E62-534, Cambridge, MA, 02142, United States, jlittle@mit.edu

The "Singularity" is the point in time when artificial intelligence (AI) exceeds human intelligence. This may occur by putting AI on computers, by biological creation, or by a mixture of both. Some of the people writing about this or developing advanced AI are Victor Vinge, Ray Kurzweil (the Singularity is Near), Tom Malone, Ben Goertzel and Hugo de Garis. The dark side is that most people in this room will be left far behind. Kurzweil notes that AI develops exponentially, whereas most of us extrapolate linearly.

4 - Performance Effects Of Diversity Of Experience In Fluid Teams

Antti Tenhiala, IE Business School, Madrid, Spain, antti.tenhiala@ie.edu, Constantin Alba, Fabrizio Salvador

Analyzing fluid teams in a software services setting, we study the performance effects of diversity of experience, partitioning the diversity construct into three dimensions: segmentation, disparity, and variety. We also explore how project complexity moderates the performance effect of each diversity dimension. The results show that depending on the dimension, diversity of experience may have either negative, positive, or inverted-U relationship with team performance and that project complexity may make the effect either more beneficial or more detrimental.

5 - A System Dynamics Analysis Of Cautious Materials Management In Hospitals

Nazaré Rego, Escola de Economia e Gestão, Universidade do Minho, Braga, Portugal, nazare@eeg.uminho.pt
Nazaré Rego, INESC TEC, Faculdade de Engenharia, Universidade do Porto, Porto, Portugal, nazare@eeg.uminho.pt, João Claro, Jorge Pinho de Sousa

The supply system of a hospital provides a wide variety of services and products through a network composed of central departments and relatively autonomous wards. This system has to assure a high service level, particularly at critical wards. In this context, a just-in-case approach to inventory control has been frequently observed and, when the inventory at the DC is insufficient to meet all requests, priority in its allocation may be given to critical wards. We use System Dynamics to analyze the effect of these practices on inventory levels and related service level of a hospital supply system. Our results indicate that they may have a negative impact on the desired materials management outcomes.

■ TA76

Legends D- Omni

Decision Analysis

Contributed Session

Chair: Jordi Weiss, PhD Student, Unil, Lausanne, 1022, Switzerland, jordi.w@outlook.com

1 - Multi-modal Optimization Of WINTIME As A Game Performance Metric And Rankings Basis With An Application To College Football

Christopher Keller, Assistant Professor, East Carolina University, Department of Marketing & Supply Chain, College of Business, Greenville, NC, 27858-4353, United States, kellerc@ecu.edu

WINTIME is the elapsed clock time for the winning team's score to exceed the losing team's final score. WINTIMES can be used to generate a rating system and an estimated WINTIME. The resulting optimization problem is to minimize the errors between the observed and the estimated WINTIMEs. For college football, the model has 129 variables and is multi-modal. Excel Solver solutions are discussed. Accuracy is comparable to other systems with predictive accuracy above 70% and retrodictive accuracy above 85%. The system could also be applied to other sports like hockey or soccer.

2 - Should I Stay Or Should I Go? The Cognition Of Exploration And Exploitation

S.S. Levine, University of Texas, Dallas, TX, 75080, United States, sslevine@gmail.com, Charlotte Reypens

In many life situations, people choose sequentially between repeating a past action in expectation of a familiar outcome (exploitation), or choosing a novel action whose outcome is largely uncertain (exploration). For instance, in each quarter, a manager can budget advertising for an existing product, earning a predictable boost in sales. Or she can spend to develop a completely new product, whose prospects are more ambiguous. Using experiments in a lab and a labor market, we examine what affects these decisions. We investigate traits of the decision-makers, such as risk aversion, but also their history. We find that the past matters, greatly: What you experience counts as much as who you are.

3 - A POMDP Model For Personalized Depression Monitoring

Jue Gong, Graduate Student, University of Washington, Industrial & Systems Engineering, Box 352650, Seattle, WA, 98195, United States, gongjue@uw.edu, Shan Liu

Mitigating depression has become a national health priority as it affects 1 out of 10 American adults. We formulate a partially observable Markov decision process (POMDP) in order to find an optimal monitoring schedule for anindividual patient. The state of the POMDP combines the health state of the patient and the direction of health change. We estimated the transition and emission matrices by extending the Baum-Welch algorithm to include a mixture of multiple transition matrices. We solved the model using the Bellman Equation via dynamic programming algorithm.

4 - Remanufacturing Decisions In A Close-loop Supply Chain With Extended Warranty Options

Kunpeng Li, Utah State University, 767 Eagle View Dr., Providence, UT, 84332, United States, kunpeng.li@usu.edu, Yang Li

The study addresses the problem of choosing the appropriate reverse channel structure for collecting of used products. We consider a two-echelon supply chain with a single manufacturer and a single retailer. By comparing five different reverse channel formats, we intend to understand how close-loop supply chain structure influences the use-product collection. We also study the impact of extended warranty on the consumption of remanufactured products.

5 - Using Online Games To Develop Manager Intuition About Demand Randomness

Jordi Weiss, PhD Student, Unil, Lausanne, 1022, Switzerland, jordi.w@outlook.com, Michael Bean, Suzanne de Treville

Quantitative-finance methods applied to the supply chain dramatically improve incorporation of demand risk into supply-chain decisions. Use of these methods is hindered by managers lack of intuition about demand randomness. We use online games to allow managers to apply such methods in the face of randomness arriving from different forecast-evolution processes (instantaneous volatility or jump diffusion). We present the results from using these games at the policy level for three cantons in Switzerland, demonstrating how increased intuition about randomness helps decision makers to consider profitable options that are counterintuitive and non linear.

■ TA77

Legends E- Omni

Opt, Integer Programing I

Contributed Session

Chair: Ed Klotz, IBM, PO Box 4670, Incline Village, NV, 89450, United States, klotz@us.ibm.com

1 - Solving Large Scale Grid-based Location Problems

Noor E Alam, MD, Assistant Professor, Northeastern University, 334 SN, 360 Huntington Avenue, Boston, MA, 02115, United States, mnalam@neu.edu, John Doucette

This talk will present mathematical models for grid-based location problems (GBLPs) with two case studies. Apart from presenting computational difficulty of the GBLPs, it will also discuss two problem-specific integer linear program (ILP) based decomposition algorithms to solve large-scale instances.

2 - A Mixed-integer Programming Approach To Optimize Typing Method And Design Of Touchscreen Keyboards On Smartphones

Mohammad Ali Alamdar Yazdi, PhD Student, Auburn University, 354 W Glenn Ave, Auburn, AL, 36830, United States, mza0052@auburn.edu, Ashkan Negahban, Fadel Mounir Megahed

Millions of people use smartphones for different typing purposes. There are significant differences in the design of keyboards for smartphones. Optimization of typing method and improvements in the design of touchscreen keyboards on smartphones is expected to have a significant impact on the total typing time. A MIP model is developed to optimize typing zones for fingers in two-thumb typing with the objective to minimize the total typing time. Through extensive experimentation, different keyboard dimensions are also compared to find the optimal keyboard design. The results shows that the best keyboard design has square keys with minimum possible horizontal and vertical spaces between the keys.

3 - Solution Value Contingent Cuts For Solving Hard Generalized Assignment Problems

Robert M Nauss, Professor, University of Missouri - St Louis, 3816 Boca Pointe Dr., Sarasota, FL, 34238, United States, robert_nauss@umsl.edu, Jeremy William North

Define hard generalized assignment problems (GAP) to be those that take more than one hour CPU time to prove optimality. Tremendous strides have been made in the capability of "off the shelf" software, such as GUROBI, to solve general integer linear programs (ILP). However, some classes of ILPs remain difficult to solve to optimality in a reasonable amount of time. Certain instances of the GAP exhibit this behavior. While good feasible solutions are found relatively quickly, the issue remains in proving optimality. We introduce some novel cuts (and methods for deriving said cuts) that are applied with an "off the shelf" solver through the use of CALLBACK functions. Computational results are presented.

4 - Improved Analysis Of Infeasible Mixed-integer Linear And Quadratic Programs

Ed Klotz, IBM, P.O. Box 4670, Incline Village, NV, 89450, United States, klotz@us.ibm.com, John W Chinneck, Andrew Scherr

Analysis of infeasible MILPs and MIQPs is complicated by the integer restrictions (IRs). Current techniques return a minimal infeasible subset of the linear constraints and variable bounds by solving a series of MILPs. They do not find a minimal subset of the IRs, because of the significant additional computational cost. We develop efficient ways to find a minimal subset of the IRs and use this to speed the isolation of a true Irreducible Infeasible Subset for MILPs and MIQPs. This is helpful when a variable is accidentally specified as integer.

■ TA78

Legends F- Omni

Opt, Network I

Contributed Session

Chair: Seyed Mohammad Nourbakhsh, Sabre, 3150 Sabre Drive, Southlake, TX, 76092, United States, seyed.nourbakhsh@sabre.com

1 - Enhanced Robust Operational Aircraft Routing

Seyed Mohammad Nourbakhsh, Sabre, 3150 Sabre Dr, Southlake, TX, 76092, United States, seyed.nourbakhsh@sabre.com, Dong Liang, Xiaodong Luo, Xiaoqing Sun, Sergey Shebalov

Enhanced Robust Operational Aircraft Routing (E-ROAR) serves as an airline planning decision support solution that is used as a post-process to the Fleet Assignment Model (FAM) to bridge the chasm between Airline Planning and Airline Operations. E-ROAR considers connections, and maintenance requirements; and provides fleet assignments and through connections feasible for Crew Planning, Maintenance Planning, and Airline Operations. The output from E-ROAR is given to Airline Operations, where tail assignments are made. We propose an advanced solution approach by combining heuristic and optimization methodologies. Computational results demonstrate significant improvement.

2 - Managing Demand Uncertainty in Collaboration Mechanism Design for Carrier Alliances

Yuhan Wang, University of California, Irvine, CA, wangyuhan1101@gmail.com, Luyi Gui, Ozlem Ergun

A carrier alliance refers to a cooperative among transportation companies that often collaborate via sharing service network capacities. In this paper, we consider a type of collaboration mechanism via capacity exchange prices that has been widely adopted in practice, and aim to provide a comprehensive analysis of its coordination effectiveness under demand uncertainty. In particular, we analyze the structure of service networks of sea cargo alliances in practice and develop a decomposition algorithm to not only much simplifies the problem but also enables a detailed analysis into the structure of a robust exchange prices and the capacity-demand properties of networks where such prices exist.

3 - Interdiction Learning-based Approaches To Combat Security Threats On Information Systems

Forough Enayaty Ahangar, University of Arkansas, Fayetteville, AR, United States, fenayaty@email.uark.edu, Chase Rainwater

We consider a information system connected across a network of servers. In part one of the talk, we solve an interdiction-based model to strategically determine how content is allocated amongst available servers so to minimize the impact of a denial of service attack. In part two of the talk, we provide an operational framework for identifying network threats across the chosen network structure via a learning-based framework. Roles of optimization within this framework are highlighted and the methodology is applied to network data taken from a national laboratories computer logs.

4 - Optimal Linepack Planning Models For Gas Transmission Network

Trung Hieu Tran, Postdoctoral Research Fellow, The University of Warwick, Coventry, CV4 7AL, United Kingdom, t.h.tran@warwick.ac.uk, Simon French, Rhys Ashman, Edward Kent, Mark Hamling, Ben Dickel

National Grid, the gas network operator in the UK, experiences challenges maintaining pressure and linepack (quantity of gas in network) limits due to the transient behaviour of customers in an open market. In this paper, 2 mixed-integer programming models are proposed for optimal linepack planning (i.e. considering the compressibility of natural gas in pipelines) to compensate for the fluctuation of gas flows. The first model minimizes total deviation between simulated & target linepack such that all demand is satisfied. The second model determines time and actions to minimize total cost for resolving linepack deficit. The efficiency of models has been validated in case studies at National Grid.

■ TA79

Legends G- Omni

Health Care, Modeling VX

Contributed Session

Chair: Sharan Srinivas, PhD Candidate and Research Assistant, The Pennsylvania State University, 310 Leonhard Building, University Park, PA, 16802, United States, sus412@psu.edu

1 - Interaction Between Operational Efficiency And Doctor Incentives In Outpatient Services

Guoming Lai, UT Austin, 1 University Station, B6500, Austin, TX, 78712, United States, laiguoming@gmail.com, Xiaofang Wang

This paper studies the interaction between a doctor and a population of patients in a congested health service delivery system. The doctor's prescribing decisions depend on her diagnostic/treatment ability, level of altruism and the institutional framework. Some patients are strategic and decide to see this doctor based on perceived quality, congestion and monetary costs. Within such a setting, we study the socially optimal decisions and provide policy insights.

2 - Equitable Nurse Scheduling By Goal Programming

Esra Agca Aktunc, Assistant Professor, Kadir Has University, Kadir Has Caddesi Cibali, Istanbul, 34083, Turkey, esra.agca@khas.edu.tr

Hospitals have to provide continuous service by employing the shift system and workers, mainly doctors and nurses, are required to work efficiently to avoid errors. Quality of healthcare services can be improved significantly if the nurse shifts are scheduled according to nurses' preferences and by distributing the workload equitably. Schedules should also abide by hospital policies and workload requirements in each shift by assigning nurses with different skill sets. In this study, monthly nurse scheduling problem is modeled and solved by goal programming observing goals that represent nurse and patient satisfaction with fairness measures such as the number of night shifts and weekend shifts.

3 - An Approximate Solution Approach For Blood Management When There Are Multiple Independent Sources Of Supply

David C Novak, Associate Professor, University of Vermont, 310 Kalkin Hall, 55 Colchester Avenue, Burlington, VT, 05405-0157, United States, dnovak@bsad.uvm.edu, Marilyn T Lucas, S. Karti Puranam

We present an approximation method to solve the infinite horizon, fixed lifetime perishable, inventory model with a lifetime of $m > 2$ periods, where there are two independent sources of supply. One source is blood ordered by the blood bank. The other source is blood that is randomly transferred from smaller, lower-usage hospitals in a regional blood exchange network to blood bank. We formulate a DP to solve the multi-period cost minimization problem and test our solution approach both theoretically and empirically.

4 - Improve Service Levels And Reduce Labor Cost Using Different Float Nursing Level Strategies Under Staff Absences In Hospitals

Kamil Ciftci, Lehigh University, 200 West Packer Avenue, Bethlehem, PA, 18015, United States, kac208@lehigh.edu

Nurse shortage is one of major problems in Healthcare Systems. Float nurse strategy is an alternative solution method in hospitals to minimize nurse shortage issue. In this research, we investigate service level, staff absences and economic effects of nurse shortage to find a core regular unit nurse level with flexible float nursing strategy. Under different regular nurse core levels, optimal service and float nurse levels are determined. Performance of our model is also compared with different service level methods in literature. Case study results demonstrate our model provide higher service level and decrease labor cost comparing with current practice in a local hospital.

5 - Design Of Multi-stage Multi-provider Hybrid Appointment System For Patient Scheduling Under Uncertainty

Sharan Srinivas, PhD Candidate and Research Assistant, Pennsylvania State University, 310 Leonhard Building, University Park, PA, 16802, United States, sus412@psu.edu, Arunachalam Ravindran

Recent research focuses on designing hybrid appointment systems (HAS) for patient scheduling by combining open access and pre-booking scheduling methods. However, the multi-stage nature of patient flow, patient availability and uncertainties in outpatient clinics are rarely integrated in the design. We propose a deterministic model, and scenario based Monte Carlo approach to address this gap. The proposed approach aims to improve patient satisfaction and resource utilization by determining the percentage of appointments reserved for pre-booking and open access. A case study with real data from a Family Medicine clinic is used to show the feasibility of the proposed approach.

■ TA86

GIbson Board Room-Omni

Marketing V

Contributed Session

Chair: Ryan Choi, Assistant Professor of Marketing and SCM, Eastern Michigan University, 300 W. Michigan Ave., College of Business, Eastern Michigan University, Ypsilanti, MI, 48197, United States, jchoi20@emich.edu

1 - Investigating The Impact Of Social Influence On The Personalization-privacy Paradox: An Eye Tracking Study

Thomas Frick, PhD Student, Rotterdam School of Management, Burgemeester Oudlaan 50, Rotterdam, 3062PA, Netherlands, frick@rsm.nl, Ting Li, Paul Pavlou

Using consumers' personal information to personalize ads does not only increase perceived ad relevance but also triggers consumer privacy concerns. To study this personalization-privacy paradox, we use eye-tracking technology and investigate how social influence affects consumers' perceived ad relevance and privacy concerns. By objectively measuring visual attention, we obtain a rich understanding of how users affectively and cognitively process information and assess ads. Our results provide insights into the mediating role of attention within the personalization-privacy paradox.

2 - Non-contractual Customer Retention In Multichannel Settings

Chun-Wei Chang, Assistant Professor, Governors State University, 1 University Parkway, University Park, IL, 60484-0975, United States, cchang@govst.edu

We present a framework for estimating multichannel customer relationship dynamics in a non-contractual setting that flexibly allows for relationship revival and investigates the effects of different channel experiences and marketing communication on retention and profitability. We use a multi-segment, multivariate hidden Markov modeling framework to model three managerially relevant customer behaviors: purchase amount, purchase incidence, and channel choice. We uncover two latent relationship states that customers migrate to and from - an active state and an inactive state characterized by different levels of purchase frequency, responsiveness to marketing, and profitability.

3 - An Analysis Of Menus Of Multi-part Tariffs

Ryan Choi, Assistant Professor of Marketing and SCM, Eastern Michigan University, 300 W. Michigan Ave., College of Business, Eastern Michigan University, Ypsilanti, MI, 48197, United States, jchoi20@emich.edu, Taewan Kim

We study which characteristics of three-part tariffs (3PTs) generate greater profit than two-part tariffs and examine the optimal values of 3PTs. Under an assumption of consumer heterogeneity and a full extraction of low type segment's surplus, the seller can extract more of high type surpluses. Literatures argue that offering high type contracts only may be more profitable than keeping the low type paying high information rent. Since the firm can charge greater rent from the high type, offering 3PTs contracts to both high and low segments will be more profitable even though the taste parameter is extremely low, regardless of the proportion of the low type.

■ TA87

Broadway A-Omni

Panel: Guide to the Analytics Body of Knowledge (ABOK)

Sponsored: Analytics

Sponsored Session

Moderator: Louise Wehrle, INFORMS, 5521 Research Park Drive, Catonsville, MD, 21228, United States, louise.wehrle@informs.org

1 - Guideto The Analytics Body Of Knowledge (ABOK)

Louise Wehrle, INFORMS, 5521 Research Park Drive, Catonsville, MD, 21228, United States, louise.wehrle@informs.org

The Guide to the Analytics Body of Knowledge (ABOK) is being created in support of the Certified Analytics Professional (CAP®) program. The ABOK will serve as a central repository for key analytics knowledge, supported by in-depth subject matter expert interviews and writing as well as formerly unpublished case studies. Join us to learn more about the Analytics BOK and provide your input to the creators of this first edition of the ABOK.

2 - Panelist

Terry Harrison, Pennsylvanis State University, University Park, PA, 16802, United States, tharrison@psu.edu

3 - Panelist

James Cochran, University of Alabama, Culverhouse College of Commerce & Bus Admin, Tuscaloosa, AL, 35487, United States, jcochran@cba.ua.edu

■ TA88

Broadway B-Omni

Service Science Best Student Paper Competition I

Award Session

Chair: Robin Qiu, Penn State University, 30 E. Swedesford Road, Malvern, PA, 19355, United States, robinqiu@psu.edu

1 - Bike-share Systems: Accessibility And Availability

Ashish Kabra, INSEAD, Boulevard de Constance, Fontainebleau, 77305, France, ashish.kabra@insead.edu, Elena Belavina, Karan Girotra

This paper estimates the relationship between ridership of a bike-share system and its design aspects— station accessibility and bike-availability. Our analysis is based on a structural demand model that considers the random-utility maximizing choices of spatially distributed users, and it is estimated using high-frequency system-use data from the bike-share system in Paris and highly granular data on sources of bike-share demand. A novel model separates the long-term and short-term effects of higher bike-availability. Because the scale of our data render traditional numerical estimation techniques infeasible, we develop a novel transformation of our estimation problem.

2 - Queues With Redundancy: Is Waiting In Multiple Lines Fair?

Leela Aarthy Nageswaran, Carnegie Mellon University, 308 GSIA, Tepper School of Business, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, leelaaarthy@gmail.com, Alan Scheller-Wolf

We study the performance of two queues serving two classes of customers, one of which is redundant: a redundant customer joins both queues simultaneously and is "served" when any one of her copies completes service. Applications of redundancy range from supermarkets with multiple checkout lines to multiple listing for kidney transplants. By analyzing different policies that a non-redundant customer may use to join a queue when faced with different levels of system information, our model provides fundamental insights on optimal queue-joining policies and on fairness in such systems.

3 - Online Decision-making With High-dimensional Covariates

Hamsa Sridhar Bastani, Stanford University, 10 Comstock Circle, Apt 304, Stanford, CA, 94305, United States, hsridhar@stanford.edu, Mohsen Bayati

Big data has enabled decision-makers to personalize choices based on an individual's observed characteristics. We formulate this problem as a multi-armed bandit with high-dimensional covariates, and present a new efficient algorithm that provably achieves near-optimal performance. The key step in our analysis is proving convergence of the LASSO estimator despite non-iid data induced by the bandit policy. We evaluate our algorithm using a real patient dataset on warfarin dosing; here, a patient's optimal dosage depends on her genetic profile and medical records. Our algorithm outperforms existing bandit methods as well as physicians to correctly dose a majority of patients.

4 - An Efficient Algorithm For Dynamic Pricing Using A Graphical Representation

Swati Gupta, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States, swatig@mit.edu, Maxime Cohen, Jeremy Kalas, Georgia Perakis

We study a multi-period, multi-item pricing problem: maximize the total profit by choosing feasible prices that satisfy various business rules. We develop a graphical model that can solve the problem for small memory. We make no assumption on the structure of the demand. For large memory, we show NP-hardness and approximate general demand functions using the reference price model. We give an approximation to solve the latter, extend it to handle cross-item effects among multiple items using the notion of a virtual reference price. We cluster items into blocks and incorporate global business constraints, and finally validate our results on demand models calibrated by real supermarket data.

5 - Evaluating The First-mover's Advantage In Announcing Real-time Delay Information

Siddharth Prakash Singh, PhD Candidate, Tepper School of Business, Carnegie Mellon University, Tepper School of Business, 5000 Fobes Avenue, Pittsburgh, PA, 15213, United States, sps1@andrew.cmu.edu, Mohammad Delasay, Alan Scheller-Wolf

We study queueing models of two comparable service providers competing for market share. The announcer (A) voluntarily provides real-time delay information, for example on a website. For the non-announcer (N), customers are only aware of a periodically updated long-term average delay. Customers make patronage decisions based on available delay information. We investigate how A, as the first-mover in announcing real-time delay information, influences market shares and customer delays. We find that when A is not the higher-capacity provider, she benefits on both market share and delay. However, when A is the higher-capacity provider, announcing may result in lower market share or longer delays.

■ TA89

Broadway C-Omni

Advances in Traffic Flow Modeling

Sponsored: TSL, Intelligent Transportation Systems (ITS)

Sponsored Session

Chair: Pitu Mirchandani, Arizona Statew University, P.O. Box 878809, Tempe, AZ, 85287, United States, pitu@asu.edu

1 - A Kalman Filter Approach For Dynamic Calibrationof a Simplified Lower-Order Car Following Model

Kerem Demirtas, Arizona State University, 699 S. Mill Ave. Tempe, Brickyard Engineering 553, Tempe, AZ, 85281, United States, kdemirta@asu.edu, Pitu Mirchandani, Xuesong Zhou

In this study, we are interested in dynamic calibration of car following parameters in order to explore both inter-driver and intra-driver heterogeneity. Specifically, we offer an augmented state space system for a lower order linear spacing car following model developed by Newell and implement a modified Kalman filter algorithm in order to track the leader-follower pairs and simultaneously predict and estimate the parameters related with the behavior of the following drivers. The algorithm is tested on the trajectories from NGSIM data and show satisfactory results. Interpretation of the results and promising future research directions are given.

2 - Efficient Supply Calibration Of Large-ScaleTraffic Simulators

Kevin Zhang, Massachusetts Institute of Technology, Cambridge, MA, United States, kzhang81@mit.edu

In this presentation, we propose a simulation-based optimization algorithm for the supply calibration of stochastic traffic simulators. We present a metamodel that combines information from the simulator with a problem-specific analytical network model. This metamodel is embedded within a derivative-free trust region algorithm. With this method, we aim to identify transportation-relevant solutions with improved performance within a strict computational budget. The approach is validated on a real traffic network; results are presented

3 - System Optimal Transit Assignment With Flow-dependent Dwell Times

Alireza Khani, University of Minnesota, 136 Civil Engineering Building, 500 Pillsbury Drive S.E., Minneapolis, MN, 55455, United States, akhani@umn.edu

Travel time of transit vehicles between stops is constant with respect to passenger flow. However, dwell time at stops changes by more boarding and alighting of passengers. This makes the transit assignment an asymmetric problem. To model this phenomenon, an optimization problem is developed and its mathematical properties are investigated.

■ TA90

Broadway D-Omni

Opt, Stochastic II

Contributed Session

Chair: Xiting Gong, Assistant Professor, The Chinese University of Hong Kong, Room 506, William M. W. Mong Engineering Building, Shatin N.T., Hong Kong, xtgong@se.cuhk.edu.hk

1 - Modeling AS/RS Travel In Order Picking Applications

Jingming Liu, Research Assistant, 1986, 920 N Leverett, Apt 824, Fayatteville, AR, 72701, United States, jl011@uark.edu, John A White

An order picking operation is modeled as an M|G|1 queueing problem, with the S/R machine being the server and order picking stations being customers. Service time is the time required for an automated storage and retrieval machine to travel from an order picking station to a random storage location and, then, to an order picking station. To obtain the variance for service time, the density function is derived. Because the two travel times are statistically dependent random variables, results obtained previously for S/R travel do not apply. Random demands for replenishment of order picking stations and Chebyshev travel by the S/R machine are assumed.

2 - Stochastic Quasi-newton Methods For Non-strongly Convex Problems: Convergence And Rate Analysis

Farzad Yousefian, Assistant Professor, Oklahoma State Univeristy, 317D Engineering North, School of Industrial Engineering & Management, Stillwater, OK, 74074, United States, farzad.yousefian@okstate.edu, Angelia Nedich, Uday Shanbhag

Motivated by applications in machine learning, we consider stochastic quasi-Newton (SQN) methods. Traditionally, the convergence of SQN schemes relies on strong convexity. To our knowledge, no rate statements exist in the absence of this assumption. We consider merely convex problems and develop an SQN scheme where both the gradient mapping and the Hessian approximation are regularized and updated in a cyclic manner. Under suitable assumptions on the stepsize and regularization parameters, the convergence is shown in both almost sure and mean senses and the rate of convergence is derived in terms of function value. The empirical results on a binary classification problem are promising.

3 - Optimization With Reference-based Almost Stochastic Dominance

Jian Hu, Assistant Professor, University of Michigan - Dearborn, 4901 Evergreen Rd., Dept. of IMSE,, Dearborn, MI, 48128, United States, jianhu@umich.edu

Stochastic dominance is a preference relation of uncertain prospect defined over a class of utility functions. While this utility class represents basic properties of risk aversion, it includes some extreme utility functions rarely characterizing a rational decision maker's preference. We introduce reference-based almost stochastic dominance (RSD) rules which well balance the general representation of risk aversion and the individualization of the decision maker's risk preference. We also propose RSD constrained stochastic optimization model and develop an approximation algorithm based on Bernstein polynomials.

4 - Balancing Flexibility And Inventory In Workforce Planning With Learning And Uncertain Demand

Silviya Valeva, University of Iowa, 710 Carriage Hill, Apt 5, Iowa City, IA, 52246, United States, silviya-valeva@uiowa.edu, Barrett Thomas, Mike Hewitt

Explicitly modeling human learning in task assignment problems offers opportunities for better decision making that can result in both increased revenue and decreased lost sales. We present an assignment model incorporating both individual learning and uncertainty in demand and compare its performance to several myopic models. Our results demonstrate that cross training the workforce can be a successful way to hedge against uncertain demand. We further explore the use of practice assignments and inventory building as ways of creating capacity and preparing to meet future demand.

5 - Approximation Algorithms For Capacitated Perishable Inventory Systems With Positive Lead Times

Xiting Gong, Assistant Professor, The Chinese University of Hong Kong, Room 506, William M. W. Mong Engineering Building, Shatin N.T., Hong Kong, xtgong@se.cuhk.edu.hk, Xiuli Chao, Cong Shi, Chaolin Yang, Huanan Zhang, Sean Zhou

Perishable inventory system with positive lead time and finite ordering capacity is an important but notoriously difficult class of problems in both analysis and computation. Its optimal control policy is extremely complicated, and no effective heuristic policy has been proposed in the existing literature. In this paper, we develop an easy-to-compute approximation policy for this class of problems and show that it admits a theoretical constant-factor worst-case performance guarantee under most demand models of practical interest. Our numerical study shows that the proposed policy performs consistently well.

■ TA94

5th Avenue Lobby-MCC

Technology Tutorial: Frontline/ SAS-GAP/EDU

Technology Tutorial

1 - Frontline: AnalyticSolver.com: Data Mining, Simulation And Optimization In Your Web Browser

Daniel Fylstra, Frontline Systems, Inc., Incline Village, NV, Daniel@solver.com

AnalyticSolver.com is the new, simple, point-and-click way to create and run analytic models using only your web browser - that also works interchangeably with your spreadsheet. Whether you need forecasting, data mining and text mining, Monte Carlo simulation and risk analysis, and conventional and stochastic optimization, you can "do it all" in the cloud. We'll show how you can upload and download Excel workbooks, pull data from SQL Server databases and Apache Spark Big Data clusters, solve large-scale models, and visualize results - without leaving your browser. If you're more comfortable working on your own laptop or server, we'll show how you can do that, too.

2 - SAS: Analysis Of a Presidential Debate Using SAS Text Analytics

André de Waal, Global Academic Program, Cary, NC, 27513, United States

During the last year of a presidential term in the United States of America, the race to the White House has everybody excited. News channels and newspapers provide "expert" analysis of day to day events. However, many of the expert opinions are biased and reflect a commentator's political viewpoint or affiliation. Can text mining be used to look at the data objectively and cut through the political rhetoric? In this talk, a script of one of the 2016 presidential debates is analyzed with SAS Text Miner. An attempt is made to look at the data "objectively" and to let the data speak. Words are counted and stemmed, documents are grouped into clusters, topics are identified and candidates are analyzed while trying to determine what separates one candidate from the rest of the field. Although it is impossible to predict using text mining alone who will win the presidential election, text mining could provide some insight into the election process (of which the debates are an integral part) that is not generally available to the general populace and might influence their choice of presidential candidate.

Tuesday, 10:00AM - 10:50AM

■ Tuesday Plenary

Davidson Ballroom-MCC

Big Data and Big Decisions

Plenary Session

Chair: Shabbir Ahmed, Georgia Tech, shabbir.ahmed@isye.gatech.edu

1 - Big Data And Big Decisions

Suvrajeet Sen, University of Southern California, 3715 McClintock Ave, Los Angeles, CA, 90089, United States, s.sen@usc.edu, Suvrajeet Sen

Over the past decade, the world of Statistical and Machine Learning have made dramatic in-roads into some of the more challenging AI problems ranging from speech recognition and natural language processing, to bio and health informatics. Both supervised and unsupervised learning methods have exploded in daily use for applications covering business analytics, e-commerce, educational/tutoring systems, and others. In many cases, new models and algorithms have been developed so that the results of learning are also easier to interpret (for a human decision maker). The partnership between AI and human cognition is not new, but its widespread success in recent years has transformed the way we do business today. The combination of modern informatics and high dimensional statistics has often been credited with this transformation. This lecture will not only highlight some successes of Big Data, but also explore settings where human cognition may not provide the best test of decision quality. This new class of problems involves not only Big Data, but also Big Decisions. This lecture will explore the continuum between Big Data and Big Decisions.

Tuesday, 11:00AM - 12:30PM

■ TB01

101A-MCC

Clustering Methods in Data Mining

Sponsored: Data Mining

Sponsored Session

Chair: Majeed Simaan, RPI, 231 Congress Street, Troy, NY, 12180, United States, simaam@rpi.edu

1 - Parable: A Parallel Random Partition Based Hierarchical Clustering Algorithm For The Mapreduce Framework

Haimonti Dutta, University at Buffalo, 325P Jacobs Management Center, Buffalo, NY, 14260, United States, haimonti@buffalo.edu

Large datasets, of the order of peta and tera bytes, are prevalent in many scientific domains. To effectively store, query and analyze these gigantic repositories, parallel and distributed architectures are popular. Apache Hadoop is one such parallel framework for supporting data-intensive applications. In this paper, we present a PArallel, RAndom-partition Based hierarchicaL clustEring algorithm for the MapReduce framework on Hadoop. It proceeds in two steps - local hierarchical clustering on nodes and integration of results by a novel dendrogram alignment technique. Empirical results indicate that significant scalability benefits can be obtained while maintaining good cluster quality.

2 - Clustering The Traffic Data Errors Using K-mean Clustering Method

Amin Ariannezhad, Graduate Research Assistant, University of Arizona, 1209 E. 2nd Street, Tucson, AZ, 85719, United States, ariannezhad@email.arizona.edu, Yao-Jan Wu

This study aims to identify the meaningful patterns of errors observed in traffic data collected from dual loop detectors in Phoenix, Arizona. A set of data quality control criteria was implemented to calculate the percentage of different types of errors observed during each day of data for each loop detector. K-mean clustering method was then utilized to cluster the 15 possible error categories in the data detected in each loop detector on daily basis. Seven significant patterns were found in these errors based on the relationship between them. Findings from the field visit revealed that the clustering method could successfully find different meaningful patterns in data errors.

3 - A New Optimization Model For Supervised Biclustering Problem In Biomedical Dataset Classification

Cem Iyigun, Associate Professor, Middle East Technical University, Inonu Blvd, Endustri Muhendisligi, Ankara, 06800, Turkey, iyigun@ie.metu.edu.tr, Saziye Deniz Oguz Arikan

Biclustering groups samples and features simultaneously in the given set of data. We focus on a supervised biclustering problem leading to unsupervised feature selection for binary class and multi-class problems. For this problem, we have proposed a new supervised biclustering optimization model which aims to maximize classification accuracy by selecting almost all features.

4 - Large Scale Spectral Partitioning By Simulated Mixing

Shahzad Bhatti, University of Illinois at Urbana Champaign, 104 S Mathews Ave,, Urbana, IL, 61801, United States, bhatti2@illinois.edu, Carolyn Beck, Angelia Nedich

Several problems can be cast as a spectral partitioning problem such as data clustering, graph partitioning, community detection, image segmentation etc. However, computational complexity of eigenvalue decompositions has handicapped application of spectral partitioning to large scale problems. Several algorithms in the recent past focus on accelerating spectral partitioning, however they sacrifice its accuracy to achieve faster speed. Our algorithm on the other hand does not require eigenvalue decomposition, rather it recursively bi-partitions the data by finding an approximate linear combination of eigenvectors of the normalized adjacency matrix of the underlying graph.

■ TB02

101B-MCC

Methods for Analysis of Next-Generation Sequencing Data

Sponsored: Data Mining

Sponsored Session

Chair: Paul Brooks, Virginia Commonwealth Univ, Richmond, VA, United States, jpbrooks@vcu.edu

1 - Quality Control For Microbiome Experiments

David Edwards, Virginia Commonwealth University, Richmond, VA, United States, dedwards7@vcu.edu, Paul Brooks

Microbiome studies aim to understand the role of the bacterial communities in physiology and disease. The primary goal of the Vaginal Microbiome Consortium is to develop methods to facilitate the discovery of patterns in 16S rRNA data and extensive clinical and demographic data as it relates to women's health. Maintaining internal consistency and understanding measurement variation in microbiome experiments is key to identifying and avoiding batch effects. In this talk, we discuss and illustrate how statistical quality control techniques (and related visualizations) are useful for assessing data consistency across time via positive and negative controls.

2 - Characterizing The Vaginal Microbiome Based On A Large Observational Study

Victoria Pokhilko, Virginia Commonwealth University, Richmond, VA, United States, pokhilkovv@vcu.edu, Paul Brooks, David Edwards

We conducted an analysis of 16S rRNA surveys of the vaginal microbiome based on samples from over 6,000 women. Vaginal microbiome profiles are typically dominated by a single bacterium, leading to a classification of samples into groups that we call vagitypes. Vagitype classifications facilitate the discovery of relationships between microbiome profile and clinical data. The presence or absence of Lactobacillus species and a diagnosis of bacterial vaginosis have been shown to play an important role in the reproductive health of a woman. Our analysis provides information about these patterns and suggests roles for other bacteria in health and dysbiosis.

3 - Longitudinal Data Analysis Techniques For Analyzing Microbiome Data

Eugenie Jackson, University of Wyoming, ejacks20@uwyo.edu

Microbiome data is characterized by a high degree of sparseness, a number of observations much smaller than the number of taxa, and often a small set of taxa that dominates the data. Goals of analysis include identifying and characterizing microbiome profiles, discovering relationships between microbial populations and health states, and understanding interdependencies among taxa. Changes in human microbial communities and their respective hosts across time is of fundamental interest. We present an overview of recent longitudinal analysis techniques for microbiome data. We discuss their respective strengths and uses, open problems, and directions for future work.

4 - Changes In Community State Types Reflect Major Shifts In The Human Microbiome

Paul Brooks, Virginia Commonwealth Univ, jpbrooks@vcu.edu

The human microbiome consists of the micro-organisms that reside in various body habitats. We present a re-analysis of five sequencing-based surveys of the vaginal microbiome with repeated measures. Our goal is to understand the expected persistence in a state, the rate of state changes, our ability to predict an upcoming change, and predictors of upcoming changes. Our results provide insight into microbiome dynamics.

■ TB03

101C-MCC

Marketing Strategies of Entertainment Products

Invited: Entertainment Analytics

Invited Session

Chair: Yong Liu, University of Arizona, 1130 E Helen Street, Tucson, AZ, 85721, United States, yoliu@eller.arizona.edu

1 - Pre-launch Analysis Of Competitive Dynamics

Natasha Zhang, University of Virginia, ynf8a@comm.virginia.edu, Fang Wu, Vithala R Rao

The market structure literature has focused on mature products and post-launch competition. Yet many industries such as entertainment see frequent product introductions with short lifecycles; and need to identify dynamic market structure pre-launch to guide marketing mix decisions largely made pre-launch. However, such identification is almost impossible because of lack of sales data and dynamic competition resulting from entries, exits, and changes in preannounced release timing. The authors thus propose a dynamic market structure model to capture the evolution of competitive sets and brand positioning, calibrated on a film prediction market.

2 - The Choice And Effects Of Movie Previews In Video-on-Demand Services

Yong Liu, University of Arizona, Tucson, AZ, United States, yoliu@eller.arizona.edu, Zhen Chen, Madhu Viswanathan, Hongtao Pan, Pei Huang

A key strategy that the Video-on-demand (VOD) providers use to help consumers choose among numerous programs is the provision of program reviews. In this paper we investigate when consumers choose to watch previews and how preview watching may influence movie choice. Our research context are the on-demand movies in the Internet Protocol TV (IPTV) systems from a large Chinese VOD service provider. We find that the movie attributes, household characteristics, and time of the week significantly affect consumer choice for previews. At the same time, the ratio of preview watching time to the length of the preview program has a significant impact on the subsequent movie choice.

■ TB04

101D-MCC

Developing Country Electricity Systems

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Valerie Thomas, Georgia Tech, 765 Ferst Drive, Atlanta, GA, 30332, United States, vthomas@isye.gatech.edu

1 - Electricity Development In Africa - A Multi-objective Optimization Approach

Amelia Musselman, Georgia Institute of Technology, Atlanta, GA, United States, amusselman@gatech.edu, Dima Nazzal, Valerie Thomas

Many people across Africa are without sufficient access to electricity. The unavailability and unreliability of energy resources in Africa contribute to developmental challenges in many areas including business, education, and healthcare. We develop a mixed integer optimization model for power generation and transmission system expansion planning in Africa. In addition to solving the least cost optimization, we consider optimal use of a fixed electrification budget when demand cannot fully be met. We test our model on the Democratic Republic of Congo, Uganda, Tanzania, Rwanda, and Burundi.

2 - Can Developing Countries Leapfrog The Centralized Electrification Paradigm?

Todd Levin, Argonne National Laboratory, tlevin@anl.gov

Due to the decreasing costs of decentralized technologies, centralized power systems are no longer a necessary condition of universal electricity access. Developing countries with less developed infrastructures may be able to adopt these new technologies more quickly. We determine the electricity consumption levels at which the costs of centralized and decentralized electrification are equivalent in three African regions. We then calculate capital costs necessary for distributed technologies to cost-effectively provide each of five tiers of energy access, as defined by the UN SE4All Framework.

3 - Analysis of a Wind-Hydro Storage System in Kenya

Maureen Murage, Cornell University, Ithaca, NY, Contact: mwm88@cornell.edu

Kenya has set a target of increasing the wind power capacity from 1% to nearly 15% of total generation capacity. The Lake Turkana Wind Power (LTWP) wind farm will be the largest installation, contributing to half of this total. In this presentation, we will discuss the reliability impact of LTWP project on the Kenyan Power system. The results indicate that the addition of wind power into the system only marginally improves the reliability of the power system, though other implementation strategies may improve this outcome.

■ TB05

101E-MCC

Optimal Power Flow

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Andy Sun, Georgia Institute of Technology, Atlanta, GA, United States, andy.sun@isye.gatech.edu

1 - Visualizing The Feasible Spaces Of Optimal Power Flow Problems And Their Convex Relaxations

Daniel K Molzahn, Argonne National Laboratory, dan.molzahn@gmail.com

Optimal power flow (OPF) problems can have non-convex feasible spaces. Visualizing these feasible spaces can aid in understanding these non-convexities. Work towards developing such visualizations uses the Numerical Polynomial Homotopy Continuation (NPHC) algorithm, which is guaranteed to find all power flow solutions. By discretizing the inequality constraints, repeated power flow solutions using NPHC enables calculation of the feasible spaces for small OPF problems. This presentation illustrates the feasible spaces of several challenging OPF problems and various convex relaxations.

2 - Global Optimization Techniques For The Optimal Power Flow Problem

Burak Kocuk, Carnegie Mellon University, Pittsburgh, PA, United States, bkocuk@andrew.cmu.edu, Santanu S. Dey, Andy Sun

In this study, we aim to solve the Optimal Power Flow problem using global optimization techniques. Our analysis starts with an equivalent SDP formulation of the problem with additional nonconvex minor constraints. We propose several convexification approaches to deal with these nonconvexities via cutting planes and envelopes. We make efficient use of bound tightening to stregthen the convex relaxations. We also develop an SOCP-based spatial branch-and-cut algorithm. Our approach is successful in proving small optimality gaps for challenging power systems instances from the literature.

3 - Convex Cuts For Optimal Power Flow

Hassan Hijazi, Australian National University, Canberra, Australia, hassan.hijazi@anu.edu.au, Carleton Coffrin, Pascal Van Hentenryck

Global optimality and feasibility guarantees are highly desirable outcomes for problems arising in application areas with critical infrastructures. These include energy, transportation, telecommunication and cyber-security systems. A global approach is necessary to prove that the underlying model is infeasible or that the provided solution is optimal. Unfortunately, off-the-shelf global optimization tools are unable to scale up to real-world size problems. This presentation will cover recent results on the generation of valid convex cuts for nonconvex quadratically constrained programs, focusing on key application problems such as the Optimal Power Flow.

4 - Convexification Of The Power System State Estimation Problem

Yu Zhang, University of California, Berkeley, Berkeley, CA, United States, yuzhang49@berkeley.edu, Ramtin Madani, Javad Lavaei

This presentation deals with the power flow (PF) and power system state estimation (PSSE) problems. The PF problem is cast as an optimization problem by adding a well-designed quadratic objective. It is shown that with a suitable set of measurements and under mild angle conditions, the semidefinite programming (SDP) relaxation can recover the true solution. Capitalizing on this result, a penalized SDP using the weighted least absolute value data fitting cost is tailored for the PSSE. The optimal SDP solution has a dominant rank-one component formed by lifting the true state. An upper bound on the estimation error is also derived, which depends on the noise power.

■ TB06

102A-MCC

Solving Hard Optimization Problems in Machine Learning

Sponsored: Data Mining

Sponsored Session

Chair: Yan Xu, SAS Institute, Inc., 100 SAS Campus Drive, Cary, NC, 27513-2414, United States, yan.xu@sas.com

1 - Strategies For Maintaining Sparse Dual Solutions In Large-scale Nonlinear SVM

Alireza Yektamaram, Lehigh University, Bethlehem, PA, sey212@lehigh.edu, Joshua Griffin

This talk will focus on distributed methods for solving large-scale nonlinear SVM problems. It is easy to show that the global solution for such problems may be dense, resulting in large impractical models returned to the user. Further, the accuracy of such models typically is poor compared to sparser approximate solutions. This talk focuses on practical methods that can be used to directly and efficiently seek out accurate sparse solutions regardless of whether or not the global solution is dense.

2 - A Hessian Free Method With Warm-starts For Deep Learning Problems

Wenwen Zhou, SAS Institute Inc, 100 SAS campus drive, Cary, NC, 27513, United States, Wenwen.Zhou@sas.com, Joshua Griffin

This talk will focus on solving deep learning problems with Krylov-based iterative methods where effective preconditioning matrices are unavailable. For such problems, convergence of the outer iterations can degrade when the iterative solver repeatedly exits on maximum Hessian-vector products rather than relative residual error . To address this issue, a new warm start strategy is proposed to accelerate an existing modified conjugate gradient approach while maintain important convergence properties. Numerical experience and addition to convergence results will be provided.

3 - An Accelerated Power Method For The Best Rank-1 Approximation To A Matrix

Jun Liu, SAS Institute Inc., Cary, NC, United States, Jun.Liu@sas.com, Ruiwen Zhang, Yan Xu

The best rank-1 approximation to a matrix is a fundamental tool in linear algebra and many machine learning applications. The power method is one of the most well-known approaches for computing the best rank-1 approximation to a matrix. In this paper, we propose to accelerate the power method for the best rank-1 approximation of a matrix by imposing an additional refinement step. The refinement step combines the current approximate solution and the previous one to obtain an optimally refined point that is used as an input to the next step of the power method. Empirical results on synthetic and real data sets demonstrate the effectiveness of the proposed method.

4 - Local Search Optimization For Hyper-parameter Tuning

Yan Xu, SAS Institute, Inc., yan.xu@sas.com

Many machine learning algorithms are sensitive to their hyper-parameter settings. In this talk we discuss the use of black-box local search optimization (LSO) for machine learning hyper-parameter tuning. Viewed as a black-box objective function of hyper-parameters, machine learning algorithms create a difficult class of optimization problems. The corresponding objective functions involved tend to be nonsmooth, discontinuous, unpredictably computationally expensive. We apply a parallel hybrid derivative-free optimization algorithm that can make progress despite these difficulties providing significantly improved results over default settings with minimal user interaction.

■ TB07

102B-MCC

Networks and Data Analytics in Finance

Sponsored: Data Mining

Sponsored Session

Chair: Shawn Mankad, Cornell University, 401H Sage Hall, Ithaca, NY, 14853-6201, United States, spm263@cornell.edu

1 - A System-wide Approach To Measure Connectivity In The Financial Sector

Sumanta Basu, Cornell University, sumbose@berkeley.edu, Sreyoshi Das, George Michailidis, Amiyatosh Purnanandam

We develop and estimate a system-wide measure of network connectivity for a sample of very large financial institutions of the U.S. Our approach is in sharp contrast with extant measures of systemic risk that, either explicitly or implicitly, estimate such connections using pair-wise relationships between institutions. We show that such a pair-wise approach may result in improper classification of banks as systemically important. Our system-wide approach, based on a recently developed Lasso penalized Vector Auto-Regression (LVAR) model, allows us to detect important systemic events and identify systemically important institutions in a statistically principled manner.

2 - The Topology Of Overlapping Portfolio Networks

Andreea Minca, Cornell University, acm299@cornell.edu

This paper analyzes the topology of the network of common asset holdings, where nodes represent managed portfolios and edge weights capture the impact of liquidations. We consider the degree centrality as the degree in the subnetwork of weak links, where weak links are those that lead to significant liquidations. We show that the degree centrality is correlated with excess returns, and is significant after we control for the Carhart four factors.The network of weak links has a scale free structure, similar to financial networks of balance sheet exposures. Moreover, a small number of clusters, densely linked, concentrate a significant proportion of the portfolios.

3 - Network Concentration And Systemic Losses

Agostino Capponi, Columbia University, ac3827@columbia.edu

We develop a majorization-based tool to compare financial networks with a focus on the implications of liability concentration. Specifically, we quantify liability concentration by applying the majorization order to the liability matrix that captures the interconnectedness of banks in a financial network. We develop notions of balancing and unbalancing networks to bring out the qualitatively different implications of liability concentration on the system's loss profile. An empirical analysis of the network formed by the banking sectors of eight representative European countries suggests that the system is either unbalancing or close to it, persistently over time.

4 - The Multilayer Structure Of The Financial System

Dror Kenett, US Office of Financial Research, dror.kenett@ofr.treasury.gov

We introduce a new multilayer map to identify, quantify, and understand interconnections that can spread a stress event across the financial system. The network map has three layers showing the flow of assets, short-term funding, and collateral that circulate among market participants. As we move from one layer to the next layer, risk is transformed and spreads. For example, a price shock to one type of securities in the asset layer may move through the network to become a funding risk in the funding layer, then emerge as a counterparty or credit risk in the collateral layer. We also discuss data gaps that must be filled to map the full scope of interconnections in a multilayer financial system.

■ TB08

103A-MCC

Business Model Innovation

Invited: Business Model Innovation

Invited Session

Chair: Serguei Netessine, INSEAD, Singapore, Singapore, serguei.netessine@insead.edu

1 - Sustainable Distribution Models At The Bottom Of The Pyramid

Bhavani Shanker Uppari, INSEAD Business School, shanker4uu@gmail.com, Ioana Popescu, Serguei Netessine

Although several products are invented to improve the lives of poor (e.g., efficient cook stoves, solar lights), they do not necessarily reach the poor because these people live in villages which are located beyond most multinationals' distribution networks. Lack of infrastructure and illiteracy only aggravate this problem. Therefore, several firms rely on door-to-door (D2D) distribution networks to sell their products. We investigate the strategic issues that arise in D2D models, such as when is it appropriate to create a proprietary D2D network or share it with a partner, what type of partner (for-profit vs. for-impact) is suitable, and how to align the incentives of partners in a shared D2D model.

2 - Pay-as-you-go Business Models In Developing Economies

Jose A Guajardo, University of California-Berkeley, jguajardo@berkeley.edu

Pay-As-You-Go business models have become widely adopted for the diffusion of off-grid energy products in developing economies. In this research we provide an empirical analysis of central aspects of this type of business models.

3 - Business Model Innovation Feature Extraction And Application To The Lean Startup Framework

Christophe Pennetier, Insead, Christophe.pennetier@insead.edu

Using a new curated dataset with more than half a million startups, we use state-of-the-art text mining and machine learning techniques to identify business model innovations and study their effects on startups' success.

4 - Division Of Labor: Managing A Portfolio Of Self-scheduling Workers

Kaitlin Daniels, Assistant Professor, Olin Business School, Washington University in St. Louis, St. Louis, MO, United States, k.daniels@wustl.edu

Self-scheduling workers value their ability to decide for themselves how much they work. However, the flexibility of self-scheduling creates costly uncertainty in the service capacity of a firm coordinating a network of self-scheduling workers. We study a system of heterogeneous workers who decide to work in response to incentives offered by a firm. The firm balances the cost of convincing some workers to work reliably with the benefit of reducing capacity uncertainty. We study how the mix of reliable and "flexible" workers changes as workers make costly demands of the firm (e.g. expense reimbursement, overtime pay, minimum wages), like those made by Uber drivers in recent lawsuits.

■ TB09

103B-MCC

Information and Market Structure

Sponsored: Applied Probability

Sponsored Session

Chair: Yash Kanoria, ykanoria@columbia.edu

1 - Designing Information Disclosure Policies

Kostas Bimpikis, Stanford, Stanford, CA, United States, kostasb@stanford.edu, Mohamed Mostagir

Participants race towards completing a project and learn about its feasibility from their own efforts and their competitors' gradual progress. Information about the status of competition can alleviate some of the uncertainty inherent in the contest, but it can also adversely affect effort provision from the laggards. This paper explores the problem of designing the information disclosure policy of a contest in a dynamic framework and provides a number of guidelines for maximizing the designer's expected payoff.

2 - Shared Information Sources In Exchanges

Mariann Ollar, University of Pennsylvania, omariann@gmail.com

In financial and commodity exchanges, shared information sources, such as common forecasting methodologies or targeted advertisement, induce common biases in forecast errors. I show here in a linear normal model, that shared information sources qualitatively affect information aggregation and trade stability. First, they hinder perfect aggregation of information even on large markets with fundamental values and they necessitate learning from price even with independent trader values, since price is then informative about the common bias. Importantly, source restrictions can resolve market collapse, especially in exchanges with strong common values.

3 - Stable Matchings Are Easy To Find

Yash Kanoria, Columbia Business School, ykanoria@columbia.edu, Itai Ashlagi, Mark Braverman, Peng Shi

Matching markets include dating markets, school/college admissions, and labor markets. We analyze two-sided markets with tiers and study how much search effort is needed to find a stable matching. We find a "small" amount of search effort suffices, if each agent reaches out to his most desirable potential matches among those who have slightly less market power than his own. Interestingly, agents should wait for dream matches to reach out to them.

■ TB10

103C-MCC

Natural Gas Markets

Sponsored: Energy, Natural Res & the Environment, Energy II Other

Sponsored Session

Chair: Felipe A Feijoo, Johns Hopkins University, 3400 N Charles St, Baltimore, MD, 21218, United States, ffeijoo@jhu.edu

Co-Chair: Sauleh Ahmad Siddiqui, Johns Hopkins University, 3400 N. Charles St., Latrobe Hall 205, Baltimore, MD, 21218, United States, siddiqui@jhu.edu

1 - Evaluating Risks Of Maritime Transportation And Countries Of Import Source For LNG

Ayumi Sekimori, Chuo University, Tokyo, Japan, a11.eceh@g.chuo-u.ac.jp, Shigeki Toriumi, Ryuta Takashima

The use of natural gas has increased due to the influence of Fukushima accident. Thus it becomes more important to choose source countries for LNG import. In this work we analyze an import policy for LNG taking into account risks of maritime transportation and countries of import source. Especially the transportation risk includes maritime accidents and a dependence on chokepoints. The import source countries for LNG are decided by minimizing both risks under constraint of transportation cost.

2 - A Simulation Model For Comparing The Robustness Of Alternative Liquefied Natural Gas Annual Delivery Programs

Fatih Mutlu, Qatar University, fatihmutlu@qu.edu.qa

Annual delivery program (ADP) is an integrated production, inventory, and delivery plan prepared by liquefied natural gas (LNG) suppliers to fulfill their contractual requirements. Traditionally, ADPs are prepared with the aim of minimizing the operational and contractual penalty coss. However, the implementation of an ADP is subject to many random disturbances, e.g., travel time delays. We develop a discrete-event based systems simulation model to simulate the implementation of an ADP by incorporating travel times uncertainty. Our model includes several contingency plans in case of delays. We compare the robustness of alternative ADPs using the simulation model.

3 - The North American Natural Gas Model: Analysis Of Long Term Natural Gas Exhaustion

Sauleh Ahmad Siddiqui, Johns Hopkins University, 3400 N Charles Street, Baltimore, MD, 21218, United States, siddiqui@jhu.edu, Felipe A Feijoo

The U.S. shale boom and new power plant regulations recently announced by the U.S. Environmental Protection Agency have stimulated substantial academic debate and numerical simulation exercises to understand the future role of natural gas in North America. Furthermore, the U.S. is expected to become a significant net exporter of natural gas over the next years. We use the North American Natural Gas Model (NANGAM) to better understand the new developments in infrastructure needed in North America to address increasing global demand. An analysis of resources being exhausted due to increased exports is also performed.

■ TB11

104A-MCC

Optimization in Network Reliability, Security, and Interdiction

Sponsored: Optimization, Network Optimization

Sponsored Session

Chair: Yongjia Song, Virginia Commonwealth University, Richmond, VA, United States, ysong3@vcu.edu

1 - Multi-layered Interdependent Network Flow Problem

Negin Enayaty, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States, nenayaty@email.uark.edu, Kelly Sullivan, Sarah G Nurre, Matthew Jd Robbins, Brian J Lunday

We propose a generalization of the minimum cost multi-commodity flow problem in which the flow of each commodity is dependent on the flow of other commodities. We present computational results for an interdependent infrastructure data set and analyze the cost of layer interdependence in this problem. We develop model reduction strategies and investigate their effect on reducing computation times.

2 - Vulnerability Analysis Of Interdependent Networks Via Integer Programming Approaches

Shanshan Hou, The University of Arizona, shanshanh@email.arizona.edu

Due to the mutual support from the other one, the interdependent network shows increasing vulnerability to failures. In this talk, we proposed integer programming formulations to identify the most vulnerable components in the network, and also the solution approaches. To validate and test the model and algorithm, we perform the numerical experiments on power grid and its supporting communication control network. The potential application of this research is to redesign or defense many networks, especially the infrastructure networks.

3 - Stochastic Network Interdiction With Incomplete Preference

Babak Saleck Pay, Virginia Commonwealth University, saleckpayb@mymail.vcu.edu

We study two different cases of the stochastic shortest path interdiction problem with incomplete preferences. In the first case, the defender makes an interdiction decision, random network costs are realized, and then the attacker chooses his path. In the second case, the decisions of both players are made before the realization of randomness. We consider the situation where the underlying utility functions of the decision makers are ambiguous. We use a minimax formulation for the defender to minimize the attacker's worst-case utility. We present numerical results based on randomly generated instances to show the performance of the models.

4 - Approximation Algorithms For Expected-value Maximum Multiple Coverage Problem And Its Variants

Kay Zheng, University of Wisconsin-Madison, kay.zheng@wisc.edu, Laura Albert McLay, James Luedtke

Motivated by cyber-security planning application, we develop an optimization framework based on maximum coverage problem addressing multiple coverage, concave objective function, group budget constraints, and random coverage failure etc. Polynomial time approximation algorithms with constant performance guarantees are formulated to solve the integer programming models. Computational results are presented to demonstrate the efficiency and accuracy of the algorithms.

■ TB12

104B-MCC

New Models and Approximation Results in Stochastic and Combinatorial Optimization

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Qie He, University of Minnesota, 111 Church Street SE, Minneapolis, MN, 55455, United States, qhe@umn.edu

1 - Approximation Algorithms For Chance-constrained Problems

Shabbir Ahmed, Georgia Institute of Technology, shabbir.ahmed@isye.gatech.edu, Weijun Xie

Chance constrained problems (CCPs) are NP-hard. We propose bicriteria approximation algorithms for CCPs by scaling and rounding optimal solutions to certain relaxations proposed in the literature. We explore the tractability of the relaxations under different probability distributions. For a CCP with discrete support, this approximation algorithm can be reduced to a single criterion one, and the approximation ratio turns out to be tight.

2 - Valid Inequalities For Separable Concave Constraints With Indicator Variables

James Luedtke, University of Wisconsin-Madison, Madison, WI, United States, jim.luedtke@wisc.edu, Cong Han Lim, Jeff Linderoth

We study valid inequalities for optimization models that contain both binary indicator variables and separable concave constraints. We propose a technique to obtain valid inequalities that are based on both the MILP constraints and the concave constraints. We demonstrate how valid inequalities for the single node flow set and for the lot-sizing polyhedron can be to “tilted” to give valid inequalities that also account for separable concave functions of the arc flows. We present promising computational results demonstrating the utility of the new inequalities for nonlinear transportation problems and for lot-sizing problems with concave costs.

3 - Strong Reductions For Linear And Semidefinite Programs

Sebastian Pokutta, Georgia Institute of Technology, sebastian.pokutta@isye.gatech.edu, Gabor Braun, Aurko Roy

Linear and semidefinite programming are two core optimization paradigms with many important applications. However, the expressive power of these modeling paradigms is only partially understood so far and extended formulations are a powerful and natural tool to analyze the possibilities and limitations of linear and semidefinite programming formulations. We will present a strong reduction mechanism both for LPs and SDPs, which allows to establish strong inapproximability results for various problems, including e.g., vertex cover, bounded-degree matching, and sparsest cut. Moreover, the reduction mechanism induces an ordering of relative hardness of the underlying problems.

4 - A Matrix Selection Problem

Zeyang Wu, University of Minnesota, wuxx1164@umn.edu, Qie He

Consider a discrete-time dynamic system xk+1 = Mkxk for k = 0,1,2, T. The matrix Mk can be chosen as one of the given two matrices A or B. The matrix selection problem is defined as follows: given an initial vector x0, select matrices M1, ..., MT such that a linear function over the states x1,... xT is minimized. This problem is motivated by an application in cancer treatment planning. We formulate this problem as a mixed-integer linear program, and derive several families of facet-defining inequalities for the resulting formulation.

■ TB13

104C-MCC

Recent Advances in Stochastic Integer Programs

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Yongjia Song, Virginia Commonwealth University, Richmond, VA, United States, ysong3@vcu.edu

1 - A Scalable Bounding Approach For Multistage Stochastic Programs

Osman Yalin Ozaltin, North Carolina State University, Raleigh, NC, 27695, United States, oyozalti@ncsu.edu

Despite being a flexible modeling framework, multistage stochastic programs are not widely adopted in practice, mostly due to their unbearable size. Moreover, incorporating integer variables renders multistage stochastic programs even less tractable. We propose a bounding approach, which does not assume convexity but it rather relies on scenario decomposition and is inherently parallelizable. Our results demonstrate that the proposed method scales nicely with problem size and produces high quality solutions.

2 - Adaptive Partition-based Level Decomposition For Stochastic Programs

Yongjia Song, Virginia Commonwealth University, Richmond, VA, ysong3@vcu.edu, Wim van Ackooij, Welington de Oliveira

We present a computational study of several strategies to solve two-stage stochastic programs by integrating the adaptive partition-based approach with level decomposition. A partition-based formulation is a relaxation of the original stochastic program, obtained by aggregating variables and constraints according to a scenario partition. Partition refinements are guided by the optimal second-stage dual vectors computed at certain first-stage solutions. The proposed approaches rely on the level decomposition with on-demand accuracy to dynamically adjust partitions until an optimal solution is found. Numerical results are presented.

3 - A Class Of Sequential Discrete Decision Problems With Stochastic Disruptions

Haoxiang Yang, Northwestern University, Evanston, IL, United States, HaoxiangYang2019@u.northwestern.edu, David Morton

We consider a sequential decision problem under uncertainty, where the uncertainty consists of a small number of disruptions and where both the magnitude and the timing of the disruption can be random. We first formulate a stochastic linear programming model and an algorithm to solve it. Furthermore, we extend the model to handle integer decision variables, investigate methods to solve this multi-stage stochastic integer program and evaluate the computational performance of our approach.

■ TB14

104D-MCC

Revenue Mgt, Pricing

Contributed Session

Chair: Chuangyin Dang, Professor, City University of Hong Kong, Dept of Systems Eng & Eng Mgmt, 83 Tat Chee Avenue, Kowloon, Hong Kong, mecdang@cityu.edu.hk

1 - When Is It Optimal To Offer Free Allowance?

Hemant K Bhargava, University of California, Gh-3108, Graduate School of Management, Davis, CA, 95616, United States, hemantb@ucdavis.edu, Manish Gangwar

In contrast to Two-Part Tariff (2PT), Three Part Tariff (3PT) offers an additional free allowance. We find that despite free allowance optimal 3PT generates the same profits as optimal 2PT. However, the free allowance in 3PT can improve firm’s profit under two conditions, when consumers are uncertain about their usage or when the market demand involves a multi modal mixture distribution.

2 - Dynamic Stochastic Knapsack Problem With Adaptive Interaction

Kyle Maclean, Ivey Business School, London, ON, Canada, k.d.maclean@gmail.com, Fredrik Odegaard

Motivated by group seating requirements in entertainment venues, we formulate and study an extension to the Dynamic Stochastic Knapsack Problem. We add a stochastic interaction between the offered set of open compartments and the item placement, generalizing previously deterministic problems and making the problem relevant to revenue management customer choice models. Then, using a specific interaction function inspired by the entertainment industry, we provide an algorithm to determine the optimal solution. Using this algorithm we obtain insights into the structural properties of the problem.

3 - Product Planning With Sensory Customer Requirements: A Plain Yogurt Case

Leman Esra Dolgun, Anadolu University, Iki Eylÿl Kampusu, Endustri Muhendisligi Bolumu, Eskisehir, Turkey, ledolgun@gmail.com, Gulser Koksal, Elcin Kartal Koc

Customers use vague terms to describe their requirements and perceptions of sensory products such as yogurt, which makes prioritizing improvements and setting targets for them difficult. In this study, we propose an improved use of Quality Function Deployment and Kansei Engineering to overcome such difficulties, and demonstrate it in a plain yogurt case. Customer needs and perceptions are assessed by special surveys based on semantic scales. Survey data are analyzed using hypothesis tests and building logistic regression models. Targets are suggested by optimizing these models.

4 - A Reformulation-based Interior-point Path-following Method For Determining Proper Equilibria

Chuangyin Dang, Professor, City University of Hong Kong, Dept of Systems Eng & Eng Mgmt, 83 Tat Chee Avenue, Kowloon, Hong Kong, mecdang@cityu.edu.hk, Yin Chen

This paper extends an equivalent reformulation of Nash equilibrium to a specifically defined perturbed game that deforms continuously with an extra variable. As a result of this extension, we develop an interior-point path-following method for determining a proper equilibrium. The method numerically follows a smooth path that starts from any given point in the Euclidean space and ends at a proper equilibrium. Numerical results further confirm the effectiveness of the method.

■ TB15

104E-MCC

Industry Job Search Panel

Invited: INFORMS Career Center

Invited Session

Moderator: Adam McElhinney, Uptake Technologies, Chicago, IL, United States, adam.m.mcelhinney@gmail.com

1 - Industry Job Search Panel

Adam McElhinney, Uptake Technologies, Chicago, IL, United States, adam.m.mcelhinney@gmail.com

Ever wonder how to make the transition from student to OR, Analytics or Data Science professional? Or maybe you are an experienced professional looking to make a career switch. Join the Industry Job Search Panel to hear tips from the pros. Specifically: 1. Strategies to ensure your skills are aligned with the job market 2. Tips and tricks for landing and succeeding at the interview 3. How to interview the interviewer

2 - Panelist

Aly Megahed, IBM Research - Almaden, 150 Palm Valley Blvd APT 2066, San Jose, CA, 95123, United States, aly.megahed@us.ibm.com

3 - Panelist

Beverly Wright, Cox Communications Inc, 125 Centennial Drive, Peachtree City, GA, 30269, United States, Beverly.Wright@scheller.gatech.edu

4 - Panelist

Warren Hearnes, Cardlytics, Lilburn, GA, 30047, United States, whearnes@hotmail.com

■ TB16

105A-MCC

Information in Optimization

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Eugene Perevalov, Lehigh University, 1, Bethlehem, PA, 18015, United States, eup2@lehigh.edu

1 - Outpatient Clinic Scheduling With Heterogeneous Patient Preference And Resource Uncertainty

Deepak Agrawal, Pennsylvania State University, University Park, PA, United States, agrawal.deepankur@gmail.com, Guodong Pang, Priyantha Devapriya, Soundar Kumara

Reasons of No-shows and how to stop them, has been focus of the research since more than a decade. No-show adds up to the increases healthcare waste. Therefore motivated by this we aim to develop advanced scheduling models which can reduce No-shows by scheduling appointments at patients' preferred day and time with their preferred physicians. Researchers have acknowledged that each patient may have different priority. Our model considers patient segments with different priorities to design an efficient yet profitable scheduling system.

2 - Mutual Information Minimization For Evaluating The Causal Impact Of Home Care Services On Patient Discharge Disposition

Alexander Nikolaev, University at Buffalo, anikolae@buffalo.edu, Yuan Zhou, Sabrina Casucci, Lei Sun, Li Lin

Recent developments in observational causal inference employ subset selection algorithms that balance the covariate distributions in the compared groups of treated and untreated units under study. We present a subset selection approach that works by minimizing the mutual information (MI) between the covariates and the treatment variable. This becomes possible thanks to the derived optimality conditions that tackle the non-linearity of a sample-based MI function. The resulting algorithm runs in polynomial (close to linear) time, allowing for treatment effect estimation with large datasets. We proceed to draw causal insights from hospital readmission data of the UB HOMEBASE project.

3 - Information Acquisition Process: The Quantitative Aspect

Eugene Perevalov, Lehigh University, eup2@lehigh.edu

The classical Information Theory was able to facilitate significant advances in information transmission by finding a way of properly describing the quantity of the form of information existence - the various symbols. On the other hand, to make similar advances in the process of information acquisition, one would need to properly understand and describe the quantities associated with the information itself - its content. We take a step in that direction.

■ TB17

105B-MCC

Stochastic Sequential Assignment and Planning

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Olga Raskina, Juno Therapeutics, Seattle, WA, United States, olga.raskina@junotherapeutics.com

1 - Stochastic Production Scheduling For Personalized Cancer Therapy Manufacturing

Olga Raskina, Juno Therapeutics, olga.raskina@junotherapeutics.com, Jon Gunther

Juno Therapeutics is a clinical-stage company developing novel cellular immunotherapies. To manufacture our therapeutic T cell product candidates, we harvest blood cells from a cancer patient, separate or enrich for the appropriate T cells, activate the cell, insert the gene sequence for the CAR or TCR construct into the cell's DNA, and grow these modified T cells to the desired dose level. The modified T cells can then be infused into the patient or frozen and stored for later infusion. We are investing substantially in a process that we believe is commercially scalable for both CARs and TCRs.

2 - Dynamic Path Assignment For Robotic Bees Under Collision Control

Felisa Vázquez-Abad, Hunter College, felisav@hunter.cuny.edu

We study the problem of dynamic routing of robotic bees towards the hive. Due to uncertainty in position measurements, the stochastic problem cannot ensure collision-free paths. We study the effects that the algorithm parameters have in reducing the computational complexity and expected number of collisions. We explore via experimentation a parallel algorithm for cloud computing as well as crowd sourcing for estimation. In this manner we seek a faster completion time reducing collisions and computational complexity.

3 - Multidimensional Birth And Death Models For Biochemical Modeling With A View To Personalized Medicine

Alexey Nikolaev, CUNY, Hunter College and Graduate Center, New York, NY, 11232, United States, anikolaev@gradcenter.cuny.edu, Felisa J Vázquez-Abad, Jon Gunther

Chemical reactions can be modeled either using ordinary differential equations, or continuous time Markov chains. The ODE describes the dynamics of the concentration of proteins. The multidimensional Birth and Death process describes the dynamics of the number of particles of proteins. We study an activator/repressor model that regulates circadian cycles in cells. We show that the ODE is an exact expectation for the B&D process, under some regimes. For other regimes we apply a novel technique of Taboo kernels. This methodology has potential to predict malfunctions and to identify treatment.

■ TB18

106A-MCC

Finance, Portfolio II

Contributed Session

Chair: Jonathan Liu, Stony Brook University, 61-40 163rd Street, Flushing, NY, 11365, United States, Jonathan.m.liu@stonybrook.edu

1 - Portfolio Selection With The Probabilistic Ordered Weighted Average

Jose M. Merigo, Full Professor, University of Chile, Av. Diagonal Paraguay 257, Santiago, 8330015, Chile, jmerigo@fen.uchile.cl, Sigifredo Laengle, Gino Loyola

This article presents a generalization of Markowitz's mean-variance portfolio selection approach by using the probabilistic ordered weighted average. The main advantage is that it can under or overestimate the information provided in the classical portfolio approach according to the attitudinal character of the decision maker. Moreover, it includes the classical Markowitz model as a particular case when the attitudinal character is not needed, by using only the expected value which is a particular case of the probabilistic ordered weighted average. The work considers a wide range of scenarios in financial decision making problems.

2 - Structural Approach To Portfolio Analysis With Diversification Constraints

Kyungchan Park, PhD Candidate, Yonsei University, Seodaemun-gu Yonsei-ro 50, School of Business (Bld.#212) Rm.#411, Seoul, 03722, Korea, Republic of, hippogras@gmail.com, Hongseon Kim, Seongmoon Kim

The maximum weight of single stock in mutual fund is limited by regulations to enforce diversification. Under incomplete information with added constraints on portfolio weights, enhanced performance had been reported in previous researches. We use a structural approach to analyze the effects of additional constraints on the portfolio's performance by computing the Euclidean distance from the tangency portfolio, as opposed to analyzing ex-post return only. We find that the diversification-constrained portfolios generally have a smaller distance than the unconstrained portfolios.

3 - Monetary Policy And Real Estate Price Fluctuation: An Analysis On Regional Heterogeneity From China

Charl Chan, Tongji University, Siping Road 1500, Room 1211, Shanghai, 200092, China, charlc@yeah.net, Jiangang Shi

This paper analyzes empirically the relationship among monetary policy, real estate price and policy aims using PVAR model. The results show that not all areas of real estate market as a carrier can play a normal function in the process of transmission from the policy tools to the ultimate goal. Extended McCallum rule executed against the regional real estate price bubble will affect the normal supply of the basic currency to other area. And Extended Taylor rule executed will exacerbate deflation in the areas which real estate market is ineffective as a carrier, while it can bring negative effects to other area economic fundamentals.

4 - Efficient Allocation Of Tarp Funds To U.s. Banks

Jonathan Liu, Stony Brook University, 61-40 163rd Street, Flushing, NY, 11365, United States, Jonathan.m.liu@stonybrook.edu, Herbert F Lewis, Dmytro Holod

In 2008 the government allocated hundreds of billions of dollars to banks all across the United States under the Troubled Asset Relief Program (TARP). The main purpose of TARP was to encourage bank lending during the financial crisis. In this paper, we apply data envelopment analysis (DEA) as part of a two-step process to measure the efficiency of the distribution of funds. DEA is a linear programming-based methodology for measuring relative efficiency of decision making units (DMU). A reallocation model is used to show how funds could have been assigned in a more efficient manner and how additional lending could have been achieved. Finally, we find common characteristics among the inefficient banks.

■ TB19

106B-MCC

Computational Methods for Healthcare Applications

Sponsored: Computing

Sponsored Session

Chair: Burak Eksioglu, Clemson University, Clemson University, Clemson, SC, 29634, United States, burak@clemson.edu

1 - Optimal Compromises Between Efficiency And Practicality

Andrew C Trapp, Worcester Polytechnic Institute, atrapp@wpi.edu

In many real-world contexts, the output of an optimization model may be impractical to implement directly due to a variety of factors. For example, an optimized medical personnel schedule may specify such a large deviation from the (non-optimized) status quo, that it might only be possible to roll out over time. We discuss our methodology, TOpS (Transition toward the Optimal Solution), that creates optimal deployment plans for binary integer programs. TOpS illuminates the most improving steps within a specified deviation from the status quo. We implement TOpS in two popular modeling environments, and demonstrate how it can find the best improving steps while managing change from present conditions.

2 - Two-stage Stochastic Programming For Vaccine Vial Replenishment

Zahra Azadi, Clemson University, zazadi@clemson.edu, Harsha Gangammnavar, Sandra D Eksioglu

Multi-dose vaccine vials must be utilized within a short time if not protected in appropriate temperature. The remaining doses are discarded. Single-dose vials do not contribute to Open Vial Wastage (OVW), but have higher purchase and inventory holding costs per dose than multi-dose vaccine vials. This study presents a two-stage stochastic programming model that aids health care practitioners identify inventory replenishment and vial opening policies which minimize costs and OVW. We compare the performance of optimal with myopic policies in the presence of random demand.

3 - Optimal Quarantining Policy For Ebola Epidemic

Ceyda Yaba, Clemson University, cyaba@clemson.edu, Burak Eksioglu, Amin Khademi

The actions taken during a deadly epidemic can be crucial in order to eradicate the disease. We model a Markov decision model for an Ebola epidemic in two districts with the objective of minimizing incidence while quarantining infectious people. However, as the capacities of the quarantine facilities are limited, we need to find a decision rule for quarantining infectious population so that the incidence is minimized in both of the districts.

■ TB20

106C-MCC

Robust Multiobjective Optimization for Decision Making under Uncertainty and Conflict

Tutorial Session

Chair: Margaret M Wiecek, Clemson University, Mathematical Sciences Dept, Clemson, SC, 29634-1907, United States, wmalgor@clemson.edu

1 - Robust Multiobjective Optimization For Decision Making Under Uncertainty And Conflict

Margaret M Wiecek, Clemson University, Mathematical Sciences Dept, Clemson, SC, 29634-1907, United States, wmalgor@clemson.edu, Garrett M Dranichak

Many real-life problems in engineering, business, and management are characterized by multiple, conflicting objectives, as well as the presence of uncertainty. The conflicting criteria originate from various ways to assess system performance and the multiplicity of decision makers, while uncertainty results from inaccurate or unknown data due to imperfect models and measurements, lack of knowledge, and volatility of the global environment. In this tutorial, the deterministic approaches to uncertainty that are integrated with multiobjective optimization to address decision making under uncertainty and conflict are discussed. The approaches are based on robust optimization and parametric optimization, both developed for single-objective settings. Six sources of uncertainty are presented, and each type of uncertainty is placed in the multiobjective optimization problem (MOP), yielding several types of uncertain MOPs (UMOPs). Some of the sources are adopted from earlier studies in (single-objective) engineering optimization, while the others result from the multiobjective optimization modus operandi. The UMOP models are classified first according to the location of the uncertainty in their formulation, second with respect to the undertaken optimization approach, and third on the basis of the proposed definition of robust efficient solutions. The models are presented along with the accompanying results on solution concepts, properties, methods, and applications that are specific to each case. It is expected that the topics selected in this tutorial and their organization may help beginners to become familiar with the area of robust multiobjective optimization while serving as a reference to researchers.

TB21

107A-MCC

Coordinated Care Delivery

Sponsored: Health Applications

Sponsored Session

Chair: Pooyan Kazemian, Harvard Medical School, 25 Shattuck Street, Boston, MA, 02115, United States, pooyan.kazemian@mgh.harvard.edu

Co-Chair: Mark P Van Oyen, University of Michigan, 1221 Beal Ave, Ann Arbor, MI, 48109, United States, vanoyen@umich.edu

1 - The Impact Of Delay Announcements On Hospital Network Coordination

Jing Dong, Northwestern University, jing.dong@northwestern.edu, Elad Yom-Tov

We investigate the impact of delay announcements on the coordination within hospital networks using a combination of empirical observations and numerical experiments. We provide empirical evidence that patients may take delay information into account when choosing emergency service providers and that such information can help increase coordination in the network. We analyze different factors that may affect the level of coordination that can be achieved. In particular, we show that delay estimators that are based on historical average may cause extra oscillation in the system when patients are sensitive to delay.

2 - Proactive Inpatient Bed Allocation For Emergency Department Patients Using Predictive Analytics

Seung Yup Lee, Wayne State University, Detroit, MI, United States, seung.lee@wayne.edu, Ratna Babu Chinnam, Evrim Dalkiran

One of the main factors driving Emergency Department (ED) crowding is boarding delay, where admitted patients are held in ED while waiting for an inpatient bed to be identified and prepared. We propose a queueing network model that allows for the development of 'proactive' coordination strategies. In particular, under the proposed setting, the inpatient bed allocation process precedes ED patient disposition. Model also accounts for the performance of the predictive analytics model in predicting disposition decisions. We present analytical results and insights through experiments motivated by a large Midwest healthcare facility.

3 - Care Coordination Models Based On Longitudinal Encounter Data

Michael Rossi, Univ of Massachusetts - Amherst, Amherst, MA, United States, mrossi09@gmail.com, Hari Balasubramanian

We discuss a framework for analyzing data concerning healthcare encounters at the individual level. These encounters can be of various types - outpatient, emergency room, inpatient, pharmaceutical etc., each corresponding to one or more diagnoses. We provide examples where such data could be used and discuss the stochastic methods that are best suited for generating insights.

4 - Coordinating Clinic And Surgery Appointments To Meet Access Service Levels For Elective Surgery

Pooyan Kazemian, Harvard Medical School, Boston, MA, United States, pooyan.kazemian@mgh.harvard.edu, Mustafa Y Sir, Mark P Van Oyen, David Larson, Kalyan Pasupathy

Providing timely access to surgery is crucial for patients with high acuity diseases like cancer. We present a methodological framework to coordinate clinic and surgery appointments so that patient classes with different acuity levels can see a surgeon in the clinic and obtain surgery (if found to be needed) within a maximum wait time target. We evaluate six heuristic scheduling policies that exploit information on the need for surgery obtained from the clinic visit. Colorectal surgery at Mayo Clinic is discussed as a case study. Numerical results suggest dramatic improvements in access for urgent patients.

TB22

107B-MCC

Data-Driven Healthcare Operations

Sponsored: Health Applications

Sponsored Session

Chair: Hessam Bavafa, University of Wisconsin, 4284C Grainger Hall, 975 University Ave., Madison, WI, 53706, United States, hessam.bavafa@wisc.edu

1 - Risk Aversion In Gatekeeping Systems: An Empirical Study Of Admission Errors In Emergency Departments

Stefan Scholtes, University of Cambridge, Judge Business School, Cambridge, United Kingdom, s.scholtes@jbs.cam.ac.uk, Michael Freeman

In a study of over 450,000 emergency department attendances, we explore the impact of gatekeeper risk-aversion and the level of diagnostic uncertainty on referral errors. While gatekeepers normally make binary decisions to refer or not, we demonstrate the value of a third decision alternative, akin to a second opinion, that can be used when the gatekeeper lacks confidence to commit. The error reduction is particularly pronounced for more risk-averse gatekeepers, for customers with a high level of diagnostic uncertainty, and when the unit is busy.

2 - Learning From Many: Partner Diversity And Team Familiarity In Fluid Teams

Jonas Jonasson, London Business School, jjonasson@london.edu, Zeynep Aksin Karaesmen, Sarang Deo, Kamalini Ramdas

We use data from London Ambulance Service to study the impact of partner diversity of new paramedics on their operational performance. We find that the greater diversity in prior partners directly improves performance for an unstandardized process. For a more standardized process, this effect is moderated by a new recruit's total experience. We explore the implications of our results for team formation strategies by balancing the benefits of partner diversity with those of team familiarity.

3 - Patient Portals In Primary Care: Impacts On Visit Frequency And Patient Health

Hessam Bavafa, University of Wisconsin, hessam.bavafa@wisc.edu

Interest in innovative healthcare delivery models has increased due to measures such as the Affordable Care Act, which is designed to expand insurance coverage and contain healthcare costs. One innovation that has been forwarded as a low-cost alternative to physician office visits is "e-visits," or secure messaging between patients and physicians. We evaluate the effect of e-visit adoption on patient health and physician productivity using a panel dataset from a primary care provider in the US.

4 - Discharge Decision In Emergency Departments: Impact Of Operational Measures And Pay-for-Performance Incentives

Eric Park, University of Hong Kong, Hong Kong, g, ericpark@hku.hk, Yichuan Ding

We study how operational measures in the emergency department such as number of patients waiting to be seen and physician's patient load affect patient discharge decisions. We also analyze the impact of a provincial hospital level pay-for-performance incentive scheme on discharge decisions. We study several major hospitals in the metro Vancouver, Canada area.

TB23

108-MCC

Models in Medical Decision Making

Sponsored: Health Applications

Sponsored Session

Chair: Zlatana Dobrilova Nenova, University of Pittsburgh, 282 Mervis Hall, Pittsburgh, PA, 15260, United States, zdn3@pitt.edu

1 - Chronic Kidney Disease: A Simulation Study

Zlatana Nenova, University of Pittsburgh, zdn3@pitt.edu, Jerrold H May

We developed a case-based reasoning simulation model to predict the one-year disease progression of chronic kidney disease patients. The model bases its projections on an analysis of the patient's historical lab values (eGFR, albumin, phosphate, and potassium) and vital signs (systolic and diastolic blood pressure, and weight), together with the history of disease comorbidities and complications (diabetes, heart failure, dialysis, PVD/CVD, and cirrhosis).

2 - Decision-making Models In Kidney Transplantation

Eric Chow, Johns Hopkins University, Baltimore, MD, 21231, United States, echow8@jhmi.edu

Clinical decision-making in kidney transplantation is a constant challenge for patients: will you benefit from a given organ being offered or are you better off waiting on dialysis for a better organ? The field is thus in need of mathematical models designed to help patients make these decisions. Fortunately, there are rich sources of big data in transplantation to support the design of these models, including a national registry of every patient on the waiting list, every organ offer made, and post-transplant outcomes. This presentation will review these data sources and their integration into several existing models.

3 - Challenges In Markov Modeling Of Cancer Treatment

Jiaru Bai, University of California, Irvine, Irvine, CA, United States, jiarub@uci.edu, Cristina del Campo, L Robin Keller

We present a way to build a Markov decision tree to model cancer progression and cost-effectiveness analysis for two or more cancer treatments. We propose several problems researchers can encounter in this kind of research and provide possible solutions.

4 - A Continuous Time Stochastic Model To Optimize Blood Pressure Treatment Decisions

Anthony Bonifonte, Georgia Institute of Technology, ABonifon@gatech.edu, Turgay Ayer, Ben Haaland, Peter Wilson

Antihypertensive drug treatment can control elevated blood pressure and reduce the risk of future cardiovascular outcomes. We develop a data-driven stochastic model of blood pressure progression that generalizes Brownian motion by modeling the change in blood pressure per unit time as a Gaussian mixture distribution. This model addresses the question of what thresholds at which to initiate antihypertensive treatment and the optimal intensity. Our main finding is initiation and intensity decisions depend jointly on systolic and diastolic pressure. The methods are generalizable to other chronic diseases with continuous valued measurements.

5 - Designing Effective Vaccine Administration Practices

Gizem Sultan Nemutlu, PhD Candidate, University of Waterloo, Faculty of Engineering University of Waterloo, Carl A. Pollock Hall 3654 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, gsnemutlu@uwaterloo.ca, Fatih Safa Erenay, Osman Yalin Ozaltin

Childhood vaccine wastage due to limited shelf-life of opened vials is still high in developing countries. Our research shows that open vial wastage can be significantly reduced by keeping vaccine stocks in different size vials, and dynamically deciding what size of vial to use next and/or when to terminate daily vaccination services. We develop a discrete-time MDP model maximizing demand coverage. We analyze the structural properties of the optimal strategies and show that the proposed model can help decision makers in determining the best vial-size combinations and optimal inventory levels.

■ TB24

109-MCC

Analytics in Evidence-Based Practice (EBP)

Sponsored: Health Applications

Sponsored Session

Chair: John Zaleski, Bernoulli Health, 4801 S. Board Street, Suite 120, Philadelphia, PA, 19112, United States, jzaleski@bernoullihealth.com

1 - Clinical Applications Of Data Analytics: A Survey

Amy Harris, Middle Tennessee State University, amy.harris@mtsu.edu

Increasing volumes and varieties of clinical data and growing interest in analytics has created opportunities for healthcare organizations to study and address clinical problems. Experience gained is often employed to improve care and, where successful, results are published in academic journals. This presentation surveys the literature and explores which types of analytics are most popular and how healthcare organizations use data analytics to inform clinical practice.

2 - The Use Of Kalman Filtering In Alarm Management Studies

John Zaleski, Bernoulli Enterprise Inc, jzaleski@bernoullihealth.com

Vitals signs monitoring in high acuity environments are often the source of alarms and notifications to care providers. In this presentation, the author demonstrates the use of a Kalman filtering technique that has been used in the identification of alarm limit thresholds for capnography monitoring of patients in the medical surgical environment post-operatively.

3 - The State Of Digital Marketing In The Healthcare Industry

Brian Harris, Lima Consulting, bharris@limaconsulting.com

Digital marketing technologies and web analytics have opened new opportunities to provide actionable analysis to decision makers. However, many analysts struggle with inconsistent or questionable data due to failed or sub optimal deployments of these technologies. This study examines two million pages across websites of hundreds of the world's largest healthcare companies to provide insights on the relative health of digital marketing and web analytics across multiple sectors. It also provides practical advice for analysts seeking to improve the quality and veracity of their web analytics data.

4 - Consistent Staffing For Long-term Care Through On-call Pools

Vincent W. Slaugh, Assistant Professor, Cornell University, Ithaca, NY, 14850, United States, vslaugh@cornell.edu, Alan Scheller-Wolf, Sridhar R Tayur

Nursing home managers have increasingly emphasized consistency of care — i.e., minimizing the number of different nurse aides who care for each resident — but have struggled with this goal due to nurse aide absences before the start of each shift. We provide structural and numerical results for the relationship between the number of aides in an on-call pool, on-call pool rules, staffing costs, and consistency level. We also demonstrate that using part-time aides can actually improve consistency of care if their on-call pool participation rate is sufficiently high.

■ TB25

110A-MCC

Scheduling and Contracts

Invited: Project Management and Scheduling

Invited Session

Chair: Nicholas G Hall, Ohio State University, Columbus, OH, United States, hall.33@osu.edu

1 - Multitasking Via Alternate And Shared Processing: Algorithms And Complexity

Chung-Lun Li, The Hong Kong Polytechnic University, chung-lun.li@polyu.edu.hk, Nicholas G Hall, Joseph Leung

This work is motivated by disruptions that occur when jobs are processed by humans, rather than by machines. E.g., humans may become tired, bored, or distracted. We present two scheduling models with multitasking features, which aim to mitigate the loss of productivity in such situations. The first model applies "alternate period processing" and aims either to allow workers to take breaks or to increase workers' job variety. The second model applies "shared processing" and aims to allow workers to share a fixed portion of their processing capacities between their primary tasks and routine activities. For each model, we consider several widely studied and practical classical scheduling objectives.

2 - Scheduling To Minimize Energy Cost

Marc Posner, The Ohio State University, posner.1@osu.edu, Nicholas G Hall

While scheduling is an effective way to improve energy efficiency in manufacturing, optimal scheduling becomes more complicated when energy costs vary. Our machine has discretely variable speeds, and increased energy usage is incurred at faster machine speeds. Three alternative scenarios about the time at which the machine can change speed are considered. In each scenario, we study the problem of minimizing total energy cost, subject to the completion of work by a given date. We describe efficient algorithms for these problems where possible, and also identify limits to their solvability.

3 - Analysis Of A Procurement Game With Option Contracts

Bo Chen, University of Warwick, Coventry, United Kingdom, b.chen@warwick.ac.uk, Edward James Anderson, Lusheng Shao

When a firm faces an uncertain demand, it is common to procure supply using some type of option in addition to spot purchases. A typical version of this problem involves capacity being purchased in advance, with a separate payment made that applies only to the part of the capacity that is needed. We address such a problem by formulating it as a procurement game, in which competing suppliers choose a reservation price and an execution price for blocks of capacity, and the buyer, facing known distributions of demand and spot price, needs to decide which blocks to reserve.

4 - Scheduling Crash Tests At Ford With Sequencing Restrictions And Capacity Constraints

Yuhui Shi, University of Michigan, 2212 Glencoe Hills Drive, Apt 11, Ann Arbor, MI, 48108, United States, yuhuishi@umich.edu, Amy Cohn, Marina Alex Epelman

We present the problem of scheduling crash tests at Ford Motor for new vehicle model development. In this problem, we assume performing crash tests requires prototype vehicles as well as other limited supporting resources such as testing facilities and engineers. We show how to solve the problem subject to these resource constraints by using various decomposition methods.

■ TB26

110B-MCC

Combinatorial Auction Pricing

Invited: Auctions

Invited Session

Chair: Benjamin Lubin, Boston University, Boston, MA, United States, blubin@bu.edu

1 - Adaptive-price Combinatorial Auctions

Benjamin Lubin, Boston University, blubin@bu.edu

This work introduces and implements an iterative combinatorial auction that aims to achieve both high efficiency and fast convergence without prior restrictions on the valuation domain. Our auction uses polynomial prices, which price combinations of items beyond just single items, and gradually extends price expressivity as the rounds progress. We also propose a heuristic approach to winner determination to ensure the auction scales. An experimental evaluation shows that our auction is competitive with bundle-price auctions in regimes where these excel, namely multi-minded valuations, but also performs well in regimes favorable to linear prices, such as valuations with pairwise synergy.

2 - New Core-Selecting Payment Rules With Better Fairness And Incentive Properties

Benedikt Buenz, Stanford, buenz@stanford.edu

Most of the recent large-scale combinatorial auctions, e.g. for spectrum rights, have used core-selecting payment rules. Such rules ensure that no subset of players is willing to outbid the total payments charged the winning players. However, while the particular rule used in practice, the Quadratic rule, is a core-selecting rule, there are many alternatives. We examine several hundred alternative core-selecting rules in Bayes-Nash equilibrium via a novel numerical solver to identify better rules. We show that Quadratic is not the optimal rule in terms of efficiency, incentives, revenue or fairness, and that we can design rules that outperform Quadratic in all of these dimensions simultaneously.

3 - Linear Item Pricing In Combinatorial Auctions

Robert Day, University of Connecticut, Storrs, CT, Bob.Day@business.uconn.edu

I will present new results regarding the use of linear item prices in combinatorial auctions. Prices for items form a solution to an altered dual of WDP, are core-selecting, and constitute a combinatorial winning-level equilibrium.

■ TB27

201A-MCC

Social Networks and Learning

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Elena Belavina, University of Chicago Booth School of Business, Chicago, IL, United States, elena.belavina@chicagobooth.edu

1 - The Use And Value Of Social Network Information In Selective Selling

Ruslan Momot, INSEAD, Fontainebleau, France, Ruslan.Momot@insead.edu, Elena Belavina, Karan Girotra

We consider the use and value of social network information in selectively selling goods and services whose value derives from exclusive ownership among network connections. Our model accommodates customers who are heterogeneous in their number of friends (degree) and proclivity for social comparisons (conspicuity). We show how the firm with information on either (or both) of these traits can use it to increase profits making a product selectively available to the firm's best targets - high-conspicuity customers within intermediate-degree segments. We find that information about degree is more valuable than information about conspicuity and that the two are substitutes.

2 - The Sharing Newsboys

Ming Hu, Rotman School at University of Toronto, Ming.Hu@Rotman.Utoronto.Ca

We study resource sharing or demand referral behavior among a network of connected newsboys. Each newsboy only locally knows the number of his neighbors but does not know the number of his neighbor's neighbors. Our focus is to investigate the change of the degree distribution on the newsboy decisions and social welfare. Surprisingly, we show that more connections may not lead to a higher social welfare.

3 - Information Externalities In Crowdfunding Projects

Senthil Veeraraghavan, Wharton School, senthilv@wharton.upenn.edu, Jiding Zhang

We study the information externalities associated with crowdfunding projects. Crowdfunding projects suffer from the tragedy of the commons. To raise capital for successful funds requires overcoming the "startup problem". We study and compare mechanisms to improve the project success — lotteries, seeking altruistic investments, up-front payments and quick dissemination of information.

4 - Managing Service Systems In Presence Of Social Networks

Gad Allon, Wharton School, Philadelphia, PA, 19010, United States, gadallon@wharton.upenn.edu, Dennis Zhang

We study a service system with the presence of a social network. In our model, firms can differentiate resource allocations among customers, and customers learn the service qualities from the social network. We study the interplay among network structure, customer characteristics, and information structure, and characterize the optimal policy. We further calibrate our model with data from Yelp.com and quantify the value of social network knowledge empirically.

■ TB29

202A-MCC

Incentives Issues in Sustainable Operations

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Luyi Gui, The Paul Merage School of Business, UC - Irvine, Irvine, CA, United States, luyig@uci.edu

1 - Green Sourcing-the Role Of Premium Sharing And Consulting Services

Xi Chen, University of Michigan - Dearborn, xichenxi@umich.edu

Certified sustainable products often times enjoy a significant green premium in the retail market. In this paper, we study a retailer's use of a sourcing contract as a tool of incentivizing suppliers to exert greening efforts which improves the chances of receiving certification, and in turn capturing the green premium. We also explore the rationale for retailer to involve in suppliers' greening efforts.

2 - Inducing Prompt Disclosure In The Presence Of Evasive Effort

Shouqiang Wang, The University of Texas at Dallas, Richardson, TX, United States, Shouqiang.Wang@utdallas.edu, Peng Sun, Francis E De Vericourt

In supply chains, firms are typically exposed to negative impacts resulting from random adverse events that occur at and are privately observable to their suppliers. The firm can use fiscal instrument as well as inspections to uncover the adverse event. The supplier, however, prefers to conceal and even deliberately hide such adverse event so as to evade its responsibility. The goal of this paper is to devise optimal strategies for firms to induce the supplier's prompt disclosure in the presence of such evasive behavior.

3 - The Adoption Of Smart Home Appliance For Energy Shifting

Wenbin Wang, Shanghai University of Finance and Economics, Shanghai, China, wang.wenbin@shufe.edu.cn, Yannan Jin

Smart home appliances can shift energy consumption in response to energy price and thus hold great potential for reducing the energy cost. This paper uses a game theoretical approach to analyze the consumers' decisions on adopting smart home appliances. We study how the adoption decisions are affected by the pricing decisions of the appliance manufacturer and the utility company, as well as the government subsidy. We find the appliance manufacturer or the utility company alone may offer sufficient incentives to adopt smart home appliances. However, to increase the social welfare the government may need to interfere with these incentive programs.

4 - Incentives For Joint Product And Process Improvement Under Collective Extended Producer Responsibility

Luyi Gui, UC Irvine, luyig@uci.edu

Extended producer responsibility legislation mandates producers' financial responsibility of proper post-use treatment of their products. This study investigates how the widely-adopted collective implementation of EPR legislation can promote more environmentally friendly product design and more efficient recycling technology. In particular, we analyze the impact of cost allocation choices on the joint design-technology advancement.

■ TB30

202B-MCC

Predictive Modeling in Healthcare

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Anita L Tucker, Brandeis, 415 South Street, MS 032, Waltham, MA, 02453-2728, United States, atucker@brandeis.edu

Co-Chair: Hummy Song, Harvard University, Soldiers Field, Boston, MA, 02163, United States, hsong@hbs.edu

1 - Accurate Emergency Department Wait Time Prediction

Mohsen Bayati, Stanford University, bayati@stanford.edu, Erjie Ang, Sara Kwasnick, Erica Plambeck, Michael Aratow

In this talk we discuss Q-Lasso method for wait time prediction, which combines statistical learning with fluid model estimators. In historical data from four remarkably different hospitals, Q-Lasso predicts the emergency department (ED) wait time for low-acuity patients with greater accuracy than existing methods. Q-Lasso achieves greater accuracy largely by correcting errors of underestimation in which a patient waits for longer than predicted. Implemented on the external website and in the triage room of the San Mateo Medical Center (SMMC), Q-Lasso achieves over 30% lower mean squared prediction error than would occur with the best rolling average method.

2 - Disease Trend Prediction And Resource Allocation for Optimal Containment

Eva Lee, Georgia Tech, evakylee@isye.gatech.edu, Kevin Liu

This work is joint with CDC. This work focuses on a computational decision modeling framework that integrates a biological disease spread predictive model, a dynamic network-based social-behavior model that captures human behavior and interaction, and a stochastic queueing model that describes treatment characteristics, day-to-day hospital and homecare processes, and resource usage (labor, time, and equipment). The computational platform includes an optimization engine that determines the minimum resource requirements needed to contain the epidemic. Results of its usage for Ebola control in West Africa will be presented.

3 - An Examination Of Early Transfers To The ICU Based On A Physiologic Risk Score

Wenqi Hu, Columbia Business School, New York, NY, United States, wh2274@columbia.edu, Carri Chan, Jose Zubizarreta, Gabriel J. Escobar

Unplanned transfers of patients from the ward to the Intensive Care Unit (ICU) can occur due to rapid deterioration and may increase the patients' risk of death and lengths of stay in hospital. A new predictive model, the EDIP2, was developed with the intent to identify patients at risk for deterioration, which in some cases could trigger a proactive transfer to the ICU. This work examines the potential costs and benefits of preventive ICU admissions based on this new dynamic warning system. We find that preventive ICU admissions have the potential to improve patient outcomes, and physicians' fears of needlessly clogging the ICU may not be as dire as initially feared.

4 - Approaches To Manage Demand Variability In An Academic Medical Center

Ryan M. Graue, Sr. Project Manager, Process Improvement, Beth Israel Deaconess Medical Center, Boston, MA, United States, rgraue@bidmc.harvard.edu, Sarah Moravick, Julius Yang

Hospitals struggle to manage variability in patient demand. For one, their physical supply (e.g., bed capacity and number of exam rooms) to accommodate patients is essentially fixed, while the daily inpatient census and number of appointments in each clinic fluctuate. In addition, minimal flexibility is built into staffing models, leading to wide day-to-day swings in staff productivity. Our work focuses firstly on approaches to reduce demand variability, and secondly on developing a newsvendor staffing model formulation that evaluates the required staff-to-patient ratios in different clinical areas and aims to minimize the costs of overstaffing and understaffing.

■ TB31

202C-MCC

Topics in Operations and Finance Interface

Sponsored: Manufacturing & Service Oper Mgmt, iFORM

Sponsored Session

Chair: S. Alex Yang, London Business School, Regent's Park, Sussex Pl, London, NW1 4SA, United Kingdom, sayang@london.edu

1 - The Dual Objectives Of Reward-based Crowdfunding

Rachel Rong Chen, University of California-Davis, rachen@ucdavis.edu, Esther Gal-Or, Paolo Roma

Reward-based crowdfunding can provide entrepreneurs information regarding future demand for their products. Such information is valuable, especially for entrepreneurs who need additional funding from a Venture Capitalist (VC), because a successful crowdfunding campaign can help convince the VC to finance the project. This paper examines the optimal campaign design when the crowdfunding campaign serves the dual objectives of raising capital and acquiring market information.

2 - Optimal Pricing And Efficiency In Group Buying: Theory And Evidence

Liu Ming, PhD Candidate, Unversity of Maryland, College Park, MD, 20742, United States, liu.ming@rhsmith.umd.edu, Tunay Tunca

We study demand risk mitigation by utilization of group buying in retail sales. We model a frequently employed group buying mechanism and derive the dynamic consumer behavior and optimal seller pricing. Utilizing data from a major retail platform, we structurally estimate the model and calculate the efficiency gains employed by the mechanism.

3 - Pass-through Contracts Volatile Inputs And Frictions

Danko Turcic, Washington Univ. in St. Louis, turcic@wustl.edu, Panos Kouvelis, Wenhui Zhao

This paper examines puts forth a risk-management framework for a supply chain exposed to both demand and input cost risks. In the setting that we consider, the supply chain participants interact via index contracts that allow for re-distribution of price risks. We identify conditions under which firms find it optimal to re-distribute risk and conditions under which firms want to both re-distribute and hedge.

■ TB32

203A-MCC

Revenue Mgt, Pricing III

Contributed Session

Chair: Fouad H Mirzaei, Santa Clara University, Unit 3, 559 Alviso St, Santa Clara, CA, 95050, United States, fhm.phd@ivey.ca

1 - Pricing In Remanufacturing Operations

Akshay Mutha, Pennsylvania State University, Smeal College of Business, 454 Business Building, University Park, PA, 16802, United States, axm536@psu.edu, Saurabh Bansal, V Daniel R Guide

We consider a firm that can remanufacture products after the demand is realized. We analyze the effect of postponing remanufacturing operations on the pricing decisions of a firm. We show the application of our model using industry data.

2 - Airline Price-sensitive Demand Forecasting And Optimization

Sylvia Zhu, Sabre Airline Solution, 3150 Sabre Dr., Southlake, TX, 76092, United States, sylvia.zhu@sabre.com

Traditional revenue management models assume the demand is independent. In recent years, there has been more attempt to handle scenarios in which the customer looks for the lowest available fare. It means that the demand for specific product depends on availability of other products. In order for us to make a recommendation on the capacity and connectivity that an airline will need to achieve higher revenue, we will need to provide reliable dependent demand forecasting and optimization methodologies. We will describe major features of the forecasting and optimization models for dependent demand revenue management and share experiments of their performance.

3 - An Analysis Of B2B Negotiations In The Context Of Data Products

Jyotishka Ray, Student, University of Texas-Dallas, Naveen Jindal School of Management, Richardson, TX, 75083, United States, jxr114030@utdallas.edu, Syam Menon, Vijay S Mookerjee

The explosive growth of eBusiness has allowed many companies to accumulate a repertoire of rich and unique data sets that can provide substantial value to other firms. We analyze how to monetize proprietary data products through negotiation. We consider whether the seller should make presentations to the buyer before the negotiation when the buyer is underestimating the value. We extend our study to understand the impact of a consultant (hired by the buyer to analyze the data) on the negotiation process. We adapt the generalization of the Nash bargaining problem to analyze this three-player negotiation. We find that the presence of a consultant reduces the possibility of a viable presentation.

4 - Managing Change Revenue With Presence Of Time Uncertain Customers

Fouad H Mirzaei, Santa Clara University, Unit 3, 559 Alviso St, Santa Clara, CA, 95050, United States, fhm.phd@ivey.ca, Fredrik Odegaard, Xinghao Yan

In this study, we focus on the dynamics between a firm charging a change fee and customers who are uncertain about their future travel plans. While the firm maximizes its revenue by imposing optimal change fees, customers consider their travel plan uncertainties and maximize their utilities by responding strategically to these fares. Without imposing any distributional assumptions, we analytically derive each market player's best reaction to the other to prescribe the characteristics of the firm/customer interaction equilibrium. We also investigate how the optimal monopolistic price should be set with the presence of a change fee.

■ TB33

203B-MCC

Queueing Models I

Contributed Session

Chair: Yao Yu, North Carolina State University, 4335-3 Avent Ferry Road, Raleigh, NC, 27606, United States, yyu15@ncsu.edu

1 - Can The Way Customers Are Assigned To Servers Affect The Unscheduled Within-day Work Breaks In A Service System?

Xu Sun, Columbia University, 363 W 123rd St, Apt 4R, New York, NY, 10027, United States, xs2235@columbia.edu, Ward Whitt

We apply many-server heavy-traffic analysis to study the impact of alternative routing rules, such as longest-idle-server-first (LISF) and randomized routing (RR), on the pattern of server idleness in a service system. We show that LISF provides more regular breaks than RR when the staffing is adequate to allow non-negligible idleness.

2 - Decoupling Job Size And Server Slowdown In Modeling Redundancy

Kristen Gardner, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA, 15213, United States, ksgardne@cs.cmu.edu, Mor Harchol-Balter, Alan Scheller-Wolf

Redundancy is an increasingly common technique for reducing response time in multi-server queueing systems. In a system with redundancy, jobs replicate themselves and wait in multiple queues; a job is complete as soon as any one copy completes service. Much of the existing theoretical work on analyzing systems with redundancy makes the unrealistic assumption that a job's service times are independent across different servers. This assumption can lead to results that are at odds with implementation results. We introduce a new, more realistic model of redundancy and design a new dispatching policy that is both analytically tractable within our model and has provably excellent performance.

3 - Gated Queues With Impatience Customers

George Mytalas, NJIT, Newark,NJ, NJ, United States, mytalas@aueb.gr

We analyze an M/M/1 queueing model with gated service discipline. In this discipline there is a waiting room and a service queue. Each time the service queue becomes empty all customers in the waiting room are instantaneously put in the service queue. Customers in waiting room can be impatient after waiting a random amount (or a certain) of time and abandon the system. We derive the joint distribution of the number of customers in waiting room and service queue, and obtain various quality of service measures.

4 - Appointment Systems Under Service Level Constraints

Rui Chen, University of Toronto, 105 St George St, Toronto, ON, M5S 3E6, Canada, rui.chen@rotman.utoronto.ca, Rowan Wang, Zhenzhen Yan, Saif Benjaafar, Oualid Jouini

We consider a new model of appointment scheduling where customers are given the earliest possible appointment times under the service level constraint that the expected waiting time of each individual customer cannot exceed a given threshold. We apply the theory of majorization to analytically characterize the structure of the optimal appointment schedule. We show that, the optimal inter-appointment times increase with the order of arrivals. We prove that, when customer service times follow an exponential distribution, our system converges asymptotically to the D/M/1 queueing system as the number of arrivals approaches infinity. We also extend our analysis to systems with multiple servers.

5 - Approximations For Heavily-loaded G/ Gi/n+ Gi Queues

Yao Yu, North Carolina State University, 4335-3 Avent Ferry Road, Raleigh, NC, 27606, United States, yyu15@ncsu.edu, Yunan Liu, Ward Whitt

Motivated by applications to service systems, we develop convenient engineering approximation formulas for the steady-state performance of heavily-loaded G/GI/n+GI multi-server queues. Based on established Gaussian many-server heavy-traffic limits in the efficiency-driven regime, however, the approximations also apply to systems in the quality-and-efficiency-driven regime where traffic intensity is close to 1 from above. Simulation experiments show that the proposed approximations are effective for large-scale queueing systems for a significant range of the traffic intensity and the abandonment rate.

■ TB34

204-MCC

Scheduling and Workload Assignment in Healthcare

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Retsef Levi, MIT, 100 Main Street, Building E62-562, Cambridge, MA, 02142, United States, retsef@mit.edu

Co-Chair: Cecilia Zenteno, Massachusetts General Hospital, 55 Fruit Street, White 400, Boston, MA, 02114, United States, azentenolangle@mgh.harvard.edu

1 - Integrated Scheduling And Capacity Planning With Considerations For Patients' Length-of-stay

Nan Liu, Columbia University, New York, NY, United States, nl2320@columbia.edu, Van-Anh Truong, Xinshang Wang, Brett Anderson

Motivated by the shortcoming of current hospital scheduling and capacity planning methods which often model different units in isolation, we introduce the first dynamic multi-day scheduling model that integrates information about capacity usage at more than one location in a hospital. In particular, we analyze the first dynamic model that accounts for patients' length-of-stay and downstream census in scheduling decisions. Through numerical experiments on real data, we show that there is substantial value in making integrated scheduling decisions. In contrast, localized decision rules that only focus on a single location of a hospital can result in up to a three-fold increase in total expenses.

2 - An Approximate Dynamic Programming Approach To Online Capacity Planning For Rehabilitation Treatment

Ingeborg A. Bikker, University of Twente, Enschede, Netherlands, i.a.bikker@utwente.nl
Ingeborg A. Bikker, Sint Maartenskliniek, Nijmegen, Netherlands, i.a.bikker@utwente.nl, Martijn Mes, Richard J Boucherie

We study an online capacity planning problem in which rehabilitation patients require a series of appointments with several disciplines, within a certain access time. In practice, appointments are typically planned in the first available time slots, leaving no space for urgent patients. In our research, we plan capacity for the appointment series of a patient at the moment of his/her arrival, in such a way that the total number of requests planned within their required access time is maximized. We formulate this problem as a Markov decision process, that takes into account predicted future arrivals. An approximate dynamic programming approach is used to obtain approximate solutions.

3 - Real-time Assignment Of Inpatients To Care Teams And Beds

Aleida Braaksma, Massachusetts Institute of Technology, 100 Main Street, E62-389, Cambridge, MA, 02142, United States, braaksma@mit.edu, Elizabeth Ugarph, Rhodes Berube, Cecilia Zenteno, Walter O'Donnell, Retsef Levi

The Department of Medicine at Massachusetts General Hospital has undergone a major care team and inpatient units redesign. In this work, we exploit the potential of the redesign to develop algorithms for real-time assignment of patients to care teams and to beds, aiming at shortening patient wait times, and decreasing the load of Medicine patients boarding in the Emergency Department. We use data-driven simulation to assess the effectiveness of the algorithms as well as to evaluate several other interventions aimed at optimizing patient flow.

■ TB35

205A-MCC

Managing Service Systems with Strategic Servers

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Philipp Afeche, University of Toronto, Rotman School of Management, Toronto, ON, M5S 3E6, Canada, afeche@rotman.utoronto.ca

1 - Product Support Forums: Customers As Partners In The Service Delivery

Stouras Konstantinos, INSEAD, konstantinos.stouras@insead.edu, Serguei Netessine, Karan Girotra

Online product support forums where customers can post complaints and questions, or report issues about a product or service of a firm abound. A large number of companies choose to crowdsource their product and service support back to their customers, employing a few dedicated service operators. We characterize the equilibrium behavior of such a novel business model for service and compare it with a call center model.

2 - Incentive Based Service System Design: Staffing And Compensation To Trade Off Speed And Quality

Amy Ward, USC Marshall School of Business, Los Angeles, CA, United States, amyward@marshall.usc.edu, Dongyuan Zhan

In many service systems, there is a trade-off between service speed and quality, and employees are paid based on both. We assume that the employees each selfishly choose their own service speed in order to maximize their own expected utility, which can have both a monetary and a non-monetary component. We show that a simple linear staffing and compensation policy is a first best solution in a large system limit. We further show the conditions under which a critically loaded, efficiency-driven, quality-driven, or mixed regime - in which there is simultaneous customer abandonment and server idling - emerges under a first-best linear policy.

3 - Managing Workplace Flexibility: The Case Of Agents With Task Preferences

Vasiliki Kostami, London Business School, vkostami@london.edu, Rouba Ibrahim

In many workplaces, employees are expected to excel in different skills as part of their job and are usually heterogeneous in their preferences to perform certain tasks. They might be willing to give up a grain of their salary to avoid working on the unlikable ones or prioritize the preferred ones. The manager, in turn, gains extra freedom in his decision to allocate tasks by charging his servers for this task discretion. We study how the choices change in equilibrium and we also derive the optimal flexibility fee under two innovative flexibility schemes and different heterogeneity scenarios.

4 - Pricing In A Two-sided Market With Time-sensitive Customers And Suppliers

Mustafa Akan, Tepper School of Business, Carnegie Mellon University, Pittsburgh, PA, United States, akan@andrew.cmu.edu, Philipp Afeche

We consider a firm that matches stochastically arriving and time-sensitive customers and suppliers. We characterize the structure and performance of the profit-maximizing and socially optimal pricing policies.

■ TB36

205B-MCC

Pricing and Supply Chain Management in Healthcare Industry

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: Mehmet Sekip Altug, George Washington University, maltug@gwu.edu

1 - Contracts For Referral Healthcare Services

Fernanda Bravo, Assistant Professor, UCLA, Los Angeles, CA, United States, fernanda.bravo@anderson.ucla.edu, Elodie Adida

This work focuses on the B2B interaction between a service requester and a service provider in a healthcare environment. The requester is responsible for managing the health of a population of patients, and refers the patient to a provider for advanced care needs. The requester may exert effort to reduce the volume of referrals and the provider may exert effort to reduce the chance of treatment failure. We analyze a variety of payment systems between the two firms and study how to coordinate the effort decisions with either the system optimum or the social optimum.

2 - Drug Pricing For Competing Pharmaceutical Manufacturers Distributing Through A Common PBM

Nan Yang, University of Miami, Coral Gables, FL, United States, yangn@wustl.edu, Panos Kouvelis, Yixuan Xiao

We study the price competition among multiple branded drug manufacturers when their drugs are distributed through a common Pharmacy Benefit Manager (PBM). We characterize the downstream PBM's optimal copayment and pricing decisions, and establish conditions for the equilibrium analysis of the price competition among the branded drug manufacturers. In particular, we provide a sufficient condition for the uniqueness of the equilibrium, and characterize the unique equilibrium in closed form. We apply our model to study the strategic implications of vertical integration between a branded drug manufacturer and the PBM.

3 - Policy And Product Launch Implications Of Parallel Imports In Pharmaceutical Industry

Mehmet Altug, George Washington University, maltug@gwu.edu, Ozge Sahin

While it may be socially optimal to introduce a new drug all over the world at the same time, doing so may have adverse implications for drug developers, such as the emergence of parallel imports. We study a pharmaceutical firm that already introduced a pioneering drug in its home country, where the product is protected by patent rules. The firm has to decide whether to launch in a second country in the same region, where parallel import between these two countries is feasible and if so how to price it. We characterize the joint equilibrium pricing and product launch decision of the firm. We discuss how these decisions are a ected by various parameters, including insurance, patient populations and negotiation.

■ TB37

205C-MCC

Sustainability Issues in Supply Chains II

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Karthik Natarajan, University of Minnesota, University of Minnesota, Edina, MN, Please fill in, United States, knataraj@umn.edu

1 - Optimal Contracts For Recycling And Refurbishment In The Reverse Supply Chain

Aditya Vedantam, State University of New York at Buffalo, Buffalo, NY, United States, adityave@buffalo.edu, Ananth Iyer

Several companies contract with third parties to dispose end-of use electronics involving recycling and refurbishment with subsequent resale. We present examples of contracts currently used in the IT Asset Disposition industry, provide insights on the profit and environmental impact and show how a customer can optimally set contract parameters under uncertainty in condition of incoming units. We parameterize our model to data from a third party e-waste recycler.

2 - Environmental Benefits Of Internet-enabled C2c Surplus Chains

Suvrat Dhanorkar, Pennsylvania State University, 120 Kenley Court, State College, PA, United States, ssd14@psu.edu

Recently, online matching platforms (e.g. Craigslist, FreeCycle, Gumtree) have enabled consumers to directly connect with each other to buy/sell surplus consumer goods (electronics, furniture etc.), which would have otherwise ended up in the waste stream. Such matching platforms can facilitate the creation of C2C "surplus chains" for used goods, which can enhance product reuse and limit reliance on recycling and disposal alternatives. We estimate the environmental benefits of internet-enabled surplus chains.

3 - The Implications Of Eliminating Grading In Food Supply Chains

Karthik Murali, University of Alabama, kmurali@cba.ua.edu, Isil Alev

Aside from imprudent consumer behavior, food grading based on aesthetics is the biggest contributor to food waste in the U.S. This study explores the implications of eliminating food grading in the agri-supply chain by considering the introduction of differentiated produce at the retail level and its impact on profitability, waste, and farmed acreage when consumers are heterogeneous and produce quality is uncertain.

4 - Investigating The Impact Of Supply-chain Factors on Counterfeit Parts

Vidya Mani, Pennsylvania State University, State College, PA, United States, vmani@psu.edu, Jayashankar Swaminathan

In this paper we investigate the relationship between supply chain factors and risk of counterfeit parts. We quantify the effectiveness of inventory positioning, distribution network, and information sharing through an empirical study of counterfeit parts in the electronic parts supply chain.

■ TB38

206A-MCC

Reliability I

Contributed Session

Chair: Hui Wang, Florida State University, Tallahassee, FL, United States, hw11b@my.fsu.edu

1 - Dynamic Reliability Modeling Of Software Errors

John G Wilson, Professor, Ivey School of Business, London, ON, N6G ON1, United States, jwilson@ivey.ca, Dov Te'eni

New errors can be dynamically introduced as new devices are produced and are found to be incompatible with software that is perfectly good for other devices. We provide a procedure for finding maximum likelihood estimators of key parameters where the number of errors and the number of users can change. This methodology is particularly apt for big data applications.

2 - Condition-Based Maintenance Policies Under The Gamma Degradation Process

David Han, University of Texas at San Antonio, One UTSA Circle, San Antonio, TX, 78249-0632, United States, david.han@utsa.edu

Condition-based maintenance is an effective method to reduce unexpected failures as well as the O&M costs. This talk discusses the condition-based maintenance policy with optimal inspection points under the gamma degradation process. A random effect parameter is used to account for population heterogeneities and its distribution is continuously updated at each inspection epoch. The observed degradation level along with the system age is utilized for making the optimal maintenance decision, and the structure of the optimal policy is examined.

3 - A Combined Repair-replacement Warranty Policy Considering Heterogeneous Usage Rate And Customer Error

Guozhen Xiong, graduate Student, Tsinghua University, Department of Industrial Engineering, Tsinghua University, Beijing, China, Beijing, 100084, China, xgz14@mails.tsinghua.edu.cn

Warranty has been widely used as a means of sales promotion. However, the warranty services usually result in considerable cost and hurt a company's profitability. It is not uncommon that some failures within warranty period are caused by customers' improper use, which should not be covered by the warranty service. Therefore, in order to minimize the total cost, this research studies the integration of maintenance strategies with appropriate testing strategies to identify failures that are out of warranty. Heterogeneous usage rate is also considered. Numerical experiments are conducted to illustrate the influence of different combinations of testing and maintenance strategies on warranty cost.

4 - Data Analysis And Experimental Design For Accelerated Life Testing With Heterogeneous Group Effects

Kangwon Seo, PhD Candidate, Arizona State University, 699 S Mill Ave., Tempe, AZ, 85281, United States, kseo7@asu.edu, Rong Pan

In accelerated life tests (ALTs), complete randomization is hardly achieved because of economic or engineering constraints. Typical experimental protocols such as subsampling or random blocks in ALT result in a grouped structure of test units, which leads to correlated lifetime observations. In this talk, generalized linear mixed model (GLMM) approach is proposed to analyze ALT data and find the optimal ALT design with consideration of heterogeneous group e ffects. First, we will demonstrate how the random group effects of ALT affect the life-stress relationship. Second, D-optimal ALT test plan will be derived when we run experiments with multiple test chambers.

■ TB39

207A-MCC

Applied Probability and Simulation I

Sponsored: Applied Probability

Sponsored Session

Chair: Henry Lam, University of Michigan, 500 S. State Street, Ann Arbor, MI, 48109, United States, khlam@umich.edu

1 - Rare Event Estimation For Gaussian Random Vectors

Ton Dieker, Columbia University, dieker@columbia.edu, Richard Gabriel Birge

We present a new technique for estimating the probability P(g(X)>x), where X is a Gaussian random vector and g is a function for which the probability becomes a rare event probability. In this setting, direct Monte Carlo is computationally expensive. We establish quantitative properties on the performance of our technique and illustrate them through numerical examples.

2 - On Adaptive Recursion For Integral Optimization

Raghu Pasupathy, Purdue University, pasupath@purdue.edu

We consider \emph{integral optimization problems}, that is, high-dimensional optimization problems where the objective function is expressed as an integral that can only be approximated using numerical quadrature. For efficient optimization, we propose an adaptive line-search recursion that dynamically determines the extent of work to be exerted during numerical quadrature. Assuming a general quadrature error-rate, we prove consistency and sample complexity results. The achieved rate in all cases is \emph{optimal} in a certain sense that we make clear.

3 - Three Asymptotic Regimes For Ranking And Selection With General Sample Distribution

Yi Zhu, Northwestern University, yizhu2020@u.northwestern.edu

In this paper, we study three asymptotic regimes that can be applied to ranking and selection (R&S) problems with general sample distributions. These asymptotic regimes are constructed by sending problem parameters (probability of incorrect selection, difference between the best and second best system) to zero. We establish asymptotic validity of the corresponding R&S procedures under each regime. We also analyze the connection among different asymptotic regimes and compare their pre-limit performances.

■ TB40

207B-MCC

Markov Decision Processes: Theory

Sponsored: Applied Probability

Sponsored Session

Chair: Matthew J. Sobel, Emeritus Professor, Case Western Reserve University, 10900 Euclid Ave., Cleveland, OH, 44106-7235, United States, matthew.sobel@case.edu

Co-Chair: Jie Ning, Case Western Reserve University, 10900 Euclid Ave., Cleveland, OH, 44106-7235, United States, jie.ning@case.edu

1 - Atomless Discounted Markov Decision Processes With Multiple Criteria

Eugene A Feinberg, Stony Brook University, eugene.feinberg@stonybrook.edu, Aleksey Piunovskiy

A Markov Decision Process (MDP) is called atomless if the initial distribution and transition probabilities are atomless. We show that, for an atomless MDP with multiple cost functions, for an arbitrary policy there is a nonrandomized stationary policy with the same vector of the total expected discounted costs. We also discuss the relevance of this result to Lyapunov's convexity theorem, to the classic results by Dvoretzky, Wald, and Wolfowitz on sufficiency of nonrandomized policies for atomless decision problems, and to our previous results on sufficiency of nonrandomized Markov policies for atomless MDPs.

2 - Optimal Policies In Decentralized Stochastic Control: Existence And Approximations

Serdar Yuksel, Queen's University, Kingston, ON, K7L 3N6, Canada, yuksel@queensu.ca

We will study optimal solutions in decentralized stochastic control. First, strategic measures will be introduced; these are probability measures induced by admissible policies. Properties such as convexity and compactness will be studied leading to existence of and structural results for optimal policies. Finally, asymptotic optimality of finite model representations will be established. These lead to asymptotic optimality of quantized control policies, so that one can construct a sequence of finite models obtained through the quantization of measurement and action spaces whose solutions converge to the optimal cost. Witsenhausen's counterexample will be a running case study.

3 - Easy Affine Mdps: Theory

Matthew J. Sobel, Case Western Reserve University, matthew.sobel@case.edu, Jie Ning

An MDP with continuous state and action vectors is shown to have an extremal optimal policy if it has affine immediate rewards and dynamics, decomposable constraints on the actions, and maximizes the expected present value of the rewards. Identifying an optimal policy and computing its value function reduces to solving a small system of auxiliary equations. This exorcises the curse of dimensionality. The same structure in a sequential game yields the existence and simple characterization of an extremal Nash equilibrium. A companion paper with algorithms and applications is in another session.

■ TB41

207C-MCC

Quantitative Methods in Finance XII

Sponsored: Financial Services

Sponsored Session

Chair: Woo Chang Kim, Associate Professor, KAIST, KAIST 291, Daehak-ro, Yuseong-gu, Daejeon, 34141, Korea, Republic of, wkim@kaist.ac.kr

Co-Chair: Changle Lin, Princeton University, Jersey City, NJ, United States, changlel@princeton.edu

1 - Robo-advisor And Personalized Asset & Liability system

Changle Lin, Merrill Lynch Wealth Management, changlelin1@gmail.com

2 - Robo-advisor: Goal-based Investing And Gamification

Paolo Sironi, IBM, paolo.sironi@de.ibm.com

The WM industry changes from distribution of products to channel of financial advice. Robo-Advisors need to innovate FIN not only TECH, embrace Goal Based Investing, move beyond MPT and craft better inter-temporal understanding of future performance of actual products, liabilities and portfolios against targets (asset values or post-retirement income). Probabilistic Scenario Optimisation facilitates the shift from market-oriented to client-centric allocations. Fears and ambitions enter the new equation if investors change their behaviour: Gamification could help to learn what money is for, how to invest and what to believe in when setting investment goals across scenarios.

3 - Robo-advisor: Application Of Advanced Portfolio Technology

Woo Chang Kim, KAIST, woochang.kim@gmail.com

4 - Evidence-based Improvements To Investor Behavior: Betterment's Approach

Daniel Egan, Betterment, 61 W. 23rd Street, 4th Floor, New York, NY, 10010, United States, dan@betterment.com

As the largest independent robo-advisor, Betterment relies on technology to further its mission of providing affordable, personalized advice to investors, regardless of their account size. Dan Egan, Vice President of Behavioral Finance and Investing at Betterment, will discuss the firm's efforts to build features that address behavioral biases that cause retail investors to make systematic investment "mistakes," including under-saving and excessive trading. He will also discuss Betterment's internal culture and how it contributes to a focus on innovation and to ongoing, evidence-based behavioral improvements.

■ TB42

207D-MCC

Learning, Estimation, and Experimentation in RM and Pricing

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Stefanus Jasin, University of Michigan, Ann Arbor, MI, United States, sjasin@umich.edu

1 - Demand Forecasting In The Presence Of Unobserved Lost Sales

Shivaram Subramanian, IBM, subshiva@us.ibm.com, Pavithra Harsha

We present an effective mixed-integer programming (MIP) based optimization approach to calibrating attraction demand models for pricing and revenue management applications using censored historical sales data. This single-step approach helps overcome some of the limitations present in prior approaches (e.g., the EM method). We discuss its practical viability by reviewing a recent commercial implementation for a large retail chain. We also comment on interesting extensions.

2 - Learning Valuation Distributions From Bundle Sales

Will Ma, ORC, MIT, willma353@gmail.com, David Simchi-Levi

Bundling has been widely studied in the literature as a form of price discrimination. We show that it can also be used as a form of price experimentation - a mixed bundling scheme allows the firm to quickly learn the customer valuation distributions without having to change any prices. We present an iterative algorithm to reverse-engineer the valuations based on bundle sales, with theoretical convergence guarantees for Uniform distributions. For other two-parameter families of distributions, our extensive numerical experiments demonstrate that optimizing over the learned parameters still extracts close to 100% of the optimal profit obtainable had we known the exact parameters.

3 - Less Can Be More In Price Experimentation

Georgia Perakis, MIT, georgiap@mit.edu, Divya Singhvi

We consider a dynamic pricing problem where a monopolist is selling a single product but has no knowledge of the demand curve. Further, there is a cost on price experimentation, as for every price the monopolist incurs a fixed operational cost. The monopolist seeks to efficiently learn the demand curve and keep the cost of price experimentation low. We propose an approach for price experimenting and learning the demand for the problem and provide bounds on the number of price experimentations needed to achieve a threshold revenue level for both parametric and non-parametric demand functions. We show that with few price experimentations (aka 4) we can be within 18% of the optimal.

4 - A Nonparametric Self-adjusting Control For Multi-product Pricing With Limited Resources

Qi (George) Chen, Ross School of Business, University of Michigan, Ann Arbor, MI, United States, georgeqc@umich.edu, Stefanus Jasin, Izak Duenyas

We study a multi-period network revenue management problem where the underlying demand function is unknown (in the nonparametric sense) to the seller who uses dynamic pricing to minimize expected revenue loss. It is known that the asymptotic revenue loss of any feasible pricing policy is O(k^{1/2}) (k indicates the size of the problem), but there is a considerable gap between this theoretical lower bound and the performance bound of all existing heuristics. We propose a Nonparametric Self-adjusting Control and show that it guarantees a revenue loss of O(k^{1/2+epsilon} log k) for any arbitrarily small epsilon>0, provided that the underlying demand function is sufficiently smooth.

■ TB43

208A-MCC

Panel: New Frontiers in Decision Analysis Practice and Theory

Sponsored: Decision Analysis

Sponsored Session

Moderator: Franklyn Koch, Koch Decision Consulting, Eugene, OR, United States, kochfg@gmail.com

Moderator: Melissa A. Kenney, University of Maryland, College Park, MD, United States, kenney@umd.edu

1 - New Frontiers In Decision Analysis Practice And Theory

Franklyn Koch, Koch Decision Consulting, kochfg@gmail.com

This panel of Decision Analysis practitioners and academicians will discuss some of the problems in Decision Analysis that they are struggling to solve. These would include decisions where the existing techniques & tools fall short, areas where practitioners are looking for new approaches & insights, and innovative ideas and techniques that may provide new insights into difficult or complex decisions. Panelists include: Greg Hamm, Berkeley Research Group; Babak Jafarizadeh, Statoil; Bill Klimack, Chevron.

■ TB44

208B-MCC

Graphical Methods

Sponsored: Decision Analysis

Sponsored Session

Chair: Jeffrey M Keisler, University of Massachusetts - Boston, 100 Morrissey Boulevard, Boston, MA, 02125, United States, jeff.keisler@umb.edu

1 - Decision Circuits For Decision Analysis

Debarun Bhattacharjya, IBM T. J. Watson Research Center, Yorktown Heights, NY, United States, debarunb@us.ibm.com, Ross D Shachter

A decision circuit is a graphical representation that is syntactic, i.e. depicts summation, multiplication and maximization operations required to solve a decision problem. Decision circuits can be viewed as a representation of decision analysis computations and therefore generalize decision trees as well as other well-known graphical forms. In this talk, I will present advances in our research on the formulation and analysis of decision analysis problems using decision circuits.

2 - On Computing Probabilities Of Dismissal Of 10b-5 Security Class-action Cases

Sumanta Singha, PhD Student, University of Kansas, 1654 Naismith Dr, Lawrence, KS, 66045, United States, sumanta.singha@ku.edu, Steve Hillmer, Prakash P Shenoy

The main goal of this paper is to propose a probability model for computing probabilities of dismissal of 10b-5 securities class-action cases filed in U.S. Federal district courts. By dismissal, we mean dismissal with prejudice in response to the motion to dismiss filed by the defendants, and not eventual dismissal after the discovery process. The proposed probability model is a hybrid of two widely-used methods: logistic regression (LR), and naïve Bayes (NB). Using a dataset of 925 10b-5 securities class-action cases, we show that the proposed hybrid model has the potential of computing better probabilities than either LR or NB models. By better, we mean lower RMSE of probabilities of dismissal.

3 - Observing Reporting And Deciding In Networks

Jeffrey Keisler, University of Massachusetts Boston, jeff.keisler@umb.edu, H Jerome Keisler

In observation networks, agents make observations, make new inferences, and report to neighbors to ultimately identify correct alternatives. Report plans ensure that this happens reliably. Junction tree algorithms applied to Bayes networks constitute report plans. General conditions for existence of report plans suggest other modeling possibilities.

■ TB45

209A-MCC

Parallel Simulation Optimization

Sponsored: Simulation

Sponsored Session

Chair: Jie Xu, George Mason University, 4400 University Dr., MSN 4A6, Fairfax, VA, 22030, United States, jxu13@gmu.edu

1 - Implementing A Ranking And Selection Procedure In The Cloud

Sijia Ma, Cornell University, Ithaca, NY, United States, sm2462@cornell.edu, Shane Henderson

The goal of ranking and selection (R&S) procedures is to identify the stochastic system with largest mean from among a finite set of competing alternatives. We are implementing a R&S algorithm within a commercial simulation software product that runs in the cloud. A cloud-computing implementation requires estimating the wall-clock running time as a function of the number of cores used. To estimate the running time we develop a sampling and estimation method to learn about the ordered means. This methodology allows us to predict the residual running time more and more accurately as the R&S algorithm proceeds, and may prove useful when estimating the running times of other R&S procedures.

2 - Speeding Up Sequential Selection-of-the-best Procedures For Large-scale Problems

Jeff Hong, City University of Hong Kong, jeffhong@cityu.edu.hk, Jun Luo, Ying Zhong

Classical sequential ranking-and-selection (R&S) procedures require all pairwise comparisons after collecting one additional observation from each surviving system, which is typically an O(k^2) operation where k is the number of systems. When k is large (e.g., millions), these comparisons can be very costly and may significantly slow down the R&S procedures. In this paper we revise KN procedure slightly and show that one may reduce the computational complexity of all pairwise comparisons to an O(k) operation, thus significantly reducing the computational burden. Numerical experiments show that the computational time reduces by orders of magnitude.

3 - Multi-objective Optimization Via Simulation On Integer-ordered Spaces

Kalyani S Nagaraj, Purdue University, West Lafayette, IN, United States, kalyanin@purdue.edu, Kyle Cooper, Susan R Hunter

Consider the context of multi-objective optimization via simulation when the search space is integer-ordered. We propose a framework to efficiently identify the Pareto set that solves a sequence of stochastically constrained problems (via the epsilon-constraint method) and is designed for deployment on a parallel computing platform. We discuss the design principles that make our framework efficient.

4 - Parallel Empirical Stochastic Branch And Bound

Jie Xu, George Mason University, 4400 University Dr., MS4A6, Fairfax, VA, 22030, United States, jxu13@gmu.edu, Scott L. Rosen, Peter Salemi, Sajjad Taghiyeh

In this talk, we show how the Empirical Stochastic Branch and Bound (ESSB) algorithm, which is an effective globally convergent random search algorithm for discrete optimization via simulation, can be adapted to a high-performance computing environment to effectively utilize the power of massive parallelism. We propose a master-worker structure driven by MITRE’s Goal-Directed Grid-Enabled Simulation Experimentation Environment. We present numerical experiments with a benchmark test function and a real-life simulator to test the scalability of parallel empirical stochastic branch and bound.

■ TB46

209B-MCC

Choice Modeling and Assortment Optimization

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Huseyin Topaloglu, Cornell Tech, 111 8th Avenue, Suite 302, Ithaca, New York, NY, 10011, United States, ht88@cornell.edu

1 - Assortment Optimization Under General Choice

Srikanth Jagabathula, NYU Stern School of Business, sjagabat@stern.nyu.edu

We consider the static assortment optimization problem where the objective is to determine the profit/revenue maximizing subset of products from a large universe of products. The product prices are exogenously fixed and the demand follows a general choice model. The problem in general is NP-hard and the greedy algorithm has been found to have good practical performance. We study the performance of a local search heuristic and show that it reaches the optimal solution for the MNL model and derive approximation guarantees for the random parameters logit (RPL) and the nested logit (NL) models. Numerically, we show that the algorithm outperforms existing heuristics in a wide-range of settings.

2 - Robust Assortment Optimization Under The Markov Chain Model

Antoine Desir, Columbia University, ad2918@columbia.edu, Vineet Goyal, Bo Jiang, Huseyin Topaloglu, Tian Xie, Jiawei Zhang

In this paper, we consider a robust assortment optimization problem under the Markov Chain model. In that setting, the true parameters of the model are unknown and belong to some uncertainty set. The goal is to select an assortment that maximizes the worst-case expected revenue over all parameter values. We present an efficient algorithm to compute the optimal robust assortment when the uncertainty set is row-wise. That is naturally the case in many settings. Our algorithm provides interesting operational insights regarding addressing uncertainty in the Markov chain model.

3 - On The Structure Of Cardinality-constrained Assortment Optimization Problems

Louis L Chen, Massachusetts Institute of Technology-ORC, llchen@mit.edu, David Simchi-Levi

Cardinality-Constrained assortment optimization, the problem of offering an assortment of items of constrained size that will maximize expected revenue, is generally regarded as a challenging problem. We provide a new perspective to the structural analysis, one that illuminates the optimality of “greedy solutions.” The approach reinterprets some known results for standard choice models but also provides some new ones as well.

4 - Competitive Pricing Under The Markov Chain Choice Model

Huseyin Topaloglu, Cornell Tech, New York, NY, 10011, United States, ht88@cornell.edu, James Dong

We consider competitive pricing problems under the Markov chain choice model. In this choice model, the customer transitions between the products according to a transition probability matrix. Based on the price of the product she visits, she decides to purchase the product or not. In our competitive setting, the prices of the different products visited by the customers are controlled by different firms. Each firm wants to maximize its own expected revenue. We show that a Nash equilibrium exists and the equilibrium prices are lower than those charged by a central planner.

■ TB47

209C-MCC

Pricing, Promotions and Bundling for Revenue Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Pelin Pekgun, University of South Carolina, 1014 Greene Street, Columbia, SC, 29208, United States, pelin.pekgun@moore.sc.edu

1 - A Pricing Model To Optimize The Promotions Period In Airlines

Daniel Felipe Otero Leon, Lecturer, Universidad de los Andes, Bogota, 1111, Colombia, df.otero128@uniandes.edu.co, Cristina Lopez, Mariana Escallon, Raha Akhavan-Tabatabaei

Promotions help increment the demand for a flight. Several decisions have to be made to offer a promotion such as its price and duration. We propose a method to estimate the behavior of customer inter-arrival time distribution, his buying probability distribution, and the dilution effect from data and develop a stochastic dynamic model to maximize the revenue, evaluating the decision of whether or not to offer the promotion. Finally we study the structural properties of the model and draw conclusions.

2 - Dynamic Pricing For Hotel Rooms When Customers Request Multiple-day Stays

Yun Fong Lim, Singapore Management University, yflim@smu.edu.sg, Selvaprabu Nadarajah, Qing Ding

We study the dynamic pricing problem faced by a hotel that maximizes expected revenue from a single type of rooms. Demand for the rooms is stochastic and non-stationary. Our Markov decision process formulation of this problem determines the optimal booking price of rooms (resources) for each individual day, while considering the availability of room capacity throughout the multiple-day stays (products) requested by customers. To offer attractive average daily prices, the hotel should not only substantially raise the booking prices for some high-demand days, but also significantly lower the booking prices for the low-demand days that are immediately adjacent to these high-demand days.

3 - On The Benefit (or Cost) Of Large-scale Bundling

Tarek Abdallah, New York University, tabdalla@stern.nyu.edu

We study the effectiveness of a simple bundling mechanism in extracting the consumer surplus in the presence of non-negative marginal costs and correlated valuations. We develop simple robust analytics that identify the main drivers for the effectiveness of the pure bundling mechanism and allow the sellers to easily quantify the potential profits of a large-scale bundling mechanism relative to more complicated selling mechanisms. Our numerical simulations show that these analytics provide high predictive power for the true performance of the bundling mechanism and are robust to different parametric assumptions even for relatively small bundles.

4 - How Perceptions Of User Reviews Impact Price Competition

Pelin Pekgun, University of South Carolina, Columbia, SC, 29208, United States, Pelin.Pekgun@moore.sc.edu, Michael Galbreth, Bikram Ghosh

We analyze the interaction of user reviews and experience uncertainty, where negative and positive reviews may be weighted differently in a consumer’s assessment of the valence of the posted reviews. We find that the competitive impact of this unequal weighting may not be intuitive in terms of pricing and profits. In particular, if consumer awareness is higher for the lower quality product, it can charge higher prices and realize higher profits in equilibrium than its higher quality competitor when consumers are strongly influenced by negative reviews.

■ TB48

210-MCC

Optimization and Statistical Learning

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Dimitri Papadimitriou, Alcatel-Lucent, Bell-Telephonelaan, Brussels, BC, 00000, Belgium, dimitri.papadimitriou@alcatel-lucent.com

Co-Chair: Dimitri Papadimitriou, Bell Labs, Copernicuslaan 50, Antwerp, 2018, Belgium, dimitri.papadimitriou@nokia.com

1 - Statistical Learning Approaches For Stochastic Optimization (SLASO)

Suvrajeet Sen, USC, s.sen@usc.edu, Yunxiao Deng

SLASO is a new distribution-free concept for Integrative Analytics, bringing together both Predictive and Prescriptive Analytics. We will illustrate the power of this concept by demonstrating how multiple activities, such as sales, marketing, and production planning can all work from the same data sources, thus helping to coordinate decisions from a variety of groups within an organization. The SLASO framework helps cross-fertilize members of an analytics team so that tools such as regression (Statistics), linear programming (Optimization), variance reduction (Simulation) and others can be viewed from an integrative perspective, rather than the current lens of disciplinary stove-pipes.

2 - Time Series Applications Of SLASO

Yunxiao Deng, USC, yunxiaod@usc.edu

We will introduce how SLASO can be used for Time Series Applications by studying a single echelon inventory model in which the demand data are time dependent and stochastic. To minimize the expected cost of holding inventory plus lost sales, we formulate a Stochastic Linear Programming model which combines statistics as well as optimization by adopting SLASO framework. With other two methods (Newsvendor and Demand Forecasting), this approach performs better in both Back-Testing and Stress-Testing during validation analysis.

3 - Bayes-optimal Entropy Minimization For Active Learning In Conjoint Analysis

Stephen N Pallone, Cornell University, 290 Rhodes Hall, Cornell University, Ithaca, NY, 14853, United States, snp32@cornell.edu, Peter Frazier, Shane Henderson

Choice-based conjoint analysis is a method for preference elicitation where the user is offered a set of alternatives and chooses the preferred option. The rate at which we learn depends on the alternatives offered. We model the user's preferences through a linear classifier. Under certain noise assumptions, we prove a linear lower bound on the posterior entropy of this linear classifier, and show entropy pursuit can attain the bound when alternatives can be fabricated. Further, we explore an information theoretic variant of the knowledge gradient policy that selects comparative questions to greedily minimize interaction information, and numerically compare this policy with entropy pursuit.

4 - Learning Uncertainty Sets And Automation Of Robust Formulation

Dimitri Papadimitriou, Bell Labs, dimitri.papadimitriou@nokia.com

Machine learning shares deep connections with robust optimization as they both perform by adding uncertainty in the model, formulating the optimization problem, and exploiting mathematical programming. Machine learning applies to i) model uncertainty by automating processing of noisy or aleatory data to produce perturbation sets, ii) automatically derive robust formulation but also adapt decision rules associated to adjustable variables, and iii) learn about the behavior of resolution algorithm(s) and tune its execution to improve its performance. We illustrate them on three network optimization problems, the multi-commodity network flow, facility location and hub location problem.

■ TB49

211-MCC

Educational Research in OR/MS

Sponsored: Education (INFORMED)

Sponsored Session

Chair: Susan Wright Palocsay, James Madison University, Harrisonburg, VA, United States, palocssw@jmu.edu

1 - Batching In Higher Education

Jan Riezebos, University of Groningen, Nettelbosje 2, P.O. Box 800, Groningen, 9700 AV, Netherlands, j.riezebos@rug.nl, Iris F Vis

Models for optimal batch sizes in industrial context, such as economic lot sizing, cannot directly be applied to the context of higher education. However, in higher education, batching is even more important than in industrial contexts, as it is not just the economical impact that has to be considered, but also various effects on learning. We explore possible ways to extend OR models for batching in higher education.

2 - Effective Teaching For Mastery Of Boolean Constraints

Scott Stevens, Professor, CIS & Business Analytics, James Madison University, James Madison University, MSC 202, Harrisonburg, VA, 22807, United States, stevensp@jmu.edu, Susan Wright Palocsay

Mixed integer optimization problems often include constraints involving Boolean variables—variables that can equal only 0 or 1—representing the truth values of some logical propositions. The pure compound propositions of either "all Ai are true" or "at least one Ai is true" for some collection of Boolean variables Ai are easy to represent as linear expressions, but students frequently find propositions of the form (pure compound 1) implies (pure compound 2) to be baffling. We introduce a technique that allows any such proposition to be written as one or more linear constraints by applying three simple rules: decomposition, translation, and compression, and then provide evidence of efficacy.

3 - A Review Of The Literature For Operations Management Education

Susan Wright Palocsay, James Madison University, Harrisonburg, VA, United States, palocssw@jmu.edu, Michael Busing

Operations management (OM) has maintained a close association with OR/MS as its scope has broadened from manufacturing to service processes. In response, OM curricula have undergone significant revision with a corresponding increase in OM pedagogical studies. We will present a summary of OM educational publications and discuss OM teaching trends.

■ TB50

212-MCC

Panel: Topics for PhD Students

Sponsored: Minority Issues

Sponsored Session

Moderator: Maria Esther Mayorga, North Carolina State University, 111 Lampe Drive, Campus Box 7906, Raleigh, NC, 27695, United States, memayorg@ncsu.edu

1 - Topics For Phd Students

Maria Esther Mayorga, North Carolina State University, memayorg@ncsu.edu

This session will serve as a panel discussion on topics of interest for PhD students nearing graduation. Topics include: - deciding on industry versus academia - how to prioritize objectives towards then end of the PhD Process - work/life balance when pursuing tenure - networking to achieve a desired faculty position - how to position yourself when pursuing the market - networking at conferences such as INFORMS

2 - Panelist

Maria Esther Mayorga, North Carolina State University, memayorg@ncsu.edu

3 - Panelist

Karen T Hicklin, University of North Carolina at Chapel Hill, Chapel Hill, NC, 27599, United States, khicklin@email.unc.edu

■ TB51

213-MCC

Matchings and Assignments with Societal Impact

Sponsored: Public Sector OR

Sponsored Session

Chair: Tina Rezvanian, Northeastern University, 360 Huntington Avenue, Boston, MA, 02115, United States, rezvanian.t@husky.neu.edu

Co-Chair: Ozlem Ergun, Northeastern University, 453 Meserve, 360 Huntington Avenue, 360 Huntington Avenue, MA, 02115, United States, o.ergun@neu.edu

1 - Two-sided Stable Matching In Markets With Multiple Periods

Tina Rezvanian, Northeastern University, Boston, MA, United States, rezvanian.t@husky.neu.edu, Ozlem Ergun

Many industries demand mechanisms for job assignments that are sustainable over multiple periods of time. It is a well-known fact that the core stays the same under any stable matching algorithm and therefore no such matching can guarantee sustainability and perfectness as a dominant strategy for participants as same participants stay unsatisfied. We introduce a popularity measure that identifies a connection between stability of the match and fairness for those unsatisfied. We use this trade off to employ negotiation schemes in our proposed algorithm. By analyzing network structures of the large-scale markets we are able to acquire near-optimal solutions.

2 - Human Interaction With Recommendation Systems: On Bias And Exploration

Sven Schmit, Stanford University, Stanford, CA, United States, schmit@stanford.edu, Ramesh Johari, Vijay Kamble, Carlos Riquelme

More and more, recommendation systems assist users decision making. These systems rely on historical data to provide suggestions. Little attention has been paid to the interaction of humans and learning algorithms. We propose an explicit model for the interaction between users and recommendations provided by a platform. First, we show that this interaction leads to a bias in naive estimators due to selection effects. This bias leads to suboptimal outcomes. Second, agents' heterogeneous preferences lead to sufficient exploration of alternatives. Both observations lead to new insights and practical advice.

3 - Uncertainty In Dynamic Matching With Application To Organ Exchange

John Dickerson, Carnegie Mellon University, Pittsburgh, PA, United States, dickerson@cs.cmu.edu
John Dickerson, University of Maryland, College Park, MD, United States, dickerson@cs.cmu.edu, Tuomas W Sandholm

We address dynamic kidney exchange, an organized market where patients with end-stage renal failure swap willing but incompatible living donors. Specifically, we focus on two types of uncertainty found in dynamic matching applications like kidney exchange: probabilistic existence of edges in the current matching graph, and determining the "best" way to match now given uncertainty over the future. We discuss recent theoretical results and optimization methods to tackle this uncertainty, and provide experimental results from applying these methods to real-world data from the UNOS US-wide kidney exchange.

4 - Assortment Planning In School Choice

Peng Shi, Massachusetts Institute of Technology (MIT), Cambridge, MA, pengshi@mit.edu

School choice systems assign students to schools by giving each student a menu of options and eliciting their relative preferences among the options. Many such systems uses the Gale-Shapely Deferred Acceptance (DA) algorithm, which also take into account students' priorities at each school. In previous literature, the menus and priorities are considered to be given. In this paper, we study how the school board can optimize the menus and priorities in order to maximum students' expected utilities subject to a budget for school busing. We apply this to real data from Boston Public Schools.

■ TB52

214-MCC

Urban Transportation and Logistics in Public Sector OR I

Sponsored: Public Sector OR

Sponsored Session

Chair: Sunghoon Chung, Binghamton University, The State University of New York, P.O. Box 6000, Binghamton, NY, 13902, United States, schung@binghamton.edu

1 - A Vehicle Routing Problem For CNG Trucks With Fueling Stations

Yihuan (Ethan) Shao, University of Southern California, Los Angeles, CA, United States, yihuansh@usc.edu, Maged M Dessouky

In this research, we consider a Vehicle Routing Problem (VRP) for Compressed Natural Gas (CNG). Due to the limited number of available fueling stations and small fuel tank capacity, CNG trucks call for special concerns with the refueling problem. We introduce a new Mixed Integer Programming (MIP) model with preprocessing and valid inequalities to solve the problem optimally, as well as a new hybrid heuristic method to solve the problem in large scale. Numerical experiments show the efficiency of our preprocessing and valid inequalities. We also draw some insights from the experiments.

2 - The Truck Line Vehicle Routing Problem Of A Hub-and-spoke Structure Based Parcel Carrier

Jaesang Park, Postech, Pohang, Korea, Republic of, rose7@postech.ac.kr, Byung-In Kim, Ho-mahn Kwak, Hyunjoon Kim, Jeongbin Kim

We handle a combined problem of trunk line vehicle routing and hub capacity planning for a real-word parcel carrier, which uses a hub-and-spoke structure of about 300 spokes and 11 hubs. Because of limited sorting capability, only ten category groups can be classified at a spoke. The classified groups then are delivered to an eligible hub, are sorted and delivered to appropriate spokes. It handles about four million parcels daily and delivers them within two days using 4500 eleven tones trucks. A solution approach minimizing the total transportation and hub operating cost is developed.

3 - Dynamic Bus Routing For Evacuation

Xiaohang Zhu, University at Buffalo, 2514 Deer Lakes Dr, Amherst, NY, 14228, United States, xzhu8@buffalo.edu, Jee Eun Kang

Bus-based evacuation serves carless population and helps reduce congestion during evacuations. This research develops a single level dynamic bus routing problem, that determines the optimal bus routing with respect to dynamics of traffic and congestion, that minimizes the total evacuation time experienced by all evacuees. The proposed model is built upon the linear programming formulation of the Cell Transmission Model (CTM).

■ TB53

Music Row 1- Omni

Innovations and Value Chain Management

Sponsored: Technology, Innovation Management & Entrepreneurship

Sponsored Session

Chair: Ying-Ju Chen, HKUST Business School, Dept. of ISOM, HKUST, Clear Water Bay, Kowloon, Hong Kong, 999077, Hong Kong, imchen@ust.hk

Co-Chair: Shihong Xiao, HKUST, Dept. of IELM, HKUST, Clear Water Bay, Kowloon, Hong Kong, 999077, Hong Kong, sxiaoab@connect.ust.hk

1 - Impact Of Forecasting Accuracy On Sharing Forecasts In Supply Chains

Hyoduk Shin, University of California - San Diego, hdshin@ucsd.edu

We investigate the role of accuracy information of demand forecasts on sharing forecasts within the supply chain between the downstream retailer and the upstream supplier. We demonstrate how the uncertainty on the forecast accuracy can help or hurt the ability to share demand forecasts.

2 - Supply Chain Contracts With Boundedly Rational Retailers

Behrooz Pourghannad, University of Minnesota, Minneapolis, MN, United States, behrooz.pourghannad@gmail.com, Guangwen Kong, Tony H Cui

We study supply chain contracts with consideration of information sharing and bounded rationality. We examine a dyadic supply chain where a supplier with more accurate demand information sells products to a bounded rational retailer. The research suggests that the supplier can be better-off by using a linear pricing contract than adopting a buy-back contract.

3 - Milking The Quality Test: Improving The Milk Supply Chain Under Competing Collection Intermediaries

Liying Mu, University of Delaware, muliying@udel.edu, Milind Dawande, Xianjun Geng, Vijay Mookerjee

We examine operational and incentive issues that conspire to reduce the quality of milk — via deliberate adulteration by milk farmers — under competing collection stations in developing countries. Two recommendations are provided to reduce the milk adulteration using minimal testing. Both solutions achieve a socially-beneficial equilibrium outcome: All the farmers provide high-quality milk and each competing station only conducts one mixed test and no individual testing.

4 - 3d Printing Vs. Traditional Flexible Technology: Implication On Manufacturing Strategies

Duo Shi, Washington University in Saint Louis, KH 401, Olin Business School, 1 Brookings Drive, St. Louis, MO, 63130, United States, dshi@wustl.edu, Lingxiu Dong, Fuqiang Zhang

In this paper, we study a firm's manufacturing strategies under two types of flexible technologies: traditional flexible technology and 3D printing. The firm adopts dedicated technology and one type of flexible technology, either the traditional one or 3D printing. It has to choose an assortment from a potential set of variants, assigns each variant to a production technology, and finally invests in resource capacities. We find that traditional flexible technology and 3D printing can have distinct technology assignment structures. Contrary to common wisdom, the adoption of traditional flexible technology can reduce product variety. 3D printing, however, always enhances product variety.

■ TB54

Music Row 2- Omni

Service Science in Emerging Economy

Sponsored: Service Science

Sponsored Session

Chair: Qiang Qiang, Penn State University, 30 E. Swedesford Road, Malvern, PA, 19355, United States, qzq10@psu.edu

1 - Big Data Based Modeling And Optimizing Of The First Aid Services In Shanghai Songjiang District

Wei Yang, Tongji University, Shanghai, China, yangvmail@163.com, Qiang Su

To guarantee the emergency demand can be responded in time, the government is obliged to implement an effective EMS plan. Most studies failure to consider adequately the effect of the spatio-temporal uncertain demand since it is difficult to quantitatively describe. As a result, the location plan is not efficient enough. In this study, Gaussian Mixture Model clustering is innovatively utilized to quantitatively describe the spatial uncertain demand. Then the chance-constraint programming model for location planning is developed. The data of Songjiang District is used to validate the method proposed. The experimental results demonstrate that the delay time can be significantly decreased.

2 - The Impact Of Linguistic Persuasiveness On The Success Rate Of Crowdfunding Services: Evidence From Kickstarter

Hongwei Wang, Tongji University, Shanghai, China, hwwang@tongji.edu.cn, Wei Wang, Wei Chen, Kevin Zhu

Fund-seekers tend to use various linguistic styles to change investors' perception on project prospects, thus leading to different persuasiveness on investment intentions. Based on Hovland's persuasion model and Aristotle's rhetorical persuasion triples, the linguistic styles are grouped into resorting to credibility, to sentiment, to logic, to reward, and to exaggeration. We then extract the keywords for these categories by text mining. An econometric model is formulated with 128345 campaigns from Kickstarter to estimate the impact of linguistic styles on successful campaigns. The results guide fund-seekers to come up the most effective linguistic styles on describing their projects.

■ TB55

Music Row 3- Omni

Inventory Management IV

Contributed Session

Chair: Apurva Jain, University of Washington, Foster School of Business, Box 353226, Seattle, WA, 98195-3226, United States, apurva@u.washington.edu

1 - Using Simulations To Evaluate And Improve Inventory Policies

Jagtej S Bewli, Director, Product Management, WalmartLabs, 850 Cherry Avenue, San Bruno, CA, 94066, United States, jbewli@walmartlabs.com

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2 - Cooperation In Spare Parts Systems With Expedited Deliveries

Ulas Ozen, Ozyegin University, Cekmekoy Campus, Nisantepe District, Orman Street, Istanbul, 34794, Turkey, ulas.ozen@ozyegin.edu.tr

We study cooperation between a group of companies, who need spare parts to maintain their expensive equipment, by pooling their spare parts inventory. To address the cost allocation problem, we borrow concepts from cooperative game theory and examine the core of the resulting cooperative games. We study three cooperation scenarios: (i) cooperation by inventory pooling, (ii) cooperation under optimal inventory investment, and (iii) cooperation under service level constraint. For many of these games, we show that the cores are non-empty by identifying a PMAS. For the games with empty cores, we present examples.

3 - Multi Period Production Planning With Uniformly Perishable Inventories

Mehdi Karimi-Nasab, PostDoc, Institute for Operations Research, University of Hamburg, Von-Melle-Park 5, Hamburg, 20146, Germany, mehdi.karimi-nasab@uni-hamburg.de

A number of products should be produced over a number of periods. After a product is produced, it is subject to perishability. Assume that product i is produced in period t0. Then life time of product i can be divided into two parts: till a certain time limit after production, tl(i), we can be sure that item i is usable in the warehouse (i.e. till the end of period t0+tl(i) we are sure that it is not perished), but it may be considered unusable during the next periods located in the interval t0+tl(i)+1, . . ., t0+tu(i) with equal chance. In other words, we can be sure that by probability of 1 it is absolutely out of use afterwards. The problem is formulated and mathematical properties of the model are studied.

4 - Operational Responses To A Demand Surge

Apurva Jain, University of Washington, Foster School of Business, Box 353226, Seattle, WA, 98195-3226, United States, apurva@u.washington.edu

We develop and analyze a model where a firm observes the evolution of a demand-surge over a short time-period. The firm's decisions about inventory, quality and delivery influence the evolution of the demand surge over short-term and have impact on the level of long-term demand it may experience. The firm must determine the time and quantity for ordering inventory to meet the surge and must choose between sources that differ in their quality-levels and delivery-times.

■ TB56

Music Row 4- Omni

Innovation through IT Management

Sponsored: EBusiness

Sponsored Session

Chair: Rajiv Mukherjee, Southern Methodist University, Frisco, TX, United States, rajiv.mukherjee@gmail.com

1 - Effect Of Consumption Flexibility On Usage

Sreekumar Bhaskaran, Southern Methodist University, sbhaskar@smu.edu, Rajiv Mukherjee, Sanjiv Erat

In this research, we examine the effect of flexibility related to consumption of services on the extent of usage of a service. Impact of consumer behavior on capacity and pricing are also considered.

2 - How Strategic Crowdfunding Design Decisions And Financial Slack Affect Funding And Post-funding Outcomes

Daniel Zantedeschi, The Ohio State University, Columbus, OH, United States, zantedeschi.1@osu.edu, Onochie Fan-Osuala, Wolfgang Jank

Based on the marketing-operations interface model, we conjecture that strategic crowdfunding campaign design decisions can impact both funding and post-funding outcomes. We show that these strategic decisions have differential effects on the both phases (fundraising and post-funding) of crowdfunding. That is, decisions that positively impact funding success may negatively impact the time to shipment of crowdfunded products. Further, and contrary to speculations, we find that overfunding (a fundraising phase outcome) provides financial slack and is associated with lower delays in product shipment. Finally, we provide implications of these findings.

3 - "Co-opetition" In The Over-The-Top (OTT) Services

Antino Kim, Indiana University, Bloomington, IN, United States, antino@iu.edu, Debabrata Dey, Atanu Lahiri

Often, an infrastructure service provider (ISP) allows an "over-the-top" service provider (OTTSP) to use its infrastructure to offer services that end up competing with the services provided by the ISP itself. Such presence of competition and collaboration at the same time leads to an interesting relationship between the ISP and OTTSP. In this research, we examine this intricate relationship to analyze the pricing strategies for both parties.

4 - Product Support And Uncertainty: Effect On Two Competing Online Retailers

Vashkar Ghosh, University of Florida, 355A Stuzin Hall, Department of ISOM, Gainesville, FL, 32611, United States, vashkar.ghosh@warrington.ufl.edu, Kyung Sung Jung, Young Kwark, Janice Carrrillo

We analyze the effect of uncertainty about the product and retailer support between two competing online retailers selling the same product. The retailers differ in both their product support and fit. We consider the impact of online reviews, and investigate the problem under wholesale and agency pricing schemes.

■ TB57

Music Row 5- Omni

Managing Decentralized Processes

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Enno Siemsen, University of Wisconsin, Madison, WI, United States, esiemsen@wisc.edu

1 - Production Process Moves

Pettis Kent, University of Minnesota, kentx143@umn.edu

To study the growing trend of multinational firms moving production processes within and between countries to address strategy needs, we develop a behavioral experiment where production teams build small devices for multiple rounds, with “template use” and “product/process change” as the individual variables of interest, and with cost (learning rate) as the dependent variable. Our research objective is to better understand how firms can effectively manage process knowledge during a production move.

2 - Ideation Execution Transition In Product Development

Evgeny Kagan, University of Michigan, ekagan@umich.edu, Stephen Leider, William Lovejoy

We show experimentally that design performance is significantly worse when designers decide for themselves how to schedule the development process. We demonstrate several remedies for situations when external allocation of time to development phases is not possible. Managers can improve performance by “nudging” individuals towards early physical build, or by requiring them to commit to a transition time beforehand. However, the most effective way to improve performance is contingent transition - a requirement to present a prototype that exceeds a minimum performance hurdle

3 - An Experimental Investigation Of Transshipment And Local Decision Making

Shan Li, Baruch College, City University of New York, New York, NY, 10601, United States, shan.li@baruch.cuny.edu, Kay-Yut Chen

When a retailer has surplus stock and another retailer has inventory shortage, it may be desirable to transfer surplus stock from the former to the latter. We experimentally examine how the possibility of such transshipment between two independent retailers affects each retailer’s local decisions of inventory and study the formation of transfer prices under different price setting processes.

4 - Inventory Sharing Behavior

Enno Siemsen, University of Wisconsin - Madison, Madison, WI, esiemsen@wisc.edu, Hui Zhao, Liang Xu

Inventory sharing systems are essential for decentralized decision makers to benefit from aggregation. We use behavioral laboratory experiments to examine inventory sharing behavior in the laboratory. Results from our experiments show that the transfer price - which is a common tool to coordinate inventory sharing systems - fails to influence our subjects initial order quantities, and thus does not lead to a coordinated system. Further, we show that subjects are reluctant to ask their supply chain partners for an adequate amount of information, and that the potential to request inventory from other players leads to a general reduction in initial order quantities.

■ TB58

Music Row 6- Omni

Energy X

Contributed Session

Chair: Farnaz Ghazi Nezami, Assistant Professor, Kettering University, 5336 Timberwood Point Drive, Flint, MI, 48532, United States, fghazinezami@kettering.edu

1 - Integrated Generated Expansion Planning By Considering Wind Intermittency

Ahmet Akgun, Wichita State University, 3540 N Inwood Street, Apt # 11305, Wichita, KS, 67226, United States, ahmetie@yahoo.com

A multiperiod mathematical programming model for integration of electricity generation and transmission expansion planning and natural gas network problem is proposed. The proposed model is formulated as a linear optimization problem and it optimizes the operation, transmission and investment costs for both systems at the same time. This paper aims to determine what kind of generation units to be built, where to build those generation units, and when to build. The mathematical model also includes the decision for new transmission line for both natural gas and electricity. The proposed model is tested on a real scale network to analyze the impact of the natural gas cost on the new investment decisions.

2 - Energy-dependent Scheduling Of Non-identical Parallel Machines

Farnaz Ghazi Nezami, Assistant Professor, Kettering University, 5336 Timberwood Point Drive, Flint, MI, 48532, United States, fghazinezami@kettering.edu, Mojtaba Heydar

In this study, we analyze the problem of job scheduling in non-identical parallel machine production system with machine dependent processing durations to minimize total completion time and energy costs. The energy costs in this study include energy demand and consumption charges. We present a mixed integer linear programming model to formulate the problem. The model is solved for optimality using an exact approach and the performance is evaluated through numerical experiments.

■ TB59

Cumberland 1- Omni

Innovations in Transporation Network Pricing

Sponsored: Transportation Science & Logistics

Sponsored Session

Chair: Roger Lloret-Batlle, University of California, CA, United States, rlloretb@uci.edu

1 - A Vulnerable Options-based Reservation Scheme For Highway Facilities Subject To Degradation: Reservation Options On Truck-only Lanes

Choungryeol Lee, Perdue University, West Lafayette, IN, United States, lee1210@purdue.edu, Srinivas Peeta

A vulnerable options-based reservation scheme is proposed for truck-only lanes. The model incorporates risks for assuring a threshold traffic condition by estimating the expected potential loss. A case study of reservation options on truck-only lanes is used to estimate the loss and price reservations from the risk-neutral perspective of rational users.

2 - Efficient Envy-free Pricing In Transportation Systems

Roger Lloret-Batlle, University of California, CA, United States, rlloretb@uci.edu, R Jayakrishnan

We explore the envy-free pricing concept in multiple transportation contexts: (1) in min-cost flow networks such as in P2P ride-sharing problems, where its implementability as an ascending auction is examined, (2) in dynamic queue-jumping highway operations, and (3) in traffic signal control, for fair compensating payments in priced exchanges

3 - Dynamic Pricing And Reservation For Intelligent Urban Parking Management

Chao Lei, University of Illinois at Urbana - Champaign, 2063 S. Orchard St. Apt A, Urbana, IL, 61801, United States, lei8785@gmail.com, Yanfeng Ouyang

We study a real-time parking pricing and online reservation problem for the intelligent parking system in busy urban neighborhoods. A dynamic non-cooperative bi-level model and a non-myopic ADP solution approach are developed to enable the agency to decide the spatial and temporal parking price while considering the drivers’ competition for limited parking spaces at equilibrium parking prices. The numerical results reveal that the ADP-based pricing policy outperforms the myopic one in achieving greater performance of the parking system.

■ TB60

Cumberland 2- Omni

Moving People and Goods More Efficiently in Traffic Networks: Models and Algorithms

Sponsored: TSL, Urban Transportation

Sponsored Session

Chair: Trilce Marie Encarnacion, Rensselaer Polytechnic Institute, Rensselaer Polytechnic Institute, Troy, NY, 00000, United States, encart@rpi.edu

1 - Design Of Multi-period Tradable Credit Scheme For Vehicular Emission Reduction

Mohammad Miralinaghi, Purdue University, smiralin@purdue.edu, Srinivas Peeta

Credit-based congestion pricing is a strategy to manage traffic congestion and emissions by creating artificial markets for mobility credits. We design a multi-period tradable credit scheme to reduce vehicular emissions in a traffic network by factoring interest rates over a long-term planning horizon. It is formulated as a bi-level model where the credit allocation and link charging schemes are determined at the upper level and the lower level describes credit usage and the travel decision-making process of travelers

2 - Fast Computation Techniques For The Stochastic On-time Arrival Problem

Samitha Samaranayake, Cornell University, samitha@cornell.edu

We present a new technique for solving the path-based stochastic on-time arrival (SOTA) problem. Our approach uses the solution to the policy-based SOTA problem - which is of pseudo-polynomial-time complexity in the time budget of the journey - as an efficient search heuristic for the optimal path. We also demonstrate how path preprocessing techniques can be used for further speedups. To the best of our knowledge, these techniques provide the most efficient computation strategy for the path-based SOTA problem for general probability distributions, both with and without preprocessing.

3 - Urban Freight Microsimulation: Evaluating Freight Parking Behavior In New York City

Trilce Marie Encarnacion, Rensselaer Polytechnic Institute, encart@rpi.edu, Jose Holguin-Veras, Johanna Amaya

As urban centers continue having increased demand for consumer goods and services, the amount of freight trafficc and the associated negative externalities increase. Previous studies have shown that carriers have to either cruise until they find a parking space or illegally park in order to make their deliveries. Using data collected from in-depth interviews of carriers as well as current traffic conditions, a discrete simulation framework was developed to replicate the parking behavior of trucks making deliveries to a case study area in Midtown Manhattan. The goal is to provide insight into optimal freight parking policies to improve freight systems performance in dense urban areas.

4 - Dynamic Pricing In One-way Car Sharing Networks: A Distributional Fluid Approximation Approach

Ling Zhang, North Carolina State University, Raleigh, NC, United States, lzhang42@ncsu.edu, Yunan Liu, Yang Liu, Shuangchi He

Balancing supply and demand across different areas is a critical issue in one-way car sharing networks. We study dynamic pricing in order to maximize the profit of a car sharing network. Since the stochastic network model is analytically intractable, we propose a fluid approximation to represent the supply and demand of vehicles. In contrast to conventional transportation fluid models that assume deterministic processing times, general rental time distributions are built into our fluid model. Moreover, our model allows for time-varying demand rates and rental time distributions. Under this formulation, dynamic pricing is reduced to a convex optimization problem that is efficiently solvable.

■ TB61

Cumberland 3- Omni

Online Delivery Routing

Sponsored: TSL, Freight Transportation & Logistics

Sponsored Session

Chair: Jan Fabian Ehmke, Freie Universität Berlin, Garystr. 21, Berlin, 14195, Germany, janfabian.ehmke@fu-berlin.de

1 - Taking Advantage Of In-store Customers To Deliver Online Orders

Iman Dayarian, Georgia Institute of Technology, 765 Ferst Dr NW, Atlanta, GA, 30318, United States, iman.dayarian@isye.gatech.edu, Martin W P Savelsbergh

Same-day delivery of online orders is becoming an indispensable service for large retailers. We explore a novel environment in which in-store customers may take over the task of delivering online orders on their way back home. Additionally, a fleet of company-employed drivers is available to cover any unserved online orders. This context represents a highly dynamic and stochastic environment for which we explore and compare two rolling horizon approaches: one that ignores any information about future arrivals of online orders and in-store customers, and one that incorporates such information by means of sampled scenarios. Our results demonstrate the superiority of scenario-based planning.

2 - An Online Cost Allocation Model For Horizontal Supply Chains

Han Zou, University of Southern California, Los Angeles, CA, United States, hanzou@usc.edu, Maged M Dessouky, John Gunnar Carlsson

This research addresses the cost allocation problem in a real-time cost sharing transportation system, which results from horizontal cooperation among multiple suppliers. We formulate the cost allocation problem for the dynamic vehicle routing environment, where only part of the customers are known in advance, and the rest become known in real time. We propose an online cost-sharing mechanism coupled with a look-ahead dynamic vehicle routing framework that explicitly forecasts future customer requests.

3 - A Branch-and-price Approach For The Vehicle Routing Problem With Roaming Delivery Locations

Gizem Ozbaygin, Bilkent University, Ankara, Turkey, ozbaygin@bilkent.edu.tr, Martin W P Savelsbergh, Hande Yaman, Oya Ekin Karasan

We study the vehicle routing problem with roaming delivery locations in which each customer is associated with multiple locations and time windows. Exactly one location per customer should be included in the delivery plan respecting the time windows. We devise a branch-and-price algorithm to solve the problem and perform a computational analysis.

4 - E-fulfillment For Attended Last-mile Delivery Services In Metropolitan Areas

Jan Fabian Ehmke, Freie Universität Berlin, Garystr. 21, Berlin, 14195, Germany, janfabian.ehmke@fu-berlin.de, Catherine Cleophas, Charlotte Köhler, Magdalena Lang

We consider service time windows as a scarce resource and combine concepts of revenue management and vehicle routing to improve e-fulfillment of last-mile delivery services. As the customer has to be present for attended deliveries such as groceries, a service time window has to be agreed upon already when the order is accepted. We will focus on the factors impacting the success for e-fulfillment in metropolitan areas, considering uncertain demand and traffic conditions. To this end, we analyse historical order data and extend time-dependent vehicle routing techniques.

■ TB62

Cumberland 4- Omni

Data Mining and Optimization for Improved Airport Operations

Sponsored: Aviation Applications

Sponsored Session

Chair: Heng Chen, University of Nebraska–Lincoln, Supply Chain Management and Analytics, Lincoln, NE, 68588, United States, heng@unl.edu

1 - Airport Capacity Estimation For Decision Support

Sreeta Gorripaty, University of California Berkeley, gorripaty@berkeley.edu, Mark M Hansen

Capacity is a critical component of airport performance and air traffic decision-making. Capacity of an airport is the throughput observed at sufficiently high demand and is thus demand censored. The demand that is observed at the airport is a result of strategic and tactical decisions made to avoid buildups of unmet demand, thus making it challenging to estimate the capacity of an airport. We demonstrate that Random Survival Forest (RSF) model can be used to capture the censored nature of capacity data and model hourly capacity. The RSF capacity model is further used in decision support algorithms to represent airport capacity.

2 - Parameter Fixing Method For Improving The Rate Of Convergence Of A Hybrid Particle Swarm Optimization

Giuseppe Sirigu, Georgia Institute of Technology, giuseppe.sirigu@aerospace.gatech.edu

A new solution is proposed to perform just in time taxi operations using autonomous electric towbarless tractors, thereby to minimize the overall cost and the environmental impact of the ground operations. An algorithm for a tool that provides conflict-free schedules for the tractor autopilots was developed, which is based on a hybrid particle swarm optimization (HPSO), hybridized with a hill climbing meta-heuristic. In order to improve the rate of convergence of the algorithm, we developed a parameter fixing method.

3 - Machine Learning Techniques For Airport Passenger Flow Management

Xiaojia Guo, University College London, London, United Kingdom, x.guo.11@ucl.ac.uk, Yael S Grushka-Cockayne, Casey Lichtendahl, Frederick Tasker, Neville Coss, Tom Garside, Bert De Reyck

Passengers missing their connection at an airport can have a major impact on passenger satisfaction and airline delays. We develop a predictive model of passengers' connecting time using machine learning techniques, and provide both point forecasts and probabilistic forecasts using historical and real-time data. Based on these forecasts, we are developing a dynamic planning tool for London's Heathrow Airport to support airport operations.

■ TB63

Cumberland 5- Omni

Deterministic Network Design

Sponsored: TSL, Freight Transportation & Logistics

Sponsored Session

Chair: Mike Hewitt, Loyola University Chicago, NA, Chicago, IL, 60611, United States, mhewitt3@luc.edu

1 - Barge Scheduled Service Network Design With Resource And Revenue Management

Teodor Gabriel Crainic, Universite du Quebec a Montreal, TeodorGabriel.Crainic@cirrelt.net, Ioana Bilegan, Yunfei Wang

We study the incorporation of revenue management (RM) considerations, usually tackled at the operational-planning level, into tactical planning models for consolidation-based freight transportation carriers, and the impact of this integration on the selection of customer to service and on the structure of the service network, e.g., should the carrier increase the offer of service through more departures or larger vessels in order to later be able to capture spot demand? We present a service network design model with resource and RM considerations, a meta-heuristic, and the experimental results and insights obtained in the context of intermodal barge transportation.

2 - The Value Of Flexibility In Long-haul Transportation Network Design

Mike Hewitt, Loyola University Chicago, mhewitt3@luc.edu, Natashia Boland, Martin W P Savelsbergh

Freight transportation carriers are facing increased demands from customers for shorter service standards. At the same time, some cusotmers are flexible in terms of when they want their shipments delivered, and will accept longer delivery times if given a discount. In this talk we present a model that will not only design a long-haul transportation network, but will do so while also determining which customers to offer a discount to in order to have more time for delivery. We present a solution approach for the model and the results of an extensive computational study.

3 - Decomposition Methods For Multi-period Network Design Problems

Ioannis Fragkos, Rotterdam School of Management, fragkos@rsm.nl, Jean-Francois Cordeau, Raf Jans

We devise decomposition methods to solve large-scale instances of multi-period network expansion problems. For capacitated networks, we devise a custom heuristic procedure combined with arc-based Lagrange relaxation. For uncapacitated networks, we employ Bender's decomposition, where the subproblems are decomposable per period and per commodity. We formulate the problem of generating Pareto Optimal cuts, and based on structural properties of optimal solutions we devise a heuristic approach to solve it, thereby improving the original Benders cuts. Computational results demonstrate the efficiency of this approach.

4 - New Lagrangian Relaxation For Multicommodity Capacitated Network Design

Mohammad Rahim Akhavan, Universite de Montreal (DIRO), Monrteal, QC, Canada, Akhavanm@iro.umontreal.ca, Teodor Gabriel Crainic, Bernard Gendron

The usual Lagrangian relaxations for multicommodity capacitated network design are the so-called shortest path and knapsack relaxations, which are obtained, respectively, by relaxing linking constraints and flow conservation equations. We present a new reformulation and Lagrangian relaxation for the problem. We show that the Lagrangian dual bound improves upon the so-called strong LP bound (known to be equal to the Lagrangian dual bounds of the shortest path and knapsack relaxations).

■ TB64

Cumberland 6- Omni

Multi-objective Optimization: Algorithms and Applications

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Lakmali Weerasena, University of Tennessee, College Dr, Chattanooga, TN, 31705, United States, lweeras@g.clemson.edu

1 - New Multicriteria Models For Robust Data Classification In Supervised Learning

Alexander Engau, University of Colorado Denver, alexander.engau@ucdenver.edu

Data classification is a key task for predictive analytics, data mining and supervised machine or statistical learning. In extension of its current state-of-the-art optimization approaches this presentation highlights several new multicriteria mixed-integer goal programming models that can further improve their performance for classification and prediction by combining a variety of different objectives including solution accuracy as well as total and minimum or maximum internal or external deviation. Computational experiments on financial and medical data sets are reported and demonstrate promising results with highly improved robustness and better classification accuracy overall.

2 - Utility Indifference Pricing Under Incomplete Preferences Via Vector Optimization

Firdevs Ulus, Bilkent University, firdevs@bilkent.edu.tr

Under some assumptions on an incomplete preference relation, utility maximization problem is a convex vector optimization problem. Accordingly, the utility buy and sell prices are defined as set valued functions of the claim. It has been shown that the buy and the sell prices recover the complete preference case where the utility function is univariate. Moreover, buy and sell prices satisfy some monotonicity and convexity properties as expected. It is possible to compute these set valued prices by solving convex vector optimization problems.

3 - Local Branching Algorithm For Approximating The Pareto Set Of The Multiobjective Set Covering Problem

Lakmali Weerasena, University of Tennessee at Chattanooga, Chattanooga, TN, United States, lweeras@g.clemson.edu

The multiobjective set covering problem (MOSCP), a challenging combinatorial optimization problem, has received limited attention in the literature. We present an algorithm to approximate the Pareto set of the MOSCP. The proposed algorithm applies a local branching approach on a tree structure and is enhanced with a node exploration strategy specially developed for the MOSCP. The key idea is to partition the search region into subregions based on the neighbors of a reference solution. Numerical experiments confirmed that the proposed algorithm performs well on the MOSCP. Results on a performance comparison with benchmark algorithms from the literature show that the new algorithm is competitive.

4 - Interactive Weight Region-based Approach For Multiobjective Optimization Problems

Mehmet Basdere, Northwestern University, Evanston, IL, United States, mehmetbasdere2016@u.northwestern.edu, Sanjay Mehrotra, Karen Smilowitz

We introduce an interactive weight region-based approach that can iteratively find the most preferred solution of a decision maker (DM) after exploring a small fraction of all nondominated solutions. To obtain preference information, the DM is given a series of questions to compare and these comparisons define constraints restricting the weight region. New solutions are obtained by using diverse weight vectors generated from the remaining weight region via a mixed integer programming formulation. We develop two finitely converging algorithms for multi-objective linear and integer programs respectively. The results show that the algorithms terminate after a reasonable number of iterations.

■ TB65

Mockingbird 1- Omni

Digital Business Models and Strategies in the Era of Analytics

Sponsored: Information Systems

Sponsored Session

Chair: Ling Xue, Georgia State University, Georgia State University, Atlanta, GA, 30302, United States, lxue5@gsu.edu

1 - Relationships Between Online Daily Deal Promotions And Local Retailers' Online Reputation

Gang Wang, University of Delaware, gangw@udel.edu

Online daily deal sites such as Groupon have recently provided an innovative marketing tool for local retailers. On the one hand, a local retailer's online reputation is an important fact that may impact its decision whether to run a promotion. On the other hand, an online daily deal promotion may also impact the local retailer's online reputation. In this study, we study the causal relationships between a local retailer's promotion decision and its online reputation using data collected from Groupon and Yelp. Our current results enhance understanding of local retailers' Groupon promotion decisions and yield important implications related to daily deal sites.

2 - Free Riders Versus Social Capital: An Empirical Analysis Of An Exogenous Shock On Online Reviews

Zaiyan Wei, Purdue University, West Lafayette, IN, United States, zaiyan@purdue.edu, Paulo B Goes, Yang Wang, Dajun Daniel Zeng

We study the effects of network sizes on individuals' contributions to online product reviews. Individuals have conflicting incentives of free riding and maximizing social benefits when producing online reviews. We leverage a "natural experiment," an exogenous expansion in the users population on a major third-party platform, to better understand the tradeoffs between the conflicting incentives. We find that a larger population of users caused individuals to post more and longer reviews. In addition, the larger population of audience led individuals to assign higher and more diverse ratings in their reviews. However, the helpfulness or "quality" of reviews is not affected.

3 - Enterprise Systems And Merger And Acquisition Activities

Chengxin Cao, University of Minnesota, 321 Nineteenth Avenue South, Minneapolis, MN, United States, caoxx161@umn.edu, Gautam Ray, Alok Gupta, Mani Subramani

This paper examines the relationship between Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) systems and upstream and downstream mergers and acquisitions (M&A). We also investigate how any such relationship is contingent on the characteristics of the focal firms' industry environment. Using a sample of 491 Fortune 1000 firms that made 4543 M&A deals from 2006 to 2012 the empirical analysis suggests that ERP (CRM) systems are negatively associated with upstream (downstream) M&A. However, if the upstream (downstream) industry is concentrated (dynamic), ERP (CRM) systems are associated with more vertical M&A.

4 - The Influences And Biases Of Social Network In Referral Hiring: Empirical Study

Kyungsun Rhee, University of Washington, 4725 24th Avenue NE, # 405, Seattle, WA, 98105, United States, ksr22@uw.edu, Elina Hwang, Param Vir Singh

It is well known that importance of social networks in labor market has been growing rapidly. However, there have been rigorous researches on characteristics of job seekers who are likely to achieve better results in job market, but not many on the referrer behavior. Using data from social referral platform, this paper constructs an empirical model to capture the influences and biases of referrers' social capital on their actual referring behavior in the IT labor market.

■ TB66

Mockingbird 2- Omni

Data Analytics for Quality and Reliability Assurance

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Mingyang Li, Tampa, FL, United States, mingyangli@usf.edu

1 - A Data-driven Heterogeneity Quantification Approach For Chloride Ingress Profiles Of Aging Marine Infrastructures

Suiyao Chen, University of South Florida, 4202 E. Fowler Avenue ENB302, Tampa, FL, 33620, United States, suiyaochen@mail.usf.edu, Lu Lu, Yisha Xiang, Alberto A Sagüés, Mingyang Li

Chloride ingress is the leading cause to corrosion failures of aging infrastructures in marine environments. Existing studies on chloride ingress mainly assumed homogeneous populations and were constrained by the simplified physical assumptions and availability of chloride ingress profiles. In this work, a data-driven approach is presented to comprehensively explore, quantify and analyze the heterogeneous chloride ingress profiles collected from a field survey on marine infrastructures. A real-world case study is provided to illustrate the proposed work and demonstrates its validity and performance.

2 - Reliability Meets Big Data: Opportunities And Challenges

Yili Hong, Virginia Tech, yilihong@vt.edu

In this talk, I will review some applications where field reliability data are used and explore some of the opportunities to use modern reliability data to provide stronger statistical methods to operate and predict the performance of systems in the field. I will also provide some examples of recent technical developments designed to be used in such applications and outline remaining challenges.

3 - Heterogeneous Recurrence Representation And Quantification Of Dynamic Transitions In Continuous Nonlinear Processes

Hui Yang, Penn State, huy25@engr.psu.edu

Many real-world systems are evolving over time and exhibit dynamical behaviors. In order to cope with system complexity, sensing devices are commonly deployed to monitor system dynamics. Online sensing brings the proliferation of big data that are nonlinear and nonstationary. Although there is rich information on nonlinear dynamics, significant challenges remain in realizing the full potential of sensing data for system control. This paper presents a new approach of heterogeneous recurrence analysis for online monitoring and anomaly detection in nonlinear dynamic processes.

4 - Latent Dirichlet Allocation (lda) Based Analytic Framework For Topic Modeling Of Cfpb Consumer Complaints

Kaveh Bastani, Recovery Decision Science, Cincinnati, OH, United States, kaveh@vt.edu, Hamed Namavari, Jeffrey Shaffer

We propose a text mining analytic framework based on latent Dirichlet allocation (LDA) to analyze Consumer Financial Protection Bureau (CFPB) consumer complaints. The proposed analytic framework aims to extract latent topics/clusters in CFPB complaint narratives, and explores their associated trends over time. The time trends will then be used to evaluate the quality of industry regulations and expectations on financial institutions in creating a consumer oriented culture that takes into account consumer protection in their decision making processes.

■ TB67

Mockingbird 3- Omni

IIE Transactions Invited Session

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Jianjun Shi, Georgia Institute of Technology, Atlanta, GA, United States, jianjun.shi@isye.gatech.edu

1 - A Random Effect Autologistic Regression Model With Application To The Characterization Of Multiple Microstructure Samples

Qingyu Yang, Wayne State University, qyang@wayne.edu

The microstructure of the material can strongly affect material properties which in turn plays an important role of the product quality produced by these materials. The existingstudies on material microstructure mainly focus on a single microstructure sample's characteristics, while the variation among different microstructure samples is ignored. In this paper, we propose a novel random effect autologistic regression model to characterize the microstructure variation of different samples for the two phase materials. A simulation study is conducted to verify the proposed methodology. A real world example of a dual-phase high strength steel is used to illustrate the developed methods.

2 - A Bayesian Variable Selection Method For Joint Diagnosis Of Manufacturing Process And Sensor Faults

Yong Chen, University of Iowa, Iowa City, IA, 52242, United States, yong-chen@uiowa.edu

This paper presents a Bayesian variable selection based diagnosis approach to identify both process mean shift faults and sensor mean shift faults simultaneously in manufacturing processes. Important concepts are introduced to understand the diagnosability of the proposed method. A conditional maximum likelihood method is proposed as an alternative method to provide robustness to selection of some key model parameters. Systematic simulation studies are used to provide insights on the relation between the success of the diagnosis method and related system structure characteristics. And a real assembly example is used to demonstrate the effectiveness of the proposed diagnosis method.

3 - A Preposterior Analysis To Predict Identifiability In The Experimental Calibration Of Computer Models

Daniel Apley, Northwestern University, apley@northwestern.edu

When calibrating computer simulation models using physical experimental data, it is usually very difficult to identify unknown physical parameters and distinguish their effects from the discrepancy function that represents the difference between the simulation model and reality. We develop a preposterior analysis to predict (prior to conducting physical experiments but after conducting simulations) the identifiability that will result for any candidate physical experimental design. This can be used as a criterion for designing physical experiments to achieve better identifiability of the physical calibration parameters.

■ TB68

Mockingbird 4- Omni

Tutorial: Wind Energy Applications

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Yu Ding, Mike and Sugar Barnes Professo, Texas A&M University, MS 3131, ETB 4016, College Station, TX, 77843, United States, yuding@tamu.edu

Co-Chair: Eunshin Byon, University of Michigan, 1205 Beal Avenue, College Station, MI, 48109, United States, ebyon@umich.edu

1 - Tutorial For Wind Energy Data Analytics

Yu Ding, Texas A&M University, College Station, TX, 77843, United States, yuding@tamu.edu, Eunshin Byon

This tutorial session discusses data analytics issues relevant to wind energy applications. It entails three parts:): (1) general background of wind energy and data availability; (2) power curve modeling and turbine performance evaluation; and (3) importance sampling and turbine reliability evaluation. The two session chairs will be the co-presenters in this tutorial session.

■ TB69

Old Hickory- Omni

Decision Support Systems I

Contributed Session

Chair: Manini Madireddy, Senior Operations Research, Sabre, 3150 Sabre Dr, Southlake, TX, 76092, United States, Manini.Madireddy@sabre.com

1 - Considering Passenger Recovery In Airline Operations Recovery

Jia Kang, Senior Operations Research, Sabre Airline Solutions, 3150 Sabre Drive, Southlake, TX, 76092, United States, jia.kang@sabre.com, Dinakar Gade, Sureshan Karichery

The Sabre AirCentre Recovery Manager (Ops) helps airlines quickly recover both the schedule and aircraft rotations from various disruptions (curfews, weather, unplanned maintenances, etc.) by taking into account operational restrictions and several conflicting tradeoffs. In this presentation we introduce a new feature of Recovery Manager called the Passenger Flow Module (PFM) that incorporates passenger re-accommodation decisions during schedule recovery. The generated solutions significantly reduce the impact to passenger flows in airline network as well as overall passenger inconvenience.

2 - Fuzzy Association Rule Mining Framework For Product Selection In E-Commerce

Shekhar Shukla, Doctoral Candidate, Indian Institute of Management Lucknow, FPM H-2 Room No. 41, IIM Campus Prabandh Nagar Off Sitapur Road, Lucknow, 226013, India, shekhar.shukla@iiml.ac.in, Ashwani Kumar

We present a robust and a unique framework of product selection that incorporates social influence factors and provides a numerical strength of suitability of each available product based on a customer’s set of requirements. The Framework generates Fuzzy Association Rules based on product attributes incorporated with customer reviews as objective weights to these attributes (using Shannon’s Entropy) and market popularity parameters as rule implications. These rules are used as a descriptive model for each product to perform an Association Based Classification.

3 - A Modeling Framework For The Strategic Design Of Local Fresh Food Systems

Hector Flores, PhD Candidate, Arizona State University, 513 W. 17th Street, Tempe, AZ, 85281, United States, hector.flores@asu.edu, Rene Villalobos

In this work we demonstrate that certain geographical regions might have the potential to produce high-value fresh fruits and vegetables that can be both profitable for current farmers and can incentivize new entrants into local food systems. Specifically, we develop an optimization-based framework that uncovers hidden production capabilities within a region by (1) identifying needed technologies and resources, (2) considering complementary environmental characteristics and market price behavior, and (3) addressing logistic and supply chain planning decisions. It also sets the framework for incorporating parameter randomness. This work addresses research related to local food systems.

4 - Product Bundling For Airline Customers

Manini Madireddy, Senior Operations Research, Sabre, 3150 Sabre Dr, Southlake, TX, 76092, United States, Manini.Madireddy@sabre.com, Goda Doreswamy, Meisam Hejazi Nia, Ramasubramanian Sundararajan

We consider the problem of product bundling (seats and ancillaries) in the context of offering the right products to the right customer at the right price and time, in such a way as to satisfy customer needs and maximize airline revenue. This problem falls in the realm of airline revenue management and retail e-commerce. We present a solution approach to construct, optimize and personalize offers to customers. We demonstrate the utility of our approach through illustrative results on real and simulated data.

■ TB70

Acoustic- Omni

Transportation, Planning I

Contributed Session

Chair: Liang Wang, Phd Candidate, Harbin Institute of Technology, Harbin, China, 14b910008@hit.edu.cn

1 - A Segmented Logistic Regression Model To Construct A Valid Set Of Itineraries From A List Of Weekly Flight Legs

Anand Seshadri, Principal, Operations Research, SABRE Airline Solutions, 3rd Floor, Navigator Building, International Tech Park, Bangalore, 560045, India, ug97044@yahoo.com, Gautam Pradhan

In this paper, we present a robust approach to rank and remove invalid itineraries and retain a set of good itineraries. Traditionally, this has been accomplished by a heuristic model. The main disadvantage of a heuristic model is that the rules are based on the past behavior of the system and is not dynamic enough to account for changes in airline service variables (alliances, flight departure times etc.). A heuristic model also does not allow the modeler to eliminate itineraries during the building stage leading to inefficient memory utilization. We calibrate the logistic regression model based on a week of historical and schedule data for a major US carrier and compare the results to a rule based model.

2 - Location Of Stations In A One-way Electric Car Sharing System

Hatice Çalık, Université Libre de Bruxelles, Université Libre de Bruxelles, Boulevard du Thriomphe, Brussels, 1050, Belgium, hatice.calik@ulb.ac.be, Bernard Fortz

We focus on an electric car sharing system where we have a set of customers, each of which wishes to travel from a point of origin to a point of destination at a certain time of the day. The customers can pick up a car from a station close to their point of origin and leave it to a station close to their destination. The location of the stations, the customers to be served, and the stations they will visit need to be decided in a way that maximizes the profit. We provide exact and heuristic methods to solve the problem and conduct computational experiments on newly generated problem instances.

3 - Spatial-temporal Crash Severity Modeling For Aging-involved Crashes: A Case Of Interstate 95 In Florida

Aschkan Omidvar, University of Florida, Gainesville, FL, 32611, United States, aschkan@ufl.edu, Arda Vanli, Eren Erman Ozguven

This research aims to develop a binary logistic regression model to discover the significant factors affecting the severe crash occurrences for aging drivers. Crash data from two major metropolitan areas, Miami and Jacksonville, for three consecutive years (2010-2012) are extracted, processed and analyzed using Geographical Information Systems (GIS). These data sets are used to determine factors influencing the severity of crashes and compare them with those for other age groups. Next, we investigate the spatial and temporal variation of the effect of the influential variables, on severity of aging-involved crashes by applying variable selection on the fitted logistic regression models.

■ TB71

Electric- Omni

Vehicle Routing III

Contributed Session

Chair: Mohamed Mahmoud Saleh Abdulkader, PhD Candidate, University of Manitoba, 708-1833 Pembina Highway, Winnipeg, MB, R3T 3X8, Canada, abdulka3@myumanitoba.ca

1 - Multi-depot Two Echelon Pollution Minimizing Routing Problem With Heterogeneous Vehicles

Surendra reddy Kancharla, PhD Student, Indian Institute of Technology Madras, Chennai, India, surendrareddy.kancharla@gmail.com, Gitakrishnan Ramadurai

A new variant of VRP to find the heterogeneous fleet mix and routes at two levels by jointly minimizing the operational and pollution cost is proposed. Fuel consumption and the pollutants emitted are a function of load, speed, and acceleration characteristics. A mixed-integer program is formulated and an effective metaheuristic solution algorithm is presented.

2 - Heuristics For Online Orders Delivery Optimization

Mohamed Mahmoud Saleh Abdulkader, PhD Candidate, University of Manitoba, 708-1833 Pembina Highway, Winnipeg, MB, R3T 3X8, Canada, abdulka3@myumanitoba.ca, Yuvraj Gajpal, Tarek ElMekkawy

E-commerce became a global trend and its volume has been expanded remarkably. Consumers can order products to be delivered at their homes. These online ordered products are supplied from the retail stores available inventories. The retail stores require products from central warehouse as well. In this paper we consider the vehicle routing problem for the delivery of products ordered online and the delivery of products from central warehouse to retailers. We provide mathematical description and heuristics to solve the problem. Numerical experiment is performed on randomly generated problem instances to evaluate the heuristics performance.

■ TB72

Bass- Omni

Supply Chain Mgt X

Contributed Session

Chair: Prateek Raj, PhD Student, University College London, Gower Street, UCL School of Management, London, WC1E 6BT, United Kingdom, p.raj.12@ucl.ac.uk

1 - Financing Schemes For Upstream Suppliers

Weixiang HUANG, City University of Hong Kong, Kowloon Tong, Kowloon, Hong Kong, China, wxhuang4-c@my.cityu.edu.hk, Yanzhi LI, Qiaohai HU

We consider four financing schemes for a supplier with limited capital: bank loans, purchase order financing (POF), retailer loans and advance payments. We model players' interaction as Stackelberg games. We show that: (1) The bank loan helps the supplier to overcome the capital constraint and produce its desired quantity. (2) While the production quantity in retailer loans or advance payments can be either lower or higher, the one under POF is always higher than the supplier's desired quantity. (3) No scheme is dominating in terms of players' own and chain's sake. (4) Different from retailer loans and advance payments, POF allows each player to obtain profits larger than that under bank loans.

2 - Optimizing Joint Replenishment Problem For Non-instantaneous Deteriorating Items With Multiple Suppliers Offering Quantity Discounts

Xueyi Ai, Huazhong University of Science and Technology, Luoyu Road, NO. 1037, Wuhan, China, Wuhan, 430074, China, aixueyi1030@gmail.com, Jinlong Zhang

This paper deals with a new joint replenishment problem, in which a number of non-instantaneous deteriorating items are replenished from several suppliers under different quantity discounts schemes. We develop a model integrated with a supplier selection system and the joint replenishment programmes for non-instantaneous deteriorating items. An improved moth-flame optimization (IMFO) algorithm is proposed to solve this NP-hard problem so that the total cost is minimized. Numerical examples are shown to illustrate the performance of IMFO algorithm. Extensive experiments are performed to further investigate the effectiveness of the proposed algorithm.

3 - Management Of Supply Chains With Perishable Assets

Maxim A. Dulebenets, Assistant Professor, Florida State University, Tallahassee, FL, United States, mdlbnets@memphis.edu, Mihalis Golias, Mehdi Amini

Nowadays many of supply chains deal with design, production, distribution, and retailing of perishable assets. Perishable assets may deteriorate due to certain external factors, such as time, temperature, humidity, pressure, power, air composition, etc. This presentation will focus on the key features of supply chains with perishable assets, attributes of perishable assets, sustainability of supply chains with perishable assets, best practices revealed in the relevant scientific literature and applied in the industry, and outline some critical issues and potential directions for the future research.

4 - Designing Power Supply Chains- Understanding India's Electrification Underachievement And Disparity

Prateek Raj, PhD Student, University College London, Gower Street, UCL School of Management, London, WC1E 6BT, United Kingdom, p.raj.12@ucl.ac.uk, Achal Bassamboo

Power supply has a complex supply chain. It involves coordination between several players for both everyday operations and for long term planning. We consider different ways of organizing decision making in power supply chains, and study the varying outcomes in capacity and efficiency of power supply. Using this framework, we study why India has lagged behind in rural electrification compared to other large countries. We also explore why there is high heterogeneity in rural electrification within India.

■ TB73

Legends A- Omni

Operations Management II

Contributed Session

1 - Queue Joining Decisions When There Is A Prerequisite Condition For Getting Service

Mona Imanpoor Yourdshahy, PhD Student, University of British Columbia, 2053 Main Mall, Vancouver, BC, V6T 1Z2, Canada, mona.imanpoor@sauder.ubc.ca, Woonghee Tim Huh, Steven Shechter

We consider an M/M/1 queueing system in which a customer requires some prerequisite condition to be met prior to receiving service. We investigate whether an individual arriving to this system should join the queue at that time, or wait to join at some future time. We formulate this problem as a Markov decision process and show how the structure of the optimal policy depends on in-queue and out-of-queue waiting costs, the arrival and service rates, as well as the time until the prerequisite condition is satisfied.

2 - Codified Knowledge Sharing And Operational Failure In Healthcare: Evidence From NHS Hospitals' Risk Management Documents

Bilal Gokpinar, University College London, London, United Kingdom, b.gokpinar@ucl.ac.uk, Mecit Can Emre Simsekler

Focusing on codified knowledge sharing among healthcare personnel in the form of written documents (e.g. risk management policies, procedures, strategies, etc.), we examined the role of the nature and content of codified knowledge on risk management performance. We used a unique dataset from NHS acute trusts in England and employed text-mining techniques to investigate the impact of documents on risk management.

3 - Study On The Scheduled Bus-bridging Service And Emergent Strategy Of Bus Fare Discount Under Operation Disruptions Of The Metro System

Li_bing Wan, Huazhong University of Science&Technology, Wuhan, China, wanlibingltt@163.com

The rail transit has many advantages, at the same time, it also often fails and operation disruptions . This thesis studies the bus-bridging evacuation service for complete passengers' travel and the emergent strategy of bus fare discount under operation disruptions of the rail transit. Firstly, we systematically summarize and analyze operation disruptions of three cities . Secondly,the conventional metro-bus evacuation equilibrium model is established . Thirdly, the thesis deeply researches the effect of bus fare discount to the original equilibrium and determines optimal bus fare discount strategies for two different targets.

4 - Multi-recipe & Multi-variety Blast Furnace Production Planning Under Carbon Cap & Trade Policy Based In An Improved Block Molding Method

Ye Yang, Southeast University, School of Economics and Management, Southeast, Nanjing, China, yangye1120@163.com, Wei-da Chen

Carbon emission reduction policies have become key elements affecting production operations in the enterprises. Considering an iron making plant which outputs various products by multiple recipes, it studies multi-period blast furnace production planning problem with two types of carbon constraints (periodic carbon constraint, cumulative carbon constraint) under Carbon Cap and Trade policy. Firstly, based on an improved block molding method, two kinds of multi-recipe and multi-variety iron blast furnace production planning MILP models are constructed. Secondly, Cplex software is used for numerical analysis, discussing the effects of carbon cap and carbon price on production planning.

■ TB74

Legends B- Omni

Optimization Methodology II

Contributed Session

1 - Global Optimum Of The Complementarity Constrained Program: Algorithm And Application

Yu-Ching Lee, Assistant Professor, National Tsing Hua University, No. 101, Section 2, Kuang-Fu Road,, Engineering Building I,, Hsinchu, Taiwan, yclee@ie.nthu.edu.tw, En-Cheng Chang Chang

The complementarity constrained program is found well applied in the area of inverse optimization, parameter selection, and hierarchical decision-making. The global optimality in these applications are important compared with other nonlinear programming problems. We discuss methodologies with some numerical experiments in this talk.

2 - Computational Study On Bilevel Mixed Integer Convex Programming Problems

Liang Xu, University of Pittsburgh, 3700 O'Hara Street, 1048 Benedum Hall, Pittsburgh, PA, 15261, United States, lix21@pitt.edu, Bo Zeng

In this talk, we present a solution algorithm for bilevel mixed integer nonlinear (BiMINLP) programming problems through reformulation and decomposition. For the mixed integer convex lower level problem, we show that strong duality and KKT conditions of the continuous portion can be incorporated to achieve fast computation. Our solution procedure is evaluated on instances from literature as well as randomly generated ones, and a superior computational performance is observed.

3 - Sales Persons Compensation Scheme Considering Customer Satisfaction And Multiple Distribution Channels

Chulok Ahn, PhD Candidate, Korea University Business School, Korea University Business School, Anam-ro, Seongbuk-gu, Seoul, 02841, Korea, Republic of, ahncokr@korea.ac.kr, Hosun Rhim, Kwangtae Park

We examine the compensation strategy of a firm's sales person in the multiple distribution channels with customer satisfaction considered. While customer's satisfaction level differs to the distribution channel, the firm tries to find an optimal compensation scheme for both direct and retail channel. The firm sells same product with constant price but the incentive schemes differ on the basic salary, sales commission, and customer satisfaction. The mathematical model provides the optimal compensation schemes for both channels and can be applied to a company using multiple distribution channels.

4 - Optimization Based Decision Tree Construction

Chaosheng Dong, University of Pittsburgh, 1025 Benedum Hall, 3700 O'Hara Street, Pittsburgh, PA, 15261, United States, chaosheng@pitt.edu, Bo Zeng

We construct Decision Tree with an optimization-based approach.

■ TB75

Legends C- Omni

Behavioral Operations II

Contributed Session

Chair: Arpit Goel, PhD Student, Stanford University, 475 Via Ortega, Huang Engineering Center, Stanford, CA, 94305, United States, argoel@stanford.edu

1 - The Behavioral Bayesian Newsvendor In Supply Chain

Ju Myung Song, Rutgers Business School, PhD Program, Washington Park, Room 430C, Newark, NJ, 07102, United States, jumyungsong@gmail.com, Xiaowei Xu

Behavioral Bayes' rule using weighted updating model has been adopted in the literature on behavioral economics. In this paper, we study a single-period newsvendor problem with the supply chain coordination structure, and show how this behavioral bias leads to forecasting bias and affects the coordination and profit distribution.

2 - Impact Of Operational Failures On Worker Productivity: Evidence From An Agribusiness Setting

Pradeep Pendem, PhD Candidate in OM, University of North Carolina, Chapel Hill, 300 Kenan Center Drive, Chapel Hill, NC, 27599, United States, pradeep_pendem@kenan-flagler.unc.edu, Bradley R Staats, Paul Green, Francesca Gino

Failures in operational processes are ubiquitous in actual environments and play an important role in worker performance. Utilizing real time with-in shift data of harvest workers, we examine the impact of one class of operational failures, Breaks and Disruptions on their productivity. We find that productivity follows an inverted U-shaped response to breaks and negative effect to disruptions. In addition, we show that these effects are exacerbated by workload. Our findings suggest the need to give more emphasis on understanding the type of failure before taking any corrective action. Our study has important implications on the design of operating systems, scheduling policies more generally.

3 - Role Of Partnerships And Point Expiry On Customer Behavior In Reward Programs

Arpit Goel, PhD Student, Stanford Univeristy, 475 Via Ortega, Huang Engineering Center, Stanford, CA, 94305, United States, argoel@stanford.edu, Ashish Goel, Vijay Kamble

Customer behavior in loyalty programs is often attributed to irrational decision making. We provide and analyze an alternate model under which this behavior has a rational explanation. The key characteristics of our model are influence of business partnerships which increase the exogenous visits by the customer leading to higher switching costs with the reward program store and frequent expiry of earned reward points which create an urgency to make more frequent visits. We show that neither of these modeling assumptions provides a rational explanation on its own, but both together justify many observed customer behavioral aspects.

■ TB76

Legends D- Omni

Resource Allocation

Contributed Session

Chair: Lei Bu, Institute for Multimodal Transportation, Jackson, MS, United States, leibu04168@gmail.com

1 - Selecting Corporate Structure For Diversified Firms

Arkadiy Sakhartov, Assistant Professor, The Wharton School, University of Pennsylvania, 2017 Steinberg Hall-Dietrich Hall, 3620 Locust Walk, Philadelphia, PA, 19104, United States, arkadiys@wharton.upenn.edu

The study explores implications of corporate structure for performance of diversified firms. The benchmark for the scrutiny is the set of extant conflicting predictions about the optimal choice of two features of corporate structure, centralization of resource allocation and incentives to unit managers. The study considers relatedness between a firm's businesses and uses the option valuation model to disentangle the existing conflicting predictions. The new results lay the groundwork for a better empirical identification of the effects of relatedness and corporate structure on corporate value, often tested in corporate diversification research.

2 - Modeling Allocation Of Project Resources In Multiproject Portfolio

Zinovy Radovilsky, Professor of Management, California State University, East Bay, 25800 Carlos Bee Blvd., Hayward, CA, 94506, United States, zinovy.radovilsky@csueastbay.edu, Vishwanath Hegde

We introduced a conceptual model of modeling resource allocations in a multi-project portfolio over its projects lifetime. Using practical resource data in a multi-project setting, we demonstrated that resource allocation patterns can be captured by parametric regression models before and after projects' due dates.This enables us to accurately forecast resource allocations during projects lifetime.

3 - Resource Allocation And Revenue Management For Age-based Products

Hossein Jahandideh, PhD Student, UCLA Anderson School of Management, 3777 Mentone Avenue, Apt 405, Los Angeles, CA, 90034-6473, United States, hs.jahan@gmail.com, Christopher S Tang, Kevin F McCardle, Behnam Fahimnia

The value of certain products such as whiskey increases with age. For such products, introducing a new age to the market means introducing a whole new product with demand uncertainty and substitution effects on existing products. Assuming that the firm is able to start the aging process of a set number of barrels every year, we study the question of what fraction of this capacity to allocate to the new age. The goal is to maximize the expected revenue extracted from a fixed yearly production capacity.

4 - Solving Resource Station Location-routing Problem In Emergency Evacuation Through A Resource-space-Time Network Representation

Lei Bu, Institute for Multimodal Transportation, Jackson, MS, United States, leibu04168@gmail.com, Zhibin Jiang, Feng Wang, Xing Fu, Chuanzhong Yin

Based on a representation of discretized resource-space-time networks, a formulation is proposed to optimize dynamic bus station location and routes decisions in an emergency evacuation of subway station. The proposed integer linear programming formulation could effectively build the modeling representation of time window, resource change and passenger travel distance constraints through a multi-dimensional network with an objective function to minimize the total travel cost. A Lagrangian relaxation approach is utilized to solve the problem. A case study of subway and bus station network in Lianhu District, Xi'an City in China verifies the effectiveness of the model and algorithm.

■ TB77

Legends E- Omni

Opt, Integer Programing II

Contributed Session

Chair: Lauren Gardner, Senior Lecturer, University of New South Wales, Kensington Campus, Building H20, Sydney, 2052, Australia, l.gardner@unsw.edu.au

1 - Application Of Linear Programming In Dimension Stone Industry

Gangaraju Vanteddu, Associate Professor, Southeast Missouri State University, Harrison College of Business, One University Plaza, MS 5815, Cape Girardeau, MO, 63701, United States, gvanteddu@semo.edu

A typical dimension stone business unit has to contend with many unique demand and availability related characteristics and constraints, which makes the application of Linear Programming techniques an ideal solution in a wide variety of contexts. In this research, a generic MILP model is proposed to maximize revenue in the presence of demand, operational and technical constraints.

3 - Portfolio Model For Natural Gas Combined Cycle Power Plant

Asiye Ozge Dengiz, Research Assistant, Baskent University, Baskent Univesity Industrial Engineering Bagl, Ankara, 06810, Turkey, aokarahanli@baskent.edu.tr, Mehmet Gulsen, Orhan Dengiz

Among different types of power generation facilities, natural gas power plants (NGPP) get considerable attention because of the advantages of being able to generate on demand and location flexibility. The producers, often operating several generators, need to make simultaneous planning for their entire plant portfolio to maximize their profit based on the information coming from the market of Turkey and equipment characteristics. For this purpose, in this study for the NGPP, a model is developed for producers to plan generation for a certain horizon considering operation costs and forecasted market data.

4 - A Generalized Framework For The Estimation Of Edge Infection Probabilities

Lauren Gardner, Senior Lecturer, University of New South Wales, Kensington Campus, Building H20, Sydney, 2052, Australia, l.gardner@unsw.edu.au, Andras Botas

Most network-based infection spreading and diffusion models require a real value or (transmission) probability on the edges of the network as an input, which is often unknown in real-life applications. This work presents a general framework to estimate the value of these probabilities on a network exposed to an infection process, where spatiotemporal information on the outbreak pattern is known. This general model works with a range of infection models, and is able to handle an arbitrary number of observations on such processes.

■ TB78

Legends F- Omni

Opt, Network II

Contributed Session

Chair: Parimal Kulkarni, Manager, Supply Chain Analytics, BJC Healthcare, 8300 Eager Rd, Suite 500 D Mailstop 92-92-277, St Louis, MO, 63144, United States, pskf44@umsl.edu

1 - Varying Routes For The Bus Driver's Sanity Problem

Paul Hadavas, Associate Professor, Armstrong State University, 11935 Abercorn Street, Savannah, GA, 31419, United States, Paul.Hadavas@armstrong.edu, Jeremy Dyal

The bus driver's sanity problem is a graph theoretic problem with variable weighted edges. A bus driver needs to minimize the total kid exposure based on kid-minutes. This amounts to summing each kid's time spent on the bus. The graph characteristics (time to the next stop, number of kids aboard) change once kids are dropped off at a particular stop. In this talk, we expand the possible routes the bus driver can take, including cul-de-sacs and tree-like structures with multiple stops located off the main road, and discuss solution techniques for optimal or near-optimal routes.

2 - A Lagrangian Heuristic For A Rapid Transit Line Design Problem

Souhaïla El Filali, University of Montreal, 3520-2920, Chemin de la Tour, Montreal, QC, H3T 1J4, Canada, souhaila.elfilali@cirrelt.ca, Bernard Gendron, Gilbert Laporte

We propose a tight formulation for the rapid transit line design problem, which consists of locating stations and segments between them to form a line, with the objective of maximizing O-D pairs coverage under topological and budget constraints. We develop a Lagrangian heuristic to solve the problem, and we test it on artificial and real-life instances.

3 - Search For An Immobile Target On An Undirected Unit Network

Songtao Li, Tsinghua University, 519A, Shunde Building, Tsinghua University, Haidian District, Beijing, 100084, China, list14@mails.tsinghua.edu.cn, Simin Huang

We consider the problem of searching an immobile target on an undirected network with unit length links. In this problem, multiple searchers traverse the network to find the target. When at least one searcher crosses the target point, the detection happens and the search process end. Our purpose is to optimally guide those searchers to the target (with known distribution) to minimize expected search duration. A binary integer programming model is built, and primary computation results is given. Based on the computation results, we discuss the influence of searcher number and targets distribution to the expected search duration.

4 - Supporting Campus Evacuation Decisions Via Network Optimization

Jorge Huertas, Graduate Student, Universidad de los Andes, Carrera 1 Este No. 19 A - 40, Bogotá, 111711, Colombia, ja.huertas1845@uniandes.edu.co, Daniel Duque, Ethel Segura, Raha Akhavan-Tabatabaei, Andres L Medaglia

In this work we evaluate different emergency scenarios to support an evacuation plan in a campus comprised of multiple buildings. With a time-space network and a Geographical Information System (GIS), we model a campus with 1.7 million square feet that holds up to 27,000 people in a critical moment. To find an evacuation plan, we formulate a MIP based on a minimum cost flow problem formulation with side constraints. To support campus managers, we visualize the solutions under various evacuation scenarios at different scales.

5 - Optimizing Procurement Of High-value Medical Products In A Health-care Network

Parimal Kulkarni, Manager, Supply Chain Analytics, BJC Healthcare, 8300 Eager Rd, Suite 500 D Mailstop 92-92-277, St Louis, MO, 63144, United States, pskf44@umsl.edu
Parimal Kulkarni, Manager, Supply Chain Analytics, University of Missouri, St.Louis, One University Blvd, St Louis, MO, 63121, United States, pskf44@umsl.edu, L. Douglas Smith, Glen Moser

We use MILP optimization and simulation in concert to develop procurement strategies for high-value medical supplies in a health-care network. With a multi-objective MILP model, we determine product groups to be purchased from alternative vendors to achieve quantity discounts while maintaining diversity of supply. Considered are physician preference, budgetary limits, and scorecards of vendor performance on several dimensions. Discrete-event simulation is used iteratively to test procurement solutions and help set the MILP constraints to keep risk at acceptable levels.

■ TB79

Legends G- Omni

Opt, Stochastic II

Contributed Session

Chair: Hernan Andres Caceres Venegas, Ph.D. Student, University at Buffalo - SUNY, 342 Bell Hall, University at Buffalo, Buffalo, NY, 14260, United States, hernanan@buffalo.edu

1 - Efficient Solving Of Multi-stage Mixed-integer Stochastic Problems Under Mean-dispersion Distributional Information

Krzysztof Postek, PhD Candidate, Tilburg University, Warandelaan 2, Tilburg, 5037 AB, Netherlands, k.postek@tilburguniversity.edu, Ward Romeijnders, Dick den Hertog, Maarten H van der Vlerk

We propose a solution method for multi-stage robust optimization and stochastic programming problems under distributional uncertainty, when the means and mean absolute deviations of the parameters are known. Using new theoretical results we show for problems with integer recourse how to construct good convex approximations with known performance bounds and how to solve these problems efficiently. Our approach gives insights into the performance of the various recourse rules, the value of distributional information, and the trade-offs between different variants of the objective function (worst-case, worst-case expected, best-case).

2 - Multi-project Scheduling With Multi-mode Resource Constrained Under Uncertainty

Berna Dengiz, Professor, Baskent University, Eskisehir Road 20th Km, Baglica Campus, Ankara, 06530, Turkey, bdengiz@baskent.edu.tr, Serdar Soysal

In this study, we address a resource constrained project scheduling problem including uncertainties in resource usage rate in a multi-project environment. The activities of each project have alternative resource usage modes. Resources are dedicated to all projects considering their dedication policy. The projects involve finish to start zero time lag, nonpreemptive activities and limited renewable and nonrenewable resources. In this study, the optimal dedication of resource capacities to the projects and minimum value of weighted tardiness over all projects will be determined by proposed solution approach.

3 - Stochastic Integer Programming With Endogenous Uncertainty In Open Access Outpatient Clinic Appointments Scheduling

Amarnath Banerjee, Associate Professor, Texas A&M University, 4041 Engineering Technology Building, 3131 Tamu, College Station, TX, 77843-3131, United States, banerjee@tamu.edu, Yu Fu

This study develops a two-stage Stochastic Integer Programming (SIP) model to solve the online outpatient scheduling problem. The model considers different types of patients and uncertain factors in system throughput, no-show, cancellation and lateness. A modified L-shaped algorithm is designed to handle the endogenous uncertainty brought by these factors and solve the SIP model. The analysis method and solution algorithm can be applied to two-stage SIP model with simple recourse function satisfying certain properties.

4 - A Stochastic Mixed Integer Programming Model For Risk Minimization

Yiming Yao, Lawrence Livermore National Laboratory, 7000 East Avenue, L-181, Livermore, CA, 94550-9234, United States, yao3@llnl.gov, Vic Castillo, Andrew Mastin, Carol A Meyers, Deepak Rajan

We present a two-stage stochastic mixed integer programming model that minimizes enterprise risk subject to supply, demand, capacity and other constraints, with the consideration of uncertainty in some parameter values. We describe risk measurement and uncertainty characterization in the application context. Finally, we describe the model's implementation in the open source optimization modeling language PYOMO/PYSP.

5 - Pricing Tax Return For Students That Opt-out From Using School Bus

Hernan Andres Caceres Venegas, PhD Student, University at Buffalo - SUNY, 342 Bell Hall, University at Buffalo, Buffalo, NY, 14260, United States, hernanan@buffalo.edu, Rajan Batta, Qing He

School districts are often mandated to provide transportation but can encounter ridership that varies between 22-72 percent. Consequently, buses run with unused capacity over long routes. We explore the scenario where students are compensated for giving up the option to ride a bus, in an effort to reduce the overall cost of the system. Mathematical formulations for this problem are developed and analyzed. Results from a case study along with algorithmic computational results will be presented.

■ TB86

GIbson Board Room-Omni

Monte Carlo Methods for Multi-stage Decision Making under Uncertainty

Sponsored: Artificial Intelligence

Sponsored Session

Chair: Michael Fu, University of Maryland, mfu@isr.umd.edu

1 - Back To The Future: Google Deep Mind, Alpha Go & Monte Carlo Tree Search

Michael Fu, University of Maryland, College Park, MD, 20742, United States, mfu@rhsmith.umd.edu

In March 2016 in Seoul, Korea, Google DeepMind's AlphaGo, a computer Go-playing program, defeated the reigning human world champion Go player, a feat far more impressive than previous computer programs victories in chess (Deep Blue) and Jeopardy (Watson). Due to the sheer combinatorial nature of the number of possibly game configurations, at the heart of all computer Go-playing algorithms is Monte Carlo tree search based on an upper confidence bound (UCB) algorithm that traces its roots back to an adaptive multi-stage sampling algorithm for estimating the value function in finite-horizon Markov decision processes (MDPs). We describe this algorithm and the main ideas behind AlphaGo.

2 - Cumulative Prospect Theory Meets Reinforcement Learning: New Monte Carlo Algorithms

Cheng Jie, University of Maryland, cjie@math.umd.edu, Prashanth L.A., Michael Fu, Marcus Steve, Csaba Szepesvari

We bring cumulative prospect theory (CPT) to a risk-sensitive reinforcement learning (RL) setting and present Monte Carlo simulation-based algorithms for both estimation and optimization. The estimation scheme uses the empirical distribution to estimate the CPT-value of a random variable. The optimization procedure is based on simultaneous perturbation stochastic approximation (SPSA). Both theoretical convergence results and numerical experiments are provided.

3 - Weighted Bandits Or: How Bandits Learn Distorted Values That Are Not Expected

L. A. Prashanth, University of Maryland, College Park, MD, 20742, United States, prashla@umd.edu, Aditya Gopalan, Michael Fu, Steve Marcus

We formulate a novel multi-armed bandit setup, where the arms' reward distributions are distorted by a weight function. The distortions are motivated by models of human decision making that have been proposed to explain commonly observed deviations from conventional expected value preferences We study two representative problems in this setup: The classic K-armed bandit setting and the linearly parameterized bandit setting. In both settings, we propose algorithms that are inspired by UCB, incorporate reward distortions and exhibit sub-linear regret assuming Holder-continuous weights. We provide empirical demonstrations of the advantage due to using distortion-aware learning algorithms.

■ TB87

Broadway A-Omni

Community-Based Operations Research II

Sponsored: Public Sector OR

Sponsored Session

Chair: Michael P. Johnson, Univrsity of Massachusetts, Department of Public Policy and Public Affairs, Boston, MA, 3, United States, Michael.Johnson@umb.edu

1 - The Foodbank Compliance Problem: A Multicriteria Vehicle Routing Approach

Sarah Nurre, University of Arkansas, snurre@uark.edu, Kellie Schneider

Over 49 million Americans do not have access to a sufficient quantity of affordable, nutritious food. To address the issue of food insecurity in our area, our food bank services many agencies that provide emergency food relief. To maintain regulatory compliance, each agency receives an audit every 12-18 months. We formulate the Food Bank Compliance problem as a multicriteria vehicle routing problem to investigate trade-offs between multiple objectives. We solve the model using both exact and heuristic approaches and provide solutions that appease various stakeholders in the community.

2 - How Can Value Elicitation In Adult Basic Education Support Learners' Success In Goal-setting Policy?

Alma Biba, University of Florida, Jacksonville, FL, United States, Alma.Biba@jax.ufl.edu, Michael P Johnson

For the last two decades, federal legislation and Massachusetts' state ABE policies have linked adult learners' educational outcomes to accountability requirements. Using a multi-method approach ABE learners' goal setting was presented as a decision problem in order to reveal and disentangle the conflicting preferences fueled by outcome-based accountability requirements. Elicitation of values using value-focused thinking (VFT) methodology revealed that learner's self-defined goals are consistently distinct from program-defined goals, that teachers recognize this disjunction, and that efforts to reconcile the two could yield significant improvements in ABE program outcomes.

3 - From Spatial Swot Analysis To Mcda And Choice Experiments: An Integrated Approach For Historical Heritage Management In A New World Heritage Site

Valentina Ferretti, London School of Economics and Political Science, London, United Kingdom, V.Ferretti@lse.ac.uk, Elisa Gandino

This study develops a multi-methodology intervention designed and deployed to support planning and management of a new World Heritage site in Italy. The proposed framework develops through subsequent phases and experiments an integrated approach based on mixed Decision and Economic Analysis techniques, i.e. Spatial SWOT Analysis and Multicriteria Decision Aiding in Phase 1 (problem identification - knowledge phase), Stakeholders Analysis and Spatial Multicriteria Decision Aiding in Phase 2 (problem formulation - planning phase), and Choice Experiments during Phase 3 (problem solving - design).

4 - Mobile Dentistry Network Design: Improving Dental Care Access For Under-served Populations In Rural Regions

Ronald McGarvey, University of Missouri, IMSE and TSPA, E3437D Lafferre Hall, Columbia, MO, 65211, United States, mcgarveyr@missouri.edu, Andreas Holger Thorsen

We investigate the implications of adding mobile dentistry services to a community health center (CHC) in southwest Montana. CHCs are not-for-profit healthcare corporations which provide comprehensive primary care services to patients in the US, including under-served and uninsured people. Mobile dentistry involves dentists and dental hygienists traveling with dental equipment in vans or trailers to serve patients. We model the mobile dentistry network design problem using a mixed-integer programming model to assess the financial feasibility of offering a mobile dentistry service in southwest Montana and measure the potential social impact of mobile dentistry on the region.

■ TB88

Broadway B-Omni

Service Science Best Student Paper Competition II

Award Session

Chair: Robin Qiu, Penn State University, 30 E. Swedesford Road, Malvern, PA, 19355, United States, robinqiu@psu.edu

1 - Appointment Scheduling And The Effects Of Customer Congestion on Service

Zheng Zhang, University of Michigan, Ann Arbor, MI, United States, zzhang0409@gmail.com, Zheng Zhang, Brian Denton, Xiaolin Xie

This paper addresses an appointment scheduling problem in which the server responds to congestion of the service system. We characterize the congestion induced behavior of the server as a function of customer waiting time. Decision variables are the scheduled arrival times for customers in order to minimize a weighted cost incurred for customer waiting time, server overtime and server speedup in response to congestion. We illustrate the importance of congestion effects using a case study for an outpatient clinic at a large medical center.

2 - Managing Consumer Return Abuse And an Assessment Of Technology-Enabled Countermeasures

Mustafa Serkan Akturk, Texas A&M University, 4217 TAMU, Wehner 320 M, College Station, TX, 77843-4217, United States, makturk@mays.tamu.edu, Michael Ketzenberg

This paper examines retail return abuse with respect to both opportunistic and fraudulent consumer returns and explores two innovative technology-enabled countermeasures: customer profiling and product tracking. A customer profiling system identifies opportunistic customers by using their personal identification and transaction history. In contrast, a product tracking system identifies fraudulent returns by recording each transaction of a product through the use of unique identifiers. We investigate the value of making such investments and evaluate how these countermeasures impact a retailer's profitability, demand structure, and policy parameters with respect to price and refund.

3 - Data-Driven Management Of Post-Transplant Medications: An APOMDP Approach

Alireza Boloori, Arizona State University, Tempe, AZ, United States, alireza.boloori@asu.edu, Soroush Saghafian, Harini Chakkera, Curtiss Cook

Anti-rejection drugs are heavily prescribed after organ transplantations to reduce the risk of organ rejections. However, this practice has been shown to increase the risk of diabetes, which makes patients insulin-dependent. To address this conflict and generate effective medication management strategies, we propose an ambiguous POMDP framework that accounts for (1) patients' quality of lives, (2) inevitable estimation errors in a data-driven system, and (3) physicians' attitudes in decision making. We also provide several managerial and medical implications for policy makers and physicians.

4 - Speedup And Slowdown In Multi-Class Service Systems With Returns

Nasser Barjesteh, University of Chicago Booth School of Business, Chicago, IL, United States, barjesteh@chicagobooth.edu, Hossein Abouee-Mehrizi

We consider a service system facing several classes of customers in which the arrival rate and service time depend on the workload, while the chance of return depends on the service time. We provide conditions under which the system is stable and characterize the equilibria of the system. We show that the system may shift between several equilibria. We demonstrate conditions under which an equilibrium is stable and prove that the stability of an equilibrium may depend on the time a customer spends outside of the system before returning for rework. We also observe that the congestion level at which the service rate of one class is changed affects the impact of adjusting the service rate of another class.

5 - Simulation Optimization For Medical Staff Configuration At Emergency Department In Hong Kong

Hainan Guo, City University of Hong Kong, KLN, Hong Kong, Hong Kong, hainaguo-c@my.cityu.edu.hk, Siyang Gao, Kwok-Leung Tsui

This paper seeks to solve the problem of minimizing the medical staff cost constrained by certain service requirements at ED in HK. In our formulation, the service requirements are characterized by some stochastic constraints. Due to the special structure of this problem and ease of computing the objective values, we proposed an efficient random search approach which iteratively identifies solutions with better objective values than that of the current best solution. Experimental studies demonstrate the significantly higher efficiency of our method. In order to obtain the same solution quality, it is able to reduce the computational time by 90% compared with the existing methods in the literature.

■ TB89

Broadway C-Omni

Evolution of Network-wide Traffic Dynamics

Sponsored: TSL, Intelligent Transportation Systems (ITS)

Sponsored Session

Chair: Alireza Khani, University of Minnesota, 136 Civil Engineering Building, 500 Pillsbury Drive S.E., MInneapolis, MN, 55455, United States, akhani@umn.edu

1 - A Node Splitting-Recovery Model For Congestion Evolution Process On Road Networks

Xianyuan Zhan, Purdue University, Evanston, IL, United States, zhanxianyuan@purdue.edu, Satish V. Ukkusuri, Suresh C. Rao

This study presents a node splitting-recovery model for congestion evolution process on urban road networks. We introduce a new dynamic graph representation of road networks that incorporates both the network structure as well as functional states. The congestion evolution in road networks can be modeled as an equivalent node splitting-recovery process on the new graph representation. The congestion evolution data of Beijing road network are collected and used to analyze the real world congestion evolution pattern as well as the node splitting-recovery process.

2 - Doubly Dynamic Traffic Assignment Model Based On Regional Macroscopic Fundamental Diagrams

Xiaozhang He, Perdue University, West Lafayette, IN, United States, seanhe@purdue.edu, Mehmet Yildirimoglu, Srinivas Peeta, Xiaozhang He

This study develops a doubly dynamic traffic assignment model, incorporating within-day and day-to-day dynamics, to capture interactions between demand and supply in heterogeneously congested urban transportation networks. The model is constructed on homogenous sub-regions with static macroscopic fundamental diagrams. Numerical examples are used to investigate the properties of equilibrium states that provide insights for developing coordinated traffic management strategies.

3 - Modeling Cruising Dynamics For Downtown CurbsideParking

Zhengtian Wu, University of Florida, Department of Civil and Coastal Engineering, Gainesville, FL, United States, zhengtianxu@ufl.edu, Yafeng Yin

Cruising for parking not only worsens traffic conditions, but also causes additional energy consumptions and emissions. This study presents a macroscopic model for cruising dynamics in a downtown parking system. The stationary states of the system as well as their stabilities are investigated under different facility scenarios and operation strategies. The optimal occupancy of curbside parking as well as the recommendations for downtown parking management are provided.

■ TB90

Broadway D-Omni

Health Care, Modeling X

Contributed Session

Chair: Stephen Hill, University of North Carolina Wilmington, 601 South College Road, Wilmington, NC, 28403-5611, United States, hills@uncw.edu

1 - Assortment And Inventory Planning In Health Care Sector

Satyaveer S Chauhan, Concordia University, 0ffice Mb11317, 1455 De Maisonneuve Boulevard West, Montreal, QC, H3G 1M8, Canada, satyaveer.chauhan@concordia.ca

In this work we present a mathematical programming model to decide the number of custom trays and their contents based on past usage, preferences, cost, etc. We design custom trays for each available surgical tray. The overall model is binary integer model and we present a decomposition based approach. The model is tested on available real data set.

2 - Healthcare Distribution Response To A Zika Virus Vaccine

Victor R Prybutok, University of North Texas, 1155 Union Circle, 311160, Denton, TX, 76203-5017, United States, prybutok@unt.edu, Rebecca A. Scott, Gayle Prybutok

Rapid healthcare response is analyzed for the yet developed Zika virus vaccine using a contextualized travelling salesman problem and newsvendor model. The model allows evaluation of the importance of decision making factors. Implications are reported that provide insights for increasing the ability to respond in a populated urban area.

3 - Agent Based Simulation Of Influenza Spread On A College Campus

Stephen Hill, University of North Carolina Wilmington, 601 South College Road, Wilmington, NC, 28403-5611, United States, hills@uncw.edu

Agent-based simulation has been shown to be a useful tool for exploration of the dynamics of social interaction. In this work, the spread of influenza in the highly-social and compact community of a university campus is explored. Implications for disease control and intervention are described.

■ TB94

5th Avenue Lobby-MCC

Technology Tutorial: SAS/SAS-JMP

Technology Tutorial

1 - SAS: Building And Solving Optimization Models With SAS

Edward P Hughes, SAS Institute, Inc., Sas Institute Inc., Sas Campus Drive, Cary, NC, 27513, United States, ed.hughes@sas.com

SAS provides a broad and deep array of data and analytic capabilities, including data integration, statistics, data and text mining, econometrics and forecasting, and operations research. The SAS optimization, simulation, and scheduling features coordinate easily and fully with other SAS strengths in data handling, analytics, and reporting. OPTMODEL from SAS provides a powerful and intuitive algebraic optimization modeling language and unified support for building and solving LP, MILP, QP, NLP, CLP, and network-oriented models. And because OPTMODEL is also a SAS procedure (software module), it integrates seamlessly with the entire family of SAS functions, procedures, and macros. We'll demonstrate how you can use OPTMODEL to solve both basic and advanced problems, highlighting its newer capabilities and its support for both standard and customized solution strategies

2 - SAS: Data Discovery And Analysis With JMP 13 Pro

Mia L Stephens, SAS Institute Inc, PO Box 290, York Harbor, ME, 03911, United States, mia.stephens@jmp.com

JMP Statistical Discovery Software is visual and interactive desktop software for Windows and Mac, with a complete array of integrated graphical and statistical features. In this workshop we use the newly released JMP 13 Pro to demonstrate tools for data preparation, visualization, and exploration, including recode, Graph Builder®, the data filter, and geographic mapping. We'll see how to analyze univariate, bivariate, and multivariate data, and will demonstrate tools for building and interacting with predictive models. Finally, we'll see how to share results using HTML output and interactive web reports.

Tuesday, 12:30PM - 2:30PM

■ Poster Session

Exhibit Hall

Tuesday Poster

Poster Session

An Optimization Algorithm For Train Timetabling Problem Based On Lagrangian Relaxation

Haiying Li, Prof., Beijing Jiaotong University, Shangyuan Cun No.3, Haidian District, Beijing, 100044, China, hyli@bjtu.edu.cn, Zhengwen Liao, Jianrui Miao, Lingyun Meng

The research established a cumulative flow variable-based binary programming model for train timetable optimization. A Lagrangian relaxation based time-space-state network was designed to decrease the problem scale by transforming the complicated schedule problem into a set of time-space shortest path problems of independent trains.

Sparsely-sampled Hyperspectral Beam-scanning Imaging System Based On 3d Triangular Lissajous Trajectory

Haonan Lin, Purdue University, West Lafayette, IN, United States, lin676@purdue.edu, Nan Kong

In this work we exploited information redundancy of spatially and spectrally adjacent pixels in hyperspectral images, so as to recover the complete image with low sampling fill rate. 3D triangular wave Lissajous trajectory with high least common multiplier was used to sparsely sample the hyperspectral data cubes. Model-based image in-painting is applied to recover the complete data cubes. Results based on the sparse-sampled version of a hyperspectral coherent Raman scattering image indicates that 10% fill rate is able to recover an image without much quality degradation.

Taxi Sharing

Mustafa Lokhandwala, Purdue University, 241 Sheetz Street, Apt 14, West Lafayette, IN, 47906, United States, mlokhand@purdue.edu

New York City has one of the busiest transportation systems in the world. This study focuses on a part of this network i.e. taxis and attempts to analyze the benefit of Taxi Sharing using simulation software and optimization techniques. The focus of our study will be to build an agent-based simulation model using trip data obtained from the New York Taxi and Limousine Commission, model the decision making methodologies of the agents in a taxi sharing scenario and run this model using the most recent trip data within New York City. The result from this experiment will be to optimize the number of taxis operating on the streets of New York City and also quantify the economic and environmental benefits of the same.

Acceleration Of A Communication Efficient Distributed Dual Block Descent Algorithm

Chenxin Ma, Lehigh University, 200 West Packer Avenue, Bethelehem, PA, 08801, United States, chm514@lehigh.edu

Distributed optimization algorithms for very large-scale machine learning suffer from communication bottlenecks. Confronting this issue, a communication-efficient primal-dual coordinate ascent framework (CoCoA) and its improved variant CoCoA+ have been proposed, achieving a convergence rate of O(1/t) for solving empirical risk minimization problems with Lipschitz losses. In this paper, we propose an accelerated variant of CoCoA+ and show that it has a rate of O(1/t2) in terms of reducing dual suboptimality. Our analysis is also notable in that our convergence rate bounds involve constants that, except in extreme cases, are significantly reduced.

Enhancing Operational Performance Of Emergency Room Team

Maryam M Mahdikhani, PhD Candidate, Rutgers University, 1 Washington Park, Room 1019C, Newark, NJ, 07102, United States, m.mahdikhani@rutgers.edu

The study investigates the effect of situational awareness concepts on the operational performance of involved agents at emergency rooms to increase the efficiency of performance. Applying ABM techniques makes contributions to illustrate that the effect of which attributes for which agent is more significant than others. We considered three main agents by developing their attributions and variables through random function. Furthermore, situational awareness is described by availability of authority in case of problems, supervisor feedback, and resource availability.

An Integrated Black Topsis And Grey Linear Programming Approach To Deal With Uncertainty And Confidence Level Of Decision Makers

Hanif Malekpoor, PhD Student, University of East Anglia, Norwich Research Park, Norwich, NR4 7TJ, United Kingdom, H.Malekpoor@uea.ac.uk

In order to deal with uncertainty of Decision Makers (DMs) opinions in supplier selection, applying interval valued data is a popular method. However the level of confidence, DMs have about their judgments, is also significant. In addition the supplier's information related to constraints of order allocation problem is not always trustable and precise. In this research to overcome the two aforementioned problems we have developed an integrated approach for order allocation, using Black-TOPSIS (TOPSIS with interval numbers which their upper and lower bounds are also grey numbers) and multi objective grey linear programing to determine the best supplier and order quantity from each suppliers.

Development Of A Least-cost Diet For The Crew Of A Brazilian Navy's Warship

LATE CANCELLATION

Ernesto Rademaker Martins, Commander, Brazilian Navy, Arsenal de Marinha no Rio de Janeiro (AMRJ), Rua da Ponte S/N, Ilha da Cobras, Centro, Rio de Janeiro, 20091000, Brazil, radmart@yahoo.com.br, Marcos Santos, Jessica Alves Souza, Fabrício Costa Dias, Marcone Freitas Reis

Develop an analytical model for the meals served to the crew of Brazilian Navy's warship. Such a diet should take into account the nutritional needs of adult men aged 18-45 years, as well as the specifics of the work activities performed aboard a warship. Due to its deterministic nature, sought a solution to the problem in the light of linear programming, specifically the Simplex Method. The analytical model was established by the data obtained in the Brazilian Navy's normative legislation. The solution of the mathematical model in screen can support the decision of the management of the military organization, to contribute to the fulfillment of the Brazilian's Law.

Modeling Strategic Decisions In Football

Christopher G McCord, Massachusetts Institute of Technology, Cambridge, MA, United States, mccord@mit.edu

Football has long been recognized as one of the most strategically advanced professional sports in the US. A team must continually take into account many different factors when making decisions. In this work, I present a probabilistic model for the decisions an NFL team may face during the course of the game. I then present the strategy that maximizes the team's probability of winning in various situations, as well as a measure of uncertainty for each decision. Finally, I compare the model's optimal decisions with the observed strategies of NFL teams and hypothesize why coaches behave sub-optimally in many situations.

A Novel Distributed Coordinated Approach For Real-time Signal Control

Mehrzad Mehrabipour, Graduate Research Assistant, Washington State University, 1630 NE valley Rd, Pullman, WA, 99164, United States, mehrzad.mehrabipour@wsu.edu, Ali Hajbabaie

This study develops a distributed-coordinated methodology for traffic signal timing optimization problem. Our formulation and solution methodology distribute the network level signal timing optimization problem to intersection level. We formulated a mathematical programing model for each intersection, based on the cell transmission model and created coordination between them to avoid finding locally optimal solutions. The neighboring intersections coordinate their decisions to avoid long queues. We also proposed a rolling horizon solution algorithm and applied it to several case study networks under various demand patterns and observed very promising results.

Optimal Parking Utilization Management Under Uncertain Demand

Amir Mirheli, Washington State University, 405 Spokane Street, Sloan 242, Pullman, WA, 99163, United States, amir.mirheli@wsu.edu, Leila Hajibabai

Excessive cruising to find parking spots contributes to additional delays and imposes indirect costs, safety, and health concerns, particularly in congested urban areas with limited parking capacity. This research develops a bi-level stochastic dynamic parking management model under uncertain demand to simultaneously minimize total costs due to drivers' decisions, maximize parking agency's revenue, and push parking utilization towards a target occupancy. The problem is solved using a hybrid technique including an approximate dynamic programming with an embedded single-level conversion. Numerical experiments show the performance of the proposed algorithm and draw managerial insights.

Regularized Discriminant Analysis For Multisensory Damage Detection And Decision Fusion Using Lamb-waves

LATE CANCELLATION

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We have propose a for damage detection which does not require an intermediate feature extraction step and therefore more efficient in handling data with high-dimensionality. A robust discriminant model is obtained by shrinking of the covariance matrix to a diagonal matrix and thresholding redundant predictors without hurting the predictive power of the model. The shrinking and threshold parameters of the discriminant function are estimated to minimize the classification error. Furthermore, bayesian decision-fusion formulation is used to improve the damage classification obtained from the regularized linear discriminant analysis approach

Identification Of Optimal Partition For Semidefinite Optimization

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The concept of optimal partition was originally introduced for linear optimization and linear complementary problems and subsequently extended to semidefinite optimization. For linear optimization and sufficient linear complementary problems, the optimal partition and a maximally complementary optimal solution can be identified in strongly polynomial time. In this paper, under no assumption on strict complementarity, we formalize the optimal partition concept for semidefinite optimization and present a methodology for an ϵ-feasible maximally complementary solution.

Should We Decrease Corn Subsidies And Subsidize Fruits & Vegetables?

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This Poster calls for programmed reductions of Corn Subsidies with a corresponding ramping up of Subsidies for fruits and vegetables. If implemented, this Public Health initiative could have a dramatic positive impact on Obesity reduction, its associated comorbidities, and healthcare costs in the USA. It should also enhance Quality of Lives.

Endogenous Time Preference And Exhaustible Resource Use

Makiko Nagaya, Showa Women' University, Tokyo, Japan, makiko.nagaya@gmail.com

This paper re-examine a classical topic of exhaustible resource use on the basis of recent developments in time preference models. We analyze the effects of endogenous time preference on dynamic properties of resource use, contrasting to classical Hotelling's results. Finally, we introduced a concept of minimum required level of consumption.

An Optimization Approach To Detection Of Epistatic Effects

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Epistasis refers to the phenomenon where the interaction of multiple genes affects a certain phenotype more than they do separately. Similar epistatic effects are also ubiquitous in other application areas, where a certain effect is only observable when a particular combination of multiple factors is present. Due to the enormous solution space, it's hard to detect the epistatic effect. We propose an optimization model that attempts to detect epistatic effects where a large number of observations are available for a relatively small number of explanatory factors. We will share our preliminary results and discuss future research directions.

Measuring Competition Between Spanish Engineering Schools

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In Spain the higher education institution choice is highly affected by the distance between a student's family home and the institutions. The higher education market is, at least in part, geographically based. Measuring competition among higher education centers needs to take also into account the specializations offered, the number of students admitted and the tuition fees. Several measures are proposed and tested. They are applied to the Spanish Engineering Schools.

Ambulance Dispatching Problem To Minimize Response Time And Hospital Congestion Using Approximate Dynamic Programming

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Ambulance dispatching problem is to decide which ambulance to send to an emergency call. Previous literature has mainly focused on minimizing response time to an emergency call. However, in the environment where congestions of each emergency room are quite different, it's important to determine to which hospital to transport patients to treat them efficiently. In this paper, an approximate dynamic programming model is suggested to optimize ambulance dispatching, minimizing response time as well as decreasing hospital congestion. In addition, a case study based on real data is performed to demonstrate the proposed model performs better in comparison with the existing ones.

Quantifying The Benefits Of Continuous Replenishment Program For Partner Selection

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Manuel D Rossetti, Shengfan Zhang, Edward A Pohl

Supply chain collaboration programs such as Continuous Replenishment Program (CRP) face challenges with regard to sharing the financial benefits. Supply chain partners often suffer from the ambiguity that exists with the Return on Investment (ROI) of the collaboration programs. This research provides a multi-echelon supply chain model that quantifies the benefits of a continuous replenishment program (CRP) for both partners, and at three levels of inventory holding, transportation and ordering cost component. The model is adopted by a major healthcare manufacturer, with thousands of products and hundreds of demand points, in the form of a software tool.

Using An Ontology To Create Content For Clinical Assessment Questions

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Using an ontology to create content for clinical assessment questions. This was done by modeling patterns of existing questions and building templates to modify existing questions using our ontological relations to create a new question.

Profile Monitoring Using Non-parametric Models For Poisson Data

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Profile monitoring is a relatively new technique used to monitor the functional relationship between a response variable and one or more explanatory variables at each time period. Although many studies have been conducted in this field, in most of them, the distribution of the response variable is assumed to be normal which is not always appropriate. To our knowledge, few works have used profile monitoring for poisson data. In this study, we aim to use non-parametric approaches in profile monitoring for those situations where the appropriate distribution is defined by the poisson.

Joint Inventory Replenishment For High Variety Mass Customizers

Michael Prokle, PhD Candidate, University of Massachusetts-Amherst, 290 N Pleasant Street, Apt 2, Amherst, MA, 01002, United States, mprokle@umass.edu, Ana Muriel

We address the joint inventory replenishment problem faced by a manufacturer that builds unique products to customer's specifications. Historic part usage shows lumpy & intermittent demand. The objective is to find a joint part replenishment policy that incorporates the status of the current order pipeline and balances inventory, ordering, and stock-out costs, under given MOQ and lot size requirements. In a case study of a small-size, fast-growing mass customizer, our computational results show that a coordinated part inventory policy results in higher customer service, virtually eliminating lost sales, while lowering cost by taking advantage of shipping economies of scale.

Cross Price Elasticities In Retail Price Optimization

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In store retail, cross price effects have a significant impact on product sales. Determining and estimating cross price elasticities for a large number of products is a challenging problem. We use categorical information and LASSO to estimate a sparse cross item set. We then solve a convexified price optimization problem.

Evolving Airplane Boarding Zone Plans

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To manage the boarding process and reduce boarding times, airlines often assign passengers into a series of 'boarding zones'. This presentation describes a methods of developing improved improved boarding zone assignment plans through the use of a passenger-level boarding simulation model combined with an evolutionary optimization algorithm.

Decision Facing Ambiguity: Mdp, Pomdp And Beyond

Mohammad Rasouli, PhD Candidate, University of Michigan, 430 South Fourth Ave, Ann Arbor, MI, 48104, United States, rasouli@umich.edu

While most of the decision making tools are developed for a Bayesian framework where the decision maker knows full stochastic description of uncertainties in the environment, decision facing ambiguity (model uncertainty and non-stochastic uncertainty) is a better approach for modeling a lot of practical situations. We discuss how decision making tools including MDP, POMDP, learning (e.g. Multi-armed bandit) and team decision making can be extended for environments with ambiguity. We discuss robustness and bounded rationality in this framework.

Optimizing Socioeconomic Balances In Schools

Rebecca Reddoch, Furman University, 3300 Poinsett Highway, Greenville, SC, 29613, United States, lattie.reddoch@furman.edu

Does the socioeconomic class of a student's peers matter in the student's ability to learn? Several studies have suggested that it does. Despite the identification of socioeconomic status as a correlating factor between education and achievement, there are still large performance gaps in high schools throughout the nation. Zoning based on distance ideally provides convenience and minimal travel costs for students, but it is effectively zoning by neighborhood and socioeconomic status. Here we study a multi-criteria model that assigns students to schools based on a combination of socioeconomic and distance factors.

Sterilization Network Design

Ahmed Saif, Postdoctoral Fellow, HEC Montréal, 3000, Chemin de la Côte-Sainte-Catherine, Montréal, QC, H3T 2A7, Canada, ansaif1976@yahoo.com

Centralizing sterilization services in hospital networks can cut cost and improve efficiency through better utilization of resources, risk-pooling and economies-of-scale. We compare three organization schemes: fully distributed, centralized processing, and centralized processing and stock keeping. The sterilization network design problem is formulated as a mixed-integer concave minimization program, then reformulated as a mixed-integer second-order cone program with a piecewise-linear cost function so it can be solved efficiently. Testing is done on a realistic case study under different scenarios. The cost components in every scheme are analyzed and managerial insights are drawn.

An Integrated Facility Location And Network Restoration Model Under Repair Time Uncertainty

Ece Sanci, PhD Pre-Candidate Student, University of Michigan, 1205 Beal Avenue, Ann Arbor, MI, 48109, United States, ecesanci@umich.edu, Mark Stephen Daskin

We propose a two-stage stochastic programming model for an integrated facility location and network restoration problem in a disaster-prone region where facility location decisions should be made in the pre-disaster stage. We capture uncertainty in the network availability by incorporating the repair times required to restore the damaged arcs. In contrast to other models that ignore repair times, our model locates some facilities in remote, low-demand areas that are unreachable for a certain number of periods following a disaster.

Application Of Multicriteria Methodology For Decision Aid In The Formation Of A Projects Portfolio

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Decide correctly is a constant challenge faced by man since the beginning of time. Among the numerous multicriteria methods of decision support, it was used the Analytic Hierarchy Process (AHP), which, as a compensatory method, it seems appropriate to solve such problems. The AHP was one of the first methods developed by the American School, one of the most used methods in the world. This paper aims to propose through AHP, a methodology for constitution the portfolio of IT projects of a non-profit company. Based on this interview it was possible to raise the projects evaluation criteria as well as the preference of the decision maker.

Pro Bono Analytics - Informs Volunteers Create Societal Impact With Applied Analytics

Rina R Schneur, ARCKS, Lexington, MA, 02420, United States, rinarsg@gmail.com, Michael P Johnson

Pro Bono Analytics was established by INFORMS in 2015, in the tradition of other disciplines' efforts to utilize specialized skills and knowledge to generate social impact. Pro Bono Analytics' goal is to provide analytics technical support for nonprofit organizations without the capacity and/or resources to perform data analysis related tasks on their own. This poster presentation will provide knowledge about why INFORMS members should consider volunteering for Pro Bono Analytics, how this initiative works, and what promising current and recently-completed engagements look like.

MLB And Regression Analysis. Predictions For The 2016 Chicago Cubs And White Sox

Kurt J Schuepfer, Graduate Researcher, Miami University, Oxford, OH, 45056, United States, schuepferk@gmail.com

Logistic and linear regression models were built to predict outcomes for the 2016 Chicago Cubs and White Sox. The models in concert predicted overall wins, runs scored, runs allowed, and finally the predicted playoff status for each team. Future directions in web scraping and model building are discussed.

Fuzzy-logic / Dempster - Shafer Based Information Fusion Formulism For Land-marine Decision Analysis

Nicholas V Scott, Spectral Scientist/Physical Oceanographer, Riverside Research, 2640 Hibiscus Way, Beavercreek, OH, 45431, United States, nscott@riversideresearch.org

A land-marine problem is heuristically addressed using a fuzzy logic/Dempster-Shafer based information fusion formulism which demonstrates the efficacy of such tools as aids in optimal decision making. The initial computational segment contains a five component feature extraction system which provides the inputs to a fuzzy logic inference system. Multiple human assessments, which emanate from the use of the inference system and ancillary intelligence, are then amalgamated using Dempster-Shafer evidential theory. A probabilistic assessment of environmental state is provided finally allowing for decisions in which information ignorance and data uncertainty are taken into account.

Reducing Social Risks In The Supply Chain: An Examination Of S&P 500 Companies

Rose Sebastianelli, Professor, University of Scranton, Brennan Hall 423, Scranton, PA, 18510, United States, rose.sebastianelli@scranton.edu, Nabil Tamimi

Approximately half of S&P 500 companies report implementing initiatives to reduce social risks in the supply chain. Based on Bloomberg data, these S&P 500 companies are compared to those without such initiatives in terms of firm characteristics (e.g., size, industry sector), related policies (e.g., child labor, human rights, environmental) and profitability (e.g., return on assets).

Optimal Balanced Sample Selection For Causal Inference Using Machine Learning

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With the availability of observational survey data and big data the ability to sample accurately to determine causal effects beyond correlational studies is important. This paper investigates machine learning supervised ensemble classification Area Under the Curve (AUC) measure, for optimization of balanced sample selection. Synthetic data sets and actual experimental data are used to compare results of existing optimization metrics.

Adaptive Sampling Trust Region Algorithms For Derivative Free Simulation Optimization

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We develop derivative free algorithms for optimization contexts where the objective function is observable only through a stochastic simulation. The algorithms we develop follows the trust-region framework where a local model is constructed, optimized, and updated as the iterates evolve through the search space. The salient feature of our algorithms is the incorporation of adaptive sampling to keep the quality of the local model in lock step with the trust-region radius, in a bid to ensure optimal convergence rates.

Ruled Based Prediction Analysis For 30-days Neurological Recovery Status Post Stand Assisted Treatment Of Brain Aneurysm

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Recently, it has been observed that stroke patients could recover with asymptomatic outcome in a short period with use of stent-assisted coiling (SAC) treatment. We employed a rule-based decision model to identify key rules that are used for predicting the clinical outcomes post 30-Days of SAC treatment. A 95% and 75% prediction accuracy were obtained for a cohort of 65 training and 21 validation patients, respectively.

The Impact Of Social Feedback On Reviewers' Review Decisions

Wenqi Shen, Virginia Tech, Blacksburg, VA, United States, shenw@vt.edu, Yan Liu

In this paper, we empirically examine how social incentives, namely online reputation and social feedback which reflects peer recognition and attention, affect reviewers' review decisions. We develop a state-space model which captures the dynamics of reviewers' incentives as influenced by both online reputation and social feedback.

Quay Crane Scheduling Problem With Considering Tidal Impact And Fuel Consumption

LATE CANCELLATION

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This study investigates a quay crane scheduling problem with considering the impact of tides in a port and fuel consumptions of ships. A mixed-integer nonlinear programming model is proposed. Some nonlinear parts in the model are linearized by approximation approaches. For solving the proposed model in large-scale problem instances, both a local branching based solution method and a particle swarm optimization based solution method are developed. Numerical experiments with some real-world like cases are conducted to validate the effectiveness of the proposed model and the efficiency of the proposed solution methods.

A Dynamic Programming Approach To Solve Bi-level Programming Problem With Fuzzy Rule-base Constraints

LATE CANCELLATION

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In this work, A bi-level programming problem has been considered where the functional relationship between decision variables and the objective functions of leader and follower are not completely known to us. So a bi-level programming problem with fuzzy rule-base constraints has been developed. A dynamic programming approach with appropriate fuzzy reasoning scheme is used to determine the crisp functional relationship between the objective functions and the decision variables. Thus a bi-level programming problem is formulated from the original fuzzy rule-based to the conventional bi-level programming problem.

Using Discrete Event Simulation To Improve Acute Stroke Care Quality Measurement

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Time from stroke onset to the administration of tissue plasminogen activator (tPA) is an important acute stroke care performance measure, but it should be adjusted for the operational characteristics of hospitals to avoid setting unrealistic benchmarks for smaller hospitals. We developed a discrete event simulation model to compare the time-to-tPA among four types of hospitals with varying stroke-related resources. Stroke patients arrive at an emergency department (ED) according to a Poisson process and navigates through the system. According to the model, larger comprehensive stroke centers can achieve better performance on time-to-tPA measures compared to non-stroke centers.

Multi-agent Simulation For Integrative Analysis Of Renewable Energy Policy – Feed-in Tariffs Vs. Renewable Portfolio Standards

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Recently support schemes for renewable energy as renewable portfolio standards (RPS) and feed-in tariff (FIT) have been introduced due to further penetration of renewable energies. In this work, multi-agent simulation analysis of RPS and FIT has been conducted. Especially, we analyze an effect of the level of RPS and FIT price on electricity price and power output. By comparing the results obtained from the simulation and the equilibrium analysis, we have examined an effect of the policies on agents' behaviors from both bottom-up and top-down viewpoints comprehensively.

Finding Constrained Paths In Edge Colored Graphs

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Edge colored graphs are used to model various real-life problems. One of them inspired us to define an orderly colored longest path (OCLP) problem which amounts to finding the longest path in a graph whose edges are colored with a given number of colors, under the constraint that the path follows a predetermined order of colors. To solve OCLP, ILP algorithms were formulated by means of max flow models with packing constraints and cycle elimination. Recently, alternative formulations of the problem led to its scheduling interpretation and proposing other variants of path with constraints. The presentation will cover basic theoretical and computational issues concerning above mentioned issues.

Optimal Policies For Deterioration Inventory Problems With Multiclass Demand Fulfillment

LATE CANCELLATION

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In this paper, we study the problem of allocating deteriorating inventory to demand from several classes of customers when partially backlogging of unfilled demand is possible. The customer classes are distinguished by the price they pay for the item and their backlogging cost. The firm is able to make an allocation decision on which demand to fill and which to delay. The unfilled demand may then wait for later fulfillment. We describe the optimal ordering and allocating policy in an inventory deteriorating environment. Through comparison to a naive allocation of inventory without inventory rationing, we show that profits are significantly influenced by the inventory allocation.

A Multiple Linear Regression Model For High Tech Talent Retention In China

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The high tech talent is the backbone of the high tech companies and higher institutions. It is especially important for the developing countries to maintain the innovative capacity and seek competitive advantage during their economic development process. The Chinese governments and organizations have experienced significant difficulties in retaining the high tech talent in spite of their continuous efforts. To address this issue, we apply the multiple linear regression model to the survey data collected from 113 high tech individuals from companies and higher institutions in China in order to identify the most effective strategies to retain them within the organizations.

The Effect Of National Culture On Safety: A Near-miss Analysis

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We argue that near-miss events can increase the likelihood of the future serious accident. We investigate the effect of national culture on safety by using data from international shipping industry. Fixed-effects Poisson regression results show that near-miss events of a ship significantly increase the likelihood of the future serious accident while power distance, individualism, and uncertainty avoidance levels play significant roles in moderating the hypothesized main effect. This study shows that near-miss events lead to unlearning of the accidents and thus increases failure likelihood in the future. It also provides evidence on the significant effects of national culture on safety.

An Investigation On Fuzzy Aggregate Production Planning Using Flexible Requirement Profiles

LATE CANCELLATION

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This paper investigates the production planning problem using a flexible optimization approach called the Flexible Requirement Profile (FRP). FRP determines flexible bounds on production levels in different periods based on previous plans and forecasted demand. In this paper, a fuzzy linear programming approach is taken to model the uncertainty of data of demand and cost parameters in the future periods, using fuzzy membership functions. The results of the fuzzy model is compared to a deterministic model.

Analyzing Supply Chain Resiliency To Mitigate Drug Shortages

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Despite efforts from the FDA, pharmaceutical companies, and other stakeholders, drug shortages continue to be a national problem. These outages can directly affect patients' health and are often caused by disruptions that expose manufacturing and supply chain vulnerabilities. These disruptions can include contamination, delays in the delivery of raw materials, and loss of the manufacturing site. We present a preliminary model designed to maximize the resiliency and robustness of the supply of drugs to reduce the impact of potential shortages when there are disruptions in production. We consider uncertainty in the occurrence of disruptions and in the recovery of manufacturing capacity.

Optimal Placement Of Inspection Points For Hazmat Routing

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There is perennial need of hazmat material transportation for various fields. Minimization of risk involved in road transportation of hazmat has been a significant OR problem. We present a model for optimally placing inspection points after every k miles to reduce the risk. However, since there is a cost involved in setting up inspection points, our model minimizes the no. of inspection points for a given amount of risk.

Merging Knapsack Constraints With Cover Inequalities

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Merged knapsack cover inequalities is a new class of cutting planes to solve integer programs. This class of cutting planes combines the information from a cover inequality and a knapsack constraint to generate strong valid inequalities. These inequalities can also be exactly lifted through a pseudo-polynomial time dynamic programming algorithm. The resulting exact lifted merged knapsack cover inequality is valid and potentially stronger than the original merged knapsack cover inequality. Computational experiments demonstrate that exact lifted merged knapsack cover inequalities, when implemented as preprocessing cuts, decrease the solution time by 15% and number of ticks from CPLEX by 10%.

Containership Deployment On A Liner Service

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This paper investigates how to determine the optimal sequence of ships in a string to minimize the expected number of delayed containers taking uncertain demand into consideration. We use the phrases "sequence of ships", "string" and "permutation" interchangeably. The main challenge for the problem is that it is almost impossible to predict the probability distribution functions for the future demand. In fact, even if we have the historical data on the demand, the data may be of limited value because the shipping environment changes rapidly. Therefore, a good string should be robust in that it is optimal or near-optimal for any random demand.

Outsourcing Decisions Under Scale Effect For Competitive Firms With Product Substitutability

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This paper discusses outsourcing decisions for a supplier with scale effect and two competitive firms(firm 1 and firm 2) with product substitutability. Based on the profit functions, this study analyzes the effect of firm 1's outsourcing on the supplier and both firms, finds out the optimal outsourcing strategies and the best wholesale prices, and compares the effects of substitutability on decision variables before and after outsourcing. The results show that a firm may make products by itself when its production cost is higher than wholesale price. However, a firm may also choose to oursource production when its production cost is lower than wholesale price.

Cost Minimization Of Government Issued Cell Phones

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Increasing costs associated with cell phone circuits has led the United States Government to study consolidation of its wireless network in attempt to minimize annual expense while maximizing efficiency. During consolidation, Private Virtual Channels (PVCs) are transferred from either low utilized or expensive circuits to existing circuits with higher utilization and lower annual cost. The consolidation process is further constrained by region, service package (VCI code), and utilization capacity per circuit. Through the use of an optimized network annual expenses are decreased from approximately $11 million to $3.1 million.

Applications Of Text Mining Techniques To Fleet Health And Maintenance Data

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Textual data is one of the richest data sources for fleet health and maintenance analytics. Taking advantage of these information is the key for optimizing airline's and Boeing's business. Due to its large volume and highly unstructured nature, however, its full potential is rarely leveraged. Advanced Analytics group works on text analytics projects with airlines in the areas such as reliability, maintenance program and Boeing customer support. Case studies on how we help businesses by applying natural language processing, machine learning and visualization techniques will be presented.

A Cross Comparison Of Proactive And Reactive Mitigation Policies For Regions Experiencing Repeated Hazards

Chengwei Zhai, University of Michigan, Ann Arbor, 1205 Beal Ave, Ann Arbor, MI, 48109, United States, cwzhai@umich.edu, Allison C Reilly, Seth Guikema

Repeated disasters affect various areas differently. We hypothesize that much of this variation may be explained by regional policies that influence building codes, constituents understanding of the hazard, and homeowners' decision to mitigate. This work builds an agent-based model that integrates a physical hazard model with a homeowner decision model to understand how various policy options promote mitigation. A case study using household-level data from 9 counties in Maryland that experience hurricanes is presented to demonstrate how various policies might affect the region's vulnerability.

Second-order Conic Robust Optimization With Application To Radiation Therapy Treatment Planning Of Breast Cancer

Zengbo Zhang, Beijing Institute of Technology, Beijing Institute of Technology, Beijing, 10081, China, zhangzengbo_1999@163.com, Zihao Jiao

We incorporate robust optimization into CVaR to formulate a loss distribution under uncertainty. We demonstrate an application of our model to the radiation therapy treatment planning problem of breast cancer. In this therapy process, the dose distribution dependented on each state is uncertain. Our framework generalize and develop this type of uncertainty and that the uncertainty set is ellipsoidal, then the formulation can be re-written as second-order conic programs. Monte Carlo simulation example are presented to illustrate the proposed approach. Our results increased dosimetric performance for former treatment planning methods and improved cardiac sparing.

Study Of Patient Satisfaction Perception Based On Medical Experience And Health Cognition

Jianjie Zhang, Beijing Institute of Technology, Beijing, China, zhjj_2013@163.com, Jinlin LI, Rong Zhang, Jian Xue

This paper examines patient experience and health cognition in outpatient from nine cities of China.By conducting discrete choice experiments,we identify discrepant patients in several attributes and the individual-difference about the health cognition that can explain such discrepancy.For the high degree of the health cognition patients,medical environment and waiting time affection is not significant.however,for the low degree of group,both two attributes affect significantly.In addition to providing the empirical description in China's healthcare market,our study offers patient behavioral optimization suggestions to improve patient satisfaction perception.

Accelerating The Adoption Of Bundled Payment Reimbursement Systems: A Data-driven Approach Utilizing Claim Data

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Bundled payments as a reimbursement mechanism have the potential to reduce health care expenditures. One of the crucial components to the implementation of a bundled payment is to identify procedural homogeneous groups within an episode of care. We propose a data-driven clustering approach to automatically detect and explicitly represent homogeneous sub-groups of services for a given episode of care. We explore the results of clustering two conditions with different complexities. The automatically extracted clusters with different cost patterns highlight the payer's expenditure and provider's financial risk under bundled payments.

Integrated Operational And Financial Hedging With Capacity Reshoring

Lima Zhao, Assistant Professor of Supply Chain Finance, WHU - Otto Beisheim School of Management, Burgplatz 2, Vallendar, 56179, Germany, lima.zhao@whu.edu, Arnd H Huchzermeier

We consider a multinational corporations (MNC) that adopts capacity reshoring, production switching, and financial hedging to manage supply—demand mismatches and currency risk. Adopting mean-conditional value-at-risk (CVaR) optimization, we decompose operations and finance: Operational flexibility maximizes expected profit subject to CVaR constraint, while financial hedging minimizes CVaR subject to minimum expected profit. We show that: Operational flexibility and financial hedging can be complements, and they are substitutes in risk reduction. Collaboration and coordination between operations and finance is crucial in minimizing the substitution effects.

Forecasting Equity Risk Using Firm Risk Disclosures

Xiaodi Zhu, Stevens Institute of Technology, Hoboken, NJ, 07030, United States, xzhu@stevens.edu, Steve Yang, Somayeh Moazeni

Corporate risk disclosures as part of U.S. public companies' financial reports provides information about companies' potential risks. This study analyzes risk types revealed in these risk disclosures and examines their potential predictive power over stock returns. Using 16,110 risk disclosures from 2011 to 2015, we apply Sentence Latent Dirichlet Allocation model to infer risk types and propose a novel algorithm to match new factors with existing risk types which generates 90% correct matches. Our findings provide evidence that the companies' self-disclosed risk factors have significant impacts on subsequent stock return volatility which can be used to predict potential stock change.

Integrating Anode Recycle In A Real-time Solid Oxide Fuel Cell Model With Pressure Loss

Amelia McIlvenna, University of Tennessee, 550 Lost Tree Ln, Knoxville, TN, 37934, United States, amcilven@vols.utk.edu

Anode recycle helps solve one of fuel cell technology's major challenges: maximizing fuel utilization without destroying the fuel cell. Anode recycle was added to an existing real-time Solid Oxide Fuel Cell (SOFC) model to investigate effects within the fuel cell. SOFC's are sensitive to small parameter changes. An increase in fuel mass flow was found to impact pressure losses in the fuel manifold. The updated model allowed for a pipe sensitivity analysis to optimize design of the fuel manifold. This work allows for improvements in SOFC design, and opens avenues to future transient analysis.

Information Network Design And Optimization With Social Media In Disaster Management

Bairong Wang, Industrial & System Engineering, University at Bufflao, SUNY, 150 longmeadow rd apt 2, buffalo, NY, 14226, United States, bairongw@buffalo.edu, Jun Zhuang

Social media becomes a popular information sharing platform during disasters. However, rumors also spread due to the problems that no information gate exists on social media to ensure information accuracy and security. This study analyzes information behavior of both common and official users, and rumor distribution patterns during Hurricane Sandy on Twitter. Our results show that nearly 90 percent of impressions are generated from followers, while one re-tweet can contribute 5,688 impressions on average. Based on results from rumor pattern analysis, we design information spreading and sharing model to debunk rumors during disasters to improve information coverage and efficiency.

Flexible High Density Puzzle Storage Network

Ehsan Shirazi, West Virginia University, Morgantown, WV, ehshirazi@mix.wvu.edu

A puzzle-based storage system has been introduced to replenish and retrieve items from the top and bottom of a highly dense storage system. Each cell of the puzzle storage is considered as a grid. Each grid is able to store an item and or to move items in the south direction. We describe a high density storage system that can retrieve and replenish items from all sides. A puzzle storage with this characteristic is a lot more flexible than what has been introduced before. We will illustrate how this puzzle storage scheme affects replenish and retrieve time based on different network policies, distributions of replenishing and retrieving items, and number of free spaces on the puzzle network

Fluid Genetic Algorithm (FGA)

Roy Jafari Marandi, Mississippi State University, Mississippi State, MS, rj746@msstate.edu, Brian Smith

Genetic Algorithm (GA) has been one of the most popular Optimization methods. A review of the literature shows extensive research attempting to adapt and develop the standard GA. Nevertheless, the essence of GA which consists of different concepts rarely has been the focus of recent researchers. In this paper method, Fluid Genetic Algorithm (FGA), some of these concepts are changed, removed, and furthermore, new concepts are introduced. The performance of GA and FGA are compared through seven benchmark functions. FGA not only shows a better success rate and better convergence control, but it can be applied to a wider range of problems including multi-objective and multi-level problems.

Privacy In Social Networks; Do People Care? A Regulatory Focus Theory Perspective

Behrooz Davazdahemami, Doctoral Student, Oklahoma State University, 4599 N Washington St, Apt 40A, Stillwater, OK, 74075, United States, davazda@okstate.edu, Pankush Kalgotra

Relying on the Regulatory Focus Theory this study extends information privacy literature to explain the reason for relatively low influence of individuals' information privacy concerns on their intention to share information on social networking websites. The proposed model was empirically tested (n=688) and sufficient support was provided for all the hypothesized relationships in the model. Results indicate that accounting for situational factors in assessing the effect of privacy concerns on willingness to share can significantly better explain the real behaviors of social network users.

Candidate List Strategies For Resource Constrained Project Scheduling

Christopher Riley, Assistant Professor of Management, Delta State University, DSU Box 3275 - Broom 252, 1003 West Sunflower Road, Cleveland, MS, 38733, United States, criley@deltastate.edu, Cesar Rego

Certain metaheuristic methods can benefit greatly from an appropriate candidate list strategy. We present our findings on the analysis of candidate lists for tabu search and filter-and-fan approaches to solving the resource constrained project scheduling problem. Both new candidate list strategies as well as strategies from the literature are considered.

A Model Of Concession Tracking To Improve Fairness Of Repetitive Shared Resource Use

Dmitry Gimon, Assistant Professor, Fort Hays State University, 600 Park St., Hays, KS, 67601, United States, d_gimon@fhsu.edu

Fair use of a shared resource is a common task in everyday life and in industry. We propose a model to improve its fairness using the theory of reciprocal concessions and refined preference functions. Our simulation demonstrates that our proposed model results in fairer use of shared resources.

I Have No Data! A Practical Introduction To Range Building

Gustavo Vinueza, Director of Custom Solutions, Palisade Corporation, 798 Cascadilla Street, Palisade Corporation, Ithaca, NY, 14850, United States, gvinueza@palisade.com

Simulation models, they require a set of inputs translated into probabilistic distributions. Fitting the data to a distribution or specific experience from expert teams in the shape of 3-point estimation. Nevertheless, there are situations in you say "I have no data, so I can t generate any distribution". The work presented is the beginning of a series of practical exercises aimed for people asked to give an opinion, a report or a napkin draft of numerical values which don t necessarily have organized supporting data. A step by step workflow is proposed along with a framework on how to rapidly generate estimations that are on the same wavelength of the people requiring them.

New Technologies And Women's Empowerment

Jimin Han, SolBridge International School of Business, Daejeon, Korea, Republic of, jhan154@Student.solbridge.ac.kr, Sung-Tae Kim

Prior research has claimed that energy poverty disempowers women in the ghetto areas and tends to increase illiteracy among their children. Such research also discovered that providing them ample access to energy and new technologies might break unfair social norm on them. However, the major barrier for the fast distribution of new technologies is the lack of understanding existing power relations between genders and the weak bargaining power of women within the households. In this regard, our study attempts to investigate (1) factors that might help improve women's decision-making power and (2) the relationship between those factors and women's decision-making power.

Voluntary Delisting & Executive Compensation

Juhi Bhardwaj Sapra, PhD Student, Rensselaer Polytechnic Institute, 110 8th Street, Troy, NY, 12180, United States, bhardj@rpi.edu

this paper explores the event of voluntary delisting in the us. Delisting is defined as the process where the firm listed on an exchangeis removed. A firm can voluntarily request to be delisted and become a privately traded firm. We primarily explore the question: does executive compensation structure influence the decision to delist? Since executive compensation can be aligned with shareholder interests, we attempt to understand if it influences the managerial decision to become a private firm. If the firms choose exit the public trading in order to avoid costs, we try to explore the extent managerial compensation, would explain the decision to delist.

Does The GLL-APS Model Reward Investor Over Time?

Maria Luisa Ceprini, Research Associate, Massachusetts Institute of Technology, 100 Main Street, Cambridge, MA, 02142, United States, mceprini@mit.edu, John D Little

Our goal is to create an investment portfolio that adapts to market conditions and rewards customer expectations over time. Answers to an interview questionnaire assess the key attributes creating a customer profile to guide the investor, trading risk versus expected return over time. Afterwards, the Generalized Little's Law-Asset Picking System model selects assets and number of shares per asset to build the portfolio according to the investor profile. Periodic updates check Average Portfolio Expected Return and Average Asset Systematic Risk performances.

A Trilevel Optimization Model For Resilient Transportation Network Design

Mohammad Rahdar, Iowa State University, 3130 Turnberry CT, Unit 195, Ames, IA, 50014, United States, rahdar@iastate.edu, Guiping Hu, Jing Dong, Lizhi Wang, Xuesong Zhou

We propose a trilevel optimization model for transportation network design, which improves the resiliency of the network against uncertain disruptions. The middle and bottom levels are the network interdiction problem, in which we identify the worst-case scenario disruptions that could lead to a maximal cost to the transportation system. The top level takes the system perspective, which designs the optimal strategy to expand the existing transportation network so that it confronts the worst-case scenario disruptions in the most resilient manner.

Team Coordination In Service Organizations: Antecedents And Consequences Of Customer Involvement

Onyi Nwafor, University of Houston, 5710 Ballina Canyon Ln, Houston, TX, 77041, United States, onyid.nwafor@gmail.com

Service encounters demand both employee and customer participation. As a result, coordination in the service context should involve the integration of customer contributions (knowledge, skills, and abilities) and employee contributions to service production and delivery. Yet, existing coordination studies set in service environments continue to focus on how best to integrate employee contributions alone. This study explores the effects of customer involvement on coordination in service environments. I also propose and test how organizations can promote customer involvement. Results of my analyses have important implications for both theory and practice.

Decision Support For Dynamic Adjusting Emergency Department Workforce

Phichet Wutthisirisart, Mayo Clinic, 200 First Street SW, Harwick Bldg. 2, Rochester, MN, 55905, United States, Wutthisirisart.Phichet@mayo.edu, Mustafa Y Sir, David Nestler, Thomas Hellmich, Kalyan Pasupathy

Emergency departments (EDs) often face changes in number of patients and level of illness severities throughout a day. The goal of this study is to develop a method to best allocate available resources, such as residents and scribes, to each physician-led care team considering patient demand volume and severity. An optimization model was proposed to minimize the number of patient care hours in excess of the team capacity. The proposed model was implemented into a decision support system through the ED Clinical Engineering Learning Lab. It compares the original master schedule with the optimized schedule based on the changes in resource availability, and provides severity index as decision measure.

Predictive Analytics Approach To Analyze Vectorcardioram To Discern Myocardial Infarcted And Healthy Heart

Rupesh Agrawal, Research Assistant, Oklahoma State University, 408 Business Building, Spears School of Business, stillwater, OK, 74078, United States, rupesh.agrawal@okstate.edu, Rahim Sewani, Bruce Benjamin, Dursun Delen

Heart disease causes 610,000 deaths among the US population per year. Coronary heart disease: myocardial infarction causes ~60% of deaths. This study uses predictive modeling on Vectorcardiogram (VCG) derived RR and QT features to discern healthy and diseased patients. Neural networks (ANN), Support vector machine (SVM), Decision tree (C5), and Ensemble model were developed and tested on a 10 K cross-validation data sample. SVM and ANN models resulted in 88.14% and 86.4% overall accuracy. C5 algorithm led to a sensitivity of 100%, specificity of 96.55% and overall accuracy of ~98%. Ensemble models led to a sensitivity of 96.67%, specificity of 100.00% and overall accuracy of ~98%.

A Tale Of Three States Factors Influencing Public Private Partnership Acceptance

Vandit Shah, California State University-Fullerton, 2404 Nutwood Avenue, Apt K-12, Fullerton, CA, 92831, United States, vandit_2293@csu.fullerton.edu, Deepak Kanhaiyalal Sharma

Several infrastructure projects have been successfully pursued through Public Private Partnerships (PPPs) across the United States. While the PPPs remain same, the PPP acceptance rate across the US has been significantly different. While major emphasis has been laid to identify PPP success factors little has been done to identify factors differentiating states' PPP acceptance. This poster presents the factors that differentiate the states' PPP acceptance. Using Principal Component Analysis (PCA) we found average education, gender distribution, traffic volume and daily vehicle miles traveled as the most influential factors affecting PPP acceptance.

Attraction Recommendation For Tour Operators Under Stochastic Demand

Chao Huang, Southeast University, Nanjing, Jiangsu Province, China, huangchao@seu.edu.cn, Weihao Hu

The main stakeholders of attraction recommendations include tourists who refer to the recommendation to make traveling decisions and the tour operator who operates the recommendation. Existing attraction recommendation methods focus on recommending most relevant attractions to the tourists, yet overlook the benefit attraction recommendation could bring to the tour operator under stochastic demand. We provide a focused study on cost-based attraction under stochastic demand from the perspective of tour operators. We analyze the costs of attraction recommendation of tour operators and the impact of stochastic tourist demand, and formulate the cost-based attraction recommendation problem. We then propose a two-stage stochastic optimization model that involves joint chance constraint to optimize the attraction recommendation solution that focuses solely on tourist preferences, and solve the optimization model with Sample Average Approximation method. To verify the effectiveness of the proposed cost-based attraction recommendation method, comprehensive experimental studies are conducted with simulated instances as well as real-world case.

Dynamic Pricing Of A Bottleneck With Heterogeneous User Preferences And Value Of Time Using Tradable Credits

Mahyar Amirgholy, Postdoctoral Research Associate, Cornell University, 220 Hollister dr, Ithaca, NY, 14850, United States, amirgholy@cornell.edu, H. Oliver Gao, Eric J. Gonzales

We propose an optimal credit-based pricing scheme for a single bottleneck with time-dependent demand and heterogeneous user preferences. Implementing such a strategy using a revenue neutral credit-based pricing scheme allows the value of the credits to be determined by the interaction between the users in the equilibrium condition of the market. The proposed strategy allocates the money raised from the “credit buyers” to subsidize the commutes of the “credit sellers” in order to incentivize the commuters to form a uniform distribution of arrival times over the peak period. As a result, designing a revenue neutral pricing strategy can raise public support by improving the social welfare of the users.

Optimal Design Of The Large-scale Transit Systems In Urban Regions Using The Macroscopic Fundamental Diagram

Lan Liu, Cornell University, Ithaca, NY, 14853, United States, ll745@cornell.edu, Mahyar Amirgholy, Mehrdad Shahabi, H. Oliver Gao

In this research, we propose a continuum approximation model for optimizing the network structure (line spacing and stop spacing) and the operating characteristics (headway and fare) of the transit system by minimizing a linear combination of (1) the generalized cost that users experience in their trips, (2) the operating cost of the transit system for the agency, and (3) the external cost of the emission in region. The optimal design of the transit system can be derived by minimizing the total cost of the transportation system in three different network allocation scenarios: (i) mixed network (Bus), (ii) dedicated lanes (Bus Rapid Transit), and (iii) parallel networks (Metro).

■ Tuesday Poster Competition

Exhibit Hall

Tuesday Poster Competition

Competition Poster Session

Dynamic Pricing And Demand Side Management In Smart Communities

Vignesh Subramanian, University of South Florida, 5006, Bordeaux Village pl, Apt 201, Tampa, FL, 33617, United States, vigneshs@mail.usf.edu, Tapas K. Das

Dynamic pricing will actively engage the electricity consumers, having an advanced metering infrastructure (AMI), in centralized demand side management (CDSM), a key to price stability and network reliability. We propose a quadratic binary programming model for a centralized controller to schedule the consumer load. The numerical result demonstrates how CDSM can lower the price peaks, reduce the reserve capacity of the generator and minimize the consumer’s hourly tariff.

Multi-stage Stochastic Optimization For Considering Investment Risk In Conflict Prone Countries – A Case Study Of South Sudan

Neha Satish Patankar, PhD Student, NC State University, 2366 Champion court, Raleigh, NC, 27606, United States, nspatank@ncsu.edu

Open source framework for energy system modeling - referred to as Tools for Energy Model Optimization and Analysis, Temoa - is employed to explore possible energy planning strategies for South Sudan. Stochastic optimization is utilized to explicitly consider the risk of conflict and the resultant damage to generators and transmission lines within the system. Because data related to both conflict probabilities and damage are subjected to deep uncertainty, we rely on sensitivity analysis to generate key insights. Results show that while large, centralized plants benefit from economies of scale, distributed solar photovoltaic are more resilient to conflict.

Two-stage Methodology For Multiobjective Robust Decision Making With Application In Water-energy Planning

Daniel Jornada, Texas A&M University, 2734 San Felipe Dr, College Station, TX, 77845, United States, djornada@tamu.edu, V.Jorge Leon

The large number of compromise solutions to choose from a multiobjective program poses significant challenge for decision making. We formalize a two-stage optimization methodology to narrow the alternatives under consideration by introducing secondary robustness criteria to hedge against implementation uncertainties. A water-energy planning problem illustrates the significance of the methodology.

Modeling And Maximizing Power For Wind Turbine Arrays

Lucas Buccafusca, University of Illinois Urbana-Champaign, Urbana-Champaign, IL, United States, buccafus@illinois.edu

This talk considers a specific application domain, that of wind turbine arrays, and explores the use of partitioning and control design to optimize energy extraction. Large wind turbine arrays, or wind farms, can be viewed as coupled networks, which present many problems when applying traditional optimization techniques. In our work, we apply heuristic techniques, exploiting the inherent symmetry found in wind turbine arrays, to obtain simplified models for large arrays. Using these simplified models we first consider a dynamic programming-like approach to maximize power extraction under the condition of uniform wind.

Using A Private Marketplace To Build A Hybrid Workforce For IT Service Delivery

Monica Johar, Associate Professor, University of North Carolina, 9201 University City Blvd, Friday 352 C, Charlotte, NC, 28223, United States, msjohar@uncc.edu, Su Dong, Ram Kumar

The emergence of on-demand service marketplaces is a relatively new phenomenon. Technology is facilitating innovative work arrangements using an on-demand workforce. As the range of services available on such marketplaces increases, organizations could explore innovative uses of on-demand workers. Organizations can explore work arrangements that benefit from using a hybrid workforce that consists of full-time and on-demand workers. This paper addresses this interesting new work paradigm by presenting a mathematical programming model of service delivery that leverages in-house workers and on-demand marketplaces for service delivery.

A New Class Of Measures For Independence Test With Its Application In Big Data

Qingcong Yuan, PhD Candidate, University of Kentucky, 305 MDS Building, 725 Rose Street, Lexington, KY 40506, Lexington, KY, 40506, United States, qingcong.yuan@uky.edu, Xiangrong Yin

We introduce a new class of measures for testing independence between two random vectors, using characteristic functions. By choosing a particular weight function in the class, we study a new index for measuring independence and its property. Sample versions and their asymptotic properties using different estimations are developed. We demonstrate the advantage of our methods via simulations and real data. In particular, we illustrate the effective use of our methods in big data analysis.

A Time-series System To Predict Glucose Concentrations Based On Continuous Glucose Monitoring

Lei LI, Beihang University, Beijing, 100191, China, lilei19940219@163.com, Yimeng Shi, Jun Yang, Xiaolei Xie

The estimated prevalence of diabetes in Chinese adults in 2013 was 11.6%, which for the first time surpassed the U.S. In recent years, Continuous Glucose Monitoring (CGM) systems are developed to record the patient’s daily blood glucose level. Such systems provide us the real- time glucose level. Recently, researchers implemented AR or ARMA models on a small pool of CGM data to predict future glucose level. In this study, we developed a method by using adaptive Autoregressive Integrated Moving Average (ARIMA) model on a larger data- set rather than models with fixed-order, which is more practical and accurate as the order of the whole data is unknown before.

Optimizing Screening Policies Inside A Food Production Facility

Nicole T Lane, PhD Candidate, North Carolina A&T State University, 3511 Carrington Street, Greensboro, NC, 27407, United States, nicole.t.lane@gmail.com, Lauren Berrings Davis

New legislation requires food production facilities to have a food safety plan including mitigation strategies to increase security. This research identifies an optimal set of implementable strategies. The two-stage stochastic model presented incorporates the need for production minimums and food safety constraints. The results of a numerical study show that for relatively low costs, the implementation of these policies ensures that products leaving the facility are safe for consumption.

Multi-agent Routing In Shared Guide Path Networks

Greyson Daugherty, Georgia Institute of Technology, 765 Ferst Dr NW, Atlanta, GA, 30318, United States, sdaugherty3@gatech.edu, Spyros Reveliotis, Greg Mohler

This poster describes a heuristic algorithm for minimizing the makespan required to route a set of agents inhabiting a shared guidepath network from their initial locations to their respective destinations. The work is motivated by operations taking place in the context of some unit-load material handling systems like zone-controlled AGV systems, as well as in quantum computers. This poster presents a brief description of the considered problem and of the inner workings of the proposed algorithm, along with a set of computational results that reveal the efficacy of the derived solutions and directions for further research.

Cost Minimization Of Government Issued Cell Phones

John Yannotty, Slippery Rock University, 1 Morrow Way, Slippery Rock, PA, 16057, United States, jcy1001@sru.edu, Alexander Reid Barclay

Increasing costs associated with DSL circuits has led the United States Pentagon to study consolidation of its wireless network in attempt to minimize annual expense while maximizing efficiency. During consolidation, Private Virtual Channels (PVCs) are transferred from either low utilized or expensive circuits to existing circuits with higher utilization and lower annual cost. The consolidation process is further constrained by region, service package (VCI code), and utilization capacity per circuit. Through the use of an optimized network annual expenses are decreased from approximately $11 million to $3.1 million.

Visualization Of Cross Validation For Prediction And Classification

Alexander Engau, Associate Professor, University of Colorado Denver, P.O. Box 173364, Department of Mathematical Sciences, Denver, CO, 80217-3364, United States, aengau@alumni.clemson.edu, Paola Andrea Gonzalez

In supervised learning, the performance of data mining and machine learning algorithms is often measured and compared only numerically using cross validation. Here, we describe two case studies in which we can complement and further extend such numerical comparisons with a visualization in the form of new validation maps. These validation maps are illustrated using several state-of-the-art classifiers from Scikit-Learn and offer substantial new insights into advantages and remaining limitations of support vector machines, decision trees, boosting and discriminant analysis.

Bayesian Optimization Of Predictive Precision For Business Ledger Analytics

Abhinav Maurya, Carnegie Mellon University, 5634 Stanton Avenue, Apt 306, Pittsburgh, PA, 15206, United States, ahmaurya@gmail.com, Aly Megahed

Predicting changes in account revenues is of vital importance to a business in order to take action on accounts that are predicted to shrink, and to learn from success stories of offerings that led to maximum revenue growth. However, the corresponding datasets are often imbalanced, and therefore accuracy is a poor metric to optimize for. We present a Gaussian Process-based method that maximizes precision, yielding actionable results without sacrificing much accuracy. We find that our method gives better results than exhaustive uniform grid search, since Gaussian Process-based optimization can focus on areas of parameter space that have higher chances of attaining the maximum objective value.

The Continuous Network Location Problem For The Alternative Fuel Refueling Station

Sang Jin Kweon, PhD Candidate, Pennsylvania State University, 310 Leonhard Building, Industrial and Manufacturing Engineering, University Park, PA, 16802, United States, svk5333@psu.edu

Unstable price of oil and concerns about the finite nature of reserves, coupled with increasing awareness of the environmental issues caused by the burning of fossil fuels, increased spotlight on alternative-fuel vehicles. In order to stimulate the use of alternative-fuel vehicles, the inherent problem with the lack of refueling infrastructure must be resolved. In this study, we propose a novel methodology to locate an alternative-fuel refueling station on a road network with the objective of maximizing the total traffic flow covered by the station, so that more customers are able to refuel their alternative-fuel vehicles.

Optimal Number Of Choices In Rating Contexts

Sam Ganzfried, Assistant Professor, Florida International University, 11200 SW 8th St, Miami, FL, 33199, United States, sam.ganzfried@gmail.com

In many settings people give numerical scores to entities from a small discrete set, e.g., attractiveness from 1-5 on dating sites and papers from 1-10 for conferences. We study the problem of understanding when using a different number of options is optimal. We study several natural processes for score generation. One may expect that using more options always improves performance, but we show that this is not the case, and that using fewer choices—even just two—can surprisingly be optimal. Our results suggest that using fewer options than typical could be optimal in certain situations. This would have many potential applications, as settings requiring entities to be ranked by humans are ubiquitous.

Improving Patient Access To Primary Care Through E-visits

Xiang Zhong, University of Florida, Gainseville, FL, 32601, United States, oliver040525@gmail.com, Jingshan Li, Philip Bain, Albert Musa, Peter Hoonakker

To improve primary care access, many healthcare organizations have introduced electronic visits to provide patient-physician communication through securing messages. In this study, we introduce an analytical model to characterize primary care physician's operations on office and e-visits, and other non-direct care tasks. Analytical formulas to evaluate the mean and variance of patient office visit and e-visit cycle times are derived, and discussions of the impacts of e-visits on traditional primary care delivery are carried out. It can be observed that the patient e-visit to office visit referral ratio plays an important role in determining whether it's beneficial to conduct e-visits.

Optimizing Inventory Under Non-stationary Demand For Profitability Improvement

Liu Yang, Assistant Professor, Purdue University, 3000 Technology Ave, New Albany, IN, 47150, United States, LYang@purdue.edu

This research presents a multi-period optimization model that integrates inventory classification and control decisions to maximize the NPV of profit. The model explicitly addresses nonstationary demand, limited inventory budget, arbitrary reviews periods, and SKU-specific lead times and holding costs. The model is applied to a real-life company that currently uses the multi-criteria inventory classification, and improves its profit by nearly 3%. The comparison to the ABC shows an average profit increase of 7.5%. We find that profit is insensitive to the number of classes in a wide range, but when the budget is tight, a large number of classes with a wide range of service levels is optimal.

Analytics In Action: When Will I Get Out Of The Hospital? Modeling Length Of Stay Using A Disease Network

Pankush Kalgotra, PhD Candidate, Oklahoma State University, 308 W Maple Avenue, Apt 5, Stillwater, OK, 74074, United States, pankush@okstate.edu, Ramesh Sharda

Comorbidity is a medical condition when a patient develops multiple diseases simultaneously. We examine the impact of comorbidity on the patient's hospital length of stay (LOS). We present a unique approach to model comorbidities by creating a network of diseases from the pair-wise combinations of the diseases diagnosed in the 1.6 million patient visits in US hospitals in 2011. Using the small-world property of the network, we proposed a new comorbidity score for a patient. Finally, we built an explanatory and predictive model on the patient visits in 2012, to predict a patient's LOS. The model with our proposed comorbidity score outperformed the existing models.

The GetFruved Project Uses Integer Programming To Match Freshmen To Peer Mentors

Wangcheng Yan, The University of Tennessee, Knoxville, Knoxville, TN, 37996, United States, wcyan2009@hotmail.com, Wenjun Zhou, Sarah Colby, Kendra Kattelmann, Anne Mathews, Melissa D. Olfert

In this study, we took a quantitative approach to the friend-matching problem to assign peer mentors (PMs) to freshmen (FMs) recruited for the GetFruved project. A 20 "fun"-question survey was used to develop the PM-FM matching algorithm. Data were collected from two semesters. Semester 1 served as training period, and matching was made in Semester 2. Our strategy was to train a model with logistic regression, and optimize the matching with integer programming. The empirical study verified the homophily theory, and demonstrated the effectiveness of our approach to identifying the optimal PM assignments.

Dynamic Model Validation Metric Based On Wavelet Thresholded Signals

Andrew D Atkinson, Captain, Air Force Institute of Technology, 2950 Hobson Way, Wright-Patterson AFB, OH, 45433, United States, andrew.atkinson@afit.edu, Raymond R Hill

Model validation is a vital step in simulation development to ensure that a model is sufficiently representative of the system. Transient phase model validation deserves special attention because the experimental system data is often contaminated with noise, due to the short duration and sharp variations in transient data. We propose a process to validate the transient phase of a model that uses wavelet thresholding to de-noise the data signals and calculates a validation metric that incorporates shape, phase, and magnitude error. A simulation study and empirical data from an automobile crash study illustrate the wavelet thresholding validation approach.

Joint Service In Primary Care Clinics

Hyo Kyung Lee, University of Wisconsin-Madison, 313 N Frances St Apt 601, Apt 601, Madison, WI, 53703, United States, hlee555@wisc.edu, Xiang Zhong, Jingshan Li, Albert Musa, Philip Bain

To improve patient flow and reduce provider workload, joint service has been proposed and implemented in many primary care clinics. As no model is available yet to quantify joint visit's impact, we introduce Markov chain models of patient flow with joint visits, and investigate the system behavior under different scenarios. Particularly, to reduce the state space dimension, convergent iterative procedures are proposed. Furthermore, the study is extended to non-Markovian case by introducing empirical formulas. To illustrate the applicability of the methods, an application study at Dean East Clinic is presented.

Tuesday, 1:30PM - 3:00PM

■ TC01

101A-MCC

Ensemble Methods in Data Mining

Sponsored: Data Mining

Sponsored Session

Chair: Waldyn Martinez, Miami University, 117 Country Club Dr., Oxford, OH, 45056, United States, wmartine@cba.ua.edu

1 - Ensemble Methods For Credit Risk Assessment

Youqin Pan, Salem State University, Bertolon School of Business, 352 Lafayette Street, Salem, MA, 01970, United States, ypan@salemstate.edu

More and more banks and financial institutions have started to pay more attention on credit risk due to the recent financial crisis. This paper aims at improving predictive powers of the credit score models using bagging and boosting algorithms.

2 - Multi-engine Out-of-sample Boosting

Meinolf Sellmann, Senior Manager, IBM Research, 1101 Kitchawan Rd, Yorktown Heights, NY, 10566, United States, meinolf@us.ibm.com

We present a new machine learning method that combines ensemble learning with meta-algorithmics, in particular algorithm portfolios. The result is a method that automatically determines a collection of predictive models which may or may not not consider the same concept class. To avoid over-fitting, these models are never trained on examples from regions they are later used for, nor do we ever combine predictions with each other. A portfolio method is used to select one and only one predictor at runtime, which effectively serves as regularization technique. Numerical results demonstrate that the new method massively improves the state of the art in predictive modeling.

3 - Applying Directed Acyclic Graph-based Ensemble Method For Analyzing Huge And Mixed Data In Mobile Manufacturing

Seonghyeon Kang, Samsung Electrotics, Suwon, Korea, Republic of, shyeon.kang@gmail.com

In mobile manufacturing, following the rapidly increasing deployment of sensing to maintain high productivity and quality, the data that we have to analyze is growing exponentially. However, in practical approach, constructing the predictive model is difficult because of the huge size of data and the mixed datatypes on the training phase. In this study, we propose the efficient ensemble method to handle those problems in mobile devices manufacturing. The effectiveness of the proposed method is demonstrated by real data from the mobile plant in one of the leading mobile companies in South Korea.

4 - Reducing The Complexity Of Ensemble Methods For Use In Large Scale Multidimensional Data

Waldyn Martinez, Assistant Professor of Business Analytics, Miami University, 117 Country Club Dr., Oxford, OH, 45056, United States, martinwg@miamioh.edu

Ensemble models refer to methods that combine a typically large number of fitted values into a bundled prediction. A key challenge of using ensembles in large-scale multidimensional data lies in their complexity and the computational burden they create. Recent research effort in ensembles has concentrated in reducing ensemble size, while maintaining their predictive accuracy. Here, we propose a way to reduce the complexity of an ensemble solution by optimizing on its margin distribution, while reducing their similarity. The proposed method results in an ensemble that uses only a fraction of the original weak learners, with improved or similar generalization performance.

■ TC02

101B-MCC

Data Mining in Medical and Brain Informatics I

Sponsored: Data Mining

Sponsored Session

Chair: Chun-An Chou, SUNY Binghamton, 4400 Vestal Parkway East, Binghamton, NY, 13902, United States, cachou@binghamton.edu

Co-Chair: Sina Khanmohammadi, SUNY Binghamton, 4400 Vestal Parkway East, Binghamton, NY, 13902, United States, skhanmo1@binghamton.edu

1 - Artificial Neurons Meet Real Neurons: Pattern Selectivity In V4

Reza Abbasi-Asl, University of California, Berkeley, CA, United States, abbasi@berkeley.edu, Yuansi Chen, Adam Bloniarz, Jack L. Gallant, Bin Yu

Vision in humans and in non-human primates is mediated by a constellation of hierarchically organized visual areas. One important area is V4 which has highly nonlinear response properties. To better understand the filtering properties of V4 neurons we recorded from 71 well isolated cells stimulated with 4000-12000 static grayscale natural images. We fit predictive models of neuron spike rates using transformations of natural images learned by a convolutional neural network (CNN). Furthermore, we introduce new processes for interpreting such models. We conclude that the V4 neurons are tuned to a remarkable diversity of shapes such as curves, blobs, checkerboard patterns, and V1-like gratings.

2 - A New Adaptive Seizure Onset Detection Framework

Sina Khanmohammadi, SUNY Binghamton, 4400 Vestal Pkwy E, SSIE Department, Binghamton, NY, 13902, United States, skhanmo1@binghamton.edu, Chun-An Chou

In this study, we present a new adaptive distance-based seizure detection algorithm that provides comparable performance to more complex seizure onset detection methods in the literature using much less computational resources. The proposed framework is validated using CHB-MIT dataset, which is one of the most comprehensive scalp EEG recordings of pediatric epileptic patients.

3 - Efficient Heuristic For Large Scale Networked Data Classification

Daehan Won, University of Washington, wondae@uw.edu

Networked data classification is a kind of data classification where each instance is a constructed by networked structure. Similar to the current data classification, it involve huge computation time and over fitting results when the input networks have complicated structure with large size of nodes and links. To overcome those drawbacks, we present a new mathematical model based on the node selection scheme and provide a heuristic algorithm to solve the proposed math. model which is NP-hard. As a demonstration, we provide investigation results based on the human brain networks as well as simulated data set.

■ TC03

101C-MCC

Panel: Publication Tips

Sponsored: Junior Faculty JFIG

Sponsored Session

Moderator: Anahita Khojandi, University of Tennessee, Knoxville, TN, United States, anahitakhojandi@gmail.com

1 - Panel Discussion: Tips For Successful Publication From Journal Editors

Anahita Khojandi, University of Tennessee, Knoxville, TN, United States, khojandi@utk.edu

The panelists consist of past and current editors from top journals, including Management Science, Operations Research, INFORMS Journal on Computing and Decision Analysis. The editors will share tips on how to get your paper successfully published, from selecting the right journal and preparing the manuscript, to revising the paper and responding to reviewers' comments. They will also answer questions pertaining to writing and publication.

2 - Panelist

Alice Smith, Auburn University, 3301 Shelby Center, Auburn, AL, 36849, United States, smithae@auburn.edu

3 - Panelist

Jay Simon, American University, 4400 Massachusetts Avenue, NW, Washington, DC, 20016, United States, jaysimon@american.edu

4 - Panelist

Alice Smith, Auburn University, Auburn, AL, United States, smithae@auburn.edu

5 - Panelist

Douglas Shier, Clemson University, Clemson, SC, United States, shierd@clemson.edu

6 - Panelist

Serguei Netessine, Insead, Singapore, Singapore, serguei.netessine@insead.edu

■ TC04

101D-MCC

Power System Operations Under Increasing Uncertainty

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Antonio J. Conejo, Prof., The Ohio State University, 1971 Neil Avenue, 286 Baker Systems Engineering, Columbus, OH, 43210, United States, conejonavarro.1@osu.edu

Co-Chair: Ramteen Sioshansi, Ohio State University, 1971 Neil Avenue, Columbus, OH, 43210, United States, sioshansi.1@osu.edu

1 - Ramp Capability Modeling For Reliable And Efficient Integration Of Renewable Energy

Congcong Wang, MISO, Carmel, IN, United States, cwang@misoenergy.org, Dhiman Chatterjee

With increasing penetration of renewable energy, net load variations and uncertainties impose challenges to maintain real-time power balance. This presentation highlights MISO's recent development of Ramp Capability Product to manage system ramping needs. It starts with an examination of recent market evolutions that drive both operational and economic needs of resource flexibility and then presents the design of Ramp Capability Product that systematically pre-position resources with flexibility to meet future net load at a specified level of confidence. More importantly, explicit price signals are developed to reflect the underlying cost causation and provide economic incentives.

2 - Is Being Flexible Advantageous For Demands?

Farzaneh Abbaspourtorbati, EPFL, Lausanne, Switzerland, Farzaneh.Abbaspourtorbati@swissgrid.ch, Antonio J. Conejo, Jianhui Wang, Rachid Cherkaoui

This paper analyzes the impacts of flexible demands on day-ahead market outcomes in a system with significant wind power production. We use a two-stage stochastic market-clearing model, where the first stage represents the day-ahead market and the second stage the real-time operation. On one hand, flexibility of demands is beneficial to the system as a whole since such flexibility reduces the operation cost, but on the other hand, shifts in demands from peak periods to off-peak periods may influence prices in such a way that demands may not be willing to provide flexibility. Specifically, we investigate the impacts of different degree of demand flexibility on day-ahead prices.

3 - Aggregating (almost) Symmetric Generators In Unit Commitment

Ben Knueven, University of Tennessee, Knoxville, TN, United States, bknueven@vols.utk.edu, Jim Ostrowski, Jean-Paul Watson, Jianhui Wang

We consider a method to precisely aggregate symmetric ramping unconstrained generators in unit commitment formulations. We apply the same methods to nearly symmetric generators to create symmetric relaxations of the unit commitment problem, and empirically test the strength of the relaxation. We demonstrate massive computational improvements over the standard formulation for the CAISO set of generators. Extensions to accelerate stochastic unit commitment are also examined.

■ TC05

101E-MCC

Reliable Power System Design and Operations

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Bo Zeng, University of Pittsburgh, Benedum Hall 1009, Pittsburgh, PA, 15261, United States, bzeng@pitt.edu

1 - Tighter Modeling And Enhanced Solutions For Power System Operations Under Uncertain Environment

Lei Wu, University of Clarkson, lwu@clarkson.edu

In emerging power systems, as the generation side gets more distributed and the demand side becomes more active, it is of critical importance to evaluate the impacts of individual assets on the reliable and economic operation of power systems. This presentation will highlight several key issues in the operation of power systems with significant penetration of renewable energy and DR assets, and discuss advanced modeling and optimization techniques, robust security-constrained unit commitment (SCUC) models in particular, for enhancing the reliability and economics of power system operations under uncertain environment.

2 - Reliable Fuel Supply Chain Design

Bo Zeng, University of Pittsburgh, bzeng@pitt.edu, Anna Danandeh, Brent Caldwell

To ensure reliable operations of a power plant, an optimization based fuel supply chain model is developed and implemented.

■ TC06

102A-MCC

Data-Intensive Computational Methods for Large-scale Infrastructure Systems

Sponsored: Data Mining

Sponsored Session

Chair: Adrian Albert, C3IoT, 1300 Seaport Boulevard, Suite 500, Redwood City, CA, 94063, United States, adrian.t.albert@gmail.com

1 - Sparse Data Analytics For Modern Engineering Systems

Borhan Sanandaji, Risk Management Systems (RMS), Hall, Newark, CA, 24061, United States, sanandaji@eecs.berkeley.edu

Forecasting plays a vital role in reliable operation of modern engineering systems such as smart grids and transportation systems. These systems are often large-scale and generate a huge amount of data. It is, therefore, quite important to come up with forecasting schemes that can deal with such high-dimensionality. In this work, we propose a Sparse Spatio-Temporal Forecasting (SSTF) scheme which exploits the intrinsic low-dimensionality and structure of the generated data. We applied SSTF to predict wind speed, residential electric load, and solar irradiance in different scenarios to prove its significance as compared to other benchmark models.

2 - A Learning Based Method For Real Time Prediction Of Cascading Failures

Yue Zhao, Stony Brook University, Stony Brook, NY, United States, yue.zhao.2@stonybrook.edu, Jianshu Chen

Real time prediction of imminent cascading failures in a dynamically evolving power grid is studied. As the cascade look-ahead window increases, the number of future cascade scenarios grows exponentially. A novel learning based method is developed to compute the marginal failure probability of each line due to cascades at times deep into the future. The proposed method enjoys the unique advantage that a labeled data set can be generated in an arbitrarily large amount at very low cost. Numerical results demonstrate that the off-line trained predictive model provides very fast online and accurate prediction of cascading failures.

3 - New Approaches In Data Analysis For Infrastructural Networks: Combinatorial Hodge Theory

Chase Dowling, University of Washington, Seattle, WA, United States, Cdowling@uw.edu, Lillian Ratliff, Baosen Zhang

Recent advances in Hodge theory have shed light on a deep relationship between graph theory and calculus. One important theorem in calculus—the Helmholtz decomposition—splits a vector field into conservative and solenoidal components. The combinatorial Hodge decomposition extends this technique to graphs, and gives conservation law respecting flows on edges. Power, gas, and traffic networks all respect some form of conservation law, and their optimal utilization has proven difficult owing to nonlinearities in flow. We explore a novel application of the Hodge decomposition in traffic and power networks with the aim of developing control strategies in face of these nonlinearities.

4 - Energy Profile Prediction: Implications For Electric Vehicle Demand Response

Caroline Camille Le Floch, University of California, Berkeley, Berkeley, CA, United States, caroline.le-floch@berkeley.edu, Scott Moura

This work shows a predictive framework that uses demographic data to predict energy profiles and acceptance of smart grid tariffs. Our analysis is based on the Australian Smart Grid Data, including electricity use interval readings, customer demographics, peak event offers and acceptances. First, we use clustering methods to define a representative dictionary of hourly load shapes, and assign individual energy profiles as his/her most frequently used shapes. Second, we present the performance of several estimators to predict energy profiles and peak event responses from demographic data. Third, we discuss implications for designing smart grid programs for Electric Vehicles owners.

■ TC07

102B-MCC

Information and Influence Diffusion in Networks

Sponsored: Data Mining

Sponsored Session

Chair: Wenjun Wang, University of Iowa, Pappajohn Business Building, Iowa City, IA, 52242-1994, United States, wenjun-wang@uiowa.edu

1 - Community Detection And Correlation Analysis

Lian Duan, Hofstra University, Hempstead, NY, United States, Lian.Duan@hofstra.edu, Nick Street, Yanchi Liu, Meral Binbasioglu, Haibing Lu

The advances in graphs play an important role to understand interrelated data. Inside graphs, there are usually community structures where different portion of nodes are more tightly connected to form a group, and community detection has wide applications in marketing, management, health care, and education. Nowadays, many different methods are proposed to detect community structures from different perspective. In our research, we build a connection between community detection and correlation analysis. It helps to utilize the progress in correlation analysis for community detection.

2 - Detection Of Online Manipulation And Information Diffusion

Onur Varol, Indiana University, ovarol@indiana.edu

Social media have become vehicles for instantly disseminating and accessing information on a global scale. Understanding mechanisms governing information diffusion is important and detection of malicious intents and activities are also curious. In this talk, I will present our prediction and early detection framework for social media campaigns and our online social bot detection platform called BotOrNot. Then I will present our work on information diffusion on heterogenous-intent networks. We experiment with user-level perception of messages, analyze large-scale information cascades, and model information diffusion in heterogeneous-intent networks.

3 - Modeling Influence Diffusion For Viral Marketing In Social Networks

Wenjun Wang, University of Iowa, Iowa City, IA, United States, wenjun-wang@uiowa.edu, Nick Street

Viral marketing is a technique that induces users in a social network to pass on a marketing message to other users so as to achieve the largest cascade of product sales. It can be formulated as an influence maximization problem under a stochastic diffusion model. In this paper, we propose a novel Multiple-path-based Asynchronous Cascade (MAC) model, which captures both direct influence from neighboring influencers and indirect influence from influencers two or three hops away. It also takes into account influence attenuation along diffusion paths, influence decay over time, and temporal diffusion dynamics. We then investigate various heuristics to address the influence-maximization problem.

4 - How Peer Influence Affects Preference Evolution And Product Selection In Offline Retail

LIN ZHAO, Tsinghua University, Tsinghua University, Shunde Builiding Room 615, Beijing, 100084, China, zhaolin14@mails.tsinghua.edu.cn

We combine offline retail with social network by presenting different types of social network information to consumers. We also investigate how the social influence mechanism may differ for different types of products. We propose a multistage conjoint choice experiment to observe initial preferences and products selection of consumers prior to observing their choice interdependence. We try to show that it is possible to improve marketing response through the visibility of consumers' social network information. Also, we want to support the recommendation system for offline retail.

■ TC08

103A-MCC

Ethics and Sustainable Business Models

Invited: Business Model Innovation

Invited Session

Chair: Elena Belavina, University of Chicago Booth School of Business, Chicago, IL, United States, elena.belavina@chicagobooth.edu

1 - Honesty, Ethical Free Agency And The Hold-up Problem

Manu Goyal, University of Utah, Salt Lake City, UT, United States, Manu.Goyal@eccles.utah.edu, Krishnan S Anand, He Chen

We construct a finite-horizon model of incomplete contracts, where contracting partners are vulnerable to ex-post opportunism and hold-ups, that also integrates bounded rationality, moral hazard and adverse selection. We prove that an honest player - who never holds up its contracting partner - can obtain strictly greater profits than an unconstrained profit-maximizer, even though the latter has access to a superset of strategies, including the option of mimicking the honest type. Our research provides a bridge between normative rationales for honesty, the province of ethics, and profit-maximization, which is axiomatic in economics, by providing a compelling economic rationale for honesty.

2 - Increasing The Adoption Of New Life-improving Technologies

Gonzalo Romero, Rotman, University of Toronto, 91 Ferrier Avenue, Toronto, ON, M4K 3H6, Canada, gonzalo.romero@rotman.utoronto.ca, Andre Du Pin Calmon

Motivated by the operations of a distributor of life-improving technologies in India, we consider a model where a retailer sells an item to risk averse consumers, who derive an uncertain value from using this product. Without external intervention, the market might collapse such that no sales occur. The distributor intervenes in the market using two levers: (i) educating consumers, which reduces the uncertainty in their valuation and (ii) implementing a reverse logistics channel that allows for regret-returns and also a higher salvage value for the retailer. We compare the relative effectiveness and substitutability degree of each of these levers.

3 - New, Refurbished, And Used: Key Factors That Influence Consumers' Choices

Erin Cassandra McKie, University of South Carolina, 1014 Greene Street, Columbia, SC, 29212, United States, erinmckie@gmail.com, Mark Ferguson, Michael Galbreth, Sriram Venkataraman

Remanufacturing is increasingly providing new profit opportunities for firms, as well as more product condition options - such as new, refurbished, and used - for consumers to choose. Using secondary data and choice model analysis techniques, we estimate the influence of various factors on consumers' purchasing decisions

4 - Kicking Ash: Who (or What) Is Winning The War On Coal?

David Drake, Harvard Business School, ddrake@hbs.edu

Power generators throughout the U.S. have shed coal capacity at an unprecedented rate over the past few years. Multiple stakeholders have claimed credit - natural gas executives, renewables advocates, policy makers, and environmental NGOs among them. In this nascent work, we explore the extent to which each has impacted the expected life of coal-fired power generating units.

■ TC09

103B-MCC

Environmental Logistics and Supply Chain Operations

Sponsored: Energy, Natural Res & the Environment I Environment & Sustainability

Sponsored Session

Chair: Dincer Konur, Missouri University of Science and Technology, Rolla, MO, United States, konurd@mst.edu

1 - Economic And Environmental Considerations In A Stochastic Inventory Control Model With Order Splitting Under Different Delivery Schedules Among Carriers

James F Campbell, University of Missouri-St Louis, campbell@umsl.edu, Dincer Konur, Sepideh Monfared

We analyze an integrated inventory control and delivery scheduling problem with stochastic demand and economic and environmental considerations. Models consider order splitting among many carriers and two delivery scheduling policies: sequential splitting and sequential delivery. Bi-objective mixed-integer nonlinear models are formulated and solved with an adaptive -constraint algorithm and an evolutionary search algorithm to approximate the Pareto front. Numerical studies are used to compare the algorithms, explore the effects of demand variance, show how delivery policy and carrier selection affect performance, and document the need for a good approximation of the Pareto front.

2 - Environmental Considerations In Liner Shipping And Vessel Scheduling

Maxim A Dulebenets, Florida State University, Tallahassee, FL, United States, mdlbnets@memphis.edu, Mihalis Golias, Sabya Mishra

Carbon dioxide emissions from maritime transportation constitute 2.2% of the world's anthropogenic carbon dioxide emissions. A number of environmental regulations were released by the International Maritime Organization to reduce the pollution levels over the last decade. Considering an increasing attention of the community to environmental issues in liner shipping, this presentation will focus on: 1) approaches for modeling emissions produced by vessels; and 2) alternatives that would reduce vessel emissions and improve environmental sustainability. A number of case studies will be presented to demonstrate how negative environmental externalities can be alleviated.

3 - Freight Demand Management And It's Role In Sustainable Supply Chains

Johanna Amaya, Rensselaer Polytechnic Institute, Troy, NY, 12180, United States, amayaj@iastate.edu
Johanna Amaya, Iowa State University, Ames, IA, 50011, United States, amayaj@iastate.edu

A wide range of potential actions could enhance the sustainability of urban freight activity ranging from supply to demand sides. By far, the least frequently used group is freight demand management (FDM). Managing the demand could play a key role in increasing the sustainability of urban freight activity as this group seeks to alter the demand for freight to mitigate the negative impacts produced. Instead of focusing on the carriers, these initiatives focus on changing the behavior of the receivers of the supplies, which are the ones that generate the demand. Their potential and current implementation is discussed as a tool to foster sustainable supply chains.

4 - Analysis Of Non-cooperative Joint Emissions Targeting Decisions In A Leader-follower Channel

Dincer Konur, Missouri University of Science and Technology, konurd@mst.edu

In this study, we analyze joint emission targeting along a leader-follower channel. In particular, a non-cooperative game theory model is constructed to determine the agents' decisions on joining their emissions targets. Joint emission targeting might decrease individual as well as channel costs while ensuring that total emissions do no exceed cumulative emission target. We characterize the equilibrium solution of this game. Furthermore, how costs and emissions change with joint targeting is analyzed. In addition, we investigate the role of the leader on channel emissions and costs. It is discussed that changing the leader might decrease not only costs but also emissions.

■ TC10

103C-MCC

Optimizing Distributed Energy Generation I

Sponsored: Energy, Natural Res & the Environment, Energy II Other

Sponsored Session

Chair: Alexandra M Newman, Colorado School of Mines, Golden, CO, newman@mines.edu

1 - Optimizing The Design Of A Hybrid, Distributed Energy Generation System With Alternate, Renewable Technologies

Gavin Goodall, Colorado School of Mines, Golden, CO, ggoodall@mymail.mines.edu

We formulate a mixed integer linear program to select renewable technologies such as photovoltaic panels, hydrogen fuel cells and plasma converters, and conventional technologies such as diesel generators and lithium-ion batteries, to minimize system costs subject to operational, load, and spinning reserve constraints. We use statistical models to generate realizations of load and solar irradiance. Solutions from our optimization model prescribe both a procurement and an hourly dispatch strategy for these realizations.

2 - Geothermic Fuel Cell System Modeling And Optimization

Gladys Anyenya, Colorado School of Mines, Golden, CO, ganyenya@mymail.mines.edu

This study presents a techno-economic nonlinear optimization model to determine the optimal design and dispatch of a Geothermic Fuel Cell (GFC) system. GFCs present an ambitious new approach to cost-effective, environmentally responsible oil-shale processing. Heat produced from solid-oxide fuel cells (SOFCs) during electricity generation is used to directly retort oil shale into liquid oil and natural gas. The electricity produced by the SOFCs during the oil-liberation process can be used to drive other balance-of-plant equipment, or be placed back onto the grid. The model solves for the optimal GFC operating conditions that meet the system electricity and heating demands at the lowest cost.

3 - Optimization Of Energy Efficient Operation Of HVAC System As Demand Response With Distributed Energy Resources

Young M Lee, IBM Research Center, 1101 Kitchanwan Road, P.O. Box 218, Yorktown Heights, NY, 10598, United States, ymlee@us.ibm.com, Raya Horesh, Leo Liberti

A model predictive control (MPC) framework that optimally determines control profiles of the HVAC system as demand response in presence of on-site distributed energy resources such as energy storage system and energy generation system is described. The approach computes optimal set point profile of HVAC system that minimizes the total energy costs and GHG emission, considering demand response signal, on-site energy storage system, and on-site energy generation system while satisfying thermal comfort (e.g., zone temperature) within physical limitations of HVAC equipment, energy storage system and energy generation system.

4 - An Optimization Model For Leftover Biomass Feedstock

N. Muhammad Aslaam Mohamed Abdul Ghani, Graduate Student, North Dakota State University, 1320 Albrecht Blvd, Quentin Burdick Building, Fargo, ND, 58108, United States, nmuhammadaslaam.moha@ndsu.edu, Chrysafis Vogiatzis, Joseph Szmerekovsky

We address the issue of leftover biomass feedstock by designing a biomass supply chain for biofuel and biopower production. A mixed integer linear program (MILP) is proposed to minimize total societal costs in the supply chain and is then used to analyze the impact of government incentives for producing biofuel and biopower. Potential farms for incentivizing will be identified using the proposed model, which can be useful tool for decision and policy makers.

■ TC11

104A-MCC

Paths, Cycles, and Transversals

Sponsored: Optimization, Network Optimization

Sponsored Session

Chair: Balabhaskar Balasundaram, Oklahoma State University, 322 Engineering North, Stillwater, OK, 74078, United States, baski@okstate.edu

1 - Algorithms For Cycles In Graphs

James B Orlin, Massachusetts Institute of Technology, jorlin@mit.edu

We present: an O(nm) algorithm for finding the least cost cycle in a graph, an O(nm log n) randomized algorithm for finding the shortest negative cost cycle in a graph, and a proof that finding the 2nd shortest s-t path is "harder" than finding the least cost cycle.

2 - New Facets For The Clique Transversal Polytope

Timothy Becker, Rice University, tjbecker04@gmail.com

The Clique Transversal Problem is the problem of finding a minimum set of nodes that covers every maximal clique in a given graph. We define three new classes of facets for the Clique Transversal Polytope. These are extensions of the classes of facets with coefficients in {0,1,2} for the set covering polytope. One class contains an odd hole with distinct cliques on each edge of the hole. The second similar class contains a clique with distinct cliques on |K| edges, where |K| is the number of nodes in the given clique. The last class contains a clique with distinct cliques on every edge of the initial clique.

3 - Elementary Shortest Path Problem On Networks Containing Negative Cycles

Baski Balasundaram, Oklahoma State University, Stillwater, OK, United States, baski@okstate.edu, Devaraja Radha Krishnan

In this talk, we consider the elementary shortest path problem (to find a shortest path from a specified origin to destination) in a directed network that contains negative cycles. This problem is known to be NP-hard unlike its classical counterpart on networks without negative cost directed cycles. We propose a delayed constraint generation framework to solve this problem using a branch-and-cut algorithm. Two variants are proposed and compared against solving direct formulations of this problem. Results and insights from our computational study will be reported.

4 - Speed Optimization Over A Path In Quadratic Time

Xiaochen Zhang, University of Minnesota, zhan4487@umn.edu, Qie He, Kameng Nip

The speed optimization problem over a path aims to determine speed over each arc of the given path to minimize the total cost, while respecting speed limits over arcs and time-window constraints of the nodes. The cost over each arc is a strictly differentiable convex function of the speed over the arc. This problem is motivated by the goal of improving fuel efficiency in maritime transportation. It can be formulated as a min-convex-cost flow problem. We propose an iterative algorithm running in time quadratic in the number of nodes over the path. This is joint work with Qie He and Kameng Nip.

■ TC12

104B-MCC

New Results on Nonconvex Optimization

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Daniel Bienstock, Columbia University, 500 W 120th St, New York, NY, 10027, United States, dano@columbia.edu

Co-Chair: Daniel Bienstock, Columbia University, Departments of IEOR and APAM, Columbia University, New York, NJ, 10027, United States, dano@columbia.edu

1 - Centerpoints: A Link Between Optimization And Convex Geometry

Amitabh Basu, Johns Hopkins University, basu.amitabh@jhu.edu, Timm Oertel

We introduce a concept that generalizes several different notions of a "centerpoint" in the literature. We develop an oracle-based algorithm for convex mixed-integer optimization based on centerpoints. Further, we show that algorithms based on centerpoints are "best possible" in a certain sense. Motivated by this, we establish several structural results about this concept and provide efficient algorithms for computing these points.

2 - On Decomposability Of Multilinear Sets

Alberto Del Pia, University of Wisconsin-Madison, delpia@wisc.edu, Aida Khajavirad

We consider the Multilinear set defined as the set of binary points satisfying a collection of multilinear equations. Such sets appear in factorable reformulations of many types of nonconvex optimization problems, including binary polynomial optimization. In this talk, we study the decomposability properties of Multilinear sets. Utilizing an equivalent hypergraph representation, we derive necessary and sufficient conditions under which a Multilinear set is decomposable based on the structure of pair-wise intersection hypergraphs. Finally, we propose a polynomial-time algorithm to optimally decompose a Multilinear set into simpler subsets.

3 - An FPTAS For Minimizing Some Indefinite Quadratics Over The Integer Points In A Polyhedron In Fixed Dimension

Robert Hildebrand, IBM Research, robdhildebrand@gmail.com

Although integer linear programming is an NP-Hard problem, Lenstra showed that in fixed dimension the problem can be solved in polynomial time. On the other hand, the problem of minimizing a quartic polynomial objective function over the the integer points in polyhedra is NP-Hard even in dimension 2. The complexity of minimizing quadratic and cubic polynomials in fixed dimension remains an open question. As a step in this direction, we will present an FPTAS for minimizing some quadratic polynomials in fixed dimension.This is joint work with Robert Weismantel and Kevin Zemmer.

■ TC13

104C-MCC

Recent Advances in Computational Optimization

Sponsored: Optimization, Computational Optimization and Software

Sponsored Session

Chair: Gonzalo Munoz, Columbia University, 500 W. 120th Street, IEOR Department, New York, NY, 10027, United States, gonzalo@ieor.columbia.edu

1 - Low-rank/sparse-inverse Decomposition

Victor Fuentes, University of Michigan, Ann Arbor, MI, United States, vicfuen@umich.edu, Jon Lee

A well-known matrix decomposition problem is to split an input matrix into sparse and low-rank components. We look at decomposing an input matrix as the sum of a matrix having a sparse inverse and a low-rank matrix. One approach that we have developed is a convex SDP approximation. Also, employing the Woodbury matrix identity, we establish another framework for attacking the problem. Our numerical results demonstrate that: (1) our proposed methodology is useful and practical, (2) our method leads to a means for generating good test instances for algorithms that we are developing for the problem, and (3) a direct generalization of the recovery theorem for the ordinary version of the problem is unlikely.

2 - Improving The Randomization Step In Feasibility Pump

Andres Iroume, Georgia Institute of Technology, airoume@gatech.edu, Santanu Subhas Dey, Marco Serpa Molinaro, Marco Serpa Molinaro

In this work, we modify the randomization step in feasibility pump. This step is used when staling is detected in order to avoid cycling. In our version, we use a WALKSAT-type method that automatically detects sparse structures. We prove theoretical upper bounds on the running time (to the best of our knowledge for the first time for feasibility pump) and provide computational results that show a considerable reduction both in terms of numbers of iterations and computing time when applied to MIPLIB instances.

3 - A Branch-and-bound Algorithm For The Facility Location Problem With Random Utilities

Eduardo Moreno, Universidad Adolfo Ibáñez, Santiago, Chile, eduardo.moreno@uai.cl, Alexandre S Freire, Wilfredo Yushimito

The maximum capture problem with random utilities seeks to locate new facilities in a competitive market such that the captured demand of users is maximized, assuming that each individual chooses among all available facilities according to a random utility model. We also introduce a new branch-and-bound algorithm based on a column generation scheme for solving the original problem. Extensive computational experiments are presented, benchmarking the proposed approach with other linear and non-linear relaxations of the problem. Computational experiments show that our algorithm is competitive with all other methods as there is no method which outperforms the others in all instances.

4 - Submodular Path Inequalities For Capacitated Lot-sizing With Inventory And Backlogging Bounds

Birce Tezel, University of California-Berkeley, Berkeley, CA, 94720, United States, btezel@berkeley.edu, Alper Atamturk

We consider single item capacitated lot-sizing problems with backlogging (CLSB) where the maximum production, inventory and backlogging values are bounded. Using the underlying fixed-charge network structure of CLSB, we derive strong submodular path inequalities. These inequalities generalize flow cover inequalities for single node relaxations of CLSB. The computational results suggest that submodular path inequalities are quite effective in solving CLSB instances when used in a branch-and-cut algorithm.

■ TC14

104D-MCC

Sustainable and Responsible Supply Chain Management I

Sponsored: Energy, Natural Res & the Environment I Environment & Sustainability

Sponsored Session

Chair: Sandra D Eksioglu, Clemson University, Clemson, SC, United States, seksiog@clemson.edu

1 - Valuing A Cellulosic Biofuel Project Considering Supply Uncertainty

Guiping Hu, Iowa State University, gphu@iastate.edu, Yihua Li, Chung-Li Tseng, Wei-Chung Miao

Iowa intends to invest in cellulosic biofuel production to expand its renewable fuels consumption. The yield of main feedstock, corn stover, fluctuates due to climate change, especially the rainfall amount. Dual sourcing is a possible strategy to mitigate the supply uncertainty, which in our case is the option of investing in growing dedicated energy crops as an additional supply source. A real options approach is used to analyze the optimal investment timing and benefits of the dual sourcing.

2 - Lot Sizing With Emission Dependent Demand

Gokce Palak, Shenandoah University, gpalak@su.edu

We extend economic lot sizing models to maximize profit and minimize emissions. This model captures the tradeoffs between supplier and mode selection decisions, as well as profits and emissions. We analyze impacts of price and emissions sensitive demand on the replenishment decisions.

3 - A Competitive Supply Chain Framework With Sustainable Environmental Policies

Min Yu, University of Portland, Portland, OR, United States, yu@up.edu, Jose Cruz

We develop a competitive supply chain network model with multiple firms, each of which produces a differentiated product. Multiple production, storage, and transport mode options are allowed. In order to control firms' environmental emissions, the policy-maker seeks to decide the optimal policy instrument. Numerical illustrations provide managerial insights and policy implications.

■ TC15

104E-MCC

Joint Session AI/SMA: Social Media Analytics and Big Network Data

Sponsored: Artificial Intelligence

Sponsored Session

Chair: Bin Zhang, Assistant Professor, University of Arizona, 1130 E. Helen St, Tucson, AZ, 85715, United States, binzhang@arizona.edu

1 - Analyzing Heterogeneity Of User Participation Behavior In Online News Article Propagation

Devi Bhattacharya, University of Arizona, dbhattac@email.arizona.edu

The session will illustrate the diversity in users' article sharing behavior on social media. The literature on social media based propagation although considerable generally undercompensates heterogeneity in users' behavior incidental to the source or type of content being propagated. In contrast, our research provides extensive empirical evidence of multiplicity in users' article sharing behavior by analyzing 5 different facets of user participation. Our research uses network theoretic and statistical techniques on a Twitter dataset of 35 news providers collected over 9 months to provide critical insights essential for modeling users' news article sharing behavior on social media.

2 - Knowledge Discovery Using Disease Comorbidity Networks

Karthik Srinivasan, University of Arizona, Tucson, AZ, 85719, United States, karthiks@email.arizona.edu, Faiz Currim, Sudha Ram

Comorbidity or disease co-occurrence is the simultaneous presence of two or more diseases. A disease comorbidity network (DCN) can be constructed based on repeated evidence of two or more diseases co-occurring in anonymized patient visit datasets. We report on an empirical study using a large dataset of electronic health records to explore the characteristics of this network including community formation and structural measures. Our network analysis is used to reinforce existing medical knowledge about comorbidity and to reveal previously unknown comorbidity relationships.

3 - Social Networks In Online Games: The Impact Of Peer Influences On Repeat Purchase

Bin Zhang, University of Arizona, binzhang@arizona.edu, Ruibin Geng, Xi Chen

Consumers' purchase decisions can be affected by both direct and indirect peer influences. However, there is no existing work about how these two types of influence impact repeat-purchase of. In this study, we fill such gap by investigating the interdependent repeat-purchase of online game players embedded in a social network. We build a new hierarchical Bayesian model that can support response variable following Poisson distribution and simultaneously include both types of peer influence, direct and indirect. Our empirical study yields interesting findings that peer influences have a significant impact on repeat purchase, but the directions of direct and indirect influences are different.

■ TC16

105A-MCC

Inverse Optimization: Applications

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Taewoo Lee, Rice University, 1, Houston, TX, United States, taewoo.lee@rice.edu

1 - Inverse Optimization For The Analysis Of Competitive Markets: An Application To The North American Fuel Market

Michael Pavlin, Wilfrid Laurier University, mpavlin@wlu.ca

In this talk we consider conditions under which inverse optimization can be used to analyze unobservable supply constraints underlying pricing of competitive markets. We present a study of price differentiation in the North American fuel market.

2 - Inverse Optimization For Intensity Modulated Proton Therapy

Neal Kaw, University of Toronto, Toronto, ON, Canada, neal.kaw@mail.utoronto.ca, Timothy Chan, Albin Fredriksson

Robust multiobjective optimization models can be used to determine treatment plans for intensity-modulated proton therapy (IMPT), which is a method of cancer therapy. The uncertainty set in such a model is a set of scenarios. In this work, we propose a novel inverse optimization model to determine objective weights and a set of scenarios, such that a historical treatment plan is optimal with respect to a given robust IMPT optimization model. We apply our model to prostate cancer data.

3 - Data-driven Objective Selection In Multi-objective Optimization: Inverse Optimization Approach

Taewoo Lee, Rice University, 6100 Main MS-134, Houston, TX, 77005, United States, taewoo.lee@rice.edu, Tayo Ajayi, Andrew J Schaefer

Performance of a multi-objective optimization problem largely depends on the choice of objectives. Currently, objectives are typically chosen in a trial-and-error manner based on subjective beliefs. We propose an inverse optimization approach to learn from data and determine a minimal set of objectives for a multi-objective optimization problem such that the problem generates solutions that are comparable to the given data. We provide theoretical properties of the methodology in comparison with regression, and establish a relationship with the traditional best subset regression approach. We demonstrate the methodology in cancer therapy applications.

■ TC17

105B-MCC

Stochastic Optimization for Large-Scale Learning

General Session

Chair: Qihang Lin, the University of Iowa, 21 East Market Street, PBB, S380, Iowa City, IA, 52245, United States, qihang-lin@uiowa.edu

1 - Adadelay: Delay Adaptive Distributed Stochastic Optimization

Adans Wei Yu, Carnegie Mellon University, Pittsburgh, PA, United States, weiyu@cs.cmu.edu

We develop distributed stochastic optimization algorithms under a delayed gradient model in which server nodes update parameters and worker nodes compute stochastic (sub)gradients. Our setup is motivated by the behavior of real-world distributed computation systems; in particular, we analyze a setting wherein worker nodes can be differently slow at different times. In contrast to existing approaches, we do not impose a worst-case bound on the delays experienced but rather allow the updates to be sensitive to the actual delays experienced. This sensitivity allows use of larger stepsizes, which can help speed up initial convergence without having to wait too long for slower machines.

2 - Rsg: Beating Subgradient Method Without Smoothness And Strong Convexity

Tianbao Yang, the University of Iowa, tianbao-yang@uiowa.edu, Qihang Lin

In this paper, we propose novel deterministic and stochastic {\bf R}estarted {\bf S}ub{\bf G}radient (RSG) methods that can find an ϵ-optimal solution for a broad class of non-smooth and non-strongly convex optimization problems faster than the vanilla deterministic or stochastic subgradient method (SG). We show that for non-smooth and non-strongly convex optimization, RSG can reduce the dependence of SG's iteration complexity on the distance to the optimal set of the initial solution to that of points on the ϵ-level set. For a family of non-smooth and non-strongly convex optimization problems whose epigraph is a polyhedron, we further show that RSG could converge linearly.

3 - Worst-case Complexity Of Cyclic Coordinate Descent

Ruoyu Sun, Stanford University, ruoyus@stanford.edu, Yinyu Ye

We establish several complexity bounds of cyclic coordinate descent (C-CD) for quadratic minimization, and prove that these bounds are almost tight. Although some existing examples showed C-CD can be much slower than randomized coordinate descent (R-CD), in many practical examples C-CD is faster than R-CD, making it unclear whether the worst-case complexity of C-CD is better or worse than R-CD. One of our bounds shows that C-CD can be O(n^2) times slower than R-CD in the worst case. One difficulty with the analysis of the constructed example is that the spectral radius of a non-symmetric iteration matrix does not necessarily constitute a lower bound for the convergence rate.

4 - Homotopy Smoothing For Structured Non-smooth Problems

Qihang Lin, Assistant Professor, University of Iowa, Iowa City, IA, 52242, United States, qihang-lin@uiowa.edu, Yi Xu, Yan Yan, Tianbao Yang

We develop a novel homotopy smoothing (HOPS) algorithm for non-smooth convex optimization where the non-smooth term has a max-structure. The best known iteration complexity of first-order method for this problem is O(1/epsilon). We show that the proposed

HOPS achieves a lower iteration complexity of O (1/epsilon^(1-theta)) with theta in (0, 1] capturing the local sharpness of the objective function around the optimal solutions. The HOPS algorithm uses Nesterov's smoothing method in stages and gradually decreases the smoothing parameter until it yields a sufficiently good approximation of the original function.

■ TC18

106A-MCC

Finance, Portfolio

Contributed Session

Chair: Christopher M Rump, Associate Professor, Bowling Green State University, College of Business Administration, Bowling Green, OH, 43403-0267, United States, cmrump@bgsu.edu

1 - A Goal Programming Approach To Municipal Bond Portfolio Management

Laura Ventura, PhD Student, The Pennsylvania State University, University Park, PA, 16802, United States, ljv115@psu.edu, Barbara Venegas Quintrileo

The consequence of the municipal bond tax-exemption is that retail investors represent the overwhelming majority of municipal bondholders. Retail investors' buy and hold strategy results in low portfolio turnover causing limited inventory levels and obscure historical pricing that render modern portfolio theory unsuitable. In exchange we propose a non-preemptive goal programming model for municipal bond portfolio management. We consider a municipal bond index replication strategy using Morningstar's municipal bond index data and Bloomberg's municipal bond market data. The model determines bond selection that meets risk and return metrics sensitized to the number of transactions.

2 - Asset Selection In Indian Stock Market Using PCA-DEA Framework

Dhanya Jothimani, Doctoral Student, Indian Institute of Technology Delhi, DMS, IIT Delhi, Vishwakarma Bhawan, Hauz Khas, New Delhi, 110016, India, dhanyajothimani@gmail.com, Ravi Shankar, Surendra S Yadav

Portfolio optimization has three important stages. Among them, asset selection is the first and important stage. We use a Principal Component Analysis - Data Envelopment Analysis (PCA-DEA) framework for asset selection in Indian stock market. The sample consisted of firms listed in National Stock Exchange. The contributions are two-fold: first, the framework helps to avoid the curse of dimensionality of DEA and second, it aids in selection of asset for the second stage of portfolio optimization.

3 - Optimal Portfolio Under Black Litterman Framework With Certain Confidence Level

Cagatay Karan, North Carolina State University, Raleigh, NC, United States, ckaran@ncsu.edu, Tao Pang

Under the Black-Litterman framework, the investor's views can be integrated with the classical mean-variance portfolio optimization in a Bayesian manner. Typically, the investor is not 100% sure about her view, so the confidence level of the view plays an important role in determining the optimal portfolio. We propose a simple but meaningful method based on the investor's confidence level on whether the market is a bull market. Conditional Value at Risk (CVaR) is used as the risk measure instead of variance, and mixed Gaussian distributions are used to model the assets' market returns. The optimal portfolio is explicitly obtained from the optimal portfolio weights under the proposed setting.

4 - Evolution Of A Lottery Jackpot

Christopher M Rump, Associate Professor, Bowling Green State University, College of Business Administration, Bowling Green, OH, 43403-0267, United States, cmrump@bgsu.edu

We develop a predictive model for the growth of the jackpot prize in large, multi-state lotteries. The prediction is based on ticket sales inferred from the number of lesser prizes awarded after each lottery drawing. With this jackpot growth model, we investigate whether or not this gamble ever has positive expected value and make recommendations for the best time to play the lottery if you must.

■ TC19

106B-MCC

Population Health: Infectious and Chronic Diseases

Sponsored: Computing

Sponsored Session

Chair: Nedialko Dimitrov, The University of Texas at Austin, The University of Texas at Austin, Austin, TX, 00000, United States, ned.dimitrov@gmail.com

1 - Risk Sensitive Control And Cascading Defaults

Agostino Capponi, Columbia University, ac3827@columbia.edu

We consider an optimal risk-sensitive portfolio allocation problem, which explicitly accounts for the interaction between market and credit risk. The investor allocates his wealth on a portfolio of assets, which can default sequentially and cause distress to the remaining assets in the portfolio. We give an explicit characterization of the optimal feedback strategies. A numerical analysis indicates that the investor accounts for contagion effects when making investment decisions, reduces his risk exposure as he becomes more sensitive to risk, and that his strategy depends non-monotonically on the aggregate risk level.

2 - Resource Allocation For Hepatitis C Elimination

Qiushi Chen, Georgia Institute of Technology, Atlanta, GA, United States, chenqiushi0812@gatech.edu, Turgay Ayer, Jagpreet Chhatwal

More than 170 million people are infected with hepatitis C virus (HCV) globally. The recent availability of highly effective treatments offers an opportunity to control current epidemic and eliminate HCV worldwide. However, high drug cost and unawareness of infection are challenges for achieving this goal. In this study, we develop an HCV transmission model, and identify optimal allocation of resources towards HCV screening and treatment to achieve the disease control target at the minimum cost. We present the allocation policies in different health care settings and target population profiles.

3 - Optimizing Arbovirus Surveillance

Xi Chen, University of Texas at Austin, carol.chen@utexas.edu

We introduce a county-level risk assessment framework for identifying areas that may be at high risk for importation of arboviruses. Human importation risk is estimated using a maximum entropy algorithm, based on historical dengue importation data, socioeconomic, demographic, and bio-climatic data. A significant reason for the popularity of the maximum entropy methodology is its applicability to presence-only data. To address the uncertainty quantification in the point estimation of maximum entropy model, we analytically derive an expression of the variance of the target species distribution probabilities and comparing the results with bootstrap methods.

■ TC20

106C-MCC

Multiagent Systems Modeling

Invited: Tutorial

Invited Session

Chair: Sanmay Das, Washington University in St. Louis, St, Louis, MS, 12, United States, sanmay@wustl.edu

1 - MultiagentSystems Modeling

Sanmay Das, Washington University in St. Louis, St, Louis, MS, United States, sanmay@wustl.edu

A multiagent system is one where multiple autonomous agents with potentially different goals interact. Viewing agents through the computational lens provides a powerful, yet principled method for understanding the behaviors of complex systems, including economic and financial markets, online social networks, etc. In this tutorial, I discuss general principles for such modeling, best practices for handling the simplicity/complexity tradeoff, and present examples of predictive and useful models.

■ TC21

107A-MCC

Payment Models, Pricing, and Incentives in Healthcare

Sponsored: Health Applications

Sponsored Session

Chair: Mehmet U.s. Ayvaci, University of Texas at Dallas, Richardson, TX, United States, mehmet.ayvaci@utdallas.edu

1 - The Role Of Physician Alignment And Organizational Structures In Bundled Payments

Jan Vlachy, Georgia Institute of Technology, Atlanta, Georgia, vlachy@gatech.edu, Turgay Ayer, Mehmet U.S. Ayvaci, Srinivasan Raghunathan

Bundled payments in healthcare unify the payments to care providers. Motivated by the low rates of voluntary bundling, we formulate game-theoretic models to understand the incentives of hospitals and physicians when forming a bundle. Our analyses lead to several interesting findings with policy implications: 1) alignment between the hospital management and physicians is critical in successful bundling, 2) integrated hospital systems or hospitals with salaried physicians are likely to benefit more from bundling, and 3) under the current bundled payment mechanism, overall care quality may decrease. We further propose alternative designs to ensure sufficient quality.

2 - Incentive Programs For Reducing Readmissions When Patient Care Is Co-produced

Dimitrios Andritsos, HEC Paris, andritsos@hec.fr,
Christopher S Tang

To compare the effectiveness of three different hospital reimbursement schemes (i.e., Fee-for-Service, Pay-for-Performance and Bundled Payment) in reducing readmissions, we develop a "health co-production" model in which the patient's readmission is "jointly controlled" by the efforts exerted by both the hospital and the patient.

3 - Reference Pricing For Healthcare Services

Shima Nassiri, University of Washington, shiman@uw.edu,
Hamed Mamani, Elodie Adida

The traditional payment system between an insurer and hospitals does not incentivize hospitals to limit their prices and patient to choose less expensive providers, hence contributing to high insurer costs. Reference pricing (RP) has been proposed as a way to better align incentives and control costs. Under RP, the patient may be responsible for part of the cost if they select a high-price hospital. We propose a model to analyze the RP payment scheme that incorporates an insurer, competing hospitals, and patients with the goal of understanding how RP compares with the current payment system.

4 - Role Of Payment Models In The Value And Adoption Of Health-information Exchanges

Mehmet U Ayvaci, University of Texas-Dallas,
800 W Campbell Rd SM33, Richardson, TX, United States,
mehmet.ayvaci@utdallas.edu, Huseyin Cavusoglu,
Srinivasan Raghunathan

We study the interrelationships among the payment model, the providers' incentives to exchange health information (HIE), and the value of HIEs in terms of improving quality or reducing costs. In the context of a stylized healthcare setting, we examine the fee-for-service, performance-, and episode-based payment contracts that induce socially optimal care levels and HIE adoption. Our findings suggest that as payment models evolve over time, there is a real need to reevaluate the value of HIE adoption and the government policies that induce providers to adopt HIEs.

■ TC22

107B-MCC

Dealing with Uncertainty in Hospital Operations

Sponsored: Health Applications

Sponsored Session

Chair: Song-Hee Kim, USC Marshall School of Business, Bridge Hall 307A, 3670 Trousdale Pkwy, Los Angeles, CA, 90089, United States, songheek@marshall.usc.edu

Co-Chair: Tinglong Dai, Johns Hopkins University, 100 International Dr, Baltimore, MD, 21202, United States, dai@jhu.edu

1 - Time-driven Activity Based Costing Of Coronary Artery Bypass Grafting Across National Boundaries To Identify Improvement Opportunities

Feryal Erhun, University of Cambridge, f.erhun@jbs.cam.ac.uk

Coronary artery bypass graft (CABG) surgery is a well-established, commonly performed treatment for coronary artery disease—a disease that affects over 10% of US adults and is a major cause of morbidity and mortality. In 2005, the mean cost for a CABG procedure among Medicare beneficiaries in the USA was \$32,201±\$23,059. The same operation reportedly costs less than \$2,000 to produce in India. The goals of this study are to (1) identify the difference in the costs incurred to perform CABG surgery by three Joint Commission accredited hospitals with reputations for high quality and efficiency and (2) characterize the opportunity to reduce the cost of performing CABG surgery.

2 - Clinical Ambiguity And Conflicts Of Interest In Interventional Cardiology Decision-making

Tinglong Dai, Assistant Professor, Johns Hopkins University,
100 International Drive, Baltimore, MD, 21202, United States,
dai@jhu.edu, Xiaofang Wang, Chao-Wei Hwang, Chao-Wei Hwang

Cardiovascular disease is the leading cause of death in the United States, and coronary artery disease (CAD) is the major underlying culprit. Percutaneous coronary intervention (PCI) has proven to be beneficial to patients with acute coronary syndrome, yet its benefit to stable CAD patients is more nuanced. Indeed, unnecessary PCI procedures for stable CAD patients have contributed to wasteful health spending and, in certain cases, patient harm. In this paper, we model both clinical ambiguity and conflicts of interest in interventional cardiology decision-making. Among other results, we show the PCI usage may be non-monotonic in the conflict-of-interest level.

3 - The Value And Price Of Flexibility In Robust Assignment Of Patients To Radiation Therapy Machines

Philip Allen Mar, Dept. of MIE, University of Toronto,
5 King's College Road, Toronto, ON, M5S 3G8, Canada,
philip.mar@mail.utoronto.ca, Timothy Chan

In a radiation cancer therapy program, radiation therapy machines are allocated to treat particular types of cancers to form a fixed network that acts as a guideline for the hospital when assigning patients to machines for treatment. We study the operational efficiency of this system from a manufacturing process flexibility viewpoint. Furthermore, we use robust optimization to prescribe new allocation and assignment guidelines which are robust against deviations from the optimal assignment, and against capacity uncertainty.

4 - Maximizing Intervention Effectiveness Through Robust Optimization

Rong Qing Brian Han, Marshall School of Business,
University of Southern California, Los Angeles, CA, United States,
rongqing.han.2019@marshall.usc.edu, Vishal Gupta,
Song-Hee Kim

In medicine and social science, practitioners often seek to implement interventions that have previously been proven effective via randomized control trials (RCT). Typically, practitioners cannot access the raw data of the RCT, but do have summary statistics from published papers. We propose a novel robust optimization framework to identify a small, targeted group of candidates for the intervention to maximize effectiveness based on these summary statistics. Using data from a large urban hospital, we show that our method often outperforms conventional methods, especially when the target and RCT populations differ substantially.

■ TC23

108-MCC

New Models in Health Care

Sponsored: Health Applications

Sponsored Session

Chair: Lawrence Wein, Stanford University, 655 Knight Way, Stanford, CA, 94305, United States, lwein@stanford.edu

1 - Personalized Medicine

Dimitris Bertsimas, MIT, dbertsim@mit.edu

We use a) Electronic Medical Records from 1.5 million patients over 15 years from the Boston Medical Center and 200 thousand cancer patients from Dana Farber and b) state of the art as well as new machine learning algorithms to propose an algorithmic theory of personalized medicine for several human diseases. We discuss the overall vision, results and possible impact.

2 - Data Uncertainty In Cost-effectiveness Analyses Of Medical Innovations

Joel Goh, Harvard University, jgoh@hbs.edu, Mohsen Bayati,
Stefanos Zenios, Sundeep Singh, David W Moore

Cost-effectiveness studies of medical innovations often suffer from data inadequacy. When Markov chains are used as a modeling framework for such studies, this data inadequacy can manifest itself as imprecision in the elements of the transition matrix. We study how to compute maximal and minimal values of the chain as these uncertain transition parameters jointly vary within a given uncertainty set. We show that these problems are computationally tractable if the uncertainty set has a row-wise structure but generally intractable otherwise. We apply our model to assess the cost-effectiveness of fecal immunochemical testing (FIT), a new screening method for colorectal cancer.

3 - New Models For Fecal Microbiota Transplantations

Lawrence Wein, Stanford University, lwein@stanford.edu,
Abbas Kazerouni

A nonprofit organization, OpenBiome, has created a public stool bank to facilitate fecal microbiota transplantation, which is an effective treatment for Clostridium difficile infection and is being investigated as a treatment for other microbiota-associated diseases. We discuss two problems: optimizing OpenBiome's operations, and using pooled stools to improve the efficacy in clinical trials against microbiota-associated chronic diseases such as ulcerative colitis.

4 - Designing Strategic National Stockpile – A Two-stage Robust Optimization Approach

Peter Yun Zhang, Massachusetts Institute of Technology,
Cambridge, MA, United States, pyzhang@mit.edu,
Nikolaos Trichakis, David Simchi-Levi

We present a model that captures two sets of decisions a supply chain network designer faces: placement of inventory in preparation for demand uncertainty, and resource allocation after the uncertain events unfold. We show optimality and tractability results for problem structure that arises from designing the Strategic National Stockpile.

■ TC24

109-MCC

Public Health and Health System Modeling

Sponsored: Health Applications

Sponsored Session

Chair: Stan Neil Finkelstein, MIT, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States, snfinkel@mit.edu

1 - A Dynamic Model Of Post-traumatic Stress Disorder For Military Personnel And Veterans

Navid Ghaffarzadegan, Virginia Tech, 307 Craig Dr., Blacksburg, VA, 24060, United States, navidg@vt.edu, Alireza Ebrahimvandi, Mohammad S. Jalali

The importance and complexity of PTSD raise a critical question: What are the future trends in the population of PTSD patients among military personnel and veterans? We developed a system dynamics simulation model of the population of combat-related PTSD patients. The model is validated by replicating the historical data from 2000 to 2014. It forecasts PTSD prevalence, and estimates costs for the military and the VA under various policies and scenarios. One particular finding is that in a postwar period, current health policy interventions have only marginal effects on mitigating the problem of PTSD.

2 - Modeling Food Supply Systems To Identify Outbreak Origins

Elena Polozova, Undergraduate Student, Massachusetts Institute of Technology, 77 Massachusetts Ave., Cambridge, MA, 02139, United States, polozova@mit.edu, Abigail Lauren Horn, Andreas Balster, Hanno Friedrich

The aim of this research is to efficiently identify the source of large-scale outbreaks of foodborne disease while contamination-caused illnesses are still occurring, thereby resolving investigations earlier and averting potential illnesses. We propose a holistic system for real-time source detection, which combines a dynamic model of commodity flows with a spatio-temporal method for source localization on networks. We evaluate the ability of the system to identify the source of simulated outbreaks and real historical outbreaks of foodborne disease in Germany, quantifying benefits in comparison to current methods in outbreak identification.

■ TC25

110A-MCC

Scheduling in Practice

Invited: Project Management and Scheduling

Invited Session

Chair: Emrah Cimren, Nike, Portland, OR, United States, cimren.1@gmail.com

1 - Integrated Staffing And Scheduling In Call Centers Using Dynamic Queueing Models

Raik Stolletz, University of Mannheim, Chair of Production Management, Schloss, Mannheim, 68131, Germany, stolletz@bwl.uni-mannheim.de

Traditional sequential approaches derive staff requirements using queueing models in a fist step and use these results as constraints in determinist shift scheduling as a second step. We present a simultaneous approach, which determines the shift schedule directly based on a forecast of the arrival rates, the constraints on shift, and service level requirements.

We present a general stochastic optimization model for the simultaneous approach. Based on an approximation method for time-dependent queues, we will analyze the respective non-linear optimization model. In a numerical study we compare both approaches.

2 - Scheduling Of Vehicles With Handover Relations At Transshipment Terminals

Dirk Briskorn, University of Wuppertal, briskorn@wiso.uni-koeln.de, Malte Fliedner, Martin Tschöke

We consider a generic problem arising when coordinating deliveries and collections at a transshipment terminal. A set of vehicles and a set of doors given, we distinguish between problem settings where each vehicle can be docked only once, each vehicle can be docked multiple times at the same door, and each vehicle can be docked multiple times at different doors. We have a set of handover relations meaning that one vehicle delivers goods to be picked up by an other. For such a handover relation to be satisfied the second vehicle must be docked at some point of time after the first arrival of the first vehicle. We consider settings where storing goods is allowed and settings where this is not the case and investigate the computational complexity of finding a feasible docking policy.

3 - Staff Scheduling For Regular And On-call Hours In Retailers When Sales Are Correlated With Store Traffic And Staffing

Osman Alp, University of Calgary, Haskayne School of Business, 2500 University Drive, Scurfield Hall 120, Calgary, AB, T2N1N4, Canada, osman.alp@ucalgary.ca

Sales in retail stores are closely related to store traffic and level of staffing, among other factors. We consider a retail store which can keep track of customer traffic continuously and has the option of scheduling some of their staff on an on-call basis in addition to their regular shift hours. Based on the observed store traffic, retailer may summon the reserved on-call workers with an offset. We investigate the staff scheduling problem of such retailers. The retailer aims to find an optimal staff schedule for regular shifts, the number of on-call staff reserved for every hour, and a decision rule to summon the workers if necessary. We propose a model to solve this problem and conduct numerical analysis.

■ TC26

110B-MCC

Combinatorial Auctions

Invited: Auctions

Invited Session

Chair: Sven Seuken, University of Zurich, Zurich, Switzerland, seuken@ifi.uzh.ch

1 - Core-selecting Payment Rules For Combinatorial Auctions With Uncertain Availability Of Goods

Dmitry Moor, University of Zurich, Zurich, Switzerland, dmoor@ifi.uzh.ch, Sven Seuken, Tobias Grubenmann, Abraham Bernstein

In some auction domains, there is uncertainty regarding the final availability of the goods being auctioned off. For example, a government auctioning off spectrum from its public safety network may need this spectrum back in times of emergency. In such a domain, standard combinatorial auctions perform poorly as they lead to violations of individual rationality (IR), even in expectation, and to very low efficiency. We present payment rules for such domains. We show that in these domains, there does not exist a payment rule which is guaranteed to be ex-post core-selecting. We then demonstrate that by making the rules "execution-contingent", we can reduce IR violations while achieving IR in expectation.

2 - SATS: A Spectrum Auction Test Suite

Michael Weiss, tba, tba, Switzerland, weiss.michael@gmx.ch, Benjamin Lubin, Sven Seuken

For the past 16 years, much of the work on combinatorial auctions (CAs) has used the CATS instance generator [Leyton-Brown et al., 2000]. While this test suite has been very beneficial to the community, it does not model spectrum auctions particularly well, which in recent years have become the most important application of CAs. In this talk, we introduce SATS, a new "spectrum auction test suite," providing a unified framework and code base for several of the spectrum auction generators that have been proposed in the literature. Furthermore, we include a novel generator that captures the important and difficult to model geographic complementarities of auctions such as the 2014 Canadian auction.

3 - Design Of Combinatorial Auctions Using Machine Learning-based Bidding

Gianluca Brero, University of Zurich, Zurich, Switzerland, brero@ifi.uzh.ch, Benjamin Lubin, Sven Seuken

Combinatorial auctions are attractive mechanisms to efficiently allocate resources even when bidders have combinatorial valuations. However, the large number of items sold in many real-world auctions prevents a direct application of combinatorial auction formats. In particular, designing concise bidding languages that do not constrain the bidders' expressiveness is a challenging task. In this talk, we will present a new paradigm for designing bidding languages based on machine learning principles. We show that we can exploit simple knowledge about bidders' preferences to automatically design concise bidding languages that don't limit the expressiveness of the bidders.

4 - Designing A Combinatorial Market For Offloading Cellular Traffic Via Wireless Access Points

Sven Seuken, University of Zurich, seuken@ifi.uzh.ch

We study a market where mobile network operators (MNOs) are enabled to offload some of their peak-time cellular traffic via wireless access points. This is a challenging domain because the MNOs have complex combinatorial preferences regarding when and where to offload their cellular traffic. We first describe how the MNOs' preferences can be modeled succinctly. Then we introduce a combinatorial allocation mechanism that computes an optimal allocation, i.e., which MNOs get to offload how much of their traffic in which of their cell sectors and at what time of the day. Finally, we show how to use core-selecting combinatorial auctions to computes prices for each MNO.

■ TC27

201A-MCC

Empirical Studies in Supply Chain Management

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Jun Li, Ross School of Business, University of Michigan, Ann Arbor, MI, United States, junwli@umich.edu

1 - The Causes Of Drug Shortages: An Empirical Analysis

Yixin (Iris) Wang, Ross School of Business, University of Michigan, Ann Arbor, MI, United States, iriswang@umich.edu, Jun Li, Ravi Anupindi

The country has seen an increasing number of drug shortages starting from mid-2000s, which led to rationing in treatment, delays in care, increasing medication errors and higher costs of care. This research tries to uncover the root causes of drug shortages and to quantify the size of each of their impacts. In particular, one of the objective is to understand what caused increasing quality problems? Is it due to manufacturing quality deterioration (and if so, why)? Or is it due to increasing FDA regulation stringency? To disentangle these possible causes, we conduct text analysis on FDA warning letters from 2000 to 2015.

2 - Ration Gaming And The Bullwhip Effect: A Structural Econometric Study

Robert Bray, Kellogg School of Management, Northwestern University, r-bray@kellogg.northwestern.edu

We develop a dynamic discrete choice estimator of (s, S) inventory models. We apply this estimator to a 5,320-SKU, 1,371-day sample from a Chinese supermarket to quantify the effect of ration gaming.

3 - Quality Propagation In The Supply Chain And Its Implication On Customer Future Purchasing Behavior: An Empirical Study

Qiuping Yu, Kelley School of Business, Indiana University, 1309 E. Tenth Street, Bloomington, IN, 47405, United States, qiupyu@indiana.edu, Shawn Mankad, Masha Shunko

We integrate transaction data from all stages of the supply chain including the manufacturers, distributors, restaurants and customers along with the customer survey and supply chain complaints data from a fast food restaurant chain to understand customer purchasing behavior. In particular, we focus on how customer satisfaction, supply chain quality, and promotions shape customer future purchasing decisions.

■ TC28

201B-MCC

Operations-Marketing Interface

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Xuanming Su, University of Pennsylvania, Philadelphia, PA, United States, xuanming@wharton.upenn.edu

1 - Online And Offline Information For Omnichannel Retailing

Fei Gao, University of Pennsylvania, Philadelphia, PA, United States, feigao@wharton.upenn.edu, Xuanming Su

Omnichannel consumers strategically make use of online and offline channels to gather information and purchase products. We study different omnichannel information strategies and their profit implications for firms.

2 - Leveraging Physical Presence In Omni-Channel Retail

Antonio Moreno-Garcia, Kellogg School of Management, a-morenogarcia@kellogg.northwestern.edu, David Bell, Santiago Gallino

With the growing relevance of online channels, retailers are exploring new ways in which they can overcome the impediments associated with selling products with non-digital attributes, such as apparel, without customers having physical access to products. By implementing a series of randomized field experiments, we study the value of virtual fit information in online retail.

3 - Signaling To The Crowd: Private Quality Information And Rewards-based Crowdfunding

Robert Swinney, Associate Professor, Duke University, 100 Fuqua Drive, Durham, NC, 27516, United States, robert.swinney@duke.edu, Soudipta Chakraborty

We consider the problem a seller designing a rewards-based crowdfunding campaign via a platform like Kickstarter. The seller solicits donations from contributors, and if total contributions exceed a pre-determined threshold the campaign is a success, the seller receives all donations and each contributor receives a reward; otherwise, contributors are refunded their donations and the campaign is a failure. When contributors know less than the seller, e.g. about the value of the reward or the likelihood of success, we determine how the seller should design its crowdfunding campaign.

4 - Donor Product-subsidies To Increase Consumption: Implications Of Consumer Awareness And Profit-maximizing Intermediaries

Terry Taylor, University of California Berkeley, Berkeley, CA, 94720, United States, taylor@haas.berkeley.edu, Wenqiang Xiao

Increasingly, donors that subsidize socially-desirable products (e.g., improved cook stoves, malaria drugs) in the developing world are shifting from distributing through non-commercial to commercial channels, ceding control of the product price to for-profit intermediaries. This paper advises a donor as to how the donor's loss of price control and the level of consumer awareness—defined as the fraction of the consumer population that is informed of the product's benefits—influence the donor's optimal subsidy and utility.

■ TC29

202A-MCC

Issues in Environmental Operations: Managing Risk, Customer Returns, and Regulations

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Gokce Esenduran, Ohio State University, Columbus, OH, United States, esenduran_1@fisher.osu.edu

1 - Risk Management Through Investment In Sustainability

Ali Shantia, HEC Paris, Paris, France, ali.shantia@hec.edu, Sam Aflaki, Hamed Ghoddusi

We study firms' incentives to hedge input price risks through investment in energy efficiency (EE) solutions. In particular, we focus on how the convexity in profit function and the level and nature of uncertainties in the price of input commodities affect the decision of a single firm regarding the level of EE investment. We then characterize conditions under which investment in EE solutions substitutes or complements conventional financial hedging mechanisms. Finally, our analysis is further extended to a case with market power, where multiple firms make strategic decisions regarding optimal hedging and production.

2 - The Impact Of Consumer Returns On The Multichannel Sales Strategies Of Manufacturers

Paolo Letizia, Assistant Professor of Business Analytics, University of Tennessee, Knoxville, TN, 37996, United States, pletizia@utk.edu, Terry P Harrison

Manufacturers can provide consumers with a higher value when selling products through thei

3 - A Framework To Estimate The Economic And Environmental Impacts Of Take-back Legislation

Eda Kemahlioglu-Ziya, North Carolina State University, Raleigh, NC, United States, ekemahl@ncsu.edu, Megan Jaunich, Hadi Gashti, Joseph F DeCarolis, Robert Handfield, Ranji S Ranjithan

We develop a process model of returned product recycling under take-back legislation. We use data from this model to populate an optimization model and use it to estimate the cost and environmental impact of take-back legislation. Our research provides insights regarding how costs and environmental impact (measured in GHG emissions) of legislation change as implementation details such as covered products, minimum take-back requirements change.

4 - Valuable E-waste: Implications For Extended Producer Responsibility

Atalay Atasu, Georgia Institute of Technology, atalay.atasu@scheller.gatech.edu, Gokce Esenduran, Luk N Van Wassenhove

In a market regulated with take-back regulation, if recycling is profitable then producers have to compete with independent recyclers in collection and recovery of end-of-life (EoL) products. We answer the question of whether recovery targets lead to better environmental and economic outcomes in a competitive market for EoL products. We also compare two regulatory scenarios, where only producer collection counts and where both producer and recycler collection count towards meeting recovery targets. Our results show that counting recycler collection towards recovery targets does not always improve the welfare.

■ TC30

202B-MCC

Supply Chain Channel Management

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Guoming Lai, University of Texas at Austin, United States, guoming.lai@mccombs.utexas.edu

Co-Chair: Abhishek Roy, UT Austin, UT Austin, Austin, TX, 78712, United States, abhishek.roy@utexas.edu

1 - Financial Cross-ownership And Information Dissemination In A Supply Chain

Noam Shamir, Tel-Aviv University, Coller School of Management, Tel-Aviv, Israel, nshamir@post.tau.ac.il, Yossi Aviv

We study the effect of financial cross-ownership on two imperative operational decisions in a supply-chain with competing retailers and a mutual supplier: Information acquisition and production level. Financial cross-ownership describes a situation in which an incumbent retailer holds non-voting stocks in an entrant retailer. We demonstrate the significant operational effect of this investment tool. At the production stage, financial cross-ownership results in lower production level and reduced competition level. However, financial cross-ownership can result in pro-competitive effects; it facilitates information acquisition, that can benefit the consumers.

2 - Broader Market Coverage For Innovative Products With Deliberate Supply Chain Leadership

Hyoduk Shin, UC San Diego Rady School of Management, hdshin@ucsd.edu, Vish Krishnan, Junghee Lee, Oleksiy Mnyshenko

How can we achieve broader market coverage for innovative products, i.e., inclusive innovation? Grounded in industrial practice, we show that deliberately choosing the contract leader and the investor in a multi-tiered supply chain can have a significant impact on market coverage. We discuss leadership handovers along the product life cycle.

3 - Manufacturer Rebate Competition In A Supply Chain With A Common Retailer

Yunjie Wang, Hong Kong University of Science and Technology, yunjie89@gmail.com, Albert Y Ha, Weixin Shang

We consider manufacturer rebate competition in a supply chain with two manufacturers selling substitutable products to a common retailer. We characterize the manufacturers' equilibrium rebate decisions and show how they depend on several key factors such as the fixed cost of a rebate program, competition intensity, cost effectiveness of rebate and the proportion of rebate-sensitive consumers in the market. We also consider the case when the retailer subsidizes the manufacturers to offer rebate.

4 - The Implications Of Visibility On The Use Of Strategic Inventory In A Supply Chain

Abhishek Roy, University of Texas at Austin McCombs School of Business, abhishek.roy@utexas.edu, Stephen M Gilbert, Guoming Lai

It is now widely accepted that a retailer's use of strategic inventory benefits both the retailer and the manufacturer. However, it has typically been assumed that the manufacturer has perfect information about the retailer's level of inventory, either by observing it directly, or by inference based on sales observations. Yet, in reality, there are many situations in which a manufacturer may lack the ability to observe either the sales or the inventory of the retailer. We investigate how this lack of inventory observability affects the use of strategic inventory in a supply chain, and how the possibility of strategic inventory shapes the information preferences of the retailer and the manufacturer.

■ TC31

202C-MCC

Operations/Corporate Finance Interface

Sponsored: Manufacturing & Service Oper Mgmt, iFORM

Sponsored Session

Chair: Jie Ning, Case Western Reserve University, 10900 Euclid Ave, Cleveland, OH, 44106, United States, jie.ning@case.edu

Co-Chair: Volodymyr O Babich, Georgetown University, 3700 O St NW, Washington, DC, 20057, United States, vob2@georgetown.edu

1 - Inventory And Signaling To Creditors

Jiri Chod, Boston College, Chestnut Hill, MA, United States, chodj@bc.edu, Nikolaos Trichakis, Gerry Tsoukalas

We argue that by borrowing goods (e.g., through supplier trade credit) rather than cash (e.g., through a bank), firms may be able to convey private information to their creditors more efficiently. As a result, in-kind financing mitigates signaling costs, rationalizing among others, why firms may prefer to finance their operations through their suppliers. Our model suggests this preference can persist even when in-kind lenders have no prior informational advantage and face comparatively higher cost of capital, and is more pronounced when the borrowed goods have higher margins or differentiation, or require less production effort.

2 - Innovative Financing For Sme Suppliers: Factoring, Reverse Factoring And Retailer's Engagement

Fasheng Xu, Washington University in St. Louis, St. Louis, MO, fasheng.xu@wustl.edu, Panos Kouvelis

We consider a pull supply chain with a large retailer and an SME supplier, who is in need of short-term pre-shipment financing. The bank offers a fairly priced loan and repayment failure leads to costly bankruptcy. Benefits of recourse factoring are limited, but non-recourse factoring achieves surprisingly better performance by eliminating market frictions. Further, we investigate two financing schemes in reverse factoring: the partial credit guarantee (PCG) and the purchase order commitment (POC). We find PCG can slightly reduce supplier's financing cost, meanwhile POC can lead to a win-win solution for the decentralized supply chain, with even higher expected profit than the centralized one.

3 - R&D Investments In The Presence Of Free-riding And Risk-shifting Incentives: Can Debt Financing Mitigate Under-investment?

Jie Ning, Case Western Reserve University, Cleveland, OH, United States, jie.ning@case.edu, Volodymyr O Babich

When information is a public good, in equilibrium firms under-invest (relative to the social optimum) in acquiring it to free-ride on investments of other firms. When firms are financed by debt, in equilibrium equity holders invest in riskier projects relative to the firm-optimal. The interactions between these two inefficiencies arise when risky investments are needed to acquire information that becomes a public good, as in some R&D projects. We model these interactions in a three-stage game with two firms and an external debt market. We show that the presence of free-riding and risk-shifting incentives may lead to either under-investment, over-investment, or socially optimal investment.

■ TC32

203A-MCC

Revenue Mgt, Pricing II

Contributed Session

Chair: Sareh Nabi Abdolyousefi, University of Washington, 2727 NE 55th Street, Seattle, WA, 98105, United States, snabi@uw.edu

1 - A Pricing Setting Retailer Sourcing From Competing Suppliers Facing Disruption

Xi Shan, Student, The University of Texas at Dallas, 800 W. Campbell Road, Richardson, TX, 75080, United States, 130630@utdallas.edu, Suresh P Sethi", Tao Li

We study the case of a price-setting retailer who sources from two strategic suppliers subject to independent or correlated disruption and sets the retail price upon delivery. We model this case as a Stackelberg-Nash game with the suppliers as the leaders and the retailer as a follower, and obtain explicitly the equilibrium of the game. We identify cases in which the retailer orders from one perfectly reliable supplier and one unreliable supplier, and two correlated unreliable suppliers. In the latter case, the equilibrium suppliers' profits can increase in supplier disruptions correlation, which is not consistent with the literature.

2 - Pricing Of Internet Dynamically Under Changing Capacity

Demet Batur, Assistant Professor, University of Nebraska - Lincoln, CBA 209, Lincoln, NE, 68588-0491, United States, dbatur@unl.edu, Jennifer Ryan, Zhongyuan Zhao, Mehmet C Vuran

Technological advancements created the TV white space (TVWS)—the opportunity to use parts of the TV spectrum for Internet when and where the TV channels are not actively used by broadcasting companies. The Internet capacity generated from the emerging TVWS systems will change stochastically. Also, the capacity needed by the customers for various Internet activities differ significantly, e.g., email checking versus video streaming. We present a Markov Decision Process model for the service provider to post dynamically changing prices to the customers based on the current available capacity and the expected customer usage with a revenue maximization objective.

3 - Evaluating The Impact Of Adopting 3d Printing Services On The Retailers

Sharareh Rajaei dehkordi, PhD Student of industrial engineering, New Jersey Institute of Technology, 10 Hill Street, Apt 2N, Newark, NJ, 07102, United States, sr552@njit.edu, Wenbo (Selina) Cai

As 3D printing technology becomes more agile to react to customers' demands, one important question for the retailers is whether they should provide 3D printing services in their brick-and-mortar store in addition to the traditional off-the-shelf product? If so, what is the pricing scheme that achieves the optimal profit? What is the optimal capacity of the 3D printers? In this study we answer these questions by examining retailer's optimal joint decisions on pricing scheme and capacity while considering consumers preferences for self-designed, 3D printed products versus off-the-shelf products, using queueing systems and stochastic optimization models.

4 - Choice-based Revenue Management Under Online Reviews

Dirk Daniel Sierag, CWI, Science Park 123, Amsterdam, 1098 XG, Netherlands, dirk@cwi.nl

This article proposes a choice-based network revenue management model that integrates the effect of reviews. Application areas include airlines, hotels, and rental cars. The dependency between reviews and revenue is two-fold: the content of a review depends on the product the customer purchases, and reviews impact the demand. A complicating factor in this model is that the effects of reviews are delayed, i.e., by sacrificing revenue now in order to get better reviews, long-term revenue can be increased. Novel solution methods are proposed that exploit the presence of reviews in order to optimise revenue.

5 - Customer'S Strategic Behavior Using Thompson Sampling

Sareh Nabi Abdolyousefi, University of Washington, 2727 NE 55th Street, Seattle, WA, 98105, United States, snabi@uw.edu

Retailer is pricing dynamically in order to maximize his cumulative expected revenue in a multi-armed bandit setting. Retailer has no information regarding expected demand and type of customers he is facing, myopic or strategic. He is applying a machine learning technique, updated Thompson Sampling, to learn expected demand and customer's type in an exploration vs exploitation fashion. We have proved analytically that retailer's long run price is lower for strategic customers compared to myopic ones. We have also shown numerically that retailer can be better off with strategic customers.

■ TC33

203B-MCC

Queueing Models II

Contributed Session

Chair: Iqra Ejaz, Texas A&M University, College Station, TX, United States, iejaz@tamu.edu

1 - Multiple Server Preemptive Scheduling With Impatience

Yang Cao, University of Southern California, Los Angeles, CA, 90089, United States, cao573@usc.edu

We study a scheduling problem with n impatient customers to be served by m parallel servers (n>m). We assume that the impatience time of customers in queue and the service time on servers are all exponentially distributed, and the system earns a positive reward upon each service completion. We consider both the case of non-preemptive servers and the case of preemptive servers. The objective is to maximize the expected total return for both cases. We give conditions under which a list policy is optimal.

2 - Optimal Control Of General Dynamic Matching System

Mohammadreza Nazari, PhD Student, Lehigh University, Lehigh University, Murray H Goodman Campus, Bethlehem, PA, 18015, United States, mon314@lehigh.edu, Aleksandr Stolyar

Consider a system with random arrivals of items of multiple types. There is a finite number of possible matchings, each being a subset of item types. Each matching has associated fixed reward, and matched items leave the system. We propose a matching algorithm and prove its asymptotic optimality in the sense of maximizing the long-term average reward, while keeping the item queues stable. This algorithm applies an extended version of the greedy primal-dual (GPD) algorithm to a virtual system, which allows negative item queues.

3 - Acuity-based Nurse-staffing Strategies For Inpatient Settings Using A Stochastic Modeling Approach

Parisa Eimanzadeh, PhD Student, Wichita State University, 6000 E Mainsgate Street, Apt 108, Wichita, KS, 67220, United States, pxeimanzadeh@wichita.edu, Ehsan Salari

Minimum nurse-to-patient ratios have been traditionally used to guide staffing decisions in inpatient units. However, the severity of nursing care may vary across inpatients, rendering those ratios ineffective. We develop a stochastic modeling framework to quantify the impact of different staff levels on the performance of inpatient units while accounting for heterogeneity in patient acuity and staff nursing skill levels.

4 - Condition-based Maintenance For Queues With Degrading Servers

Iqra Ejaz, Texas A&M University, College Station, TX, United States, iejaz@tamu.edu, Michelle M. Alvarado, Nagi Gebraeel, Natarajan Gautam, Mark Alan Lawley

We derive an analytical model for condition monitoring of a single server queue with Markovian degradation, Poisson arrivals, and general service and repair times. Stability conditions and performance measures (e.g., average queue length, average degradation.) are derived through steady state analysis. An optimal repair decision model is presented that minimizes an objective function with four costs: repair, catastrophic failure, quality and holding. We develop and verify a simulation model, perform a sensitivity analysis, and show insights learned from relaxing underlying assumptions.

■ TC34

204-MCC

Public Policy and Healthcare Operations

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Susan F Lu, Purdue University, West Lafayette, IN, United States, lu428@purdue.edu

Co-Chair: Lauren Xiaoyuan Lu, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States, lauren_lu@unc.edu

1 - Do Mandatory Overtime Laws Improve Quality? Staffing Decisions And Operational Flexibility Of Nursing Homes

Lauren Xiaoyuan Lu, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States, lauren_lu@unc.edu, Susan F Lu

During the 2000s, over a dozen U.S. states passed laws that prohibit health care employers from mandating overtime for nurses. Using a nationwide panel dataset from 2004 to 2012, we find that these mandatory overtime laws reduced the service quality of nursing homes, as measured by an increase in deficiency citations. This outcome can be explained by two undesirable changes in the staffing hours of registered nurses: decreased hours of permanent nurses and increased hours of contract nurses per resident day.

2 - Predicting Nurse Turnover And Its Impact On Staffing Decisions

Eric Webb, Indiana University, Bloomington, IN, United States, ermwebb@indiana.edu, Kurt Bretthauer

Nurse turnover remains a significant problem in skilled nursing facilities across the United States. High turnover leads to two important questions: (1) Hiring decisions - What applicant attributes should be valued when hiring nurses, in order to hire nurses that are effective at their jobs and likely to stay for a long duration? (2) Staffing decisions - How should nurse workload be managed in order to prevent burnout and decrease turnover? Based on a large dataset from skilled nursing facilities in the United States, we first use a survival model to predict nurse turnover. For this talk we then focus on staffing and incorporate these empirical results into analytical models for nurse staffing decisions.

3 - Hospital Readmissions Reduction Program: An Economic And Operational Analysis

Dennis Zhang, Washington University in St. Louis, St. Louis, MO, 90024, United States, zjj1990228@gmail.com

The Hospital Readmissions Reduction Program (HRRP) requires the Centers for Medicare and Medicaid Services to penalize hospitals with excess readmissions. We take an economic and operational (patient flow) perspective to analyze the effectiveness of this policy in encouraging hospitals to reduce readmissions. We develop a game-theoretic model to show that the competition among hospitals can be counterproductive: it increases the number of nonincentivized hospitals. We calibrate our model with a data set of more than 3,000 hospitals and draw several policy recommendations to improve this policy's outcome.

■ TC35

205A-MCC

Public Sector Service Operations

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Gad Allon, Northwestern University, Kellogg School of Management, Evanston, IL, 60208, United States, g-allon@kellogg.northwestern.edu

1 - Social Engagement And Learning In Massive Open Online Courses: Evidence From Field Experiments

Dennis Zhang, Washington University, 8342 Delcrest Drive, Apt 328, University City, MO, 63124, United States, denniszhang@wustl.edu, Gad Allon, Jan A Van Mieghem

This paper studies how service providers can design social interaction among participants and quantify the causal impact of that interaction on service quality. We focus on education and analyze whether encouraging social interaction among students improves learning outcomes in Massive Open Online Courses (MOOCs), which are a new service delivery channel with universal access at reduced, if not zero, cost. We analyze three randomized experiments in a MOOC with more than 30, 317 students from 183 countries. Combining results from these three experiments, we provide recommendations for designing social interaction mechanisms to improve service quality.

2 - Menu Design In Subsidized Housing Lotteries

Peng Shi, Massachusetts Institute of Technology, pengshi@mit.edu

The right to purchase subsidized housing is often allocated by lottery. When allocating multiple types of houses, one design question is whether to run the lotteries in sequence or in parallel. When the lottery is done in parallel, which is the case for example in Singapore for Build To Order (BTO) flats, another design question is what menu of options to offer at the same time. We develop a tractable model to help policy makers think about the welfare consequences of different lottery designs.

3 - Matching Applicants To Apartments In The Nyc Public Housing Waiting List

Jacob Leshno, Columbia University, yarboz@gmail.com

Public housing apartments become available stochastically over time, and get assigned to applicants in an overloaded waiting list. Applicants choose apartments based on their preferences and the expected wait estimates for the different apartments open to them. We combine theoretical work looking at waiting list allocation mechanism and data from the assignment from new york city to investigate efficiency of current and suggested policies.

4 - Should Hospitals Keep Their Patients Longer? The Role Of Inpatient Care In Reducing Post-discharge Mortality

Carri Chan, Columbia Business School, cwchan@columbia.edu, Ann Bartel, Song-Hee Kim

CMS endorsed 30-day mortality rates as important indicators of hospital quality, despite concerns that post-discharge mortality rates consider the frequency of an event that occurs after a patient is discharged and no longer under the watch and care of the hospital. Using a dataset of all Medicare hospital encounters from 2000 to 2011 and an instrumental variables methodology to address the potential endogeneity bias in hospital length-of-stay, we find evidence that 30-day mortality rates are appropriate measures of hospital quality. For patients with diagnoses of Pneumonia or Acute Myocardial Infarction, an additional day in the hospital could decrease 30-day mortality rates by up to 12.8%.

■ TC36

205B-MCC

Innovative Pricing

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: Yao Cui, Cornell University, 401N Sage Hall, Ithaca, NY, 14853, United States, yao.cui@cornell.edu

1 - Price Competition In The Presence Of Social Comparison And Demand Uncertainty

Yun Zhou, University of Toronto, Toronto, ON, Canada, Yun.Zhou13@Rotman.Utoronto.Ca, Ming Hu, Tony H Cui

We consider the price competition between a duopoly selling differentiated substitutable products under additive demand uncertainty, in which firms' decisions are influenced by social comparison. Social comparison theory, as well as conventional wisdom, suggests that social comparison behaviors, such as behind aversion (upward comparison) and ahead seeking (downward comparison), all work in the similar fashion to intensify competition. We demonstrate how opposite-directional social comparisons interact with demand variability to change competitive behaviors.

2 - The Operational Advantages Of Threshold Discounting Offers

Simone Marinesi, WHARTON, marinesi@wharton.upenn.edu, Karan Girotra, Serguei Netessine

We study the use of threshold discounting, the practice of offering a discounted service only if a pre-determined number of customers subscribe to the service, as pioneered by Groupon. We show novel operational advantages of these offers, including making strategic customers beneficial to the firm.

3 - Dynamic Pricing Under Debt: Spiraling Distortions And Efficiency Losses

Dan Andrei Iancu, Stanford University, 655 Knight Way, Stanford, CA, 94305, United States, daniancu@stanford.edu, Omar Besbes, Nikolaos Trichakis

We analyze the distortions induced by the presence of debt on a seller's dynamic pricing policy, as well as the efficiency losses that such distortions generate. We show that sellers under debt always price higher and discount items at a lower pace than optimal, and that these distortions compounds over time, leading to a form of spiraling down in efficiency.

4 - Price Dispersion And Consumer Upgrades: Theory And Empirical Evidence From Airline Industry

Yao Cui, Cornell University, Ithaca, NY, United States, yao.cui@cornell.edu, A. Yesim Orhun, Izak Duenyas

We study how the offering of premium seating upgrades affects the airline's ticket price dispersion. We provide insights into this effect both analytically and empirically.

■ TC37

205C-MCC

Sustainable Operations II

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Natalie Huang, Scheller College of Business - Georgia Institute of Technology, GA, United States, ximin.huang@scheller.gatech.edu

1 - Carrot Or Stick? An Analysis Of Environmental Policies In Supply Chains

Xuan Zhao, Associate Professor, Wilfrid Laurier University, 75 University Ave. W., Waterloo, ON, N2L3C5, Canada, xzhao@wlu.ca, Junsong Bian

We examine two types of environmental policies: pollution abatement subsidy ("Carrot" policy) and pollution emission tax ("Stick" policy), in a supply chain where the manufacturer invests in a pollution abatement technology. We find the "Carrot" policy furnishes a higher incentive to the manufacturer's pollution abatement, does not intensify double marginalization, and yields higher profits for both the manufacturer and the retailer. However, when the pollution abatement is very costly and the production emission is highly damaging, the government prefers to implement the "Stick" policy as the "Carrot" policy leads to lower social welfare and environmental performance.

2 - Strategies To Combat Refurbished And Remanufactured Counterfeit Products

Morteza Pourakbar, Erasmus University, Vignolahof 14, Rotterdam, 3066 AV, Netherlands, MPourakbar@rsm.nl, Paolo Letizia, Mohammad Nikoofal

End-of-life and end-of-use products are considered as one of the main sources of core acquisitions for counterfeiters. In this paper, we study what and how anti-counterfeiting strategies could be used to deter counterfeiters from producing refurbished and re-manufactured counterfeit products.

3 - The Value Of Competition In Remanufacturing

Narendra Singh, Indian School of Business, Sector 81, Mohali, 140306, India, narendra_singh@isb.edu, Karthik Ramachandran, Ravi Subramanian

We study an OEM's product strategy when the OEM offers a new product that depreciates over time and consumers are strategic. The OEM competes with a third-party remanufacturer for acquisition and remanufacturing of the depreciated products. We study how competition from the third-party remanufacturer affects the OEM.

■ TC38

206A-MCC

Service Science II

Contributed Session

Chair: Do-Hyeon Ryu, Pohang University of Science and Technology, Pohang, Kyungbuk, Korea, Republic of, dhryu@postech.ac.kr

1 - Financial Valuation Of Wellness Centered Operations

Min Kyung Lee, Clemson University, 100 Sirrine Hall, Clemson, SC, 29634, United States, minl@g.clemson.edu, Aleda Roth, Rohit Verma, Bernardo F. Quiroga

The importance of individual health and their wellbeing sheds light on the evolution of building design to achieve human sustainability. This study contributes the unstudied area of the financial and market impact of hotel guest rooms with wellness inspired features by comparing the Revenue Per Available Room (RevPAR) and customer satisfaction score.

2 - Extended Warranty Information Availability Formats: Impact On Consumer Purchase Decisions

Paul R Messinger, University of Alberta, Faculty of Business, 3-20e Faculty Of Business Bldg, Edmonton, AB, T6G 2R6, Canada, paul.messinger@ualberta.ca, Moein Khanlari Larimi

Information about extended service contracts, mainly price, is generally offered to buyers subsequent to their product purchase decision during the checkout. However, extended service contract (ESC) information has also been made available alongside product attribute information. In this research, we ask whether and how the mere availability of ESC information during the product choice phase might affect consumers' product and ESC purchase decisions. To answer this question, we pit the simultaneous vs. delayed ESC information availability strategies against one another in choice experiments.

3 - Technology In Service – From Dumb To Thinking To Feeling

Ming-Hui Huang, Distinguished Professor, National Taiwan University, 1 Sec 4, Roosevelt Road, Taipei, 10617, Taiwan, huangmh@ntu.edu.tw

In this paper a three-generational technology evolution (from automated to thinking to feeling technology) is presented and the way they can be used in service is illustrated. Automated technologies are mainly developed for productivity, which achieves greater output with less input by standardization. Thinking technologies are designed to handle cognition-based personalization for customer satisfaction. Feeling technologies are to handle emotion-based personalization that enriches interactions. Given the multiplicity of technology, we should explore how to use the right technology for the right purpose in the right context by the right employees for the right customers.

4 - Development Of An Online To Offline Service Blueprint

Do-Hyeon Ryu, Pohang University of Science and Technology, Pohang, Kyungbuk, Korea, Republic of, dhryu@postech.ac.kr, Chie-Hyeon Lim, Kwang-Jae Kim

The online to offline(O2O) service is to find and attract users online and direct them to offline stores. Examples include Uber, Zipcar, Groupon, and so on. Although the term, O2O, is frequently used in academia and industries, research on systematic methods for developing O2O services has been scarce. This research aims to develop a new type of service blueprint specially designed for O2O services. This blueprint is expected to help O2O service providers visualize their services from the customer perspective.

■ TC39

207A-MCC

Dynamic Learning Applications

Sponsored: Applied Probability

Sponsored Session

Chair: N. Bora Keskin, Duke University, Durham, Durham, NC, 27708, United States, bora.keskin@duke.edu

1 - Dynamic Pricing In Unknown Environments With Memory

Abbas Kazerouni, Stanford University, Stanford, CA, 94305, United States, abbask@stanford.edu, Benjamin Van Roy

We consider the problem of dynamic pricing in an unknown environment where the demand at any time is governed by the prices at that time as well as the previous time steps. The delayed consequences of the prices introduce new challenges to the problem and require more sophisticated pricing strategies. To deal with this problem, we propose a pricing strategy based on Reinforcement Learning techniques and derive bounds on its performance. We show the efficiency of the proposed strategy by comparing its performance against other strategies as well as the lower bound through some examples.

2 - Online Active Linear Regression

Carlos Riquelme, Stanford University, rikel@stanford.edu, Ramesh Johari, Baosen Zhang

We study the problem of online active learning to collect data for regression modeling; a decision maker that faces a limited experimentation budget but must efficiently learn an underlying linear model. Our main contribution is a novel threshold-based algorithm for selection of most informative observations; we characterize its performance and fundamental lower bounds. We extend the algorithm and its guarantees to sparse linear regression in high-dimensional settings. Simulations show significant benefits over random sampling in several real-world datasets that exhibit high nonlinearity and high dimensionality - strongly reducing the mean and variance of the squared error.

3 - Learning Preferences With Side-information: Near Optimal Recovery Of Tensors

Andrew A Li, MIT, Cambridge, MA, United States, aali@mit.edu, Vivek Farias

Many recent problems of great interest in e-commerce can be cast as large-scale problems of tensor recovery in three dimensions. Thus motivated, we study the problem of recovering 'simple,' 3D tensors from their noisy observations. We provide an efficient algorithm to recover structurally simple tensors given noisy (or missing) observations of their entries; our version of simplicity subsumes low-rank tensors for various definitions of tensor rank. Our algorithm is practical for large datasets and provides a significant performance improvement over incumbent approaches to Tensor completion. Further, we show theoretical recovery guarantees that under certain assumptions are order optimal.

4 - On Incomplete Learning And Certainty-equivalence Control

N. Bora Keskin, Duke University, Durham, NC, United States, bora.keskin@duke.edu, Assaf Zeevi

Motivated by dynamic pricing applications, we consider a dynamic control-and-estimation problem. The decision-maker sequentially chooses controls and observes responses that depend on both the chosen controls and an unknown parameter. The decision-maker uses a certainty-equivalence policy, and we characterize the asymptotic accuracy performance of this policy.

■ TC40

207B-MCC

Applied Probability and Machine Learning I

Sponsored: Applied Probability

Sponsored Session

Chair: Guy Bresler, Massachusetts Institute of Technology, 32 Vassar St, 32-D672, Cambridge, MA, 02139, United States, guy@mit.edu

1 - Controlling Bias From Data Exploration Using Information Theory

Daniel Russo, Northwestern University, Evanston, IL, United States, dan.joseph.russo@gmail.com, James Zou

Modern data is messy and high-dimensional, and it is often not clear a priori which questions to ask. Instead, the analyst typically needs to use the data to search for interesting analyses to perform and hypotheses to test. It's widely recognized that this process, even if well-intentioned, can lead to biases and false discoveries, contributing to the reproducibility crisis in science. We propose a general information-theoretic framework to quantify and provably bound the bias of an arbitrary adaptive analysis process. We prove that our bound is tight in natural models, and then use it to give rigorous insights into when common procedures do or do not lead to substantially biased estimation.

2 - K-nearest Neighbor Methods For Information Estimation

Sewoong Oh, University of Illinois, Urbana, IL, United States, swoh@illinois.edu

Estimators of information theoretic measures such as entropy and mutual information from samples are a basic workhorse for many downstream applications in modern data science. State of the art approaches have been either geometric (nearest neighbor (NN) based) or kernel based. In this paper we combine both these approaches to design new estimators of entropy and mutual information. Our estimator uses bandwidth choice of fixed k-NN distances; such a choice is both data dependent and linearly vanishing in the sample size and necessitates a bias cancellation term that is universal and independent of the underlying distribution.

3 - Semidefinite Programming Relaxations For Exact Recovery Of Hidden Communities

Jiaming Xu, Purdue University, West Lafayette, IN, United States, xu972@purdue.edu, Bruce Hajek, Yihong Wu

We study a semidefinite programming (SDP) relaxation of the maximum likelihood for exactly recovering hidden communities under the stochastic block model. It is shown that when the community size is large comparing to the network size, the SDP relaxation achieves the information-theoretic recovery threshold with sharp constants; when the community size is small, the SDP becomes strictly suboptimal comparing to the maximum likelihood estimator.

4 - Influence Maximization In Linear Threshold And Triggering Models

Po-Ling Loh, UW - Madison, Madison, WI, 53717, United States, polingloh@gmail.com

We discuss upper and lower bounds for the influence of a set of nodes in certain types of contagion models. We quantify the gap between our upper and lower bounds in the case of the linear threshold model and illustrate the gains of our upper bounds for independent cascade models in relation to existing results. Furthermore, our lower bounds are monotonic and submodular, implying that a greedy algorithm for influence maximization is guaranteed to produce a maximizer within a $\left(1-\frac{1}{e}\right)$-factor of the truth. Our bounds may be evaluated efficiently, leading to an attractive, highly scalable algorithm for influence maximization with rigorous theoretical guarantees.

■ TC41

207C-MCC

Quantitative Risk Management

Sponsored: Financial Services

Sponsored Session

Chair: Abel Cadenillas, University of Alberta, Edmonton, AB, Canada, abel@ualberta.ca

1 - Systemic Influences On Optimal Equity-credit Investment

Christoph Frei, University of Alberta, cfrei@ualberta.ca, Agostino Capponi

Recent events showed that the dependence structure of financial markets is more complex than what is captured by classical models. For example, the financial instability of some companies spread out to affect other companies. We analyze how such systemic influences are reflected in optimal investment decisions. To this end, we introduce a model with dependence structure between market risk and default risk of the companies. An investor can use stocks and credit default swaps (CDSs) to participate in the market. We derive an explicit expression for the optimal investment strategy in stocks and CDSs. An empirical analysis reveals the critical role of systemic risk in portfolio monitoring.

2 - Optimal Governement Debt Ceiling

Abel Cadenillas, University of Alberta, abel@ualberta.ca, Ricardo Huaman-Aguilar

Motivated by the debt crisis in the world, we apply methods of stochastic control to obtain an explicit formula for the optimal government debt ceiling.

3 - Optimal Cash Holdings Under Funding Risk

Andreea Minca, Cornell University, acm299@cornell.edu

This talk explores a one-period model for a firm that finances itsoperations through debt provided by heterogeneous creditors. Creditorsdiffer in their beliefs about the firm's investment outcomes. We showthe existence of Stackelberg equilibria in which the firm holds cashreserves in order to provide incentives for pessimistic creditorsto invest in the firm. We find interest rates and cash holdings tobe complementary tools for increasing debt capacity. In markets witha high concentration of capital across a small interval of pessimisticcreditors or by a few large creditors, cash holdings is the preferredtool to increase the debt capacity of the firm.

4 - EM Algorithm and Stochastic Control

Steven Kou, National University of Singapore, matsteve@nus.edu.sg

We propose an algorithm called EM-Control (EM-C) algorithm to solve multi-period finite-time horizon stochastic control problems. Generalizing the idea of the EM algorithm, the EM-C algorithm sequentially updates the control parameters in each time period in a backward manner. The EM-C algorithm has monotonicity of performance improvement in every iteration. We apply the EM-C algorithm to solve stochastic control problems in real business cycle and monopoly pricing of airline tickets. This is a joint work with Xianhua Peng and Xingbo Xu.

■ TC42

207D-MCC

Revenue Management with Advertising Applications

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: John G Turner, University of California - Irvine, Room SB2 338, Irvine, CA, 92697-3125, United States, john.turner@uci.edu

1 - The Bid Adjustment Problem In Search Advertising

Mustafa Sahin, University of Maryland, mustafa.sahin@rhsmith.umd.edu, Subramanian Raghavan, Abhishek Pani, Abhishek Pani

We discuss the problem faced by the advertiser in search advertising in the presence of bid adjustments. Recent developments in search advertising created a setting in which the advertiser can target specific demographics by using bid adjustments. We propose a Mixed Integer Programming formulation for the problem. However, the problem is computationally hard and cannot be solved by a generic commercial solver for any instance of reasonable size. Therefore, we offer heuristic approaches to tackle the intractability issues and present results on hard instances.

2 - Analysis Of Competitive Pricing With Multiple Overlapping Competing Bids In Revenue Management

Goutam Dutta, Professor, Indian Institute of Management, House No 407, Iima Old Campus, Vastrapur, Ahmedabad, 380015, India, goutam@iima.ac.in

We formulate the pricing problem from the point of view of one seller having one or multiple competitors (say n). Based on past experience, we know the distribution of bid prices of the competitors. We consider uniform and normal distribution to describe the bid price of the competitors. The prices of the competitors are mutually independent and the price ranges are either identical or different and overlapping. We maximize the expected contribution of the seller. Assuming the contribution as a linear function of price we find the conditions for maximization of the expected contribution to profit in case of n bidders. Further, we also compare the optimization results with simulation results.

3 - Markov Chain Models For Controlling The Frequency Distribution Of Online Advertising

Seyed Ali Hojjat, University of New Hampshire, Durham, NH, United States, ali.hojjat@unh.edu, John G Turner

Recent trends in online advertising show that explicit reach and frequency specifications are more desired over aggregate impression or budget goals. Depending on whether the frequency of ad serving to each user is measured over a fixed timespan (e.g., the number of times each user is exposed to the ad within each calendar week) or on a rolling basis (e.g., over any contiguous 24-hour period throughout the campaign's horizon), we propose an appropriate Markov chain model for serving ads and investigate its properties in maintaining a desired frequency distribution for an online ad campaign.

4 - Planning Online Advertising Using Lorenz Curves

John G Turner, University of California - Irvine, Irvine, CA, United States, john.turner@uci.edu, Miguel A Lejeune

Lorenz curves are commonly-used to depict dispersion; e.g., income inequality. Motivated by online advertising campaigns that desire impressions spread over targeted audience segments and time, we formulate a problem that minimizes Gini Coefficients (area under the Lorenz curve), and develop a specialized decomposition technique to solve instances quickly.

■ TC43

208A-MCC

Decision Making in Public Policy

Sponsored: Decision Analysis

Sponsored Session

Chair: Cameron MacKenzie, Iowa State University, Ames, IA, United States, camacken@iastate.edu

1 - Hurricane Decision Simulator

Eva D Regnier, Naval Postgraduate School, eregnier@nps.edu, Cameron MacKenzie, Eric S Hodson

When threatened by a hurricane, Marines in New Orleans face a classic sequential decision under uncertainty with regularly updated information, but few opportunities to learn from experience. The Hurricane Decision Simulator allows personnel to run experience key decisions in the context of many realistic simulated storms, to develop a better understanding of the interrelated decisions required, and a familiarity with the forecast products and their evolving uncertainty. This talk highlights application of both "hard" and "soft" sides of analytics in the development of the tool. This is the first hurricane training tool that allows users to explore many different decision paths.

2 - Subsidizing Cybersecurity Information Sharing: A Game Between A Government And N-Companies

Ali Pala, University at Buffalo, Buffalo, NY, 14260, United States, alipala@buffalo.edu
Ali Pala, Turkish Military Academy, Devlet Mahallesi, Bakanlıklar, Ankara, Turkey, alipala@buffalo.edu, Jun Zhuang

More cybersecurity information sharing would lead to stronger resistance against cyber-attacks in the presence of a cooperative and trustworthy sharing network. Sharing cyber-attack information, however, could harm reputation, create disadvantages against competitors and additional costs, and cause disclosing vulnerabilities and some private information. In this research, we study what, how, and to whom government incentives should be provided in order to encourage and improve information sharing. We incorporate game theory and agent-based simulation modeling to develop a dynamic decision support tool that generates information sharing strategies in the face of strategic attackers.

3 - Resource Allocation Decisions With Deep Uncertainty

Cameron MacKenzie, Iowa State University, camacken@iastate.edu

Mathematical models to help public policy decision makers often have a great amount of uncertainty, sometimes called deep uncertainty. Decision makers may also be skeptical about solely relying on model recommendations. A solution to this deep uncertainty and a decision maker's skepticism is for the model output to consist of ranges or intervals rather than point solutions. This presentation will offer a method for identifying intervals for resource allocation models in which every solution within the interval differs from the optimal solution by a predetermined value.

4 - Economic Contagion And The Role Of Beliefs: Findings From A Borrower-lender Game

Jonathan William Welburn, University of Wisconsin - Madison, welburn@wisc.edu

We present a within-period sequential-move game with multiple borrower countries and a single common lender to model cross-country contagion. We discuss the role of beliefs, modeled through Bayesian updating, and determine equilibrium solutions using nonlinear optimization. The model is calibrated to the 2010 Eurozone crisis, but sensitivity analysis is used to identify conditions under for contagion. Results demonstrate that what appears to be contagion may be the result of a crisis of confidence. Findings and their implications for decision making and policy are discussed.

■ TC44

208B-MCC

Decisions, Sensitivity and Applications

Sponsored: Decision Analysis

Sponsored Session

Chair: Emanuele Borgonovo, Bocconi University, Via Roentgen 1, Milano, 20833, Italy, emanuele.borgonovo@unibocconi.it

1 - Strength Of Preferences In Repeated Prospects

Alessandra Cillo, Assistant Professor, Bocconi University, Milan, 20146, Italy, alessandra.cillo@unibocconi.it, Enrico G De Giorgi

Experimental studies have found that people reject a single lottery but accept a repeated play of the same lottery. Other studies have also found that the higher acceptance rates for the repeated play when the overall distribution is displayed depends on the type of prospect. These results have critical managerial relevance, but they are based on acceptance rates. The paper provides a theoretical framework, which allows quantifying the strength of preferences in repeated prospects. We provide an experiment to test possible editing processes in the context of repeated prospects.

2 - Tolerance Sensitivity And Maximum Regret In Linear Programming

Richard E. Wendell, University of Pittsburgh, Pittsburgh, PA, 15260, United States, wendell@katz.pitt.edu, Emanuele Borgonovo

Within a tolerance framework for linear programming, we present a new approach for calculating optimal coefficient sets. The approach solves an otherwise NP hard problem and, moreover, allows us to streamline the computation of regret functions.

3 - Randomized Differential Sensitivity

Sumeda Siriwardena, Bocconi University, sumeda.siriwardena@phd.unibocconi.it, Emanuele Borgonovo

Sensitivity analysis is an integral part of the decision analysis process. In several situations, analysts have not only the dataset of realizations of the model output but also of the corresponding partial derivatives. We introduce a new method based on the randomization of the differential importance measure. This sensitivity indicator does not require independence and possesses the additivity property, which makes the calculation of joint sensitivities seamless. We study numerical estimation and obtain the expression of the convergence rate. Managerial insights are discussed in detail.

4 - Estimating Strategic Impacts Of Foreclosed Housing Redevelopment Using Spatial Analysis

Michael Johnson, University of Massachusetts Boston, MA, michael.johnson@umb.edu

Community-based organizations engaged in foreclosure response wish to quantify the relative value of housing units for redevelopment. We measure the 'strategic value' of property acquisition candidates based on proximity to site-specific neighborhood amenities and disamenities, given the relative importance of that proximity to CDC organizational and community objectives. We show that strategic values can differ in systematic ways depending on the types of amenities and disamenities identified as relevant for acquisition decisions, the relative importance assigned to those amenities and disamenities, and the utility maximization objectives of the organization.

■ TC45

209A-MCC

Multi-Objective Optimization Via Simulation

Sponsored: Simulation

Sponsored Session

Chair: Susan R Hunter, Purdue University, West Lafayette, IN, United States, susanhunter@purdue.edu

Co-Chair: Enlu Zhou, Georgia Institute of Technology, na, Atlanta, GA, na, United States, enlu.zhou@isye.gatech.edu

1 - A Partition-based Random Search For Stochastic Multi-objective Optimization Via Simulation

Loo Hay Lee, National University of Singapore, Singapore, Singapore, iseleelh@nus.edu.sg, Weizhi Liu, Siyang Gao

We proposed two parallel partition-based random search methods to solve the stochastic multi-objective optimization via simulation considering Pareto optimality for constrained and unconstrained case. The idea is to explore the whole feasible region and exploit on current most promising regions in the same time. Partition methods are used to shrink current most promising regions iteratively, and simulation allocation rules are adopted to decrease the noise. Both methods are proven to converge to the global Pareto set with probability one. Numerical experiments are conducted to demonstrate the effectiveness and robustness of the proposed algorithm compared to well-known methods.

2 - An Assessment Of Model Based Methods In Multi-objective Optimization

Joshua Hale, Georgia Institute of Technology, 755 Ferst Drive, NW, Atlanta, GA, Atlanta, GA, United States, jhale32@gatech.edu, Helin Zhu, Enlu Zhou

We propose domination measure as a new concept to measure the quality of solutions in multi-objective optimization. The domination measure of a solution can be intuitively interpreted as the size of the portion of the decision space that dominates that solution. We reformulate the multi-objective problem to a single-objective stochastic problem and solve it using a model-based approach. The numerical experiment shows that our proposed algorithm is effective at approximating the optimal Pareto set and is competitive with some previously proposed methods.

3 - On Multi-objective Ranking And Selection Methods

Susan Hunter, Purdue University, susanhunter@purdue.edu, Guy Feldman, Raghu Pasupathy

Consider the context of selecting Pareto-optimal systems from a finite set of systems based on multiple stochastic objectives. We seek a characterization of the asymptotically optimal sample allocation that maximizes the rate of decay of the probability of misclassification, i.e., the probability a Pareto system is falsely estimated as non-Pareto, or a non-Pareto system is falsely estimated as Pareto. We discuss recent advances in solving this problem.

4 - Precision Irrigation System Optimization Using Subsurface Water Retention Technology For Multiple Conflicting Objectives

Kalyanmoy Deb, Michigan State University, kdeb@egr.msu.edu

Water is precious and recent efforts to achieve precision irrigation with minimum use of water through subsurface water retention technology (SWRT) are getting popular. In this study, we have linked a water permeation simulation process with a multi-objective optimization algorithm to obtain optimized solutions involving shape and location of subsurface impermeable membranes and simultaneously obtain optimal surface water supply. The procedure is pragmatic and is customized for specific soil and crop combination and average precipitation level.

■ TC46

209B-MCC

Empirical and Data-Driven Studies in Revenue Management and Pricing

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Jun Li, Ross School of Business, University of Michigan, Ann, MI, United States, junwli@umich.edu

Co-Chair: Serguei Netessine, INSEAD, Singapore, Singapore, serguei.netessine@insead.edu

1 - Compete With Many: Price Competition In High Dimensional Space

Jun Li, Ross School of Business, University of Michigan, junwli@umich.edu, Serguei Netessine, Sergei Koulayev

We study price competition in markets with a large number (in the magnitude of hundreds or thousands) of potential competitors. We propose a new instrument variable approach to address simultaneity bias in high dimensional variable selection problems. The novelty of the idea is to exploit online search and clickstream data to uncover demand shocks at a granular level, with sufficient variations both over time and across competitors. We apply this data-driven approach to study the New York City hotel market.

2 - Randomized Markdowns And Online Monitoring

Ken Moon, The Wharton School, Philadelphia, PA, United States, kenmoon@wharton.upenn.edu, Kostas Bimpikis, Haim Mendelson

Using data tracking customers of a North American retailer, we present empirical evidence that monitoring products online associates with successfully obtaining discounts. We develop a structural model of consumers' dynamic monitoring to find substantial heterogeneity, with consumers' opportunity costs for an online visit ranging from $2 to $25 in inverse relation to their price elasticities. We show implications for retail operations and also discuss targeting customers with price promotions using their online histories.

3 - A Nonparametric Approach To Learning Mixture Models

Srikanth Jagabathula, NYU Stern, sjagabat@stern.nyu.edu, Lakshminarayanan Subramanian, Ashwin Venkataraman

We consider the problem of learning a mixture model, where the number of mixture components is learned directly from the data. Our framework applies to any mixture model, but we specialize our techniques to learn the mixture of multinomial (MNL) models. We pose the learning problem as that of minimizing a loss function (likelihood, squared-loss, etc.) over the data and model parameters. Common formulations result in a non-convex problems. We overcome this through a novel reformulation that converts the problem into a semi-infinite convex program. We then apply conditional-gradient techniques to solve the convex program. We validate our methods theoretically and empirically.

4 - Leveraging Inventory In Profit Maximization For Personalized Online Bundle Pricing Recommendation

Anna M Papush, Massachusetts Institute of Technology, 1 Amherst Street, Cambridge, MA, 02139, United States, apapush@mit.edu, Pavithra Harsha, Georgia Perakis

E-commerce has been vastly growing in popularity over the past decade. It has been capturing increasing proportions of the retail market. Thus gaining the competitive edge in this sector is of utmost importance to any firm's success. This work presents a model for providing relevant product recommendations at personalized prices while leveraging knowledge of inventory at-risk for markdowns and maximizing retailer profits. We demonstrate practical applications through implementation on actual e-tailer data, as well as establishing performance guarantees relative to an optimal offline approach.

■ TC47

209C-MCC

Choice-based Demand and Strategic Consumers

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Gustavo Vulcano, New York University, 44 West Fourth St, Suite 8-76, New York, NY, 10012, United States, gvulcano@stern.nyu.edu

1 - Predicting Individual Customer Responses To Product Promotions

Dmitry Mitrofanov, NYU, dm3537@stern.nyu.edu, Srikanth Jagabathula, Gustavo Jose Vulcano

We consider the problem of predicting an individual customer's response to a product promotion using historical purchase transactions data, tagged by the customer id. The problem is challenging because of the limited number of observations available for each individual. To extract the signal from the limited data most efficiently, we model each individual through a partial-order consisting of weak and strong preferences (A is strongly preferred to B if non-promoted A is purchased over promoted B). We calibrate an MNL model over the partial orders and quantify its prediction power on out-of-sample transactions. Then, we use this information to optimize personalized promotions.

2 - The Heteroscedastic Exponomial Choice Model

Aydin Alptekinoglu, Penn State, aydin@psu.edu, John H Semple

We develop analytical properties of the Heteroscedastic Exponomial Choice (HEC) model and demonstrate its estimation using a household panel data of grocery purchases. The HEC model compares quite favorably to MNL in out-of-sample prediction.

3 - Assortment Optimization With Product Costs And Constraints

Sumit Kunnumkal, ISB, sumit_kunnumkal@isb.edu, Victor Martinez de Albeniz

We consider the assortment optimization problem under the MNL model with product fixed costs and constraints. We propose a new method to obtain an upper bound on the optimal expected profit. We show that our method is tractable and has provable performance guarantees for some common types of assortment constraints.

4 - Optimal Pricing In Continuous Time

José Correa, University of Chile, Santiago, Chile, correa@uchile.cl

We consider continuous time pricing problems with strategicconsumers that arrive over time. By combining ideas from auctiontheory and recent work on pricing with strategic consumers we derivethe optimal continuous time pricing scheme in some situations. Ournovel approach is based on optimal control theory and is well suitedfor numerical computations.

■ TC48

210-MCC

Social Media Analysis IV

Invited: Social Media Analytics

Invited Session

Chair: Anandasivam Gopal, University of Maryland, Smith School of Business, College Park, MD, 11111, United States, agopal@rhsmith.umd.edu

1 - Extraction Of Adverse Events From Social Media

Lina Zhou, University of Maryland-Baltimore County, 1000 Hilltop Circle, Baltimore, MD, 21250, United States, zhoul@umbc.edu, Yin Kang

Adverse events have significant impacts on patients' safety. Understanding patient reports of adverse events in social media remains a significant research challenge. We proposed new methods based on syntactic dependency relations to extract adverse events. The experiment results demonstrate that our proposed methods improve the extraction performance across all data sets in terms of both precision and recall.

2 - When It Rains, It Pours: Effect Of Social Media On Stock Price Behavior During Firm Crises

Soo Jeong Hong, Michigan State University, 404 Wilson Rd, Room 311, East Lansing, MI, 48824, United States, hongsoo3@msu.edu, Kwangjin Lee

We examine the effect of social media usage on the capital market under a firm crisis situation. Focusing on consumer product recalls, we investigate the factors which determine individuals' information sharing decisions in social media. We also analyze when recall information shared via social media can exacerbate negative market reactions.

3 - Networked Pattern Recognition Frameworks For Understanding And Detecting Future Terrorism Threats

Salih Tutun, Turkish Military Academy, and Binghamton University, 4400 Vestal Pkwy E, Binghamton, NY, 13850, United States, slh.tutun@gmail.com, Mohammad Khasawneh

The challenge of governments are how to track threats, since terrorists have learned how to avoid unsecured communications, such as social media. This research is proposed as a new framework that will better understand the characteristics of future suicide attacks by analyzing the relationship among the attacks. It is also proposed as a new unified detection framework that applies pattern classification techniques to network topology to detect terrorist activity. The finding results can potentially use to propose reactive strategies thus enabling precautions to be taken against future attacks.

■ TC49

211-MCC

Experiential Field Learning

Sponsored: Education (INFORMED)

Sponsored Session

Chair: Benjamin Grannan, Virginia Military Institute, Lexington, VA, United States, grannanbc@vmi.edu

1 - A Survey Of Issues And Best Practices In Field-based Education

Michael F Gorman, University of Dayton, michael.gorman@udayton.edu

There is a growing literature on field-based education in OR/MS. I survey recent literature and share common benefits, issues and best practices from published works.

2 - A Toolkit To Facilitate Quality Work In Field Courses

Patrick S. Noonan, Emory University, Atlanta, GA, United States, patrick.noonan@emory.edu

Two beliefs about field courses are widely shared: 1. Good field experiences can greatly boost student ability to apply course concepts & tools to real-world challenges ahead. 2. Facilitating "good field experiences" is hard... for everyone. Tackling real-world problems is inherently difficult - that's the point! But one central problem that educators can address is that few participants - students, faculty, TAs - have been trained in the consultative process. Adapting the toolkit of management consultants can improve the learning experience and the results for clients/problem-owners, and ease the teaching burden. We share experience & techniques from Emory's "Management Practice" program.

3 - Supervising Undergraduate Field Based Analytics Projects

Benjamin Grannan, Virginia Military Institute, grannanbc@vmi.edu

Supervising undergraduate students working on real world analytics projects results in unique challenges. In this talk we discuss the experience of recruiting undergraduate students from multiple disciplines, selling the value of analytics to clients and helping students transition their classroom skills to the often messy real world project setting. Examples from both a summer five week field based independent research course and an extracurricular student-led analytics consulting club are presented.

■ TC50

212-MCC

SpORts: Sports Analytics I

Sponsored: SpORts

Sponsored Session

Chair: Stephen Hill, University of North Carolina Wilmington, 601 South College Road, Wilmington, NC, 28403-5611, United States, hills@uncw.edu

1 - Do Pitchers Differ on Batting Average on Balls In Play or Defense Independent Slugging Percentage?

Matthew Hall, University of Alabama, Culverhouse College of Commerce and Business Administration, Tuscaloosa, AL, 35487-0226, United States, mjhall5@crimson.ua.edu, James Cochran

Using ANOVA and MANOVA, we systematically examine data for pitchers who have pitched at least 160 innings in five or more seasons since 1999 to assess whether they differ on Batting Average on Balls in Play (BABIP - common Sabermetric wisdom says they do not) or Defense Independent Slugging Percentage (DISP).

2 - Are You Ready For Some Football? An Analysis Of Monday Night Football Viewership

Bhupesh Shetty, University of Iowa, bhupesh-shetty@uiowa.edu

Analyzing data from 1993 to 2014, we conduct a three-pronged analysis of Monday Night Football (MNF) viewership. First, we present a model using ex post facto factors that explains over 90% of the variability. Then we present a model using only factors known in the April preceding the season (when the NFL schedule is announced). Finally, we use the predictive regression model to estimate objective function coefficients in an integer program formulation that maximizes expected MNF viewership. We conduct simulation experiments to determine the impact of forecast error on the optimal MNF schedule.

3 - A Handicap System For Tennis

Timothy Chan, University of Toronto, Toronto, ON, Canada, tcychan@mie.utoronto.ca, Raghav Singal

Handicap systems are used in many sports and games to improve competitive balance and equalize the probability of winning a match between two or more players. In this paper, we develop a handicap system for tennis using a MDP model to quantify the appropriate handicap between two players of unequal ability. We apply the model to real match data to estimate professional handicaps. We also demonstrate how our handicap can be mapped to a tennis rating system, which can facilitate broader uptake at a grassroots level.

4 - Does The Current Golf Handicap System Bias Match Play Outcomes?

Martin L Puterman, Professor Emeritus, University of British Columbia, Sauder School of Business, 2053 Main Mall, Vancouver, BC, V6T 1Z2, Canada, martin.puterman@sauder.ubc.ca, Timothy Chan, David Madras

In amateur golf, lower handicap players "give strokes" to higher handicap players on the basis of the difference between handicaps so as to make head-to-head matches fair. In a match, the "standard way" to allocate handicap strokes is on the basis of the course hole difficulty ranking. Using a data driven simulation based on over 600 rounds, we show that standard stroke allocation and hole rankings favor the superior player. We investigate the simultaneous impact on match fairness of alternative hole rankings, allocations of handicap strokes to specific holes and awarding extra strokes to higher handicap players.

■ TC51

213-MCC

Modeling Complex Systems in Education

Sponsored: Public Sector OR

Sponsored Session

Chair: Roxanne Moore, Georgia Institute of Technology, 1, Atlanta, GA, 30333, United States, roxanne.moore@gatech.edu

1 - Applying System Dynamics Models To Steam Interventions

Michael Helms, Georgia Tech, michael.helms@gatech.edu

Education researchers implement education interventions in highly complex systems, where intervention outcomes depend heavily on the system attributes, actors and interactions over time. We developed a modeling process using system dynamics principles to better understand the complex interactions and mechanisms of a STEAM education intervention. In this presentation we will discuss the resulting causal loop diagram, and the implications of our modeling process in terms of intervention design, implementation and sustainability.

2 - Education as a Complex System: Opportunities, Challenges, and Perspectives

Mirsad Hadzikadic, University of North Carolina, Charlotte, NC, United States, mirsad@uncc.edu

Education is a large complex systems. It presents many challenges for its full understanding. However, if done well, it can bring tremendous benefits to people, society, and industry. It can be simulated and modeled from different perspectives, including the content of education, the modality of teaching/learning, improving access to education, school assignments, classroom assignmnents, seating assignments, within classroom interaction, student-student interaction, or student-teacher interaction. This talk will present an overview of various technologies to analyze/simulate/model the previously stated perspectives.

3 - Modeling Interventions In Complex Educational Systems

Britte H Cheng, SRI International, Menlo Park, AL, United States, britte.cheng@sri.com

The ability of complex social systems to resist policy mandates—to revert to the norm—has gained increased attention in educational research. This paper presents a perspective on the reasons behind the policy resistance of education systems including the lack of approaches for evaluating possible policies before implementation. We highlight two projects (one around STEM retention in undergraduate and one on K-12 formative assessment systems) that modeled educational systems to explore proposed policy implementations before they are put into practice.

■ TC52

214-MCC

Urban Transportation and Logistics in Public Sector OR II

Sponsored: Public Sector OR

Sponsored Session

Chair: Sung Hoon Chung, Binghamton University, PO Box 6000, Binghamton, NY, 13902, United States, schung@binghamton.edu

1 - A New Fast Algorithm For The Time-expanded Network Of Dynamic Building Evacuation

Dong-jin Noh, Postech, Pohang, Korea, Republic of, visionph@postech.ac.kr, Chang Hyup Oh, Young Myoung Ko, Byung-In Kim

Time-expanded network models have been widely used in many evacuation studies. Linear programming and heuristics algorithms have been applied for the models. In this presentation, we propose a new fast exact algorithm for a time-expanded network model arisen in a dynamic building evacuation. The proposed algorithm takes advantage of the characteristic that there exist no cycle in the time-expanded network model. Experimental results demonstrate the efficiency of the proposed approach. The proposed algorithm can be applied for real-world dynamic building evacuation problems.

2 - Human In The Loop Optimization For Recovery From Extreme Events

Aybike Ulusan, Northeastern University, Boston, MA, 02115, United States, ulusan.a@husky.neu.edu, Ozlem Ergun

We consider the problem faced by contractors of collecting debris from a transportation network to the disposal facilities in the aftermath of a disaster. The problem has a multi-objective nature which embodies implementable division of a service region among subcontractors such that the assigned workload among different subcontractors is balanced and time to complete debris collection operations is minimized. In this study, we explore the potential of having humans collaborate with algorithms, and the use of game-based experiments to build a decision support tool. We investigate how to exploit human input to achieve a performance that can not be achieved by human or computer itself individually.

3 - Clearing Roads And Collecting Debris By Integrating Remote Sensing Technique And Vrp

Eunsu Lee, New Jersey City University, ELee3@njcu.edu

Every natural disaster generates large amount of debris on roads. Clearing the debris from roads is crucial to recover mobility and accessibility to support humanitarian aids and normal life. This study investigates an integrated approach using remote sensing technology and vehicle routing problem to find, clear, and dispose the items quickly and efficiently.

4 - Disaster Relief Routing under Uncertainty

Sung Hoon Chung, Binghamton University, 4400 Vestal Parkway East, Binghamton, NY, 13902, United States, schung@binghamton.edu, Yinglei Li

We propose a robust optimization approach for vehicle routing problems (VRPs) under uncertainty for humanitarian logistics. In addition to classical cost-minimizing and route-minimizing objectives of the VRPs, we employ alternative objectives such as minimizing the average arrival time, the latest arrival time, and the demand weighted arrival time, as it is critical for deliveries to be fast and fair in routing for relief efforts. We show the use of the proposed approach using benchmark problems and identify instances in which solutions of the VRP variants are significantly different than ones of conventional VRPs.

■ TC53

Music Row 1- Omni

Management of Product and Service Innovation

Sponsored: Technology, Innovation Management & Entrepreneurship

Sponsored Session

Chair: Juliana Hsuan, Professor, Copenhagen Business School, Solbjerg Plads 3, B.5.27, Frederiksberg, DK-2000, Denmark, jh.om@cbs.dk

1 - Linking The Firm's Internal Innovation Context With Commercialization Choices

Lee Davis, Copenhagen Business School, ld.ino@cbs.dk, Karin Hoisl, Jerome Davis

This paper investigates the linkages between the firm's internal innovation context and how the innovation is commercialized (by the firm itself or an external third party). By analyzing these linkages at the level of the individual innovation, we add to the literature on how firms profit from R&D. We base our study on original survey data comprising 3,773 commercialized innovations from 23 countries in all major industries. We find that three aspects of the innovation context - external knowledge inputs, encouragement of creativity, and high autonomy - are positively related to external commercialization. Sufficient resources are negatively related to external commercialization.

2 - Managing External Intellectual Capital In New Product Development: The Case For Ontological Semantic Analysis Of Patent Data

Charles Weber, Portland State University, webercm@pdx.edu, Farshad Madani, Nitin Mayande

Historically, intellectual capital from outside the firm has been derived from patent metadata. This paper presents a potentially much more effective approach, which automatically analyzed the body text of patents.

3 - Logistics Service Performance In Nova Scotia: Facilitators, Barriers, And Measurement

M. Ali Ulku, Rowe School of Business, Dalhousie University, Halifax, NS, B3H3S7, Canada, ulku@dal.ca, Horand I. Gassmann, Michael Foster

Logistics plays a pivotal service role in efficient management of supply chains. Building on the extant literature and company-survey results, we explore the facilitators and barriers logistics companies face in the province of Nova Scotia, Canada. We also propose key metrics for measuring the performance of regional logistics services.

4 - Management Of Service And R&D Portfolios

Kai Basner, PhD Candidate, Copenhagen Business School, Solbjerg Plads 3, Frederiksberg, DK-2000, Denmark, kba.om@cbs.dk, Thomas Frandsen, Jawwad Raja, Juliana Hsuan

Managing technological innovation is critical to the continued success of industrial companies, which in recent years have been observed to expand their business models by complementing their products with services. For manufacturers with a strong focus on product technology, we explore the challenges of introducing service innovation in R&D portfolios.

■ TC54

Music Row 2- Omni

Service Science: Best Cluster Paper Presentation

Sponsored: Service Science

Sponsored Session

Chair: Paul Maglio, University of California, Merced, 5200 N Lake Rd, Merced, CA, 95343, United States, pmaglio@ucmerced.edu

1 - Scheduling Promotion Vehicles To Boost Profits

Lennart Baardman, Massachusetts Institute of Technology, Cambridge, MA, United States, baardman@mit.edu, Maxime Cohen, Georgia Perakis, Kiran Panchamgam, Segev Danny

With our collaborators from Oracle, we model how to schedule promotion vehicles to maximize profits using ideas from the non-linear bipartite matching problem. Promotion vehicles should be assigned to time periods, subject to capacity constraints. We introduce a class of models for which the boost effects of vehicles on demand are multiplicative. We show that the problem is computationally intractable and develop a greedy method as well as a (1-epsilon)-approximation using an IP of polynomial size. We analyze our methods as well as validate them on actual data and finally, quantify their impact.

2 - Optimizing Precision In Machine Learning Models For Actionable Predictions Of Revenue Change

Abhinav Maurya, Carnegie Mellon University, 5634 Stanton Avenue, Apt 306, Pittsburgh, PA, 15206, United States, ahmaurya@cmu.edu, Aly Megahed, Ray Strong, Jeanette Blomberg, Alaa Elwany

Predicting changes in account revenues is of vital importance to a business in order to take action on accounts predicted to shrink, and learn success stories of offerings that led to revenue growth. However, the corresponding datasets are often imbalanced, and so optimizing prediction accuracy, as the majority of classifiers do, yields poor results in this case. We present a Gaussian Process-based method that directly maximizes precision subject to a minimum recall level, yielding actionable results without sacrificing much accuracy. Numerical experiments show very promising results.

3 - Data Analytics Approaches For Winning Service Contracts: Development And Impacts on Practice

Aly Megahed, IBM Research - Almaden, San Jose, CA, 95123, United States, aly.megahed@us.ibm.com, Taiga Nakamura, Kugamoorthy Gajananan, Mark Smith, Gregory Heim

Service providers in B2B often must prepare bids to win service outsourcing contracts. For high-value IT service outsourcing deals, the solution design and deal pricing process can be a complicated, expensive gamble. We present an approach based in data analytics to automate and customize the often manual practices used to configure such contract proposals. We propose a base model and model enhancements, demonstrating their performance using historical contract data and third-party vendor market data. The actionable methods demonstrate how data analytics tools can enable more effective manager decisions regarding contract proposal solution design and pricing.

4 - Welfare Implications Of Congestion Pricing: Evidence from SFpark

Hsin-Tien Tsai, University of California, Berkeley, 1822 Francisco St., Apt 4, Berkeley, CA, 94703, United States, hsintien@berkeley.edu, Pnina Feldman, Jun Li

SFpark is a congestion pricing program for street parking implemented in San Francisco. We investigate whether consumers benefit from congestion pricing using data from this program. We build a structural model of consumer search and quantify the change in consumer welfare.

5 - On a Variation Of Two-part Tari Pricing Of Services: A Data Driven Approach

Charles Thraves, Massachusetts Institute of Technology, Cambridge, MA, United States, cthraves@mit.edu, Georgia Perakis

We present a pricing optimization problem for the data plans of a big satellite firm. First we address the problem of missing data (as reservation prices are not directly observed especially for those who are not current customers). We formulate the price optimization problem as a MIP and develop properties and heuristics in order to solve realistic instances providing analytical lower bounds of their performance. We conclude that with our method the company can increase its profits by more than 10% and outperform the current plans' prices even under misspecifications of the assumptions.

■ TC55

Music Row 3- Omni

Inventory Management V

Contributed Session

Chair: Hueon Lee, PhD Candidate, University of Arkansas, 4207 Bell Engineering Center, 1 University of Arkansas, Fayetteville, AR, 72701, United States, hueonlee@uark.edu

1 - Long Term Outsourcing Under Stochastic Learning And Information Asymmetry

Ting Luo, UT Dallas, 7208 Fair Valley Way, Plano, TX, 75024, United States, tingluo2006@gmail.com

We study a firm's procurement and selling decisions in a multiclass demand and multisupplier inventory system. We show that optimal procurement is driven by multisourcing and intertemporal substitution, while optimal selling is driven by customer segmentation and intertemporal rationing.

2 - Selling Luxury Fashion Online With Social Influences

Bin Shen, Donghua University, Xuri Building, 1882 Yanan Road,, Donghua University, Shanghai, China, binshenjerry@gmail.com

In the luxury fashion retailing industry, consumers can be categorized into the groups of fashion leader and fashion follower. These two groups influence one another and create social influences in the market. In this paper, we construct an analytical model to examine the effects of demand changes on a luxury fashion supply chain with social influences. We consider the case when the supply chain consists of one supplier and one online retailer providing differentiated services to different groups of consumers.

3 - A Multi-product Dynamic Block Stacking Problem With Deterministic Demand

Hueon Lee, PhD Candidate, University of Arkansas, 4207 Bell Engineering Center, 1 University of Arkansas, Fayetteville, AR, 72701, United States, hueonlee@uark.edu, Kelly Sullivan, John A White

Block stacking is a commonly used storage method for palletized loads where unit loads are stacked on top of each other and stacks are aligned in storage rows having different depths. In a multi-product storage system each product is assigned to storage rows having a specific depth. As the inventory level changes for a product, it can be relocated to storage rows having a different depth if relocation minimizes the cost of relocation and the cost of storage space. In our formulation, we require all inventory of a product to be stored in rows having the same depth. With the assumption of a given layout and known inventory cycles, we formulate the problem as a variation of the multicommodity flow problem.

■ TC56

Music Row 4- Omni

Managing Sales in On-demand Economy

Sponsored: EBusiness

Sponsored Session

Chair: Michelle Wu, Washington State University, WA, United States, michelle.wu@wsu.edu

1 - We Are On The Way: Analysis Of On- Demand Booking Systems

Guiyun Feng, Student, University of Minnesota, 1006 27th Avenue SE, Apt E, Minneapolis, MN, 55414, United States, yunny.feng@gmail.com, Guangwen (Crystal) Kong, Zizhuo Wang

On-demand platforms such as Uber allow passengers with smartphones to submit trip requests and match them to drivers based on their locations and drivers' availability. We build a model to analyze the efficiency of such on-demand systems and compare it to systems where people hail taxis on streets. We simulate customers' waiting time in the two different systems and find that customers' waiting time with on-demand system can be higher than street hailing. We provide a cap policy that takes advantages of both on-demand system and street hailing in order to minimize customers' waiting time.

2 - Conform Or To Be Cast Out: Quantifying The Effect Of Platform Endorsement And Consumer Generated Reputation In Online Service Marketplace Demand System

Yong Tan, University of Washington, ytan@uw.edu, Jinyang Zheng, Youwei Wang

We estimate demands for online service to understand heterogeneous sensitivity to platform endorsement and consumer generated reputation, and to investigate "conform or to be cast out" policy which is applied to force sellers to improve platform endorsement. Our finding shows individuals exhibiting consistent sensitivity to consumer generated reputation, but perceiving platform endorsement differently. With regard to the policy, we find that even though casting out reduce variety of sellers, the negative effect is offset by conforming sellers' improvement. Furthermore, we find sellers' further quality escalation in the establishment of new equilibrium, benefiting consumer welfare.

3 - Measuring Consumer Surplus In The On Demand Economy The Case Of Ride Sharing

Meng Liu, MIT Sloan, Cambridge, MA, United States, mengliu@mit.edu

Uber and Lyft, two pioneer ride-sharing platforms have seen dramatic growth over the last few years. To understand their roles and impacts on the economy, we estimate the consumer welfare of these platforms in a structural demand model for rides. In our model, consumers choose their rides based on price, convenience, brand, and unobserved characteristics. Our identification leverage on the taxi/Uber/Lyft trip records from the New York City, and Uber/Lyft surge price and waiting time at granular location-time levels. We contribute to the understanding of the On-Demand Economy by providing evidence of an increase in consumer welfare due to the fast-growing satisfied instantaneous demand.

4 - Mobility Analytics For Parking Support

Michelle Wu, Washington State University, michelle.wu@wsu.edu, Zachary Owen, David Simchi-Levi

Ford is developing smart mobility business model as part of the company's strategic plan to deliver the next level of connectivity, mobility, and customer experience. We develop analytics for dynamic pricing strategies that enable efficient matching of supply with demand.

■ TC57

Music Row 5- Omni

New Topics in Behavioral Operations

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Leon Matias Valdes, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States, lvaldes@mit.edu

1 - Observational Learning Through Inventory Availability Information: Empirical And Field Evidence

Ruomeng Cui, Kelley School of Business, Indiana University, Bloomington, IN, 47401, United States, cuir@indiana.edu, Achal Bassamboo, Dennis Zhang

Consumers, when making such purchasing decisions, tend to be influenced by others' actions, i.e., observational learning, or the out-of-stock pressure, i.e., product availability information. Using a unique dataset of more than thousands of daily deals, we empirically measure the herding effect. Well-sold products in the last hour tend to attract more customers in the next hour. The phenomenon persists after controlling for alternative explanations such as consumer reviews, search/experience goods and discount depth. We study the underlying drivers: observational learning or out-of-stock risk.

2 - The Decision To Recall: A Behavioral Investigation In The Medical Device Industry

George Ball, Indiana University, Kelley School of Business, gpball@indiana.edu, Karen L Donohue, Rachna Shah

The decision to recall can impact a manager's career and the performance of the firm. We identify a set of situational and dispositional factors that may influence the recall decision despite not being specified by the FDA. We test these factors through an experiment with a Fortune 500 firm. We find that a physician's inability to detect a defect in the product and understanding the root cause of the defect increases the likelihood of recalling the product but these factors vary across individuals. We find that an individual's cognitive reflection level helps divide managers into two groups, those who are more influenced by situational factors and those who are more influenced by dispositional factors.

3 - The Behavioral Impact Of Queueing Visibility On Server Effort Allocation.

Yaroslav Rosokha, Purdue University, yaroslav.rosokha@gmail.com, Masha Shunko, Julie Niederhoff

Using behavioral lab experiments we explore the impact of feedback on workers' effort allocation in a queueing environment with multiple human servers. We focus on the visibility of workload and the visibility of other servers' effort as mechanisms controlling feedback.

4 - Supply Chain Visibility And Social Responsibility: Investigating Consumers' Behaviors And Motives

Leon Valdes, Massachusetts Institute of Technology, lvaldes@mit.edu, Tim Kraft, Yanchong Zheng

We conduct an experiment to investigate: (i) when does supply chain visibility impact consumers' valuations of social responsibility (SR)? And (ii) what roles do reciprocal motives and prosocial orientations play in affecting their valuations? We show that consumers value visibility when workers are disadvantaged or when consumers use the lack of visibility as an excuse not to pay for SR. We also observe that high prosocial consumers do not exhibit reciprocal motives, while these motives can have a significant impact on low prosocial consumers' valuations. Our work thus identifies when there is a revenue benefit to greater visibility and what information best resonates with different consumers.

■ TC58

Music Row 6- Omni

Energy XII

Contributed Session

Chair: Kenneth Bruninx, Post-doctoral researcher, KU Leuven, Leuven, Belgium, kenneth.bruninx@kuleuven.be

1 - The Relationship Between Energy Consumption And Economic Development

Yuan Qian, Tsinghua University, Beijing, China, qiany14@mails.tsinghua.edu.cn, Pingke Li

This paper estimates the causal relationship between aggregate energy consumption, disaggregate energy consumption and real GDP of China for the 1994-2013 period. Results indicated that bidirectional Granger causality runs from total energy consumption to real GDP and from industrial energy consumption to real GDP but no Granger causality between real GDP and transport energy consumption.

2 - Applying The Modern Portfolio Theory For A Dynamic Energy Portfolio Allocation In The Electricity Markets

Reinaldo Crispiniano Garcia, Associate Professor, University of Brasilia - UnB, Faculty of Technology, Industrial Engineering Department, Brasilia, 70904-970, Brazil, rcgar@yahoo.com, Javier Contreras, Janiele Custodio, Virginia Gonzalez

New energy markets undergoing deregulation induce participants to face increasing competition and volatility, where the objective of a Generation Company (Genco) is to maximize their profit while minimizing their risk. This work proposes two MPT models applying the Mean Variance Criteria (MVC) and the Conditional Value at Risk (CVaR) one. The MPT models are combined with a Generalized Autoregressive Conditional Heteroskedastic (GARCH) prediction technique for a Genco to optimally diversify its energy portfolio. The two models are applied to the PJM electricity market showing their capabilities and comparisons between them helping decisions makers to apply these two models as tools for a Genco.

3 - Carbon Dioxide Source Selection And Analysis

Xin Li, Pennsylvania State University, University Park, PA, 16803, United States, xzl118@psu.edu, Jose Antonio Ventura, Luis F. Ayala H., Uday Shanbhag

This paper aims at identifying and analyzing potential sources of CO_2 from power plants and industrial facilities in any geographical location in the U.S. that can be used to supply CO_2 for fracturing operation in well pads. Different approaches to capture CO_2 from power plants and industrial sources, as well as their corresponding technological maturity, are discussed. Detailed models to calculate costs incurred by CO_2 capture in two types of prime candidates for CO_2 capture, coal-fired power plants (CPP) and high-purity CO_2 sources (HPS), are presented.

4 - Cooptimization Of Series Facts Device Set Points And Generation Dispatch

Mostafa Sahraei-Ardakani, Assistant Professor, University of Utah, 1249 E Spence Avenue, Apt 242, Salt Lake City, UT, 85281, United States, mostafa.ardakani@utah.edu

No energy or market management system today optimizes the set point of flexible AC transmission system (FACTS) devices along with generation dispatch, due to the computational complexity of the problem. We propose an extremely effective and fast linear programming heuristic that facilitates such co-optimization. As a result, the operation of FACTS devices can be significantly enhanced leading to substantial economic and reliability gains.

5 - A Probabilistic Unit Commitment Model

Kenneth Bruninx, Post-doctoral researcher, KU Leuven, Leuven, Belgium, kenneth.bruninx@kuleuven.be, Erik Delarue

Stochastic unit commitment models allow calculating an optimal trade-off between the cost of scheduling and activating reserves, load shedding and curtailment, but may become computationally intractable for real-life power systems. Therefore, we develop a probabilistic unit commitment (PUC) formulation, which allows internalizing the reserve sizing and allocation in a deterministic unit commitment problem, considering the full cost of reserve allocation and activation. This PUC formulation yields UC schedules that are nearly as cost-effective as the theoretical optimal solution of the stochastic model in calculation times similar to that of a deterministic equivalent.

■ TC59

Cumberland 1- Omni

Robust and Reliable Optimization in Transportation and Logistics

Invited: Transportation Science & Logistics

Invited Session

Chair: Ehsan Jafari, University of Texas, Hart Lane, Austin, TX, 78731, United States, ejafari@utexas.edu

1 - Multicriteria Shortest Path Problem For Electric Vehicles In Stochastic Networks

Ehsan Jafari, University of Texas, Hart Lane, Austin, TX, 78731, United States, ejafari@utexas.edu, Stephen Boyles

This presentation focuses on the problem of finding a prior path for a single electric vehicle in a network with stochastic travel times. There are a number of non-identical charging stations (different charging prices and charging rates) through the network and charge depletion rate is modeled as a function of arc length and arc travel time. We formulate the problem as a multicriteria shortest path problem with three components: reliability, cost and time.

2 - Reliability Of Transit Connections For Informed Traveler Decision-making

Michael Redmond, University of Iowa, Iowa City, IA, 52240, United States, michael-a-redmond@uiowa.edu, Ann Melissa Campbell, Jan Fabian Ehmke

When faced with the decision of journeying from an origin to a destination, travelers have a multitude of options and criteria for making this decision. Travel websites generally look at price and travel time, leaving out the important component of reliability. We compute the probability of making all of the required connections and arriving on-time at the destination and refer to this as reliability. We utilize publicly available airline data to model the probability distributions and will present the reliability associated with different paths between several origin and destination pairs involving different hubs and start times.

3 - Stochastic Multi-period Orienteering With Time Windows And Uncertain Customer Adoption

Shu Zhang, Chongqing University, Chongqing, China, zhangshu@cqu.edu.cn, Jeffrey W Ohlmann, Barrett Thomas

We introduce an orienteering problem in which a sales representative visits customers over a multi-period horizon to increase the chance of customer adoption. Each customer's adoption likelihood is uncertain and evolves stochastically over the horizon. The salesperson may experience queueing after arrival and the wait times are uncertain. We model the problem as a Markov decision process and propose heuristic approaches to facilitate decision making. In the computational experiments, we demonstrate the effectiveness of our heuristic methods on various customer behaviors.

4 - Application Of A Robust Approach For Vessel Crew Scheduling

Seda Sucu, University of Strathclyde, 130 Rottenrow Gardens, Sir Willam Duncan Building, Glasgow, G4 0QE, United Kingdom, seda.sucu@strath.ac.uk, Kerem Akartunali, Robert van der Meer

Crew scheduling problems have a significant place among the NP-Hard problems, and are very popular especially in the transportation settings. Although there are many studies in airline crew scheduling, there is a lack of literature for crew scheduling for offshore supply vessels. In our problem, we focus on having a robust crew schedule to handle unexpected weather conditions and changes in crew members' conditions for a global vessel company with long planning horizon.

■ TC60

Cumberland 2- Omni

Network Optimization for Efficiency, Sustainability and Resilience

Sponsored: TSL, Urban Transportation

Sponsored Session

Chair: Mohammadali Shirazi, TAMU, College Station, TX, United States, alishirazi@email.tamu.edu

1 - A Fast Method To Estimate The Minimal Revenue Tolls In Large-scale Roadway Networks

Mohammadali Shirazi, TAMU, alishirazi@email.tamu.edu

The minimum toll revenue problem is one of the models that were proposed for toll pricing. When applied to real and large-scale road networks, this model is difficult to be solved optimally in reasonable time, due to its large size. We propose a fast method to estimate the minimal revenue tolls in large-scale road networks using the dynamic penalty function method. The proposed method also allows measuring the improvement of the network when the system flows are considered only for a subset of network links.

2 - Pothole Repair Planning

Fatemeh Aarabi, University at Buffalo, faarabi@buffalo.edu

Potholes degrade the functionality of roadway networks (throughput of traffic flow) in addition to concerns of safety and vehicle damages. A suitable repair planning strategy is developed to minimize total traffic flow throughput degraded over time. The proposed model determines the optimal decisions of repair segment, type, and timing given limited resources. We apply the proposed model to a New York City case study.

3 - Joint Optimization Of Traffic Rationing Schemes And Transit Services Under Environmental And Mobility Considerations

Daniel Rodriguez Roman, URPM, daniel.rodriguez6@upr.edu

An optimization-based approach for the design of traffic rationing schemes is proposed that accounts for: (1) the environmental goals of urban planners, (2) the budgetary and fleet size limitations of transit agencies, and (3) the mobility preferences of travelers. The proposed optimization problem can be used to determine traffic rationing levels and related transit service adjustments that minimize the health impacts of air pollution and the traveler dissatisfaction caused by rationing programs, subject to pollutant concentration and transit budget constraints. A surrogate-assisted, multi-objective differential evolution algorithm is presented for the proposed problem.

4 - Modeling And Enhancing The Resilience Of Complementary Transportation Systems

Saumya Sangoi, Purdue University, West Lafayette, IN, 47906, United States, ssangoi@purdue.edu, Xiaozheng He, Srinivas Peeta

This study proposes a new resilience measure by capturing the complementarity among interdependent transportation systems, such as bus and metro systems. Based on the proposed resilience measure, we construct an optimization model to identify the optimal allocation of resources and maximize the interdependent system resilience under a budget constraint. Numerical examples are constructed to evaluate the effectiveness of the optimization model on a network comprising bus and metro systems.

■ TC61

Cumberland 3- Omni

Stochastic Network Design

Sponsored: TSL, Freight Transportation & Logistics

Sponsored Session

Chair: Mike Hewitt, Loyola University Chicago, NA, Chicago, IL, NA, United States, mhewitt3@luc.edu

1 - Scheduled Service Network Design With Stochastic Travel Times

Teodor Gabriel Crainic, Professor, Universite du Quebec a Montreal, Case postale 8888, succursale Centre-ville, Montreal, QC, H3C 3P8, Canada, TeodorGabriel.Crainic@cirrelt.net, Giacomo Lanza, Nicoletta Ricciardi, Walter Rei

We propose to study a SSND problem focusing on the uncertainty related to the variability in travel times and the respect of service quality targets, while aiming for a cost-effective operation plan. We will discuss the issues and modeling challenges, and present a two-stage stochastic programming formulation with wimple recourse. The results of a proof-of-concept analysis will also be presented.

2 - Multi-commodity Stochastic Network Design

Stein W Wallace, Norwegian School of Economics, stein.wallace@nhh.no, Stein W Wallace, University of Sichuan, Chengdu, China, stein.wallace@nhh.no, Congshi Sun

We investigate the quality of the solution to the expected value problem by checking the Value of the Stochastic Solution VSS, the quality of the skeleton (that is, taking the discrete variables from the expected value problem and letting a stochastic linear program set the capacities) and finally by checking if the expected value problem can be upgraded to a good solution for the stochastic case. Numerical results are reported. For most situations the skeleton is very good, so for these problems, it seems enough to solve a deterministic MIP and a stochastic LP, rather than a stochastic MIP.

3 - Dynamic Load Planning For Less-than-truckload Carriers

Luke Marshall, Georgia Institute of Technology, Atlanta, GA, United States, luke.jonathon.marshall@gmail.com, Martin W P Savelsbergh, Natashia Boland, Alan Erera, Iman Dayarian

In practice, deterministic service network design for LTL problems on a given time horizon, can yield poor results if the quantities for future commodities have been estimated from data with high fluctuations. We investigate a sampled scenario based modelling approach that aims to improve solution quality on real-life, large scale instances, while constraining computational time.

4 - Stochastic Interdependent Network Design Problem

Andrés D González, Rice University, 6100 Main St., MS-318, Houston, TX, 77005, United States, andres.gonzalez@rice.edu Leonardo Dueñas-Osorio, Andres L Medaglia, Mauricio Sánchez-Silva, Andrew J Schaefer

Diverse models now exist to study the resilience of interdependent networks. Nevertheless, the prevailing methods are post-event schemes designed to identifying recovery strategies for particular disaster instances, making it difficult to extend these for pre-event decision making. In this work, we present a new methodology that considers the uncertainty associated with the occurrence of a destructive event, fusing both pre- and post-event decision analysis into a two-stage optimization problem, effectively enabling the stochastic resilience optimization of interdependent networks.

■ TC62

Cumberland 4- Omni

Robust and Low Cost Airline Operations under Uncertainty and Disruptions

Sponsored: Aviation Applications

Sponsored Session

Chair: Heng Chen, University of Nebraska-Lincoln, Supply Chain Management and Analytics, Lincoln, NE, 68588, United States, Supply Chain Management and Analytics

1 - Incorporating Downstream Disruptions In Robust Planning And Recovery

Jeremy Castaing, PhD Student, University of Michigan, 1205 Beal Avenue, 2753 IOE Building, Ann Arbor, MI, 48109-2117, United States, jctg@umich.edu, Amy Cohn

When disruptions occurs in the network, airlines have to make recovery decisions to recover and minimize future cancellations, delays, passenger missed connections etc... These decisions are often made solely based on the current state of the system. We propose a robust recovery approach that takes into account correlation and propagation of delays to mitigate future disruptions.

2 - Lower Cost Airport Departure Operations Under The Departure Metering Concept

Heng Chen, Assistant Professor, University of Nebraska–Lincoln, Lincoln, NE, 68588, United States, heng@unl.edu, Senay Solak

Departure metering is an airport surface management procedure that limits the number of aircraft on the runway by holding aircraft at gates or at a predesigned metering area. We develop a stochastic dynamic programming framework to identify the optimal gate, metering area and departure queue allocation policies to minimize expected overall fuel burn costs. In addition, we introduce easy-to-implement practical departure metering policies and evaluate their performances. We also identify the optimal metering area capacity and quantify the value of the presence of a departure metering area at airports.

3 - On The Competition Intensity Of U.S. Airline Market With Fuel Cost Fluctuations

Soheil Sibdari, University of Massachusetts, Charlton College of Business,, Dartmouth, MA, 0, United States, ssibdari@umassd.edu

We investigate a recent phenomenon in the U.S. airline market that despite lower jet fuel costs, which is a major part of airlines' operational cost, airline customers are experiencing higher airfares and more crowded planes. This can be, in part, due to the recent policies of airlines in selecting airplane sizes that changes the competition intensity. In this paper, we analyze the operations of seven major airlines including two low cost carriers and measure the impact of fuel cost fluctuations in capacity choice and competition intensity.

■ TC63

Cumberland 5- Omni

Location Analysis I

Sponsored: Location Analysis

Sponsored Session

Chair: Dmitry Krass, University of Toronto, 105 St. George Street, Toronto, ON, M5S 3E6, Canada, krass@rotman.utoronto.ca

1 - Random Attractiveness Level In Huff's Competitive Model

Tammy Drezner, California State University-Fullerton, Steven G. Mihaylo College of Business and Economics, 800 N State College, Fullerton, CA, 92834, United States, tdrezner@fullerton.edu, Dawit Zerom, Zvi Drezner

We investigate the Huff competitive location model assuming that the attractiveness level is normally distributed. It is realistic to assume that different consumers have a different perception of the attractiveness level. The model becomes the standard model when the standard deviation of the normal distribution for all facilities vanishes. We investigate the effect on the market share captured by the new facility and its optimal location by increasing the standard deviation of the new facility and/or the existing facilities.

2 - An Alternative Solution For The Time-difference-of Arrival (TDOA) Location Problem

Lin Dearing, Clemson University, 520 Bentbrook Lane, Clemson, SC, 29631, United States, pmdrn@clemson.edu

The TDOA location problem is to locate the source of a signal using the known locations of a set of receivers and the arrival times of a signal sent from the source to the receivers. A new approach for intersecting n-dimensional hyperboloids gives the location.

3 - Optimal Addition Of A New Facility To The Existing Network. Planar Continuous Demand Case

Dmitry Krass, University of Toronto, Toronto, ON, Canada, krass@rotman.utoronto.ca, Jonathan Lorraine

We consider the optimal addition of a new facility to a set of facilities serving continuously distributed demand under the Euclidean norm. The objective is to maximize the demand attracted to the new facility; in the case of continuously distributed demand, this is equivalent to maximizing the area of the Voronoi cell of the new facility. New computational results, as well as extensions to non-uniform demand, will be presented. Relation to the L1 norm case will be discussed.

4 - Joint Optimization Of Location And Design Of New Facilities

Dmitry Krass, University of Toronto, krass@rotman.utoronto.ca, Robert Aboolian, Oded Berman

We address the problem of simultaneous location and design of a network of service facilities. A novel solution approach is developed, consisting of a optimal design solution for the single facility case and a an approximation scheme for the case of multiple facilities. Computational results illustrating the efficiency of the method will be presented.

■ TC64

Cumberland 6- Omni

Multiple Criteria Decision Making Applications I

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Banu Lokman, Middle East Technical University, Ankara, Turkey, lbanu@metu.edu.tr

1 - An Interactive Approach To Design Parameter Optimization Considering Response Surface Prediction Errors

Melis Ozates, Middle East Technical University, Çankaya/Ankara, 06800, Turkey, mozates@metu.edu.tr, Gulser Koksal, Murat Mustafa Koksalan

An interactive approach is presented for finding parameter settings of a product or process design that allows achieving targets for two responses as well as robustness. The approach utilizes response surface models and it allows the decision maker to consider magnitude of prediction errors in choosing the design solution.

2 - Prioritization Of Military Threats For Ground Based Air Defense By Analytic Hierarchy Process

Gulser Koksal, Middle East Technical University, Ankara, Turkey, koksal@metu.edu.tr, Omer Kirca, Can B. Cetin, Derya Dinler, Derya Ipek Eroglu, Gulten Gokayaz

In threat evaluation and weapon assignment for ground based air defense it is aimed to make threats such as bombers and missiles ineffective with systems involving weapons and jammers. Assignment of these weapons to threats may require prioritization of the threats. In this study, a threat prioritization approach based on AHP is developed and implemented. Final weights of prioritization criteria are determined by following an iterative test and optimization approach. The approach has been effective in handling inconsistencies of decision makers, and verification and validation of results.

3 - Finding Representative Nondominated Sets For Multi-objective Integer Programs

Banu Lokman, Middle East Technical University, lbanu@metu.edu.tr, Gokhan Ceyhan, Murat Mustafa Koksalan

We develop algorithms to generate representative nondominated sets for multi-objective integer programs. The algorithms are designed to produce a desired number of nondominated points satisfying certain quality criteria. We show that our algorithms work well on randomly generated instances of multi-objective assignment and knapsack problems.

4 - Issues In Selecting A Representative Set For Multi-objective Integer Programs

Sami Serkan Ozarik, ASELSAN, ssozarik@hotmail.com, Banu Lokman, Murat Mustafa Koksalan

We observe that many alternative representative sets may satisfy existing performance measures equally well. It may be useful to develop additional performance measures to break ties. We provide various properties of such sets and discuss additional possible measures. We present some empirical results.

■ TC65

Mockingbird 1- Omni

Topics on Internet Economics

Sponsored: Information Systems

Sponsored Session

Chair: Hossein Ghasemkhani, Purdue University, Purdue University, West Lafayette, IN, 47907, United States, hossein@purdue.edu

1 - Ad-blockers, Publishers And The Internet: A Study On The Economic Implications Of Ad-blockers

Abhishek Ray, Purdue University, ray52@purdue.edu

The rise of Ad-Blockers has prompted discussions about whether the age of free content on the internet are numbered. This research is aimed at investigating issues at the heart of this discussion - does adoption of Ad-Blocker necessarily mean that users will be better off and whether websites will have to start looking elsewhere to monetize their content? Through applied game theory, we aim to answer important questions about the implications of the increasing popularity of Ad-Blockers for users and whether Ad-Blockers are blessings in disguise or a crash waiting to happen.

2 - The Advertising Big Picture: Analyzing The Cross Platform Synergies Between TV And Online Advertising

Mohammed Alyakoob, Purdue University, alyakoob@purdue.edu

The advent of the Internet gave rise to digital advertising, which provides a unique avenue for researchers to monitor customers' responses to different types of advertisements. This research utilizes this potential in combination with a detailed television advertising data set to gain insights regarding the synergies that exist between television and online advertising platforms. By utilizing a Bayesian Vector Autoregressive model to account for the lagged interdependencies among variables in a marketing context, we study the relationships between the online and television advertising platforms and the impact these synergies have on a customer's propensity to purchase online.

3 - Social Influence In Public And Private Behaviors

Shan Huang, MIT, shanh@mit.edu

To compare peer influence between public and private behaviors quantitatively, I designed and analyzed a large-scale field experiment involving more than 37 million users on WeChat Moments ads. I randomized the number of social cues and identified the effects of them on consumers' public (i.e.liking) and private (i.e.clicking and following) responses to ads. We found that public responses were associated with significantly more positive effects of social cues than private responses. Tie strength generally exerted larger effects on public responses than on private responses. Relative to homophily, influence explains more of the temporal clustering of public behaviors than private behaviors.

4 - Labor Market Risk And Technological Investment

Daniel Rock, MIT, Cambridge, MA, 02114, United States, drock@mit.edu, Prasanna Tambe

Prior work in financial economics demonstrates that firms make capital structure choices to mitigate their employees' exposure to unemployment risk. We combine firm-level financial data from 2010 to 2014 with data from Burning Glass Technologies, an online labor market intermediary to provide evidence consistent with the argument that firms choose technologies in part to mitigate the financial risk faced by technical workers. We also find that while greater employer market value is associated with a decrease in our measure of skill generality cross-sectionally, companies with very large market values tend to demand similar technical skills as other employers in the same region.

■ TC66

Mockingbird 2- Omni

Networked System Reliability and Resilience

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Chi Zhang, Tsinghua University, Tsinghua University, Beijing, 100084, China, czhang@tsinghua.edu.cn

1 - Resilience Optimization Of Interdependent Critical Infrastructure Systems Under Multiple Hazards

Min Ouyang, Huazhong University of Science and Technology, min.ouyang@hust.edu.cn

Considering multiple types of initiating events in critical infrastructure systems (CISs), including terrorist attacks, natural hazards and random failures, and taking interdependent power and gas systems as an example, this paper proposes a resilience optimization model and its solution algorithm for interdependent CISs, where the candidate resilience enhancement strategies are selected from all three disaster stages, including resistant stage, absorptive stage and restorative stage.

2 - Multi-dimensional Vulnerability Of Public Transportation Services Provided To Urban Residential Communities In China

Liu Hong, Associate Professor, Huazhong University of Science and Technology, Wuhan, 430074, China, liu.hong@hust.edu.cn, Min Ouyang, Xiaozheng He, Yongze Yan

This paper proposes a network-based approach to model and analyze the multi-dimensional vulnerability of public transportation services provided to urban residence communities in a Chinese city, where complementary subway and bus systems in the city forms the public transportation system and its service for residential communities are measured by multi-dimensional metrics, such as average accessibility to all public subway and bus stations, accessibility to the hospitals, accessibility to large shopping centers and accessibility to long distance travel services.

3 - Modeling And Visualizing Reliability In An Urban Bicycle Sharing Program

Gabriela Góngora-Svartzman, Stevens Institute of Technology, Hoboken, NJ, 07030, United States, ggongora@stevens.edu, Jose Emmanuel Ramirez-Marquez, Kash Barker

Bicycle sharing programs are providing modern cities with an alternative mode of transportation. Thereby it becomes important to analyze such systems to asses their reliability. This work presents a behavioral analysis, aided by visualization, and proposes a methodology for assessing reliability in New York City's bicycle sharing program, CitiBike. This is performed on a station basis and two errors; the error where a user is not able to return a bicycle to a docking station, and the error of not having bicycles for the users to take at a docking station. In future work this methodology could be used to rebalance stations according to demand distributions, enabling a decision-making optimization.

4 - A New Approach For Approximating Complex Network Reliability

Huaxing Zhu, Tsinghua University, Beijing, 100084, China, zhuhx15@mails.tsinghua.edu.cn, Chi Zhang

Our modern society is highly dependent on networked critical infrastructures, such as telecommunication, power transmission, and so forth. Thus, it is paramount to ensure their high reliability, to fulfill which we need to efficiently evaluate their reliability. Represented by complex networks, critical infrastructures usually have non-trivial topology and large amounts of components, which make their reliability computation intractable and existed enumeration-based algorithms inefficient. To solve this problem, we propose a new algorithm to approximate a complex network's reliability, based on identifying its edge-disjoint minimal path sets, guided by its minimal cut sets.

■ TC67

Mockingbird 3- Omni

Industrial Big Data System

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Ran Jin, Virginia Tech, Blacksburg, VA, United States, jran5@vt.edu

Co-Chair: Hui Wang, Florida State University, 2525 Pottsdamer St, B-373D, Tallahassee, FL, 32310, United States, hwang10@fsu.edu

1 - Manufacturing Modeling And Interpretation Via Natural Language Processing Techniques

Hongyue Sun, Virginia Tech, hongyue@vt.edu

To extract useful information from industrial data for better system understanding and decision making is urgent. Motivated by techniques from natural language processing, a framework for learning informative and interpretable patterns from industrial data is proposed. A Czochralski crystal growth process is used to demonstrate the proposed framework.

2 - Monitoring E-commerce Reviews By Discovering Hidden Rating Criterion

Ke Zhang, Hong Kong University of Science and Technology, kzhangah@connect.ust.hk

Recently, the boom of electronic merchants have attracted many researchers on analyzing customer reviews, which usually contain text-data and ratings. Conventional monitoring methods are mainly based on the ratings provided by customers, failing to reflect a customers' accurate opinions, since a customer may possess different attitudes towards different facets of a product. Here we investigate an extension of LDA method to discover hidden aspects and aspect-ratings by analyzing textual contents and associated ratings jointly. Then we propose a control chart based on the discovered rating criterion. Simulations and real-data analysis is presented to show effectiveness and efficiency.

3 - Classification Based Approach To Nanorod Segmentation In Scanning Electron Micrographs

Mostafa Gilanifar, Florida State University, Tallahassee, FL, United States, mg14m@my.fsu.edu, Abhishek Shrivastava

Estimation of nanorod morphology from scanning electron micrographs requires extracting nanorods from the image. This foreground-background segmentation of nanorods is challenging due to several reasons - low signal to noise ratio, high degrees of nanorod overlap and shape similarity. In this talk, we present a classification-based approach to the segmenation problem. We use a decomposition-based approach to identify nanorod and background image patterns, which can be discriminated accurately using a trained classifier. We demonstrate the accuracy of the approach through several examples.

4 - An Order-invariant Cholesky-log-garch Model For Multivariate Financial Time Series

Xinwei Deng, Associate professor, Virginia Tech, 211 Hutcheson Hall, 250 Drillfield Drive, Blacksburg, VA, 24060, United States, xdeng@vt.edu, Xiaoning Kang, Kam-Wah Tsui, Mohsen Pourahmadi

Accurate estimation of time-varying covariance matrices is of great importance in the analysis of financial data. Most existing models are known to break down at the estimation stage for dimensions larger than ten or so. In this work, we propose a novel order-invariant Cholesky-log-GARCH model for estimating the covariance matrix of multivariate time series based on a random sample from a population of all possible permutations of the p variables. The ensuing methodology not only provides accurate estimation, but also gives accurate prediction at future time points. The merits of the proposed method are illustrated through three real financial data sets in comparison with conventional methods.

■ TC68

Mockingbird 4- Omni

Reliability Evaluation and Optimization from Complex Systems II

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Eunshin Byon, University of Michigan, College Station, MI, United States, ebyon@umich.edu

Co-Chair: Qingyu Yang, Wayne State University, Detroit, MI, United States, qyang@wayne.edu

1 - Reliability Estimation Of Systems With Spherically Distributed Units

Jingbo Guo, Rutgers, The State University of New Jersey, guojingbochina@gmail.com, Elsayed A. Elsayed

Spherically distributed systems are emerging in a diverse range of industries such as aerospace, nuclear, military and oceanography. We refer this kind of units on a spherical arrangement as k-n-i: G balanced systems. In such a system, n pairs of units are distributed evenly on i vertical planes in a sphere. The system is considered functioning when at least k out of n pairs of units operate properly while satisfying the system's balance requirement. In this presentation, we introduce an efficient and general algorithm to estimate the reliability of such systems for any range of k, n, i. We also present a numerical example to illustrate the algorithm.

2 - Condition-based Selective Maintenance Optimization For A Large-scale System

Young Myoung Ko, Pohang University of Science and Technology, youngko@postech.ac.kr, Eunshin Byon

We extend our previous study on condition-based maintenance optimization that schedules maintenance activities in a large-scale system comprising identical units. Our previous method was based on the assumption that each maintenance activity renews all units, which made the analysis tractable by taking advantage of the results from the renewal theory, but indeed restricts the applicability of the method. In this talk, we present a new approach that relaxes the renewal assumption and finds the optimal thresholds that trigger maintenance operations to repair a subset of units (i.e., highly deteriorated or failed units) in a system.

3 - A Two-stage Structural Degradation Modeling In Sparse Datasets

Abdallah Chehade, University of Wisconsin - Madison, chehade@wisc.edu, Kaibo Liu

Degradation modeling has become essential to the field of condition monitoring for better logistics and decision-making. Existing approaches assume there exists a high-quality data-rich environment. However, in many scenarios, the provided dataset is sparse with limited observations. For example, patients tend to skip their semi-annual clinic visits and result in a highly sparse dataset. To fill the literature gap, we propose a novel two-stage approach for structural degradation modeling in sparse datasets. Both simulation and case studies that involve a dataset (ADNI) for Alzheimer disease were used to numerically evaluate and compare the performance of the proposed methodology.

4 - Title: Resistance Level Determination At The Reliability-based System Design

Qiyun Pan, University of Michigan, qiyun@umich.edu, Eunshin Byon

In order to provide a guideline for choosing appropriate design parameters to meet a required level of system reliability, resistance level determination becomes crucial in many applications. At the design stage, resistance level can be estimated using stochastic simulations, and the resistance level estimation can be formulated as a statistical quantile estimation problem. We present a new adaptive importance sampling algorithm to improve the estimation accuracy, given a computational budget.

■ TC69

Old Hickory- Omni

Airports, Runways, and Descents

Sponsored: Aviation Applications

Sponsored Session

Chair: Emad Alharbi, NJIT, 8 Gordon Cir, Parsippany, NJ, 07054, United States, eaa3@njit.edu

1 - An Airport Scheduling Mechanism Based On Efficiency, Equity And On-time Performance Objectives

Alexandre Jacquillat, Assistant Professor of Operations Research, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA, 15213, United States, ajacquil@andrew.cmu.edu, Vikrant Vaze

Airport congestion can be mitigated through scheduling interventions that control imbalances between peak-hour demand and capacity. We design and optimize a non-monetary scheduling mechanism that starts with scheduling inputs from the airlines and airport capacity estimates, and that reschedules flights based on efficiency, inter-airline equity and on-time performance objectives. Theoretical and computational results suggest that large equity gains can be achieved at no, or small, losses in efficiency, and that accounting for airline preferences can enhance the mechanism outcomes.

2 - Integration Of Airport Runway And Taxi Planning

Giuseppe Sirigu, ETS Ingeniería Aeronáutica y del Espacio, Dep Matemática Aplicada Ingenieria Aeroespaci, Plaza Cardenal Cisneros 3, Madrid, 28040, Spain, angel.marin@upm.es, John-Paul Clarke, Angel Marin

We develop and compare network flow-based and Monte Carlo sampling-based deterministic algorithms for the joint optimization of runway and taxiway operations considering required separation minima and environmental concerns. The objective is to minimize the movement time and/or taxi delay considering the desired takeoff time windows and earliest pushback times. The algorithms are compared using numerical simulations that replicate real-word airport operations.

3 - Departure Queue Management - A Data Driven Analysis

Marc Rose, Senior Operations Research Analyst, MCR Federal, LLC, 600 Maryland Ave, 306E, Washington, DC, 20024, United States, mrose@mcri.com

At the FAA the Terminal Flight Data Manager (TFDM) is composed of many capabilities. A major component is the Departure Queue Manager (DQM) which is designed to shift aircraft taxi-out delay away from the runway queue to either the gate (preferred) or a designated waiting area, thus saving fuel. In this paper I discuss the databases and calculations applied to estimate the amount of time that can be shifted from the queue. This will include some discussion of the programming and constraints required to capture some of the uncertainties in the concept

4 - Continuous Descent Arrival Adoption During High Traffic Periods: A Data-driven And Predictive Modeling Approach

Emad Alharbi, PhD Candidate, New Jersey Institute of Technology, Newark, NJ, 07102, United States, eaa3@njit.edu, Layek Abdel-Malek

This study investigates Continuous Descent Arrival (CDA) adoption during high traffic levels periods. We utilize data-driven system approach and predictive analytics to build an online CDA predictive model for an enhanced Air Traffic Management (ATM) procedures as well as an efficient CDA adoption. A Hierarchical Clustering Analysis (HCA) is performed to aggregate data from offline flight tracking logs and Meteorological Aviation Reports (METARs) at selected U.S. airports. The analysis facilitates the visualization of descent profiles and assists in developing a predictive model for CDA instances using Decision Trees with AdaBoost and Support Vector Machines (SVM).

■ TC70

Acoustic- Omni

Transportation, Planning II

Contributed Session

Chair: Bruce C Hartman, Professor, University of St Francis, 684 Benicia Drive #50, Santa Rosa, CA, 95409, United States, bruce@ahartman.net

1 - Modeling Wet Pavement Crashes

Michael Anderson, Professor, UAH, Civil Engineering, Huntsville, AL, 35899, United States, andersmd@uah.edu, Mehrnaz Doustmohammadi

Crashes when the pavement is wet are a significant issue within Alabama. This work develops models to identify the key roadway and pavement characteristics that are associated with wet pavement crashes. Additionally, the analysis will include the type of crash generally occurring and the cause of the crash associated with wet pavement.

2 - A Framework For Intelligent Decision Support System For Traffic Congestion Management System

Mohamad kamal El Din Ahmad Hasan, Professor of Operations and Supply Chain Manag, Dept. of Quantitative Methods and Information Systems, CBA, Kuwait University, Department of Quantitative Methods and Information Systems, College of Business Administration, Kuwait University, P.O. Box 5486, Safat 13055, Kuwait City, 13055, Kuwait, mkamal@cba.edu.kw

Traffic congestion problem is one of the major problems that face many transportation decision makers for urban areas. The problem has many impacts on social, economic and development aspects of urban areas. In this paper we propose a comprehensive framework for an Intelligent Decision Support System (IDSS) for Traffic Congestion Management System that utilizes a state of the art transportation network equilibrium modeling and providing an easy to use GIS-based interaction environment. The developed IDSS reduces the dependability on the expertise and level of education of the transportation planners, transportation engineers, or any transportation decision makers.

3 - Locating Emergency Vehicles With An Approximate Queueing Model And A Meta-heuristic Solution Approach

M. Altan Akdogan, Research Assistant, Middle East Technical University, Ankara, Turkey, aaltan@metu.edu.tr, Z Pelin Bayindir, Cem Iyigun

In this study, optimal location decision of Emergency Service(ES) vehicles such as ambulances as a server-to-customer service is discussed. Spatial Queueing Model (SQM) is introduced for spatial networks in locating emergency vehicles in the literature. This study proposes a generalization of SQM for complete networks. Service times for the calls are differentiated for every demand call regarding the location of the responding vehicle and the demand call. The number of servers located in a single location is taken unrestricted. The effect of allowing multiple servers in a location is reported. A genetic algorithm is proposed to solve the model for which no closed-form expression exists.

4 - Toll Road Profit Maximization Under Mixed Travel Behaviors Of Cars And Trucks

Xiaolei Guo, Associate Professor, University of Windsor, Odette School of Business, 401 Sunset Avnue, Windsor, ON, N9B 3P4, Canada, guoxl@uwindsor.ca, Da Xu, Guoqing Zhang

This paper examines the profit maximizing behavior of a private firm which operates a toll road competing against a free alternative in presence of cars and trucks. Trucks differ from cars in value of time, congestion externality, pavement damage, and link travel time function. We assume that trucks choose routes deterministically (i.e., choose the route with the lowest actual cost) while cars follow stochastic user equilibrium in route choice (i.e., choose the route with the lowest perceived cost).

5 - Transportation, Jobs And Social Networks

Bruce C Hartman, Professor, University of St Francis, 684 Benicia Drive #50, Santa Rosa, CA, 95409, United States, bruce@ahartman.net
Bruce C Hartman, Professor, California State University Maritime, 200 Maritime Academy Drive, Vallejo, CA, 94590, United States, bruce@ahartman.net

Logistics clusters provide economic benefit, but expansion has not produced proportionate sector job growth. We hypothesize a network effect not accounted for in traditional analysis. We apply egonets from social network analysis to a weighted network modeled by Total Requirements matrix data for 15 US industry clusters. We propose network measures of value creation and leverage for each sector. A quadrant assessment of our two measures classifies influence of industry sectors. Transportation and Wholesaling sectors create high leverage in the industries they touch, using relatively low value added.

■ TC71

Electric- Omni

Vehicle Routing IV

Contributed Session

Chair: Jimena A. Pascual, P. Universidad Católica de Valparaíso, Valparaíso, Chile, jimena.pascual@pucv.cl

1 - Using Drones To Minimize Waiting Times Of Customers

Mohammad Moshref-Javadi, PhD Candidate, Purdue University, School of Industrial Engineering, 315 N. Grant St., West Lafayette, IN, 47907, United States, moshref@purdue.edu, Seokcheon Lee

Drone is an emerging technology which can be used in logistics operations for more efficient transportation. We propose a new problem which incorporates drones in delivery processes to minimize waiting time of recipients.

2 - A Mathematical Programming Framework That Integrates Customer Decisions Within The Distribution Planning Of Petroleum Products

Yan Cheng Hsu, University at Buffalo, SUNY, 412 Bell Hall, Buffalo, NY, 14260, United States, yhsu8@buffalo.edu, Jose Luis Walteros, Rajan Batta

This work develops a methodological framework for designing the daily distribution and replenishment operations of petroleum products by simultaneously considering the perspectives of both the transporter and its customers. We provide empirical evidence that minor alterations to the customer requirements, triggered by some strategic decisions by the transporter, can in turn fexibilize the transporters' restrictions, allowing for better routing strategies that reduce late deliveries. Therefore, The main objective of this work is studying the interactions that exist between these strategic and operational decisions within a unied approach.

4 - Solving Multi Period Multi Traveling Salesmen Problem With Time Windows: Comparison Of Heuristic Approaches

Haluk Yapicioglu, Assist. Prof. Dr., Anadolu University, Anadolu Universitesi Yunusemre Kampusu, Proje Birimi Ogrenci Merkezi Kat: 1, Eskisehir, 26470, Turkey, hyapicio@anadolu.edu.tr

The problem addressed in this study aims at minimizing number of university representatives visiting exam locations by departing from a central location and returning back. Visits to the exam locations must be done in specified time windows. The problem is modeled as a multi-period traveling salesmen problem with time window. Two stochastic optimization approaches based on simulated annealing and robust taboo search are used. For this a new solution representation is proposed. Finally, a method for obtaining travel distance and travel time matrices from Google Distance Matrix API is developed. The results obtained from a real case are discussed and future research directions are provided.

5 - Optimal Routing Of Unmanned Aerial Vehicles In Wind Fields

Jimena A. Pascual, P. Universidad Católica de Valparaíso, Valparaíso, Chile, jimena.pascual@pucv.cl, Ricardo A. Gatica, Andrea Leticia Arias, Andrea Leticia Arias, Kundu Abhishake, Darío Canut De Bon, Timothy I Matis

The power consumption of an Unmanned Aerial Vehicle (UAV) to overcome directional wind forces may be represented as a non-linear convex function of airspeed. As a result, the optimal flight path between two targets may not be Euclidean, and may have implications on the optimal sequencing of multiple targets. In this presentation, we present research related solving shortest path and traveling salesman type problems to determine the optimal flight path for UAVs, and discuss how this might be extended to other classes of unmanned vehicles, often referred to as UXVs.

■ TC72

Bass- Omni

Supply Chain Mgt XI

Contributed Session

Chair: Fang Fang, California State University, LA, 1250 S Alhambra Circle, Apt 18, LA, CA, 33146, United States, f.fang@umiami.edu

1 - Traceability And Supply Chain Design

John F Kros, Vincent K. McMahon Distinguished Professor, East Carolina University, College of Business Dept of M&SCM, 3205 Harold Bate Building, Greenville, NC, 27858-4353, United States, krosj@ecu.edu, James Zemanek, Jon Kirchoff

In light of recent issues, supply chain managers' focus on product and service traceability has increased. While research on how/where disruptions occur and supply chain risk mitigation have taken center stage, the topic of traceability across the supply chain has received little attention. This research seeks to investigate the topic of traceability across the supply chain and what policies/procedures supply chain managers have implemented to trace their products/services within and across the supply chain.

2 - Developing A Novel Service-part Classification Approach For Large-scale Multi-echelon Replenishment System

Alireza Sheikhzadeh, PhD Candidate, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States, asheikhz@uark.edu, Manuel D Rossetti

The purpose of this research is to create, analyze and test a new classification approach for large-scale multi-echelon service-part replenishment system. The classification approach is defined to address the need to provide the lowest penalty cost associated with grouping. In this research, we define the concept of artificial stocking policy (ASP) as a new classification criterion. We also propose a new partitioning approach which takes into the account the characteristics of the (aggregated) pseudo-items.

3 - How To Get The Conflict Out Of The Mineral Supply Chain

Han Zhang, Student, Kelley School of Business, Indiana University Bloomington, IN, 47408, United States, hz8@indiana.edu, Goker Aydin, H. Sebastian Heese

New legislation requires manufacturers to disclose their sources of “conflict minerals” - natural resources whose trade might finance conflicts. We study the effect of such interventions, using a model with mines, smelters, and manufacturers. We show that imposing penalties on manufacturers alone is not sufficient to eliminate conflict minerals from supply chains, and that an industrial alliance to pool audit costs among compliant manufacturers can be effective in increasing the equilibrium quantity traded of certified metal.

4 - Sourcing And Procurement Coordination In Multi-division Firms

Fang Fang, California State University, LA, 1250 S Alhambra Circle, Apt 18, LA, CA, 33146, United States, f.fang@umiami.edu, Harihara Natarajan

Large firm must coordinate multiple divisions’ procurement activities to leverage volume discounts from suppliers. Facing such a procurement coordination problem, we examine how a firm can design transfer prices to maximize firm-wide cost savings considering divisional off-contract buying. Our analysis of commonly-used transfer pricing rules shows interesting impacts on vendor selection, divisional participation, and gain allocation

■ TC73

Legends A- Omni

Operations Management III

Contributed Session

Chair: Sanchoy Das, New Jersey Institute of Technology, University Heights, Newark, NJ, 7102, United States, das@njit.edu

1 - Design Of Operational Policies To Reduce Boarding Time In Emergency Departments

Cheng Zhu, McGill University, 701-801 Sherbrooke Est, Montreal, QC, H2L 0B7, Canada, cheng.zhu@mail.mcgill.ca, Beste Kucukyacizi

In this research, we aim to reduce emergency department overcrowding by shortening waiting times for: i) for an admission by a consulting physician, ii) boarding to the inpatient ward. We consider patient flows in an open queueing network in the hospital, while the availability of inpatient beds in each ward is exogenous for physicians. Then, we focus on designing admission and boarding policies based on different possibility of given inpatient bed availability.

2 - Efficient Business Operations In A Poultry Firm

Sanjeev K Bordoloi, University of St. Thomas, Opus College of Business, 1000 LaSalle Avenue, TMH 443, Minneapolis, MN, 55403, United States, sbordoloi@stthomas.edu, Jahnavi Indukuri, Indukuri Srinivas Varma

In life-stock business, it is important to make operational decisions. This paper is an analysis of a poultry business in India. We conducted several optimization analyses on decision parameters such as life cycle of birds, break-even point, investment options, branding, and expansion.

3 - Advanced Orders Picking Heuristics For Internet Fulfillment Warehouses With And Explosive Storage Policy

Sanchoy Das, New Jersey Institute of Technology, University Heights, Newark, NJ, 07102, United States, das@njit.edu, Sevilay Onal

IFWs use an explosive storage policy whereby the same item is stored simultaneously in small lots in a large number of locations. Customer orders arrive continuously and the IFW objective is to minimize the fulfillment time. For a free picker the list of candidate picks is very large, and the solution space is described by the product of the number of pending orders and the active inventory locations. Decision variables are (i) which orders to serve next and (ii) which storage locations to fulfill the orders from. We present a narrow band selection heuristic which generate dynamic pick lists.

■ TC74

Legends B- Omni

Optimization Methodology III

Contributed Session

Chair: Mahamaya Mohanty, Research Scholar, IIT Delhi, Shaheed Jeet Singh Marg, New Delhi, 110016, India, mahamayamohanty@gmail.com

1 - Service Network Design With Heterogeneous Resource Constraints: Branch-and-price Approach

Kai Wei, PhD, Tongji University, Siping Road, Shanghai, China, 0359weikai@tongji.edu.cn

In this paper, we first present two kinds of different formulations for service network with heterogeneous asset constraints. The first is node arc formulation and the second is path cycle formulation. In the problem, we assume that each asset has a specific fixed cost and capacity and each arc can be used be several assets simultaneously. We introduce a branch and price algorithm to solve the path cycle formulation and use CPLEX to solve node arc formulation. The experimental results show our branch and price outperform CPLEX, especially in large benchmark instances.

2 - Selective Linearization For Multi-block Convex Optimization

Yu Du, PhD Candidate, Rutgers University, 100 Rockafeller Road, Piscataway, NJ, 08854, United States, duyu@rutgers.edu, Andrzej Ruszczynski, Xiaodong Lin

We consider the problem of minimizing a sum of several convex non-smooth functions. We introduce an algorithm called the selective linearization method, which iteratively linearizes all but one of the functions and employs simple proximal steps. The algorithm is a form of multiple operator splitting in which the order of processing partial functions is not fixed, but rather determined in the course of calculations. Global convergence is proved and estimates of the convergence rate are derived. Specifically, the number of iterations needed to achieve solution accuracy is of order O(ln(1/)/). We also illustrate the operation of the algorithm on large scale structured regularization problems.

3 - Globally Convergent Probability-one Homotopies For Linear Programs With Complementarity Constraints

Stephen C Billups, Associate Professor, University of Colorado Denver, Dept. of Mathematical & Statistical Sciences, Campus Box 170, P.O. Box 173364, Denver, CO, 80217-3364, United States, stephen.billups@ucdenver.edu

Probability-one homotopy algorithms work by tracking the zero set of a specially constructed homotopy mapping from a known point to a solution to the problem at hand. To apply this idea to linear programs with complementarity constraints (LPCCs), we consider a family of relaxations of the LPCC and replace the complementarity constraints with nonlinear relaxations of NCP functions. Two different homotopy mappings have been developed based on these ideas. We show that these mappings have several desirable properties and we illustrate these properties using small numerical examples.

4 - Application Of Analytics In Modeling The Decision Making Perspectives Of Integrated Logistics In Supply Chain

Mahamaya Mohanty, Research Scholar, IIT Delhi, Shaheed Jeet Singh Marg, New Delhi, 110016, India, mahamayamohanty@gmail.com, Ravi Shankar

As sustainability is a growing concern in a supply chain, we aim to model integrated logistics with a formulation of Sustainable Index(SI). To obtain an optimal solution to rising problems of logistics in a company, the decision maker should take into consideration the reduction of energy consumption, carbon emission, and waste generation to achieve sustainability. Formulation of Sustainability Index is considered by taking into account minimization of cost, time, and risk and maximizing quality, flexibility and revenue.

■ TC75

Legends C- Omni

Behavioral Operations III

Contributed Session

Chair: Sam Kirshner, UNSW Business School, Level 2, West Wing, Quadrangle Building, UNSW, Sydney, 2052, Australia, s.kirshner@unsw.edu.au

1 - The Price Of Privacy: Experimental Evidence For The Value Of Privacy With Respect To Social Norms

Rachel Cummings, California Institute of Technology, 1200 E California Boulevard, MC 305-16, Pasadena, CA, 91125, United States, rachelc@caltech.edu

In a series of multi-player experiments, we measure people's willingness to pay for privacy, and how this value depends on behavioral social norms. Each player is given the option to ``steal" monetary payments from the other players; the information shared about these decisions varies across treatments, which includes revealing partial or noisy information information about the player's actions. By varying the information sharing policy, we can measure how people trade off money for privacy. We also measure how people's willingness to steal changes as stealing behavior becomes more prevalent.

2 - Behavioral Analysis Of Consumers' Purchase Timing Decision

Ilhan Emre Ertan, PhD Candidate, University of Texas at Dallas, 430 Southwest Pkwy., Apt 2102, College Station, TX, 77840, United States, emre.ertan@gmail.com

From a long history of markdown sales, consumers have expectations that retailers will provide markdown discounts during a selling horizon. The consumer purchase timing decision is analyzed by using discounted expected utility theory. The consumer's sequential decision-making process is formalized under uncertain product availability and several behavioral biases. An optimal purchase timing policy is identified in a market environment, in which a strategic customerknows the markdown pricing scheme, available inventory level, and remaining time to the end of the selling horizon.

3 - A Behavioral Experiment On Sharing Advance Warning Of A Supply Chain Disruption

Sourish Sarkar, Assistant Professor, Pennsylvania State University - Erie, 5500 Copper Dr, Apt 104, Erie, PA, 16509, United States, sourishs@gmail.com, Sanjay Kumar

Using the beer distribution game in a controlled laboratory setting, we explore the effect of advance warning of a supply chain disruption. Effect of sharing that information with supply chain partners is also investigated. Considering both upstream and downstream disruptions, we summarize the results from our experiment with several scenarios: disruption with no advance warning but information sharing; disruption with no advance warning and no information sharing; disruption with advance warning but no information sharing; disruption with advance warning and sharing of this warning information.

4 - The Behavioral Traps Of Making Multiple, Simultaneous, Newsvendor Decisions

Shan Li, Assistant Professor, Baruch College, City University of New York, Baruch College, 55 Lexington Avenue, New York, NY, 10010, United States, shan.li@baruch.cuny.edu, Kay-Yut Chen

We conducted an experimental study to explore behaviors of newsvendors who make order decisions for two stores simultaneously. While the two stores are independent, we find that order decisions are impacted not only by the history from the same store, but also by the past information from the other store.

5 - The Impact Of Reference Points On Supply Chain Coordination

Sam Kirshner, UNSW Business School, Level 2, West Wing, Quadrangle Building, UNSW, Sydney, 2052, Australia, s.kirshner@unsw.edu.au, Lusheng Shao

Prospect theory and reference points have recently been utilized to explain the behavioral ordering of human newsvendors. Adopting this approach to modeling newsvendor behavior, we analytically explore the implications of reference points in a two-tier supply chain. We show that reference points enable coordination in a wholesale contract setting, and demonstrate how the reference points alter coordinating contracts under buy-backs and revenue sharing agreements.

■ TC76

Legends D- Omni

Decision Analysis I

Contributed Session

Chair: Chih-Yang Tsai, Professor, State University of New York at New Paltz, 1 Hawk Drive, New Paltz, NY, 12561-2443, United States, tsaic@newpaltz.edu

1 - General Model For Dynamic Learning Ambiguity vs Bayesianism

Mohammad Rasouli, University of Michigan, 430 South Fourth Ave, Ann Arbor, MI, 48104, United States, rasouli@umich.edu

We propose a general framework for adaptive learning that can model both Bayesian and non-Bayesian learning. We show how different objectives including expected outcome, minmax, and min regret can be modeled in this framework. This framework gives a unified view to the existing results in learning. We complete the existing results by proposing new sufficient statistics and dynamic programming techniques. The connection with zero-sum games is discussed. We will discuss conditions under which pure strategies can achieve optimal performance.

2 - Remove A Paradox In Data Envelopment Analysis

Dariush Khezrimotlagh, Dr., Miami University, Oxford, OH, 45056, United States, khezrid@miamioh.edu

Data Envelopment Analysis (DEA) is a non-parametric linear programming tool to assess the relative efficiency of a set of homogenous firms with multiple input factors and multiple output factors. DEA has been used in thousands of published papers and books in well-known qualified journals and by reputable publishers since 1978. DEA assumes that the relationships between the factors can be varied from one firm to another. This article proves that this assumption has a contradiction with the homogeneity of firms and concludes that the provided scores by DEA models are not relatively meaningful and should not be used to rank or benchmark firms. The instructions to remove the paradox in DEA are illustrated.

3 - Reproducing Kernel Hilbert Space Approach To Stochastic Frontier Semiparametric Estimation

Carlos Felipe Valencia Arboleda, University of los Andes, Cra 1 Este No 19A - 40, Edificio Mario Laserna, Bogota, 11001000, Colombia, cf.valencia@uniandes.edu.co

We develop a nonparametric estimator for the Stochastic Frontier Analysis problem based on the Reproducing Kernel Hilbert Space approach. We prove minimax optimality of convergence for the frontier estimator, and semiparametric efficiency for the finite dimensional parameters. Using Sobolev Hilbert Spaces, we implement the method under monotonicity and concavity constrains. We perform a simulation study to show the benefits of our estimators.

■ TC77

Legends E- Omni

Opt, Integer Programing III

Contributed Session

Chair: John Shane Lyons, PhD Student, Western University-Ivey Business School, 23 Pine Ridge Drive, London, ON, N5X 3G7, Canada, jlyons.phd@ivey.ca

1 - Computer-assisted Discovery And Automated Proofs Of Cutting Plane Theorems

Yuan Zhou, University of California - Davis, One Shields Avenue, Davis, CA, 95616, United States, yzh@math.ucdavis.edu, Matthias Koeppe

Inspired by the breakthroughs of the polyhedral method for combinatorial optimization in the 1980s, generations of researchers have studied the facet structure of convex hulls to develop strong cutting planes. We ask how much of this process can be automated: In particular, can we use algorithms to discover and prove theorems about cutting planes? We focus on general integer and mixed integer programming, and use the framework of cut-generating functions. Using a metaprogramming technique followed by practical computations with semialgebraic cell complexes, we provide computer-based proofs for old and new cutting-plane theorems in Gomory-Johnson's model of cut generating functions.

2 - Mixed-integer Programming For Detecting Cycles In Non-reversible Markov Processes

Ambros Gleixner, Zuse Institute Berlin, Takustr. 7, Berlin, 14195, Germany, gleixner@zib.de, Isabel Beckenbach, Leon Eifler, Konstantin Fackeldey, Andreas Grever, Marcus Weber, Jakob Witzig

Spectral clustering methods are used successfully to identify so-called metastable sets or dominant cycles of Markov processes. They analyze the spectrum of matrices based on the transition probabilities between states. However, current spectral methods have limited applicability for many biological and catalytic processes with a systematic, but slow cyclic behavior on the timescale of the simulation. We use mixed-integer programming to develop a new method that is able to detect the existence and measure the strength of such cyclic processes.

3 - Enhanced Equations For Linearizing Discrete Product For Generalized Programming Problems

Qi An, North Carolina State University, 2119A Gorman Street, Raleigh, NC, 27606, United States, nival.ann@gmail.com, Tiantian Nie, Shu-Cherng Fang

This paper advances ``Equations for Linearizing Discrete Product” — a set of equations that linearize discrete polynomial terms in an effective manner. We exploit the logarithmic feature and propose an enhancement technique to further reduce the number of linear constraints for the current ELDP-based reformulations. We extend the applicability of ELDP to a more general set of ``representable programming problems”. Computational experiments on both random problems and literature-reported problems support that the proposed method indeed increases the computational effectiveness.

4 - A Farm-level Precision Land Management Model Based On Integer Programming

Qi Li, Iowa State University, 0076 Black Engineering, Ames, IA, 50010, United States, qili@iastate.edu, Guiping Hu, Zaki Jubery, Baskar Ganapathysubramanian

A farm level precision farmland management model based on mixed integer linear programming has been proposed. Optimal decisions are provided for preseason crop planning and irrigation water allocation. The model captures the effect of size and shape of decision scale as well as special irrigation patterns. We illustrate the model by conducting a case study on a farm in California and show the model is capable of representing the decision making process and flexible to accommodate various scenarios. The results show that a threefold increase of annual net profit could be achieved by carefully choosing irrigation and seed types.

5 - Whistler-Blackcomb Mega Day As An Integer Programming Problem

John Shane Lyons, PhD Student, Western University-Ivey Business School, 23 Pine Ridge Drive, London, ON, N5X 3G7, Canada, jlyons.phd@ivey.ca

The Whistler-Blackcomb ski area has recently implemented a system which tracks use of 25 lifts across both mountains. A web-based application offers skiers a variety of analytic information pertaining to their skiing activity, and poses a number of ‘badges’ to be earned. One of these, called Mega Day, requires a skier to ride all lifts on both mountains, and consequently ski roughly 10,000 vertical metres. On a particular date of study less than 0.1% of skiers on the mountain achieved this goal. This presentation describes an integer programming model developed to identify feasibility and optimal routing for the Mega Day challenge.

■ TC78

Legends F- Omni

Opt, Network III

Contributed Session

Chair: Oliver Lum, U of Maryland, College Park, 11604 Parkedge Drive, Rockville, MD, 20852, United States, oliver@math.umd.edu

1 - On The Complexity Of Sparse Maximum Flow Problems

Andrew Romich, Systems Engineer, Sandia National Laboratories, 4617 Gerrilyn Way, Apt 206, Apt. 206, Livermore, CA, 94550, United States, aromich@sandia.gov, Cole Smith, Guanghui Lan

We consider several sparsity-inducing restrictions of the standard maximum flow problem. Each restriction is a unique combination of the number of nodes having an out-degree greater than one and the inclusion of either a restriction on the total amount of flow on all arcs or the total number of arcs used in the network. Assuming an option of initially allowing continuous or integer flow, we analyze a total of twelve problems.

2 - Mathematical Optimization For Managing Selective Catalytic Reduction For A Fleet Of Coal-fired Power Plants

Jay Michael Rosenberger, University of Texas-Arlington, Dept of Industrial Manuf Systems Eng, PO Box 19017, Arlington, TX, 76019, United States, jrosenbe@uta.edu, Antonio Alejandro Alanis

Selective Catalytic Reduction (SCR) reduces emissions of oxides of nitrogen (NOx) in coal-fired power plants. With a given set of scheduled outages for a fleet of power plants, we develop a heuristic multi-commodity flow problem with schedule elimination constraints, and a knapsack problem with assignment constraints, to create an SCR management plan, which minimizes the total SCR operational cost of the entire fleet of power plants and maintains NOx emissions below a desired target. We present results indicating that our approach provides an equally optimal solution to that of a schedule generation and optimization approach in less computational processing time.

3 - A Parametric Linear Programming Approach To A Cluster Ratio Based Hierarchical Consensus Clustering Algorithm

Victoria Ellison, North Carolina State University, 2152 Burlington Labs 2500 Stinson Dr., Raleigh, NC, 27695, United States, vmelliso@ncsu.edu, Yahya Fathi, Amy Langville

The minimum cluster ratio cut is a well studied partition-based clustering method used to partition a data set into two or more clusters of balanced size. We propose a natural extension of the minimum cluster ratio cut, which we call the minimum beta-ratio cut, which lends itself to hierarchical clustering methods. We propose a divisive hierarchical consensus clustering algorithm which uses the minimum beta-ratio cut and a heuristic for this algorithm by modifying a BILP formulation of Median Partition problem and applying a parametric programming algorithm to it.

4 - A Hybrid Heuristic For The Windy Rural Postman Problem With a Time-Dependent Zigzag Option

Oliver Lum, U of Maryland, College Park, 11604 Parkedge Drive, Rockville, MD, 20852, United States, oliver@math.umd.edu, Rui Zhang, Bruce L Golden

In some vehicle routing applications, service is required along both sides of the road. During early morning hours, the vehicle may service both sides of the street during a single traversal by zigzagging between the two. This scenario is modeled by the Windy Rural Postman Problem with Time-Dependent Zigzag Options (WRPPZTW). We present a hybrid heuristic for the WRPPZTW which uses well-known insertion techniques in concert with a new integer programming formulation for the WRPPZ. We compare computational performance relative to an existing exact procedure for a set of small instances and present more extensive results for a set of larger instances.

5 - The Deviation-flow Continuous Location Problem For A Single Refueling Station On A Tree Network

Sang Jin Kweon, PhD Candidate, Pennsylvania State University, 310 Leonhard Building, Industrial and Manufacturing Engineering, University Park, PA, 16802, United States, svk5333@psu.edu

In this study, we address the continuous version of the single refueling station location problem on a tree network considering that a given portion of drivers has the option to deviate from their preplanned paths to be able to refuel their vehicles. The objective of the problem is to determine the set of optimal station locations that maximizes the total traffic flow covered (in round trips per time unit). To achieve this goal, we derive optimality properties regarding deviation and determine the sets of candidate sites to locate the refueling station. Then, we develop a polynomial algorithm to determine the set of optimal locations.

■ TC79

Legends G- Omni

Opt, Stochastic III

Contributed Session

Chair: Md Abdul Quddus, PhD Student, Mississippi State University, Department of Industrial & Systems Engineering, PO Box 9542, Starkville, MS, 39762, United States, mq90@msstate.edu

1 - Multi-depot Fleet Dimensioning For Seasonal Stochastic Demand

Marcus V. Poggi, PUC-Rio, Rua M. S. Vicente 225, Rio de Janiero, 22591-900, Brazil, poggi@inf.puc-rio.br, Fabian Penaranda

Given a predicted demand behavior represented by a generation function over time and space, distances between clients and the depots, cost to lease one vehicle for the period, unity cost for traveling a distance for leased and for short time hired vehicles and a demand allocation rule, find the (heterogeneous) fleet size at each depot that minimizes the expected operation cost for the period. We propose a decomposition approach based on Stochastic Dual Dynamic Programming that allows dealing with the integrality of the sub-problems. Instances based on CVRPLIB are generated and experimental results are presented.

2 - Scenario Generation Assessment For Stochastic Programs

Didem Sari, Iowa State University, 3219 Roy Key Avenue, Unit 207, Ames, IA, 50010, United States, dsari@iastate.edu, Sarah M Ryan

We propose an approach for assessing the reliability of a scenario generation method using historical outcomes. The distances among scenarios and the observed value are measured by fixing first-stage decisions to a common value and computing second-stage costs. A rank histogram constructed from these distances, motivated by mass transportation metrics, can diagnose bias or other defects. The method is demonstrated using unit commitment case studies and server location simulations.

3 - Route Optimization: A Risk Averse Shortest Path Problem

Marcelo Ricardo Figueroa, Rutgers University, 93 Marvin Lane, Piscataway, NJ, 08854, United States, marcelo.figueroa@rutgers.edu, Melike Baykal-Gursoy

We study a risk-averse shortest path route optimization problem on a vehicular traffic setting, to inform users of optimal routing decisions under particular levels of risk-aversion. We make use of specialized travel-time distributions derived from analytic queueing models with Markov modulated service times to model random traffic interruptions.

4 - Developing A CCHP-microgrid Operation Decision Model Under Uncertainty

Md Abdul Quddus, PhD Student, Mississippi State University, Department of Industrial & Systems Engineering, PO Box 9542, Starkville, MS, 39762, United States, mq90@msstate.edu, Carlos Marino, Mohammad Marufuzzaman, Mengqi Hu

A combined cooling, heating, and power (CCHP) system provides a cost efficient solution for energy demand, energy security supply along with sustainability. The power grid is heavily vulnerable to breakdowns, natural disaster and targeted attacks. Researchers have proposed stochastic optimization models for CCHP operation for small scale (i.e. single buildings). However little attention has given for modeling CCHP units operation that satisfy multiple energy demand nodes. This study bridges the research gap by developing a scalable two stage stochastic programming model for large scale micro-grid operation under uncertainty considering a larger number of scenarios.

■ TC86

Glbson Board Room-Omni

Marketing VII

Contributed Session

Chair: Rajeev Kumar Tyagi, Professor, University of California, Irvine, 5 Murasaki, Irvine, CA, 92697, United States, rktyagi@uci.edu

1 - Showrooming And The Length Of Product Line

Yilong Luo, Illinois Institute of Technology, 6716 Idaho Avenue, Hammond, IN, 46323, United States, yluo4@hawk.iit.edu, Jiong Sun

Showrooming is a strategy that consumers touch and feel the products in the offline store but purchase from online store which usually offer a lower price. As the improvement of technology, like high speed internet and mobile phone, showrooming are widely applied by consumers. Thus offline stores always regard showrooming as something evil and attribute the sales decline to this effect. In our paper, however, we explore the strategy that brick store can actually benefit from showrooming effect by partially carrying the product line. We also show that the presence of showrooming behavior may or may not induce the brick-and-mortarretailer to reduce the length of the product line it carries.

2 - A Model Of Cause-related Marketing

Sreya Kolay, Assistant Professor, University of California, Irvine, Irvine, CA, 92697, United States, skolay@uci.edu

Cause-related marketing (CRM) is the popular practice of linking purchases to donations made to charitable causes. They include price-based CRM policies wherein a firm donates a percentage of revenues or profits for every purchase made, or quantity- or unit-based CRM policies wherein the firm donates a unit of its own product for every unit purchased. In this paper, we develop an analytical model to examine conditions on consumer valuations and seller's cost structure that determine the optimality of CRM, price-based CRM, and quantity-based CRM from the perspective of a seller. We also compare and contrast these conditions with those that maximize donations and social welfare.

3 - Optimal Pricing Of Multiple Events

Rajeev Kumar Tyagi, Professor, University of California, Irvine, 5 Murasaki, Irvine, CA, 92697, United States, rktyagi@uci.edu

Event organizers often sell a series of events that occur sequentially over time. For example, concert series with multiple performers and sports tournaments. Consumers may enjoy more than one event in the series, and the events may differ in popularity with the audience (e.g. two operas of different popularity in successive months, pre-season games followed by more popular regular-season games). In this paper, we analytically characterize the optimal pricing and bundling strategy of such an event organizer. We allow for sellers who can commit to future prices as well as those who cannot.

■ TC87

Broadway A-Omni

Minority Issues Forum Paper Competition

Sponsored: Minority Issues

Sponsored Session

Chair: Karen T Hicklin, University of North Carolina at Chapel Hill, 308 Bynum Hall, Chapel Hill, NC, 27599, United States, khicklin@email.unc.edu

■ TC88

Broadway B-Omni

Service Science Best Student Paper Competition III

Award Session

Chair: Robin Qiu, Penn State University, 30 E. Swedesford Road, Malvern, PA, 19355, United States, robinqiu@psu.edu

1 - Managing Service Systems With Unknown Quality And Customer Anecdotal Reasoning

Hang Ren, University College London, London, United Kingdom, hang.ren.13@ucl.ac.uk, Tingliang Huang

In this paper, we study a service system where customers estimate service quality from anecdotal evidence. We characterize the service provider's pricing, quality information disclosure, and quality control decisions. We find that the service provider adopts a pricing strategy very different from the fully rational benchmark. Moreover, she should reserve quality information when queueing is more costly, and she may disclose one type of service quality anecdote but not the other type. Lastly, the service provider may reduce service quality when customers obtain more anecdotes.

2 - The Use And Value Of Social Network Information In Selective Selling

Ruslan Momot, INSEAD, Fontainebleau, France, Ruslan.momot@insead.edu, Elena Belavina, Karan Girotra

We consider the use and value of social network information in selectively selling goods and services whose value derives from exclusive ownership among network connections. Our model accommodates customers who are heterogeneous in their number of friends (degree) and proclivity for social comparisons (conspicuity). We show how the firm with information on either (or both) of these traits can use it to increase profits making a product selectively available to the firm's best targets - high-conspicuity customers within intermediate-degree segments. We find that information about degree is more valuable than information about conspicuity and that the two are substitutes.

3 - Embedding Assignment-Routing Constraints through Multi-Dimensional Network Construction For Solving Multi-Vehicle Routing With Pickup & Delivery Time Windows

Monireh Mahmoudi, Arizona State University, Tempe, AZ, United States, mmahmoudi@asu.edu, Junhua Chen, Xuesong Zhou

Optimization of ride-sharing services in on-demand transportation systems involves solving a class of complex vehicle routing problems with pickup and delivery with time windows. In this paper, by embedding complex assignment-routing constraints through constructing a multi-dimensional network, we intend to reach optimality for local clusters derived from a reasonably large set of passengers on real world transportation networks. In addition, by the aid of the passengers' cumulative service patterns defined in this paper, our solution approach is able to tackle the symmetry issue which is a common issue in the combinatorial problems.

4 - Using Patient-centric Quality Information To Unlock Hidden Health Care Capabilities

Guihua Wang, Ross School of Business, University of Michigan, Ann Arbor, MI, 48105, United States, guihuaw@umich.edu, Jun Li, Wallace J Hopp

We document a wide variation in quality among 188 surgeons at 35 hospitals in New York state that perform mitral valve surgery. Our analysis shows that patients of different demographics and levels of acuity benefit differently from elite surgeons. In this paper, we develop an approach for computing patient-centric information from outcome data and evaluate the potential health benefits from using such information to guide patients to surgeons. We estimate that the total societal benefits from using patient-centric information are comparable to those achievable by enabling the best surgeons to treat 40% more patients under population-average information.

5 - On The Benefit (or Cost) Of Large-scale Bundling

Tarek Abdallah, New York University, tabdalla@stern.nyu.edu

We study the effectiveness of a simple bundling mechanism in extracting the consumer surplus in the presence of non-negative marginal costs and correlated valuations. We develop simple robust analytics that identify the main drivers for the effectiveness of the pure bundling mechanism and allow the sellers to easily quantify the potential profits of a large-scale bundling mechanism relative to more complicated selling mechanisms. Our numerical simulations show that these analytics provide high predictive power for the true performance of the bundling mechanism and are robust to different parametric assumptions even for relatively small bundles.

■ TC89

Broadway C-Omni

Applications of Optimization and Control Theory in Traffic Management

Sponsored: TSL, Intelligent Transportation Systems (ITS)

Sponsored Session

Chair: Xiaozhang He, Purdue University, 1, West Lafayette, IN, 47906, United States, seanhe@purdue.edu

1 - On The Equity Issue Of Taxi Market Under A Centralized Recommendation System

Xinwu Qian, Purdue University, West Lafayette, IN, United States, qian39@purdue.edu, Xianyuan Zhan, Sattish Ukkusuri

The lack of perfect information between passengers and drivers is the main cause of the taxi system inefficiency, and having a centralized recommendation system will effectively address this inefficiency. In this study, we model the taxi market with centralized recommendation system, with the objective to minimize the income differences among taxi drivers. The model aims to address the equity issue related to income variance, which helps to improve the stability of the taxi market. We first prove that the problem is NP-hard, and we propose a meta-heuristic algorithm to solve the large-scale real world case efficiently.

2 - Feedback-based Traffic Signal Perimeter Control For Urban Networks Under special Traffic Events

Jiawen Wang, Tongji University, School of Transportation Engineering, Shanghai, China, 07wangjiawen@tongji.edu.cn, Xiaoguang Yang, Xiaozheng He, Srinivas Peeta

This study develops a proportional-integral-derivative controller for traffic signal perimeter control to maximize the throughput of urban networks under special traffic events. The proposed control strategy applies the notion of macroscopic fundamental diagram to dynamically estimate the control targets. Numerical examples are constructed to investigate the benefits of the proposed control strategy in improving the traffic mobility when special traffic events occur.

3 - Simulation-based Optimization With AdaptiveSampling Strategy For Network-wide Traffic Management And Control

Shubham Agrawal, Purdue University, West Lafayette, IN, 47907, United States, shubham@purdue.edu, Xiaozheng He, Ragu Pasupathy, Srinivas Peeta

This study develops a simulation-based optimization model to address network-wide traffic management and control problems under a tight computational budget by applying an adaptive sampling strategy. The proposed model is suitable to solve traffic management and control problems, which can determine traffic signal timing, route guidance, and ramp metering simultaneously. Numerical results are used to illustrate the efficiency of the adaptive sampling strategy in enhancing the performance and reliability of traffic management and control systems in operational context.

■ TC90

Broadway D-Omni

Logistics, Humanitarian

Contributed Session

Chair: Behnam Malmir, Kansas State University, 2034 Durland Hall, 1701A Platt street, Manhattan, KS, 66506, United States, malmir@ksu.edu

1 - Human Trafficking: Opportunities For Operations Research And Management Science

Renata Alexandra Konrad, Worcester Polytechnic Institute, School of Business, 100 Institute Road, Worcester, MA, 01609, United States, rkonrad@wpi.edu

This talk highlights how OR/MS techniques can be used to address the growing issue of human trafficking. We provide insights into the unique challenges and opportunities for the OR/MS community and suggest development areas. We present a case study of victim shelter location in Nepal and share our experiences in working in this field.

2 - Pre-disaster Unmanned Air Vehicle Base Location & Routing For Road Damage Assessment & Search & Rescue

Seyyed kian Farajkhah, Cankaya-Middle East Technical University, Universiteler, Dumlupinar, Bulvari No1, Ankara, 06800, Turkey, kian.farajkhah@metu.edu.tr

we consider the problem of locating UAV bases in anticipation of alarge-scale disaster in an urban environment.We propose a two-stage stochastic programming approach for this problem, where first-stage decisions consist of base locations and UAV routes, and the second-stage is comprised of assigning these ambulances to different demand point and hospitals. Using small-sized instances, we aim to analyze the structure of the optimal solutions and use the results of this analysis to develop a heuristic approach for larger instances.

3 - Impact Of Patient Centered Discharge On Quality Of Life And Readmission Rates For Kidney Transplant Recipients

Aravind Chandrasekaran, The Ohio State University, 600 Fisher Hall, 2100 Neil Avenue, Columbus, OH, 43210, United States, chandrasekaran.24@osu.edu, Luv Sharma, Gopesh Anand

This study looks at the impact of a patient centered discharge process in improving the quality of life and readmission rates for kidney transplant recipients. This three year study was conducted at a large teaching hospital in the Midwest and involved designing and implementing a new patient centered discharge process with inputs from patients and caregivers. Initial results demonstrate a 15% reduction in readmission rates post implementation of the new discharge process. A comparable improvement in readmission rate is also observed when compared to a control group comprised of other types of transplant patients.

■ TC94

5th Avenue Lobby-MCC

SIMIO/Neusrel

Technology Tutorial

1 - New Innovations: Cloud Computing, Real-Time Scheduling, Healthcare, And More

Claude Dennis Pegden, CE/Founder, Simio LLC, Sewickly, PA, United States, cdpegden@simio.com, Renee Thiesing

Simio now leverages the cloud computing power of Microsoft Azure to support your most demanding applications; compatibility with Schneider Electric's Wonderware to allow detailed production scheduling with real-time data and risk analysis; and healthcare and other capabilities in the services field. Outside our immense technology partner advances, we have great new features, application areas and capabilities! Come explore an overview of the new Simio experience and see why we are always "Forward Thinking."

2 - NEUSREL - Success Drivers

David Buckler, Neusrel, Chantilly, VA, United States, dbuckler@caci.com

NEUSREL is self-learning causal analysis software and leverages Advanced Machine Learning techniques. It builds cause-effect networks (path models) in order to understand the impact and role of success factors. The software is the only solution worldwide that is able to explore unexpected nonlinearities and unexpected interactions - a capability that not only lead to largely increased explanation power but turned out to be crucial when understanding true key drivers of outcomes. The software is applied in all fields were many factors drives a particular outcome and therefore it is not clear how important those are and how they interact.

Tuesday, 3:10PM - 4:00PM

■ Keynote Tuesday

Davidson Ballroom A-MCC

Optimizing the Future – Supply Chain at Amazon

Keynote Session

Chair: Anne Robinson, Verizon Wireless, Basking Ridge, NJ, anne.robinson@verizonwireless.com

1 - Optimizing The Future - Supply Chain at Amazon

Jason Murray, Amazon, 410 Terry Avenue North, Seattle, WA, 89109, United States, n.a@na.org

The retail supply chain of the future will be built on massive data, advanced analytics and innovative technology. At Amazon, we are constantly pushing the frontier in each of these areas to help create that future. Our vision is to move products at an unprecedented scale through the most technologically advanced supply chain possible, where intelligent optimization algorithms drive efficiency. To achieve this vision, we focus on three core pillars: research, technology, and business ownership. We develop new research, implement it in technology, and own the top- and bottom-line of the business. To be successful, we believe business ownership, research, and development must be tightly coupled. During this presentation, I will discuss our vision for the future of retail supply chain — where we have been, where we are, and where we plan to go. I will share some cases of research innovation and its integration with technology and business. These include inter-disciplinary modeling and optimization (from machine learning, statistics, simulation and optimization) to make Amazon's supply chain more efficient. Finally, I will provide examples of some challenges we will need to overcome to make our vision a reality.

■ Keynote Tuesday

Davidson Ballroom B-MCC

Wagner Prize Winner Reprise

Invited: Plenary, Keynote

Invited Session

Chair: Allen Butler , Daniel H Wagner Associates, Inc., Hampton, VA, allen.butler@va.wagner.com

1 - Wagner Prize Winner Reprise

C. Allen Butler, Daniel H Wagner Associates, Inc., 2 Eaton Street, Hampton, VA, 23669, United States, Allen.Butler@va.wagner.com

The Daniel H. Wagner Prize for Excellence in Operations Research Practice emphasizes the quality and coherence of the analysis used in practice. Dr. Wagner strove for strong mathematics applied to practical problems, supported by clear and intelligible writing. This prize recognizes those principles by emphasizing good writing, strong analytical content, and verifiable practice successes

■ Keynote Tuesday

Davidson Ballroom C-MCC

Edelman Reprise-UPS

Keynote Session

Chair: Michael Trick, Carnegie Mellon University, Pittsburgh, PA, (IFORS President) trick@cmu.edu

1 - UPS Optimizes Delivery Routes

Jack Levis, Director of Process Management, UPS, Timonium, MD, United States, jlevis@ups.com, Ranganeth Nuggehalli

UPS, the leading logistics provider in the world, and long known for its penchant for efficiency, embarked on a journey to streamline and modernize its pickup and delivery operations in 2003. This journey resulted in a suite of systems, including an optimization system, which is called "On Road Integrated Optimization and Navigation" (ORION). Every day, ORION provides an optimized route for each of UPS' 55,000 U.S. drivers based on the packages to be picked up and delivered on that day. The innovative system creates routes that maintain the desired level of consistency from day to day. To bring this transformational system from concept to reality, UPS instituted extensive change management practices to ensure buy-in from both users and executives. Costing more than $250 million to build and deploy, ORION is expected to save UPS $300 to $400 million annually. ORION is also contributing the sustainability efforts of UPS by reducing the CO2 emissions by 100,000 tons annually. By providing a foundation for a new generation of advanced planning systems, ORION is transforming the pickup and delivery operations at UPS.

Tuesday, 4:30PM - 6:00PM

■ TD01

101A-MCC

New Methods in Data Mining

Sponsored: Data Mining

Sponsored Session

Chair: Mariya Naumova, Rutgers University, 640 Bartholomes Road, Piscataway, NJ, 08854, United States, mnaumova@rci.rutgers.edu

1 - A Fast Algorithm For Discretization In A Big Data Space

Abdelaziz Berrado, Associate Professor, University Mohammed V in Rabat, BP 765, Avenue Ibn Sina, Agdal, Rabat, 10080, Morocco, berrado@emi.ac.ma

Discretizing continuous attributes is a necessary preprocessing step before association rules mining or using several inductive learning algorithms with a heterogeneous big data space. This important task should be carried out with a minimum information loss. We combine bagging and nonlinear optimization techniques to build an automated supervised, global and dynamic discretization algorithm that derives its ability in conserving the data properties from the Random Forest algorithm. Empirical results indicate the performance of our discretization algorithm.

2 - Orthogonal Tensor Decomposition

Cun Mu, PhD Student, Columbia University, 500 West 120th Street, Room 315, New York, NY, 10027, United States, cm3052@columbia.edu, Donald Goldfarb

Many idealized problems in signal processing, machine learning, and statistics can be reduced to the problem of finding the symmetric canonical decomposition of an underlying symmetric and orthogonally decomposable (SOD) tensor. In this talk, we will address several practical issues arising from conducting this orthogonal tensor decomposition.

3 - Distance-based Methods For Classification Of Groups Of Objects

Mariya Naumova, Rutgers University, 110 Frelinghuysen Rd., Piscataway, NJ, 08854, United States, mnaumova@rci.rutgers.edu

Given a finite number of learning samples from several populations (groups) and a collection of samples from the union of these populations, it is required to classify the entire collection (not a single sample) to one of the groups. Such problems often arise in medical, chemical, biological and technical diagnostics, classification of signals, etc. We consider different methods of solving the problem based on distance formulas and make comparison of their quality based on numerical results. We give an illustrative example with real data to demonstrate the effectiveness of the classification methods.

■ TD02

101B-MCC

Data Mining in Medical and Brain Informatics II

Sponsored: Data Mining

Sponsored Session

Chair: Chun-An Chou, SUNY Binghamton, 4400 Vestal Parkway East, Binghamton, NY, 13902, United States, cachou@binghamton.edu

Co-Chair: Sina Khanmohammadi, SUNY Binghamton, 4400 Vestal Parkway East, Binghamton, NY, 13902, United States, skhanmo1@binghamton.edu

1 - Statistical Learning Of Neuronal Functional Connectivity

Chunming Zhang, University of Wisconsin - Madison, cmzhang@stat.wisc.edu

Identifying the network structure of a neuron ensemble is critical for understanding how information is transferred within such a neural population. We propose a SIE regularization method for estimating the conditional intensities under the GLM framework to better capture the functional connectivity among neurons. A new algorithm is developed to efficiently handle the complex penalty in the SIE-GLM for large sparse data sets applicable to spike train data. Simulation results indicate that our proposed method outperforms existing approaches. An application of the proposed method to a real spike train data set provides some insight into the neuronal network.

2 - Graph Mining For Alzheimer Disease

Fei Gao, Arizona State University, Tempe, AZ, 85281, United States, fgao16@asu.edu, Teresa Wu

Apolipoprotein E (APOE) is a gene considered to be highly correlated with the risks of having Alzheimer's disease (AD). In this study, imaging data (T1 and DWI) of two cohorts of patients: APOE carrier and non-carrier is studied. Brain network were first generated based on which linear regression on graphic features such as clustering coefficient, mean degree versus age was conducted. The results showed there may be differences between the two cohorts. This finding motivated us further to develop a multi-task feature selection method to identify the critical sub-graphic regions that can significantly improve the discriminative power using the new graph features versus age correlation.

3 - Mining Hierarchical Event Labels In Large-scale Eeg Collections

Kay Robbins, University of Texas at San Antonio, Kay.Robbins@utsa.edu, Nima Bigdely-Shamlo

When comparing results from two similar EEG studies, researchers must manually map event types in one study to those of the other. To address event mapping and to facilitate large-scale data sharing, we created an event-labeling scheme called Hierarchical Event Descriptors (HED). HED is a common, extensible vocabulary, with more detailed tags appearing lower in the hierarchy. We tagged over 3 million events across 1,127 datasets using the HED tag system. We perform a cross study analysis by investigating ERP/ERSP patterns calculated by averaging over data recording trials extracted by matching HED tags. We evaluate the correlations of these patterns and their relationship to particular tags.

4 - Capturing Dynamics Of Brain Functional Networks Through Data Driven Techniques

Laleh Najafizadeh, Rutgers University, laleh.najafizadeh@rutgers.edu

The brain is a highly complex dynamic system in which neuronal connections are continuously formed and dissolved at multiple temporal scales. A challenging problem in the field of neuroscience has been to find reliable techniques that can describe such inherently dynamic properties of brain function. One promising approach to investigate brain's functional architecture is to study its function at the network level within the context of functional connectivity. Utilizing this approach, here, we present data driven frameworks to examine the dynamic nature of neuronal activity, during the execution of tasks.

■ TD03

101C-MCC

Recent Developments in Opaque and Probabilistic Selling

Invited: Business Model Innovation

Invited Session

Chair: Tingliang Huang, Carroll School of Management, Boston College, Chestnut Hill, MA, United States, tingliang.huang@bc.edu

1 - Selling Through Priceline? On The Impact Of Name-your-own-price In Competitive Market

Xiao Huang, John Molson School of Business, Concordia University, xiao.huang@concordia.ca, Greys Sosic, Gregory E Kersten

We study how competitive sellers with substitutable goods may sell their products (1) as regular goods, through a direct channel at posted prices, and/or (2) as opaque goods, through a 3rd-party NYOP channel. We establish a stylized framework with two competing sellers, an intermediary NYOP firm, and a sequence of customers. We characterize customers' optimal purchasing/bidding decisions and sellers' dynamic pricing equilibrium, and then illustrate the impact of inventory and time on prices, profits and channel strategies via numerical studies. Interestingly, although competing sellers seldom benefit from the existence of NYOP, it is possible that some seller(s) may adopt it in equilibrium.

2 - Opaque Selling And Last-minute Selling: Revenue Management In Vertically Differentiated Markets

Hang Ren, School of Management, University College London, London, United Kingdom, hang.ren.13@ucl.ac.uk, Tingliang Huang

Firms in many industries often reduce the price of products/service at the end of the selling season to dispose of unsold inventory/capacity. This last-minute selling induces consumers to wait for sales and thus lowers the regular price. To overcome the problem, many firms switch to opaque selling, i.e., mixing different types of leftovers and sell them as one type of product. We study the performance of last-minute selling and opaque selling in vertically differentiated markets, and find that opaque selling is less efficient in cleaning up leftovers, and the firm may switch to last-minute selling when high demand becomes more likely. Both results are contrary to the horizontal differentiation case.

3 - Vertical Probabilistic Selling Under Competition: The Role Of Consumer Anticipated Regret

Dongyuan Zhan, University College London, London, WC1E 6BT, United Kingdom, d.zhan@ucl.ac.uk, Yong Chao, Lin Liu

We study probabilistic selling with vertically differentiated products when firms compete and consumers anticipate the potential post-purchase regret raised by obtaining the inferior products. Intuitively, anticipated regret hurts the attractiveness of probabilistic selling. However, we find that probabilistic selling can be more profitable, and more likely to arise with anticipated regret than without it. That is due to the "reverse quality discrimination" (perceived quality of the random product is non-increasing in consumer type), which increases the perceived differentiation at the competition margin, and maintains the random products attractive to the infra-marginal consumers.

■ TD04

101D-MCC

Joint Session QSR/ENRE: Data-driven Modeling and Analytics in Wind Power Systems

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Arash Pourhabib, Oklahoma State University, 322 Engineering North, Stillwater, OK, 74078, United States, arash.pourhabib@okstate.edu

Co-Chair: Eunshin Byon, University of Michigan, College Station, MI, United States, ebyon@umich.edu

1 - Extreme Loads Analysis: Extrapolation And Importance Sampling

Peter Graf, National Renewable Energy Laboratory, 15013 Denver West Parkway, Golden, CO, 80401, United States, Peter.Graf@nrel.gov

Assessing wind turbine extreme loads requires estimating tails of probability distributions to construct "exceedance plots" of probability versus peak loads in a 10 minute simulation corresponding to a once-in-50-years event. The IEC standard contains a prescription for how to estimate these loads. Many find it unsatisfying because it relies on extrapolation to achieve the 10E-8 level. Alternative methods based on more strategic sampling of conditions are promising because they may allow for direct statistical realization of the extreme loads. This paper compares the existing IEC approach to one based on Importance Sampling.

2 - Space-time Modeling Of Asymmetric Local Wind Fields

Ahmed Aziz Ezzat, Texas A&M University, College Station, TX, United States, aa.ezzat@tamu.edu, Mikyoung Jun, Yu Ding

Local wind fields refer to the wind dynamics in a space-time domain composed of a dense grid of locations with close space-time proximity. A typical application is modeling wind stream behavior using measurements at wind turbines on a wind farm. Existing literature tends to overlook space-time interaction by imposing separable, symmetric models. Our analysis suggests that local wind dynamics are asymmetric in nature, and this asymmetry pattern is dynamically changing due to alternation of dominant winds. Modeling such physical phenomenon can have a vital impact on our understanding of local wind dynamics, enabling better forecasts and robust control strategies in wind energy applications.

3 - Data-driven Stochastic Transmission Expansion Planning

Ali Bagheri, Oklahoma State University, ali.bagheri@okstate.edu

Due to the significant improvements of power generation technologies and replacing traditional power plants with renewable ones, the generation portfolio will experience dramatic changes. The uncertainty of renewable energy and their sitting call for economic plans for expanding the transmission capacities. In this study, by learning from the historical data, we first construct a confidence set for the unknown distribution of the uncertain parameters. Then, we develop a two-stage data-driven transmission expansion framework, by considering the worst-case distribution within the constructed confidence set. To tackle the model complexity, we propose a decomposition framework.

4 - Data-driven Approach For Wake Effect Analysis: Generalization To All Wind Directions

Mingdi You, University of Michigan, mingdyou@umich.edu, Eunshin Byon, Judy Jin

Utility-scale wind farms consist of a large number of turbines. To improve the power generation efficiency of turbines, accurate quantification of power generations of multi-turbines is critical in wind farm design and operations. One challenging issue is that the power outputs of multiple turbines are different because of complex interactions among turbines, known as wake effects. In general, downstream turbines tend to produce less power than upstream turbines. When wind direction changes, such wake correlations among turbines also change. This study proposes a new statistical approach that quantifies the wake effects on power generations under different wind directions.

■ TD05

101E-MCC

Forest Management

Sponsored: Energy, Natural Res & the Environment II Forestry

Sponsored Session

Chair: Aaron Bradley Hoskins, United States Naval Research Laboratory, 7220 Briarcliff Drive, Springfield, VA, 22153, United States, abh318@msstate.edu

Co-Chair: Sándor F. Tóth, University of Washington, School of Environmental & Forest Sciences, Seattle, WA, 9, United States, oths@uw.edu

1 - Stochastic Forestry Planning Problem Using Progressive Hedging

Cristobal Pais, PhD Student, Instituto de Sistemas Complejos de Ingeniería, Domeyko 2367, Santiago, 8370397, Chile, cpais@ing.uchile.cl, Andres P Weintraub

The forest planning problem with road construction consists in managing the production of a land divided into harvest cells. The goal is the maximization of the expected NPV for a tactical plan subject to uncertainties. A method is applied for generating scenario trees (price, demand and growth) with their probabilities. Non-anticipativity constraints are needed in the model to link scenarios. This problem is difficult to solve due to the number of scenarios. We have implemented Progressive Hedging which separates the problem by scenarios, with multiple adjustments to improve its solvability exploiting its parallel implementation. With this approach, instances up to 1000 scenarios were solved.

2 - Using Critical Component Detection In Graphs For Wildfire Fuel Management

Dmytro Matsypura, The University of Sydney, Business School, Abercrombie Building H70, Sydney, 2006, Australia, dmytro.matsypura@sydney.edu.au

We study the problem of wildfire fuel management. The problem is formulated as a non-linear optimization problem. We apply the formulations and objectives used for critical element detection in graphs. We present the results of simulations and empirical study.

3 - A Stochastic Programming Approach To Satellite Constellation Design

Aaron B Hoskins, PhD Candidate, Mississippi State University, P.O. Box 9542, Starkville, MS, 39762, United States, abh318@msstate.edu, Hugh Medal

A constellation of satellites is launched to collect data on wildfires. The time and location of the wildfires is not known at the time the satellites are launched into orbit. This research implements a stochastic programming algorithm to select the initial constellation design that minimizes the expected cost of maneuvering the satellites to collect data once the location of the wildfire has been realized.

4 - Optimal Carbon Sampling In Remote Forest Regions

Sándor F. Tóth, University of Washington, School of Environmental & Forest Sciences, Seattle, WA, 9, United States, oths@uw.edu, Hans Eric Andersen

We present a spatial optimization approach to find the best integrated ground and air sampling strategy for carbon in remote boreal forests. We minimize the expected variance on estimates of the mean carbon tonnage in six forest pools by optimal flight path selection for remote sensing and by optimal vehicle routing for ground calibration. We apply the model, which incorporates budgetary and logistical constraints, to the Tanana District of the U.S. Forest Service in the Interior of Alaska.

■ TD06

102A-MCC

Optimization for Large-Scale Learning

Sponsored: Data Mining

Sponsored Session

Chair: Dzung Phan, IBM Research, Yorktown Heights, NY, United States, phandu@us.ibm.com

1 - Gradient Sliding For Structured Convex Optimization

Yuyuan Ouyang, Clemson University, yuyuano@clemson.edu, Guanghui Lan

We present a gradient sliding method for a class of structured convex optimization. In particular, we assume that the optimization problem has the structure of the sum of two components. The proposed method is capable of skipping the evaluation of one of the components in the problem, will preserving the overall iteration complexity. The proposed method can be applied to smooth optimization, bilinear saddle point optimization, and variational inequalities.

2 - Storm: Stochastic Optimization Using Random Models

Matthew Joseph Menickelly, Lehigh University, mjm412@lehigh.edu

In this talk, we will discuss work in developing an algorithmic framework (STORM) for the unconstrained minimization of a stochastic function, f. The framework is based on the class of derivative-free trust-region methods. It essentially requires that both the quality of random models of f and the error in a pair of point estimates - one at the current iterate and a second at the trial step - scale with the square of the trust region radius. We compare this approach to usual methods of stochastic optimization, e.g. stochastic gradient descent, and discuss possible applications of STORM in hyperparameter tuning and AUC optimization.

3 - Extended Gauss-Newton-Type Algorithms For Low-rank Matrix Optimization

Quoc Tran-Dinh, University of North Carolina at Chapel Hill, quoctd@email.unc.edu

We develop a Gauss-Newton framework for solving nonconvex optimization problems involving low-rank matrix variables. The algorithm inherits advanced features from classical Gauss-Newton method to this extension such as local linear and quadratic convergence. Under mild assumptions, we prove the local linear and quadratic convergence of our method.By incorporating with a linesearch, the algorithm has a global convergence guarantee to a critical point of problems. As a special case, we customize our framework to handle the symmetric case with provable convergence guarantees. We test our algorithms on various practical problems including matrix completion, and quantum tomography.

4 - Projection Algorithms For Nonconvex Minimization With Application To Sparse Principal Component Analysis

Dzung Phan, IBM Research, phandu@us.ibm.com, William Hager, Jiajie Zhu

We minimize a concave function over nonconvex sets, and propose a gradient projection algorithm (GPA) and an approximate Newton algorithm (ANA). Convergence results are established. In numerical experiments arising in sparse principal component analysis, it is seen that the performance of GPA is very similar to the fastest current methods. In some cases, ANA is substantially faster than the other algorithms, and gives a better solution.

■ TD07

102B-MCC

Emerging Topics on Internet of Things (IoT) and Data Analytics

Sponsored: Data Mining

Sponsored Session

Chair: Chen Kan, Pennsylvania State University, University Park, PA, United States, cjk5654@psu.edu

1 - A Pomdp Approach For Optimal Alerting To Remotely Monitored Asthma Patients Considering Alert Compliance Issue

Junbo Son, Assistant Professor, University of Delaware, Newark, DE, United States, sonjunbo@gmail.com, Shiyu Zhou

Driven by the IoT, a smart asthma management (SAM) system has been implemented where rescue inhalers with a wireless connection record the inhaler usage and transmit the data to a centralized server. Based on the diagnosis result, the system may alert the patient for timely interventions. A crucial challenge is to decide when to alert the patients considering the fact that the patient may not comply the alert. This alert compliance issue complicates the decision process. In this research, a novel partially observable Markov decision process considering alert compliance is proposed and useful insights were found which would benefit both the asthma patients and company who run the SAM system.

2 - Integration Of Data-level Fusion Model And Kernel Methods For Degradation Modeling And Prognostic Analysis

Changyue Song, University of Wisconsin-Madison, Madison, WI, United States, csong39@wisc.edu, Kaibo Liu

Internet of things has enabled a data-rich environment with multiple sensors to monitor the degradation process of a unit in real time. As each sensor signal often contains partial and dependent information, data-level fusion methods have been developed that aim to construct a health index via the combination of multiple sensor signals. The existing data-level fusion methods are limited by only considering a linear fusion function, which may be insufficient to accurately characterize the complex relations of sensor signals in practice. This study fills the literature gap by integrating the kernel methods with data-level fusion approaches to incorporate nonlinear fusion functions.

3 - Parallel Computing For The Optimization Of A Large-scale Dynamic Network - The Internet Of Hearts

Chen Kan, Pennsylvania State University, University Park, PA, 16802, United States, cjk5654@psu.edu, Hui Yang

Rapid advancements of mobile computing provide an unprecedented opportunity to empower a next generation mobile health system - the internet of heart (IoH). The IoH embeds patients into a dynamic network and reveals the change of patient's status through network variations. However, it poses a great challenge for real-time recognition of disease patterns when large number of patients are involved in IoH. This study develops a novel scheme to optimize the network in a parallel, distributed manner, thereby improving the the efficiency of computation. Experimental results show that the developed scheme is effective and efficient for realizing smart connected healthcare in large-scale IoH contexts.

4 - Control Policies For Iot Manufacturing Systems: A Two Stage Stochastic Approach

Xu Jin, Texas A&M University, College Station, TX, United States, jinxu@tamu.edu, Natarajan Gautam, Satish Bukkapatnam, Hoang Tran

We consider a smart manufacturing setting where materials and machines are part of an IoT. A two-stage stochastic model is formulated to determine tool replacement and processing speed decisions based on the availability of the job arrival as well as machine health and processing status information. Stage 1 uses a Lyapunov method to cluster jobs for throughput optimization, and Stage 2 employs a stochastic scheduling algorithm to minimize cycle times. We also analyze the effectiveness of this approach using extensive numerical testing.

■ TD08

103A-MCC

Outsourcing Innovation

Invited: Business Model Innovation

Invited Session

Chair: Ersin Korpeoglu, University College London, London, United Kingdom, e.korpeoglu@ucl.ac.uk

1 - Performance Feedback In Competitive Product Development

Daniel P Gross, Harvard Business School, dgross@hbs.edu

Performance feedback is ubiquitous in competitive settings where new products are developed. This paper introduces a tension between incentives and improvement in performance evaluation. Using a sample of four thousand commercial logo design tournaments, I show that feedback reduces participation but improves the quality of submissions, with an ambiguous effect on high-quality output. To evaluate this tradeoff, I develop a procedure to estimate agents' effort costs and simulate counterfactuals under alternative feedback policies. The results suggest that feedback on net increases the number of high-quality ideas produced and may thus be desirable for a principal seeking innovation.

2 - Workforce Mobility And Innovation Outcomes In Manufacturing

Philipp Cornelius, University College London, London, United Kingdom, philipp.cornelius.12@ucl.ac.uk, Bilal Gokpinar, Fabian Sting

Employee ideas are a valuable starting point to improve operational efficiency. We empirically investigate how moves between problems and sites affect the innovation value created by employee ideas for the organization. We document that the dynamic effects of problem switches differ fundamentally from the effects of site switches: The innovation outcomes of problem switching employees follow a concave inverse u-shaped pattern, whereas the innovation outcomes of site switching employees follow a convex u-shaped pattern over time. We discuss implications for theory.

3 - Contest Among Contest Organizers

Ersin Korpeoglu, School of Management, University College London, London, United Kingdom, e.korpeoglu@ucl.ac.uk, Isa E Hafalir

This paper analyzes the organization of multiple innovation contests in which organizers post problems to a group of agents, and elicit innovative solutions. We compare the contest organizers' payoffs when they organize multiple contests simultaneously or when they compete with other contest organizers for the effort of agents towards solving their problems. We show that depending on problem structure, more intense competition among organizers and organizing multiple contests may harm or, counter-intuitively, benefit each organizer. Our findings explain why organizers find it beneficial to hold multiple contests or organize similar contests with their competitors simultaneously.

■ TD09

103B-MCC

Big Data II

Contributed Session

Chair: Haibo Wang, Killam Distinguished Associate Professor, Texas A&M International University, 5201 University Boulevard, Laredo, TX, 78045, United States, hwang@tamiu.edu

1 - Integrating Data Science In Statistical Practice And Analytics

Steven B Cohen, RTI International, 701 13th Street NW, Washington, DC, 20005, United States, scohen@rti.org

The field of data science has served to rapidly expand the knowledge base and decision-making ability through the combination of seemly disparate and diverse sources of information and content, which include survey and administrative data, social, financial and economic micro-data, and content from mobile devices, the internet and social media. Other attributes of data science include data visualization; predictive, mathematical and simulation modeling; use of Bayesian methods, machine learning; GIS and geospatial analytics and Big Data technologies. In this presentation, attention is given to demonstrate the capacity of data science to enhance study designs and predictive analytics.

2 - Next-generation Sequencing (NGS) Data Analysis: Developing A Scalable Framework For The Future

Michael Chuang, State University of New York, 1 Hawk Drive, New Paltz, NY, 12561, United States, chuangm@newpaltz.edu

NGS analysis presents a domain for biomedical and information technology professionals to explore. Due to the large amount of data involved and various constraints of technologies, we delineate issues to consider to develop a framework using parallel computing and NoSQL database service to greatly reduce the required time under less infrastructure investments while achieving satisfactory accuracy.

3 - Five Steps To Big Data Analytics

Xuan Wang, PhD Student, Louisiana State University, 2200 Business Education Complex, Nicholson Extension, Baton Rouge, LA, 70803, United States, xwang35@lsu.edu, Helmut Schneider

Analytics has been categorized as descriptive, predictive and prescriptive. However, much many challenges lie in the data preparation. Also, analytics is typically concerned about prediction rather than explaining, leaving manager's to question whether to trust results. Hence, data preparation and causal inference are two important steps in analytics at the beginning and end of an analytics project life cycle.

4 - Prescriptive Analytic For Public Transportation Corridor Planning

Haibo Wang, Killam Distinguished Associate Professor, Texas A&M International University, 5201 University Boulevard, Laredo, TX, 78045, United States, hwang@tamiu.edu, Wei Wang, Jun Huang

We investigate how public transportation planning affects the economic growth and social development in the urban areas, especially the economic enhancement zones in US cities. We build visualization tools to help decision makers understand the impact of future planning and issues of existing system.

■ TD10

103C-MCC

Optimization in Renewable Energy

Sponsored: Energy, Natural Res & the Environment, Energy II Other

Sponsored Session

Chair: Sushil Raj Poudel, MSU, MSU, Starkville, MS, 39760, United States, srp224@msstate.edu

1 - Sustainable Network Design For Multi-purpose Pallet Processing Depots Under Biomass Supply Uncertainty

MD Abdul Quddus, PhD Student, Mississippi State University, Department of Industrial & Systems Engineering, P.O. Box 9542, Starkville, MS, 39762, United States, mq90@msstate.edu, Niamat Ullah Ibne Hossain, Mohammad Marufuzzaman, Raed Jaradat

This study develops a two-stage stochastic mixed-integer programming model to manage sustainable pellet processing depots under feedstock supply uncertainty. The proposed optimization model not only minimizes cost but also mitigates emissions from the supply chain network. We develop a hybrid decomposition algorithm that combine Sample average approximation with an enhanced Progressive Hedging (PH) algorithm. Mississippi and Alabama are selected for testing ground of this model. The results of the analysis reveal promising insights that could lead to recommendations to help decision makers to achieve a more cost-effective environmentally-friendly supply chain network.

2 - Supply Chain Design As A Mechanism To Introduce Biofuel Feedstock Adoption In Africa

Liang Lu, UC Berkeley, Berkeley, CA, United States, lld2x1515@berkeley.edu, Wei Qi, Zuo-Jun Max Shen, David Zilberman

Many biofuel projects in Africa are not sufficiently developed to benefit smallholders. We propose models of capacity planning and dynamic feedstock sourcing design for a biorefinary. We show that refineries have to reach a critical capacity to justify outsourcing. The role of smallholders' learning rate/project length/credit availability/government subsidy are discussed.

3 - Designing A Reliable And Congested Multi-modal Facility Location Problem For Bio-fuel Supply Chain Network

Sushil Raj Poudel, Mississippi State University, Dept of Industrial & Systems Engineerring, PO Box 9542, Starkville, MS, 39762, United States, srp224@msstate.edu, MD Abdul Quddus, Mohammad Marufuzzaman, Sudipta Chowdhury, Brian Smith, Linkan Bian

This study presents a mathematical model that designs a reliable multi-modal transportation network for a bio-fuel supply chain system. The proposed model investigates the effect of different levels of congestion and disruption on locating multi-modal facilities and bio-refineries. The nested decomposition algorithm we propose combine Constraint Generation (CG) and Rolling Horizon (RH) to solve this NP-hard problem. Results obtained from the experiments revealed that the effect of congestion reduces the total number of multi-modal facilities and the consideration of disruption probability move away the facilities from coastal areas while increasing the total unit cost of bio-fuel.

■ TD11

104A-MCC

Quality-Guaranteed Network Design: Interdiction, Routing, and Resource Allocation

Sponsored: Optimization, Network Optimization

Sponsored Session

Chair: Tachun Lin, Assistant Professor, Bradley University, 1501 W Bradley Ave, Bradley Hall 171, Peoria, IL, 61625, United States, djlin@bradley.edu

1 - Risk-averse Bi-level Stochastic Network Interdiction Model For Cyber-security

Tanveer Hossain Bhuiyan, Mississippi State University, P.O Box 9542, 260 McCain Hall,, Mississippi State University, Starkville, MS, 39762, United States, tb2038@msstate.edu, Apurba K Nandi, Hugh Medal

We propose a bi-level stochastic network interdiction model to enable a risk-averse and resource constrained cyber network defender to optimally deploy security countermeasures. The model minimizes both the overall expected maximum loss and the expected loss from worst cyber-attacks while capturing the interaction between the defender and the attacker. The budget of an attacker in our model is uncertain. In the presence of uncertain attack scenarios, this risk aversion approach provides a more robust interdiction plan as compared to the risk-neutral approach. We develop parallelizable exact and heuristic algorithms to solve the model.

2 - Revisiting Integrated Fleeting And Routing Design For International Flight Management

Zhili Zhou, United Airlines, zhili.zhou@united.com

We study the integrated fleeting and routing problem for international flight management, which requires maximally preserve the consistency of fleet and flight leg assignment. We analyze the historical patterns of fleet routes and develop approximation algorithms for fleet routing through splitting and adding with historical patterns as base. We further integrate the routing model with fleeting model. Computational results demonstrate that the solution approaches achieves assignment consistency and CAPEX maximization.

3 - Network Function Placement: A Game-theoretic Approach

Tachun Lin, Bradley University, djlin@bradley.edu

Network function virtualization decouples network functions from proprietary networking hardware and enables adaptive services to end-user requests. We study a network virtualization scheme and propose an integrated design for network function instance allocation and end-to-end demand realization sharing the same physical substrate network. We first propose an MILP formulation to find the optimal solution, and then present a two-player pure-strategy game which captures the competition on physical resources between network function instance allocation and routing. We then design an algorithm based on iterative weakly dominated elimination in Game Theory to solve this problem.

■ TD12

104B-MCC

New Results on Polyhedral Relaxations

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Akshay Gupte, Clemson University, Clemson, SC, United States, agupte@clemson.edu

1 - Approximation Guarantees Of Closures

Joseph Paat, Johns Hopkins University, jpaat1@jhu.edu

Intersection cuts for Gomory's corner polyhedron can be generated using lattice-free sets. While the intersection of all of these cuts reproduces the corner polyhedron, a question of interest is how well does a subfamily of intersection cuts approximate the corner polyhedron. We examine this question and develop conditions for approximation based on the number of facets of the underlying lattice-free sets. This work was done in collaboration with Gennadiy Averkov from the University of Magdeburg in Germany, and Amitabh Basu from Johns Hopkins University in the USA.

2 - Some Lexicographic Perspectives On Valid Inequalities

Michael Eldredge, Clemson University, michaelgeldredge@gmail.com, Akshay Gupte

If B is a box in n-dimensional space, then the convex hull of integer points that are lexicographically between two given points is describable with 4n linear constraints. In this presentation we analyze a process that exploits this representation to define disjunctions and split cuts in integer programming problems, including presenting complexity results for determining the feasibility of lexicographically defined sets.

3 - An Efficient Algorithm For Trivial Lifting In Two Dimensions

Alinson Xavier, University of Waterloo, Waterloo, ON, Canada, axavier@uwaterloo.ca, Ricardo Fukasawa, Laurent Poirrier

When generating cuts for MIPs from multiple rows of the simplex tableau, the usual approach has been to relax the integrality of the non-basic variables, compute an intersection cut, then strengthen the cut coefficients corresponding to integral non-basic variables using the so-called trivial lifting procedure. Although of polynomial-time complexity in theory, this lifting procedure can be computationally costly in practice. For two-row relaxations, we present an algorithm that computes trivial lifting coefficients in constant time, for arbitrary maximal lattice-free sets. Computational experiments confirm that the algorithm works well in practice. We discuss possible generalizations.

4 - On MIP Relaxations For Nonlinear Programs

Taotao He, Purdue University, Rawls Hall, 100 S Grant Street, West Lafayette, IN, 47907-2076, United States, he135@purdue.edu, Mohit Tawarmalani

In this talk, we propose new recursive relaxation techniques for factorable programs. We consider the graph of product on non-negative convex functions and show that tighter relaxations than the McCormick scheme can be developed in a variety of ways. We use these schemes in conjunction with disjunctive programming to develop a hierarchy of MIP relaxations whose optimal value converges asymptotically to that of the nonlinear program. We provide preliminary computations to demonstrate the efficacy of our scheme.

■ TD13

104C-MCC

Software and Methodologies for (Nonlinear) Integer Programming

Sponsored: Optimization, Computational Optimization and Software

Sponsored Session

Chair: Alexandra M Newman, Colorado School of Mines, Golden, CO, United States, anewman@mines.edu

1 - Software For Nonlinearly Constrained Optimization

Sven Leyffer, Argonne National Laboratory, leyffer@anl.gov

We survey different methodologies for solving general nonlinearly constrained optimization problems, including interior-point, augmented Lagrangian, and active-set methods. We discuss linear algebra requirements of these different techniques; present different globalization strategies; and comment on their relative performance for solving large-scale optimization problems. Time permitting we will present preliminary results with a new solver library that we are developing.

2 - Choosing A Solution Strategy For Discrete Quadratic Optimization

Robert Fourer, AMPL Optimization Inc., 4er@ampl.com

The combination of integer variables with quadratic objectives and constraints is a powerful formulation tool. But when it comes to solving the resulting optimization problems, there are numerous good approaches but no one best way — even in simpler cases where the objective is convex or the constraints are linear. Both linearization of quadratic terms and quadratic generalization of linear methods turn out to be preferable in some circumstances. This presentation exhibits a variety of examples to illustrate the questions that should be asked and the decisions that must be made in choosing an effective formulation and solver.

3 - Performance Tuning For Cplex's Spatial Branch-and-bound Solver For Global Nonconvex Mixed Integer Quadratic Programs

Ed Klotz, IBM, klotz@us.ibm.com

MILP solvers have been improving for more than 40 years, and performance tuning tactics regarding both adjusting solver strategies and model formulations have evolved as well. State-of-the-art global nonconvex MIQP solvers have improved dramatically in recent years, but they lack the benefit of 40 years of evolution. Also, they use a broader notion of branching that can create different performance challenges. This talk will assess the effectiveness of existing MILP tuning tactics for solving nonconvex MIQPs, as well as consider more specific strategies for this challenging type of problem.

4 - On The Benefits Of Enumeration Within An Optimization Framework

Alexandra M Newman, Colorado School of Mines, Golden, CO, anewman@mines.edu

While the branch-and-bound algorithm, and associated enhancements such as cuts and heuristics, vastly dominates the performance of pure enumeration for obtaining optimal solutions for (mixed) integer programming problems, this basic strategy can sometimes expedite solutions. Specifically, for cases in which enumeration of partial solutions leaves an exploitable structure in place, a small amount of enumeration over fast-solving subproblems drastically reduces solution time. We demonstrate using examples from mining (with reformulations of a monolith) and interdiction (with Benders decomposition).

■ TD14

104D-MCC

Predictive Analytics: Big Data with Purpose

Sponsored: Analytics

Sponsored Session

Chair: Rob Lantz, Novetta Solutions, 7921 Jones Branch Drive, McLean, VA, 22102, United States, rwlantz@gmail.com

1 - Volatility-based Metrics To Analyze Network Traffic Over Time: Situational Awareness And Anomaly Detection

Soumyo Moitra, Carnegie Mellon University, Software Engineering Institute, Pittsburgh, PA, 15213, United States, smoitra@sei.cmu.edu

We develop some metrics to analyze temporal data that investigate different aspects of volatility. The metrics would be useful for monitoring network traffic data as well as other time series data. We discuss the motivation for the metrics and apply them to simulated data to demonstrate the properties of the metrics and to show how they can be used to derive insights into traffic patterns. Results under different scenarios are presented and compared.

2 - Security And Multidimensional Prediction Problems

Anthony Boyles, Novetta, 7921 Jones Branch Drive, McLean, VA, 22102, United States, ABoyles@Novetta.com

Modern security forecasting often requires comparatively high-dimensional predictions: for example, a drug bust can only be made at a specific location during the window of time that the drugs will be in that location. A forecaster must therefore be able to predict in at least three dimensions: latitude, longitude, and time. We examine techniques to reduce the complexity and increase predictive power of models grappling with this problem.

3 - Smart Strategies For Matching Big Data

Matthew Teschke, Novetta, 1111 Arlington Blvd., Apt. 707, Arlington, VA, 22209, United States, mteschke@novetta.com

Matching, such as entity resolution, is often a required part of an analysis; however, in a Big Data environment this can be a challenging task for analysts. Naive matching implementations are not computationally feasible when record counts are measured in millions or even billions, so a different approach is needed. Blocking is a strategy for making these problems tractable, taking them from an n-squared time to near-linear time. This presentation will provide an overview of blocking, its applications, and details of implementation.

4 - Predicting Return Abuse With Data Analytics

Michael Ketzenberg, Associate Professor, Texas A&M University, Mail Stop 4217, College Station, TX, 77845, United States, mketzenberg@tamu.edu

We apply data analytics to the transactional history of a large national retailer to identify the characteristics of customers who abuse return policies and then utilize this information to develop and test predictive models to help prevent such abuse.

■ TD15

104E-MCC

Joint Session AI/Analytics: Machine Learning for Public Policy

Sponsored: Artificial Intelligence/Analytics

Sponsored Session

Chair: John J Nay, Vanderbilt University, PMB 351826 2301 Vanderbilt Place, Nashville, TN, 7235-1826, United States, john.j.nay@vanderbilt.edu

1 - Text Modeling For Understanding And Predicting The Federal Government

John J Nay, Vanderbilt University, john.j.nay@vanderbilt.edu

We describe the application of neural network based language modeling to better understand and predict the federal government. We embed institutions and the words from their policy documents into shared "semantic" space to explore differences across institutions with respect to policy topics. We apply our method to learn useful representations of the Supreme Court, House, Senate, and President. We also develop a machine learning approach to forecasting the probability that any bill will be enacted. The model outperforms competitor models across the three validation measures and is systematically analyzed to investigate textual and contextual factors predicting enactment.

2 - Simple Rules For Pretrial Release Decisions

Jongbin Jung, Stanford University, jongbin@stanford.edu

While predictive machine learning techniques might seem appealing for policy decisions, their opaque nature often render them inappropriate for the task. We investigate the possibility of constructing transparent and interpretable rules, and evaluate their performance compared to complex models in the context of pretrial release decisions. Although complex models generally outperform simple rules, we find the difference to be arguably small, especially considering the benefit of transparent rules being more likely to be implemented.

3 - Data-driven Agent-based Modeling

Yevgeniy Vorobeychik, Vanderbilt University, eug.vorobey@gmail.com, Haifeng Zhang

Agent-based modeling has been extensively used to study innovation diffusion. We develop a novel methodology for data-driven agent-based modeling that enables both calibration and rigorous validation at multiple scales. Our first step is to learn a model of individual agent behavior from individual event data. We then construct an agent-based simulation with the learned model embedded in artificial agents, and proceed to validate it using a holdout sequence of collective adoption decisions. We instantiate our model in the context of solar PV adoption, and utilize it to evaluate and optimize policy decisions aimed at promotion of rooftop solar.

■ TD16

105A-MCC

Joint Session DM/Optimization Under Uncertainty: Optimization in Data Mining and Machine Learning

Sponsored: Optimization, Optimization Under Uncertainty/DM

Sponsored Session

Chair: Ozgu Turgut, Wayne State University, 1230 Wisteria Drive, A321, Ann Arbor, MI, 48104, United States, ozguturgut@wayne.edu

Co-Chair: Michael Hahsler, Southern Methodist University, Dallas, TX, United States, mhahsler@lyle.smu.edu

1 - Sequential Aggregation-disaggregation Optimization Methods For Data Stream Mining

Michael Hahsler, SMU, Dallas, TX, 75275, United States, mhahsler@lyle.smu.edu, Young Woong Park

Clustering-based iterative algorithms to solve certain large optimization problems have been proposed in the past. The algorithms start by aggregating the original data, solving the problem on aggregated data, and then in subsequent steps gradually disaggregate the aggregated data. In this contribution, we investigate the application of aggregation-disaggregation on data streams, where the disaggregation steps cannot be explicitly performed on past data, but has to be performed sequentially on new data.

2 - Building Ensembles Of Support Vector Machine Classifiers Through Multi Objective Optimization

Ozgu Turgut, Wayne State University, ozguturgut@wayne.edu, Ratna Babu Chinnam

The trade-off parameter 'C' of support vector machine (SVM) classifiers is the key input of training which tries to balance the generalization and empirical error. However existing methods in determining this parameter usually based on brute force search which is inefficient. The intend of this study is to incorporate a genuine exact multi objective optimization algorithm that generates representative Pareto optimal sets, with SVM in order to avoid C tuning phase. Utilization of the algorithm for additional two major purposes is also studied; namely, ensemble formation and confidence calculation of SVM classifiers.

3 - Multi-objective Optimization Under Multicollinearity

Haidar Almohri, Wayne State University, almohri@wayne.edu, Ratna Babu Chinnam, Arash Ali

While data driven process optimization methods are routine, several challenges arise when dealing with variables with strong multicollinearity. In practice, there might be multiple conflicting objectives as well, influenced by a common set of variables. We propose optimization algorithms to jointly optimize multiple objectives under multicollinearity. Methods are motivated by problems from retailing and manufacturing domains.

■ TD17

105B-MCC

Statistical Learning with Convex Optimization

Sponsored: Optimization, Nonlinear Programming

Sponsored Session

Chair: Robert Freund, Massachusetts Institute of Technology, 100 Main Street, Cambridge, MA, 02142-1347, United States, rfreund@mit.edu

Co-Chair: Rahul Mazumder, Massachusetts Institute of Technology, 100 Main Street, Cambridge, MA, 02142-1347, United States, rahulmaz@mit.edu

1 - An Optimal Aggregation Procedure For Nonparametric Regression With Convex And Non-convex Models

Alexander Rakhlin, University of Pennsylvania, rakhlin@gmail.com

Exact oracle inequalities for regression have been extensively studied in statistics and learning theory over the past decade. In the case of a misspecified model, the focus has been on either parametric or convex classes. We present a new estimator that steps outside of the model in the non-convex case and reduces to least squares in the convex case. To analyze the estimator for general non-parametric classes, we prove a generalized Pythagorean theorem and study the supremum of a negative-mean stochastic process (which we term the offset Rademacher complexity) via the chaining technique. (joint work with T. Liang and K. Sridharan)

2 - Convex Regularization For High-dimensional Tensor Regression

Ming Yuan, University of Wisconsin, myuan@stat.wisc.edu

Data in the format of tensors, or multilinear arrays, arise naturally in many modern applications. In this talk, I shall discuss several examples where convex optimization approaches can be utilized for solving high-dimensional tensor problems under low-dimensional structural assumptions.

3 - Distributed Proximal Algorithms For Convex Optimization

Garud Iyengar, Columbia University, garud@ieor.columbia.edu

We propose a distributed first-order augmented Lagrangian algorithm to minimize the sum of composite convex functions, where each term in the sum is only known at one of the nodes, and only nodes connected by an edge can directly communicate with each other. This optimization model abstracts a number of applications in distributed sensing and machine learning. We show that any limit point of the iterates is optimal; and for any epsilon>0, an epsilon-optimal solution can be computed within O(log(1/epsilon)) iterations, whichrequire O((d_max^{1.5}/d_min) /epsilon}) communications steps, where d_max (resp. d_min) denotes the degree of largest (resp. smallest) degree node.

4 - Linear Estimation Through Unknown Non-linear Transformations

Constantine Caramanis, University of Texas, constantine@utexas.edu

Abstract to come.

■ TD18

106A-MCC

Resource Allocation Problems in Nonprofit Settings

Sponsored: Public Sector OR

Sponsored Session

Chair: Gemma Berenguer, Purdue University, 403 W State St, West Lafayette, IN, 47907, United States, gemmabf@purdue.edu

1 - Public Facility Location And Fair Distribution Problem: Fractional Programming Approach

Chong Hyun Park, Purdue University, West Lafayette, IN, 47906, United States, park456@purdue.edu, Gemma Berenguer

We consider a public facility location problem. A decision maker wants to maximize the aggregated utilities of the service recipients while achieving the fair distribution of distributed items. A bi-objective mixed integer linear fractional programming problem is formulated and solved by various algorithms.

3 - Payment For Results: Funding Non-profit Operations

Sripad K Devalkar, Indian School of Business, Hyderabad, India, sripad_devalkar@isb.edu, Milind Sohoni, Neha Sharma

We consider the interaction between a donor making voluntary contributions to fund a development project and the non-profit organization (NPO) using the funds to implement the project. With information asymmetry about the NPO's efficiency and exogenous uncertainty affecting the actual benefit delivered by the project, we show that ex-post funding (payment for results) may not always maximize the donor's utility even though it helps overcome information asymmetry. We also characterize conditions under which ex-ante funding (traditional funding) and ex-post funding (payment for results) are equilibrium outcomes of the donor-NPO interaction.

4 - Using Optimization To Maximize Diversity In Engineering Discussion Groups at The University Of Michigan

Kayse Lee Maass, University of Michigan, Ann Arbor, MI, United States, leekayse@umich.edu, Mark Daskin

The College of Engineering at the University of Michigan assigns over 1250 freshmen to discussion groups for a "freshman reads" program. They want each group to be as diverse as possible with respect to (a) country of origin, (b) gender, (c) ethnicity, (d) in-state/out-of-state status, and (e) whether a student is the first in his/her generation to attend college. We implemented a large-scale optimization model to assign students to groups and have successfully used the results for two years. The model and implementation are discussed.

■ TD19

106B-MCC

Stable Sets, Zero-forcing Sets, and Target Sets in Graphs

Sponsored: Computing

Sponsored Session

Chair: Balabhaskar Balasundaram, Oklahoma State University, 322 Engineering North, Stillwater, OK, 74078, United States, baski@okstate.edu

1 - Discrete vs. Continuous Formulations For Computing The Stability Number: Results And Insights

Jitamitra Desai, Nanyang Technological University, jdesai@ntu.edu.sg, Jitamitra Desai, Nanyang Technological University, Singapore, Singapore, jdesai@ntu.edu.sg, Balabhaskar Balasundaram

In this research, we compare and contrast discrete (0-1) and continuous formulations for determining stable (independent) sets of a graph. In this context, we define a new class of "vertex sets", and derive an explicit characterization to compute the number of alternate optima present in both the 0-1 and fractional programming formulations. A byproduct of these vertex sets is another approach to determine maximal independent sets. We also pose a conjecture that relates the solution of the LP-relaxation to the 0-1 formulation to the number of alternate optima to the stable set problem. Finally, some preliminary computations on some standard testbed problems from the literature are presented.

2 - Connected Zero Forcing Of A Graph

Boris Brimkov, Rice University, boris.brimkov@rice.edu

Zero forcing is a dynamic graph coloring process whereby a colored vertex with a single uncolored neighbor forces that neighbor to be colored. This talk introduces the connected forcing process - a restriction of zero forcing in which the initially colored set of vertices induces a connected subgraph. The connected forcing number - the cardinality of the smallest initially colored vertex set which forces the entire graph to be colored - can be used to bound various linear algebraic and graph parameters, as well as to model the spread of diseases and information in social networks. Other properties of the connected forcing number are discussed, and closed formulas are given for several families of graphs.

3 - An Integer Programming Approach To Finding Minimum Zero-forcing Sets

Caleb Fast, Rice University, caleb.c.fast@rice.edu, Illya V Hicks

In this talk, we introduce an integer programming approach for finding minimum zero-forcing sets. Zero-forcing is a graph coloring process that, in addition to applications in power networks and quantum computing, is used to bound the minimum rank of matrices characterized by the given graph. Straightforward integer programming formulations of this problem do not perform well; however, we incorporate new bounds on the zero-forcing iteration index and zero-forcing number to improve the performance of the integer program.

4 - Mathematical Programming Approaches To Influence Maximization Problems On Social Networks

Rui Zhang, University of Colorado - Boulder, Boulder, CO, United States, rui.zhang@colorado.edu, Subramanian Raghavan

We study influence maximization problems on social networks from an integer programming perspective. In this talk, we focus on the weighted target set selection problem. Motivated by the desire for exact approaches, a tight and compact extended formulation is presented on trees. A complete description of its polytope is given as well. Furthermore, based on the extended formulation, a branch-and-cut approach is proposed for general networks. Computational results based on large scale graphs are discussed. Lastly, we present our results for different variants and generalizations of influence maximization problems.

■ TD20

106C-MCC

Optimality Conditions for Inventory Control

Invited: Tutorial

Invited Session

Chair: Eugene A Feinberg, Stoney Brook University, Department of Applied Mathematics, Stoney Brook, NY, 11794, United States, eugene.feinberg@stonybrook.edu

1 - Optimality Conditions For Inventory Control

Eugene A Feinberg, Stoney Brook University, Department of Applied Mathematics & Statistics, Stoney Brook, NY, 11794, United States, eugene.feinberg@stonybrook.edu

This tutorial describes recently developed general optimality conditions for Markov Decision Processes that have significant applications to inventory control. In particular, these conditions imply the validity of optimality equations and inequalities. They also imply the convergence of value iteration algorithms. For total discounted-cost problems only two mild conditions on the continuity of transition probabilities and lower semi-continuity of one-step costs are needed. For average-cost problems, a single additional assumption on the finiteness of relative values is required. The general results are applied to periodic-review inventory control problems with discounted and average-cost criteria without any assumptions on demand distributions. The case of partially observable states is also discussed.

■ TD21

107A-MCC

Data Analytics for Healthcare

Sponsored: Health Applications

Sponsored Session

Chair: Qingpeng Zhang, City University of Hong Kong, 83 Tat Chee Ave, Kowloon Tong, TX, 00000, Hong Kong, qingpeng.zhang@cityu.edu.hk

1 - Bayesian Data Analytics For Individualized Health Care Demand Modeling Of Aging Population

Xuxue Sun, University of South Florida, 4202 E. Fowler Ave. ENB118, Tampa, FL, 33620, United States, xuxuesun@mail.usf.edu, Paul Cirino, Hongdao Meng, Nan Kong, Mingyang Li

With high risk of having health problems, elderly people are mainly users of health care services. Successfully modeling of their demands will facilitate decision makings in health care management. Existing approaches mainly utilized aggregate-level data from single type of health care facility and studied the observed factors' influence. In this study, a Bayesian data analytics approach accounting for competing risk of different facilities is proposed to characterize individualized health care demand and to jointly quantify both unobserved individual heterogeneity and observed factors' influence. A real case study is further provided to demonstrate the effectiveness of proposed method.

2 - Harnessing The Power Of Twitter With Offline Contact Networks For Probabilistic Flu Forecasting

Kusha Nezafati, University of Texas, Dallas, TX, United States, Kusha.Nezafati@utdallas.edu, Qingpeng Zhang, Yulia Gel, Leticia Ramirez-Ramirez

The prompt detection and forecasting of infectious diseases are critical in the defense against these diseases. Despite many promising approaches, the lack of observations for near real-time forecasting is still the key challenge for operational disease prediction and control. In contrast, online social media has a great potential for real-time epidemiological forecasting and could revolutionize modern biosurveillance capabilities. We investigate utility of Twitter to serve as a proxy for unavailable data on flu occurrence and propose a predictive platform for disease dynamics by accounting for heterogeneous social network interactions, space-time, and socio-demographic information. .

3 - The Diffusion Of User Behavior via Social Network In Online Health Communities

Xi Wang, University of Iowa, xi-wang-1@uiowa.edu, Kang Zhao, Gautam Pant

As a major source of social support for people with health problems, Online Health Communities (OHCs) have attracted a great number of members. Prior research has examined that users involved in online community motivated either by community-interest or by self-interest. Using text mining and unsupervised machine learning techniques, we revealed that users of a popular breast cancer OHC acting different roles corresponding to their motives. We also found user role can diffuse via social ties. Our research has implications to for OHC operators to track users' behaviors in order to manage an OHC.

■ TD22

107B-MCC

Decision Making in Healthcare Supply Chain

Sponsored: Health Applications

Sponsored Session

Chair: Mili Mehrotra, University Of Minnesota, 321 19th Ave S, Minneapolis, MN, 55455, United States, milim@umn.edu

1 - Gatekeeper Or Roadblock: Optimizing Evidence Generation Andgatekeeper Or Roadblock: Optimizing Evidence Generation And Access To New Drugs

Liang Xu, Pennsylvania State University, 419A Business Building, Penn State University, State College, PA, 16801, United States, lzx103@psu.edu, Hui Zhao

In 1992, the accelerated approval pathway (AP) is was instituted to speed up the development of new drugs but failed to be effective due to sponsors' lack of incentives to complete post-market study. We propose and analyze three mechanisms, i.e., extra market exclusivity, pay for evidence, and augmented user fee to incentivize post-market study. Our results provide insights for policy makers on granting accelerated approval with the consideration of post-market study.

2 - Hospital Quality, Medical Charge Variation, And Patient Care Efficiency: Implications For Bundled Payment Reform Models

Seokjun Youn, Texas A&M University, College Station, TX, United States, syoun@mays.tamu.edu, Gregory R Heim, Subodha Kumar, Chelliah Sriskandarajah

We examine how unwarranted variation in hospital medical charges relates to patient-centric goals. From a policy maker's viewpoint, the results imply that managerial incentives based on process quality (rather than outcome quality) may be more effective for changing operational behaviors that lead to lower variation and higher efficiency. We investigate these implications for bundled payment programs. Empirical results suggest that the current bundled payment provider selection mechanism does not consider the degree of unwarranted variation in charges, which we claim to be the improvement opportunity for each participating provider.

3 - The Hospital Readmission Reduction Program: Coordinating Service Rate And Readmission Reduction Efforts

Kenan Arifoglu, University College London, k.arifoglu@ucl.ac.uk, Hang Ren, Tolga Tezcan

We study the performance of Hospital Readmissions Reduction Program (HRRP) in inducing hospitals to choose the socially-optimal service rate and readmission reduction efforts. Readmissions pose two incentive misalignments between the social planner and each hospital. The HRRP in use cannot fix both misalignments simultaneously and thus cannot coordinate in general. We propose a coordinating contract, which highlights the function of the reimbursement rate in reducing readmissions.

■ TD23

108-MCC

Operations Management Approaches Applied in Healthcare Settings: Achieving Patient Health and Operational Effectiveness.

Sponsored: Health Applications

Sponsored Session

Chair: Yann Ferrand, Clemson University, 131-A Sirrine Hall, Celmson, SC, 29634, United States, yferran@g.clemson.edu

1 - Incentive Scheme For Diabetes Patients To Take A1c Test Quarterly

Muer Yang, University of St. Thomas, Minneapolis, MN, United States, yangmuer@stthomas.edu, Sameer Kumar, Paul Bekx

Type II diabetes patient is recommended to take A1c measurement quarterly. However, many patients do not. Comparing their empirical behavior and the optimal behavior derived from a mathematical model, we seek to recommend practical incentives that encourage patients to take A1c tests close to the optimal rational behavior.

2 - Operating Room Management When Considering Microbial Loads

Brandon Lee, Clemson University, Clemson, SC, United States, woohyel@clemson.edu, Lawrence Fredendall, Kevin M Taaffe, Anjali Joseph

We examine the OR activities and their effect on the microbial bacteria environment using air filters, culture dishes and video recordings. The goal is to identify how to reduce the microbial load in the OR and to identify the effect that traffic flows and door openings have on the microbial load. This research will discuss findings from a specific case study of orthopedic and pediatric OR's at an academic health center in South Carolina.

3 - Reducing Patient Wait In The Emergency Department With New Patient Flow Models

Yann Ferrand, Clemson University, yferran@clemson.edu, Todd F. Glass, Duane Steward

Before opening a newly constructed emergency department, a discrete event simulation model was employed to validate novel patient flow concepts envisioned. This approach was uniquely applied to enable a specific operations strategy with a naive facility and staff, contributing to significantly lower average length of stay than comparable facilities.

4 - Implementing Lean Operations In Service

Yunsik Choi, PhD Student, Clemson University, 100 Sirrine Hall, Clemson, SC, 29634-1305, United States, yunsikc@g.clemson.edu, Lawrence Fredendall, Aleda Roth

Service industries have been applying lean principles to achieve continuous improvement. However, the industries have not fully used lean principles like top manufacturers have done. The study provides service providers with insight about how lean operations change employees' behaviors to improve small steps every day.

■ TD24

109-MCC

Modeling Systems for Public Health

Sponsored: Health Applications

Sponsored Session

Chair: Hyojung Kang, University of Virginia, 102A Engineer's Way, Charlottesville, VA, 22904, hkang@virginia.edu

1 - Optimizing Screening For Secondary Renal Cell Carcinoma

Jennifer Mason Lobo, Assistant Professor, University of Virginia, Charlottesville, VA, United States, jem4yb@virginia.edu, Tracey Krupski

Renal cell carcinoma is the most common form of kidney cancer. After surgery, patients are at risk for local and metastatic recurrence. We use our Monte Carlo simulation model to identify the optimal timing, duration, and modalities of imaging surveillance considering cost, radiation exposure, and cancer control. We present numerical results comparing the optimal strategies to current guidelines from four clinical organizations: American Urological Association, Canadian Urological Association, European Association of Urology, and National Comprehensive Cancer Network.

2 - Incentive Contract Design For Food Retailers To Reduce Food Deserts In The US

Nathaniel D. Bastian, The Pennsylvania State University, University Park, PA, 16802, United States, nathaniel.bastian@fulbrightmail.org, Eric Swenson, Linlin Ma, Hyeong Suk Na

In the US, obesity affects over 37% of the adult population and over 16% of the child and adolescent population. Although not-for-profit agencies cannot directly control what a person eats, they can influence the supply side of the obesity epidemic by incentivizing food retailers to open stores in regions of the US where food deserts exist. As a risk-sharing grant incentive program, we develop principal-agent based optimization models that determine the optimal subsidy these agencies should offer to food retailers to incentivize operation in certain regions. These subsidies are designed to create financially viable conditions for food retailers to offer high quality, healthy food alternatives.

3 - Modeling Supply, Demand, And Allocation In Liver Transplantation

Wesley Marrero, University of Michigan, Ann Arbor, MI, United States, wmarrero@umich.edu, Jingyuan Wang, Justin Steuer, Eunshin Byon, Mariel Sofia Lavieri, David W Hutton, Neehar D Parikh

Liver transplantation can be a lifesaving intervention for patients with end-stage liver disease. Unfortunately, there has been an increase in the disparity among the number of patients listed for liver transplants and the liver transplants performed. We first aimed to forecast the availability for liver donors in the US considering populations shifts. Furthermore, geographical redistricting models have been proposed as an alternative to decrease the supply-demand inequity. We then aimed to understand the impact of redistricting on the availability of donors per population. Lastly, we aimed to predict the future demand for liver transplantation as a function of obese population in the US.

4 - Simulation And Spatio-temporal Modeling Approaches For Surveillance Of Hospital-acquired Infections

Hyojung Kang, University of Virginia, Charlottesville, VA, 22904, United States, hkang@virginia.edu, Jennifer Mason Lobo

The prevalence and mortality of antibiotic-resistant infection has increased globally and in the U.S. Traditionally, studies have focused on identifying transmission chains of infected patients as the reservoir for organisms to be transferred to new patients in order to track hospital outbreaks with drug resistant pathogens. This study aims to understand the role care providers and other non-patient reservoirs within a hospital play in transmission of the infection. We will develop agent-based simulation models using various sources of data to analyze risk factors and evaluate what-if scenarios.

■ TD25

110A-MCC

Scheduling with Applications

Invited: Project Management and Scheduling

Invited Session

Chair: Hui-Chih Hung, National Chiao Tung University, 1001 University Rd., MB103, Hsin-Chu, 300, Taiwan, hhc@nctu.edu.tw

1 - On Scheduling Restoration Tasks For Pipeline Networks In Post-disaster Management

I-Lin Wang, Professor, National Cheng Kung University, Tainan, Taiwan, ilinwang@mail.ncku.edu.tw

Pipeline networks that ship flows of gas or water are important for daily living support. Suppose arcs of a pipeline network are damaged by disasters and the resources (equipment, manpower, and time) required to restore each damaged arc have been estimated. We investigate when and who to restore which arcs such that the flows over pipelines become accessible for people along all arcs at minimum total waiting time in the post-disaster management. We propose a network reduction scheme, an integer program, and heuristics for solving this special resource constrained project scheduling problem.

2 - Scheduling Sequential Locks Along Waterways

Frits Spieksma, KU Leuven, frits.spieksma@kuleuven.be

Inland waterways form a natural network infrastructure with capacity for more traffic than is currently the case. Transportation by ship is widely promoted as it is reliable, efficient and an environmental friendly way of transport. Nevertheless, locks managing the water level on waterways may constitute bottlenecks for transport over water. We aim to minimize total waiting time of ships in a setting where locks are located in a sequential manner along a waterway.

3 - V-shaped Sampling Based on Kendall-distance To Enhance Optimization With Ranks

Haobin Li, Scientist, A*STAR, Institute of High Performance Computing, 1 Fusionopolis Way, #16-16 Connexis North, Singapore, 138632, Singapore, lihb@ihpc.a-star.edu.sg, Giulia Pedrielli, Loo Hay Lee, Ek Peng Chew, Chun-Hung Chen

Optimization over rank values has been of concern in multi-fidelity simulation optimization. Specifically, Chen et al. (2015) proposes the concept of Ordinal Transformation (OT) to translate multi-dimensional discrete optimization problems into simpler single-dimension problem, where the dimension being used is the rank in the ordinal space. In this paper we build on the idea of OT in order to derive an efficient sampling algorithm to identify the solution with the best rank in the settings of multi-fidelity optimization. We refer to this algorithm as V-shaped, in which the concept of Kendall distance adopted in the machine learning theory, is used to characterize solutions in the OT space.

4 - Bicycle-sharing With Reallocation Trucks And Private Exchange Taipei YouBike System as Example

Hui-Chih Hung, National Chiao Tung University, Hsin-Chu, 300, Taiwan, hhc@nctu.edu.tw, Jun-Min Wei, Ming-Te Chen

Subject to limited numbers of bicycles and docks, we consider trucks for bicycle reallocation and mobile apps for private exchange in bicycle-sharing systems. Trucks are hired to dynamically redistribute bicycles among unbalanced stations and mobile apps are used to transfer bicycles among users without docks. This allows bicycle exchange even when all docks are full. Three objectives are studied: (1) maximizing the utilization of bicycles, (2) maximizing the net profit of system, and (3) optimizing the fleet sizes of bicycles and trucks. Finally, mathematical programming models are built and real data of Taipei YouBike system from 2013 to 2015 are adopted for numerical study.

■ TD26

110B-MCC

Spectrum Auction

Invited: Auctions

Invited Session

Chair: Oleg Baranov, University of Colorado at Boulder, 256 UBC, University of Colorado, Boulder, CO, 80309, United States, oleg.baranov@colorado.edu

1 - Efficient Dynamic Auction For U-shaped Returns

Oleg Baranov, Colorado, Oleg.Baranov@Colorado.edu

When bidders have decreasing returns, the efficient dynamic auction is well-known. Recently, Baranov et al. (2016) described an efficient dynamic auction for bidders with increasing returns. In this paper, we design an efficient auction for bidders with single-peaked returns. For auctions to buy, our setting includes one of the most typical cost structures in economics. For auctions to sell, our setting is a good approximation for single-band spectrum auctions.

2 - Obtaining The Final Channel Assignment In The Federal Communications Commission's First-ever Incentive Auction

Karla L Hoffman, Professor, George Mason University, Mail Stop 4A6, 4400 University Drive, Fairfax, VA, 20124, United States, khoffman@gmu.edu, Brian Smith, Steven Charbonneau, James Costa, Tony Coudert, Rudy Sultana

In this talk, we will discuss the procedure for determining the Final Channel Assignment for U.S. and Canadian broadcasters at the conclusion of the "Incentive Auction." The FCC is utilizing a sequence of optimizations to create a channel assignment that will be the least disruptive to both broadcasters and the over the air television viewers. We will outline this sequence and explain how this sequence satisfies the objectives of the FCC, Industry Canada and broadcasters.

3 - Determining The Stations Not Needed In The Federal Communication Commission'S First-ever Incentive Auction

Karla L Hoffman, George Mason University, System Eng and Operations Research Dept, 4400 University Drive Mailstop 4a6, Fairfax, VA, 22030, United States, khoffman@gmu.edu, James Andrew Costa, Steven Charbonneau, Anthony Coudert, Brian Smith, Rudy K Sultana

The FCC uses a novel descending-price auction to determine the spectrum to be purchased from broadcasters. The auction is designed for stations to compete until there are no channels available in the market. If a station always has a channel available, they are not needed in the auction. An optimization procedure was used to determine whether a station always had a channel available, and therefore had no chance of winning in the auction.

4 - Combinatorial Land Assembly

Tzu-Yao Lin, University of Maryland, LinT@econ.umd.edu

We propose a reverse auction for real estate developers to acquire complementary urban lands from multiple owners. Apart from the all-or-nothing mechanisms in the previous literature, we determine the set of land parcels to be assembled in a descending clock auction, which gradually lowers the offer to each remaining owner until the trading condition is met. This mechanism is obviously strategyproof for sellers. The optimal price adjustment trajectory is a solution for the corresponding stochastic optimal control problem, which minimizes the expected welfare loss from inefficient rejection."

■ TD27

201A-MCC

Stochastic Modeling In Healthcare Operations

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Carri Chan, Columbia Business School, New York, NY, United States, cwchan@columbia.edu

Co-Chair: Vahid Sarhangian, Columbia Business School, New York, NY, United States, vs2573@columbia.edu

1 - Identify Optimal Overflow Policies Using Approximate Dynamic Programming

Pengyi Shi, Purdue University, shi178@purdue.edu, Jim Dai

To alleviate Emergency Department congestion, boarding patients who wait to be admitted to inpatient wards may have to be overflowed to a non-primary ward when they wait too long. We develop approximate dynamic programming tools to identify the optimal overflow policies under different system states.

2 - Yardstick Competition For Emergency Department Queues

Ozlem Yildiz, University of Rochester, Rochester, NY, United States, ozlem.yildiz@simon.rochester.edu, Nicos Savva, Tolga Tezcan

We study whether an alternate pay-for-performance method can alleviate ED overcrowding through incentivizing socially-desired ED capacity levels, although the healthcare regulator does not know the capacity cost structure. Using yardstick competition, we propose a regulatory scheme that achieves this using the wait time and arrival rate information of each ED.

3 - Timing Of Hospital Discharges Matters

Jonathan Helm, Indiana University, helmj@indiana.edu, Rene Bekker

The mismatch in timing of arrivals and discharge processing in hospitals leads to a census process that causes the hospital to experience significant congestion in the middle of the day. This leads to a chaotic environment and major operational efficiencies. In this research we formulate and analyze a stochastic census process to investigate the effect of the timing of doctor's discharge processing on inpatient census levels and identify new approaches to discharge processing that can alleviate congestion and also provide benefits to the patients being discharged themselves.

4 - Dynamic Server Allocation In A Multiclass Queueing System With Shifts: Nurse Staffing In Emergency Departments

Vahid Sarhangian, Columbia Business School, New York, NY, United States, vs2573@columbia.edu, Carri Chan

Nurse staffing decisions in emergency departments (EDs) are typically assigned weeks in advanced, which can create staffing imbalances as patient demand fluctuates. In this work, we consider the potential benefits of assigning nurses to different areas within an ED at the beginning of each shift. We study the problem of optimal reassignment of nurses to areas by considering a multiclass queueing model of the system. We analyze an associated fluid control problem and use the solution to develop policies that achieve asymptotically optimal performance under fluid-scaling for the original stochastic system. We find this additional flexibility can substantially reduce waiting times for patients.

■ TD28

201B-MCC

Topics in Sustainability

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Arzum E Akkas, Boston University, Cambridge, MA, United States, aakkas@bu.edu

1 - Design Of Sales Compensation Schemes To Reduce Product Waste

Arzum Akkas, Boston University, aakkas@bu.edu, Sahoo Nachiketa

We investigate sales-force compensation schemes that can alleviate product expiration driven by over-selling in retail supply chains. Using sales commission data from a consumer packaged goods manufacturer, we recommend parameters for a compensation scheme based on our structural model of sales-force selling behavior.

2 - Extended Warranties And Secondary Market Strategies

Wayne Fu, Georgia Institute of Technology, Atlanta, GA, United States, Wayne.Fu@scheller.gatech.edu, Atalay Atasu, Necati Tereyagoglu

We investigate the implications of extended warranties in a durable goods market from both producer and environmental perspectives. Considering a product subjected to failure, offering extended warranties helps an OEM increase the value-added of its products, but implies repair costs and cannibalization from its secondary market. In this context, we formulate a stylized durable goods model that explores the interaction between the OEM's warranty offerings and buy-back programs (to reduce secondary market cannibalization). We find that the choice of warranty offering is surprising non-monotonic in product failure and that secondary market interference influences the choice significantly.

3 - Sustainable Urban Water Management

Buket Avci, Singapore Management University, Singapore, Singapore, buketavci@smu.edu.sg, Onur Boyabatli

Climate change, escalating costs and other risks are causing cities to face ever-increasing difficulties in efficiently managing scarcer and less reliable water resources. We develop a stylized analytical model that captures the salient features of urban water management by modeling different demand classes (domestic vs. industrial) and supply processes (rainwater catchment, reclaimed water and desalination).

4 - Re-manufacturability And Investment Planning

Avinash Geda, University of Florida, 361B Stuzin Hall, Gainesville, FL, 32611, United States, avinashgeda@ufl.edu, Gulver Karamemis, Gulver Karamemis, Vashkar Ghosh, Asoo J Vakharia

We consider a monopolist manufacturer who produces a single-branded product and uses a mix of virgin and recycled materials in its production. The manufacturer can invest in either upstream or downstream technologies or both to improve recyclability/re-manufacturability and to reduce recycling costs respectively. We investigate profit maximizing investment strategies in presence of green consumers.

■ TD29

202A-MCC

Issues in Sustainable Operations

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Adem Orsdemir, University of California Riverside, 900 University Ave., Riverside, CA, CA 92521, United States, orsdemiradem@gmail.com

1 - Why And How Do Consumers Discount Remanufactured Products?

James Duane Abbey, Texas A&M University, 4217 TAMU, College Station, TX, 77843-4217, United States, jabbey@mays.tamu.edu, Rainer Kleber, Gilvan Souza, Guido Voigt

We empirically isolate the impact of quality concerns on consumers' willingness to pay (WTP) and the likelihood to purchase remanufactured products. Perceived risk, in the form of quality defects and cosmetic defects, has a significant impact on WTP, even after controlling for the WTP for new products, and other attributes.

2 - Coopeting For Green Product Development

Karthik Murali, University of Alabama, Tuscaloosa, kmurali@cba.ua.edu

We study the impact of collaboration between supply chain partners and coopetition between supply chains on the level of investment in green product design and development and its ensuing implications to society and the environment. We also address the role of policy makers in stimulating such partnerships between organizations.

3 - Designing Sustainable Products Under Co-production Technology

Shouqiang Wang, Clemson University, 131D Sirrine Hall, Clemson, SC, 29634, United States, shouqiw@clemson.edu, Yen-Ting (Daniel) Lin, Haoying Sun

We consider a firm who utilizes co-production technology to introduce a green product with raw material that would be otherwise discarded. Some consumers value resource savings achieved by green product while others do not. We examine impact of resource scarcity, technology feasibility, consumers' greenness on firm's profitability and environmental impact.

■ TD30

202B-MCC

Innovative Data-driven Analyses in Healthcare Research

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Carri Chan, Columbia University, 3022 Broadway, Uris Hall 410, New York, NY, 10025, United States, cwchan@columbia.edu

Co-Chair: Jose Zubizarreta, Columbia University, 3022 Broadway, 417 Uris Hall, New York, NY, 10025, United States, zubizarreta@columbia.edu

1 - Personalized Diabetes Management Using Electronic Medical Records

Alexander M Weinstein, Massachusetts Institute of Technology, Cambridge, MA, United States, amw22@mit.edu, Dimitris Bertsimas, Nathan Kallus, Ying Zhuo

Current clinical guidelines for managing type 2 diabetes do not differentiate based on patient-specific factors. We present a data-driven algorithm for personalized diabetes management using a k-nearest neighbor approach. Using electronic medical records for 10,806 type 2 diabetes patients from Boston Medical Center, we evaluated the effect of the algorithm's recommendations on matched patient outcomes from unseen data. The personalized approach yielded substantial improvements in glycated hemoglobin outcomes relative to the standard of care. The algorithm's evidence-based recommendations can be summarized for providers in an intuitive, interactive dashboard.

2 - A Template Matching Approach To Comparing Hospital Quality In An Integrated Health Care System

Wenqi Hu, Columbia Business School, New York, NY, United States, whu17@gsb.columbia.edu, Carri Chan, Jose Zubizarreta, Gabriel Escobar

There is a growing interest from healthcare providers and policymakers to better measure and improve quality of hospital care. Commonly used risk adjustment models can be inconsistent measures of hospital quality and do not enable a clear understanding of the potential impact of unobservable risk factors on hospital rankings. This work applies a new template matching approach to define a reference population over which 21 hospitals within an integrated healthcare system are compared. This approach enables more transparent comparisons than prior approaches. We further quantify the influence of hospital operational factors on patient outcomes for performance improvement considerations.

3 - A Room With A View: An Econometric Analysis Of How Facility Layout Impacts Care Provision In The Emergency Department

Lesley Meng, Doctoral Candidate, The Wharton School, University of Pennsylvania, 3730 Walnut Street, Suite 500 JMHH, Philadelphia, PA, 19104, United States, lmeng@wharton.upenn.edu, Robert Batt, Christian Terwiesch

The hospital emergency department (ED) has frequently been used to study the dynamics of service operations and how such operations adapt to fluctuations in workload. We study how the facility layout of ED patient rooms impacts nurse workflow decisions. Specifically, our dataset is comprised of infrared nurse location tracking data from a large urban teaching hospital over a study period of six consecutive months in 2013. In linking this to room occupancy patient data, we are able to investigate potential facility layout variables, such as distance from the nurses' station, that impacts the patient's length of stay in the ED through variation in the amount of nurse attention received.

■ TD31

202C-MCC

Information Economics in Operations

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Senthil Veeraraghavan, University of Pennsylvania, The Wharton School, Philadelphia, PA, 19104, United States, senthilv@wharton.upenn.edu

Co-Chair: Shiliang Cui, Georgetown University, 548 Rafik B. Hariri Building, 37th and O Streets NW, Washington, DC, 20057, United States, shiliang.cui@georgetown.edu

1 - Listen To The Crowd: Network Effects And Online Reviews In Restaurant SalesForecasting

Shawn Mankad, Cornell University, Ithaca, NY, United States, smankad@cornell.edu, Qiuping Yu, Masha Shunko

Using a comprehensive dataset from a major restaurant franchise, we forecast weekly store sales using classical measures of service quality from internal surveys at focal and neighboring stores, in addition to online ratings. Our results show that higher quality at the neighboring stores leads to higher sales at the focal store. We also find that the accumulation of online reviews reduces the importance of internal quality surveys at focal and neighboring stores as predictors.

2 - Information Sale And Competition

Kostas Bimpikis, Stanford University, kostasb@stanford.edu, Davide Crapis, Alireza Tahbaz-Salehi

This paper studies the strategic interaction between a seller of information and a set of firms competing in a downstream market. We show that the nature and intensity of competition play a first-order role in determining the seller's optimal strategy. When firms's actions are strategic complements (Bertrand competition), it is optimal for the seller to trade with all her customers. In contrast, when actions are strategic substitutes (Cournot competition), the seller maximizes her profits by restricting the supply of information and/or distorting its content. Furthermore we establish that her incentives to restrict the supply of information grow stronger in the presence of information leakage.

3 - Efficient Information Heterogeneity In A Queue

Yang Li, CUHK Business School, liyang@baf.cuhk.edu.hk, Ming Hu, Jianfu Wang

How would the growing prevalence of real-time delay information affect a service system? We consider an M/M/1 queueing system in which only a fraction of customers are informed about real-time delay. Perhaps surprisingly, we find that throughput and social welfare can be unimodal in the fraction of informed customers. In other words, some amount of information heterogeneity in the population can lead to strictly more efficient outcomes, in terms of the system throughput or social welfare, than information homogeneity. Moreover, we show that the impacts of growing information prevalence on system performance measures are determined by the equilibrium joining behavior of uninformed customers.

4 - Multi-stage Intermediation In Display Advertising

Ozan Candogan, University of Chicago, ozan.candogan@chicagobooth.edu, Santiago Balseiro, Huseyin Gurkan

We consider a setting where an advertiser seeks to acquire impressions from an advertising exchange through a network of intermediaries, and characterize mechanisms offered by strategic intermediaries when the advertiser's value is private. Our results indicate that the position in the intermediation process has a significant impact on the profits of the intermediaries and the most profitable position depends on the underlying value distribution. Intuitively, when the private value distribution is heavy tailed, downstream intermediation positions are more profitable, and otherwise upstream positions are more profitable. We also analyze merger decisions of intermediaries.

■ TD32

203A-MCC

Revenue Mgt, Pricing IV

Contributed Session

Chair: Yanqiao Wang, UC Berkeley, Berkeley, CA, United States, yanqiao@berkeley.edu

1 - Application Of Optimization Techniques And Survival Analysis On Pricing And Revenue Management In Semiconductor Industry

Amir Meimand, Pricing Scientist, Zilliant Inc, 1781 Spyglass Drive, Apt 359, Austin, TX, 78746, United States, amir.meimand@zilliant.com, Steve Tao, Lee Rehwinkel

Prices in some markets such as the semiconductor industries tend to decrease over time due to market pressure, product life-cycle, etc. Hence, it is desirable to reduce discounting behavior while maximizing sale/profit simultaneously. To meet this goal, we present a novel two-phase method. The first phase is based on an optimization model relies on elasticity estimation emerging from historical transactions. The second phase is modification of optimization solution based on price survival analysis to minimize the discount rate considering transaction date. We also present the numerical result of model applied to a real world problem with +2,000 products and +5,000 customers over a year.

2 - A Customized Dynamic Pricing Based Optimization Model For In-house Electricity Consumption Scheduling With Energy Storage Renewable Option

Goutam Dutta, Professor, Indian Institute of Management, Wing 3, Room No 3H, Production Quantitive Methods Area, Ahmedabad, Gujarat, 380015, India, goutam@iima.ac.in, Krishnendra Mitra

In this paper we propose a scheduling model for electrical appliances in a dynamic pricing environment. Initially we provide a vector of price points for the next twenty four hours. Then we develop an optimization model that minimizes cost to customer subject to different operating constraints of the appliances. We consider five different cases of price variation. We also study the effects of including energy storage and renewable energy generation at the consumer level. In this case we propose a linear price function that helps in automatically generating a price value for a time slot.

3 - Pricing Consumable Products To Maximize Profit

Randy Robinson, Assistant Professor, Bemidji State University, 1500 Birchmont Dr. #30, Bemidji, MN, 56601, United States, rrobinson@bemidjistate.edu

An introduction of a new consumable product to market is expected to have a sales growth rate that follows a sigmoid growth curve. If changes in price will affect the growth rate of this curve, what price should the producer charge to maximize profit over the time period in which they believe the product will remain popular? This talk will explore an explicit solution for the optimal price and the associated sensitivity analysis.

4 - Joint Optimization Of Capacitated Assortment And Pricing Problem Under The Tree Logit Model

Yanqiao Wang, UC Berkeley, Berkeley, CA, United States, yanqiao@berkeley.edu, Zuo-Jun Max Shen

Assortment and pricing decisions are of significant importance to firms and have huge influences on profit. How to jointly optimize over both assortment and prices draws increasing attention recently. However, in the existing literature, there is no flexible and comprehensive way to deal with the joint effects of assortment and price since the tangle between them makes the joint optimization problem less tractable. In this paper, we study the joint assortment and price optimization problem under the d-level nested logit model. Assume there are k lowest-level nests and each has n products, we develop an efficient algorithm that runs in O(kn^2) time to locate the joint optimal assortment and prices.

■ TD33

203B-MCC

Queueing Models III

Contributed Session

Chair: Petra Vis, VU Amsterdam, De Boelelaan 1105, Amsterdam, 1081 HV, Netherlands, petra.vis@vu.nl

1 - Meeting Service-level Constraints In Multi-class Service Systems

Rene Bekker, VU Amsterdam, De Boelelaan 1081a, Amsterdam, 1081 HV, Netherlands, r.bekker@vu.nl, Ger M Koole, Petra Vis

In many service systems, the service level (SL) is defined in terms of the tail probability of the waiting time. Different customer classes typically have different SL constraints. We first study a call blending system with an urgent (inbound) and best effort (outbound, email, call back) class, where the former has a severely more stringent SL. For threshold control, we show that the waiting time distribution is a mixture of exponentials. Second, we identify how to optimally assign agents to customers by exploiting the waiting time process of the first customer in line; we derive the value function for an isolated customer class and then apply one-step policy improvement.

2 - A General Workload Conservation Law With Applications To Queueing Systems

Muhammad A El-Taha, Professor, University of Southern Maine, Department of Mathematics and Statistics, 96 Falmouth Street, Portland, ME, 04104-9300, United States, el-taha@maine.edu

In the spirit of Little's law L=\lambda W and its extension H=\lambda G we use sample-path analysis to give a general conservation law. For queueing models the law relates the asymptotic average workload in the system to the conditional asymptotic average sojourn time and service times distribution function. This law generalizes previously obtained conservation laws for both single and multi-server systems, and anticipating and non-anticipating scheduling disciplines. Applications to single and multi-class queueing and other systems that illustrate the versatility of this law are given.

3 - Queue Now Or Queue Later

Brett Hathaway, Doctoral Candidate, UNC Chapel Hill, Chapel Hill, NC, United States, Brett_Hathaway@kenan-flagler.unc.edu, Seyed Emadi, Vinayak Deshpande

We study caller redial behaviors using call center data from a US-based bank. We show which factors affect the probability of redialing and the time between queue abandonment and redial. Using structural estimation, we show through counterfactual experiments how a center with callers who redial performs under various routing policies.

4 - Access Times In Appointment-driven Systems And Level-dependent MAP/G/1 Queues

Petra Vis, VU Amsterdam, De Boelelaan 1105, Amsterdam, 1081 HV, Netherlands, petra.vis@vu.nl
Petra Vis, Centrum Wiskunde & Informatica, Amsterdam, Netherlands, petra.vis@vu.nl, Rene Bekker

We study access times in appointment-driven systems. The access time is the number of days between a request for an appointment and the day that the appointment can take place. To meet target access times, we allow for overbookings, as they often occur in practice. Applications of this type of systems can be found in health care; e.g., patients making appointments with a doctor. We argue that such a system can naturally be modelled as an MAP/G/1 queue; the level corresponds to the access time and the phase to the dynamics of the number of free slots at the first available day. To allow for overbookings, we analyze a level-dependent version of the MAP/G/1 queue, leading to intuitively appealing results.

■ TD34

204-MCC

Joint Session HAS/MSOM-HC: Care Transition Policy and Management

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Nan Kong, Purdue University, West Lafayette, IN, United States, nkong@purdue.edu

1 - System Modeling For Patient Transitions Within Hospital

Hyo Kyung Lee, University of Wisconsin Madison, 1, Madison, WI, 1, United States, wilchess27@gmail.com, Jingshan Li, Albert J. Musa, Philip A. Bain

Among various issues in healthcare delivery, many complex and critical problems occur at the interfaces of healthcare systems. A patient's hospital stay may encompass various care units, but due to limited capacity, substantial amount of patients experience delay during the transition. This not only impacts the care quality and patient satisfaction, but in some cases is directly associated with mortality risk. Thus, to contribute to this end, we present a Markov chain model to study the transitions between emergency department, intensive or critical care unit, and hospital ward in community hospitals. Furthermore, an iteration method is introduced to evaluate the performance.

2 - Reduce COPD Readmission - Risk Identification And Patient-centered Intervention

Xiang Zhong, University of Wisconsin, 1513 University Avenue, Room 3235, Madison, WI, 53706, United States, oliver040525@gmail.com, Cong Zhao, Philip Bain, Albert Musa, Craig Sommers

30-day hospital readmission has been established as a critical performance indicator in promoting quality and patient-centered care. Individuals with serious chronic conditions such as chronic obstructive pulmonary disease (COPD) suffer high readmission risks and incur significant hospital penalty cost. To reduce COPD readmission, it's important to provide tools for physicians and hospitals to manage patients post discharge. In this study, we build statistical models to identify the risk factors for COPD readmission. Based on patients' risk levels, different patient-centered intervention policies prior to discharge and post discharge are developed.

3 - Optimal Inpatient Discharge Planning Under Uncertainty

Maryam Khatami, Texas A&M University, 4050 ETB, College Station, TX, 77840, United States, maryam.khatami@tamu.edu, Mark Lawley, Nan Kong, Michelle M. Alvarado

We study the inpatient discharge planning problem to enable efficient design of optimal discharge plans on a daily basis. If some of the discharge processes are delayed, the ensuing backup in the upstream units will cause inpatient admission delays. Hence, it is critical to tradeoff competing issues of upstream patient boarding (e.g. Emergency Department (ED) boarding), inpatient discharge lateness, and Inpatient Unit (IU) workload integration. We develop a novel two-stage stochastic programming model with uncertain IU discharge processing time and IU bed request time. Using data from a Texas hospital, we calibrate our model and fine-tune our solution method.

■ TD35

205A-MCC

On Demand Services

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Pnina Feldman, University of California-Berkeley, Haas School of Business, Berkeley, CA, 94720, United States, feldman@haas.berkeley.edu

Co-Chair: Robert Swinney, Duke University, Fuqua Drive, Durham, NC, 27708, United States, robert.swinney@duke.edu

1 - Drivers, Riders And Service Providers: The Impact Of The Sharing Economy On Mobility

Harald Bernhard, Singapore University of Technology and Design, Singapore, Singapore, harald_bernhard@mymail.sutd.edu.sg, Saif Benjaafar, Costas Courcoubetis

We study a heterogeneous population of agents interacting through a platform that facilitates on-demand ride-sharing. We build an equilibrium model to analyze the impact of key parameters such as car usage and ownership costs on traffic volume and welfare. Furthermore we define and find conditions to differentiate between a 'need' and 'profit' driven sharing economy.

2 - The Role Of Surge Pricing On A Service Platform With Self-scheduling Capacity

Gerard P Cachon, University of Pennsylvania, cachon@wharton.upenn.edu, Kaitlin Daniels, Ruben Lobel

Recent platforms, like Uber and Lyft, offer service to consumers via "self-scheduling" providers who decide for themselves how often to work. These platforms may charge consumers prices and pay providers wages that both adjust based on prevailing demand conditions. We study the effectiveness of different contractual forms, from the perspective of platform profit, provider surplus and consumer surplus. We find that while surge pricing is not optimal, it is nearly so. We describe conditions under which all parties benefit from the use of surge pricing.

3 - Bike-share Systems: Accessibility And Availability

Ashish Kabra, INSEAD, Boulevard de constance, Fontainebleau, 77305, France, ashish.kabra@insead.edu, Elena Belavina, Karan Girotra

This paper estimates the relationship between ridership of a bike-share system and its design aspects— station accessibility and bike-availability. Our analysis is based on a structural demand model that considers the random-utility maximizing choices of spatially distributed users, and it is estimated using high-frequency system-use data from the bike-share system in Paris and highly granular data on sources of bike-share demand. A novel model separates the long-term and short-term effects of higher bike-availability. Because the scale of our data render traditional numerical estimation techniques infeasible, we develop a novel transformation of our estimation problem.

■ TD36

205B-MCC

MSOM/Supply and Procurement

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: Zhixi Wan, University of Oregon, 1208 University of Oregon, Eugene, OR, 97403, United States, zwan@uoregon.edu

1 - Optimal Procurement In Assembly Supply Chains

Bin Hu, University of North Carolina, Chapel Hill, NC, 27519, United States, bin_hu@unc.edu, Anyan Qi

We consider an OEM's contracting mechanism to procure multiple components from different suppliers and assemble them into products under simultaneous and sequential contracting. We derive optimal mechanisms in both cases, and show that they can be implemented by simple quantity flexibility contracts. Furthermore, we find that optimal simultaneous and sequential contracting are revenue-equivalent for all parties, despite them having different asymmetric information structures. All results are extended to general convex costs and concave revenues, confirming that the results capture fundamental properties of optimal procurement in assembly supply chains.

2 - Optimal Procurement Auctions Under Multi-stage Supplier Qualification

Wei Chen, University of Kansas, wei.chen@ku.edu, Milind Dawande, Ganesh Janakiraman

We consider a firm that solicits bids from a fixed-sized pool of yet-to-be-qualified suppliers for an indivisible contract. The contract must be awarded to a supplier who passes a multi-stage qualification process. For each stage of the process, the buyer incurs a fixed testing cost for each supplier she chooses to test. Motivated by the buyer's urgency of time (or the lack of it) for completing the process, we study optimal mechanisms for the buyer under two testing environments: simultaneous testing, where in each stage, the buyer selects a subset of previous-stage-qualified suppliers and tests them simultaneously; and non-simultaneous testing, where simultaneous-testing is not required.

3 - Global Sourcing Under Non-contractible Capacity And Asymmetric Cost Information

Ehsan Bolandifar, The Chinese University of Hong Kong, Hong Kong, Hong Kong, ehsan@baf.cuhk.edu.hk, Fuqiang Zhang, Tianjun Feng

This paper studies a global sourcing problem where a buyer sources a product from a supplier to satisfy uncertain market demand. The buyer faces two issues when designing the sourcing contract: the supplier's cost structure is private information and the supplier's capacity investment is not contractible. We show that the presence of moral hazard does not necessarily lead to a lower profit for the buyer, but it may require a more complex contract format. We find that a single, linear contract could be optimal for the buyer under certain conditions. Even when such a contract is suboptimal, it can deliver close-to-optimal profit for the buyer for a wide range of situations.

4 - Screening Product Quality With Service Contracts

Dong Li, Singapore University of Technology and Design, Singapore, Singapore, lidong1107@gmail.com, Nishant Mishra, Serguei Netessine

We study contracting for product support under information asymmetry. Product reliability is privately informed for the customer, and the supplier then designs mechanisms to achieve screening product failure rates. We investigate the screening effects of two types of service agreement: Performance-based Contracts (PBC) and Transaction-based Contracts (TBC). Despite the advantages of PBC highlighted in previous studies, we find that TBC may have a lower screening cost than PBC when the customer has high levels of reserved utility. Our model provides theoretical supports for co-existence of multiple contract forms in product repair and maintenance outsourcing.

■ TD37

205C-MCC

Investment in Renewable Energy and Energy Efficiency

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Safak Yucel, Duke University, 100 Fuqua Drive, Durham, NC, 27705, United States, safak.yucel@duke.edu

1 - The Impact Of Carbon Pricing On Improving Supply Chain Energy Efficiency

Quang Dang Nguyen, University of Minnesota, nguy1762@umn.edu, Karen Donohue, Mili Mehrotra

We study the impact of a carbon pricing policy and its accompany on the energy efficiency investment decisions of a small manufacturing supplier facing competition for the business from a large industrial buyer. We also derive the optimal strategy for policy maker and the resulting social welfare, taking into consideration the social and environmental externalities of the supplier's operations.

2 - Quantifying The Impact Of Intermittent Renewable Generation On German Electricity Market

Shadi Goodarzi, HEC Paris, shadi.goodarzi@hec.edu
Shadi Goodarzi, California State University Fullerton, Fullerton, CA, United States, shadi.goodarzi@hec.edu, Derek W Bunn, Syed Basher

How does the penetration of renewable energy affect electricity market? Using high frequency 15-minute interval data, we quantify the impact of wind and solar production forecast errors on intraday electricity market equilibrium in Germany. We find, among others, higher wind and solar production forecast errors decrease the spot price and supply-demand imbalance.

3 - Designing Hydro Supply Chains For Water, Food, Energy And Flood Nexus

Kwon Gi Mun, Assistant Professor, Fairleigh Dickinson University, 1000 River Rd. H-DH2-06, Teaneck, NJ, 07666-1914, United States, kgmun@fdu.edu, Raza Ali Rafique, Yao Zhao

We study the nexus of water, food, energy and flood, which are among the most formidable challenges faced by developing countries around the world. The development of hydropower has the potential to address all these issues in the same time and thus is prioritized in the international community to reduce poverty, promote the sustainable development of the economy, and achieve the Millennium Development Goals. We apply the SCM concept to water resource development and provide the end-to-end and dynamic perspectives (the supply chain perspectives) needed in the expansion of hydropower network for energy security, irrigation and flood control.

4 - Reversing The Death Spiral: A New Business Model For Utility Firms Under Social Network Effects

Safak Yucel, Georgetown University, Washington, DC, United States, safak.yucel@georgetown.edu, Gurhan Kok, Kevin Shang

Utility death spiral describes a phenomenon in which retail electricity prices increase as more consumers invest in residential rooftop solar panels. In this paper, we present a technology-adoption model and show that this phenomenon occurs because of the current net metering policy, which allows consumers to sell their excess electricity back to utility firms. We then study several new business models that aim to counteract the death spiral phenomenon.

■ TD38

206A-MCC

Service Science I

Contributed Session

Chair: Sreekanth V K, Research Scholar, Indian Institute of Technology Kharagpur, Kharagpur, 721302, India, sreekanthvettikkadu@iitkgp.ac.in

1 - Impact Of Staffing Flexibility On Unit Climate And Patient Safety In Hospitals

Adelina Gnanlet, Associate Professor, California State University-Fullerton, 800 N State College Blvd, Department of Management, Fullerton, CA, 92831, United States, agnanlet@fullerton.edu, Chris McDermott, Rommel O Salvador

Floating, the frequent use of flexible staff, is typically associated with the benefits of scheduling ease and lowered costs but results in work interruption and discontinuity of patient care in hospitals. Therefore, higher floating can lead to deterioration of staff unit climate and patient safety. Using unit-level data from hospitals, we find that floating more than 8hrs negatively impacts patient safety, with unit climate mediating the relationship between floating and patient safety.

2 - Two New History-based Delay Predictors For Call Centers

Wyean Chan, Universite de Montreal, DIRO Pavillon Andre-Aisenstadt, CP 6128 succ Centre-Ville, Montreal, QC, H3C 3J7, Canada, chanwyea@iro.umontreal.ca, Mamadou Thiongane, Pierre L'Ecuyer

We propose two predictors to estimate the delay of customers in call centers or similar service systems. The first method predicts the delay by extrapolating the wait history of customers currently in queue. The second predictor uses an exponential smoothing of the delays of past customers conditional to the queue length. These predictors are attractive in practice because they are simple to implement, they require very few parameters and basically no optimization.

3 - Designing Service Machine For Emergency Medical Services

Sreekanth V K, Research Scholar, Indian Institute of Technology Kharagpur, Kharagpur, 721302, India, sreekanthvettikkadu@iitkgp.ac.in, Ram Babu Roy, Paul M Lillrank

Service machine is a metaphorical concept used in Translational Systems Sciences to explore the possibilities of applying machine design principles to the design of service production systems. The design of a service machine needs to consider several constraints arising from the nature of services: immateriality of the offering, heterogeneity of demand, inseparability of the production process, and perishability of resources. The customer behavior must be incorporated in the design as the service value is realized through co-creation by customers and producers. This research proposes an application of service machine concept for designing emergency medical services in Indian context.

■ TD39

207A-MCC

Applied Probability and Optimization III

Sponsored: Applied Probability

Sponsored Session

Chair: Chaitanya Bandi, c-bandi@kellogg.northwestern.edu

1 - Adaptive Control Of Flexible Queueing Networks

Yuan Zhong, Columbia University, New York, NY, 10027, United States, yz2561@columbia.edu, Ramtin Pedarsani, Jean Walrand

We consider the problem of designing adaptive control policies for queueing networks with flexible servers of overlapping capabilities. We show that a simple, adaptive version of the classical maxweight policy can lead to system instability. We then provide tight characterizations for systems that are stable under the simple, adaptive maxweight policy. Finally, we propose class of adaptive control policies that are throughput optimal for general parallel server systems.

2 - Delay Performance Of Scheduling Algorithms For Data Center Networks And Input Queued Switches

Sivateja Maguluri, IBM, siva.theja@gmail.com

Today's era of cloud computing is powered by massive data centers hosting servers that are connected by high speed networks. It is therefore desirable to design scheduling algorithms for data packets that have low computational complexity and result in small average packet delays. We consider the scheduling problem in an input-queued switch, which is a good abstraction for a data center network. We present low complexity scheduling algorithms that have optimal queue length (equivalently, delay) behavior in the heavy traffic regime. We also present bounds on the queue length in light traffic. These results are obtained using drift based arguments.

3 - Characterizing Global Stability Of Queueing Networks Via Robust Optimization

Chaithanya Bandi, Northwestern University, Evanston, IL, United States, c-bandi@kellogg.northwestern.edu, Itai Gurvich

We study the conditions of global stability in open multi-class queueing networks, that is stability under any work conserving policy. We propose a new approach, where rather than aiming at the full characterization of global stability, we seek toidentify assembly (LEGO) operations, such as pooling of networks, and assembly rules-of-thumb that, when followed, crate a globally stable network from globally stable building blocks. We also use robust optimization as a key methodology that brings a new perspective to known results on global stability, state space collapse and the network Skorohod problem.

4 - Using Robust Queueing To Expose The Impact Of Dependence In Single Server Queues

Wei You, PhD Student, Columbia University, 500 W. 120th St., Mudd 323, New York, NY, 10027, United States, wy2225@columbia.edu, Ward Whitt

Queueing applications often exhibit dependence among interarrival times and service times, e.g., when there are multiple customer classes with class-dependent service-time distributions, or when arrivals are departures or overflows from other queues or superpositions of such complicated processes. In this talk, we show that the robust queueing approach proposed by Bandi et al. can be extended to describe the impact of dependence structure on customer waiting times and the remaining workload in service time as a function of the traffic intensity. Thus, robust queueing can be useful to develop performance approximations for queueing networks and other complex queueing systems.

■ TD40

207B-MCC

Applications in Applied Probability

Sponsored: Applied Probability

Sponsored Session

Chair: Kevin Leder, University of Minnesota, 111 Church St, Minneapolis, MN, 55455, United States, kevinleder@gmail.com

1 - A Stochastic Model Of Order Book Dynamics Using Bouncing Geometric Brownian Motions

Xin Liu, Clemson University, xliu9@clemson.edu

In a limit order book, market ask price is always greater than market bid price, and these prices move upwards and downwards due to new arrivals, market trades, and cancellations. We model the two price processes as "bouncing geometric Brownian motions (GBMs)", which are defined as exponentials of two mutually reflected Brownian motions (BM). We then modify these bouncing GBMs to construct a discrete time stochastic process of trading times and trading prices, which is parameterized by a parameter $c > 0$. It is shown that the logarithmic trading price process, under a suitable scaling, converges to a standard BM, and the modified ask and bid price processes approach the original bouncing GBMs, as c goes to 0.

2 - Synchronization Of Discrete Pulse-coupled Oscillators

David Sivakoff, Ohio State University, dsivakoff@stat.osu.edu

We introduce a discrete state, discrete time model of inhibitory oscillators, and analyze the long time behavior of a system of oscillators located on the integer lattice. We show that, when started from random initial condition, the system clusters (weakly synchronizes), and give upper and lower bounds on the clustering rate.

3 - Sample Path Large Deviations For Heavy Tailed Levy Processes And Their Applications

Chang-Han Rhee, CWI, C.Rhee@cwi.nl

While the theory of large deviations has been wildly successful in providing systematic tools for studying rare events, the central ideas behind the classical large deviations theory critically hinge on the assumption that the underlying uncertainties are light-tailed. As a result, the heavy-tailed counterparts have remained significantly less mature. In this talk, we introduce a new large deviations result for heavy-tailed Levy processes, which enables systematic study of the rare events associated with multiple big jumps, beyond the celebrated "principle of one big jump." We illustrate the implications of the new theory in applications in computational finance and stochastic networks.

■ TD41

207C-MCC

Quantitative Methods in Finance

Sponsored: Financial Services

Sponsored Session

Chair: Qi Wu, Chinese University of Hong Kong, Hong Kong, Shatin, NT, 12345, Hong Kong, qwu@se.cuhk.edu.hk

1 - Option Pricing In The Presence Of Market Microstructure

Nan Chen, Chinese University of Hong Kong, nchen@se.cuhk.edu.hk

No-arbitrage prices of vanilla options becomes nontrivial when the underlying dynamic is modeled at the order book level. By taking into account the market microstructure such as market depth and resilience, we formulate the traditional option pricing problem as a singular-impulsive control problem. Our analysis demonstrates that the liquidity-related microstructure has a profound impact on the resulting prices.

2 - On The Measurement Of Economic Tail Risk

Xianhua Peng, Hong Kong University of Science & Technology, maxhpeng@ust.hk, Steven Kou

This paper attempts to provide a decision-theoretic foundation for the measurement of economic tail risk, which is not only closely related to utility theory but also relevant to statistical model uncertainty. The main result is that the only risk measures that satisfy a set of economic axioms for the Choquet expected utility and the statistical property of general elicitability (i.e. there exists an objective function such that minimizing the expected objective function yields the risk measure) are the mean functional and Value-at-Risk (VaR), in particular the median shortfall, which is the median of tail loss distribution and is also the VaR at a higher confidence level.

3 - Persistence And Procyclicality In Margin Requirements

Qi Wu, Chinese University of Hong Kong, qwu@se.cuhk.edu.hk

Derivatives central counterparties (CCP) impose margin requirements on their clearing members to protect the CCP from the default of a member firm. A spike in volatility leads to margin calls in times of market stress. Risk-sensitive margin requirements are procyclical in the sense that they amplify shocks. We analyze how much higher margin levels need to be to avoid procyclicality. Our analysis compares the tail decay of conditional and unconditional loss distributions to compare stable and risk-sensitive margin requirements. Greater persistence in volatility leads to a slower decay in the tail of the unconditional distribution and a higher bu er needed to avoid procyclicality.

4 - Over-the Counter Markets andCounterparty Risk

Agostino Capponi, Columbia University, ac3827@columbia.edu

We develop a parsimonious model to study how counterparty risk influences the structure of OTC markets. A unit continuum of traders, who are risk-averse agents with exponential utility, are organized into banks. Traders of a bank strategically engage in bilateral transactions with traders of another bank taking into account the terms of deal and counterparty risk. We show that the rise of counterparty risk leads to a higher concentration of dealers.

■ TD42

207D-MCC

RM in Online Markets

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Dragos Florin Ciocan, INSEAD, Fontainebleau, France, florin.ciocan@insead.edu

1 - Learning Demand Curves In B2b Pricing: A Case Application Of Optimal Learning

Ilya Ryzhov, Robert H. Smith School of Business, University of Maryland, iryzhov@rhsmith.umd.edu, Huashuai Qu, Michael Fu

We consider a sequence of B2B transactions involving a wide variety of buyers, products, and other characteristics, where the seller only observes whether buyers accept or reject the offered prices. The seller must adapt to this uncertain environment and learn quickly from new deals as they take place. We propose a new framework for statistical and optimal learning in this problem, based on approximate Bayesian inference, that has the ability to measure and update the seller's uncertainty about the demand curve based on new deals. A case study demonstrates the practical potential of this approach.

2 - Pricing Of Conditional Upgrades In The Presence Of Strategic Consumers

Yao Cui, Cornell University, Ithaca, NY, United States, yao.cui@cornell.edu, Izak Duenyas, Ozge Sahin

We study a conditional upgrade strategy that is recently used by the travel industry. A consumer can accept an upgrade offer in advance and pay the upgrade fee at check-in if higher-quality products are still available. Consumer make forward-looking decisions regarding which product type to book. We characterize the firm's optimal upgrade pricing strategy and identify multiple benefits of conditional upgrades. We also evaluate the revenue performance of conditional upgrades by comparing to other policies.

3 - Revenue Management With Repeated Interactions

Dragos Florin Ciocan, INSEAD, florin.ciocan@insead.edu, Andre Du Pin Calmon, Gonzalo Romero

We consider an RM problem where a seller of heterogeneous goods interacts with a dynamically evolving population of buyers over multiple periods. The basic trade-off we explore is between myopically optimizing the seller's revenues over one period versus optimizing buyer surplus in the hope of increasing buyer participation in future periods. We exhibit a simple policy that is asymptotically optimal.

4 - Joint Pricing And Inventory Management With Strategic Customers

Yiwei Chen, Singapore University of Technology and Design, stevenyiweichen@gmail.com, Cong Shi

We consider a joint pricing and inventory management problem wherein a seller sells a single product over an infinite horizon via dynamically determining anonymous posted prices and inventory replenishment quantities. Customers have a deterministic arrival rate but heterogeneous product valuations. Customers are forward-looking, who can strategize their times of purchases. A customer incurs waiting and monitoring cost if he delays his time of purchase. The seller seeks a joint pricing and inventory policy that maximizes her long-run average profit. We show that the optimal policy is cyclic. Under the optimal policy, strategic customer equilibrium behaviors are proven to be myopic.

■ TD43

208A-MCC

Portfolio Decision Analysis

Sponsored: Decision Analysis

Sponsored Session

Chair: Janne Kettunen, The George Washington University, The George Washington University, Washington, DC, 00000, United States, jkettune@gwu.edu

1 - Systematic Bias, Selection Bias, And Post-decision Disappointment

Eeva Vilkkumaa, Aalto University, Helsinki, Finland, eeva.vilkkumaa@aalto.fi, Juuso Liesiö

Based on empirical studies, the realized values of highest-ranked decision alternatives tend to be lower than estimated. This phenomenon has been explained by a systematic bias in the alternatives' value estimates, or selection bias. We develop models for estimating the relative magnitudes of these biases using data on the estimated values of all alternatives but the realized values of selected alternatives only. Results obtained from real data on 5,610 transportation infrastructure projects suggest that out of the total cost overrun of $2.77 billion, 25% is due to systematic bias and 75% due to selection bias.

2 - Scheduling Public Procurement Contracting

Janne Kettunen, Assistant Professor, The George Washington University, Washington, DC, United States, jkettune@gwu.edu, Young Hoon Kwak

We show that the schedule according to which procurements are contracted can impact the number of proposals and thereby the cost of procured services or products. To help the owner of the procurements to schedule the contracts, we develop an optimization framework and apply it to the Florida Department of Transportation's procurement contracts scheduling problem. Our results show that the optimal schedule yields about 2% ($15 million) cost savings annually.

3 - Multi-period, Multi-objective Portfolio Optimization

Ernest H Forman, George Washington University, forman@gwu.edu

Multi-Period, Multi-Objective and Multi-Perspective portfolio optimization requires synthesis of hard data as well as judgment. The Analytic Hierarch Process and extensions are increasingly being used to facilitate the portfolio optimization process in a variety of applications, ranging from project portfolio optimization to capital budgeting.

■ TD44

208B-MCC

Applications of Multiattribute Preferences

Sponsored: Decision Analysis

Sponsored Session

Chair: Jay Simon, American University, 4400 Massachusetts Ave NW, Washington, DC, 20016, United States, jaysimon@american.edu

1 - Preference Programming For Spatial Multiattribute Decision Analysis

Mikko Harju, Aalto University, Espoo, Finland, mikko.harju@aalto.fi, Kai Virtanen, Juuso Ilari Liesio

The additive spatial value function models preferences among decision alternatives with spatially varying multiattribute consequences. Use of this value function can be challenging as it requires assessing a weighting function across the (uncountably infinite) set of spatial locations. To overcome this challenge, we develop (i) methods for capturing incomplete preference information about relative importance of locations, and (ii) models for identifying the resulting dominance relations among the alternatives. The use of these models is demonstrated with a military planning application. Finally, we provide some new insights about the axiomatic basis of spatial value functions.

2 - Multiattribute Preference Models For Computational Creativity

Debarun Bhattacharjya, IBM T. J. Watson Research Center, Yorktown Heights, NY, United States, debarunb@us.ibm.com, Lav Varshney

There is vigorous debate around definitions of creativity, yet there is general consensus that creativity inherently involves a subjective value judgment by an evaluator. In this talk, I will present evaluation of creative artifacts and computational creativity systems through a multiattribute preference modeling lens. Various implications are illustrated with the help of examples from and inspired by the creativity literature.

3 - Multilinear Utility Functions For Multiattribute Portfolio Decision Analysis

Juuso Ilari Liesio, Aalto University, Helsinki, Finland, juuso.liesio@aalto.fi, Eeva Vilkkumaa

In project portfolio selection applications, portfolio utility is often modeled as the sum of the projects' multi-attribute utilities. We establish the preference assumption underlying this linear portfolio utility function. Furthermore, we show how relaxing some of these assumption leads to a more general class of multilinear portfolio utility functions, which can capture risk preferences on the portfolio level. We also develop techniques to elicit these utility functions, and optimization models to identify the project portfolio which maximizes the expected utility subject to resource and other portfolio feasibility constraints.

4 - Multiattribute Procurement Auctions With Unknown Buyer Preferences

Jay Simon, American University, jaysimon@american.edu

In procurement auctions for new large-scale products or services, the length of time between the request for bids and the selection of the winning bid can be extremely long. During this time, the specific needs of the buyer may change. Additionally, the new product or service being procured may involve technology that is not fully understood. Thus, the buyer may not know what her eventual preferences will be when the bid selection decision is made. However, the buyer must tell the bidders how their bids will be scored at the start of the process. This work explores optimal strategies for the buyer in the case where preferences at the time of bid selection are uncertain when the scoring rule is chosen.

■ TD45

209A-MCC

Simulation Optimization and Ranking and Selection

Sponsored: Simulation

Sponsored Session

Chair: Demet Batur, University of Nebraska-Lincoln, CBA 209, Lincoln, NE, 68588, United States, dbatur@unl.edu

1 - Optimization-based Learning Of Simulation Model Discrepancy

Henry Lam, University of Michigan, Ann Arbor, MI, United States, khlam@umich.edu, Matthew Plumlee

The vast majority of stochastic simulation models are imperfect in that they fail to fully emulate the entirety of real dynamics. Despite this, these imperfect models are still useful in practice, so long as one knows how the model is inexact. We propose a method to learn the amount of the model inexactness using data collected from the system of interest. Our approach relies on a Bayesian framework that addresses the requirements for estimation of probability measures that are ubiquitous in stochastic simulation, and an embedded optimization to enhance the involved computational efficiency.

2 - Quantile-based Ranking And Selection In A Bayesian Framework

Yijie Peng, Fudan University, pengy10@fudan.edu.cn, Chun-Hung Chen, Michael Fu, Jian-Qiang Hu, Ilya O Ryzhov

We propose two quantile-based ranking and selection schemes in a Bayesian framework, i.e. myopic allocation policy (MAP) and optimal computing budget allocation (OCBA). MAP has a superior small sample performance, while OCBA shows a desirable asymptotic behavior. As a result, a switching strategy that that switches from MAP to OCBA is provided to achieve balanced performances in both small sample and large sample scenarios.

3 - Multi-information Source Optimization With Applications

Matthias Poloczek, Cornell University, poloczek@cornell.edu, Jialei Wang, Peter Frazier

We consider Bayesian optimization of an expensive-to-evaluate black-box function, where we also have access to cheaper approximations of the objective that are typically subject to varying unknown bias. Our novel algorithm rigorously treats the involved uncertainties and uses the Knowledge Gradient to maximize the predicted benefit per unit cost. We discuss applications and demonstrate that the method consistently outperforms other state-of-the-art techniques, finding designs of considerably higher objective value at lower cost.

4 - Tractable Dynamic Sampling Strategies For Quantile-based Ordinal Optimization

Dongwook Shin, Columbia Business School, dshin17@gsb.columbia.edu, Mark Nathan Broadie, Assaf Zeevi

Given a certain number of stochastic systems, the goal of our problem is to dynamically allocate a finite sampling budget to minimize the probability of falsely selecting non-best systems, where the selection is based on quantiles of their performances. The key aspect is that the objective depends on underlying probability distributions that are unknown. To formulate this problem in a tractable form, we introduce a function closely associated with the aforementioned objective. To derive sampling policies that are practically implementable, we suggest a policy that combines sequential estimation and myopic optimization, as well as certain variants of this policy for finite-time improvement.

■ TD46

209B-MCC

Empirical Research on Pricing and Revenue Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Pnina Feldman, University of California-Berkeley, Berkeley, CA, United States, feldman@haas.berkeley.edu

Co-Chair: Necati Tereyagoglu, Scheller College of Buss - Georgia Institute of Technology, Atlanta, GA, United States, necati.tereyagoglu@scheller.gatech.edu

1 - Welfare Implications Of Congestion Pricing: Evidence from SFpark

Hsin-Tien Tsai, University of California, Berkeley, 1822 Francisco St., Apt 4, Berkeley, CA, 94703, United States, hsintien@berkeley.edu, Pnina Feldman, Jun Li

SFpark is a congestion pricing program for street parking implemented in San Francisco. We investigate whether consumers benefit from congestion pricing using data from this program. We build a structural model of consumer search and quantify the change in consumer welfare.

2 - Inventory Announcements And Customer Choice: Evidence From The Air Travel Industry

Katherine Ashley, University of California-Berkeley, kate_ashley@haas.berkeley.edu, Pnina Feldman, Jun Li

Does inventory announcement influence consumer decision-making in the market for airline tickets? We estimate the impact of the firm's announcement policy on customer purchase timing and itinerary choice. In doing so, we measure the information content of inventory announcements, and analyze the extent to which customers treat these messages from the firm as cheap talk or credible information.

3 - Designing Listing Policies For Online B2b Marketplaces

Wenchang Zhang, University of Maryland, COLLEGE PARK, MD, CA, United States, wzhang@rhsmith.umd.edu, Konstantinos Bimpikis, Wedad Jasmine Elmaghraby, Kenneth Moon

Excess inventory amounts to $500 billion a year for big-box retailers. Much of this inventory is sold through online B2B auctions. Based on a natural experiment, we provide strong evidence that increasing the market thickness by concentrating the auction ending times to just a couple of days of the week has a significant positive effect on their final prices. We find that bidders' monitoring cost has a large impact on their auction entry choices and outweighs the potentially negative effect of cannibalization among competing auctions. Our findings may have implications for the design of online marketplaces beyond liquidation auctions.

4 - Distribution Channel Relationships And Multimarket Competition

Necati Tereyagoglu, Assistant Professor of Operations Management, Scheller College of Bussiness - Georgia Institute of Technology, 800 W Peachtree St NW, Atlanta, GA, 30308, United States, necati.tereyagoglu@scheller.gatech.edu, O. Cem Ozturk

We study the role of the distribution channel relationships in determining competitive intensity when manufacturers encounter in multiple markets. We explore the manufacturers' pricing decisions when they have asymmetric distribution channel relationships with retailers across multiple markets. Using an extensive scanner data set, we find that cross-market interdependence due to shared ties with the retailers softens competition when manufacturers have asymmetric distribution channel relationships across multiple markets.

■ TD47

209C-MCC

Cloud Computing in RM

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Cinar Kilcioglu, Columbia Business School, Columbia Business School, New York, NY, 10027, United States, ckilcioglu16@gsb.columbia.edu

Co-Chair: Costis Maglaras, Columbia University, New York, NY, United States, c.maglaras@columbia.edu

1 - Optimal Resource Consumption via Data Driven Prophet Inequalities With An Application To Cloud Infrastructure

Andrew A Li, MIT, Cambridge, MA, United States, aali@mit.edu, Muhammad J Amjad, Vivek Farias, Devavrat Shah

Buyers of cloud compute resources are generally interested in completing workloads by fixed deadlines as cheaply as possible. This entails purchasing enough resources at the lowest prices possible, which is a challenge in today's market where the largest providers all use some form of demand-driven pricing. We formulate this as a covering problem, and introduce the Data-Driven Prophet Model, which uses historical price data to interpolate between stochastic modeling and a fully adversarial model. We propose a simple, scalable threshold policy that is order-optimal and has, in a real-world implementation, completed workloads significantly cheaper than the current practice benchmark.

2 - Stochastic Optimal Control Of Time-varying Cloud Workloads

Mark S Squillante, IBM Thomas J. Watson Research Center, mss@us.ibm.com, Yingdong Lu, Mayank Sharma, Bo Zhang

We consider a cloud computing system modeled as a GI/GI/1 queue under workloads (arrival and service processes) that vary on one time scale and under controls (server capacity) that vary on another time scale. Taking a stochastic optimal control approach and formulating the corresponding optimal dynamic control problem as a stochastic dynamic program, we derive structural properties for the optimal dynamic control policy in general. We also derive fluid and diffusion approximations for the problem and propose analytical and computational approaches in these settings. Computational experiments demonstrate the benefits of our approach.

3 - Conic Optimization Model For Replicated Data Stores In Geo-distributed Cloud Applications

Julio Cezar Goez, NHH Norwegian School of Economics, Bergen, Norway, jgoez1@gmail.com, Juan F. Pérez

We consider a software application provider that serves geographically distributed users using cloud resources. The application provides a service to access content via a set of channels, and it must comply with a certain quality of service (QoS). The provider must decide where to locate and how to replicate the data considering traffic patterns. The goal is to find the deployment of minimum cost. We introduce a mixed integer non-linear optimization model, which may be reformulated as a mixed integer second order cone optimization problem. In many of our test instances CPLEX reaches the time limit without feasibility. We developed a feasibility test that also provides an initial feasible solution.

4 - Large Scale Dynamic Network Revenue Management With Application In Pricing Of Interactive Cloud Applications

Hossein Jahandideh, UCLA Anderson School of Management, 3777 Mentone Avenue, Apt 405, Los Angeles, CA, 90034-6473, United States, hs.jahan@gmail.com, Julie Ward, Filippo Balestrieri

We consider a cloud provider making customized dynamic pricing decisions for hosting interactive applications. The dynamic pricing problem is a large-scale dynamic network revenue management problem. We decompose the stochastic dynamic program into single-resource problems by exploiting structural properties of the optimal Lagrangian variables, removing the necessity for an extensive search over Lagrangian variables. We define a pricing mechanism based on the solution to the decomposed problem, and demonstrate its effectiveness through several numerical experiments.

■ TD48

210-MCC

Social Media Analytics Award Session

Invited: Social Media Analytics

Invited Session

Chair: Tauhid Zaman, MIT, 77 Massachusetts Ave, Boston, MA, 0, United States, zlisto@gmail.com

1 - Social Media Analytics Best Student Paper Award

Tauhid Zaman, MIT, Atlanta, GA, zlisto@gmail.com

Presentations by the finalists in the Social Media Analytics Best Student Paper Award Contest.

■ TD49

211-MCC

Panel: First Course in Analytics or Only Course in Analytics – What Difference Does It Make?

Sponsored: Education (INFORMED)

Moderator: Thomas G Groleau, Carthage College, Kenosha, WI, United States, tgroleau@carthage.edu

1 - Exploratory Questions

Thomas G Groleau, Carthage College, tgroleau@carthage.edu

The moderator will explain the purpose of the panel, provide examples from other disciplines, and propose a few questions to the panel to get the discussion started.

2 - Panelist:

Peter C Bell, Ivey Business School at Western University, Canada, pbell@ivey.uwo.ca

3 - Panelist:

Jeffrey D Camm, Wake Forest University, cammjd@wfu.edu

4 - Panelist:

Dimitris Bertsimas, Massachusetts Institute of Technology, dbertsim@mit.edu

5 - Panelist:

Robert Krider, Professor, Simon Fraser University, Vancouver, BC, Canada, rkrider@sfu.ca

■ TD50

212-MCC

SpORts: Sports Analytics II

Sponsored: SpORts

Sponsored Session

Chair: Stephen Hill, University of North Carolina-Wilmington, 601 South College Road, Wilmington, NC, 28403-5611, United States, hills@uncw.edu

1 - Breaking The Chill Of The Tie In The National Hockey League

Marty Thomas, Georgia Gwinnett College, athomas1@ggc.edu

In order to increase fan excitement in overtime periods, the National Hockey League changed the point structure of the overtime period (winner receives 2 points and the loser receives 1 point). However, tied games now had more points associated with them (regulation win = 2 points; regulation loss = 0 points). This research explores the implications of a soccer point system (3 points = regulation win; 2 points = overtime win; 1 point = overtime loss). The Real Time Scoring System is used to develop probability distributions of goal production for each of the 30 NHL teams. Monte Carlo simulation is used to determine whether the new point system benefits certain teams over others in terms of making the playoffs?

2 - The Advantage Of Lefties In Sports

Hal Cooper, PhD Candidate, Columbia University, 500 West 120th Street, Rm. 345, Mudd, New York, NY, 10027, United States, hal.cooper@columbia.edu, Francois Fagan, Martin B Haugh

Left-handers comprise a staggering 15% of professional tennis players, but only 11% of the general population. In sports as varied as boxing, baseball and fencing, the contrast is even more stark. Here we present a method for extracting the advantage of being left-handed in sports (as well as the inherent skill of each player) from match results. Unlike previous approaches to this problem, our formulation is Bayesian and uses induced order statistics to address the truncated nature of the data set. We further demonstrate an approach in the absence of explicit match result data that can be used to determine the latent advantage of specific factors wherever there exists notions of ranking and competition.

3 - The Optimal Value Bill James' Pythagorean Method For Major League Lacrosse

Hayden Howell, University of Alabama, Culverhouse College of Commerce and Business Administration, Tuscaloosa, AL, 35487-0226, United States, hphowell@crimson.ua.edu, James Cochran

Bill James' Pythagorean Method of Baseball, which quantifies the nature of the relationship between the win/loss percentage of a Major League Baseball (MLB) team and the number of runs the team scores and allows over the course of a season, is extended to Major League Lacrosse (MLL). We find the optimal form of James' model using both the squared and the absolute error criteria over a broad range of algebraic possibilities. We also examine the stability in the relationship between win/loss percentage and runs scored and allowed over time.

4 - Determining The Optimal Locations For Indoor Tennis Camps In Canada

Islay Wright, University of Toronto, 1, Toronto, ON, Canada, islay.wright@mail.utoronto.ca, Timothy Chan

Winter tennis camps are often inaccessible for Canadians due to the high rental costs of indoor tennis facilities. To increase the involvement of youth in tennis, it is important to make camps available year-round at a reasonable price. Tennis Canada wants to evaluate holding tennis camps at indoor turf stadiums instead of at indoor tennis facilities. To help them, we developed a location model to optimize camp locations, using demand estimates generated by a logistic regression model and data from surveys and census.

■ TD51

213-MCC

Models of Influence and Optimal Response

Sponsored: Public Sector OR

Sponsored Session

Chair: Theodore T Allen, Ohio State University, 210 Baker Systems Engineering, 1971 Neil Avenue,, Columbus, OH, 43210, United States, allen.515@osu.edu

1 - The Role Of Peer Influence On Vaccine Uptake In A Pandemic Disease Spread Model

Kevin Chan, University of Toronto, Toronto, ON, Canada, kevinm.chan@mail.utoronto.ca, Dionne Aleman

Most pandemic spread models that consider vaccination assume vaccine adopters are evenly spread across the population. However, evidence suggests vaccine adoption is peer-influenced. Treating populations as contact networks with vaccination determined by influence-spread models, we analyze pandemic outcomes using agent-based simulation. Far more infections occur with peer-influenced v. uniformly-spread vaccination.

2 - Emergency Medical Service Response Models With Patient Priorities

Soovin Yoon, University of Wisconsin, 1415 Engineering Drive, Room 3261, Madison, WI, 53706, United States, yoon57@wisc.edu, Laura Albert McLay

In this talk, we study how to use optimization models and algorithms to effectively leverage patient triage information when determining how to locate and dispatch ambulances. Research in this area is valuable since it provides important guidance into how emergency medical services departments should use scarce resources to balance the needs of high-priority and low-priority patients given that triage information regarding patient needs is dynamic. This research has resulted in several key insights into how to optimally use scarce public resources for responding to health emergencies.

3 - Generalized Binary Search With Indifference Zones So All Can Wait Less than 30 Minutes

Shijie Huang, Carillion Clinic, skylovtata@gmail.com

We propose efficient methods to identify all resource combinations which minimally satisfy a standard with probability greater than P*. These methods are based on a generalized binary search combined with the fully sequential methods of Andradóttir and Kim. Numerical examples and case studies illustrate and compare the method with alternatives.

4 - Operations Research Meets Voting Laws In The U.S.A.: NAACP v. Mccrory, Arizona, And Others

Theodore T Allen, Ohio State University, allen.515@osu.edu

Waiting lines are a political weapon to demoralize voters on the other side. Evidence shows aspirants lost in New Mexico because of provisioning causing lines. Also, in North Carolina we explore the possibility that racially motivate lines affected a key senate election even while a judge has a different opinion.

■ TD52

214-MCC

Urban Transportation and Logistics in Public Sector OR III

Sponsored: Public Sector OR

Sponsored Session

Chair: Sung Hoon Chung, Binghamton University, PO Box 6000, Binghamton, NY, 13902, United States, schung@binghamton.edu

1 - An Open Source Tool For The Visualization, Analysis And Reporting Of Regional And Statewide Transit Networks

Saeed Ghanbartehrani, Ohio University, Stocker Engineering Center 276, Athen, OH, 45701, United States, ghanbart@ohio.edu, Jose David Porter

Assessing the current "state of health" of individual transit networks is fundamental when planning improvements to a transportation network. These improvements must be guided by strategies based on key performance metrics, which require the availability of accurate data. This research focuses on the design and implementation the transit network analysis (TNA) software tool. Some of the inputs to this tool include transit network data from 66 different Oregon transit agencies, census data, and employment data, and can be used to visualize, analyze, and report on the Oregon transit network.

2 - Mobility Patterns And Service Level Analysis Of A Free Floating Bike Sharing System

Aritra Pal, University of South Florida, Tampa, FL, United States, aritra1@mail.usf.edu, Yu Zhang, Changhyun Kwon

Bike Sharing is a sustainable mode of urban mobility. Free-floating bike sharing (FFBS) is an innovative bike sharing model, which saves on start-up cost and offers significant opportunities for smart management. In this study, we identify mobility patterns of users of Share-A-Bull Bikes (SABB) FFBS and analyse the effect of external factors (eg: weather) on them. These results are then used to measure lost demand in SABB FFBS, which is used to compute desired inventory levels, of various regions in the SABB FFBS operating area. We also present a model to estimate the probability of a bike being unusable and identify users who are mishandling bikes, based on available historical trip data.

3 - Bike-sharing Market Acceptance Considering A Mixed Fleet Of Bicycles

Mohammad Hossein Shojaei, Michigan State University, Building, East Lansing, MI, 48824, United States, shojaeim@msu.edu, Mehrnaz Ghamami

This study aims to minimize emission and launch costs of a transportation system, while maximizing its health benefits. The system consists of currently available services, as well as an intended bike-sharing scheme with mixed fleets of bicycles. Fleets can include regular bikes, pedelces and power-on-demand e-bikes. User's choice is captured with a utility function defined by the average distance to be traveled, mode availability, area's topology, travel time, and user costs. Results will help policy makers provide a cost-effective, eco-friendly and more active transportation system.

■ TD53

Music Row 1- Omni

Managing Product Development and Collaboration

Sponsored: Technology, Innovation Management & Entrepreneurship

Sponsored Session

Chair: Wenli Xiao, University of San Diego, 5998 Alcala Park, San Diego, CA, 92110, United States, wenlixiao@sandiego.edu

1 - A Behavioral Analysis On The Use Of An Intermediary In Manufacturing Outsourcing

Qiong Chen, University of Science and Technology of China, qcchen@ustc.edu.cn, Aleda Roth, Gulru F Ozkan-Seely, Fred Switzer

In this paper, we examine how the level of outsourcing competence of the firm, the amount of time-to-market pressure and the buyer's perceived incentive alignment with the agent, act to systematically influence the decision to outsource the new product directly or indirectly through an intermediary.

2 - Managing Supplier Incentives For Key Component Testing

Timofey Shalpegin, The University of Auckland Business School, t.shalpegin@auckland.ac.nz

Suppliers of a key component for a new product are often required to perform testing of the key component. However, they might not have sufficient incentives to perform a sufficient number of tests if they do not fully internalize the risks of new product failure. We examine different contracts, such as reward and residual claimant contracts, and analyze their influence on the supplier incentives for component testing. Finally, we design a contract ensuring the suppliers keep to the efficient component testing level.

3 - Optimal Product Launch Times For A Firm With A Niche Product

Jacqueline Ng, Northwestern University, Evanston, IL, 60201, United States, jacqueline.ng@northwestern.edu, Izak Duenyas, Seyed Iravani

We consider the optimal production introduction policy for a technology firm that produces a single niche product that progresses through a series of product generations over time. The novel part of this problem is that the firm's niche product is a subset or peripheral part of a larger product offering from a multi-product firm. We develop a dynamic programming model to analyze the small firm's new product introduction strategy, and prove the optimality of a threshold policy. We then compare and contrast the optimal policy with the common time-pacing and event-pacing product introduction policies use in practice.

4 - Student Perceptions Of The Entrepreneurial Mindset Within Capstone Design Projects

Ahad Ali, Lawrence Technological University, sali@ltu.edu

For many engineering curricula, student teams are formed to complete a capstone design project. Besides technical knowledge, capstone projects can foster team building skills, leadership skills, problem-solving skills, opportunity recognition, project planning and budgeting, innovation, tolerance for uncertainty/ambiguity, and risk management among other attributes of the entrepreneurial mindset. This paper provides an expanded analysis of student perceptions of the entrepreneurial activity and the recognition of the entrepreneurial mindset associated with capstone design projects.

■ TD54

Music Row 2- Omni

Service Science: Health Care Services

Sponsored: Service Science

Sponsored Session

Chair: George Cai, Santa Clara University, Leavey School of Business, Santa Clara, CA, 95053, United States, gcai@scu.edu

Co-Chair: Hui Zhang, Lakehead University, Lakehead University, Thunder Bay, ON, P7B 5E1, Canada, hzhang2@lakeheadu.ca

1 - Payment Contracts To Promote Use Of Optional Diagnostic Tests In Cancer Treatment

Salar Ghamat, Ivey Business School, Western University, sghamat.phd@ivey.ca, Greg Zaric, Hubert Pun

We examine performance-based payment contracts to promote the use of an optional diagnostic test for newly diagnosed cancer patients. We model the interaction between a health care payer and an oncologist with both adverse selection and moral hazard. We show that, in the presence of information asymmetry, an oncologist should never test all patients, even when the test was available for free. Moreover, although the oncologist has additional information about a patient's risk, the payer can guarantee that the oncologist obtains the same profit regardless of the characteristics of the patients. Finally, we find that the payer might benefit from an increase in reputational concerns of the oncologist.

2 - Fair Competition Of Brand Name Drugs Under Rebate Arrangements

Hui Zhang, Faculty of Business Administration, Lakehead University, hzhang2@lakeheadu.ca

When new drugs are listed for a third-party payer's coverage, they are often required to sign rebate arrangements to reduce payers' financial risk. In this paper, we consider two forms of rebate arrangements. 1, the new drug is paid at its original price if its sale is under a volume threshold and then is paid at the old drug's price otherwise. 2, a volume threshold is specified for all drugs. If the total sales of all drugs exceed the threshold, each drug is required to pay a rebate according to its market share. We investigate the optimal decisions of the payer and the drug manufacturers and identify the impact of the rebate on the fairness of competition.

■ TD55

Music Row 3- Omni

Inventory Management VI

Contributed Session

1 - Dynamic Pricing, Hedging, And Inventory Management In A Two-product Monopoly Under Cost And Demand Risk

Max F Schoene, Doctoral Student, WHU - Otto Beisheim School of Management, Reinhold-Friedrichs-Str. 49, Muenster, 48151, Germany, max.schoene@whu.edu, Stefan Spinler, John R Birge

We study the joint inventory management, dynamic pricing, and financial hedging problem of a risk-averse, two-product monopolist facing cost and demand risk. These risks can be correlated across markets and customers may view the two products as substitutes or complements creating demand interdependencies. We provide an analytic solution to the firm's multi-period decision problem and characterize the implications of operating in several interdependent markets for integrated policy making.

2 - A Newsvendor Analysis Of Binomial Yield Production Process

Sungyong Choi, Assistant Professor of Supply Chain Management, Yonsei University, 1 Yoneseidae-gil, College of Government and Business, Wonju, 26493, Korea, Republic of, sungyongchoi@gmail.com, Sumin Jeon, Jinmin Kim, Kwangtae Park

We study a Binomial yield production process with a newsvendor approach. We provide a reformulation of the original model to convert the discrete exact model to the continuous approximate model by Normal approximation. We conduct comparative static analysis for model parameters in the approximate model and derive monotone properties to the optimal solution. All the analytical results are consistent with our insights and supported by economic explanations. Our numerical examples by sample-based optimization show that the approximate model is sufficiently close to the exact model. Finally, all the results of sensitivity analysis in model parameters are also confirmed numerically.

3 - Onshore And Offshore Procurement: Global Sourcing Strategies

Zhe Liu, PhD Candidate, Columbia University, 511 W 112th Street, Apt 24C, New York, NY, 10025, United States, zliu18@gsb.columbia.edu, Awi Federgruen, Lijian Lu

This paper studies a finite horizon, single product, periodic review inventory system with two supply sources, which originates from real world global sourcing firms facing onshore and offshore procurement problems. Supply sources are differentiated by their fixed and variable ordering costs, delivery lead times, as well as constraints on the order sizes. Excess inventories may be salvaged at the end of each period with a fixed cost and variable revenue, or be carried over to the next period. We derive structural results for the optimal solution, based on which we are able to characterize the optimal sourcing and salvaging decisions.

4 - Evaluating The Potential Of Additive Manufacturing For Spare Parts Supply

Rob Basten, Assistant professor, Eindhoven University of Technology, PO Box 513, IE&IS - OPAC, Eindhoven, 5600MB, Netherlands, r.j.i.basten@tue.nl, Bram Westerweel, Geert-Jan Van Houtum

We investigate the decision of whether or not to replace a regularly produced spare part with an alternative produced via additive manufacturing (AM), also called 3D printing. Such a transition requires a one-time investment and changes characteristics such as procurement lead time, production costs and component reliability. We consider the entire product lifecycle and take into account performance benefits and design, inventory, maintenance and downtime costs. We derive analytical properties of the required reliability and production costs of the AM part such that its lifecycle costs break even with that of its regular counterpart.

■ TD56

Music Row 4- Omni

Online Crowdfunding

Sponsored: EBusiness

Sponsored Session

Chair: Zaiyan Wei, Purdue University, West Lafayette, IN, United States, zaiyan@purdue.edu

1 - Users' Resilience To Kickstarter Scam

Xue Tan, University of Washington, xuetan@uw.edu, Yingda Lu, Yong Tan

Users' expected quality of crowdfunding projects is an important determinant of their backing choice. Users who have experienced scam or unsuccessful projects may update their belief in the quality of projects over the platform to a lower level. In this study, we analyze how users learn from their past experience of unsuccessful or scam projects. We use longitudinal backing history of Kickstarter backers, and adopt text mining technique to analyze project failure types. By categorizing the unsuccessful delivery of products into several types, we examine the impacts of different types of project failures. Our work contributes to the policy design of crowdfunding platforms.

2 - Institutional Investors In Online Crowdfunding

Zaiyan Wei, Purdue University, West Lafayette, IN, 47907, United States, zaiyan@purdue.edu, Mingfeng Lin, Richard Sias

The "crowd" in online crowdfunding is no longer only comprised of retail investors; in fact, debt-based crowdfunding has long attracted the interest of institutional investors. We study whether they are indeed better able to screen borrowers than, and have any impacts on the behaviors of, retail investors. We find that although institutional investors indeed behave differently, overall their portfolios do not outperform those of retail investors. Their bids have significant impacts on the behavior of retail investors, as well as funding outcomes. We find that this effect is driven by the designation of "institutional investors" rather than just the portfolio size.

3 - Effects Of Charitable Giving In Crowdfunding: Crowds Fund Our Kids

Qiang Gao, University of Arizona, Tucson, AZ, 85721, United States, qiangg@email.arizona.edu, Paulo B Goes, Mingfeng Lin

We investigate how crowdfunding contributes to public goods by exploring the geographical expansion of a donation-based crowdfunding funding platform for educational purpose. Our initial results show that the emergence of crowdfunding as a viable financial source actually affects classroom activities and that crowd donation contributes to the improvement of education. We also find that the impact vary among different projects. Our findings help promote the awareness of such opportunities not documented in literature and benefit society as a whole.

4 - Information Disclosure And Crowdfunding

Keongtae Kim, City University of Hong Kong, keongkim@cityu.edu.hk, Jooyoung Park

Several strategies in crowdfunding have been introduced to dampen information asymmetry between funders and creators. This study examines one such possible mechanism, namely a platform-wide rule to require the disclosure of project risk, implemented in a crowdfunding platform during our study period. We find that the new disclosure policy led to a decrease in the creation of new projects, even successful ones. Our additional analyses show a stronger effect on creators bearing a larger burden from the disclosure requirement. We further find that the decrease is partly driven by the negative perceptions of funders about the risk information disclosed.

■ TD57

Music Row 5- Omni

Emerging Behavioral Work by Doctoral students

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Julie Niederhoff, Syracuse University, 721 University Ave, WSOM 500, Syracuse, NY, 13244, United States, jniederh@syr.edu

1 - Risk And Loss Aversion In Information Security Investment: Theory And Experiments

Jie Zhang, The University of Texas at Arlington, 701 S Nedderman Dr, Arlington, TX, 76019, United States, jie.zhang2@mavs.uta.edu, Kay-Yut Chen, Jingguo Wang

Information security has gained much attention in the information systems literature. In this paper, we study how organization should decide the proper levels of investment to reduce the chances of loss, under different risk and loss aversion assumptions. We found that, theoretically, investment should decrease with firm revenue under specific settings and preference conditions, while experiments suggest the reverse. We also uncover dynamics in decisions where the setting is independent over time, counter to the theory.

2 - Incentivizing Suppliers Using Scorecard

Sina Shokoohyar, University of Texas at Dallas, 800 West Campbell Road, Richardson, TX, Jindal School of Management, Richardson, TX, 75080, United States, Sina.shokoohyar@utdallas.edu, Elena Katok, Anyan Qi

Suppliers' scorecard is a tool for manufacturers to track suppliers' performance. We investigate the effectiveness of two approaches for a manufacturer to incentivize suppliers to improve their performance based on the evaluation of their scorecard performance, the absolute and relative approaches. Under the absolute approach, the manufacturer provides incentive to the supplier if the supplier reaches a targeted score. Under the relative approach, the manufacturer incentivizes suppliers based on the suppliers' scorecard ranking in the supplier base. Comparing the suppliers' resultant scores under the two approaches, we characterize conditions on which approach is preferable.

■ TD58

Music Row 6- Omni

Service Science

Contributed Session

Chair: Sara Saberi, Worcester Polytechnic Institute (WPI), Washburn Rm 217, Foisie School of Business, Worcester, MA, 01609, United States, ssaberi@wpi.edu

1 - Server Scheduling Policies For The Queues With Abandonment

Sina Ansari, Northwestern University, McCormick School of Engineering, 2145 Sheridan Road, Evanston, IL, 60208, United States, sinaansari2013@u.northwestern.edu, Seyed Iravani, Laurens G Debo

We study the optimal server scheduling policy in a two-class service system with abandonment. With the objective of minimizing the total average abandonment cost per unit time, we characterize the optimal control policy at the server using Markov Decision Process.

2 - A Data_driven Approach To Model Fatigue At The Workplace

Zahra Sedighi Maman, PhD Student , Research Scientist, Auburn University, Auburn, AL, 36849, United States, zzs0016@auburn.edu, Mohammad Ali Alamdar Yazdi, Fadel Megahed, Lora Cavuoto

This paper presents feature selection and predictive modeling approaches for physical workload that can improve the fatigue prediction. The goal of this feature selection is to reduce the number of the used sensors and variables obtained from multiple sensors. The results show that the proposed approaches perform well both in prediction performance and more importantly in feature reduction.

4 - A Network Economic Game Theory Model Of A Service-oriented Internet With Price And Quality Competition In Both Content And Network Provision

Sara Saberi, Assistant Professor, Worcester Polytechnic Institute, Foisie School of Business, 100 Institute Road, Worcester, MA, 01609, United States, ssaberi@wpi.edu, Anna B Nagurney, Tilman Wolf

This paper develops both a basic and a general network economic game theory model of a quality-based service-oriented Internet to study the competition among the service providers. We derive the governing equilibrium conditions and provide the equivalent variational inequality (VI) formulations. In order to illustrate the modeling framework and the algorithm, we present computed solutions to numerical examples. The results show the generality of the proposed network economic model for a future Internet.

■ TD59

Cumberland 1- Omni

Green Vehicle Routing

General Session

Chair: Mesut Yavuz, University of Alabama, Box 870226, Tuscaloosa, AL, 35487, United States, myavuz@cba.ua.edu

1 - Electric Vehicle Routing Problem With Time Windows And Multiple Charger Types

Bulent Catay, Prof., Sabanci University, FENS, Tuzla, Istanbul, 34956, Turkey, catay@sabanciuniv.edu, Merve Keskin

The electric vehicle charging stations may be equipped with chargers having different power supply, power voltage, and maximum current configurations. The type of the charger affects the recharge duration. In this study, we extend the Electric Vehicle Routing Problem with Time Windows by allowing partial recharges using three different charger types. The objective is to minimize total energy costs while operating minimum number of vehicles. We formulate this problem as a mixed integer linear program and propose a matheuristic approach to solve it effectively. The proposed approach uses an Adaptive Large Neighborhood Search algorithm to construct the routes and utilizes a solver to improve them.

2 - Cost Minimization And Fleet Sizing For Multifunction Electric Bus Fleets

Amanda Farthing, Clemson University, Clemson, SC, United States, adfarth@g.clemson.edu, Nora Harris, Robert Riggs, Scott J. Mason

We address the unique barriers facing university campus fleet managers considering a transition to electric bus fleets. Specifically, the logistical issues pertaining to multifunction vehicle fleets with fixed daytime routes and nighttime dial-a-ride service are addressed. A university vehicle fleet is analyzed in order to integrate real-world constraints, industry perspectives, and previous optimization research to develop a vehicle selection and fleet-sizing model that minimizes total cost. The model considers electric vehicle and infrastructure purchases, operation costs, and environmental benefits in this setting.

3 - The Maximum Profit Mixed-fleet Electric Vehicle Routing Problem

Isil Koyuncu, University of Alabama, Tuscaloosa, AL, United States, ikoyuncu@crimson.ua.edu, Mesut Yavuz

This talk presents a maximum profit mixed fleet electric vehicle routing problem. A mixed fleet consists of traditional gasoline or diesel and electric vehicles. Electric vehicles enable the fleet operator to reduce their operating costs as well as carbon emissions. In addition, a set of customers are willing to pay a premium to receive service by electric vehicles to reduce their supply chain carbon footprint. We formulate the emerging problem as a mixed integer linear program, and present a route first cluster second and a greedy algorithm as well as their computational evaluation from our preliminary experiment.

4 - Greening Patrol Routing Via Extended-range Electric Vehicles

Mesut Yavuz, University of Alabama, myavuz@cba.ua.edu, Burcu B Keskin, Cameron Harvey, Patrick Mitchell

This study investigates patrol routing on state highways with hybrid electric vehicles, which operate in electric mode until battery depletion, and then switch to the more expensive gasoline mode. We present a mixed-integer non-linear programming formulation of the problem as well as analyze some special cases in which the problem reduces to one of minimum cost network flow. The objective is a weighted combination of "hot spot" coverage maximization and cost minimization. The model is tested on real data from Alabama State Troopers.

■ TD60

Cumberland 2- Omni

Understanding Shared Mobility and Autonomous Vehicles: Data, Models and Optimization

Sponsored: TSL, Urban Transportation

Sponsored Session

1 - Studying Trip Planning Behavior For Taxi Drivers

Xian-Biao Hu, Metropia, Inc., Tucson, AZ, 85718, United States, xb.hu@metropia.com, Song Gao

Taxi cabs account for a significant portion of traffic in megacities. However, research on taxi driver behaviors are limited and mostly formulated to maximize the probability of picking up or minimize search time to find next passenger. Such myopic approach departs from the driver's actual objective to maximize profit over the entire operation period, and may fail to explain the search behavior around certain hotspots with high customer demand. This research aims to bridge this gap by studying the daily trip planning behavior for taxi drivers with the goal of maximizing profit over the entire operation period. Numeric analysis based on one-month taxi trajectory data will also be presented.

2 - Discovering Relationships Of Round-trip Carsharing Factors With Association Rules Technique

Dahye Lee, Texas A&M University, College Station, TX, United States, dahyelee1991@tamu.edu, Luca Quadrifoglio, Benedetta Sanjust di Teulada, Italo Meloni

The objective of this research is a comprehensive analysis for discovering relationships between factors of round-trip carsharing with the association rules approach. Results of analysis show that the strongest dependent variables do not have high correlations with the variables of distance from customers' residence locations. Although the results gave an idea of connections of round-trip operations characteristics, the degree of impact of each variable still need to be investigated. The goal for future studies is to maximize connectivity to public transportation to help in reducing congestion and pollution.

3 - Household Use Of Autonomous Vehicles: Modeling Framework And Traveler Adaptation

Yashar Khayati, University at Buffalo, Amherst, NY, United States, yasharkh@buffalo.edu, Jee Eun Kang, Mark Henry Karwan, Chase Murray

We define a framework to model and evaluate potential household-level use of Autonomous Vehicles (AVs), to understand advantages, potential issues and negative external effects. We introduce a new formulation, the Household Activity Pattern Problem for AVs, to simulate the travel patterns of people using AVs. The key modeling challenge is to include modeling capabilities of driverless parking, pickup, drop-off and waiting during travelers' engagement in activities. We develop solution approaches to this NP-hard problem and conduct a scenario analysis to evaluate changes in travel behavior.

■ TD61

Cumberland 3- Omni

Routing and Scheduling

Sponsored: TSL, Freight Transportation & Logistics

Sponsored Session

Chair: Ali Ekici, Ozyegin University, TBD, Istanbul, TBD, Turkey, aliekici@gmail.com

1 - Integration Of Passenger And Freight Rail Scheduling

Liang Liu, University of Southern California, Los Angeles, CA, United States, liangliu@usc.edu, Maged M Dessouky

We study the integration of passenger and freight rail scheduling to improve the efficiency of freight trains while maintaining the punctuality of passenger trains. An optimization model that jointly considers the travel times of freight trains and the tardiness of the passenger trains is formulated. We proposed a decomposition based solution procedure to solve the problem, in which optimization-based or heuristic algorithms are applied on each of the subproblems.

3 - Congestion Reduction Through Efficient Empty Container Movement

Santiago Carvajal, University of Southern California, 1150 W 29th Street, Los Angeles, CA, 90007, United States, scarvaja@usc.edu

The optimization problem for efficiently routing multi-container trucks to better reposition both loaded and empty containers is studied. Our formulation adds the multi-container truck to the empty container reuse problem. Our aim is that by more efficiently routing trucks that the number of truck trips would be reduced, thus decreasing transportation costs, and reducing the natural environmental impact of transporting goods.

4 - A Tour Generation-based Algorithm For An Inventory Routing Problem

Ali Ekici, Ozyegin University, Istanbul, Turkey, ali.ekici@ozyegin.edu.tr, Okan Orsan Ozener

We study a variant of inventory routing problem and develop an integrated two-phase solution approach. In the first phase, we cluster the customers such that each clustered is served by a single vehicle. Then, in the second phase, we determine the delivery routes and volumes for each cluster using an integer programming based heuristic approach. In this phase, we first generate several tours and solve mixed integer program to choose among these generated tours and determine the delivery volumes. We compare the performance of the proposed algorithm against the ones in the literature.

■ TD62

Cumberland 4- Omni

Data and Decisions for Airline and Air Traffic Management

Sponsored: Aviation Applications

Sponsored Session

Chair: Alexandre Jacquillat, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA, 02116, United States, alexjacq@mit.edu

1 - Flight Scheduling, Flight Planning And Operations Recovery To Minimize Airline Operating Costs

Jane Lee, University of Illinois at Urbana Champaign, jjlee1@illinois.edu

The focus of this work is to evaluate impact of stochasticity of disruptions on airline's recovery decision. In particular, we aim to model the dynamic recoverability of flight schedule in response to disruptions based on Stochastic Queueing Model of airport congestion. We consider the typical mechanisms of departure time holdings, flight cancellations, and aircraft swaps used in aircraft recovery in practice today using Integer Programming. Additionally, we also consider dynamic decision making in recovery based on Dynamic Programming model. Our real-world experiments involve the original schedule of a major carrier in the US and disruptions at a secondary hub.

2 - A Combinatorial Auction For Allocation Of Departure And Arrival Slots

Alexander Estes, University of Maryland-College Park, College Park, MD, 20742, United States, aestes@math.umd.edu, Michael O Ball, Mark M Hansen, Yulin Liu

We present a combinatorial auction mechanism for the allocation of arrival and departures slots at an airport. This mechanism selects a profile of slots that will be available and provides an allocation of these slots to airlines based on their bids in the auction. Vickrey-Clarke-Grove payments are used so that it dominant strategy for airlines to bid truthfully. This provides a way in which the airlines' valuation of congestion costs can be incorporated into slot allocations.

3 - Data-driven Choice-based Airline Fleet Assignment

Chiwei Yan, Massachusetts Institute of Technology, chiwei@mit.edu, Cynthia Barnhart, Vikrant Vaze

We propose models to incorporate customer choice behaviors into the capacity allocation problem under a network revenue management setting, namely, the airline fleet assignment problem. Unlike network revenue management, the capacity allocation problem with customer choice is usually intractable for real-world instances. We thus devise efficient decomposition approaches with provable performance guarantees. Our approach is data-driven in nature, which learns a choice model from transaction data and builds effective fleeting decisions based on that.

4 - A Model For Airport Schedule Coordination Based On The IATA Guidelines

Nuno Ribeiro, University of Coimbra, Coimbra, Portugal, nuno_r_@hotmail.com

The International Air Transport Association (IATA) slot allocation process is the dominant demand management mechanism used at busy airports worldwide. In this process, each coordinated airport provides its "declared capacity", the airlines submit their scheduling requests, and a slot coordinator sets the schedule of flights at the airports. This research develops a new modeling approach to support slot coordinators to accommodate airline preferences better, while complying with the IATA guidelines and other constraints. Results are shown from a case study at Madeira airport (FNC).

■ TD63

Cumberland 5- Omni

Location Analysis II

Sponsored: Location Analysis

Sponsored Session

Chair: Zvi Drezner, California State University-Fullerton, 800 N. State College Blvd., Fullerton, CA, 92834-3599, United States, zdrezner@fullerton.edu

1 - Optimal Placement Of M Finite-size Rectangular Facilities In An Existing Layout

Rakesh Nagi, University of Illinois, Urbana-Champaign, 117 Transportation Building, MC-238, 104 South Mathews Avenue, Urbana, IL, 61801, United States, nagi@illinois.edu, Ketan Date

We study the problem of placing M new finite size rectangular facilities (NFs) in a layout with N existing rectangular facilities (EFs). Interactions are present between different pairs of EFs and NFs, serviced through the Input/output points located on the facility boundary. The objective is to minimize the total weighted rectilinear distance between the interacting facilities by optimally placing the NFs. Main contribution of this paper is an analytical framework that unifies and generalizes the facility location/layout problems for minisum objective and rectilinear distance metric.

2 - Solving The Quadratic Assignment Problem Using Graphics Processing Unit Clusters On The Blue Waters Supercomputer

Ketan Date, University of Illinois at Urbana-Champaign, Urbana, IL, United States, date2@illinois.edu, Rakesh Nagi

In this work, we discuss a parallel branch-and-bound algorithm for solving the Quadratic Assignment Problem (QAP). Our parallel architecture is comprised of CUDA enabled NVIDIA Graphics Processing Unit (GPU) clusters on the Blue Waters supercomputer at the University of Illinois at Urbana-Champaign. For obtaining a lower bound, we adopt the RLT2 formulation of the QAP, and we propose a novel parallelization of the Dual Ascent algorithm on the GPUs, which shows excellent parallel speedup for large problems. We show that this GPU-accelerated approach is extremely effective in solving large QAPs to optimality.

3 - Discrete Budget Allocation In Competitive Facility Location.

Tammy Drezner, Cal State Fullerton, tdrezner@fullerton.edu, Zvi Drezner

We apply the gravity-based model for estimating the market shares attracted by competing facilities. We assume that a budget is available for expanding existing facilities and building new ones. We assume that the investments for improving existing facilities or constructing new ones are an integer multiple of a basic value such as 0.1% of the available budget.

4 - An Iterative Procedure For Solving Non-Convex Non-Linear Programs

Zvi Drezner, Cal State Fullerton, zdrezner@fullerton.edu, Pawel J. Kalczynski

Non-linear programming problems of minimizing a convex objective function subject to convex constraints are convex, and can be optimally solved by numerous approaches and canned programs. Non-convex programs such as a maximization of a convex objective subject to constraints which are outside of convex regions usually have many local optima and are generally difficult to solve. We found that such problems can be heuristically solved by a multi-start approach based on solving a sequence of linear programs. Our iterative approach is much faster than a direct multi-start approach (one to three orders of magnitude) and provided better results on four test problems and 116 instances.

■ TD64

Cumberland 6- Omni

Multiple Criteria Decision Making Applications 2

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Murat Mustafa Koksalan, Middle East Technical University, Ankara, Turkey, koksalan@metu.edu.tr

1 - Probabilistic Algorithms For Multiple Criteria Sorting

Sinem Mutlu, Roketsan, sinemmutlu01@gmail.com, Murat Mustafa Koksalan, Yasemin Serin

We develop interactive approaches to place alternatives that are defined by multiple criteria into preference-ordered classes. Our approaches place alternatives into classes either deterministically or probabilistically with a desired level of accuracy. We also control the magnitude of misclassification regarding the number of classes between the true and placed classes of a misplaced alternative. We demonstrate the approach on a variety of problems.

2 - Properties Of Optimal Stochastic Programming Solutions In Portfolio Optimization With Different Criteria And Planning Periods

Ceren Tuncer Sakar, Hacettepe University, cerents@hacettepe.edu.tr, Murat Mustafa Koksalan

Incorporating multiple criteria, considering different risk measures and using multiple-period models have been recent important developments in portfolio optimization. We make a detailed analysis of the properties of optimal stochastic programming solutions for portfolio optimization problems. We work with models that have different criteria and planning periods. We compare the solutions of single and multiple-period models using expected return and Conditional Value at Risk as criteria, and demonstrate our results with tests performed with stocks traded on Istanbul Stock Exchange (Borsa Istanbul). We also consider rolling horizon settings.

3 - An Interactive Approach For Biobjective UAV Route Planning In Continuous Space

Murat Mustafa Koksalan, Middle East Technical University, Indus Engineering Department, Ankara, 06531, Turkey, koksalan@metu.edu.tr, Diclehan Tezcaner Ozturk, Hannan Tureci

We consider the route planning problem for Unmanned Air Vehicles (UAVs) which we formulate as finding the path that the UAV follows in a continuous terrain visiting all target points. We consider two criteria: minimization of distance traveled and radar detection threat. We develop an interactive algorithm that finds the most preferred point of a route planner (RP). We assume that the RP has an underlying linear preference function whose parameters are unknown to us. We ask the RP to compare pairs of tours and his/her preferences guide us to his/her most preferred nondominated point.

4 - Interactive Algorithms For a Wide Variety Of Preference Functions

Gulsah Karakaya, Middle East Technical University, Ankara, Turkey, kgulsah@metu.edu.tr, Murat Mustafa Koksalan, Selin Damla Ahipasaoglu

In this study, we introduce a broad family of preference functions that can represent a wide variety of preference functions. We develop interactive algorithms that guarantee to find the most preferred solution of a decision maker whose preferences are consistent with such functions. Our algorithms converge to the most preferred solution of the decision maker by reducing the solution space based on the preference information obtained from the decision maker and the properties of the assumed preference functions. We demonstrate the algorithms on an example problem.

■ TD65

Mockingbird 1- Omni

Social Media and Health 2.0

Sponsored: Information Systems

Sponsored Session

Chair: Lu Yan, Indiana University, Indiana University, Bloomington, IN, 47405, United States, yanlucy@indiana.edu

1 - How Online Comments And Government Ratings Affect Patients' Opinion Of Medical Providers

Weiguang Wang, University of Maryland, 3330 B Van Munching Hall, College Park, MD, 20742-1815, United States, weiguangwang@rhsmith.umd.edu, Niam Yaraghi, Guodong (Gordon) Gao, Ritu Agarwal

One critical decision for every patient is to choose a high quality doctor. In recent years, new online channels have profoundly changed how patients access physician quality information. Most notably are the government-led efforts such as PhysicianCompare, and the grass-root movement by voluntary patient reviews such as those on Yelp.com. However, little is known how these two channels affect patient decision making. Using experimental designs, we examine patient's choice of primary physicians with quality information from both Yelp and the government website. Our study provides the first empirical evidence of how patients weigh different information sources to inform their decision making.

2 - Modeling Dynamics Of Service Mechanism, Feedback Mechanism, And Sharing Mechanism: An Empirical Analysis Using Vector Autoregression

Liuan Wang, Harbin Institute of Technology, Harbin, China, wangliuan1973@163.com, Xitong Guo

With the utilization of social media in healthcare online healthcare communities has become an integral part of people's daily lives. In this study, we explore how the interdependencies among service mechanism, feedback mechanism, and sharing mechanism affect physicians and patients in the online healthcare communities. We use vector auto-regression to model the co-movements of service mechanism, feedback mechanism, and sharing mechanism and provide evidence of strong Granger-causal interdependencies. In addition, we also investigate the effect of values in the online healthcare communities. Our results provide both theoretical and practical implications.

3 - Facilitate Fit Revelation In a DistributionChannel

Lin Hao, University of Notre Dame, 351 Mendoza College Of Business, Notre Dame, IN, 46556, United States, lhao@nd.edu, Yong Tan

We investigate a retailer's and a supplier's incentive to facilitate fit revelation, i.e., facilitate consumer learning of their true product fit, under two popular channel pricing models, agency pricing model and wholesale pricing model.

■ TD66

Mockingbird 2- Omni

Technometrics Invited Session: Recent Statistical Methods for Analyzing Big Data

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Peihua Qiu, Professor and Chair, University of Florida, 2004 Mowry Road, Gainesville, FL, 32611, United States, pqiu@phhp.ufl.edu

1 - Discovering The Nature Of Variation In Nonlinear Profile Data

Daniel Apley, Northwestern University, apley@northwestern.edu

Most prior work on profile data in the quality control literature has focused on monitoring to detect sudden changes in the characteristics of the profiles, relative to an in-control sample of profiles. In contrast, we develop an approach for exploratory analysis of a sample of profiles to discover the nature of any profile-to-profile variation present over the sample via manifold learning. Instead of analyzing parameter variation in some prespecified parametric profile model, our focus is on discovering and visualizing an appropriate characterization or parameterization of the variation, as a tool to facilitate discovery (and ultimately elimination) of its root causes.

2 - A Bootstrap Metropolis-hastings Algorithm For Bayesian Analysis Of Big Data

Faming Liang, University of Florida, faliang@ufl.edu

MCMC methods have proven to be a powerful tool for analyzing data of complex structures. However, their computer-intensive nature precludes their use for big data analysis. We propose the bootstrap Metropolis-Hastings (BMH) algorithm, which provides a general framework for how to tame powerful MCMC methods to be used for big data analysis; that is to replace the full data log-likelihood by a Monte Carlo average of the log-likelihoods that are calculated in parallel from multiple bootstrap samples. The BMH algorithm possesses an embarrassingly parallel structure and avoids repeated scans of the full dataset in iterations, and is thus feasible for big data problems.

3 - Online Updating Of Statistical Inference In The Big Data Setting

Elizabeth D. Schifano, University of Connecticut, Storrs, CT, United States, elizabeth.schifano@uconn.edu, Ming-Hui Chen, Chun Wang, Jing Wu, Jun Yan, Yuping Zhang

We present statistical methods for big data arising from online analytical processing, where data arrive in streams and require fast analysis without storage/access to historical data. In particular, we develop computationally efficient, minimally storage-intensive iterative estimating algorithms and statistical inferences for linear models and estimating equations that update as new data arrive. We propose goodness of fit tests, a new estimator within the estimating equation setting, and a modification to incorporate new variables midway through the data stream. We demonstrate the effectiveness of our procedures through theoretical and empirical analysis, as well as in application.

■ TD67

Mockingbird 3- Omni

QTQM Invited Session

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Jing Li, Arizona State University, Arizona State University, Tempe, AZ, 85287, United States, jing.li.8@asu.edu

1 - A Mixed-effect Model For Analyzing Experiments With Multistage Processes

Kaibo Wang, Tsinghua University, kbwang@tsinghua.edu.cn

In industrial practice, most products are produced by processes that involve multiple stages. In this paper, through an analysis of the error transmission mechanism, we propose a mixed-effect model for analyzing experiments with multistage processes. Based on an analysis of simulated and real experimental data, we find that different conclusions about factor significance may be drawn if the data are analyzed differently. In addition, the mixed-effect model can help separate errors at different stages and hence provide more information on process improvement.

2 - Setup Adjustment For Asymmetric Cost Functions Under Unknown Process Parameters

Arda Vanli, Florida State University, 2525 Pottsdamer St, Tallahassee, FL, FL, 32310, United States, oavanli@eng.fsu.edu, Zilong Lian, Enrique Del Castillo"

We present a bayesian approach for the optimal control of a machine that can experience setup errors assuming an asymmetric off-target cost function. It is assumed that the setup error cannot be observed directly due to presence of measurement and part-to-part errors and the variance of this error is not known a priori. The setup error can be compensated by performing sequential adjustments of the process mean based on observations of the parts produced. We show how the proposed method converges to the optimal (known variance) trajectory, recovering from a possibly biased initial variance estimate. Simulations results are presented for constant asymmetric and quadratic asymmetric cost functions.

3 - Bounded Loss Functions And The Characteristic Function Inversion Method For Computing Expected Loss

Matthias Tan, City University of Hong Kong, matthtan@cityu.edu.hk

In robust parameter design, the quadratic loss function is commonly used. However, this loss function is not always realistic. We propose a general class of bounded loss functions that are cumulative distribution functions and probability density functions. New loss functions are investigated and they are shown to behave differently from the quadratic loss. For models linear in the noise factors, we give a numerical method based on characteristic functions inversion for computing expected loss. The method is very quick and accurate. It is applicable as long as the distributions chosen to represent the loss function and variation in the noise factors have tractable characteristic functions.

4 - Quasi-feedforward And Feedback Control For Random Step Shift Disturbance Models

Lihui Shi, Senior Data Scientist, Centerfield Corporation, El Segundo, CA, 90245, United States, shilihui@uw.edu
Lihui Shi, Senior Data Scientist, University of Washington, Seattle, WA, 98195, United States, shilihui@uw.edu

Process monitoring and process adjustment strategies are two important parts of the process improvement methods, and they should be integrated together in stead of separated. Integrated moving average (IMA) model is the most common disturbance model, and step shift model is one type of more complicated one that often exists in real applications. We investigate the IMA background disturbance subject to random step shifts with a certain probability. We propose a feedback control with a quasi-feedforward control by monitoring the output errors. It is very robust against parameter misspecifications. We also investigate the type I and type II errors in process adjustment on this disturbance model.

■ TD68

Mockingbird 4- Omni

Reliability Modeling and Optimization in Early Product Design Stages

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Zhaojun Li, Western New England University, Springfield, MA, United States, zhaojun.li@wne.edu

1 - Assessing Failure Dependency In A Complex System

Rong Pan, Arizona State University, Rong.Pan@asu.edu, Petek Yontay

In this talk we will discuss a Bayesian network model for assessing system reliability of a complex system. Coupling with Bayesian inference methods , the posterior distributions of the conditional probabilities in a BN model can be estimated by combining failure information and expert opinions at both system and component levels.

2 - A Multi-objective Approach For Multi-stage Reliability Growth Planning By Considering The Timing Of New Technologies Introduction

Steven LI, Western New England University, zhaojun.li@wne.edu, Mohammad Sadegh Mobin, Hossein Cheraghi

This paper proposes a new multi-stage reliability growth planning model which optimizes and balances the product development cost, time, and the product reliability. The number of test units, test time, and the percentage of introduced new technologies are major decision variables. Different reliability growth rates are considered for each sub-system in each stage. An integrated approach is developed to optimize the problem, which starts with a multi-objective evolutionary algorithm to find a set of Pareto optimal solutions followed by the application of clustering tools to cluster the solutions. The clustered solutions are further ranked using a multiple criteria decision making tool.

■ TD70

Acoustic- Omni

Transportation, Planning III

Contributed Session

Chair: Fan Xiao, Ph.D Student, Tongji University, Zhangwu Rd 1, Tongji Building A, 1913, Shanghai, 200092, China, 892225786@qq.com

1 - The Effect Of Parking Price Adjustment On Drivers Behavior Evidence From Sf Park Program

Ahmad Mohassel, PhD Candidate, University of Arizona, 1130 E helen st, McClelland Hall, 401, Tucson, AZ, 85721, United States, mohassel@email.arizona.edu

Congestion pricing is considered the solution to the high traffic congestion cost. One way to implement congestion pricing is to use real time pricing for parking spaces in the downtown areas of the large cities. Using the data from SFpark pricing experiment that was conducted between 2011 and 2014 in San Francisco, I investigate the effect of real-time pricing on driver's behavior. The effect of the experiment is a reduction in the traffic congestion and a decrease in the search cost for available parking. The results of this paper help to design a market mechanism to relieve congestion.

2 - Service Network Design With Heterogeneous Fleet And Time Requirements

Zujian Wang, Tsinghua University, Beijing, China, buwansangyu@gmail.com

To satisfy specific real-life demand of freight transportation carriers, this paper proposes an arc-based formulation for service network design with time requirements to schedule heterogeneous fleet. The computational study indicates the validity of the formulation both academically and practically. The results shows that heterogeneous fleet is essential to tactical planning for increasing the loading rate of vehicles.

3 - Holistic Trip Planning In The Charter Bus Business

Alexander Döge, Technical University of Munich, Schaufeleinstrasse 27B, Munich, 80687, Germany, alexander.doege@tum.de

In the charter bus business, generally a single request is planned and priced at a time. This practice leads to a considerable amount of empty trips and driver idle times. Our holistic approach is to dynamically plan and price all requests within a certain time interval yielding significant economic and environmental benefits. The approach is based on dynamic programming and state of the art metaheuristics.

Applied to real-world data, our results reveal that bus operators use their buses and drivers more efficiently, customers pay less and the booking agency makes more profit. Further, since empty trips are minimized, environmental pollution is reduced.

4 - Modeling Dynamics Of Crowd-delivery And Activity Participation Behavior

Mahdieh Allahviranloo, Assistant Professor, City College New York, CUNY, Steinman Hall, Rm T-134, 160 Convent Avenue, New York, NY, 10031, United States, mallahviranloo@ccny.cuny.edu

The work presented here is devoted to designing an optimal crowd-shipping model based on activity enrollment behavior of travelers and assessing its impacts on shifting demand for travel on a synthesized population. The analysis was performed using household travel survey data for New York City.

■ TD71

Electric- Omni

Vehicle Routing V

Contributed Session

Chair: Debdatta Sinha Roy, PhD Student, Robert H. Smith School of Business, University of Maryland, 7699 Mowatt Lane, 3330 Van Munching Hall, College Park, MD, 20742, United States, debsroy@rhsmith.umd.edu

1 - A Multi Depot Vehicle Routing Problem With Partial Coverage

Elham Kookhahi, wichita state university, 2330 N Oliver St Apt 1018, Wichita, KS, 67220, United States, exkookhahi@wichita.edu Elham Kookhahi, wichita state university, Wichita, KS, United States, exkookhahi@wichita.edu, Mehmet Bayram Yildirim, Mehmet Bayram Yildirim

In this paper, a mathematical model is presented for a multi depot capacitated vehicle routing problem with partial coverage in which a sub tour of a set of cities can be visited to maximize the number of customers that can be served with a limited budget and time. The problem is solved using a genetic algorithm and numerical results are presented.

2 - Heuristic Approaches For Advanced Pick, Place, And Transport-vehicle Routing Optimization Problems: Applications In Warehouse Order Picking Robotics

Hung-Yu Lee, PhD Student, Auburn University, 306 E Magnolia Avenue, 3339 Shelby Center, Auburn, AL, 36849, United States, hzl0024@auburn.edu, Chase Murray

The pick, place, and transport vehicle routing problem (PPT-VRP) was presented in our previous work. The problem is a variant of vehicle routing problems with multiple synchronization constraints representing the collaborations between two types of heterogeneous vehicles at certain locations for warehousing order picking. For shortening the routes, an advanced PPT-VRP is proposed to consider the collaborations at more potential locations. Heuristic approaches are proposed to solve the problems of practical sizes. From the managerial prospective, trade-offs to improve the routing performance, such as between using vehicles with faster speeds versus with higher capacity, are investigated.

3 - Addressing Uncertainty In Meter Reading For Utility Companies Using Radio-frequency Identification Technology

Debdatta Sinha Roy, PhD Student, Robert H. Smith School of Business, University of Maryland, 7699 Mowatt Lane, 3330 Van Munching Hall, College Park, MD, 20742, United States, debsroy@rhsmith.umd.edu, Bruce L Golden

Utility companies have to collect usage data from meters on a regular basis. It is done automatically using radio-frequency identification (RFID) technology. Each meter has a signal transmitter and a receiver can read it within a certain specified distance. It is a Close Enough Vehicle Routing Problem (CEVRP) on a street network. In reality, there is lot of uncertainty while reading meters. Each meter differs with respect to the distance from which they are read and this distance varies from day-to-day. We address this uncertainty using data analytics and we seek to design improved routes.

■ TD72

Bass- Omni

Supply Chain Mgt XII

Contributed Session

Chair: Jooyol Maeng, Assistant Professor, Pacific Lutheran University, School of Business, 12180 Park Avenue S, Tacoma, WA, 98447-0003, United States, maengjy@plu.edu

1 - Vertical Integration And Diversification: Value Chain Analysis From The Smartphone Industry

Suri Gurumurthi, University of North Carolina, 3516 Sawtelle Boulevard, Apt 114, Los Angeles, CA, 90066, United States, Suri_Gurumurthi@kenan-flagler.unc.edu

The strategy literature studies vertical integration from the perspective of core competencies, while the operations literature uses models based on cost and risk structures. Both however, points to the diminished differentiation capacity for a vertically integrated firm that might make outsourcing more attractive at various stages in the value chain. Using economic and operational models, I outline some long term benefits of vertical integration to the diversified firm whose business segments have considerable overlap. The benefits are shown to be predicated on the increased synergies and capabilities in innovation provided to a vertically integrated firm.

3 - Supply Chain Ambidexterity

Mehmet G Yalcin, University of Rhode Island, 216 Ballentine Hall, 7 Lippitt Road, Kingston, RI, 02881, United States, mgyalcin@uri.edu, Douglas N Hales

Grounded with ambidexterity theory, this research study proposes that while supply chain ambidexterity (SCX) has a positive influence in firm performance, SCX factors consist of supply chain integration (SCI), and supply chain agility (SCA). Employing literature review, interviews, and survey methods within the research design, the applied SCX is proposed in an empirical model with supply chain management related concepts that are used in the extant literature and among practitioners. In other words, the applied model posits a relationship between SCI and SCA towards forming SCX. The interaction between SCI and SCA is further investigated.

4 - Entry Deterrence And Price Competition Under Asymmetric Information

Jooyol Maeng, Assistant Professor, Pacific Lutheran University, School of Business, 12180 Park Avenue S, Tacoma, WA, 98447-0003, United States, maengjy@plu.edu, Sungyong Choi

An incumbent has an incentive to deter entry of a potential entrant by lowering pre-entry price. We study limit pricing in a price-based duopoly market under asymmetric demand information. We present a separating perfect Bayesian equilibrium, which indicates the incumbent with private information can successfully deter entry.

■ TD73

Legends A- Omni

Operations Management IV

Contributed Session

Chair: Jose M. Merigo, University of Chile, Av. Diagonal Paraguay 257, Santiago, 8330015, Chile, jmerigo@fen.uchile.cl

1 - Understanding And Managing Sequences Of Alignment Between Technologies And Adopters: Case Research Of Implementations Of A Health Screening Program

Jose Coelho Rodrigues, Researcher, INESC TEC and Faculty of Engineering, University of Porto, Rua Dr Roberto Frias, Porto, 4200, Portugal, jose.c.rodrigues@inesctec.pt, Ana C Barros, João Claro

Misalignments (lack of compatibility) between technologies and adopters cause productivity losses in early stages of implementation projects. Alignment management is particularly challenging when the adopter is a network of organizations. We use multiple case research of implementations of a health screening program in networks to understand how alignment efforts are sequenced, focusing on the non-linear and cascading sequences. We provide guidelines to improve implementations' performance, by addressing why non-linear and cascading sequences occur and what are their impacts on such projects.

2 - Mapping Production And Operations Management With VOS Viewer

Jose M. Merigo, University of Chile, Av. Diagonal Paraguay 257, Santiago, 8330015, Chile, jmerigo@fen.uchile.cl, Claudio Muller, Sigifredo Laengle

The VOS viewer is a computer software that visualizes the bibliographic material through different bibliometric indicators. This study develops a visualization of production and operations management research by using the VOS viewer. The analysis considers bibliographic coupling, co-citation, co-occurrence of keywords and co-authorship for journals, documents, authors, institutions and countries. The results indicate that this field is very diverse with two main cores focused on engineering and management. Researchers from all over the World are making important contributions in the field although the USA is still the leader.

■ TD74

Legends B- Omni

Optimization Methodology IV

Contributed Session

Chair: Xiang Gao, University of Minnesota, 111 Church Street SE, Minneapolis, MN, 55455, United States, gaoxx460@umn.edu

1 - Auction Algorithms For Distributed Integer Programming Problems With A Coupling Cardinality Constraint

Ezgi Karabulut, Georgia Institute of Technology, 755 Ferst Drive, NW, Atlanta, GA, 30308, United States, ezgi.karabulut@gatech.edu, Shabbir Ahmed, George L Nemhauser

We are interested in optimizing discrete problems that use a common resource, namely integer programming problems coupled with a cardinality constraint. Our auction algorithm finds the optimal resource allocations when individual problems are concave. When the problems are not concave, but rather have a concave approximation; and we provide respective error bounds for the auction algorithm.

2 - Fuzzification Of Search Techniques For Linear And Nonlinear Optimization

Paul Eugene Coffman, Technical Leader, Virtual Manufacturing and O.R., Ford Motor Company, 6100 Mercury Drive, Dearborn, MI, 48126, United States, gcoffman@ford.com, Stephany Coffman-Wolph

Using a three-step framework any algorithm can be converted into an equivalent abstract version known as a fuzzy algorithm. This goes beyond simply converting the raw data into fuzzy data by converting both operators and concepts into their abstract equivalents. Although precision may be reduced, it can be counteracted by gains in computational efficiency. This presentation will discuss linear and non-linear search algorithms that can benefit from fuzzification, results within the context of potential applications, and the characteristics of an algorithm where fuzzification can be utilized.

3 - Non-stationary Regret Analysis For A Non-convex Online Learning Model

Xiang Gao, University of Minnesota, 111 Church Street SE, Minneapolis, MN, 55455, United States, gaoxx460@umn.edu, Xiaobo Li, Shuzhong Zhang

In this talk we present a non-stationary regret analysis for an online learning model with smooth but non-convex cost functions. The cost functions are assumed to satisfy a condition which is more relaxed than the usual pseudo-convexity. Moreover, the cost functions are assumed to satisfy an error bound condition, which is implied by the analyticity. Under this framework, assuming only the loss function values can be evaluated we design a learning algorithm without the gradient information, and show that the regret of the algorithm is proportional to the square root of the product of learning periods and the variational budget which is the total variation of the optimal solutions measured in distance.

■ TD75

Legends C- Omni

Behavioral Operations IV

Contributed Session

Chair: Junlin Chen, Associate Professor, Central University of Finance and Economics, 39 South College Road, Haidian District, Beijing, 100081, China, chenjunlin@cufe.edu.cn

1 - Manufacturer Salespersons Relationships In Global Markets Considering Inventory Policies And Cultural Effects

Sepideh Alavi, PhD Candidate, University of Wisconsin Milwaukee, 1559, N Prospect Ave. Apt 309, Milwaukee, WI, 53202, United States, alavi@uwm.edu

The influence of salespersons' intermediary behaviors on customer retention has encouraged the manufacturers to develop and monitor strategies to increase loyalty in salespersons (Keiko Yamakawa, 2002).Also, cultural types reflect different trust characteristics in their relationship. Little is known about the impacts of culture in manufacturer- salespersons' relationships. This paper intends to address this gap by investigating the research questions: What are the inventory- related policy factors that enhance manufacturer-salespersons' relationship? And does culture play a role in the manufacturer- salespersons' relationship?

2 - Prediction Of SNS User's Behavior Preference

Peng Zhu, Nanjing University of Science and Technology, School of Economics and Management, 200 Xiaolingwei Street, Nanjing, 210094, China, p.zhu@outlook.com

Analysis and prediction of user behavior has become significant means to enhance the user experience in Social Networks Services(SNS). However, due to features of social networks, the limitations of user's time and energy, the social relationships of most social users are incomplete and sparse, it restricts the coverage and accuracy of user behavioral prediction. In response to these problems, this paper extracts user potential social relationship, and by making use of user preference information, it designs effective user preference consistency algorithm. Meanwhile, it proposes a visualizer evaluation method, which also can evaluate the performance of prediction algorithm from micro level.

3 - Strategic Consumer Behavior In Single Rider Lanes At Adventure Parks

Arpit Goel, PhD Student, Stanford, 475 Via Ortega, Huang Engineering Center, Stanford, CA, 94305, United States, argoel@stanford.edu

Adventure park rides often have separate lanes for single riders. Single riders are added to any ride tram which is not fully occupied, which increases the efficiency of the queuing process. Thus single rider lanes are usually served much faster than regular lanes. But often these lanes are strategically used by families to expedite their waiting times, the risk being the family not being able to take the same ride tram. We model this scenario as a stochastic process, understanding the strategic tradeoffs, showing situations where this strategic behavior significantly harms the welfare, and thereby implying some managerial ideas for adventure parks to further improve their queuing process.

4 - Crowding-out And Overjustification Effects On Pro-social Behaviors: A Quasi-experimental Study

Dandan Qiao, Tsinghua University, HaiDian District, Beijing, China, qiaodd.12@sem.tsinghua.edu.cn, Shun-Yang Lee, Andrew B Whinston, Qiang Wei

We explore how external incentives would influence one's pro-social behavior both in the short term and in the long run. Using a large data set on Amazon product reviews (1997-2014), we design a quasi-experimental approach by combining a propensity score matching (PSM) and a difference-in-differences (DiD) method. Several novel measures are proposed to capture reviewers' writing style and quality by applying linguistic, language processing, and machine learning techniques. Through estimating a series of fixed-effect DiD models, we find evidence consistent with reciprocity, crowding-out, and overjustification effects.

5 - An Experimental Study Of Customer's Risky And Egalitarian Behaviors In a Clearance Sales Problem

Junlin Chen, Associate Professor, Central University of Finance and Economics, 39 South College Road, Haidian District, Beijing, 100081, China, chenjunlin@cufe.edu.cn, Yingshuai Zhao

We consider a monopolist set prices in a two-period selling season such that low-value customers postpone the purchase for a lower price but subject to rationing risk, whereas high-value customers buy regularly. Traditionally, the optimal regular price is usually set with making high-value customers indifferent between buying early and late, and then basically all high-value customers are assumed to buy regularly. By conducting laboratory experiments, we provide evidence against this basic assumption. We demonstrate that the behavior of subjects can be explained by risky and egalitarian behaviors. We also find evidence about irrational waiting and myopic buying strategic customers.

■ TD76

Legends D- Omni

Decision Analysis II

Contributed Session

Chair: Nikita Korolko, PhD Candidate, Massachusetts Institute of Technology, 1 Amherst st, E40-106 ORC, Cambridge, MA, 2139, United States, korolko@mit.edu

1 - Impact Of Service Payment On Product And Service Supply Chain Considering Time Value

Jiayuan Liu, Tsinghua University, Tsinghua University, 14 Zijing Department, Beijing, 100084, China, liujiayuan46@163.com, Wanshan Zhu

We investigate a supply chain consisting of a service provider (e.g. AT&T) and a product maker (e.g. Apple), where the payment for service is in installments through a contract time frame. By modeling the installment payment and time value and solving the equilibrium strategies of pricing and inventory decisions, we analyze the impact of the service payment on the structure of the supply chain.

2 - Almost Stochastic Dominance When Utility Is Action-dependent

Chunling Luo, National University of Singapore, Singapore, Singapore, c_luo@u.nus.edu, Chin Hon Tan

Current stochastic dominance rules assume that utility function is identical across all actions. This assumption makes stochastic dominance rules not applicable under some practical settings. To help reveal decision makers' preferences under these settings, we generalize almost stochastic dominance by allowing utility functions to differ among actions.

3 - Decision Analysis For Locating Partial Building Renovations Regarding Adaptive Reuse

Kristopher Harbin, Doctoral Candidate, The University of Alabama, Tuscaloosa, AL, 35487-0205, United States, kbharbin@ua.edu

When considering a building renovation for an adaptive reuse there are numerous building attributes and systems that should be considered. These building attributes should be compared to the proposed reuse and any alterations needed should be noted. The impact of these alterations should be noted and assigned an appropriate weight reflecting the level of impact. This is done for multiple areas of the building which helps ensures a complete listing of the renovation options are seen.

4 - Covariate-adaptive Optimization In Online Clinical Trials

Nikita Korolko, PhD Candidate, Massachusetts Institute of Technology, 1 Amherst st, E40-106 ORC, Cambridge, MA, 02139, United States, korolko@mit.edu, Dimitris Bertsimas, Alexander M Weinstein

Pharmaceutical companies spend tens of billions of dollars each year to operate clinical trials needed for the approval of new drugs. We present an online allocation algorithm for clinical trials that leverages robust mixed-integer optimization. In simulated experiments involving both single and multiple controlled covariates, our method reduces the number of subjects needed to achieve a desired level of statistical power by at least 35% relative to state-of-the-art allocation algorithms. Correspondingly, we expect that our computationally tractable approach could significantly reduce both the duration and operating costs of a clinical trial.

■ TD77

Legends E- Omni

Opt, Integer Programing IV

Contributed Session

Chair: Joseph B Mazzola, Cleveland State University, 1860 East 18th Street, BU 530, Cleveland, OH, 44115, United States, j.b.mazzola@csuohio.edu

2 - Using Odheuristics To Solve Hard Mixed Integer Programming Problems

Alkis Vazacopoulos, Optimization Direct, Inc., 202 Parkway, Harrington Park, NJ, 07640, United States, alkis@optimizationdirect.com, Robert Ashford

It is not practical to prove optimality for most large scale MIP models. Indeed, many are so computationally onerous that it is not possible to raise the best bound at all beyond the root solve. ODHeuristics is a general purpose program built on CPLEX for obtaining good feasible solutions to such MIPs. It is designed for scheduling problems but works for any MIP which has a reasonable number of integer feasible solutions. It has been deployed effectively on packing problems, supply chain and telecoms as well as scheduling applications. This talk looks at what ODHeuristics does and how - in general terms - it goes about it with reference to some simple examples.

3 - Objective Scaling Ensemble Approach For Integer Linear Programming

Weili Zhang, University of Oklahoma, 202 W. Boyd St., Room 116, Norman, OK, 73019, United States, weili.zhang-1@ou.edu, Charles D. Nicholson

The objective scaling ensemble approach is a novel, approximate solution procedure for integer linear programming problems\deleted[id=WZ]{in general} \added[id=WZ]{shown to be effective on a wide variety of ILP problems}. The technique identifies and aggregates multiple partial solutions to modify the problem formulation and significantly reduce the search space. An empirical analysis on widely available difficult problem instances demonstrate the efficacy of our approach by outperforming the existing advanced solution strategies implemented in modern optimization software.

4 - Preventive Maintenance And Replacement Scheduling

Farzad Pargar, University of Oulu, Oulu, Finland, farzad.pargar@oulu.fi, Jaakko Kujala

In this paper, a pure integer linear programming model is developed to determine the optimal preventive maintenance and replacement schedules for a series of multi-component systems. In this model, we have considered a finite and discretized planning horizon in which three possible actions must be planned for each component in each system, namely maintenance, replacement, or do nothing. The objective is to minimize the total cost of projects by grouping maintenance and replacement operations. Because of the complexity of the model, several heuristic methods are applied to tackle the problem.

5 - Non Monotone Submodular Knapsacks And Applications

Avinash Bhardwaj, Postdoctoral Fellow, Georgia Institute of Technology, Room 336, 755 Ferst Drive, NW, Atlanta, GA, 30332, United States, abhardwaj@gatech.edu, Alper Atamturk

We study the facial structure of the convex hull of the level sets of a given submodular set function. In particular we derive valid inequalities and their extensions for the general lower level sets of submodular set functions, and propose the facet defining conditions for the same. We relax the monotonicity assumptions on the underlying set function and thus offering a generalization to earlier studies on this subject matter. We derive the appropriate valid inequalities and their extensions from the aggregation of the linear knapsack inequalities corresponding to the extended polymatroid of the set function in context.

1 - Generalizations And Applications Of The Multiperiod Assigment Problem

Joseph B Mazzola, Professor and Endowed Chair, Cleveland State University, 1860 East 18th Street, BU 530, Cleveland, OH, 44115, United States, j.b.mazzola@csuohio.edu

The Multiperiod Assignment Problem (MultiAP) involves the cost-minimizing assignment of a set of tasks to a set of agents within each period of a finite planning horizon when, in addition, there are transition costs associated with changing agent-task assignments from one period to the next. We review the literature on MultiAP and consider generalizations of the MultiAP including, for example, a model in which task learning occurs when an agent is able to work repeatedly on the same task. We also discuss applications of MultiAP.

■ TD78

Legends F- Omni

Opt, Network IV

Contributed Session

Chair: Devendra Anil Shelar, Graduate Research Assistant, Massachusetts Institute of Technology, 550 Memorial Drive, Tang Residence Hall, 8D2, Cambridge, MA, 2139, United States, shelard@mit.edu

1 - Cost Minimization Of Government Issued Cell Phones

Alexander Reid Barclay, Slippery Rock University, 20439 Hillview Road, Saegertown, PA, 16433, United States, axb1106@sru.edu, John Yannotty

Increasing costs associated with cell phone circuits has led the United States Pentagon to study consolidation of its wireless network in attempt to minimize annual expense while maximizing efficiency. During consolidation, Private Virtual Channels (PVCs) are transferred from either low utilized or expensive circuits to existing circuits with higher utilization and lower annual cost. The consolidation process is further constrained by region, service package (VCI code), and utilization capacity per circuit. Through the use of an optimized network annual expenses are decreased from approximately $11 million to $3.1 million.

2 - Bi-objective Maximal-covering Minimal-tour Problem With Applications In Disaster Relief

Sanaz Goldani, PhD. Student, North Carolina State University, 2127A Gorman Street, Raleigh, NC, 27606, United States, sgoldan@ncsu.edu, Yahya Fathi

The Bi-objective Maximal-covering Minimal-tour Problem (BCTP) is defined on a graph G = (V W, E), where W is a set of vertices associated with the demand. The BCTP aims at determining a Hamiltonian cycle on a subset of V so as to simultaneously minimize the cycle length and the total uncovered demand. A demand is covered if its associated vertex lies within a pre-specified distance from a vertex of the cycle. The problem is formulated as a bi-objective IP and a branch-and-cut algorithm is proposed to solve this problem in the context of the -constraint method. Computational results are presented.

3 - A Dynamic Programming Approach For Solving The Orienteering Problem With Time Windows Stochastic Profits And Risk Constraints

Hadi Feyzollahi, State University of New York at Buffalo, Buffalo, NY, 14260, United States, hadifeyz@buffalo.edu, Jose Luis Walteros

Given a graph with stochastic profits, risk levels and time windows associated with stopping at each of its nodes, we tackle the problem of finding a route that visits a subset of nodes, within a predefined time, so that the expected sum of the prizes collected is maximized, without exceeding a limit on the observed risk. We model the random nature of the profits and risk levels as mixed probability distributions and propose a dynamic programming approach to solve the resulting problem. We test our approach by solving a test bed of instances arising from the context of airborne sensor routing.

4 - Pedestrian-vehicle Mixed-flow Routing Problem In Emergency Evacuation Network For Public Places

Lei Bu, Institute for Multimodal Transportation, Jackson, MS, United States, leibu04168@gmail.com, Chuanzhong Yin, Wang Feng, Wenchao Shen, Liang Zou

Pedestrian-vehicle mixed-flow routing problem is studied at a public place to decrease the traffic delay at intersection based on a network planning strategy. An integer linear programming formulation is proposed to optimize the representation of space-time status, intersection selection, signal timing, turning strategy, walkway capacity and roadway capacity constraints with an objective function to minimize the total cost in the evacuation network. A case study using traffic microsimulation S-Paramics for pedestrian-vehicle mixed-flow evacuation around Tianhe Sports Centre Stadium in Guangzhou, China verifies the effectiveness of the formulation.

5 - Vulnerability Analysis Of Optimal Power Flow Problem Under Data Manipulation Attacks

Devendra Anil Shelar, Graduate Research Assistant, Massachusetts Institute of Technology, 550 Memorial Drive, Tang Residence Hall, 8D2, Cambridge, MA, 02139, United States, shelard@mit.edu, Saurabh Amin

A transmission network operator (TSO) solves the classical optimal power flow (OPF) problem to ensure supply-demand balance, subject to the constraints on generator outputs, line capacities, and power flows. We study the effects of malicious parameter manipulations on the OPF solutions using a sequential game formulation. The defender is the TSO who minimizes the cost of generation. The attacker is a malicious adversary who can manipulate certain parameters of the network to introduce capacity bounds violations. We show that an approximately optimal attack can be computed using a MILP.

■ TD79

Legends G- Omni

Opt, Stochastic IV

Contributed Session

Chair: Junfeng Zhu, University of Minnesota, 1019 29th Ave SE Unit C, Apt 103, Saint Paul, MN, 55414, United States, zhuxx793@umn.edu

1 - A Chance-constrained Two-stage Stochastic Program For A Reliable Microgrid System

Md Abdul Quddus, PhD Student, Mississippi State University, Department of Industrial & Systems Engineering, PO Box 9542, Starkville, MS, 39762, United States, mq90@msstate.edu, Carlos Marino, Ridvan Gedik, Mohammad Marufuzzaman

Curtailment of renewable resources generation during the Microgrid operation affects revenues and increases greenhouses gas emissions. Researchers pay little attention in scalable stochastic models for Microgrid for multiple nodes considering the variability of renewable resources. This study bridges the research gap by developing a scalable a chance-constrained two-stage stochastic program to ensure that a significant portion of the renewable resource power output at each operating hour will be utilized.

2 - Tackling Drug Shortages By Examining Resiliency And Robustness In Pharmaceutical Supply Chains

Rana Azghandi, PhD Candidate, Northeastern University, 360 Huntington Avenue, Boston, MA, 02115, United States, azghandi.r@husky.neu.edu, Jacqueline Griffin, Ozlem Ergun

Over the past five years, there has been an epidemic of drug shortages. While the drug shortage problem is widespread, there is a poor understanding of the features of disruptions in the complex system that lead to these shortages, which are difficult to recover from. Using a stochastic optimization modeling framework, we identify system features and policies that are needed to operate a robust and resilient pharmaceutical supply chain, with minimal drug shortages and quick recovery from shortages.

3 - Robust And Optimistic Games With Bounded Polyhedral Uncertainty Sets

Giovanni Paolo Crespi, Associate Professor, Universita' Degli Studi dell'Insubria, Via Monte Generoso, 71, Varese, 21100, Italy, giovanni.crespi@uninsubria.it, Matteo Rocca, Davide Radi

We introduce a distribution-free model of incomplete information for finite games with bounded polyhedral payoff uncertainty sets. We assume players adopt either a robust or an optimistic approach to contend with payoff uncertainty. When all players adopt a robust optimization approach, we obtain a robust game as in Aghassi and Bertsimas in 2006. When all players adopt an optimistic optimization approach, we define an optimistic game. Existence of equilibrium in both approaches is proven. Further, we propose an algorithm for optimistic-optimization equilibria. Both equilibria are identifiable by a method analogous to those used for Nash equilibria of a finite game with complete information.

4 - Robust Optimization For Chronic Myeloid Leukemia Treatment Under Uncertainty

Junfeng Zhu, University of Minnesota, 1019 29th Ave SE Unit C, Apt 103, Saint Paul, MN, 55414, United States, zhuxx793@umn.edu

We propose an approach to deal with parameter uncertainty for multistage mixed integer optimal control problem(MIOCP) in CML applications. We first build a model to describe the dynamics of leukemic cells and side effects during CML treatment. The nominal optimization problem is to minimize the cumulative leukemic cell size over a planning horizon. We then consider about how the parameter uncertainty affects the optimal solution. In this project, we only consider about uncertainty for parameter with the most important factor. Finally, we propose the robust mixed integer problem and transform it into a mixed integer linear problem which is solvable.

■ TD86

Gibson Board Room-Omni

Marketing VII

Contributed Session

Chair: Zhouyang Lu, Hohai University, Business School, Hohai Univ, 8 Fochengxilu, Jiangning, Nanjing, 211100, China, lzyseu@hhu.edu.cn

1 - Using Trade-in Programs To Mediate Secondary Market Effects In Platform Competition

Chia-Hang Li, PhD Candidate, Illinois Institute of Technology, 10 W. 35th Street, Chicago, IL, 60616, United States, cli63@hawk.iit.edu, David Richardson, Elizabeth J Durango-Cohen

We develop an analytical model of sales of successive generations of a consumer durable in which each generation brings an exogenous quality improvement to vertically differentiated consumers who can sell legacy products in a secondary market. Our model provides closed form solutions for the optimum pricing policy with and without trade-in programs. We use comparative statics on the model to characterize the circumstances in which trade-in programs prove advantageous and gain insights into how they increase profits in monopoly and duopoly settings with network effects.

2 - Evaluating Start Ups Marketing Strategies Using An Agent Based Modeling And Simulation Approach.

Ali Arian, Graduate Student, University of Arizona, 1202 e 2nd street, Tucson, AZ, 85721, United States, arian@email.arizona.edu, Yi-Chang Chiu

Marketing for a start-up company is a great challenge due to limited capital and intellectual resources and lack of brand recognition and visibility. This talk using an agent based simulation and modeling (ABMS) approach to evaluate various marketing opportunities. Existing and past data were used to calibrate the model.

3 - Brand Leadership, Competitive Pressure, And Social Marketing In The High-end Fashion Industry

Cuicui Chen, PhD Candidate, Harvard University, 79 JFK St, Cambridge, MA, 02138, United States, cuicuichen@fas.harvard.edu, Jorge Ale Chilet, Yusan Lin

While the fashion industry has been subject to mostly qualitative research, we adopt a data-driven approach to study high-end fashion brands' leadership, competitive pressure and social marketing. Applying Natural Language Processing to department store listings, expert runway reviews, and Instagram posts, we find that high-end fashion brands respond to competitive pressure more by relying on brand-building posts (such as celebrity patronage and press mentions) on social media, than by sharing product information. Furthermore, this effect is stronger for following, or adopting, brands than leading, or innovative, brands. We develop a microeconomic model to explain these findings.

4 - A Game Theoretic Approach For Achieving Higher Communities Satisfaction On Ppp Infrastructure Projects

Zhouyang Lu, Hohai University, Business School, Hohai Univ, 8 Fochengxilu, Jiangning, Nanjing, 211100, China, lzyseu@hhu.edu.cn, Jason Salim, Xuemei Su

PPP are often mistaken as merely a relationship between private and government agencies. Real "public" (the community) is often ignored, and public marginalization may cause future problem, like protests and/ or low demand. Analysis based on game theory shows that chance of community acceptance towards a project is inversely related to the chance of PPP agents behaving fairly towards the community.

■ TD87

Broadway A-Omni

Economics I

Contributed Session

Chair: Youzong Xu, Wuhan, China, xu.youzong@wustl.edu

1 - Pricing In A Robust Approach To Electricity Markets

Xiaolong Kuang, Lehigh University, 14 Duh Drive, Apt 324, Bethlehem, PA, 18015, United States, xik312@lehigh.edu, Alberto J Lamadrid, Luis F Zuluaga

The existence of market clearing prices and the economic interpretations of strong duality for integer programs in the economic analysis of markets with nonconvexities have been studied in literature. We follow this line of research and study the market clearing prices in a robust approach to electricity markets.

2 - Voting With Behavioral Heterogeneity

Youzong Xu, Xi'an Jiaotong-Liverpool University, Wuchan, Suzhou, China, xu.youzong@wustl.edu

This paper studies collective decisions made by behaviorally heterogeneous voters with asymmetric information. Here "behavioral heterogeneity" models voters' different levels of sophistication in handling information, in the sense that some voters take the information revealed by pivotality into account when making decisions (call "sophisticated voters"), while other voters vote only according to their private information (called "sincere voters"). The presence of sincere voters enriches information revelation of pivotality and such enriched information exacerbates the "pivotal voter's curse." The exacerbation of the "pivotal voter's curse" can improve collective decisions

3 - Committee Size And Resistance To Information Manipulation

Youzong Xu, Xi'an Jiaotong-Liverpool University, Suzhou, China, xu.youzong@wustl.edu, Bo Li

Consider a committee that needs to choose between two alternatives. This committee employs an agent (she) who may be biased to provide information for the committee members to make the decision. Say that the committee resists information manipulation if the biased agent's desired alternative is chosen with a lower probability when the committee knows that the agent may be biased than when the committee knows for sure that the agents is unbiased. We show that small-size committees resist information manipulation while large-size committees do not. Actually, when committee size is large enough, all committee members act as if they entirely ignore the possibility that the agent may be biased.

4 - Surviving Recessions: Relationships In Thoroughbred Horse Industry

Cristina Nistor, Chapman University, One University Drive, Orange, CA, 92866, United States, nistor@chapman.edu, Darcy Fudge Kamal

The great recession of 2008 affected the entire US and world economy. The Thoroughbred horse industry emerged from the recession with higher quality, and less overall risk in the market. We study how the Thoroughbred horse industry was affected by the recession by using a large longitudinal dataset containing details of relationships between Thoroughbred stud farms and nurseries that spans ten years of detailed transactions between 2005 and 2014. Our results indicate that the increase in quality is more pronounced in situations where firms transact with each other repeatedly in a relationship.

■ TD88

Broadway B-Omni

Queues and Server Behavior

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Mirko Kremer, Frankfurt School of Finance and Management gGmbh, Frankfurt, Germany, m.kremer@fs.de

1 - Goal Setting In Teams: A Real-effort Coordination Experiment

James Fan, Penn State University, State College, PA, 16802, United States, juf187@psu.edu, Joaquin Gomez-Minambres

We experimentally study the impact of non-binding goals for a team of workers facing high levels of strategic complementarity. These production settings include assembly lines and group projects. Participants act as workers and managers on a team completing a real-effort task that contributes towards team production. The manager can assign a goal to her team that does not impact monetary payoffs. Consistent with our theoretical predictions, we find that when managers are able to set goals for the team, team production increases. The positive effect of goal setting is especially strong when goals are challenging but attainable for the weak-link worker, whose output determines team production.

2 - Experiment Of Hospital Admission Decision Behavior Under Congestion And Patient Severity Uncertainty

Song-Hee Kim, Marshall School of Business, University of Soouthern California, Los Angeles, CA, United States, songheek@marshall.usc.edu

Hospitals have limited capacity to admit patients who arrive at different wards, such as an intensive care unit. We explore how physicians make decisions to admit patients in order to understand how to improve this important decision-making process. Specifically, in a controlled laboratory experiment setting, we observed and compared admission decision-making behaviors based on current unit occupancy and severity of arriving patient conditions.

3 - Social Norms In Customer-operated Service Systems

Chen Jin, Northwestern University, chen.jin198829@gmail.com

We study whether and how social norms evolve in, and affect the performance of, customer-operated service systems, where service times are (partially) endogenously determined by the customers. We find that service times are positively serially correlated and explore several boundary conditions of this phenomenon, as well as managerial levers to mitigate its adverse impact on system level metrics. Our results complement a growing literature that demonstrates the effect of system load on service times in server-operated systems.

■ TD89

Broadway C-Omni

Modeling Information for Intelligent Transportation Systems

Sponsored: TSL, Intelligent Transportation Systems (ITS)

Sponsored Session

Chair: Lili Du, Illinois Institute of Technology, 3201 South Dearborn Street, Chicago, IL, 60616, United States, ldu3@iit.edu

1 - Information Spreading Dynamics Over Vehicular Ad Hoc Network On Road Segments Based On Cell Transmission Model

Siyuan Song, Illinois Institute of Technology, Department of Civil, Architectural, and Environmental Engineering, Chicago, IL, 60616, United States, sgong1@hawk.iit.edu, Lili Du, Xiang-Yang Li

This research develops an information-traffic coupled cell transmission model (IT-CTM) to capture discrete information spreading dynamics along with traffic flow dynamics on a road segment. The IT-CTM is built upon CTM, and involves mathematical formulations to capture in-cell and intro-cell information spreading so that we can track the information spreading dynamics along the chain of IT-CTM cells. Numerical experiments based on simulation data were conducted to validate the accuracy of the proposed approach.

2 - How Likely Am I To Find Parking? – Modeling of Stochastic Parking Processes And Probabilistic Estimation Of Parking Availability

Jun Xiao, Arizona State University, Tempe, AZ, United States, jun.xiao.1@asu.edu, Yingyan Luo, Joshua Frisby

This research has developed two Markov models to describe the stochastic parking process with capacity constraint. Given parameters in the process, the Markov transition matrix can be calculated for each model, which in turn leads to the probability distribution of the parking facility occupancy as a function of time. Mathematical properties of these models have been derived analytically under specific conditions. Using real data from San Francisco, we have demonstrated that the proposed approach is able to predict time-dependent occupancy accurately.

3 - Identifying Social Interaction Networks For Planned Special Events

Arif Mohaimin Sadri, Purdue University, West Lafayette, IN, United States, asadri@purdue.edu, Samiul Hasan, Satish Ukkusuri, Juan Esteban Suarez

Planned Special Events (PSE) include large sporting events, conventions and other similar events. Because of specific locations and times of occurrence, PSEs are associated with operational needs that can be anticipated and managed ahead of time. Social media platforms can be used to disseminate information more efficiently. In this study, we propose a new technique to infer social interaction networks for PSEs by using data from Twitter. This network of direct social influence can serve as an important tool to disseminate information effectively and manage real-time traffic.

4 - Psychological Effects Of Real-Time TravelInformation On Route Choice Behavior Of Heterogeneous Travelers – Analysis Of Interactive Driving Simulator Experiment Data

Dong Yoon Song, Purdue University, School of Civil Engineering, West Lafayette, IN, United States, song50@purdue.edu, Srinivas Peeta

Using interactive driving simulator data, we investigate the psychological effects of real-time travel information on route choice decision-making by considering travelers' heterogeneity in information perception. An analytical framework for characterizing the traveler classes and interpreting the psychological processes under the information provision for each class is proposed.

■ TD90

Broadway D-Omni

Health Care, Modeling XI

Contributed Session

Chair: Miao Bai, Lehigh University, Bethlehem, PA, 18015, United States, mib411@lehigh.edu

1 - Evaluating Prioritization Schemes For Hepatitis C Treatment Under Budget Constraints

Lauren E Cipriano, Assistant Professor, Ivey Business School, 1255 Western Road, Room 2361, London, ON, N6G 0N1, Canada, lcipriano@ivey.uwo.ca, Shan Liu, Kaspar S. Shazada, Mark Holodniy, Jeremy D Goldhaber-Fiebert

Highly effective, but expensive, treatments could improve the health of individuals chronically infected with hepatitis C virus (HCV). We develop a multi-period HCV treatment budget allocation model to evaluate the trade-offs of prioritization schemes including first-come first-served, priority to patients with most severe disease, and priority to patients based on incremental cost effectiveness ratio. We also apply an optimization framework to determine the priority sequence that maximizes net monetary benefit in the population. Explicit prioritization guidelines targeting younger patients with more severe disease first provide the greatest population health benefits.

2 - Robust Surgery Planning And Scheduling With Downstream Bed Capacity In ICU

Chun Peng, PhD Candidate, Beijing Institute of Technology, Haidian District, 5 South Street, Beijing, 100081, China, pengchun12.18@163.com, Jinlin Li, Shanahan Wang

Due to the coupled effect of multiple sources of uncertainty, planning and scheduling surgeries is a complicated combinatorial optimization problem. In this paper, we consider the downstream bed capacity in ICU, employ uncertainty set to capture the uncertainties for surgery duration and length-of-stay in ICU. Then, we propose a two stage robust model to address these uncertainties, derive the tractable robust counterpart. Numerical results show that, compared with uncertainty of length-of-stay, surgery duration uncertainty has a significant effect on the total cost and the overtime of blocks, whereas uncertainty of length-of-stay has a dramatic impact on the amount of short beds in ICU.

4 - Using Simulation To Improve Access To Care For Underserved Populations

Rozhin Doroudi, Northeastern University, 360 Huntington Ave, Boston, MA, 02115, United States, doroudi.r@husky.neu.edu, Ayten Turkcan, Tammy Toscos, Huanmei Wu, Brad Doebbeling

Underserved patients experience multiple barriers for health care access. Community Health Centers play an important role in improving access to care for the underserved by accepting all patients regardless of their financial status. We developed simulation models tailored for three different CHCs from a range of geographic and populations with various clinical operational concerns. We tested several scenarios and found best interventions to enhance patient access to care.

5 - Reactive Surgery Rescheduling On The Day Of Surgery

Miao Bai, Lehigh University, Bethlehem, PA, 18015, United States, mib411@lehigh.edu, R.H. Storer, G.L. Tonkay, Terrill Theman

Surgery schedules are subject to disruptions on the day of surgery due to random surgical durations, insufficient resource, unpunctual patients and emergency. We incorporate a sample-based gradient descent algorithm in a rescheduling strategy to make timely adjustment to alleviate the negative consequences of schedule disruptions. Our objective is to minimize the cost of patient waiting time, surgeon idle time, operating room (OR) blocking time, OR overtime and post-anesthesia care unit (PACU) overtime in multiple OR with PACU capacity constraints. Numerical results demonstrate the effectiveness of our method in reducing the overall cost on the day of surgery.

■ TD94

5th Avenue Lobby-MCC

Technology Tutorial: FICO

Technology Tutorial

1 - FICO: How To Deploy Your Analytic Models To Empower Non-technical Business Users

James Williams, FICO, Roseville, MN, United States, JWilliams@fico.com

You have a team with great analytics background. They have developed advanced analytical tools using SAS, Python, R or with your current traditional optimization solver. They have derived crucial insights from your data, and figured out how your decisions shape your customers' behaviors. Now it's time to put these critical analytical insights in the hands of your non-technical business users. In this tutorial, we will cover how FICO's Optimization Suite (including Xpress and Optimization Modeler) make it possible to embed your analytic models in user-friendly business-user facing applications. Learn how you can supercharge your analytic models with simulation, optimization, reporting, what-if analysis and agile extensibility.

Wednesday, 8:00AM - 9:30AM

■ WA01

101A-MCC

Forecasting

Sponsored: Data Mining

Sponsored Session

Chair: Ivan G Guardiola, Missouri S&T, 600 W. 14th St, Rolla, MO, 65409, United States, guardiolai@mst.edu

1 - Ensemble Methods With Disparate Data Sources For Stock Market Prediction

Lin Lu, Auburn University, Auburn, AL, United States, lzl0032@auburn.edu, Bin Weng, Fadel Mounir Megahed

Stock market has time critical characteristics which draws attentions from both investors and researchers. The objective of this study is to develop a prediction model for stock's short-term movement forecasting. We assume more related data sources used will increase the prediction performance. In this study, we consider data from Wikipedia, Financial news, Market sentiment and Stock market history data. Different features are generated from these data sources and data mining methods are applied to select the most important ones. Next, ensemble methods are used to develop the model. As a result, our prediction model dominates related studies for the stock market forecasting.

2 - Occupancy Level Analysis At A VA Hospital That Considers Discharge Of Patient Medical Decisions

Ivan G Guardiola, Associate Professor, Missouri S&T, 600 W. 14th St, Rolla, MO, 65409, United States, guardiolai@mst.edu, Tatiana Cardona

The improvement of short-term information is vital to obtain positive gains in various hospital operational and business processes. To this end, the prediction or forecasting of hospital census gives insight into hospital resource use that results in better planning. This paper presents a combination of nonparametric and parametric models to deal with the intra-week seasonality from the daily discharge distribution.

3 - Neural Networks Based Linear Ensemble Framework for Time Series Forecasting

Lin Wang, Huazhong University of Science and Technology, Wuhan, China, Zhigang Wang

In this study, a combination forecasting model resulting from a novel ensemble framework of four neural networks is proposed for time series forecasting. The proposed framework has two primary advantages: (a) a heuristic to determine the number of input and hidden neurons for each neural network, and (b) a BPNN-BSA based mechanism for the associated combining weights. Both of the advantages will improve the accuracy of each individual model and the final linear combination modle. Experimental results performed on nine time series datasets show that the ensemble framework outperforms the component neural network models and other well recognized models.

■ WA02

101B-MCC

Data Mining in Healthcare 1

Sponsored: Data Mining

Sponsored Session

Chair: Adel Alaeddini, University of Texas at San Antonio, Department of Mechanical Engineering, One UTSA Circle, San Antonio, TX, 78249, United States, adel.alaeddini@utsa.edu

Co-Chair: Anh Pham, University of Arkansas, 1411 S Washington Avenue, Fayetteville, AR, 72701, United States, anh.pham1234@gmail.com

1 - Using Data Mining To Detect Fraud And Abuse Under National Health Insurance System In China

Chong Li, Beijing Institute of Technology, Beijing, 100081, China, lichongbit@163.com, Zihao Jiao, Huijuan Cao

Health care fraud and abuse are pressing problems, causing an important fraction of total health expenditure wasted. Data mining methods can be used to automatically detect fraud in billions insurance claim data, superior to the time-consuming and practically efficient traditional auditing methods. Nevertheless, few studies have been dedicated to this field in China. This paper presents how to apply unsupervised methods to extract useful information and identify a smaller subset from the claims for further assessment under China National Health Insurance system. Our approach will help in streamlining auditing approaches towards the suspect groups rather than routine auditing of all claims.

2 - Understanding The Association Of Clinical Characteristics Of Low Grade Gliomas With Disease Outcomes

Anh Pham, Student, University of Arkansas, 1 University Avenue, Fayetteville, AR, 72701, United States, anh.pham1234@gmail.com, Shengfan Zhang

Glioma is among the most prevalent and most devastating primary brain tumor. Gliomas represent 28% of all brain tumors and 80% of malignant brain tumors. 70% of Low Grade Glioma patients eventually die from cancerous tumor transformation. This study uses The Cancer Genome Atlas (TCGA) data to understand relationships between different clinical characteristics of Low Grade Glioma, such as tumor grades, tumor status, vital status and first presented symptoms. Two data mining methods, association rules and decision trees, are used.

3 - Modeling The Accumulation Of Comorbidities In Patients With Multiple Chronic Conditions

Adel Alaeddini, University of Texas at San Antonio, Department of Mechanical Engineering, One UTSA Circle, San Antonio, TX, 78249, United States, adel.alaeddini@utsa.edu

Long-lasting diseases known as chronic conditions can be considered as a staple example of degradation processes that can progress and accumulate over time. Approximately a quarter of all Americans and 75% of citizens aged 65 years and older are burdened with two or more (multiple) chronic conditions (MCC). Here, we introduce a latent regression Markov mixture (LRMM) model to explore major patterns of disease accumulation in MCC patients and identify the risk factors affecting the accumulation process. The new methodology will be validated through a national healthcare dataset.

■ WA03

101C-MCC

Big Data

Contributed Session

1 - Discriminant Analysis And The Baseball Hall Of Fame

Tom Brady, Purdue University, 1401 S US Hwy 421, Westville, IN, 46391, United States, tbradyjr@pnc.edu, Tom Brady

Baseball has long been referred to as the national past time in America. The most fundamental discussions center around the inclusion, or exclusion of individual players in the Baseball Hall of Fame. Election to this esteemed organization is done on a purely subjective basis. The movie "MoneyBall" has highlighted the recent trend towards using a more quantitative approach to managing and operating a professional baseball team. The term Sabermetrics refers to the application of quantitative techniques in all areas of baseball. In this paper, we apply Discriminant Analysis to the selection problem faced by the Baseball Hall of Fame members and analyze the performance of the process since its inception.

2 - Graphical Lasso And Thresholding: Conditions For Equivalence

Somayeh Sojoudi, University of California, Berkeley, 1543 Delaware Street, Berkeley, CA, 94703, United States, somayeh.sojoudi@gmail.com

Graphical lasso is a popular technique for finding a sparse inverse covariance matrix from a small number of samples. Graphical lasso is computationally expensive for large-scale problems due to a positive semidefinite constraint. A cheap heuristic method for finding a graphical model is to simply threshold the sample correlation matrix. By introducing the notions of sign-consistent and inverse-consistent matrices, we derive sufficient conditions under which graphical lasso and thresholding produce the same solution. These conditions are expected to be satisfied for sufficiently sparse graphical models. We test the conditions on electrical circuits and functional MRI data.

3 - Quantitative Compliance As A Driver For Automation

Leif Meier, Professor, University of Applied Sciences Bremerhaven, An der Karlstadt 8, Bremerhaven, 27568, Germany, lmeier@hs-bremerhaven.de

Compliance management covers all efforts to comply with regulations such as laws and rules, policies and standards. Automated processes are dealing with a huge number of (trans-) actions to be executed in short term, depending on big data sets. Each single transaction that is executed must comply with regulations and must be transparent to auditors. Quantitative Compliance provides methods to manage processes and risks in complex systems considering regulations to improve decisions from available information. We provide an example to identify risks from Anti-Money-Laundering (AML) in Financial Transactions and show applications of this approach to data-driven systems in new areas.

4 - Representing Uncertainty With Convex Model Databases

Anushka Chandrababu, Research Scholar, International Institute of Information Technology, Bangalore, 26/C, Electronic City, Bangalore, India, anushka.babu@iiitb.org, Srinivasa Prasanna

We present Convex Model Databases for storing and querying uncertain data sets. The database stores convex models which could be a collection of polytopes, ellipsoids etc. We will discuss methods to represent them, generate them from uncertain or big-data applications, associated relational algebra and results from new optimized queries based on I-structures, a generalization of database indices. We will also show case real world applications of this database representing uncertain or big data.

5 - A Recommender Systems Approach For Predicting Utility Of Various Mobile Services

Abhay Kumar Bhadani, Indian Institute of Technology-Delhi, Ground Floor office, New Delhi, 110016, India, abhaybhadani@gmail.com, Ravi Shankar, Vijay Rao

Modeling human behavior and predicting their preferences is of interest to many organizations. The ability of predict one's preference in mobile ser- vices arena pertains high business value for the service providers. This paper attempts to model user's preference using collaborative filtering based recommender system.

■ WA04

101D-MCC

Optimization in converter-based power systems

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Joshua Adam Taylor, University of Toronto, 10 King's College Road, SF 1021C, Toronto, ON, M5S 3G4, Canada, taylor.a.josh@gmail.com

1 - Designing Microgrid Dynamics

Baosen Zhang, University of Washington, zhangbao@uw.edu

Power electronics interfaces allows us to design dynamical behaviors in microgrids. As an important example, the moment of inertia and damping coefficients can be designed to optimize system performance. In this talk, we will consider the optimal design problem of choosing these coefficients, subject to the physical constraints of the power electronics. We show how to cast this problem as an eigenvalue problem, which can then be approximated via a convex program. We also investigate the role of network topology.

2 - Frequency Control In Microgrids: Distributed Implementation And Intrusion Detection

Lin-Yu Lu, University of Illinois at Urbana Champaign, Urbana, IL, United States, lyl@illinois.edu, Hao Zhu

High penetration of distributed generation in microgrids has raised the frequency stability issue. Secondary control can resolve it by dispatching active power resources, which may be vulnerable to malicious attacks on the communication infrastructure. A distributed secondary control for distributed energy resources is developed in this paper along with the cyber-security considerations. The control scheme can achieve the goal of power sharing while restoring frequency in a distributed fashion. Attack detection and localization strategies are developed using local measurements and neighbor information.

3 - Optimizing The Interplay Between The Micro And Macro Grids: From Challenges To Perspectives

Luckny Zephyr, Postdoctoral Associate, Cornell University, Ithaca, NY, 14853, United States, lz395@cornell.edu, C. Lindsay Anderson

Efficient management of power networks is a difficult task. This is exacerbated by the integration of renewables. Finding good operating policies depends upon two complementary tasks (i) finding an acceptable representation for the underlying stochastic process, and (ii) given an approximation, finding an optimal operating policy for the power network. The interface between these two steps is a challenge. We assert that a significant proportion of the flexible loads are located in the distribution system, we then want to develop a comprehensive stochastic co-optimization scheme for the interplay between the generation and transmission system, and the distribution-system-as-micro grid.

4 - Optimizing Power Electronic Converters Using Geometric Programming

Andrija Stupar, University of Toronto, andrija@stupar.com

We formulate the design of power electronic converters as a geometric program (GP). The GP formulation allows the use of existing convex optimization solvers and techniques which greatly speeds up the optimization process. Some components are naturally modeled as posynomials, and those that are not can be accurately approximated via empirical fitting. The GP formulation allows a quick generation of Pareto curves and surfaces over a number of operating points and component combinations for a converter. This is illustrated using an example where loss-volume Pareto-optimal solutions for different multi-level converter topologies are compared.

■ WA05

101E-MCC

Forest Management II

Sponsored: Energy, Natural Res & the Environment II Forestry

Sponsored Session

Chair: Peter Rauch, BOKU-Univ of Natural Resources & Life Sciences, Institute of Production and Logistics, Wien, 1180, Austria, Peter.rauch@boku.ac.at

1 - Quantifying The Conflict between Competing Forest Ecosystem Services under Alternative Climate Scenarios

Nicholas Kullman, University of Washington, Nick.Kullman@gmail.com, Sandor Toth

The potential impact of climate change on the production of forest ecosystem services is well-documented. Much less understood is how the tradeoffs among these services would change. Would more conflicts arise? How would one measure such a conflict at the first place? We introduce a new method to quantify conflict as the ratio between the volume of n-dimensional objective space under the production possibilities frontier of a set of competing ecosystem services vs. the space defined by the ideal solution. We illustrate the method via use of real examples from management.

2 - A Replanning Model For Maximizing Woodland Caribou Habitat Alongside Timber Production

David L Martell, University of Toronto, david.martell@utoronto.ca, Andrew B. Martin, Jonathan Leo William Ruppert, Eldon Gunn

Woodland caribou in the boreal forest region of Canada tend to prefer older jack pine forest stands but such habitat needs can conflict with industrial fibre needs. We present a forest harvest scheduling model that meets timber harvest targets while maximizing a proxy for woodland caribou habitat, the configuration of preferred habitat on the landscape. We used our model to carry out a case study of the Trout Lake forest in northern Ontario, Canada, and found that our model creates about 10% more caribou habitat than an earlier heuristic procedure and 30% more than the current plan for the forest.

3 - Modeling The Spatial Interactions Of Timber Harvesting And Sitka Deer Habitat On The Tongass National Forest

Yu Wei, Colorado State University, yu.wei@colostate.edu, Michael Bevers, Curt Flather, Greg Hayward, Ben Case, Mary Friberg, Thomas Hanley

We developed and implemented a spatially explicit timber harvest scheduling model to optimize the joint production of timber and deer habitat capability on management units of the Tongass NF. We found model solutions to be sensitive to variation in sea level snow depths, with notable effects on timber harvest schedules, deer habitat capacity, and the amount and location of old-growth remaining at the end of a forest planning horizon. We also discovered that a spatially scattered harvesting pattern helped create diversified forest compositions; which consequently could improve the overall deer forage production.

4 - How Does Climate Change Impact On Wood Supply Security?

Peter Rauch, BOKU-Univ of Natural Resources & Life Sciences, Peter.rauch@boku.ac.at

In order to assess climate change risks and their mid and long-term impacts on the bio-based industry a System Dynamics model of the Austrian wood supply was developed that includes a stochastic simulation of the main risk agents. The model examines future annual cut and evaluates wood supply security considering climate change impacts. Simulation results provide insights on probabilistic future wood supply security and reveal a contra-intuitive system effect for the climate change scenario.

■ WA06

102A-MCC

Text Mining I

Sponsored: Data Mining

Sponsored Session

Chair: Majeed Simaan, RPI, 231 Congress Street, Troy, NY, 12180, United States, simaam@rpi.edu

1 - Text Mining Based Prediction Model For Incident Occurrences In Steel Plant

Sobhan Sarkar, Research Scholar, IIT, IIT kharagpur, kharagpur, 721302, India, sobhan.sarkar@gmail.com, Vishal Lakha, Irshad Ansari, Jhareswar Maiti

The aim of this study is to provide the predictive solution using text mining and classification algorithms. Data on accident occurrences for a period of four years from a steel industry was collected. The outputs of text mining have been fed into four binary classification algorithms (SVM, k-NN, Random Forest, Maximum Entropy) which were tested further for evaluation of the best fit model to predict

the accident classes (injury or property damage). The year-wise results showed that RF outperforms other classifiers with higher accuracy, i.e., 92.7%, 91.4%, and 91.8%, and area under curve values as 0.926, 0.910, and 0.912, respectively as tested with 10-fold cross validation for years 1, 3, and 4.

2 - Analyzing Analytics Curricula

Thomas Tiahrt, Assistant Professor of Decision Sciences, University of South Dakota, 414 E. Clark St., Beacom School of Business, Vermillion, SD, 57069, United States, thomas.tiahrt@usd.edu

The data deluge has produced a need for analytics professionals across the organizational spectrum. The academic response has been the establishment of a host of new analytics programs, combining courses already taught with innovative offerings, often leveraging existing institutional strengths. We examine the curricula of one hundred twenty-three analytics programs using text mining to discover commonality, differences and subdivisions. Our objective is to provide information for academics either developing or modifying an analytics curriculum, employers evaluating graduate skills and their needs, as well as students considering the alignment of coursework with their interests.

3 - When Positive Sentiment Is Not So Positive Textual Analytics And Bank Failures

Majeed Simaan, RPI, 231 Congress St., TroyY, NY, 12180, United States, simaam@rpi.edu, Aparna Gupta, Mohammed Zaki

Looking at 10-K annual reports for a large sample of banks in the 2000-2014 period, 52 public bank holding companies that were associated with bank failures during the global financial crisis serve as a natural experiment. Utilizing negative and positive dictionaries proposed by Loughran and McDonald (2011), we find that both sentiments on average discriminate between failed and non-failed banks 80% of the time. However, we find that positive sentiment contains stronger predictive power than negative sentiment; out of ten failed banks, on average positive sentiment can identify seven true events, whereas negative sentiment identifies five failed banks at most.

■ WA07

102B-MCC

Data Mining in Marketing

Sponsored: Data Mining

Sponsored Session

Chair: Jiaqi Liu, MD, United States, buptliujiaqi@qq.com

1 - Value In The Eye Of The Beholder: Insights From Data Mining Diamond Prices.

Stanislav Mamonov, Montclair State University, 1 Normal Ave, School of Business, Montclair, NJ, 07043, United States, stanislav.mamonov@montclair.edu, Tamilla Mavlanova, Nibedita Mohanty, Jacqueline Galal

We use a large dataset of diamonds, currently available for sale, to analyze the effects of physical properties of diamonds on diamond prices. The results suggest a high degree of subjectivity in diamond pricing that challenges the accuracy of predictive models. To illustrate the apparent subjectivity, we discuss several price anomalies that are present in the dataset.

2 - Paid Search Advertising: Ideas And Pitfalls

Lihui Shi, Centerfield Corporation, 1637 E Maple Avenue, Apt 6, El Segundo, CA, 90245, United States, shilihui@uw.edu

In internet marketing, search advertising is a method of placing online advertisements on web pages that show results from search engine queries. I will cover search engine marketing (SEM), search engine optimisation (SEO), pay-per-click (PPC), cost-per-click (CPC), cost-per-impression (CPM), search engine advertising, sponsored listings, paid for placement, etc. Keyword bidding, search ads, display ads, product listing ads (PLA), native ads will be discussed in details, with their definitions, methodologies and challenges. It will provide an overview of paid search advertising, and how this industry utilizes the statistical methods, data mining and machine learning techniques.

3 - Research On The Influence Of Microblog Advertising Of Theatre Chain On Its First Week Box Office Revenue

Jiayin Qi, Shanghai University of International Business and Economics, Shanghai, 100876, China, qijiayin@139.com, Jiaqi Liu

With the participation of enterprise in social network, a question arises of how enterprise can gain more real profit from social network advertising. This article analyzes the relationships among contents of enterprise's online post, consumer's participation on microblog, and short-term product sales. Taking movie market as research set, this research finds that short-term product sales is positively influenced by the information quantity of enterprise's post, and the influence is mediated by the "repost" of other users of Sina microblog. The mechanism examined in this research on the influence of microblog advertising on short-term sales can be guidelines of social network advertising.

■ WA08

103A-MCC

Supply Chain Mgt, Green

Contributed Session

Chair: Cao Binbin, PhD Candidate, School of Management, Xi'an Jiaotong University, No.28, Xianning Road, Xi'an, Shaanxi, Xi'an, Shaanxi, 710049, China, caobinbin89@stu.xjtu.edu.cn

1 - On The Optimal Control Of Remanufacturing Activities With Quality Variation Of Returns

Sajjad Farahani, PhD Student, University of Wisconsin - Milwaukee, Milwaukee, WI, 53211, United States, farahani@uwm.edu, Wilkistar A Otieno, Xiaohang Yue

This paper develops a model for the optimal disposition decision for product returns in a remanufacturing system with limited recoverable inventory capacity. The quality grade of returned products is uncertain and remanufacturing cost increases as the quality level decreases, and remanufacturer wishes to determine which returned product to accept to be remanufactured for reselling, and any unaccepted returns may be salvaged at a value that increases with their quality level. A continuous time Markov chain defined and Matrix-Geometric method is applied to evaluate various performance measures for this system and obtain the optimal remanufacturing policy.

2 - Forwarders' Cooperative Game In Excessive Capacity Exchange

Xuefei Shi, Southeast University, Sipailou II, nanjing, 211189, China, 230159160@seu.edu.cn, Haiyan Wang, Minghui Lai

We study logistics forwarders' cooperative game in capacity exchange. The forwarders book their capacity in advance, and may have capacity deficit or excessiveness after their random demand are realized. Thus they can cooperatively exchange their excessive capacities to improve their profits. We develop several profit sharing rules.

3 - The Implications Of Environmental Regulations On Market Area Size And Green Investment Decisions

Nazli Turken, Assistant Professor, Cleveland State University, 11900 Edgewater Dr. Apt 1308, Apt 1308, Lakewood, OH, 44107, United States, n.turken@csuohio.edu

In this paper we analyze the effect of different environmental regulations on the market area size and green technology investment of a company. We try to identify the environmental regulations that minimize local or global emissions. We identify scenarios when the green technology and end-of-pipe abatement decisions are completely separated from each other.

4 - Supplier's Environmental Innovation Under Government's Emission Tax On A Manufacturer

Bosung Kim, PhD Candidate, KAIST College of Business, 85 Hoegi-ro, Dongdaemun-Gu, Seoul, 130-722, Korea, Republic of, kim-bs@business.kaist.ac.kr, Se Youn Jung, Kun Soo Park

We study supplier's environmental innovation in a supply chain under government's emission tax. We analyze and compare the equilibrium outcomes under three types of supply chain contracts: wholesale-price, quality-dependent, and revenue-sharing contracts. In addition, we discuss the impact of factors that can discourage the supplier's innovation.

5 - Joint Decision on Emission And Pricing In Waste-based Supply Chain: Insights from Hybrid Environmental Policies

Cao Binbin, PhD Candidate, School of Management, Xi'an Jiaotong University, No.28, Xianning Road, Xi'an, Shaanxi, 710049, China, caobinbin89@stu.xjtu.edu.cn, Xiao Zhongdong

Carbon Disclosure Project reported around 50% of a product's emission is generated from manufacturing process. A more general waste-based supply chain model including one retailer, one manufacturer and one supplier was built. We analytically showed joint decision processes on emission level of the manufacturer and pricing in supply chain under three hybrid policies including tax and offset, cap and trade, tax and trade. An analytical comparison between different hybrid policies was provided in terms of profits and emission reduction. Numerical study was presented to further illustrate the effects of emission reduction investment factors and parameters of each hybrid environmental policy.

■ WA09

103B-MCC

Sustainable and Responsible Supply Chain Management II

Sponsored: Energy, Natural Res & the Environment I Environment & Sustainability

Sponsored Session

Chair: Jose Cruz, Associate Professor, University of Connecticut, 100 Constitution Plaza, West Hartford, CT, 06103, United States, jcruz@business.uconn.edu

1 - Social Responsibility Investments: Financial Networks Analysis

Jose Cruz, University of Connecticut, jcruz@business.uconn.edu

This paper develops a network equilibrium model in conjunction with capital asset pricing model (CAPM) and the net present value (NPV) to determine the optimal portfolio, prices, profits, and equity values of financial network firms under financial risks and economic uncertainty. We investigate how social responsible financial investment decisions affect the values of interconnected financial firms from a network perspective. We model the behavior of the decision-makers, derive the equilibrium conditions, and establish the variational inequality formulation.

2 - Corporate Environmental And Social Responsibility In Supply Chains: Exploring Actions And Performance

Trisha Anderson, Texas Wesleyan University, trdanderson@txwes.edu

A company's financial strength (doing good in the market place) is based on the social reputation of the company. We study the level of corporate social responsibility and performance in Environmental and Social Corporate Social Responsible activities from the period 2009-2013. We investigate the level of involvement in each factor over time and determine the relationships between the CSR factors for the major supply chain players.

3 - Economic Generation Dispatch: A Viral Approach

Carlos Marco Ituarte-Villarreal, SWCA Environmental Consultants, El Paso, TX, 79912, United States, cmituartevillarreal@miners.utep.edu, Francisco O Aguirre

The authors present a hybrid Viral Systems Algorithm-Universal Generating Function approach to solve the multiple-objective network-constrained economic reallocation of generation resources problem. The here proposed algorithm considers not only the economic resource dispatch and reliability system restrictions, but also takes into account environmental constraints, particularly mass and rate carbon dioxide and nitrogen oxides emissions.

■ WA10

103C-MCC

Open Pit and Supply Chain Mine Planning

Sponsored: Energy, Natural Res & the Environment, Natural Resources I Mining

Sponsored Session

Chair: Alexandra M Newman, Colorado School of Mines, 1104 Maple Street, Golden, CO, 80401, United States, anewman@mines.edu

1 - Optimal Stockpiling Strategies In Open Pit Mining

Mojtaba Rezakhah, Colorado School of Mines, mrezakha@mines.edu

Mines use stockpiles for blending different grades of material, storing excess mined material until processing capacity is available, or keeping low-grade ore for possible future processing. We consider stockpiles as part of our open pit mine scheduling strategy, and propose multipleinteger-linear models to solve the open pit mine production scheduling problem. Numerical experiments show that ourproposed models are tractable, and correspond to instances which can be solved in afew minutes, at most, in contrast to nonlinear models whose instances fail to solve.

2 - An Aggregation Branching Scheme For The Resource-constrained Open Pit Mine Scheduling Problem

Renaud Pierre Chicoisne, University of Colorado denver, renaud.chicoisne@gmail.com

For the purpose of production scheduling, open-pit mines are discretized into 3D arrays known as block models. Production scheduling consists of deciding which blocks should be extracted and when they should be extracted during the time horizon. Blocks that are close to the surface should be extracted first, defining a set of precedence constraints, and capacity constraints limit the production in each time period. This Resource Constrained Open Pit Mining scheduling problem (RC-OPM) can be cast as a linear Integer Programming problem. In this work, we describe a constraint branching that uses special features of RC-OPM to reach an integer solution when solving the formulation by Branch and Bound.

3 - Heuristic Method For The Stochastic Open-pit Mine Production Scheduling Problem

Adrien Rimélé, Master's Student,École Polytechnique de Montréal, 7593 Rue Berri, Montréal, QC, H2R2G8, Canada, adrien.rimele@polymtl.ca, Michel Gamache, Roussos Dimitrakopoulos

Long term open-pit mine planning under geological uncertainty can be assessed with a Stochastic Integer Program. The complexity of such program is so high that it is usually hopeless to obtain an optimal or at least good feasible solution within a reasonable time. This work first presents the application of new partial relaxation strategies to facilitate the resolution by solver using the strong interconnections of the variables. Then, a topological sorting algorithm is applied on the fractional obtained schedule to make it fully binary. Tested on a real deposit, the methods have given solutions proven to be very close to the optimality after a short computational time.

4 - A Benders-decomposition-based Method For The Simultaneous Optimization Of A Mineral Value Chain

Jian Zhang, McGill University, Montreal, QC, Canada, jian.zhang9@mail.mcgill.ca, Roussos G. Dimitrakopoulos

The classical Benders decomposition is used to solve the simultaneous optimization of a mineral value chain. A dynamic bench-pushback generation method is developed based on the dual price in each benders iteration to optimize the upstream mine production schedule and a moving window amelioration method is developed to improved the obtained schedule. The proposed method is tested in a hypothetical case where the market uncertainty is integrated. The test results show the importance of integrating market uncertainty in mineral value chain optimization.

■ WA11

104A-MCC

Risk Averse Optimization in Networks

Sponsored: Optimization, Network Optimization

Sponsored Session

Chair: Pavlo Krokhmal, Professor, University of Arizona, 1127 E James E. Rogers Way, Tucson, AZ, 85721, United States, krokhmal@email.arizona.edu

1 - Analysis Of Budget For Interdiction On Multicommodity Network Flows

Neng Fan, University of Arizona, nfan@email.arizona.edu, Pengfei Zhang

In this talk, we first discuss several versions of network interdiction models for multicommodity flows, including the model with risk-averse leader. For this kind of Stackelberg game, where a leader try to destroy the network with limited budget and the follower seeks the minimum cost of flows to meet the demands in the resulted network. We will mathematically analyze the interdiction results under different models and budget limits. Some theories and properties will be shown. Additionally, some solutions approaches will be proposed.

2 - Detecting Large Risk-averse 2-clubs In Graphs With Random Edge Failures

Foad Mahdavi Pajouh, University of Massachusetts Boston, Boston, MA, United States, foad.mahdavi@umb.edu, Esmaeel Moradi, Balabhaskar Balasundaram

We address the problem of detecting large risk-averse 2-clubs in graphs subject to probabilistic edge failures, which is modeled as a CVaR-constrained single-stage stochastic program. We present a new decomposition algorithm based on a Benders decomposition scheme, which outperforms an algorithm based on an existing decomposition idea on random, and real-life biological and social networks.

3 - Clusters Represent Cliques

Maciej Rysz, Air Force Research Lab, mwrysz@yahoo.com

We propose a solution algorithm for identifying the most central clusters in graphs and examine its effectiveness when the centrality measure is defined by betweenness and the clusters represent cliques. Numerical experiments demonstrating the computational performance of the proposed method are conducted and compared with results obtained from solving an equivalent mixed integer programming representation.

4 - Optimization Of Cascading Processes In Multiscale Networks With Stochastic Interactions

Oleg A Prokopyev, University of Pittsburgh, 1037 Benedum Hall, Pittsburgh, PA, 15261, United States, droleg@pitt.edu, Juan Borrero, Pavlo Krokhmal

We study the problem of optimal cascade propagation in a network, where the cascade's spread depends on a vector of given attributes. Given there are costs associated with changing the attributes' values, a decision-maker desires to minimize the time until all network nodes receive influence, subject to a budget constraint. To this end, we propose a stochastic optimization model based on Markov chains. Under simple assumptions, we derive analytical solutions for the optimal budget allocation in terms of a minimum spanning arborescence on an auxiliary graph. These results establish that optimal solutions have a hierarchical structure, and show that they can be found in polynomial time.

■ WA12

104B-MCC

Optimization in Cyber Defense

Sponsored: Optimization, Integer and Discrete Optimization
Sponsored Session

Chair: Les Servi, MITRE, 202 Burlington Road, Bedford, MA, 01730, United States, lservi@mitre.org

Co-Chair: Doug Altner, MITRE Corporation, 7525 Colshire Drive, McLean, VA, 22102, United States, daltner@mitre.org

1 - A Supply Chain Network Game Theory Model Of Cybersecurity Investments With Nonlinear Budget Constraints

Shukla Shivani, University of Massachusetts, Amherst, MA, United States, sshukla@som.umass.edu, Anna B Nagurney, Patrizia Daniele

In our paper, we develop a supply chain network game theory model consisting of retailers that compete noncooperatively to maximize their expected profits and reduce network vulnerability by determining their optimal product transactions as well as cybersecurity investments subject to nonlinear budget constraints that include the cybersecurity investment cost functions.

2 - Optimal Scheduling Of Cybersecurity Analysts For Minimizing Risk

Rajesh Ganesan, George Mason University, Fairfax, VA, 22030-4422, United States, ashah20@masonlive.gmu.edu, Ankit Shah, Sushil Jajodia, Hasan Cam

The talk presents a generalized optimization model for scheduling cybersecurity analysts to minimize risk (a.k.a maximize significant alert coverage by analysts) and maintain risk under a pre-determined upper bound. The paper tests the optimization model and its scalability on a set of given sensors with varying analyst experiences, alert generation rates, system constraints, and system requirements.

3 - Dynamic Scheduling Of Cybersecurity Analysts For Minimizing Risk Using Reinforcement Learning

Rajesh Ganesan, George Mason University, Fairfax, VA, 22030-4422, United States, ashah20@masonlive.gmu.edu, Ankit Shah, Sushil Jajodia, Hasan Cam

The talk presents a reinforcement learning-based stochastic dynamic programming optimization model that incorporates the estimates of future alert rates and responds by dynamically scheduling on-call cybersecurity analysts to minimize risk (a.k.a maximize significant alert coverage by analysts) and maintain the risk under a pre-determined upper bound.

4 - A Two-stage Stochastic Shift Scheduling Model For Cybersecurity Workforce Optimization With On Call Options

Doug Altner, MITRE Corporation, McLean, VA, United States, daltner@mitre.org, Les Servi

This talk proposes a two-stage stochastic program for optimizing staffing and shift scheduling decisions at a 24/7 cybersecurity operations center with three shifts per day, several staffing and scheduling constraints, uncertain workloads and on call staffing options. We then show how near optimal solutions can be obtained in a few minutes without a full branch-and-price implementation.

■ WA13

104C-MCC

Recent Developments in Optimization Software

Sponsored: Optimization, Computational Optimization and Software
Sponsored Session

Chair: Hans Mittelmann, Arizona State University, Box 871804, Tempe, AZ, 85287-1804, United States, mittelmann@asu.edu

1 - Selected Benchmark Results

Hans Mittelmann, Arizona State University, mittelmann@asu.edu

We will present results from selected benchmarks we are maintaining in both continuous and discrete optimization by both commercial and open source software.

2 - Recent Advances In The New Mosek 8

Andrea Cassioli, MOSEK, andrea.cassioli@mosek.com Erving Anderson

In this talk we present the new features and improvements in the new MOSEK 8 solver. Improved presolving, automatic dualization for conic quadratic problems and other new developments in the core routines has lead to a significant improvements of the solver performance both in terms of speed and accuracy. Computational results will be presented and discussed.

3 - Recent Advances In The SCIP Optimization Suite

Gregor Hendel, Zuse Institute Berlin, Takustrasse 7, Berlin, 14195, Germany, hendel@zib.de

The general-purpose branch-and-cut solver SCIP is one of the fastest noncommercial software tools for solving mixed integer linear optimization problems. In this talk, we will give an overview of algorithmic advances in the upcoming release with a special focus on new and extended primal heuristics of SCIP.

4 - UG[PIPS-SBB, MPI]: A Massively Parallel Branch-and-bound Solver For Stochastic Mixed-integer Programs

Yuji Shinano, Zuse Institute Berlin, shinano@zib.de, Lluis-Miquel Munguia, Geoffrey Malcolm Oxberry, Deepak Rajan

PIPS-SBB is a LP-based branch-and-bound solver using a distributed-memory simplex algorithm that leverages the structure of stochastic mixed-integer programs (MIPs). However, it does not parallelize its branch-and-bound tree search. The Ubiquity Generator (UG) is a general framework for the external parallelization of mixed-integer programming solvers. It has been used to develop ParaSCIP, a massively parallel version of the academic constraint integer programming solver SCIP. In this talk, we will introduce a parallel solver ug[PIPS-SBB, MPI] in which PIPS-SBB's branch-and-bound tree search is parallelized on top of the parallel solution of the LP relaxations.

■ WA14

104D-MCC

Inventory Management

Contributed Session

Chair: Reha Uzsoy, North Carolina State University, Dept. of Industrial & Systems Engg, 300 Daniels Hall Camps Box 7906, Raleigh, NC, 27695-7906, United States, ruzsoy@ncsu.edu

1 - Inventory Control Policy For A Periodic Review System With Expediting

Yi Tao, Assistant Professor, Guangdong University of Technology, 161 Yinglong Road, Tianhe District, Guang Zhou, 510520, China, kenjimore@gmail.com, Loo Hay Lee, Ek Peng Chew, Gang Sun, Charles Vincent

We study a periodic review inventory system where two modes, regular and fast mode, are available to obtain replenishment. A firm can choose fast mode with shorter lead time at a higher cost when necessary. A two-replenishment-mode model, with random expediting points is established and an ordering policy (S,e) which replenishes the inventory to S in every cycle and expedites part of the order using fast mode when the inventory drops below e, is proposed. A simulation optimization based heuristic which uses infinitesimal perturbation analysis (IPA) method and gradient search algorithm is employed to find the best (S,e). Numerical experiments have shown our new policy outperforms existing policies.

2 - A Hybrid Approach To Centralized Drug Inventory Management In A Chain Of Pharmacy Stores

Tom Brady, Purdue University, 1401 S US Hwy 421, Westville, IN, 46391, United States, tbradyjr@pnw.edu

Inventory analysis has long been a fundamental component of operations research, decision analysis, and operations management. In this paper, we discuss a hybrid approach of inventory policy to pharmaceuticals applied to small pharmacy chain. Decentralized inventory management policy had been in place as the chain grew where the individual store managers were responsible for inventory decisions. After an analysis of the inventory from the chain perspective, it was theorized that by moving certain inventory policy decisions to the chain level rather than the store level could result in potential inventory savings while maintain customer service targets.

3 - Managing Inventory Of Perishable Products at Multiple Locations

Fang Liu, Assistant Professor, Nanyang Technological University, S3-B2a-13, 50 Nanyang Avenue, Singapore, 639798, Singapore, liu_fang@ntu.edu.sg, Yun Fong Lim

A retailer selling multiple perishable products with random demands over a single season. The warehouses, each with a limited storage capacity, have different store and retrieve costs. Before demand realizes, the products are stored to each warehouse and after demand realizes products are retrieved from the warehouses. We develop a two-dimension table to determine under optimality which warehouses are non-empty, and among the non-empty warehouses, the products are stored following a nested assortment structure. In the retrieval stage, it is optimal to retrieve a product from a warehouse with the lowest retrieve cost that contains the product.

4 - Solving Stochastic Inventory Problems By Integer Programming

Reha Uzsoy, North Carolina State University, Dept. of Industrial & Systems Engg, 300 Daniels Hall Camps Box 7906, Raleigh, NC, 27695-7906, United States, ruzsoy@ncsu.edu, Jaap Arts, Ton de Kok, Seza Orcun

We propose binary integer programming models to approximately solve finite-horizon stochastic inventory problems with stochastic demand. The models proceed by discretizing the PDF of the demand in each period in a manner emulating numerical integration. The resulting integer programs have a consecutive ones property which provides additional computational efficiency. Cost minimizing service levels are endogenously determined. Computational results are reported for a variety of single-stage stochastic inventory models.

■ WA16

105A-MCC

Large-scale Stochastic Mixed-integer Programs

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Gabriel Lopez Zenarosa, University of Pittsburgh, 3700 O'Hara Street, Benedum Hall 1048, Pittsburgh, PA, 15261, United States, glz5@pitt.edu

1 - PH-BAB: A Progressive Hedging Based Branch And Bound Algorithm

Semih Atakan, PhD Student, University of Southern California, Los Angeles, CA, United States, atakan@usc.edu, Suvrajeet Sen

Progressive Hedging (PH) is a well known algorithm for solving multi-stage stochastic convex optimization problems. Most previous extensions of PH for stochastic mixed-integer programs (SMIPs) have been implemented without convergence guarantees. In this talk, we present a new framework that shows how PH can be utilized while guaranteeing convergence to globally optimal solutions of SMIPs. We demonstrate the efficacy of the proposed framework through computational experiments.

2 - New Approaches For The Stochastic Network Interdiction Problem

Eli Towle, University of Wisconsin-Madison, etowle@wisc.edu, Jim Luestke

We investigate methods to solve the maximum-reliability stochastic network interdiction problem (SNIP). To begin, we introduce a novel reformulation of the SNIP extensive formulation. We then propose a path-based formulation of the SNIP. We present cuts for this new formulation which are dependent on the structure of the given interdicted arc probabilities. To solve this path-based SNIP formulation, we implement a branch-and-cut (BC) algorithm. Computational results demonstrate an improvement of this BC algorithm over a traditional Benders decomposition.

3 - Two-stage Stochastic Programming For Influence Maximization

Hao-Hsiang Wu, Ohio State University, Columbus, OH, 43202, United States, wu.2294@osu.edu, Simge Kucukyavuz

Influence maximization problem is to find top-k influential nodes in a social network. Kempe. et al propose the greedy algorithm as a heuristic to solve the linear threshold and independent cascade models for influence maximization. By using the greedy algorithm, only 63% optimal value can be guaranteed. In this project, we formulate influence maximization problem as a two-stage stochastic program, and use a delayed constraint generation algorithm for its exact solution. Our algorithm exploits the submodularity of the influence spread function. We demonstrate the performance of our algorithm on large-scale real-world datasets.

4 - Solving Large-scale Stochastic Programs Using Generalized Value Function

Onur Tavaslioglu, PhD Student, University of Pittsburgh, Pittsburgh, PA, United States, ont1@pitt.edu, Andrew J Schaefer, Oleg A Prokopyev

This work considers two-stage mixed integer programs with discretely distributed stochastic right-hand sides and objective functions. We present an equivalent superadditive dual formulation that uses the value functions of both stages. We introduce the generalized value function of a mixed-integer program simultaneously parametrized by its objective function and right-hand side. We describe fundamental properties of the generalized value function and three algorithms to calculate it. Then, we present a global branch-and-bound algorithm for solving one stage pure integer and one stage mixed integer program. We conclude with computational results.

■ WA17

105B-MCC

Convex and Conic Relaxations in Machine Learning

Sponsored: Optimization, Nonlinear Programming

Sponsored Session

Chair: Amir Ali Ahmadi, Princeton University, 329 Sherrerd Hall, Princeton, NJ, 08540, United States, a_a_a@princeton.edu

Co-Chair: Georgina Hall, Princeton University, Sherrerd Hall, Princeton, NJ, 08544, United States, gh4@princeton.edu

1 - A New Perspective On Boosting In Linear Regression Via Subgradient Optimization And Relatives

Rahul Mazumder, MIT Sloan School of Management, rahulmaz@mit.edu

Boosting is one of the most powerful and popular tools in machine learning/statistics that is widely used in practice. They work extremely well in a variety of applications. However little is known about many of the statistical and computational properties of the algorithm, and in particular their interplay. We analyze boosting algorithms in linear regression from the perspective modern first-order methods in convex optimization. We derive novel comprehensive computational guarantees for several boosting algorithms, which provide a precise theoretical description of the amount of data-fidelity and regularization imparted by running a boosting algorithm.

2 - Making Sketchy Decisions: Semidefinite Programming With Optimal Storage

Madeleine Udell, Cornell University, Ithaca, NY, United States, udell@cornell.edu, Joel Tropp, Alp Yurtsever, Volkan Cevher

Is it possible to solve an optimization problem using far less memory than the natural size of the decision variable? In this talk, we propose an affirmative answer to this question when both the problem data and solution have a concise representation. We present an algorithm for provably solving many semidefinite programming problems whose natural size is O(n^2) using no more than O(n) memory.

■ WA18

106A-MCC

DMA Data-Driven Models

Contributed Session

Chair: Nuo Xu, University of Alabama at Birmingham, 5720 11th Avenue South, Birmingham, AL, 35222, United States, nuoxu@uab.edu

1 - Remaining Useful Life Prediction Of Lithium Ion Batteries Using A Novel Degradation Model

Fangfang Yang, City University of Hong Kong, Hong Kong, China, fangfyang2-c@my.cityu.edu.hk, Kwok-Leung Tsui

Some lithium-ion battery materials show two-phase degradation behavior, such as lithium nick manganese cobalt oxide (NMC) cells. To predict remaining useful life (RUL) for these types of batteries, a model-based Bayesian approach is propose. First, a novel degradation model is developed to capture the degradation trend of NMC batteries. Next, a particle filtering-based prognostic method is incorporated into the model to estimate possible degradation trajectories of the batteries. The effectiveness of the developed method is verified using our experimental data. The results indicate that the proposed prognostic method can achieve high prediction accuracies at an early stage of life.

2 - Process Monitoring And Diagnosis Of Hot Rolled Trip Based On Regression Coefficients Of Batches

Fei He, University of Science and Technology Beijing, China, Beijing, China, hefei@ustb.edu.cn

First of all, regression model between process parameters and product quality data is established. And then regression coefficients are used for process monitoring and diagnostics. In this paper the model based on partial least squares is bulit between process variables and width of finishing hot rolling, and regression coefficients of all batches are obtained that is used for process monitoring and diagnostics. Experiments on simulated data sets and real data sets show that can effectively locate the important abnormal process parameters.

3 - Data Science And The Liberal Arts Curriculum

Anna Engelsone, Maryville College, Maryville, TN, United States, anna.engelsone@yahoo.com

This paper draws on over ten years of experience practicing DMA in an industry setting and teaching data science concepts to students ranging from 8th graders to MBAs. Our main interest is in incorporating DMA into the liberal arts curriculum. Liberal arts colleges are uniquely positioned to produce versatile data professionals with the ability to ask the right questions, consider the social implications of their work, and communicate their findings effectively to different audiences. We discuss the challenges of introducing DMA to undergraduates and present examples of in-class exercises, homework problems and research projects suitable for students of different levels and backgrounds.

4 - A Measure Of General Functional Dependence Among Multiple Continuous Variables

Nuo Xu, University of Alabama at Birmingham, 5720 11th Avenue South, Birmingham, AL, 35222, United States, nuoxu@uab.edu, Xuan Huang

Existing measures in the literature that are specifically concerned with testing and measuring independence between two continuous variables are all based on examining the definition of independence. In a previous paper of ours, we construct a new measure that uses the absolute value of first difference on adjacent ranks of one variable with respect to the other. This measure captures the general functional dependence between two variables. Here, we are presenting the method of generalizing this measure to capture functional dependence among N variables and some preliminary results of its application in variable interaction detection and variable selection.

■ WA19

106B-MCC

Uncertainty in Engineered Networks

Sponsored: Computing

Sponsored Session

Chair: Russell Bent, Los Alamos National Laboratory, Los Alamos National Laboratory, Los Alamos, NM, 00000, United States, rbent@lanl.gov

1 - Optimal Robust Battery Operation

Shuoguang Yang, Columbia University, sy2614@columbia.edu

We present formulations, algorithms and computational results on mult-time period problems involving battery operation. In this context, batteries are used to compensate for errors in forecasts for renewable power generation. We model uncertainty sets using the uncertainty budgets model, and we describe efficient implementations. Joint work with D. Bienstock, G. Munoz and C. Matke.

2 - Unit Commitment With N-1 Security And Wind Uncertainty

Kaarthik Sundar, Texas A&M, kaarthik01sundar@gmail.com, Harsha Nagarajan, Miles Lubin, Sidhant Misra, Russell Bent, Line Roald, Daniel Bienstock

As wind energy penetration rates continue to increase, a major challenge facing grid operators is the question of how to control transmission grids in a reliable and a cost-efficient manner. The stochasticity of wind forces an alteration of traditional methods for solving the day-ahead unit commitment problem. To address these questions, we present an N-1 Security and Chance-Constrained Unit Commitment that includes the modeling of generation reserves to respond to wind fluctuations and tertiary reserves to account for single component outages. We develop a benders decomposition algorithm to solve the problem to optimality and present a detailed case study on the IEEE RTS-96 three-area system.

3 - Efficient Dynamic Compressor Optimization In Natural Gas Transmission Systems

Pascal Van Hentenryck, University of Michigan, pvanhent@umich.edu

The growing reliance of electric power systems on gas-fired generation to balance intermittent sources of renewable energy has increased the variation and volume of flows through natural gas transmission pipelines. Adapting pipeline operations to maintain efficiency and security under these new conditions requires optimization methods that account for transients and that can quickly compute solutions in reaction to generator re-dispatch. This talk presents an efficient scheme to minimize compression costs under dynamic conditions where deliveries to customers are described by time-dependent mass flow.

■ WA20

106C-MCC

Mining Qualitative Attributes to Assess Corporate Performance

Invited: Tutorial

Invited Session

Chair: Ananda Swarup Das, IBM India Research Labs, India, New Delhi, 1, India, anandas6@in.ibm.com

1 - Mining Qualitative Attributes To Assess Corporate Performance

Aparna Gupta, Rensselaer Polytechnic Institute, 110 Eighth Street, Troy, NY, 12180, United States, guptaa@rpi.edu, Ananda Swarup Das, L Venkata Subramaniam, Gagandeep Singh

We present an overview of systems and methods to track ongoing events from sources such as corporate filings, financial articles, expert or analyst reports, press releases, customers' feedback and news articles that have an effect on corporate performance. In this paper we discuss text analytics and sentiment mining approaches to determine quantitative attributes that can be an indicator of corporate performance. For example, strengths, weaknesses, opportunities and threats (SWOT) analysis is a well-known structured planning method widely applied to identify the factors determining success or failure of an enterprise. This analysis can be strongly indicative of the business or financial health of the enterprise. It can provide broader indicators for the firm's business environment, in terms of ease of doing business in the country, government policies helping (or hurting) business environment.

■ WA21

107A-MCC

Chronic Disease Management

Sponsored: Health Applications

Sponsored Session

Chair: Vedat Verter, McGill University, 1001 rue Sherbrooke Ouest, Bronfman Building, Montreal, QC, H3A 1G5, Canada, vedat.verter@mcgill.ca

Co-Chair: Michael Klein, McGill University, McGill, Montreal, QC, Canada, michael.klein2@mail.mcgill.ca

1 - Chronic Disease Management And The Role Of Incentives

Christian Wernz, Virginia Tech, cwernz@vt.edu, Hui Zhang

Chronic diseases can be prevented by changing the behavior of patients and physicians. Incentives are one of the mechanisms to motivate such change. We present a two-player, multi-period model in which patients and physicians jointly decide on prevention activities. The physician-patient interaction is modeled as a general-sum stochastic game with switching control structure. The Health Belief Model (HBM) is incorporated to capture behavioral aspects. We illustrate our modeling approach by applying it to a coronary heart disease cases study. Result show how and to what extent a re-alignment of incentives can improve chronic disease management initiatives.

2 - Dialysis Facility Network Design

Michael Klein, McGill University, 1001 Sherbrooke Street West, Montreal, QC, H3A 1G5, Canada, michael.klein2@mail.mcgill.ca, Vedat Verter, Brian Moses

We study the problem of improving access for patients in a rural area by designing a network of dialysis facilities. We incorporate the possibility of home dialysis for which the patients need to travel to a city centre for training.

■ WA22

107B-MCC

Healthcare Analytics

Sponsored: Health Applications

Sponsored Session

Chair: Zahra Gharibi, Southern Methodist University, 3145 Dyer Street, Suite 372, Dallas, TX, 75205, zgharibi@mail.smu.edu

1 - Optimal Care Pathways For Lower Back Pain Patients

Danny R Hughes, Harvey L. Neiman Health Policy Institute, Reston, VA, United States, dhughes@neimanhpi.org
Danny R Hughes, George Mason University, Fairfax, VA, United States, dhughes@neimanhpi.org, Jeremy Eckhause, Katharina Ley Best

Aggressive treatment of lower back pain is frequently cited as low value care that contributes to rising health care costs with limited effects on patient outcomes. In order to identify cost-effective early treatment policies for these patients, we model the physician's sequential decision problem as a finite-horizon Markov decision process where the boundary condition is defined as the patient completing the episode of care. We compare the results from historical claims data with optimal decisions solved via stochastic dynamic programming to determine desirable initial treatment strategies.

2 - Effect Of Report Cards On Kidney Transplantation Related Decision Making

zahra Gharibi, Dept. of Engineering Management, Information, and Systems Bobby B. Lyle School of Engineering, SMU, zgharibi@smu.edu, Mehmet U.S. Ayvaci, Michael Hahsler

Report card programs collect and publicize information on patient outcomes as a means of improving quality. However, it is unclear whether behavioral responses to such programs improve patient outcomes. We study the report cards as an incentive mechanism to induce socially-optimal medical decisions in the context of kidney transplantation. Using a game theoretic framework, we investigate how performance reporting and flagging for low performance influence acceptance/rejection decisions for offered kidneys and patient selection by transplant centers. We also study the implications of new allocation system for such decisions.

■ WA23

108-MCC

Operations Research for Public Health: Data-Driven and Dynamic Decion Making Approaches

Sponsored: Health Applications

Sponsored Session

Chair: Soroush Saghafian, Harvard Univeristy, 79 John F. Kennedy Street, Mailbox 37, Cambridge, MA, 02138, United States, soroush_saghafian@hks.harvard.edu

1 - Impact Of Breast Density And Supplemental Screening Methods On Breast Cancer Screening Policies

Mucahit Cevik, University of Wisconsin - Madison, Madison, WI, United States, cevik2@wisc.edu, Burhaneddin Sandikci

Mammography screening is the golden standard for breast cancer screening, but it is less accurate for women with dense breasts. Supplemental screening methods are recently introduced to improve detection accuracy. We study the impact of supplemental tests through incorporating breast density information in a partially observable Markov decision process model.

2 - Impact Of Ambiguity on Medications Management Strategies: An Application To NODAT

Alireza Boloori, Arizona State University, Tempe, AZ, United States, alireza.boloori@asu.edu, Soroush Saghafian, Harini A. Chakkera, Curtiss B. Cook

Patients after organ transplantations receive high amounts of immunosuppressive drugs (e.g., tacrolimus) to reduce the risk of organ rejection. However, this practice has been shown to increase the risk of New-Onset Diabetes After Transplantation (NODAT). We propose an ambiguous POMDP framework to generate effective medication management strategies for tacrolimus and insulin. Our approach increases the patient's quality of life while reducing the effect of transition probability estimation errors. We also provide several managerial and medical implications for policy makers and physicians.

3 - Robust Dynamic Programming For Medical Decision Making

Lauren N. Steimle, University of Michigan, Ann Arbor, MI, United States, steimle@umich.edu, Brian T Denton

Markov Decision Processes (MDPs) are useful for studying the management of chronic diseases, which is characterized by a series of treatment decisions under uncertainty about the future progression of the disease. Dynamic programming algorithms can be used to determine the optimal treatment policies for these diseases, but these policies may not be robust to perturbations of the model parameters. We discuss robust dynamic programming algorithms that provide protection against variation in the estimates of MDP model parameters. We present our results in the context of treatment of cardiovascular disease.

4 - Optimal Intervention Strategies For Hypertensive Disorders Of Pregnancy

Aysegul Demirtas, Arizona State University, Tempe, AZ, United States, Aysegul.Demirtas@asu.edu, Esma S Gel, Soroush Saghafian, Dean Coonrod

Hypertensive disorders of pregnancy (HDP) constitute one of the leading causes of maternal and neonatal mortality and morbidity. We consider the decision problem of timing and mode of child delivery for women with HDP. We formulate a discrete-time Markov decision process (MDP) model that minimizes the risks of maternal and neonatal adverse outcomes, and assess its outcomes with clinical data by performing probabilistic sensitivity analysis. We also build a robust MDP model in which the transition probabilities are contained in a controllable uncertainty set. Our robust MDP approach considers the sensitivity of estimated transition probabilities while avoiding over-conservative policies.

■ WA24

109-MCC

Scheduling and Capacity Management in Healthcare

Sponsored: Health Applications

Sponsored Session

Chair: Maya Bam, University of Michigan, 1205 Beal Avenue, Ann Arbor, MI, 48109, United States, mbam@umich.edu

1 - Scheduling Operating Rooms With Elective And Emergency Surgeries

Kyung Sung Jung, University of Florida, 364 Stuzin Hall, PO Box 117169, Gainesville, FL, 32611, United States, ksjung@ufl.edu, Michael L Pinedo, Chelliah Sriskandarajah, Vikram Tiwari

Hospital accounted for 30% of total health expenditures. Operating rooms (ORs) are typically a bottleneck during the entire processes. We solve multiple-OR scheduling problems with elective and emergency patients. First, we provide general guidelines for these scheduling problems, and then develop several scheduling and rescheduling methods for these patients.

2 - Two-stage Robust Optimization Of Multi-stage Care Planning: Formulation And Computational Challenges

Saba Neyshabouri, George Mason University, Fairfax, VA, 22030, United States, sneyshab@gmu.edu, Bjorn Berg

We study the problem of scheduling surgeries in a block-booking setting in which both the surgery duration and length-of-stay (LOS) in the surgical intensive care unit are subject to uncertainty. We utilize the theory of robust optimization and propose a novel formulation that captures the complexities in modeling uncertainty in LOS, which is modeled as a discrete random variable. We propose an exact solution approach and perform computational experiments to analyze the quality of the solutions obtained. Computational challenges and future directions are discussed.

3 - Capacity And Flow Management In Emergency Departments With A Fast Track

Elham Torabi, University of Cincinnati, 2925 Campus Green Dr., Cincinnati, OH, 45221, United States, torabiem@mail.uc.edu
Elham Torabi, University of Cincinnati Medical Center, Cincinnati, OH, United States, torabiem@mail.uc.edu, Craig Froehle, Craig Froehle, Craig Froehle, Christopher Miller

In EDs with a fast track, sub-optimal allocation of patients to capacity results in under-utilization of the fast track while main ED area is congested. Using data-mining we identify sub-groups of moderate-acuity patients who can be treated in the fast track instead of the main ED. We use simulation analysis to find routing policies that better allocate the identified patients to the two capacity segments. The proposed routing policy results in less patient waiting and more parity in utilization of the capacity segments.

4 - Planning Models For Skills-sensitive Surgical Nurse Staffing
Maya Bam, University of Michigan, Ann Arbor, MI, United States, mbam@umich.edu, Maya Bam, University of Michigan Health System, Ann Arbor, MI, United States, mbam@umich.edu, Zheng Zhang, Brian T Denton, Mark P Van Oyen, Mary Duck, Joshua Pigula

Surgical nurses are essential resources in the surgery delivery system. However, surgical nurse staffing decisions present a challenge due to the stochastic nature of surgical demand, nurse availability, skill requirements, and hospital regulations. Based on collaboration with a large academic hospital, we present planning level optimization models to group services into teams based on difficulty and overnight call volume, and then assign shifts to services and teams subject to skill requirements. We present results that provide insight into optimal nurse staffing decisions based on a large hospital data set.

■ WA25

110A-MCC

Logistics I

Contributed Session

Chair: Jiahong Zhao, Guangdong University of Technology, No.100 Waihuanxilu Daxuecheg, Guangzhou, 510006, China, zhaojiahong1@126.com

1 - The Regional Logistics Hubs Location Problem Based On The Topsis And Genetic Algorithm The Case Of Sichuan In China
Si Chen, Dr., Southwest Jiaotong University, #111 The First Block of North Erhuan Road, Chengdu, 610031, China, chensi@swjtu.edu.cn, Dong Chen, Mi Gan

The regional logistics demands, which are the key factor for logistics hubs location problem, are changing with the developing regional economic and the structure of industry. Noted that different industries will result in different kind of logistics demand, we aims to modeling the regional logistics hubs location problem with consider of industries affected logistics demand. Then the real data case of Sichuan province is employed to verify the feasibility of proposed models and approach, the results indicate that Chengdu, Leshan and Deyang is selected from 18 candidate cities as the comprehensive logistics hub, cross-regional logistics hub and internal-oriented logistics hub, respectively.

2 - Data Driven Approach To Crowd Delivery In Last Mile
Loo Hay Lee, National University of Singapore, 10 Kent Ridge Cresent, Industrial and Systems Engineering, Singapore, 119260, Singapore, iseleelh@nus.edu.sg, Yuan Wang, Dong Xiang Zhang, Ek Peng Chew

In urban logistics, the last-mile delivery has become more challenging with the continuous growth of E-commerce. In this paper, we propose an effective large-scale mobile crowd-tasking model in which a large pool of citizen workers are used to perform the last-mile delivery. To efficiently solve the model, we present network min-cost flow based method with pruning techniques and constrained clustering approach to partition large data points. Comprehensive experiments were conducted with Singapore and Beijing datasets. The results show that our solution can support real-time delivery optimization in the large-scale mobile crowd-sourcing problem.

3 - Adaptive Warehouses: Look At The Past, Not The Future
Nima Zaerpour, Assistant Professor of Operations Management, California State University San Marcos, 333 S Twin Oaks Valley Rd., Markstein 446, San Marcos, CA, 92096, United States, nzaerpour@csusm.edu, Sholeh Norouzzadeh

The growth of online shopping is bringing new challenges to warehouses. For instance, Amazon receive 35 orders/second, each including few items. The timing for delivery varies between the same day deliveries to a couple of days. The product popularity and assortment varies frequently influenced by various factors. Thus, warehouses need to become more responsive to customers and more adaptive to changes while the customer information does not become available sufficiently in advance. We ask the following: can self-learning techniques improve efficiency of warehouses and reduce the time/effort required to retrieve a product for a customer order? This paper tries to answer this question.

4 - A Location Inventory Routing Optimization Model For Explosive Waste Management
Jiahong Zhao, Guangdong University of Technology, No.100 Waihuanxilu Daxuecheg, Guangzhou, 510006, China, zhaojiahong1@126.com, Ginger Yi Ke

Recently, attentions have been drawn to reducing the risks derived from facility location, inventory management, and multi-depot vehicle-routing of the explosive waste management. In this research, risks are assessed as impact solids with certain hazardous radii posed by explosions happening en route and at site. An optimization model minimizing the total cost and risk is developed to determine the corresponding location-inventory-routing plan. In addition to a well-defined solution procedure, a real-world problem of Southwest China is examined to provide further managerial insights.

■ WA26

110B-MCC

Display Advertising Markets

Invited: Auctions

Invited Session

Chair: De Liu, Carlson School of Management, 3-163 CSOM, University of Minnesota, Minneapolis, MN, 55455, United States, deliu@umn.edu

Co-Chair: Dengpan Liu, Iowa State University, 3321 Gerdin Building, Ames, IA, 50011, United States, dliu@iastate.edu

1 - Closed-loop Versus Open-loop Advertising Competition In Electronic Retailing: Operational And Organizational Considerations
Dengpan Liu, Iowa State University, dliu@iastate.edu

This study examines two different types of dynamic advertising competition, namely, closed-loop and open-loop, among e-retailing firms. In particular, we focus on how the considerations of IT operations and organizational structure would affect firms' performance in dynamic advertising competitions. Using a differential game framework, we find that firms can be better off engaging in the closed-loop competition. Another interesting finding is that the advantage of flexibility in closed-loop game may reduce as IT becomes more costly.

2 - Architecture Of In App Ad Recommender System
Anik Mukherjee, Indian Institute of Technology - Madras, India, anikit.jgec@gmail.com

Increased adoption of smartphones has caused mobile advertising to be the second-most revenue-generating medium among all forms of existing online advertising. Appl developers try to monetize their apps by selling in-app ad-spaces to the advertisers through various intermediaries such as ad-networks. Surveys indicate that mobile ad campaigns are not as successful as they can be due to inappropriate audience targeting and user-apathy toward such ads. This motivates the need for a system, where both the parties gain from the in-app advertising eco-system. So, we propose an architecture of design-science artifacts for an ad-network, to meet the objectives of both these stakeholders.

3 - Procurement Policies For Mobile-promotion Platforms
Manmohan Aseri, University of Texas - Dallas, Richardson, TX, 75080, United States, mxa113030@utdallas.edu

Mobile-Promotion platforms such as Cidewalk enable advertisers to directly launch their personalized mobile advertising campaigns. These platforms contract with advertisers to provide a certain number of impressions on mobile apps in their desired sets of geographic locations within their desired time durations; the execution of each such contract is referred to as a campaign. In practice, campaigns arrive dynamically over time and the platform bids in real-time at an ad exchange to fulfill their demands. Our analysis offers a rolling-horizon procedure in which the platform periodically recomputes its procurement/bidding policy and its policy for allocating the impressions to the campaigns.

■ WA27

201A-MCC

Humanitarian Operations Management

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Alfonso J Pedraza-Martinez, Indiana University, 1309 E 10th Street, Bloomington, IN, 47405, United States, alpedraz@indiana.edu

1 - Volunteer Management In Charity Storehouses
Alfonso J Pedraza-Martinez, Indiana University, Kelley School of Business, 1309 East 10th Street, Bloomington, IN, 47405, United States, alpedraz@indiana.edu, Maria Besiou

We study volunteer management at a large faith-based organization. The whole supply chain operates exclusively with volunteers (from supply to delivery). We focus our study on the preparation of beneficiaries' orders by volunteers in a storehouse. There are different categories of volunteers; some are more experienced while others may work in the system for the first time. The volunteers' arrival in the system and their skills are uncertain. Using empirical data we explore the drivers of on-time order fulfillment at the storehouse level.

2 - Deployment Guidelines For Community Health Workers In Sub-saharan Africa

Jonas Jonasson, London Business School, London, United Kingdom, jjonasson@london.edu, Carri Chan, Sarang Deo, Jeremie Gallien

Community health workers (CHWs) are increasingly important to the delivery of health care in many African countries. Leveraging an extensive dataset featuring time, clinical findings and GPS information for CHW visits in Ghana, we develop a stochastic model describing the health dynamics of a population served by a time-constrained CHW. This model supports the design of managerial guidelines for patient prioritization and catchment area assignment in a CHW operation.

3 - Global Vehicle Supply Chains In Humanitarian Operations: A Network Analysis Approach

Jon M. Stauffer, Texas A&M University, College Station, TX, United States, jstauffer@mays.tamu.edu, Alfonso J Pedraza-Martinez, Lu Yan

We examine the vehicle supply chain network structure of the International Federation of the Red Cross (IFRC) as they respond to a mega disaster while continuing to support development programs and minor disasters. Using Exponential Random Graph Models, we examine the significance of the vehicle supply chain network changes year-to-year. Results show that temporary hubs are utilized in mega disaster locations and that supply chain support for areas outside the mega disaster region, while present, is reduced. This allows us to better understand how all supply chain networks could improve their response to large disruptions.

4 - Assessing The Impact Of Network Vulnerability On Relief Distribution Operations Considering Social Costs

Miguel Jaller, University of California Davis, mjaller@ucdavis.edu, Luis Fernando Macea, Victor Cantillo

This paper develops a model to asses the impacts that network vulnerability can have on the distribution of critical supplies after a disaster. The model estimates the changes in total social costs due to stochastic network disruptions. The analyses are based on the difference between the logsum, which measures the changes in consumer surplus or benefits, before and after the failure. In addition, the model allows identifying the critical links in a network from the critical response perspective.

■ WA29

202A-MCC

Operations with Social Impact

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Deishin Lee, Boston College, Chestnut Hill, MA, United States, deishin.lee@bc.edu

1 - Dynamic Staffing Of Volunteer Gleaning Operations

Erkut Sonmez, Assistant Professor, Boston College, Carroll School of Management, Boston College, Fulton Hall, Office 350D, Chestnut Hill, MA, 02467, United States, sonmeze@bc.edu, Baris Ata, Deishin Lee

Gleaning refers to collecting food from what is left in the fields after harvest, and donating the goods to food bank or pantries that serve food insecure individuals. In this paper we study a dynamic control problem for volunteer capacity management of gleaning operations.

2 - Strategic Commitment To A Production Schedule With Supply And Demand Uncertainty: Renewable Energy In Day-ahead Electricity Markets

Nur Sunar, UNC at Chapel Hill, nur_sunar@kenan-flagler.unc.edu, John R Birge

Motivated by fast penetration of variable renewable energy (such as wind and solar energy) into the electricity generation mix, we study a day-ahead electricity market that consists of finitely many competing firms, each facing supply uncertainty. In electricity markets, the purpose of an undersupply penalty is to improve reliability by motivating each firm to commit to a production schedule it can deliver in the production stage. Using differential equations theory, we prove that imposing or increasing a market-based undersupply penalty rate can result in a strictly lower equilibrium reliability with probability 1. (Joint work with John Birge)

3 - Distributed Renewable-energy Generation And Implications For Strategic Consumer Behavior, Electricity Pricing And Installed Capacity

Alex Angelus, UT Dallas, Alexandar.Angelus@utdallas.edu

We propose a continuous-time model of electricity markets, in which heterogeneous consumers can purchase and install their own renewable-energy generators, such as solar panels, and thus reduce electricity consumption from the local utility. We analyze both in-the-grid and off-the grid scenarios. The optimal time to install distributed generation follows a threshold policy on customer demand. We derive explicit expressions for the threshold level and optimal distributed generation to install, and determine the optimal price the utility should charge to maximize its revenue. Contrary to the prevailing industry practice, higher electricity prices can lead to lower revenues for the utility.

4 - Converting Retail Food Waste Into By-product

Mustafa H Tongarlak, Bogazici University, istanbul, Turkey, tongarlak@boun.edu.tr, Deishin Lee

By-product synergy (BPS) is a form of joint production that uses the waste stream from one (primary) process as useful input into another (secondary) process. The synergy is derived from avoiding waste disposal cost in the primary process and virgin raw material cost in the secondary process. We investigate how BPS can mitigate food waste in a retail grocer setting, and how it interacts with other mechanisms for reducing waste (i.e., waste disposal fee and tax credit for food donation). We also present a hybrid approach to implementing BPS that preserves managerial autonomy.

■ WA30

202B-MCC

Joint Session HAS/MSOM-HC: Patient Flow Analytics

Sponsored: Manufacturing & Service Oper Mgmt/HAS Healthcare Operations

Sponsored Session

Chair: Nan Liu, Columbia University, New York, NY, United States, nl2320@columbia.edu

Co-Chair: Zhankun Sun, University of Calgary, 2500 University Dr. NW, Calgary, AB, T2N 1N4, Canada, zhankun.sun@haskayne.ucalgary.ca

1 - Models For Hospital Inpatient Operations: A Data Driven Optimization Approach For Reducing ED Boarding Times

Shasha Han, National University of Singapore, shashahan@u.nus.edu, Shuangchi He, Hong Choon Oh

The long ED boarding times are a threat to most public hospitals. To tackle this problem, we examine datasets from a public hospital in Singapore and propose a data-driven approach to optimizing bed assignments. Our formulation incorporates practical features conventionally absent from the queueing control framework. With a slightly increased overflow proportion, it can greatly reduce the mean boarding times as well as the percentage of them exceeding given targets. It also helps to resolve the time-of-day effect of boarding times, which results from routine discharge procedures in hospitals. Interestingly, we show there exists an optimal solution that is fair to patients within each category.

2 - An Empirical Study Of Adding Physician Assistants To Critical Care Consultation Teams

Yunchao Xu, New York University, yxu4@stern.nyu.edu, Mor Armony, Carri Chan, Michelle Gong

Physician assistants (PAs) can sometimes be cost-effective alternatives to physicians in healthcare systems, but their impact on critical care delivery remains unclear. Over the course of 18 months, PAs were added to the Critical Care Consultation team at a major urban hospital system. In new multi-period analysis, we empirically measure the impact of part-time versus full-time PA coverage. We find that adding PAs can reduce the average time-to-transfer for all ICU patients and reduce mortality risk for low-severity patients. Interestingly, we do not find evidence that the benefits of having PAs further improves patient outcomes when adding PAs on non-weekdays.

3 - Predicting Triage Standing Orders

Han Ye, U of Illinois at Urbana-Champaign, hanye@illinois.edu, Zhankun Sun, Haipeng Shen

Overcrowding in emergency department (ED) has become a major problem worldwide. In order to mitigate ED overcrowding, we explore the potential of triage nurse ordering by developing models for predicting test orders using detailed information available at the triage stage. We then study the impact and trade-off of such predictive models in ED patient flows and patient outcomes.

4 - Optimal Workload Management During A Physician's Shift In Emergency Departments

Zhankun Sun, University of Calgary,
zhankun.sun@haskayne.ucalgary.ca

ED physicians can adjust their workload, which is measured by the number of patients signed up, to reduce patient handovers at the end of their shift. Patient handovers raise safety concerns due to the discontinuation of care. We present a dynamic programming model to inform patient flow management during a single ED physician's work shift. Case studies based on real data will also be discussed.

■ WA31

202C-MCC

Service Management: Economics and Operations

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Achal Bassamboo, Northwestern University, Kellogg School of Management, Northwestern University, Evanston, IL, 60208, United States, a-bassamboo@northwestern.edu

C-Chair: Ramandeep Randhawa, University of Southern California, Marshall School of Business, University of Southern California, Los Angeles, CA, 90089, United States, ramandeep.randhawa@marshall.usc.edu

1 - Scheduling Networks With Synchronization Constraints And Heterogeneous Customers

Amy R Ward, Professor, University of Southern California, Marshall School of Business, Bridge Hall BRI 401H, Los Angeles, CA, 90089-0809, United States, amyward@marshall.usc.edu, Erhun Ozkan

Networks in which the processing of jobs occurs both sequentially and in parallel are prevalent in many applications domains, such as computer systems, healthcare, and manufacturing. The relevant control decision is how to dynamically determine job priority at the servers that process multiple job types. A key difficulty in finding a delay-minimizing control is that the parallel processing of jobs gives rise to synchronization constraints. We propose a state-dependent departure pacing control under which job priorities are determined so as to balance the jobs waiting to be joined at the synchronization servers. We prove our control is asymptotically optimal for certain network topologies.

2 - Collaboration And Multitasking In Networks: Aligning Task Priorities And Collaboration Levels

Itai Gurvich, Kellogg School of Management,
i-gurvich@kellogg.northwestern.edu, Jan A Van Mieghem

We study networks where some tasks require the simultaneous processing by multiple types of multitasking indivisible resources. As one maximizes capacity, we prove, the achievable performance space collapses into a single policy.: the highest priority must be given to the tasks that require the most collaboration: a mismatch between priority levels and collaboration levels inevitably inflicts a capacity loss. We further establish a fundamental difference between the achievable performance spaces of preemptive and non-preemptive collaborative networks.

3 - The Costs And Benefits Of Ridesharing: Sequential Individual Rationality And Sequential Fairness

Ragavendran Gopalakrishnan, Research Scientist, Xerox Research Centre India, Bangalore, India, Ragavendran.Gopalakrishnan@xerox.com, Koyel Mukherjee, Theja Tulabandhula

We formulate a cost sharing framework for ridesharing that explicitly takes into account the inconvenience costs of passengers due to detours. We then introduce a notion of sequential individual rationality (SIR) that requires that the disutilities of existing passengers decrease as additional passengers are picked up, and show that these constraints induce a natural limit on the permissible incremental detours as the ride progresses. We characterize routes for which there exists some cost sharing scheme that is SIR on that route, and explore the consequences of SIR on the design of sequentially fair cost sharing schemes. We conclude by addressing the algorithmic challenges associated with SIR.

4 - Scheduling Impatient Customers Based on Time In Queue

Achal Bassamboo, Northwestern University,
a-bassamboo@northwestern.edu, Ramandeep Randhawa

We study scheduling impatient customers in multi-class parallel server queueing systems. From the system's perspective, customers that are of the same class at time of arrival get further differentiated on their residual patience time as they wait in the system. Using a fluid approach, we propose a novel cost-minimizing policy that schedules customers on two dimensions of heterogeneity: class and time-in-queue information.

■ WA32

203A-MCC

Risk Analysis I

Contributed Session

Chair: Ming Zhou, Professor, Shenzhen University, College of Management, Shenzhen, 518060, China, mzhou@szu.edu.cn

1 - Optimal Capital Requirements In Financial Networks With Fire Sales

Jongsoo Hong, Duke University, 100 Fuqua Drive, Durham, NC, 27707, United States, jh176@duke.edu

We consider an interbank network with fire sales externalities of multiple illiquid assets and study the problem of optimally trading off between capital reserves and systemic risk. We find that the optimal capital requirements under maximum payments and prioritized liquidation rule can be formulated as a convex and convex mixed integer programming, respectively. To solve the convex MIP, we offer an iterative algorithm that converges to the optimal. We show the results of the methodology on numerical examples and provide implications for capital regulation policy and stress test.

2 - A New Approach To Fuzzy Risk Assessing Large Renewable Energy Construction Projects

Jose-Ignacio Munoz-Hernandez, University of Castilla - La Mancha, Edifico Politecnico - UCLM, Avda Camilo Jose Cela, S/N, Ciudad Real, 13071, Spain, joseignacio.munoz@uclm.es, Luis Serrano-Gomez

The Fuzzy Sets Theory deals with simple linguistic terms in order to classify the level of an impact or a probability in risk assessing. Expressions like "Moderate Impact" or "Very High Probability" are more clear and intuitive to experts for carrying out risk assessments than the use of numerical values. However, idiomatic expressions are not useful to calculate severity or probability levels accurately. This work uses Fuzzy Logic and Monte-Carlo simulation not only to evaluate those expressions numerically but also to calculate experts evaluations coherence, weighing up their results according to the coherence level in their responses.

3 - Accounting For Heterogeneity And Macroeconomic Variables In The Estimation Of Transition Intensities For Credit Cards

Jonathan Crook, University of Edinburgh, Business School, 29 Buccleuch Place, Edinburgh, EH8 9JS, United Kingdom, j.crook@ed.ac.uk, Viani Djeundje

The literature has considered intensity models that give predictions of the probability, for each customer, that he/she will transit from one state of delinquency to another between any two months in the life of the loan. The transitions include not only transitions into further delinquency but also transitions to lesser states of delinquency, that is cure. We now extend this work by including frailty terms relating to the individual cases. This means that any statistical bias that may exist because of the omission of unobserved effects due to these types of variation should be removed. Results of applying the method to a large dataset relating to credit card holders will be illustrated.

4 - Risk Strategy For Managing Information Privacy

Gwendolyn K Lee, Chester C. Holloway Professor, University of Florida, Gainesville, FL, 32611, United States, gwenlee@ufl.edu, Ye Xia

Firms' risk strategy involves choosing a probability of success/failure in realizing a certain size of impact on the firm's competitive strength. We observe a disturbing pattern general across a broad family of shapes of risk distribution (e.g., changing from Gaussian to Pareto distributions where the tails of the distribution become longer or heavier). One and one firm only always chooses to take risks that carry the possibility of inflicting extreme privacy harm. The risk strategy does not shift as the risk-return distribution changes its shape. The risk strategy for managing information privacy is studied in the context of firms pursuing data-intensive innovation such as personalized medicine.

■ WA33

203B-MCC

Production and Scheduling I

Contributed Session

Chair: Atieh Madani, University at Buffalo, The State University of New York, 11221 Nickel Way, Amherst, NY, 14228, United States, atiehmad@buffalo.edu

1 - Transient Analysis Of Geometric Serial Lines With Perishable Intermediate Products

Feng Ju, Assistant Professor, Arizona State University, 699 S. Mill Avenue, #553, Tempe, AZ, 85287, United States, fengju@asu.edu, Ningxuan Kang, Li Zheng

Perishable intermediate products are commonly seen in practical manufacturing systems, where the residence time of intermediate products in the buffer is limited. Parts have to be scrapped if their maximum allowable time is exceeded. In order to reduce the scrap ratio and optimize the production operation in a timely manner, the transient behavior of the system needs to be investigated to evaluate and predict the system performance in real time. In this paper, we develop an analytical model to analyze the transient behaviors for such systems. Compared with simulation, it is shown that the proposed method could estimate the system's transient performance with high accuracy.

2 - Integrated Production Planning And Distribution Problems

Utku Koc, MEF University, Huzur Mah. Ayazaga Cad No:4, Maslak-Sariyer-Istanbul, Istanbul, 34396, Turkey, utku.koc@mef.edu.tr

In this study, we consider multiple integrated production and distribution problems. Given a set of orders, a subset will be selected to be included in the production plan. Each order has a profit, size and deadline for distribution. Among the two types of vehicles available for distribution, the first type is unlimited in supply but costly. The availability of the second type of vehicle, which is less costly, varies by time. A number of problem classes are defined depending on the distribution characteristics of the system. The difficulty of each class is determined. Moreover, the value of integration is assessed depending on the distribution characteristics.

3 - Incorporation Of Breaks In A Staffing Model For A Service Center With Flexible Servers

Atieh Madani, University at Buffalo, The State University of New York, 11221 Nickel Way, Amherst, NY, 14228, United States, atiehmad@buffalo.edu

The shift scheduling problem (SSP) is a problem of assigning tasks to the resources for each shift with the aim of minimizing costs and fulfilling the demand. In our study we consider breaks, different levels of skill (for staff), and multiple tasks for resources in the shift scheduling problem. In our work we use the shift scheduling model that is developed by Batta, Berman, and Wang as the base model. A column generation heuristic is developed and used to solve this problem. The performance of this model and heuristic method is good. The average gap between the integer program result and the lower bound (for different size of problems) is 2.47%.

■ WA34

204-MCC

Operational and Economic Models in Healthcare

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Huiyin Ouyang, University of North Carolina, Hanes Hall CB# 3260, Chapel Hill, NC, 27599, United States, ouyang5@live.unc.edu

Co-Chair: Serhan Ziya, University of North Carolina, 356 Hanes Hall CB# 3260, Chapel Hill, NC, 27599, United States, ziya@unc.edu

1 - Managing Returning Customers In An Appointment Based Service System

Yichuan Ding, University of British Columbia, daniel.ding@sauder.ubc.ca

We study how to manage returning customers in a slotted queue with the goal of maximizing service volume. Applications of this model include outpatient or dental appointment scheduling. We consider a simple strategy that a service provider may use to reduce balking — book a potential returning customer right before she leaves the clinic. We focus on a threshold-type policy and prove that the throughput rate is a quasi-concave function of the threshold under the retrials see time averages (RTA) assumption. We also analyze possible impact of the panel size and panel mix on the choice of this threshold.

2 - Proactive Patient Service: An Operational And Economic Analysis

Kraig Delana, London Business School, kdelana@london.edu, Nicos Savva, Tolga Tezcan

We present an operational and economic analysis of the value derived from healthcare providers using knowledge of upcoming patient care needs to proactively initiate service. On the operational side, we develop a novel queueing model to show that proactive service leads to significant reduction in delays. On the economic side, we show that if proactive service generates an inconvenience cost, strategic patients are less likely to choose to adopt than socially optimal due to economic frictions. This has important implications for providers working to implement proactive service in practice.

3 - Online Surgical Case Scheduling With Repeating Blocks

Shashank Goyal, University of Minnesota, Minneapolis, MN, United States, goyal030@umn.edu, Diwakar Gupta

Hospitals often assign surgeons a fixed number of blocks of operating-room time on a periodic basis. The value and the duration of a surgery request are revealed upon its arrival. The surgeon must place it in one of the blocks or decline it without knowing the future requests. This decision must respect capacity constraints and cannot be modified at a later time because the patients have to make arrangements for travel and post-operative care. The aim is to maximize the total value of accepted requests. We model the problem as the online multiple knapsack problem and propose algorithms that have provable worst-case performance. We also present bounds on the best performance that any algorithm can achieve.

4 - Data-driven Patient Scheduling In Emergency Departments: A Hybrid Robust-stochastic Approach

Meilin Zhang, National University of Singapore, meilin.zhang@u.nus.edu

Emergency care necessitates adequate and timely treatment, which has unfortunately been compromised by crowding in many emergency departments (EDs). To address this issue, we study patient scheduling in EDs so that mandatory targets imposed on each patient's door-to-provider time and length of stay can be collectively met with the largest probability. Exploiting patient flow data from the ED, we propose a hybrid robust-stochastic approach to formulating the patient scheduling problem, which allows for practical features such as a time-varying patient arrival process, general consultation time distributions, and multiple heterogeneous physicians.

■ WA35

205A-MCC

Topics in Service Operations

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Yong-Pin Zhou, University of Washington, Seattle, Michael G. Foster School of Business, Seattle, WA, 98195, United States, yongpin@uw.edu

1 - Search Among Queues Under Quality Differentiation

Luyi Yang, University of Chicago, Chicago, IL, United States, luyi.yang@chicagobooth.edu, Laurens G Debo, Varun Gupta

To understand implications of policy initiatives to cut elective surgical wait times, we build an equilibrium search model where customers choose over a large collection of vertically differentiated, congested service providers. We find that policies that reduce either the search cost or customer demand may increase the average waiting time in the system as customers substitute toward high-quality service providers. Moreover, the improved quality customers obtain may not compensate the prolonged wait, degrading the overall search reward while yielding no returns in customer welfare.

2 - Observational Learning In Environment With Multiple Options

Chen Jin, Northwestern University, chenjin2011@u.northwestern.edu

This paper studies, both theoretically and empirically, the choice strategy (behavior) of agents in a system with multiple options for which agents observe the aggregate choices of previous agents. With information asymmetry regarding the quality of the different options, the choices of better informed agents turn sales into informative signals, allowing uninformed agents to learn about the options' quality. Contrary to the traditional observational learning literature with binary choice, our theoretical analysis shows that options with less sales usually have higher chance of being high quality. But the experiment data reveals that uninformed subjects tend to choose options with most sales.

3 - Customer Segmentation And Fairness: A Queueing Perspective

Yong-Pin Zhou, Professor, Foster School of Business, University of Washington, Seattle, Seattle, WA, 98195-3226, United States, yongpin@uw.edu, Jian Liu

When a service firm uses limited capacity to serve heterogeneous customers, it can employ customer segmentation and prioritization techniques to maximize profit. Customers are often assumed to be rational decision makers in choosing which service option to use. In this research, we incorporate customers' sense of fairness and show that it can make a difference in how the firm should choose which services to offer, and how to prioritize.

■ WA36

205B-MCC

Cooperation in Supply Chain Management

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: Xiangyu Gao, University of Illinois, University of Illinois at Urbana-Champaign, Champaign, IL, 61801, United States, xgao12@illinois.edu

Co-Chair: Xin Chen, UIUC, UIUC, Urbana, IL, 61801, United States, xinchen@illinois.edu

1 - Population Monotonicity In Newsvendor Games

Xiangyu Gao, UIUC, 104 S. Mathews, Urbana, IL, 61801, United States, xgao12@illinois.edu, Xin Chen, Zhenyu Hu, Qiong Wang

We use the concept of population monotonic allocation scheme (PMAS), which requires the cost allocated to every member of a coalition to decrease as the coalition grows, to study the cooperative newsvendor game. We focus on the dual-based allocation scheme and identify conditions under which it is a PMAS.

2 - Strategic Inventories And Supplier Encroachment

Xin Geng, University of Miami, Miami, FL, United States, xgeng@bus.miami.edu, Huiqi Guan, Haresh Gurnani, Yadong Luo

We study the interaction between strategic inventories and supplier encroachment in a two-period model. The buyer may withhold excess inventory and the supplier can introduce a direct selling channel in the second period. We find that irrespective of the buyer's unit holding cost, strategic withholding may occur and the supplier's encroachment strategy is distorted.

3 - A Non-cooperative Approach To Cost Allocation In Joint Replenishment

Xuan Wang, Hong Kong University of Science and Technology, Kowloon, Hong Kong, xuanwang@ust.hk, Simai He, Jay Sethuraman, Jiawei Zhang

We consider the joint replenishment game in which the major setup cost is split equally among the retailers who place an order together. Each retailer pays his own holding and minor setup cost. Under this allocation rule each retailer determines his replenishment policy to minimize his own cost anticipating the other retailers' strategy. We show that a payoff dominant Nash equilibrium exists and quantify the efficiency loss of the non-cooperative outcome relative to the social optimum.

4 - Cost-sharing Mechanism Design For Supply Chain Consolidation

Wentao Zhang, University of Southern California, Los Angeles, CA, United States, wentao@usc.edu, Nelson A Uhan, Alejandro Toriello, Maged M Dessouky

We design cost-sharing mechanisms to incentivize suppliers to cooperate in freight consolidation, in which suppliers have their shipping demand consolidated before sending it to the customers to benefit from lower transportation rates. The nonconvex and nonconcave cost functions resulting from multiple-truck volumes make it impossible to design a truthful and budget-balanced cost-sharing mechanism under the Moulin mechanism framework. With this in mind, we propose a truthful cost-sharing mechanism that attempts to maximize the fraction of the total cost that will be recovered from the prices charged. We also study our proposed cost-sharing mechanism from the social welfare perspective.

■ WA37

205C-MCC

Sustainable Operations and Environmental Decisions

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Xin Wang, Tepper School of Business- Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA, 15213, United States, xinwang1@andrew.cmu.edu

1 - Remanufacturing Strategies For Oems Without Remanufacturing Capabilities

Zhou Yu, Chongqing University, Chongqing, China, cquyuzhou@163.com, Anton Ovchinnikov, Yu Xiong

We discuss two strategies for how an OEM without remanufacturing capabilities could interact with independent remanufacturers: outsourcing and relicensing. Factoring in the possibility of unauthorized remanufacturing and the resultant participations concern, we solve for the equilibrium strategies and discuss how the problem fundamentals impact the resultant solution. In addition to the analytical results we also present numerical illustrations with behaviorally-estimated parameters for North American and Chinese consumers and highlight how the equilibrium solution depends on the consumer behavior and market characteristics.

2 - Design And Technology Choice For Recycling: Collective Versus Individual Implementation

Morvarid Rahmani, Georgia Tech, Atlanta, GA, United States, Morvarid.Rahmani@scheller.gatech.edu, Luyi Gui, Atalay Atasu

Efficient and effective treatment of end-of-life products requires not only product design improvements but also advancement in recycling technologies. In this paper, we study how the complementarity between product design and recycling technology affects the efficiency of collective and individual recycling implementations.

3 - Green Technology Development And Adoption: Competition, Regulation, And Uncertainty – A Global Game Approach

Xin Wang, Assistant Professor, Hong Kong University of Science and Technology, IELM, HKUST, Clear Water Bay, 15213, Hong Kong, xinwang@ust.hk, Soo-Haeng Cho, Alan Scheller-Wolf

When a government is considering tightening a standard on a pollutant, their decision often is influenced by the number of firms being able to meet the tightened standard, because a higher number indicates a more feasible standard. We study how such regulation may affect a firm's incentive to develop a new technology to reduce a pollutant. To analyze this problem, we use the global game framework recently developed in economics. We find that regulation that considers industry capability, compared with regulation that ignores it, can more effectively motivate development of a new green technology. Surprisingly, uncertainty in the payoff can also help promote development of a new green technology.

■ WA38

206A-MCC

Opt, Robust

Contributed Session

Chair: Abhilasha Aswal, Phd Candidate, International Institute of Information Technology, Bangalore, 26 Willow drive, Apt 8B, Ocean, 7712, India, abhilasha.aswal@iiitb.ac.in

1 - Efficient Methods For Stronger Performance Bounds On Two-stage Adaptive Optimization Models

Frans de Ruiter, PhD Candidate, Tilburg University, Warandelaan 2, Tilburg, 5037AB, Netherlands, f.j.c.t.deruiter@tilburguniversity.edu, Dimitris Bertsimas

Many efficient methods have been developed to find suboptimal solutions to two-stage adaptive linear optimization problems. Although these solutions appear to perform very well in practice, bounds on the performance of these solutions are often far off. We present new efficient methods to obtain stronger performance bounds. We show numerically that our method can obtain bounds quickly and improve upon existing techniques.

2 - Performance Of Affine Policies In Dynamic Robust Optimization

Omar El Housni, Columbia University, NYC, NY, United States, omarhousni@hotmail.com, Vineet Goyal, Chaithanya Bandi

We study the performance of affine policy approximation for multi-stage robust linear optimization problem under right hand-side uncertainty. Such problems arise in many applications where right hand side models demand uncertainty. Surprisingly, affine policies are not necessarily optimal even for simplex uncertainty sets in multi-stage unlike two-stage. We show that affine policies give a $O(\sqrt{ \lot T m})$-approximation if the uncertainty is a Cartesian product of identical (or nested) uncertainty sets in each period and $O(\sqrt {Tm})$-approximation for general multi-stage uncertainty.

3 - Robust And Reliable Solutions Bilevel Optimization Problems Under Uncertainties

Zhichao Lu, Michigan State University, 16789 Chandler Rd Apt 0436D, East Lansing, MI, 48823, United States, luzhicha@msu.edu, Kalyanmoy Deb

Bilevel optimization problems have received a growing attention in the recent past due to their relevance in practice. A number of studies on bilevel applications and solution methodologies are available for deterministic set-up, but studies on uncertainties in bilevel optimization are rare. In this paper, we suggest methodologies for handling uncertainty in both lower and upper level decision variables that may occur from different practicalities. For the first time, we discuss and demonstrate the effect of uncertainties in each level on the overall definition of a robust and reliable bilevel solution and present simulation results on a number of problems.

4 - Uncertainty Quantification For Robust Optimization

Abhilasha Aswal, Phd Candidate, International Institute of Information Technology, Bangalore, 26 Willow drive, Apt 8B, Ocean, 07712, India, abhilasha.aswal@iiitb.ac.in, Srinivasa Prasanna

We present a Hartley-like measure for quantification of information driving the optimization using robust uncertainty sets. Based on this, we present transformation based uncertainty equivalent materializations of alternative uncertainty sets from a given uncertainty set. We show that using polyhedral models for uncertainty leads to optimization models that are computationally simpler than probabilistic alternatives, with potentially mixed continuous and discrete variables.

■ WA39

207A-MCC

Joint Learning and Optimization in Supply Chain Systems

Sponsored: Applied Probability

Sponsored Session

Chair: Cong Shi, University of Michigan, Ann Arbor, Ann Arbor, MI, 48105, United States, shicong@umich.edu

1 - Nonparametric Learning Algorithms For Optimal Base-stock Policy In Perishable Inventory Systems

Huanan Zhang, University of Michigan, zhanghn@umich.edu

We develop the first nonparametric learning algorithm for periodic-review perishable inventory systems, where the firm does not know the demand distribution a priori but makes the replenishment decision in each period based only on the past sales (censored demand) data. It is well-known that even with complete information about the demand distribution a priori, the optimal policy for this problem does not possess a simple structure. Hence in this paper we focus on finding the best base-stock policy, which performs near-optimal in these systems. We establish a square-root convergence rate of the proposed algorithm, which is the best possible for this class of problems.

2 - Dynamic Inventory Control With Stockout Substitution And Demand Learning

Beryl Boxiao Chen, University of Illinois at Chicago, Chicago, IL, United States, boxchen@umich.edu, Xiuli Chao

Stock-out substitution is the phenomenon that if the primary choice of a customer is out of stock, besides leaving the market immediately, the customer may also substitute for other products. In this paper, we study a data-driven inventory management problem and infer the customer substitution behavior from historical sales data.

3 - Demand Estimation And Price Optimization With Endogeneity Effect

He Wang, Massachusetts Institute of Technology, Cambridge, MA, United States, wanghe@mit.edu, Milashini Nambiar, David Simchi-Levi

Inspired by many applications, we consider a revenue management setting where heterogeneous products are offered sequentially over a finite horizon. Demand for each product is modeled as a function of price, a product feature vector, and a random noise. Our model allows for price endogeneity — a common problem in the presence of heterogeneous product features — where price is correlated with demand noise. We propose an online pricing algorithm which uses randomized price shocks to estimate parameters via a two-step regression. Theoretical and numerical evidence is provided to show the performance of this algorithm.

■ WA40

207B-MCC

Probabilistic Combinatorial Optimization

Sponsored: Applied Probability

Sponsored Session

Chair: Alessandro Arlotto, Duke University, 100 Fuqua Drive, Durham, NC, 27708, United States, aa249@duke.edu

1 - Limiting Theorems For The Optimal Alignments Score In Multiple Random Words

Ruoting Gong, Illinois Institute of Technology, rgong2@iit.edu

Let X_{1}, ..., X_{m} be m independent sequences of i.i.d. random variables taking values in a finite alphabet A. Let the score function S, defined on A^{m}, be non-negative, bounded, permutation-invariant, and satisfy a bounded differences condition. Under a variance lower-bound assumption, a central limit theorem is proved for the optimal alignments score of the m random words. This is in contrast to the Bernoulli matching problem or to the random permutations case, where the limiting law is the Tracy-Widom distribution. In particular, when S(x)=1_{x_{1}=x_{2}= ... =x_{m}}, a central limit theorem is obtained for the length of the longest common subsequence of random words X_{1}, ..., X_{m}.

2 - Changing Graph Structure For Performing Fast, Approximate Inference In Probabilistic Graphical Models

Areesh Mittal, The University of Texas at Austin, areeshmittal@utexas.edu

Complexity of exact marginal inference algorithms in probabilistic graphical models is exponential in the treewidth of the underlying graph. We develop a method to perform approximate inference on discrete graphical models by modifying the graph to a new graph of lower treewidth. We prove error bounds on the approximate inference solution compared to the exact solution. We formulate the problem of finding parameters of the new graph which gives the tightest error bounds as a linear program (LP). The number of constraints in the LP grow exponentially with the number of nodes. To solve this issue, we develop a row generation algorithm to solve the LP. We discuss heuristics for choosing the new graph.

3 - Tight Adaptive Policies For The Dynamic And Stochastic Knapsack Problem

Xinchang Xie, Duke University, Durham, NC, United States, xinchang.xie@duke.edu, Alessandro Arlotto, Yehua Wei

In this talk, we consider a dynamic and stochastic knapsack problem in which items have unitary values and the knapsack has finite capacity. A decision maker is sequentially presented with n items with independent and identically distributed sizes, and the goal of the decision maker is to maximize the expected number of items that are included in a knapsack subject to the capacity constraint. We propose adaptive selection policies that are tight. That is, such adaptive policies have an expected number of selected items that is close to that of the optimal policy.

4 - A Central Limit Theorem For Temporally Non-homogenous Markov Chains With Applications To Dynamic Programming

Alessandro Arlotto, Duke University, Fuqua Drive, Durham, NC, 27708, United States, aa249@duke.edu, J. Michael Steele

We prove a central limit theorem for a class of additive processes that arise naturally in the theory of finite-horizon Markov decision problems. The main theorem generalizes a classic result of Dobrushin (1956) for temporally non-homogeneous Markov chains, and principal innovation is the summands are permitted to depend on both the current state and a bounded number of future states of the chain. We show through examples that this added flexibility gives one a direct path to asymptotic normality of the optimal total reward of finite-horizon Markov decision problems. The examples explain why such results are not easily obtained by alternative Markovian techniques such as enlargement of state space.

WA41

207C-MCC

Machine Learning for Finance

Sponsored: Financial Services

Sponsored Session

Chair: Justin Sirignano, University of Illinois at Urbana-Champaign, Champaign, Champaign, IL, 61801, United States, jasirign@illinois.edu

1 - Recurrent Neural Networks For Modeling Financial Data

Justin Sirignano, University of Illinois at Urbana-Champaign, Champaign, IL, jasirign@illinois.edu

We explore using recurrent neural networks for modeling financial time series. Recurrent neural networks depend upon the full history of the time series, allowing for modeling long-term correlations. In out-of-sample tests on financial data, we show recurrent neural networks can outperform standard feedforward neural networks.

2 - Deep Learning For Mortgage Risk

Apaar Sadhwani, Stanford University, apaars@gmail.com

We analyze mortgage risk at loan and pool levels using an unprecedented data set of over 120 million mortgages originated in United States, which includes the origination data, monthly updates on loan performance, and several time-varying economic variables. We develop, estimate, and test dynamic models for mortgage prepayment, delinquency, and foreclosure that capture loan-to-loan correlation. At heart of our model is a deep neural network trained using GPU-accelerated clusters. We develop several metrics to test model performance, which is a major improvement over existing models and highlights the importance of local factors. This is joint work with Justin Sirginano and Kay Giesecke.

3 - Background Subtraction For Pattern Recognition In High Frequency Financial Data

Alex Papanicolaou, Integral Development Corporation, alex.papanic@gmail.com

Financial markets produce massive amounts of complex data from multiple agents, and analyzing these data is important for building an understanding of markets, their formation, and the influence of different trading strategies. We apply low-rank plus sparse background subtraction methods to high frequency FX quote data. For prices in a single currency pair from many sources, we model the market as a low-rank structure with an additive sparse component representing transient market making behavior. We show case studies with real market data, showing both in-sample and online results, for how the model reveals pricing reactions that deviate from prevailing patterns.

WA42

207D-MCC

RM in Practice I

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Wei Wang, Pros, Inc, 3100 Main St, Ste 900, Houston, TX, 77002, United States, weiwang@pros.com

1 - Dynamic Pricing And Learning In Airline Revenue Management

Ravi Kumar, PROS Inc, rkumar04@pros.com, Wei Wang

Many airlines have been actively looking into class-free demand control structures, which requires demand models where price varies over a continuous interval. As evidenced both in literature and in practice one of the big challenges in this setting is the trade-off between policies that learn quickly and those that maximize expected revenue. We investigate applicability of recent advances in the area of optimal control with learning. We examine a demand model where customers maximum WTP is modeled as Gaussian and study approaches that generate sufficient variability in pricing to ensure discovery of the underlying customer behavior while providing appropriate level of expected revenue.

2 - Risk Management In Price And Revenue Optimization

Yanqi Xu, Princess Cruises, yanqi6@yahoo.com

Price and revenue optimization has been instrumental in delivering profit lift for companies across industries. Typical analytical models in this area involve providing a forecast, and then use price and revenue optimization model to balance supply and demand to extract the maximum profit for company's assets. In many cases, critical factors in the model are treated as deterministic and their stochastic nature is frequently ignored, a trade-off for simplicity in models. The utility of such solutions may be doubtful at best in situations where the modeled factors have large variances. In this talk, we will discuss models that account for risks in optimization, and show why it can be productive to do so.

3 - Implementing Optimal Decisions In Business Processes Using 4Ps: Proof Of Concept, Prototyping, Production, Performance

Sachin Sumant, Hertz Car Rental, sumantsachin@yahoo.com

In the new era of analytics, there is abundance of data, analytical models, visualization tools and integration technologies. Corporations are spending millions of dollars in building analytical infrastructure in the hope of significant ROIs. Large teams are getting formed and everybody is talking about "Next Generation Systems" within analytics team and "Change Management" among business users. This paper discusses how 4Ps can be utilized to unify the analytics team and business users to achieve the optimal benefit from decision making systems and processes by reducing rework, providing well-calibrated solutions, increasing acceptability and guaranteeing positive results.

4 - Deriving Price Elasticity Estimates In The UK Cruise Market

John Harvey, Carnival UK, johnandrewharvey@googlemail.com

I shall outline the data-driven approach used in deriving a first set of price elasticities for the UK Cruise Market, using purely observations from booking history. By segmenting UK cruises based on their demand and price behaviour, I will show how we approximated elasticity estimates through constructing willingness-to-pay models and including a weighting factor based on the average expected demand in different time intervals; we can estimate elasticities that represent the impact of price at points in the booking curve versus an average assumed weekly demand across the booking horizon.

WA43

208A-MCC

Spreading Decision Competencies

Sponsored: Decision Analysis

Sponsored Session

Chair: Chris Spetzler, Decision Education Foundation, DEF, Palo Alto, CA, 00000, United States, chris.spetzler1@gmail.com

1 - Adding Social Impact To Research Efforts And Grants.

Ali Abbas, University of Southern California, aliabbas@price.usc.edu

2 - Teaching Decision Skills In College And Career Readiness

Frank Koch, Koch Decisions, frank@kochdecision.com

During the 2015-2016 school year, Thurston High School in Springfield Oregon offered a College and Career Readiness class to juniors and seniors. The basic principles of decision quality were taught as well as how to write effective essays for college applications and how to plan to improve their college and career decisions during the rest of the school year. We learned that many of the same approaches used in business decision analysis are very effective with teenagers. The approach that has been used at Thurston should be easily adaptable to other schools as well as other organizations where the youth are starting to face significant life decisions.

3 - Recent Advances In Spreading Decision Skills

Chris Spetzler, Decision Education Foundation, chris@decisioneducation.org

The Decision Education Foundation has been working on spreading decision skills for more than a decade. Numerous opportunities exist for practitioners and academics to contribute and help spread the word. This talk will discuss possible collaboration scenarios.

WA44

208B-MCC

Environmental and Water Resources Decision Analysis

Sponsored: Decision Analysis

Sponsored Session

Chair: Fengwei Hung, Johns Hopkins University, Baltimore, MD, United States, hfengwe1@jhu.edu

Co-Chair: Liang Chen, Johns Hopkins University, Baltimore, MD, United States, chenliang1468@gmail.com

1 - Case Studies In Water Resources Management For Sustainability And Resilience

Cate Fox-Lent, US Army Corps of Engineers, 696 Virginia Rd, Concord, MA, 01742, United States, Catherine.Fox-Lent@usace.army.mil, Igor Linkov

The US Army Corps of Engineers has several missions related to Environmental Restoration, Water Quality, and goals for Sustainability and Resilience. Meeting those goals requires life-cycle planning and decision making beyond the usual project time horizon. This presentation will present 3 case studies of the various ways in which formal decision analytics are integrated in to water resources management in a Federal agency context.

2 - Optimizing Adaptive Stormwater Management With Green Infrastructure: A Case Study In Wingohocking Watershed, Philadelphia

Fengwei Hung, Johns Hopkins University, 3400 North Charles Street Ames Hall 313, Baltimore, MD, 21218, United States, hfengwe1@jhu.edu, Benjamin F Hobbs, Arthur E McGarity

Due to heterogeneous hydrology and uncertain maintenance effectiveness, the long run performance of Green Infrastructure (GI) for managing urban stormwater and pollution is highly uncertain. Implementing GI adaptively provides opportunities to modify plans in response to learning. We apply three stochastic optimization models for adaptive GI planning that represent monitoring and active experimentation. The models recommend optimal immediate GI and learning actions.

3 - Flood Risk Management Using Artificial Avulsions In The Yellow River Delta

Liang Chen, Johns Hopkins University, chenliang1468@gmail.com, Benjamin Hobbs

Due to high in-channel sedimentation rates, the Yellow River Delta of China has changed course frequently in its history, with huge socioeconomic impacts. Water storage and deliberately engineered avulsions can reduce these impacts, but at a cost. Multi-objective analysis and Monte Carlo simulation is used to develop decision rules and choose sizes and locations for engineered avulsions and floodways, considering uncertain future floods and trade-offs between flood risk and management cost.

4 - The Process Of Co-producing a ClimateIndicators System

Melissa A Kenney, University of Maryland, kenney@umd.edu

In this talk I will discuss the development and implementation of a climate indicators system that was designed to be owned collaboratively by multiple Federal agencies and designed to support for undefined climate adaptation and mitigation decisions. The process of development involved over 200 producers and users of climate information from the Federal government, academic, and private sector/NGOs over the past 5 years. I will reflect on the implications and lessons learned for future co-production processes that similarly adopt best practices in the development of indicators.

■ WA45

209A-MCC

Learning for Simulation and Simulation Optimization

Sponsored: Simulation

Sponsored Session

Chair: Giulia Pedrielli, National University of Singapore, TBD, Singapore, TBD, Singapore, giulia.pedrielli.85@gmail.com

1 - Simulation Analytics For Virtual Statistics

Yujing Lin, Northwestern University, yujinglin2013@u.northwestern.edu

“Virtual statistics” are performance measures that are conditional on the occurrence of an event; the virtual waiting time of a customer arriving to a queue at time t is one example. We describe methods for estimating virtual statistics post-simulation from the retained sample paths, examining both their small-sample properties and asymptotic consistency.

2 - The Effects Of Estimation Of Heteroscedasticity On Stochastic Kriging

Xi Chen, Virginia Polytechnic Institute and State University, xchen6@vt.edu

In this talk, we discuss the effects of using smoothed variance estimates in place of the sample variances on the performance of stochastic kriging (SK). Different variance estimation methods are investigated, and we show that such a replacement leads to improved predictive performance of SK. An SK-based dual metamodeling approach is further proposed to obtain more accurate prediction results given a fixed simulation budget.

3 - Extended Kernel Regression Method To Combine Analytical Methods And Simulation

Andrea Matta, Shanghai Jiao Tong University, matta@sjtu.edu.cn

Simulation is widely adopted to predict system performance. The main drawback is that it is slow in execution and the related computer experiments can be very expensive. On the other hand, analytical methods can rapidly provide system estimates but they are approximate. Recently the Extended Kernel Regression (EKR) has been proposed to combine simulation with analytical methods. This work has different purposes: 1) test EKR on different cases; 2) compare EKR with other state of the art techniques; 3) propose two different methods for calculation of confidence bands. Numerical results show the EKR method provides accurate predictions, particularly when DOE size is small.

4 - G-STAR A New Kriging Based Trust Region Method For Global Optimization

Giulia Pedrielli, Arizona State University, giulia.pedrielli.85@gmail.com, Szu Hui Ng

Stochastic Trust region methods iteratively generate meta-models for local optimization. We propose the Global Stochastic Trust Region Augmented Method (G-STAR): local meta-models are iteratively improved, through a new sampling criterion balancing exploration and exploitation. Specifically, a global model guides the search, while local models are fitted using sampled points in the generated trust regions. The best point is predicted at each iteration through an ensemble of the global and the local meta-models generated along the search. Preliminary numerical tests show an improved performance with respect to the previously proposed extended Two Stage Sequential Optimization algorithm.

■ WA46

209B-MCC

Revenue Management with Strategic Customers

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Woonghee Tim Huh, University of British Columbia, Vancouver, BC, Canada, tim.huh@sauder.ubc.ca

Co-Chair: Jaelynn Oh, University of Utah, Salt Lake City, UT, United States, jaelynn.oh@business.utah.edu

1 - Dynamic Pricing In The Presence Of Strategic Consumers: Theory And Experiment

Anton Ovchinnikov, Queen’s School of Business, 143 Union Street, Kingston, ON, K7L 3N6, Canada, ao37@queensu.ca, Mirko Kremer, Benny Mantin

We investigate the behavior of retailers who sell a fixed inventory of products over a two period horizon (main selling season followed by a markdown period) to a mixture of myopic and strategic consumers. We present a stylized model and an experimental study. Our main result is that retailers myopically underprice when facing consumers who are strategic. We explore the drivers for such underpricing and show that it is related to a counter-intuitive model prediction that most revenue is obtained at markdowns.

2 - Choosing To Be Strategic: Implications Of The Endogenous Adoption Of Forward-looking Purchasing Behavior On Multiperiod Pricing

Arian Aflaki, Duke University, 923 White Pine Drive, Durham, NC, 27705, United States, aa251@duke.edu, Pnina Feldman, Robert Swinney

We consider whether strategic consumer behavior benefits consumers when they purchase from a revenue-maximizing firm that sets prices over multiple periods. We show that many consumers have lower surplus if they are strategic than if they are myopic. We then develop a model in which consumers choose to become strategic by exerting costly effort, and show that considering this choice can have a significant qualitative impact on firm and consumer decisions. In addition, we illustrate that it is possible to increase firm profit and consumer welfare simultaneously by increasing the cost of strategic behavior. Finally, we find that price commitment can encourage more strategic waiting and harm firms.

3 - Product Quality And Pricing Management

Ruxian Wang, Johns Hopkins Carey Business School, Baltimore, MD, 21202, United States, ruxian.wang@jhu.edu, Shiliang Cui

Product quality, price and service are arguably the most important factors consumers consider in purchasing a product. We investigate a firm’s strategy for managing multiple products under various monopolistic and oligopolistic settings. Our analytical results show that the optimal quality level of any product should always be set at the global optimum, even if the firm can change price simultaneously, faces other firms’ competition, or offers a free ancillary service. Moreover, consumer surplus may be higher.

■ WA47

209C-MCC

New Models for Pricing and Assortment Optimization

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Adam Nabil Elmachtoub, Columbia University, 500 W 120th St., New York, NY, 10027, United States, adam@ieor.columbia.edu

1 - Assortment Optimization And Pricing Under A Nonparametric Tree Choice Model

Jake Feldman, U Washington, jbf232@cornell.edu

We consider assortment and pricing problems under a nonparametric ranking-based choice model. Under this nonparametric choice model, each customer class is distinguished by a unique ranking of the available products and an arrival probability. Given the arrival of a customer from a particular customer class, this customer will purchase the highest ranking offered product in her respective ranking list. First, we study assortment problems, where the goal is to find a set of products to offer so as to maximize the expected revenue from each customer. Second, we study the joint assortment and pricing problem, where the goal is to simultaneously select the set of products to offer as well as their prices.

2 - Revenue Management By Strategic Customer Selection

Roger D Lederman, IBM, rlederman@gmail.com, Vineet Goyal, Adam Elmachtoub

We describe a framework for managing product transitions, including the role that sales targeting can have in shaping customer decisions, managing inventory, and increasing revenue. We provide algorithms that select customers dynamically, each with their own choice model, in order to maximize revenue from a limited supply of inventory. We propose constant factor approximations when assortments may be chosen dynamically, and for a constrained setting where the set of offered products can only decrease over time.

3 - The Price Of Opacity

Michael Hamilton, Columbia, mh3461@columbia.edu

In this work, we study the value of selling opaque products, i.e., products where some features are hidden from the customer until after purchase. Opaque selling has seen use in airline and hotel contexts as well as by online retailing companies such as on Amazon and Threadless. Opaque selling allows for price discrimination between customers with strong or weak preferences among products. We study the impact of this discrimination and compare the revenue garnered against traditional selling strategies. We theoretically show that the revenue increase from opaque selling, which we call "The price of opacity", can be considerable in a number of contexts that we explore.

■ WA48

210-MCC

Interdisciplinary Business Analytics

Invited: Social Media Analytics

Invited Session

Chair: Mingfei Li, Bentley University, Waltham, MA, 02452, United States, mli@bentley.edu

Co-Chair: David Oury, Bentley University, 175 Forest Street, Waltham, MA, 02451, United States, doury@bentley.edu

1 - Role Of Collaborative Consumption Factors: A Cross-national Case Of Airbnb

Funda Sarican, Bentley University, fsarican@bentley.edu

With the rise of social platforms consumers recreated value by sharing resources. As a result, there has been an increase in collaborative consumption. To contribute to a better understanding of this phenomenon I focused on the peer-to-peer travel accommodation service Airbnb. The value of my research lies in identifying meaningful factors; product, social, cultural, and economic that have been studied in relation to the price or economy in previous literature.

2 - Health Analytics On The Quality And Efficiency Of Clinical Practice On Several Major Cancers

Chao Wang, Bentley University, cwang@bentley.edu

Cancer treatment has been a hot topic for healthcare domain for quite a long time. Efficiency and quality of the cancer treatment has been accessed from the medical point of view for past decades. However, for this study, HCUP state level inpatient data would be used to evaluate the changes of the quality and efficiency of major cancers' treatment in hospital care.

3 - Socio-economic Perceptions In Emerging Markets

Fernanda Maciel, Bentley University, Waltham, MA, United States, fmaciel@bentley.edu

In recent years, citizens in emerging economies are reporting higher levels of satisfaction with their living conditions and demonstrating high optimism about future perspectives compared to people in advanced economies in self-reported well-being surveys. This paper investigates the convergence of the socio-economic perceptions in emerging markets over time, tracking statistical clustering and movement of these countries using self-organizing maps (SOMs).

4 - Diversification Of Risk Management Strategies

Olga Biedova, Bentley University, obiedova@bentley.edu

Diversification of risk management strategies allows to achieve a well-balanced risk-return profile, which surpasses the profile of an approach of simple asset diversification. We present the results of numerical simulations of two conceptually different risk management techniques: a dynamically risk-managed fund and a guarantee structure linked to capital markets, which can be often seen in indexed Variable Annuity or Fixed Indexed Annuity. We show how these techniques would have worked in the past and compare their performance to a more traditional balanced portfolio with 60% equity and 40% bond without risk management.

■ WA49

211-MCC

Strategic Behavior, Competition, and Coordination under Uncertainty

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Sila Cetinkaya, Southern Methodist University, 3145 Dyer street, Dallas, TX, 75205, United States, sila@smu.edu

Co-Chair: Olga Bountali, Southern Methodist University, 3145 Dyer street, Dallas, TX, 75205, United States, obountali@smu.edu

1 - The Impact Of Batch Services On Customers' Equilibrium Actions And On Social Welfare

Olga Bountali, Southern Methodist University, obountali@smu.edu, Antonis Economou

We consider a single-server batch service queue and investigate the equilibrium behavior of customers when they strategically decide whether to join the system or not, driven by maximizing their own revenue. Usually congestion forms a discouraging factor for joining, as it is associated with long waiting. In batch-service systems, however, it induces both positive and negative externalities to customers' decisions. This leads to an intricate mixture of Avoid The Crowd and Follow The Crowd behavior. Consequently, it is not clear whether it becomes socially beneficial to incite customers to join or not. We shed light on these topics and investigate ways to regulate the queue.

2 - Price And Lead-time Competition With Customer Choice

Philipp Afèche, Rotman School of Management, University of Toronto, Toronto, ON, Canada, afeche@rotman.utoronto.ca

We consider the price/lead-time design problem of capacity-constrained providers that compete for heterogeneous price- and time-sensitive customers with private information on their preferences. We model the problem as a queueing game and discuss how the equilibrium properties depend on the capacity and the demand characteristics.

3 - The Impact Of Inspection Cost On Equilibrium, Revenue And Social Welfare In A Single Server Queue

Ricky Roet-Green, Simon Business School, University of Rochester, CS 3-345, Rochester, NY, 14627, United States, ricky.roet-green@simon.rochester.edu, Refael Hassin

Classical models of customer decision making in unobservable queues assume it is too costly to acquire queue length information. However, various services now make this kind of information accessible to customers at a reasonable cost. In our model customers choose among three options: join the queue, balk, or inspect the queue length at a cost before deciding whether or not to join. We map all possible input parameter sets into three scenarios. Each scenario is characterized by a different impact of inspection cost on both equilibrium and revenue maximization queue disclosure policy: fully observable, fully unobservable, or observable by demand (when inspection cost is at an intermediate level).

■ WA50

212-MCC

SpORts: Sports Analytics III

Sponsored: SpORts

Sponsored Session

Chair: Scott Nestler, University of Notre Dame, Mendoza College of Business, Notre Dame, IN, 46556, United States, snestler@nd.edu

1 - National Hockey League Goaltending: An Analysis Of Goaltender Performance In Relation To Amount Of Days Rest

Paul Weisgarber, U.S. Air Force Academy, USAF Academy, CO, United States, paul.a.weisgarber@gmail.com, Jeremy Forbes, Luke Guinan

When deciding which goalie to start, professional hockey teams have historically made that decision based on who the better overall goaltender is and whether they need a night (or more) rest. Aside from coach and player intuition, little data has been involved in such decisions. Motivated by an SB Nation article on broadstreethockey.com, we attempt to better inform NHL coaches and general managers on the relationship between the number of days rest between games (DRBG) for a goalie, his save percentage (SV%), and team wins and losses.

2 - Analysis Of Corner Kicks In Football (Soccer)

Nils Rudi, INSEAD, Nils.Rudi@insead.edu, Tong Wang

Using coded events and tracking data from football matches in a major football (soccer) league, we (1) study the prediction of the number of corner kicks in a match statically (using only the information available before the match starts) and dynamically (using live feed of critical events) and (2) investigate the dynamics that convert an awarded corner kick into a goal and factors that affect the conversion rate.

3 - Is Strength Of Schedule A Real Strength For NFL Teams

Ismail Civelek, WKU, ismail.civelek@wku.edu, Murat Kurt

The National Football League (NFL) uses both complex analytical tools and panel of experts to schedule regular season games to assure owners, coaches, players and fans that no team has an advantage. The strength of schedule has been a major disagreement in scheduling NFL games due to ongoing dispute about this measure. This paper proposes a mixed-integer-linear program to investigate the relationship between the strength of schedule and teams' making into the play-off and tries to answer whether the strength of schedule is a real strength for the NFL teams.

■ WA51

213-MCC

Evaluating Health Systems of Public Interest

Sponsored: Public Sector OR

Sponsored Session

Chair: Andres Garcia-Arce, University of South Florida, USF, Tampa, FL, 3, United States, andresg@mail.usf.edu

1 - Hospital Preventable Readmissions And Interventions In Medicare Patients

Andres Garcia-Arce, University of South Florida, Tampa, FL, United States, andresg@mail.usf.edu, Jose L. Zayas-Castro

Hospital preventable readmissions in the US are considered as a target for quality improvement by the affordable care act. Medicare uses economic penalties for hospitals with excessive readmissions. National experts present concerns about the appropriateness and fairness of these measurements such as the excessive impact on safety net hospitals. The use of disease-specific interventions reduces readmissions while directly improves the quality of care and produce savings. This research aims to use disease-specific health interventions to reduce readmissions. The results from this work are intended to open a discussion on alternative policies to address preventable readmissions.

2 - Predicting Likelihood Of Drug Approval From Clinical Trials

Felipe A Feijoo, Johns Hopkins University, ffeijoo@jhu.edu, Sauleh Ahmad Siddiqui, Jenny Bernstein

Pharmaceutical companies face huge risks and costs in order to launch a new drug to market. These costs are associated with expensive and timely clinical trials with a success rate that from 10% to 20%. In order to understand the drivers that make drugs to fail at some stage of a clinical trial, we developed a machine learning (based random forest) to determining the factors that are associated with clinical success. Our model is capable to predict with an 85% accuracy the new compounds that will get FDA marketing approval.

3 - The Future Burden Of CKD In China: A Simulation Model For The CKD Initiative

Nan Chen, Tsinghua University, Room 615, Shunde Building, Tsinghua University, Haidian District, Beijing, 100084, China, chenn618@gmail.com, Jinwei Wang, Xiaolei Xie, Luxia Zhang, Li Zheng

The prevalence of chronic kidney disease (CKD) is high in China, which is approximately 10.8% in 2010. However, awareness of CKD remains low, only 12.5% of the 119.5 million patients are aware of the condition. There exist very few studies to estimate the future burden of CKD. We developed a CKD Health Policy Model for Chinese people based on annual decrements in estimated glomerular filtration rates that depend on age and risk factors. We used this model to simulate the residual lifetime incidence of CKD and project the prevalence of CKD in China.

■ WA52

214-MCC

Network Repair and Resiliency for Service Restoration

Sponsored: Public Sector OR

Sponsored Session

Chair: Ozlem Ergun, Northeastern University, 453 Meserve, 360 Huntington Avenue, Boston, MA, 02115, United States, o.ergun@neu.edu

Co-Chair: Aybike Ulusan, Northeastern University, 360 Huntington Avenue, Boston, MA, 02115, United States, ulusan.a@husky.neu.edu

1 - Network Science Based Quantification Of Resilience Of Multi-scale Infrastructure Systems

Udit Bhatia, Northeastern University, bhatia.u@husky.neu.edu

Natural or human-induced disruptions to multi-scale critical lifeline infrastructure networks can damage economies and cause loss of lives. Characterizing brittleness and guiding restoration are crucial for post-hazards recovery and proactive design. Here we develop a quantitative network-science framework to understand fragility and resilience of interdependent lifelines, which we demonstrate on the interdependent Boston Mass Transit, Power transmission system by assessing robustness and evaluating recovery strategies. Natural hazards and cyber-physical attacks, as well as non-systematic and cascading infrastructure failures are considered.

2 - Transportation Network Recovery Based On Multi-industry Economic Impact

Mohamad Darayi, The University of Oklahoma, mdarayi@ou.edu, Kash Barker, Nazanin Morshedlou

Freight transportation networks, considered a means to enable the flow of commodities and to facilitate economic productivity, are prone to natural and human-made hazards. This research pursues an approach to improve restoration order decision making based on the broader perspective of their impact to multiple industries and multiple regions.

3 - On The Cost Of Decentralized Scheduling For Interdependent Network Restoration

Hongtan Sun, Rensselaer Polytechnic Institute, 110 8th St., Troy, NY, 12180, United States, sunh6@rpi.edu, Thomas Sharkey

We consider the problem of restoring disrupted services across multiple interdependent networks after extreme events. The restoration efforts are usually formulated in a decentralized manner as each system optimizes their own restoration schedule. We consider integer programming approaches to determine the equilibrium (stable) solutions for this decentralized scheduling system. These approaches help to calculate the price of anarchy and the price of stability which help to measure the loss in the centralized objective from the decentralized scheduling process.

4 - Restoration Of Network Connectivity In Large-scale Disaster Management Problems

Aybike Ulusan, Northeastern University, ulusan.a@husky.neu.edu, Ozlem Ergun

The goal of this study is to offer enlightening insights on the network restoration problems by developing network science based quantitative frameworks. As the name suggests, the generic network restoration problem seeks for the best recovery strategy for a given perturbed network. As a case study, a disrupted network from a pot-disaster environment is tackled. Proposed frameworks are demonstrated on the real world disrupted road networks of different cities in USA having various topological properties.

WA53

Music Row 1- Omni

New Product Development and Process Development in Healthcare

Sponsored: Technology, Innovation Management & Entrepreneurship

Sponsored Session

Chair: Zhili Tian, Florida International University, 11200 SW 8th St, Miami, FL, 33199, United States, zhili.a.tian@gmail.com

1 - An Empirical Analysis Of The Barriers To And Optimal Use Of Clinical Decision Support Systems In Health Care

Xiaojin Liu, University of Minnesota, Minneapolis, MN, United States, liux1591@umn.edu, Susan Goldstein, Karen Soderberg, Kingshuk K Sinha

Clinical Decision Support (CDS) systems provide critical clinical information for health care processes, and development of capabilities related to their use enable provide knowledge related to both the current workflow and for process improvement. Yet, little is known about the barriers and outcomes of the development of these capabilities. We empirically investigate the barriers to CDS use and the consequences of using CDS features, controlling for organizational characteristics in the clinical setting.

2 - Management Of Cancer Drug Shortage Under Demand And Supply Uncertainty

Shanling Li, McGill University, shanling.li@mcgill.ca, Dali Zhang, Xiaowen Chang, Huifu Xu

In this research, we aim at developing an optimization model that characterizes the supply chain disruption of a generic cancer drug resulted from operational problems. We consider the trade-off between generic and brand name drugs and uncertainties in demand and supply. The cancer drug shortage problem is formulated as a chance-constrained model. Our aim is to investigate the severe impact of short supply of the generic cancer drug on supply chain decisions and to propose optimal purchasing plans to mitigate the drug shortage risk.

3 - Outsourcing Stategy For Intermediate Production Steps

Yang Wang, UC Berkeley, 4174 Etcheverry Hall, University of California Berkeley, Berkeley, CA, 94720, United States, yangwang0803@berkeley.edu, Philip Kaminsky

Small biopharmaceutical firms often outsource their final filling and labeling operations to a third party, but these firms use a variety of different outsourcing strategies. In particular, we consider two types of strategies. In the first, the firm orders when inventory position is low, so that its order is triggered by inventory level. In the second, the firm reserves a limited amount of capacity at the outsourcer at repeated fixed intervals, so that its order is triggered by time. These strategies impact inventory management at the biopharma firm, as well as capacity utilization at the outsourcer, and we develop models to explore the trade-off between these two types of strategies.

4 - Clinical Trials And New Drug Development: Optimal Investment Policies And Application

Zhili Tian, Florida International University, 11200 S.W. 8th Street, Miami, FL, 33199, United States, zhili.a.tian@gmail.com

Firms conduct Phase 3 trials by enrolling and treating patients who meet certain conditions. Opening test centers and finding patients to participate in trials are expensive and time consuming, with a great deal of uncertainty around these. We develop a dynamic recruitment policy for clinical trials, which depends on the available information on drug quality, potential market size, and likelihood of FDA approval. It also takes into account the costs of the clinical testing and the current success in enrolling patients. We consider cases with and without interim analysis of the clinical data. We develop structural results and provide conditions for accelerating or suspending a clinical study.

WA54

Music Row 2- Omni

Agent-based Modeling in Management Sciences and Economics

Sponsored: Service Science

Sponsored Session

Chair: Wei Zhang, Tianjin University, Tianjin, China, weiz@tju.edu.cn

Co-Chair: Shu-Heng Chen, National Chengchi University, 64, Chih-nan Rd.,Sec. 2, Wenshan, Taipei 11623, Taipei, 11623, China, chen.shuheng@gmail.com

Co-Chair: Silvano Cincotti, University of Genoa, via Opera Pia, 15 - 16145 Genova, ITALY, Genova, 16145, Italy, silvano.cincotti@unige.it

1 - Agent-based Modeling Of Chinese University Admission Mechanisms: From The Boston Mechanism To The Chinese Parallel Mechanism, Mission Accomplished?

Shu-Heng Chen, National Chengchi University, chen.shuheng@gmail.com

Between 1952 and 2003, all provinces in China used the algorithms equivalent to the Boston mechanism to admit college students. However, after a prolonged period of experimentation, the Boston mechanism has been criticized for its invoking "justified envy." In response, since 2003, some Chinese provinces have gradually promulgated a new system called the Chinese parallel mechanism, aiming to allocate students based more on their abilities than on their choices in order to answer the criticism of justified envy. Has this policy reform accomplished its mission? In this article, we use the agent-based model to evaluate the admission policy reform in Chinese higher education.

2 - An Empirical Zero-intelligence Model Of Chinese Stocks

Wei-Xing Zhou, East China University of Science and Technology, 130 Meilong Road, Shanghai, 200237, China, wxzhou@ecust.edu.cn, Gao-Feng Gu, Xiong Xiong, Wei Zhang, Yong-Jie Zhang, Wei Chen

Computational experimental finance is an important topic in finance. Order-driven models constructed based on the statistical properties of order flows are able to reproduce the main stylized facts of financial variables. In this talk, we will introduce a microscopic model based on the order flows of Chinese stocks. We will also discuss the potential applications of order-driven models in stock market micro structures and financial engineering. For instance, we study the optimal trading strategy problem of large orders and the impact of asymmetric price limits on stock price evolution.

3 - Nonlinear Transient Shock, Implementation Shortfall Optimum Strategy And Market Influences: Based On The Framework Of Computational Finance

Haifei Liu, Nanjing University, Nanjing, China, hfliu@nju.edu.cn, Xindan Li, Xiong Xiong

This paper builds an artificial stock market to simulate the real market, and make sure that the artificial market has the same statistical features with the real market. The mechanism of information sharing will also play an important role in the artificial market. Then the paper proposes a nonlinear quadratic IS (Implementation Shortfall) algorithm. We will analysis the impact on market when perform the algorithm and the different effects when compared with linear IS and Minimum Risk Volume Weighted Average Price. To conduct robust test, this paper also analysis the performance of the above algorithms under the different levels of private information in the market.

4 - Biased Information, Peer Pressure And Expectation Formation

Dehua Shen, Tianjin University, Tianjin, China, dhs@tju.edu.cn, Yongjie Zhang, Andrea Teglio, Wei Zhang

Behavior economics has relaxed the assumption on perfect rationality and recognized the impact of psychological biases on the expectation formation. However, existing literature mainly postulates the unbiased information generated by information sources. In that sense, the information reporting behavior is hugely simplified. In this paper, we address this issue by simulating an agent-based computational model with the consideration of the diffusion of biased information and investigate its influence on expectation formation. Meanwhile, the peer pressure mechanism is introduced to depict the social learning behavior among investors.

WA55

Music Row 3- Omni

Inventory Management VII

Contributed Session

Chair: Sepideh Alavi, University of Wisconsin Milwaukee, 1559 N Prospect Ave. Apt 309, Milwaukee, WI, 53202, United States, alavi@uwm.edu

1 - Inventory Replenishment Decision Support

Matthew D. Dean, University of Southern Maine, Portland, ME, Contact: matthew.dean1@maine.edu

We describe an MBA-led project to help a local glass and metal fabricator improve its inventory replenishment system. Historically, it relied on a manual inventory system controlled by a single person with many years of experience. The MBA team developed a spreadsheet-based linear programming model to recommend purchasing decisions. This tool was then migrated to a user-friendly web-based application.

2 - A Rental Problem With Unreliable Products

Mohammad Firouz, PhD Candidate, University of Alabama, 610 13th, Apt 19, Tuscaloosa, AL, 35401, United States, mfirouz@crimson.ua.edu, Burcu B Keskin, Linda Li

We investigate a capacity planning problem of a rental system as an M/M/c/c queuing model with breakdowns and reneging, and derive the closed form state distributions for a special case. Our proposed algorithm finds the guaranteed global optimal for the non-concave profit function. Bounds are derived for the general case. Numerical experiments demonstrate the performance of our algorithm and some managerial insights.

3 - Shelf And Backroom Inventory Management Under Shelf Stock Dependent Demand

Weili Xue, Southeast University, Hankou Road 22, Nanjing, China, wlxue1981@gmail.com, Ozgun Caliskan Demirag, Frank Y Chen, Yang Yi

Under shelf-stock-level-dependent demand, we develop inventory control policies to determine the amount of inventory to maintain in the backroom and the amount to display on the retail shelf.

4 - Inventory Classification Versus Statistical Clustering For Solving Multi-echelon Inventory Grouping Problem

Alireza Sheikhzadeh, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States, asheikhz@uark.edu, Manuel D Rossetti

Inventory classification and statistical clustering methods are two distinct approaches that can be used for inventory grouping. In this research, we compare the performance of the inventory classification and statistical clustering methods in the context of the multi-echelon stocking policy problem. Numerical experiments indicate there is a significant difference between these two methods, in terms of the service performance. We discuss the reasons why clustering is not an appropriate method for inventory grouping problem.

5 - Inventory Management Of Products With Irregular And Intermittent Demand Pattern

Sepideh Alavi, University of Wisconsin Milwaukee, 1559 N Prospect Ave. Apt 309, Milwaukee, WI, 53202, United States, alavi@uwm.edu

In this paper, we highlight the weakness of inventory turnover curve analysis proposed by Ballou (1981) in cases where products have intermittent demand pattern. The inventory management of a cookware manufacturer is studied in this research where planning for the stock of the products which do not have any demand in most of the months in a year or have lumpy demand, is important. We try to fit a gamma distribution to a set of fast- moving. We then will be able to estimate the base stock level for each item under study based on a periodic review inventory policy.

■ WA56

Music Row 4- Omni

Open Source & Online Communities

Sponsored: EBusiness

Sponsored Session

Chair: Pratyush Sharma, University of Delaware, Newark, DE, United States, pnsharma@udel.edu

1 - Single Loop And Double Loop Learning: The Link Between Open Source Software Developer Motivation, Contribution Behavior And Turnover Intentions

Shadi Janansefat, University of Pittsburgh, shadi.j@pitt.edu, Sherae Daniel

In this study we examine the link between learning motivation, two kinds of learning that occur through OSS development (single- and double-loop learning), and their impact on developer contributions. We distinguish among the impact of learning, use-value and collaboration motivation on the two kinds of learning and on developers' contributions and turnover intentions. We find that learning can be an intervening mechanism between motivation to work on a project, subsequent contributions and intentions to leave that project.

2 - Effective Selection Mechanisms In Open Innovation

Vipul Aggarwal, University of Washington, Seattle, WA, United States, aggarv@uw.edu, Elina Hwang

Open Innovation is proposed as an effective way to generate novel and innovative solutions to existing problems but it has been observed that the winning solutions offer only incremental improvement over the existing solutions. Using data from OpenIdeo.com and unsupervised learning algorithms, we aim to investigate the idea evaluation process in screening ideas from distant areas.

■ WA57

Music Row 5- Omni

Strategic Customer Behavior in Retail and Manufacturing

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Pelin Pekgun, University of South Carolina, Columbia, SC, United States, Pelin.Pekgun@moore.sc.edu

1 - Punishment And Reward In a Cooperative Advertising Game

Yukun Zhao, Tsinghua University, Beijing, China, zhaoyk1989@gmail.com, Tony H Cui, Xiaobo Zhao

In this paper, we investigate the counterfactual effects of punishment and reward decisions in an investment-pricing game. Specifically, we consider a dyadic channel where a manufacturer and a retailer first make investments to increase market base demand and then make sequential pricing decisions to sell to end consumers. We build a behavioral model with several relevant behavioral biases to study how firms pricing and profits are affected by the incorporated behavioral constructs. Experimental results confirm the behavioral model's predictions.

2 - Consumer Stockpiling Behavior In A Changing Economy: Implications For Retail Inventory Management

Xiaodan Pan, University of Maryland, College Park, MD, United States, xiaodan.pan@rhsmith.umd.edu, Benny Mantin, Martin E Dresner

Assessing consumer stockpiling behavior is critical for managing promotions. Distinguishing between non-stockpilers and stockpilers we explore how the changing economy influences consumers' purchasing behavior. While the consumption rates of both consumer segments increase (decrease) during expansion (contraction) period, we find that consumer stockpiling propensity is higher during contraction than during expansion period and that regional variations emerge. We discuss implications for inventory management.

3 - Behavioral Ordering And Competition

Brent Moritz, Penn State University, University Park, PA, 16802, United States, bmoritz@psu.edu, Bernardo Quiroga, Anton Ovchinnikov

We investigate the impact of behavioral ordering on profitability. Since most firms compete for customers, we compare the decisions of humans and a management science-driven competitor who places orders under three plausible policies. We evaluate performance when consumers are fully loyal and when they switch to the competitor with higher service levels. We show that the large differences in profits are primarily driven by suboptimal ordering of behavioral decision makers rather than the sophistication of their management-science-driven competitors.

4 - Using Capacity Allocation Policies For Truthful Forecast Sharing

Minseok Park, University of South Carolina, 1520 Senate Street, Apt 127, Columbia, SC, 29201, United States, minseok.park@grad.moore.sc.edu, Pelin Pekgun, Pinar Keskinocak

Through a behavioral study, we investigate customers' strategic forecasting and ordering behavior under different allocation policies from their supplier. Our results suggest that rewarding forecast accuracy in allocating inventory can lead to improved forecast sharing, particularly when the supplier communicates this policy to the customers.

■ WA58

Music Row 6- Omni

Finance I

Contributed Session

Chair: Huawei Niu, Nanjing Audit University, School of Finance, Nanjing, 211815, China, niuhuawei@gmail.com

1 - Optimal Construction And Rebalancing Of Index-Tracking Portfolios

Oliver Strub, University of Bern, Schuetzenmattstrasse 14, FM Quantitative Methoden, Bern, 3012, Switzerland, oliver.strub@pqm.unibe.ch, Philipp Baumann

Index funds have become popular because they offer attractive risk-return profiles at low cost. The index-tracking problem consists of revising (rebalancing) the composition of the index fund's tracking portfolio in response to new market information and cash changes such that the tracking accuracy of the index fund is maximized. We propose a novel formulation of the index-tracking problem as a mixed-integer linear program. In an empirical study, we demonstrate that the proposed formulation outperforms existing formulations in terms of tracking accuracy and running time.

2 - An Endogenous Structural Credit Risk Model And Its Application In Pricing Derivatives With Credit Risk

Huawei Niu, Nanjing Audit University, School of Finance, Nanjing, 211815, China, niuhuawei@gmail.com, Yajuan Lu

We propose an endogenous structural credit risk model with rollover debt by incorporating with the optimal contracting between the agent and equity holders. The model quantitatively shows that the agency costs induced by the moral hazard can endogenously have significant impacts on a firm's credit risk. Besides, we embed this structural approach into pricing vulnerable options as an application.

3 - Approximation Of Long Memory Process With Short Memory Process With Application To Option Valuation

Barret Pengyuan Shao, Crabel Capital Management, Charlottesville, VA, Contact: barretshao@gmail.com

Options on an asset which follow a long memory process are difficult to value, due to the existence of arbitrage opportunities. Here we show how to avoid the problem of arbitrage opportunities and value vanilla European options when underlying asset returns follow a FARIMA processes which is widely used as an model of long memory price processes. By approximating FARIMA by a stationary ARMA process, we show that the well understood option values for a sufficiently close stationary ARMA process can be taken as option values for the FARIMA process, with very low probability of error. We examine how long memory affects the option values and implied volatility surface.

■ WA59

Cumberland 1- Omni

Sharing Logistics

Sponsored: TSL, Facility Logistics

Sponsored Session

Chair: Wei Qi, Lawrence Berkeley National Laboratory, 1 Cyclotron Rd, Berkeley, CA, 94720, United States, qiwei@berkeley.edu

1 - A Study Of Corporate Barter Exchange Mechanisms

Min Zhao, University of California at Berkeley, Berkeley, CA, United States, vivianmzhao@berkeley.edu, Zuo-Jun Max Shen, Xiaobo Zhao

The study considers a modern corporate barter platform operating under different exchange mechanisms. It focuses on the chance that a participant can find exchange partners and his waiting time before being able to exchange. We derive closed form waiting time distribution under certain conditions and analyze participant's preference according to the waiting time. Insights on improving the performance of a barter platform are also provided.

2 - Household-level Economies Of Scale In Transportation

John Gunnar Carlsson, University of Southern California, jcarlsso@usc.edu

One of the fundamental concerns in the analysis of logistical systems is the trade-off between localized, independent provision of goods and services versus provision along a centralized infrastructure such as a backbone network. We study the "mini-economies" of scale that arise when households make multi-stop trips rather than using package delivery services. Our study is facilitated by an analysis of the Generalized Travelling Salesman Problem in the Euclidean plane.

3 - Shared Mobility For Last-mile Delivery: Implications Of Costs And Green House Emissions

Wei Qi, Lawrence Berkeley National Laboratory, qiwei@berkeley.edu, Lefei Li, Sheng Liu, Zuo-Jun Max Shen

We evaluate the prospect where shared mobility of passenger cars prevails throughout urban areas for home delivery services. We develop logistics planning models that characterize drivers' responses to wages, optimal open-loop routes and service zone design. Then we prescribe several scenarios where this business model is economically and environmentally favorable.

4 - Setting Inventory Levels In A Bike Sharing Network

Michal Tzur, Professor, Tel Aviv University, Tel Aviv, Israel, tzur@eng.tau.ac.il, Sharon Datner, Tal Raviv

Bike sharing operators address the non-homogeneous asymmetric demand processes by repositioning operations. This is a challenging task due to the nature of the user behavior that creates interactions among inventory levels at different stations. For example, an empty/full station can create a spill-over of demand to nearby stations. For the first time, we take this effect into consideration when setting target inventory levels for repositioning. We develop a robust guided local search algorithm and show that neglecting the interactions among stations leads to inferior decision-making.

■ WA60

Cumberland 2- Omni

Understanding and Optimizing Route and Mode Choices in a Dynamic/Multimodal Environment

Sponsored: TSL, Urban Transportation

Sponsored Session

Chair: Monireh Mahmoudi, Arizona State University, Arizona State University, Tempe, AZ, 85281, United States, mmahmoudi@asu.edu

1 - A Dynamic Programming Approach Based On State Space Time Network Representations For The Pickup And Delivery Problem

Monireh Mahmoudi, PhD Student, Arizona State University, Tempe, AZ, 85281, United States, mmahmoudi@asu.edu, Xuesong Zhou

This research proposes a new time-discretized multi-commodity network flow model for the VRPPDTW based on the integration of vehicles' carrying states within space-time transportation networks. Our three-dimensional state-space-time network construct is able to comprehensively enumerate possible transportation states at any given time along vehicle space-time paths, and further allows a forward dynamic programming solution algorithm to solve the single-VRPPDTW. By utilizing a Lagrangian relaxation approach, the primal multi-VRP is decomposed to a sequence of single-vehicle routing sub-problems, with Lagrangian multipliers for individual passengers' requests.

2 - Route Choice In Highly Disrupted Network: Learning, Inertia And Real-time Information

Xinlian Yu, University of Massachusetts, Amherst, MA, United States, xinlianyu@umass.edu, Song Gao

This paper studies the role of inertia, learning and real-time information in route-choice decisions in highly disrupted networks where travel time varies greatly with significant delays. A route-choice experiment with two different scenarios was conducted: the Information scenario provides subjects with real-time information regarding a probable incident and the Incident scenario does not. In both scenarios, subjects were provided with feedback information about the actual travel times on the chosen route. A discrete choice model with a Mixed Logit specification, accounting for panel effects, was estimated based on the experiment's data.

3 - Understanding Traveler Route Choices In Stochastic Multimodal Travel Environment Using Automatic Fare Collection Data

Laiyun Wu, University at Buffalo, 326 Bell Hall, University at Buffalo, Buffalo, NY, 14226, United States, laiyunwu@buffalo.edu, Jee Eun Kang, Alexander Nikolaev

The goal of this paper is to extract traveler behavior patterns from route choice observations in a stochastic multimodal environment, based on Automatic Fare Collection (AFC) data. First, we reconstruct the stochastic travel environment to enable simulation, with the travel times, transfer times, and level-of-service information accounted for. Second, route choices are analyzed to understand and model traveler decision-making.

4 - Personalized Multimodal Mobility Options Discovery In A Social Structure

Ali Arian, PhD Student, University of Arizona, Tucson, AZ, 85721, United States, arian@email.arizona.edu, Yi-Chang Chiu

This study uses a supernetwork to investigate the feasibility and attractiveness of multimodal mobility options. The modeling approach considers driving, walking, public transit and carpooling among users in an existing social structure. Besides desirability measures, algorithmic details and case studies using Metropia data are presented.

■ WA61

Cumberland 3- Omni

Shared-use Rail Corridor Operation and Planning

Sponsored: Railway Applications

Sponsored Session

Chair: Bo Zou, University of Illinois at Chicago, 2073 ERF, 842 West Taylor Street, Chicago, IL, 60607, United States, bzou@uic.edu

1 - Capacity Screening Tool For Mixed Operations

Mei-Cheng Shih, University of Illinois at Urbana - Champaign, Urbana, IL, 61801, mshih2@illinois.edu

In order to determine the appropriate solutions for rail network congestion, we need to identify the capacity constraints of the network first. In this study, we will develop a capacity screening tool based on the concept of "Root Cause Analysis" proposed by White (2005). This tool can calculate the traffic conflict density by taking account the current train schedule and the associated train departure and trip time variation. The traffic conflict density can later be used to identify the capacity constraints of a mainline. Using this tool can help the practitioners to find the weakness of their network in the most efficient way.

2 - Schedule Flexibility And Shared Corridor Capacity

Darkhan Mussanov, University of Illinois at Urbana - Champaign, Urbana, IL, 61801, mussano2@illinois.edu

North American railways operate in the unstructured manner, i.e without strictly adhered to timetable and pre-planned meets. Unscheduled operation poses a challenge the railway planners by increasing the number of possible meets on railway track. This research aimed to investigate the relationship between the schedule flexibility, infrastructure investment and level of service. The results revealed the fragile nature of the structured operation and the substantial investment requirements for the small shifts toward unscheduled operation.

3 - Siding Length, Train Length, And Capacity For Additional Traffic On Single Track Lines

Bradford Kippen, University of Illinois at Urbana - Champaign, Urbana, IL, 61801, United States, kippen2@illinois.edu

Operation of longer freight trains on single track lines has allowed North American Class 1 Railroads to expand freight car throughput without investment in additional infrastructure. However, implementation of this strategy is often limited when the length of longer trains exceeds length of existing passing sidings. RTC analysis has been used to model train delay patterns associated with various strategies of implementing long trains on a hypothetical corridor. In addition, following a simulated increase in traffic volume, a model was developed to determine the infrastructure investment required in either new or longer sidings to return to a baseline level of service.

4 - Capacity Allocation In Vertically Integrated Rail Systems: A Bargaining Approach

Bo Zou, University of Illinois at Chicago, Chicago, IL, United States, bzou@uic.edu, Ahmadreza Talebian

This paper presents a game-theoretic bargaining approach to allocating rail line capacity in vertically integrated systems. A passenger rail agency (PRA) negotiates with the host freight railroad (FRR) to determine train schedules and the associated payment. Bargaining in both complete and incomplete information settings are considered; the latter arises because FRR may withhold its private cost information. Equilibrium schedule with complete information, maximizes system welfare. With incomplete information, PRA may choose between pooling and separating equilibrium strategies while proposing a payment, depending on its prior belief the cost type of FRR.

■ WA62

Cumberland 4- Omni

Air Traffic Management and Airline Operations

Sponsored: Aviation Applications

Sponsored Session

Chair: Peng Wei, Iowa State University, 2312 Howe Hall, 537 Bissell Road, Ames, IA, 50011, United States, pwei@iastate.edu

1 - Terminal Area Sequencing And Scheduling: The Single Runway Case

Jitamitra Desai, Professor, Nanyang Technological University, Singapore, Singapore, jdesai@ntu.edu.sg, Rakesh Prakash

This paper addresses the aircraft sequencing problem over the entire terminal maneuvering area (TMA) under a mixed-mode, single runway operating scenario. In contrast with existing approaches that only consider the runway as a bottleneck, our 0-1 mixed-integer LP formulation optimizes flight sequences and schedules by taking into account the configuration and associated constraints of the entire TMA region. Variable fixing strategies and valid inequalities are derived to tighten the continuous relaxation of the problem. Computational results show the overall delay in the system can be reduced by nearly a 30% margin over the default FCFS policy and by nearly 10% over the runway sequencing policy.

2 - Passenger Route Choice Prediction In The U.S. Airline Industry: Statistical Methods versus Machine Learning Techniques

Chia-Mei Liu, FAA, Chia-Mei.Liu@faa.gov, Peng Wei, Jerrod Sharpe

In the community of airline forecast research, while there are plenty research in airline passenger demand modeling that designs to forecast passenger growth, relatively little attention has been paid to passenger route choice forecast between nonstop and connecting flights. This paper contributes to this area of the research by constructing a route choice model, estimated through statistical methods as well as machine learning methods. The results have important implications in operation forecast as route choice forecast affects airline fleet planning. Consequently, this research benefits policy makers and industry practitioners by expanding our understanding on passenger route choice.

3 - Capturing Passenger Compensation Impacts For An Integrated Airline Recovery

Luis Cadarso, Rey Juan Carlos University, Camino del Molino s/n, Fuenlabrada, 28943, Spain, luis.cadarso@urjc.es, Vikrant Vaze

The European flight delay compensation regulation (EC) No 261/2004 establishes common rules on compensation to passengers in the event of disruptions. We develop an integrated approach that recovers airline timetable, fleet assignment, aircraft routings, and passenger itineraries capturing the impacts of airlines' decisions on passenger compensation. We evaluate scenarios involving disruptions, and optimize recovery decisions to maximize profits by modeling passenger no-shows after disruptions.

■ WA63

Cumberland 5- Omni

Location Models

Sponsored: Location Analysis

Sponsored Session

Chair: Oded Berman, University of Toronto, 105 St. George Street, Toronto, ON, M5S 3E6, Canada, berman@rotman.utoronto.ca

1 - Responsive Supply Chain Network Design

Oded Berman, University of Toronto, 105 Saint George Street, Toronto, ON, M5S 3E6, Canada, berman@rotman.utoronto.ca, Robert Aboolian, Jiamin Wang

In this paper, we address the network design of a responsive supply chain consisting of make-to-order facilities facing stochastic demand. Each facility has a finite capacity and stochasticity of demand may lead to congestion delays at the facilities. We consider three problems. In the first, we minimize the total network cost including delivery and capacity costs while maintaining an acceptable response time to customers. In the second, a penalty is charged on the number of units delivered later than the targeted response time. In the third, the penalty charged also depends on the number of days that the delivery is late. The penalty cost in both problems 2 and 3 are a function of network's response time.

2 - The p-center On A Network With Probabilistic Demand Weights

Jiamin Wang, Long Island University, Brookville, NY, United States, Jiamin.Wang@liu.edu, Oded Berman

We study the p-center problem on a network with probabilistic demand weights. Two models are presented. The objective of the first model is to maximize the probability that the longest weighted distance from the nodes to the closest facility does not exceed a pre-selected target level. In the second model, facilities are located so as to minimize the value-at-risk, namely, a quantile of the longest weighted distance with a specified confidence level. Special cases are identified that are equivalent to the deterministic center model. The problem is shown to be NP-hard. Exact solution procedures and heuristics are developed for demand weights of discrete and continuous probability distributions.

3 - Location Depots To Facilitate Routing A Mixed Fleet Of Electric And Conventional Vehicles

Nan Ding, Univesity of Buffalo (SUNY), Buffalo, NY, nanding@buffalo.edu, Rajan Batta

Most of current works of routing electric vehicles (EVs), assuming charging availability en route, may need high cost of establishing charging infrastructures. In this work, an alternative strategy to adopt EVs is proposed. This strategy considers charging to be only allowed at depots over the night. To this end, intermediate depots (IDs) are introduced to facilitate routing EVs to customers while conventional vehicles are used to serve IDs from center depot. To determine optimal locations of IDs and routing plans, a joint location-routing problem is formulated. A bi-level heuristic method with upper level determining the locations of IDs and lower level determining routing plans is developed.

■ WA64

Cumberland 6- Omni

Pareto Set Reduction Theories and Methods

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Daniel Jornada, Texas A&M University, 1700 Research Parkway, College Station, TX, 77843, United States, djornada@tamu.edu

1 - New Notions Of Efficiency For Multicriteria Optimization Under Uncertainty

Devon Sigler, PhD Candidate, University of Colorado Denver, Denver, CO, United States, devon.sigler@ucdenver.edu, Alexander Engau

We present several new notions of efficiency for multicriteria optimization problems under uncertainty. We demonstrate that these new definitions can be fully characterized theoretically in a hierarchical manner and methodologically using a collection of modified scalarization and generation methods. Related computational comparisons and applications will be discussed.

2 - Robust Solutions To Uncertain Multiobjective Linear Programs

Garrett M. Dranichak, Department of Mathematical Sciences, Clemson University, Clemson, SC, United States, gdranic@clemson.edu, Margaret M Wiecek

We study highly robust efficient solutions to multiobjective linear programs with uncertainty in the objective function coefficients drawn from finite uncertainty sets. We present results on existence and identification of highly robust efficient solutions, as well as properties of and bounds on the highly robust efficient set. Additional attention is given to a special case of problems yielding a robust counterpart that is easily solvable.

3 - Pareto Set Reduction Theories And Methods

Kalyanmoy Deb, Department of Electrical and Computer Engineering, Michigan State University, kdeb@egr.msu.edu

In many multi-objective optimization problems, objectives become correlated to each other thereby reducing the dimension of the Pareto-optimal set. In an evolutionary multi-objective optimization method, we have integrated a principal component analysis method to identify redundant objectives and solve very large-scale problems.

4 - A Post-pareto Approach Using A Non-uniform Weight Generator Method With Prioritized Objectives

Juan V Fernandez, Industrial, Manufacturing and Systems Engineering Department, University of Texas at El Paso, jvfernandez@miners.utep.edu

Multi-objective optimization has been recognized as an important research area in the last years since many real life problems present multiple criteria that need to be optimized simultaneously. Using metaheuristic methods or evolutionary algorithms as solution methodologies leads to a large number of Pareto solutions rather than a single unique optimum. Ultimately, all solutions are considered to be Pareto-optimal and selecting the one solution among others can be an arduous task for the decision-maker. This research presents a new developed approach that uses a non-uniform weight generator method to reduce the size of the Pareto-optimal set under the consideration of prioritized objectives.

■ WA65

Mockingbird 1- Omni

Digital Transformation of Labor, Media, Telecom, and Financial Markets

Sponsored: Information Systems

Sponsored Session

Chair: Wei Chen, University of Arizona, University of Arizona, Tucson, AZ, 85721, United States, weichen@email.arizona.edu

1 - What Do Employers Look For In Candidates?

Xuan Ye, New York University, xye@stern.nyu.edu, Prasanna Tambe

Using novel data with descriptions of job interview processes collected from a career intelligence platform, I test the hypothesis that employers assess job candidates' ability, i.e. problem-solving skills and analytical skills, not labor market experience when they recruit for jobs that require new technical skills. These cognitive skills are hypothesized to be important in a fast moving production environment. Employers' evaluation methods are measured by text-mining the interview questions contributed by the job candidates. With employer fixed effects estimates, I find that employers use ability-based assessment question 39% more frequently for NewTech jobs than for other jobs.

2 - New Product Launch With Capacity Constraints And Congestion-sensitive Consumers

Duy Dao, University of California, San Diego, Duy.Dao@rady.ucsd.edu, Terrence August, Hyoduk Shin

A problem faced by the entertainment industry is the impact of congestion on the release of a product. For theatrical releases, consumers have learned to delay consumption, trading off this congestion cost with the loss of movie buzz as the movie fades in relevance over time. Some may even forgo purchase because of congestion. For online games, a surge of consumers logging on to play an MMORPG can result in server issues during the initial release. In this paper, we model how consumers decide when to make a purchase, considering the congestion they experience. We then offer a strategy for how to profitably expand the market when taking into consideration congestion-sensitive consumers.

3 - The Role Of Technological Discontinuity On Incumbency Advantage

Xiahua Wei, University of Washington, Bothell, xhwei@uw.edu

This study examines how technological discontinuity contributes to market competition, especially the incumbency of established firms. Based on the theory of barrier to entry, we investigate the consequence of technological change in the mobile telecommunications industry. We find that the ability of new entrants to disrupt incumbents depends on the responsiveness of incumbents to the new technologies. Further, we show that intense competition in the wake of technological discontinuities, driven entirely by incumbents, can delay industry shakeouts.

4 - Taxes And Equity Investment: Evidence From Equity Crowdfunding

Wei Chen, University of Arizona, weichen@email.arizona.edu, Mingfeng Lin

Given the positive externality that entrepreneurial activities bring to the economy, governments around the world have routinely resorted to various incentives to spur entrepreneurship. In this paper, we empirically study whether and how investments in early stage businesses respond to tax incentives, using a natural experiment due to a policy change, and a comprehensive transaction-level dataset from leading online equity crowdfunding platforms in the United Kingdom.

■ WA66

Mockingbird 2- Omni

Data Analytics in Emerging Applications

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Nan Chen, National University of Singapore, Singapore, Singapore, isecn@nus.edu.sg

1 - Inferring Three-dimensional Porous Defects Based On Cross-sectional Images In Metal-based Additive Manufacturing

Jianguo Wu, Assistant Professor, University of Texas-El Paso, 500 W University Ave, Engineering Building, A-244, El Paso, TX, 79968, United States, jwu2@utep.edu, Nan Chen, Haijun Gong

Porosity is one of the most critical quality issues in the metal-based additive manufacturing. This paper develops a novel quality inspection method by inferring the size distribution, void density and volume fraction of 3D porosity defects based on 2D cross-sectional images. The linkage between the size of ellipsoidal defects and the size of cross-sectional elliptical contours is established. An efficient Quasi-Monte Carlo EM algorithm is developed for 3D size distribution estimation. The relationship between the 3D and 2D void densities is developed to estimate the 3D void density and porosity. The effectiveness of the proposed method is demonstrated through simulation and case studies.

2 - Change-point Detection On Solar Panel Performance Using Thresholded Lasso

Youngjun Choe, University of Washington, Seattle, WA, United States, yjchoe@umich.edu, Weihong Guo, Eunshin Byon, Judy Jin, Jingjing Li

Solar energy is a fast growing energy source. Solar energy stakeholders are, however, concerned with sudden deterioration of photovoltaic systems' performance. This study focuses on retrospectively identifying the time points of abrupt changes. We present a nonparametric detection method based on Thresholded LASSO. The proposed method is able to accurately detect performance changes, while being robust against false detection under noisy signals. The performance of the proposed method is evaluated and compared with state-of-the-art methods through extensive simulations and a case study using data collected from four solar energy facilities.

3 - Data-driven Diagnosis For Asthma Control Status In Smart Asthma Management System Based On Correlated Gamma-based Hidden Markov Model

Junbo Son, Assistant Professor, University of Delaware, Newark, DE, United States, sonjunbo@gmail.com, Shiyu Zhou, Patricia Brennan

Driven by the IoT, a smart asthma management (SAM) system has been implemented in practice. The SAM system includes rescue inhalers with a wireless connection and the system records the inhaler usage and transmits the data to a centralized server. To effectively manage the asthma, a statistical model based on the patient monitoring data from the SAM system is crucial. In this research, we propose a data-driven diagnostic tool for assessing underlying asthma control status of a patient based on hidden Markov model (HMM). The proposed correlated gamma-based HMM can visualize the asthma progression to aid therapeutic decision making and its promising features are shown in both simulation and case study.

4 - Reliability Analysis Considering Dynamic Material Local Deformation

Wujun Si, Wayne State University, fk9456@wayne.edu, Qingyu Yang, Xin Wu

We conduct reliability analysis utilizing dynamic material local deformation information. A novel multivariate general path model with a new variance-based failure criterion is proposed. A two-stage parameter estimation method is developed to overcome the computational complexity. Both simulation studies and physical experiments are conducted for verification and illustration.

■ WA67

Mockingbird 3- Omni

Data Analytics for System Improvement II

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Xi Zhang, Peking University, Beijing, China, xi.zhang@pku.edu.cn

Co-Chair: Kaibo Liu, Universityof Wisconsin, Madison, 1513 University Avenue, Madison, WI, 53706, United States, kliu8@wisc.edu

1 - Statistical Process Control Of Stochastic Textured Surfaces

Anh T Bui, Northwestern University, Evanston, IL, United States, atbui@u.northwestern.edu, Daniel Apley

We develop a defect monitoring and diagnostic approach for manufactured products that have stochastic textured surfaces (e.g., textiles or material microstructures). We first use generic supervised learning methods to characterize the stochastic behavior of “normal” in-control samples of the textured surfaces. Based on the residuals of the supervised learning model applied to new samples in a statistical process control context, we propose two spatial moving statistics for detecting local aberrations in the textured surfaces. We illustrate the approach using simulated and real examples.

2 - Causation-based Process Monitoring And Diagnosis For Multivariate Categorical Processes

Xiaochen Xian, the University of Wisconsin, Madison, WI, xxian@wisc.edu

Statistical surveillance for multivariate categorical processes have attracted more and more attentions. In many applications, causal relationships may exist among categorical variables, where the shifts at upstream variables will propagate to their downstream variables. We employ Bayesian network to characterize such causal relationships and integrate it with the statistical process control technique. We propose two control charts for detecting shifts in the conditional probabilities of the multiple categorical variables that are embedded in the Bayesian network. Both simulation and real case studies are used to demonstrate the effectiveness of the proposed schemes.

3 - A Thermal Field Estimation Method Based On Spatial-temporal Dynamics Using Multi-channel Sensor Data

Xi Zhang, Peking University, Beijing, China, xi.zhang@pku.edu.cn, Di Wang, Kaibo Liu

Thermal field profile is one of the critical issues for the quality assurance of the grain warehouse. However, only limited sensors are afforded to characterize the dynamics in the grainhouse, leading to an inappropriate decision for grain maintenance. This article presents a field estimation approach to model spatio-temporal dynamics of warehouse temperature through integrating thermodynamics model and spatiotemporal stochastic processes. Specifically, we integrate a 3-D unsteady heat transfer model into a Gaussian Markov random field to achieve a parsimonious representation of spatial patterns. Simulation and real case are conducted to show the effectiveness of the developed method.

4 - Multivariate Ordinal Categorical Process Control Based On Log-linear Modeling

Jian Li, Xi’an Jiaotong University, Xi’an, China, jianli@mail.xjtu.edu.cn, Junjie Wang, Qin Su

The quality of products or services is sometimes measured by multiple categorical characteristics, each of which is classified into attribute levels such as good, marginal, and bad. There is usually natural order among these attribute levels. By assuming that each ordinal categorical quality characteristic is determined by a latent continuous variable, this work incorporates the ordinal information into an extended log-linear model and proposes a multivariate ordinal categorical control chart. Simulations show that the proposed chart is efficient in detecting location shifts and dependence shifts in the corresponding latent continuous variables of ordinal categorical characteristics.

■ WA68

Mockingbird 4- Omni

Statistical Models for Computer Experiments

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Qiong Zhang, Richmond, VA, United States, qzhang4@vcu.edu

1 - Efficient Gaussian Process Modeling For Computer Experiments

Yibo Zhao, Rutgers State University of New Jersey, Piscataway, NJ, United States, yz346@scarletmail.rutgers.edu

We study the problem of simultaneous variable selection and parameter estimation in Gaussian process models. Conventional penalized likelihood approaches are attractive but the computational cost of the penalized likelihood estimation (PMLE) or the corresponding one-step sparse estimation (OSE) can be prohibitively high as the sample size becomes large. This is because the likelihood function heavily involves operations of a covariance matrix of the same size as the number of observations. To address this issue, this article proposes an efficient subsample aggregating (subagging) approach with an experimental design-based subsampling scheme. The proposed method is computationally cheaper, yet it can be shown that the resulting subagging estimators achieve the same efficiency as the original PMLE and OSE asymptotically. The finite-sample performance is examined through simulation studies. Application of the proposed methodology to a data center thermal study reveals some interesting information, including identifying an efficient cooling mechanism.

2 - Change-point Detection For Spatial-temporal Organ Image Data

Shuyu Chu, Virginia Tech, cshuyu@vt.edu, Xinwei Deng, Ran Jin

The demand for organ transplantation increases rapidly, but only a limited number of viable organs is available. Poor preservation and evaluation cause many organs to be discarded. Current evaluation methods are often inaccurate or result in organ damage. There is a great need for accurate non-invasive evaluation methods. In this work, we focus on detecting quality changes in organs under preservation by only using biomedical thermal image data. Scalable Gaussian processes with expressive spectral mixture kernels is applied on the large multidimensional image data to conduct model fitting and inference. A real case study will be used to elaborate the performance of the proposed method.

3 - Asymmetric Process For Stochastic Simulation

Qiong Zhang, Virginia Commonwealth University, qzhang4@vcu.edu

Quantiles serve as important measurements in stochastic simulation. In simulation practice, we need statistical methods to model these quantiles for optimization or calibration. However, the traditional Gaussian process model often fails to capture the behavior of quantiles if the sample path is not long enough. To resolve this issue, we will introduce the asymmetric process for modeling the quantiles in stochastic simulation. Numerical results will be provided to show the effectiveness of this new approach.

■ WA69

Old Hickory- Omni

Joint Session Telecom/MIF: Modeling and Optimization for Social Network Analysis

Sponsored: Telecommunications/MIF

Sponsored Session

Chair: Eli Olinick, Southern Methodist University, P.O. Box 750100, Dallas, TX, 75275, United States, olinick@lyle.smu.edu

1 - Design Of Survivability Networks Under Vulnerability Constraints

Luis Gouveia, University of Lisbon, legouveia@fc.ul.pt, Markus Leitner

We consider the Network Design Problem with Vulnerability Constraints (NDPVC) which simultaneously addresses resilience against failures and bounds on the lengths of each communication path. We show how the new problem differs from the Hop-Constrained Survivable Network Design Problem. We explain that the reason for this difference is that hop-constrained Mengerian theorems do not hold in general. Three graph theoretical characterizations of feasible solutions to the NDPVC are derived and used to propose integer linear programming formulations that are compared in a computational study.

2 - Characterizing Cohesive Subgroups In Social Networks

Zeynep Ertem, university of Texas at Austin, Austin, TX, United States, ertem@utexas.edu, Zeynep Ertem, University of Texas at Austin, Austin, TX, United States, ertem@utexas.edu, Sergiy Butenko, Alexander Veremyev, Yiming Wang

Identifying closely-knit groups of entities within complex systems might reveal interesting social circles. In this talk, we first introduce a new mathematical model that corresponds to a new definition for cohesive subgroups based on a commonly used graph metric, clustering coefficient. We develop a network-clustering algorithm using this new model. Second, we develop exact and approximate algorithms for a special case of our first model, for which two classical canonical problems (i.e., maximum independent set and maximum clique) are lower bounds.

3 - The 2-club Polytope

Illya Hicks, Rice University, ivhicks@rice.edu, Foad Pajouh, Balabhaskar Balasundaram

Given some positive integer k, a k-club of a graph G is a subset of its vertices S such that the subgraph induced by S, say G[S], has diameter at most k. The concept of k-clubs is one of many known relaxations of the concept of cliques for graphs. The k-club model is particularly interesting from a polyhedral point of view since it does not posses the hereditary property for k values larger than one. In this talk, we explore the 2-club polytope and derive facets related to distance domination. We also present some computational results displaying the effectiveness of these new inequalities. This is joint work with Foad Pajouh and Balabhaskar Balasundaram.

4 - A Network Flow Duality Foundation For Hierarchical Cluster Analysis

Eli Olinick, Southern Methodist University, olinick@lyle.smu.edu

Many popular data clustering and classification techniques from the social sciences lack a rigorous foundation in graph theory and mathematical optimization even though they are often based on graph and network models of interaction and affinity. We show that a clustering method based on the fundamental graph-theoretic concept of density and implemented via a duality to network flows can produce more comprehensive and meaningful results in appropriate problem domains.

■ WA70

Acoustic- Omni

Transportation, Ops I

Contributed Session

Chair: Markus Matthaus Frey, Dr., Technical University Munich, Arcisstrasse 21, Munich, 80333, Germany, markus.frey@tum.de

1 - A Simulation-based Optimization Framework For Online Urban Traffic Control Problems

Linsen Chong, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Room 1-245, Cambridge, MA, 02139, United States, linsenc@mit.edu, Carolina Osorio

We propose an online simulation-based optimization (SO) framework that uses computationally expensive microscopic simulators for real time traffic control problems. The framework consists of a metamodel SO method, a data-fed analytical traffic model method and a data-driven method. This framework is computationally efficient and allows a high-dimensional non-linear optimization problem to be solved in real time. We illustrate the performance of the proposed method through a large-scale urban traffic responsive control case study.

2 - Spatial-temporal Air Quality Mapping For Smart-in Vehicle Climate Control Management

Yimin Liu, Ford Motor Company, Dearborn, MI, United States, yliu59@ford.com, Yu Chen, Jinjing Yang, Yun-Jhong Wu

The proliferation of connected car technologies with App and cloud-based analytics provided opportunities for effective vehicle climate control management. To enable the technologies, we propose an advanced spatial-temporal model to forecast a high resolution air pollution map fusing existing government data with the data from vehicle external sensors. Furthermore, an optimization algorithm is developed to manage in-vehicle air quality at the optimal level during the trip via the technology.

3 - Road Pricing For Informed Users With Risk Neutral Time Cost And Risk Averse Health Cost

Zhen Tan, Cornell University, 314 University Ave., Apt 7, Ithaca, NY, 14850, United States, zt78@cornell.edu

We analyze tolling for road users with differentiated trip value and delay and health cost incurred by congestion. Users are informed with delay and pollutant exposure level. We assume users are risk-neutral to delay but risk-averse to toxic air inhalation. The linear delay disutility has a multiplier increasing in the trip-value, while user's disutility function of inhalation has absolute risk-aversion decreasing in trip-value. Based on properties of steady-state volume-delay/inhalation relationships, we characterize the welfare /revenue maximizing price for one bottleneck and for one prioritized route among two. We discuss on how health information affects congestion management.

4 - Using Optimization To Improve The Freight Transportation Operations Of A Fedex Licensee

Omar Ben-Ayed, Qatar University, College of Business and Economics, Doha, Qatar, omar.benayed@qu.edu.qa, Salem Hamzaoui, Leandro C Coelho

We describe the applications of network design and timetabling optimization to a major freight transportation company in the MENA region in order to improve its performance in terms of cost and delivery time. The application involved two sequential projects. The first developed and implemented new design and new timetable that led to remarkable gains for the company. Later, the second project involved devising better optimization models, obtaining more accurate data, and more importantly establishing a broader cooperation with the practitioners, mostly thanks to the trust gained after the success of the first project. Again, the implementation of our results led to significant improvements.

5 - Column Generation For Vehicle Routing Problems With Synchronization Constraints

Markus Matthaus Frey, Dr., Technical University Munich, Arcisstrasse 21, Munich, 80333, Germany, markus.frey@tum.de, Martin Fink, Ferdinand Kiermaier, Francois Soumis, Guy Desaulniers, Rainer Kolisch

Synchronization of workers and vehicles plays a major role in many industries and belongs to the class of vehicle routing problems with multiple synchronization constraints (VRPMSs). We present a VRPMSs archetype covering all synchronization types including movement and load, and propose two mathematical formulations to efficiently model all synchronization types. Additionally, we develop a column generation approach employing a novel fixing strategy.

■ WA71

Electric- Omni

Game Theory I

Contributed Session

Chair: Jian Yang, Associate Professor, Rutgers University, 1 Washington Park, Rm 1084, Newark, NJ, 7102, United States, jyang@business.rutgers.edu

1 - A Unified Framework For Vehicle Licenses Allocation

Zhou Chen, Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong, Hong Kong, zchenaq@connect.ust.hk, Qi Qi, Changjun Wang

Recently, many big cities began to adopt the vehicle licenses quantitative control policies. In these cities, a limited number of licenses are allocated every month. The current allocation policies differ from city to city. In this work, we propose to target the dual objectives of efficiency and equality and present a two-stage framework that unifies most current mechanisms and outperforms all existing mechanisms in both efficiency and equality. The unified framework also leads to easy implementation due to its truthfulness, distribution-free and highly efficiency. Furthermore, we extend our unified framework into multiple stages and fully characterize the optimal mechanism.

2 - Exclusivity In Online Advertising

Marjan Baghaie, Microsoft, Seattle, WA, 98105, United States, marjanb@microsoft.com, Amin Sayedi, Kinshuk Jerath

We investigate auction mechanisms for sponsored search in which advertisers can bid to be displayed exclusively after a keyword search. We find that allowing advertisers to bid for exclusivity can increase the revenue of the search engine because bidders compete not only for positions in the non-exclusive outcome but also for the outcome to be exclusive or non-exclusive. Interestingly, however, under certain conditions, the revenue of the search engine can decrease because competition between outcomes leads to bidders reducing bids for their non-preferred outcome. We also find that, under certain conditions, advertisers have the incentive to bid above their true valuations.

3 - Game-theoretic Modeling Of Players' Ambiguities On External Factors

Jian Yang, Associate Professor, Rutgers University, 1 Washington Park Rm 1084, Newark, NJ, 07102, United States, jyang@business.rutgers.edu

We propose a game-theoretic framework that incorporates general ambiguity attitudes on factors external to all players. Our starting point is players' preferences on payoff-distribution vectors, essentially mappings from states of the world to distributions of payoffs to be received by players. When the preferences possess ever more features, we can gradually add ever more structures to the game. Particular attention is paid to what we shall call the enterprising game, in which players exhibit ambiguity seeking attitudes while betting optimistically on the favorable resolution of ambiguities.

4 - Equilibrium Structure Of Fixed-cost-reducing Alliances When Firms' Market Power Is Asymmetric

Edward Anderson, The University of Texas at Austin, Austin, TX, hirosano@fc.ritsumei.ac.jp, Hiroki Sano

With the context of alliance formation between semiconductor manufacturers in new technology development, we study how competing firms' cooperative decisions in a new market entry opportunity can be stabilized from a game-theoretic perspective. We discuss the equilibrium alliance structure when firms can be asymmetric in their relative market power while the individual investment cost is symmetric. In a three-firm case, we show that, under certain conditions, the firm with the second highest market power can choose not to enter a new market while the other two firms cooperatively enter.

■ WA73

Legends A- Omni

Operations Management V

Contributed Session

Chair: Ling Liu, Huazhong U of Science and Technology, 1037 Luoyu Road, Hong Shan District, Wuhan, 430074, China, 182028870@qq.com

1 - Web-based Grocery Retail Business With Order Cancellation And Refund Options

Yi Zhang, Shandong Institute of Business and Technology, Yantai, China, iynnezhangyi@foxmail.com, Yang Li, Xiangpei Hu

This research is based on a real web-based B2C grocery retail business in China. Customers to this business demand fresh products and efficient delivery, at the same time, want to keep options of cancelling the orders and getting refund. In this study, we aim to derive an effective joint strategy on inventory planning, selling price and the order cancellation charges, which maintains the profitability and sustainability of the business.

2 - A Meta-analytic And Latent Semantic Analysis Approach To Informing Quality Management

Xianghui Peng, Assistant Professor, Eastern Washington University, Spokane, WA, United States, xpeng@ewu.edu, Victor R Prybutok

A meta-analytic study of empirical Baldrige Quality Award research is conducted. The analysis includes an evaluation of the relationships among award categories. The Baldrige framework is examined using latent semantic analysis to analyze winning applications. We identify opportunities to further develop quality management theory based on the integrated results.

3 - A Capacitated Vehicle Routing Problem With Order Available Time

Ling Liu, Huazhong U of Science and Technology, 1037 Luoyu Road, Hong Shan District, Wuhan, 430074, China, 182028870@qq.com

The capacitated vehicle routing problem with order available time is considered in this paper, the orders are not available for delivery at the beginning of the planning period. It is observed in the context of integrated production and transportation scheduling. An efficient tabu search algorithm and a genetic algorithm are presented to tackle the problem.

■ WA74

Legends B- Omni

Ops Mgt/Marketing I

Contributed Session

Chair: Xue Li, Tsinghua University, Beijing, China, lix2.11@sem.tsinghua.edu.cn

1 - Equilibrium Analysis On Price-matching Policy For Two Competitive Retailers

Jinpeng Xu, Xidian University, 266 Xinglong Section of Xifeng Road, Xi'an, 710126, China, jinpxu@foxmail.com, Yufei Huang

Price-matching policy is widely used by retailers as a competitive strategy to stimulate demand. Under this policy, retailers promise to match the lowest price in the market. We consider two retailers selling the same product in their exclusive market and a competitive market. We use a game theoretical model to investigate whether price-matching policy should be offered by the retailers in competition, and how such decisions are influenced by the size of the exclusive and competitive market. Our results show that the retailer with larger exclusive market is more likely to offer the price-matching policy, and the optimal equilibrium strategy depends on the cost of providing price-matching policy.

2 - Keys To Green Product Line Design: Consumer Perceptions, Cost Implications, Price And Quality Optimization

Monire Jalili, PhD Candidate, University of Oregon, 1208 University of Oregon, Eugene, OR, 97403, United States, mjalili@uoregon.edu, Tolga Aydinliyim, Nagesh N Murthy

Consumers may have opposing perceptions of the green quality (the amount of recycled content in a green product). Naturalite consumers may prefer a green product with some recycled content, while conventional consumers prefer a base product with no recycled content. While the firm can save on material cost by using some recycled content, processing a mixed material input may increase the production cost. Considering these contrasting demand and supply forces, we study a monopolist's price and quality optimization problem in a product line context and in particular, answer whether/when it is optimal for the monopolist to offer only the green version of the product.

3 - Does Social Image (Pakistani Consumers) Mediate Relationship Between Brand Performance And Brand Attachment For An Imported Cosmetic Brand?

Huma Amir, Chairperson Marketing Deptt., Assistant Professor, Inst of Bus Admin- Karachi, Suite # 218, Main Campus, University Road, Karachi, 75270, Pakistan, huma.amir@hotmail.co.uk, Wajid Rizvi

Empirical study on cosmetic industry suggests brand performance influences brand attachment (= .71 p <.05) with explained variance, R2 =.51. Further investigation on whether this relationship is mediated by social image suggests full mediation. When social image was used as mediating variable the direct influence of brand performance on brand attachment reduced from = .71 (p <.05) to = .01 (p >.05) and became insignificant, whereas indirect effect was = .83 (p < .05). After the mediation, variance explained by the model also increased from R2 =.51 to R2 =.71. The model fit indices also show model fit. The sample size was bootstrapped to 5000 to assess mediation effect and also showed full mediation.

4 - Empirical Evidence On The Contagion Effect Of Product Harm Recall

Alireza Azimian, Wilfrid Laurier University, 75 University Avenue West,, Unit 103, Waterloo, ON, N2L 3C5, Canada, azim9110@mylaurier.ca, Kevin B Hendricks

The results of the studies on the impact of product harm recalls on rivals are quite mixed. Our research explores whether the signal value of the harm, commoditization level of the industry and physical length of the value chain can explain the differences.

5 - Uniform Pricing Vs. Non-uniform Pricing For Branded Variants: Implications For Channel Structure Equilibrium

Xue Li, Tsinghua University, Beijing, China, lix2.11@sem.tsinghua.edu.cn, Jian Chen

Traditionally, firms adopt non-uniform pricing to discriminate product prices and improve profitability. However, considering consumers' concerns of peer-induced price fairness, it is a reasonable choice for a firm to adopt uniform pricing for branded variants. Under these two different pricing strategies, we analyze channel structure equilibrium in a game-theoretic model.

WA75

Legends C- Omni

Health Care, Strategies III

Contributed Session

Chair: Neset Hikmet, Associate Professor, University of South Carolina, 1301 Gervais St, Suite 1010, Columbia, SC, 29208, United States, nhikmet@sc.edu

1 - Hierarchical Response Model For Casualty Processing In Mass Casualty Incidents

Alkis Vazacopoulos, Optimization Direct, Inc., 202 Parkway, Harrington Park, NJ, 07640, United States, alkis@optimizationdirect.com, Nathaniel Hupert, Dimitris Paraskevopoulos, Panagiotis Petros Repoussis, Panagiotis Petros Repoussis

This work presents a response and resource allocation model in the aftermath of a Mass-Casualty Incident. A mixed integer math programming formulation is proposed for the combined ambulance dispatching, patient-to-hospital assignment, and treatment ordering problem. The goal is to allocate effectively the limited resources during the response effort so as to improve patient outcomes, while the objectives are to minimize the overall response time and the total flow time required to treat all patients. The model is solved via exact and MIP-based heuristic methods. The applicability of the model and the performance of the new optimization methods are challenged on realistic scenarios.

2 - Key Factors And Patterns In Employee Choice Of High Deductible Health Plans

Qing Ye, Purdue University, 315 N Grant St, West Lafayette, IN, 47907, United States, yqing@purdue.edu, Bhagyashree Katare, Yuehwern Yih

U.S. employers have increasingly provided high-deductible health plans in response to the rising cost of health care. This study provides insight into selecting and switching behavior of employees towards high-deductible health plans. Data mining techniques are utilized to identify factors associated with their plan choice mobility. A case study is presented using five years' claims information.

3 - Hospital Information Technology Investment Impacts On Patient Satisfaction, Clinical Performance, Efficiency, And Patient Outcomes

Neset Hikmet, Associate Professor, University of South Carolina, 1301 Gervais St, Suite 1010, Columbia, SC, 29208, United States, nhikmet@sc.edu, Benjamin Schooley

This study extends prior research on healthcare information technology (HIT) investment impacts on hospital performance. We analyzed 102 different HIT investment types; categorized them as clinical, administrative, strategic, and infrastructure HIT investments; and examined relationships between these and hospital performance scores. Combining secondary survey data from U.S. hospitals and a separate data set from CMS, we found significant positive and negative relationships between clinical and infrastructure HIT investment and hospital total performance, clinical performance, patient satisfaction, and efficiency scores - controlling for organizational factors.

WA76

Legends D- Omni

Applied Probability I

Contributed Session

Chair: Julian Sun, Cornell, Ithaca, NY, 14850, United States, ys598@cornell.edu

1 - Flexible Estimation Of Conway-maxwell Poisson Distribution

Suneel Babu Chatla, Doctoral Student, National Tsing Hua University, Hsinchu, 30013, Taiwan, suneel.chatla@iss.nthu.edu.tw, Galit Shmueli

The Conway-Maxwell Poisson (CMP) distribution is popularly used for its ability to handle both overdispersed and underdispersed count data. Yet, there is no efficient algorithm for estimating CMP regression models, especially with high-dimensional data. Extant methods use either nonlinear optimization or MCMC methods. We propose a flexible estimation framework for CMP regression based on iterative reweighted least squares (IRLS). Because CMP belongs to the exponential family, convergence is guaranteed and is more efficient. We also extend this framework to allow estimation for additive models with smoothing splines.

2 - Fast Approximate Policies For Large Networks

Ankur Mani, University of Minnesota, 808 Berry St. Apt. 410, St. Paul, MN, 55114, United States, amani@umn.edu

Optimal policies for networks may be computationally hard and still may lead to suboptimal outcomes if the network information is noisy. We present simple heuristics with comparable performance. These policies are easy to compute and we provide guarantees for their performance. As an example we study price discrimination in networks and show that our heuristics give approximately optimal expected profits for large random networks.

3 - Multivariate Subexponential Distributions And Their Applications

Julian Sun, Cornell, Ithaca, NY, 14850, United States, ys598@cornell.edu, Gennady Samorodnitsky

We propose a new definition of a multivariate subexponential distribution. We compare this definition with the two existing notions of multivariate subexponentiality, and compute the asymptotic behavior of the ruin probability in the context of an insurance portfolio, when multivariate subexponentiality holds. Previously such results were available only in the case of multivariate regularly varying claims.

WA77

Legends E- Omni

Opt, Integer Programing V

Contributed Session

Chair: Victoire Denoyel, PhD Candidate, ESSEC Business School, Paris, France, victoire.denoyel@essec.edu

1 - Territory Design With Risk For A Micro Finance Institution

Tahir Ekin, Assistant Professor of Quantitative Methods, Texas State University, 601 University Dr. Mccoy 411, San Marcos, TX, 78666, United States, t_e18@txstate.edu, Fabian Lopez Perez, Francis Mendez, Jesus Jimenez

Micro finance institutions (MFIs) play an important role in emerging economies as part of programs that aim to reduce income inequality and poverty. This talk addresses a territory planning problem for a MFI. We propose a mixed integer programming model that lets the decision maker choose the location of the branches to be designated as territory centers and allocate the customers to these territory centers with respect to risk and planning criteria: the total workload, monetary amount of loans and profit allocation. In order to solve this model for the large size instances of the MFI, we utilize heuristics such as fixing variables, perturbation, and dynamic relocation of territory centers.

2 - Model Of Ambulance Deployment And Dispatch Arrangement And Simulation-based Assessment Of Mass Casualty Incident

Yu-Ching Lee, Assistant Professor, National Tsing Hua University, Hsinchu, Taiwan, liuyentingthomas@gmail.com, Yen-Ting Liu, Albert Y. Chen, Yu-Shih Chen

A major focus of emergency medical service (EMS) systems is to save lives, minimize response time and to increase the survival rate in both the cases of stochastic events and extreme events. The extreme events, such as natural disaster (earthquake) and man-made disaster (terrorist attacks), are usually not predictable and need multiple rounds of ambulance dispatch. This paper is committed to model the deployment and split dispatch of ambulances, and to generate numerical results to assess the overall services, hoping to be an optimization-model-aided support to the real world operations.

3 - Solving Utility-maximization Multinomial Choice Problems: When Is The First-choice Model A Good Approximation?

Victoire Denoyel, PhD Candidate, ESSEC Business School, Paris, France, victoire.denoyel@essec.edu, Victoire Denoyel, PhD Candidate, Brooklyn College, Brooklyn, NY, NY, United States, victoire.denoyel@essec.edu, Laurent Alfandari, Aurelie Thiele

For optimization problems with a utility maximization objective, it is common to model consumer behavior with MNL logit. This can lead to high fractional complexity when binary decision variables are involved. A first-choice or assignment model is computationally simpler although less close to reality. We design the first comparison of the two approaches in the context of optimization. Our main contribution is to quantify which probabilistic assumptions allow the use of the solution of the first-choice model as an approximation to the MNL logit model. Applications vary from policy to retail or facility location.

■ WA78

Legends F- Omni

Opt, Metaheuristics I

Contributed Session

Chair: Pakayse Koken, PhD Candidate, Binghamton University, 4400 Vestal Parkway East, Binghamton, NY, 13902, United States, pakoken@gmail.com

1 - Optimizing Communication In Parallel Algortihm Portfolios

Andrii Berdnikov, Graduate Student, University of Tennessee, Knoxville, 525 John D. Tickle Building,851 Neyland Drive, Knoxville, TN, 37996-2315, United States, andrii@utk.edu

We establish a Markov model of parallel algorithm portfolio performance that captures communication between individual algorithms. Based on the proposed model we investigate different probabilistic measures of efficiency and speed to evaluate performance of algorithm portfolios. These measures are used to optimize communication between individual algorithms in portfolio configuration.

2 - Metaheuristics For Dynamic Lot Sizing Problem With Returns And Hybrid Products

Pakayse Koken, PhD Candidate, Binghamton University, 4400 Vestal Parkway East, Binghamton, NY, 13902, United States, pakoken@gmail.com

For a hybrid system with manufacturing and remanufacturing, a variant of dynamic lot sizing problem is addressed. In the hybrid system, manufactured, remanufactured and hybrid products are produced. Hybrids are composed of approximately 90% new parts and 10% returns. The main objective of this study is to investigate the profitability conditions for producing hybrids. Therefore, a variant of dynamic lot sizing problem is formulated as a mixed-integer nonlinear programming (MINLP) problem. The performance of the system with hybrids is compared to the same system with no hybrids. Metaheuristic algorithms are used to find near optimal solutions to the MINLP problem.

3 - A Hybrid Genetic Algorithm For The Fixed Charge Transportation Problem With The Non-linear Unit Costs

Kiseok Sung, Gangneung-Wonju National University, Gangneung, Korea, Republic of. Contact: sung@gwnu.ac.kr

We present a hybrid method of the Genetic Algorithm for the Fixed Charge Transportation Problem with the Non-linear Unit Costs, mathematically formulated with the 0-1 mixed integer program with non-linear objective function and linear constraints. The GA is used in the upper level to optimize the connectivity of the transportation route between each supply and demand pair. The Continuous GA is used in the lower level to optimize the amount of transportation between each supply and demand pair. In the upper and lower level of procedure, the solutions are verified of the feasibility and modified if necessary to maintain the feasibility.

■ WA79

Legends G- Omni

Opt, Stochastic V

Contributed Session

1 - A New Framework For Shortest Path Problem In Dynamic Network

Yingying Kang, Senior Operations Research Developer, Southwest Airlines Co., Dallas, TX, United States, eing.008@gmail.com

Shortest path algorithm has been well developed over years. The classic dijkstra's algorithm provides exact solution with reasonable run time. However, it has limitation in solving complicated problems, especially when network is dense and changes dynamically. This presentation presents a new framework and enhanced searching procedure to raise the efficiency in dynamic network. This solution has been proved to improve the solution quality and efficiency significantly in large scaled dynamic network and provide a practical and effective solution to real time problems.

2 - An Enhanced Sample Average Approximation Technique To Solve A Two-stage Chance-constrained Optimization Problem

Sudipta Chowdhury, PHD Student, Mississippi State University, 260 McCain Engineering Building, ISE Department, Starkville, MS, 39762, United States, sc2603@msstate.edu, Adindu Emelogu, Mohammad Marufuzzaman, Linkan Bian

This study proposes an enhanced Sample Average Approximation (SAA) technique to solve a two-stage stochastic chance-constrained optimization problem. The problem is challenging to solve as the feasibility region defined by chance constraints is generally non-convex and hence requires multi-dimensional integration. The numerical studies show that for all sized instances the combined enhanced SAA approach gives faster and better quality solution than the combined SAA approach. Results also indicate that, strengthened formulation which is typically much faster to solve chance constrained MILP, can also be outperformed by the enhanced SAA approach for larger instances.

■ WA80

Broadway E- Omni

Health Care, Public I

Contributed Session

Chair: Amit K Bardhan, Professor, University of Delhi, Delhi, 110007, India, amit-bardhan@fms.edu

1 - Application Of System Dynamics To Private Sector Versus Medicare Cost Projections

Michael P D'Itri, Associate Dean and Professor, Dalton State College, 650 North College Drive, Dalton, GA, 30720, United States, mditri@daltonstate.edu, Robert Culp, Jon Littlefield

A source of contention over the Affordable Care Act results from analyses based on segmentation of the population studied into public (Medicare) versus private healthcare providers. This research controls for this effect by employing a systems dynamic method to model private sector and Medicare costs over time. Age data from the 2000 United States Census is represented using a distributed delay with net annual changes in population calibrated to match the 2010 census data. Average costs per person in each age group are calculated and used to make future cost projections.

2 - Identifying The Impact Of Outdated Drug Limit Library Usage By Smart Infusion Pump Logs

Kang-Yu Hsu, PhD Student, Purdue University, Gerald D and Edna E Mann Hall, 203 S. Martin Jischke Drive, Lafayette, IN, 47907, United States, hsu66@purdue.edu, Poching DeLaurentis, Yuval Bitan, Daniel Degnan, Yuehwern Yih

Drug Limit Library (DLL) in infusion pumps may not be updated efficiently. The inconsistency between DLL in pumps and the most up-to-date DLL may put patient safety at risk. In this study, we quantify the impact of adopting out-of-date DLL through investigating smart infusion pump logs, and examine infusions which potentially jeopardized patient safety with outdated DLL usage.

3 - A Game Theoretic Approach To Pediatric Vaccine Pricing

Banafsheh Behzad, Assistant Professor, California State University, Long Beach, 1250 Bellflower Blvd, MS 8506, Long Beach, CA, 91101, United States, banafsheh.behzad@csulb.edu, Sheldon H Jacobson

Pricing strategies in the US pediatric vaccines market are studied using a Bertrand-Edgeworth-Chamberlin price game. The game analyzes the competition between asymmetric, capacity-constrained manufacturers producing differentiated products in a market with linear demand. The results indicate that the pure strategy equilibrium exists if the production capacity of a manufacturer is at their extreme. In a duopoly setting, the distribution functions of the mixed strategy equilibrium for manufacturers are provided. The proposed game is applied to the US pediatric vaccine market, where competing vaccines are differentiated based upon the number of reported medical adverse events.

4 - Storage And Transport Considerations In Designing The WHO-EPI Vaccine Distribution Network

Jayant Rajgopal, Professor, University of Pittsburgh, Department of Industrial Engineering, University of Pittsburgh, Pittsburgh, PA, 15261, United States, rajgopal@pitt.edu, Jung Lim, Bryan A Norman

The WHO-EPI vaccine distribution chain is used to deliver vaccines for inoculating children against vaccine-preventable diseases. The structure of this chain is rigid and almost identical in most low and middle income countries, despite significant demographic, geographical and economic differences. We describe the problem of designing a network that is based on the parameters associated with a specific country and present an integer programming formulation that optimizes the structure for a given country while also determining the primary parameters of cold storage and transportation along with the design. Issues related to solving this model are also discussed.

5 - Healthcare Facility Location Model Based On Choice Behaviour Of Catchment Population

Amit K Bardhan, Professor, University of Delhi, Delhi, 110007, India, amit-bardhan@fms.edu, Arun K Sharma, Kaushal Kumar

Due to excessive demand and limited capacity, public healthcare delivery systems in developing countries operate under immense pressure. New facilities when established should not only be useful to the unserved, they should also reduce pressure on existing centers. Most healthcare facility location models focus on ease of access criteria like distance, travel-time, population density etc. In recent studies it has been reported that assurance and quality of care are also important while choosing healthcare facility. In this paper we propose a hierarchical facility location model that incorporates such behavioral choice criteria of target population.

WA81

Broadway F- Omni

Health Care, Strategies I

Contributed Session

Chair: Luv Sharma, Ohio State University, 601 Tuscarawas Court, Columbus, OH, 43210, United States, sharma.154@osu.edu

1 - Coordinated Scheduling Policies For Improving Patient Access To Surgical Services

Mustafa Y Sir, Mayo Clinic, 200 First Street SW, Rochester, MN, 55905, United States, sir.mustafa@mayo.edu, Maria Gabriela Martinez, Todd Huschka, Kalyan Pasupathy

Delayed access to receive treatment negatively affects patient satisfaction and health outcomes. This study presents scheduling policies that integrate patient flow in an elective surgical department in order to match capacity to patient needs. A data-driven model is formulated to determine appropriate scheduling time bounds for a fair distribution of surgical load among surgeons, considering medical need of patients. A simulation model is implemented to evaluate the performance of the proposed policies.

2 - Assessing Decisions In Medical Referral Networks From Empirical Data

Michael Pavlin, Wilfrid Laurier University, School of Business and Economics, 75 University Avenue West, Waterloo, ON, N2L 3C5, Canada, mpavlin@wlu.ca, Mojtaba Araghi

Informal referral networks are central to the allocation of medical resources in many healthcare systems. In this paper we assess decisions in a cataract surgery referral network. The system is modeled as a bipartite queueing network and empirical techniques are developed to estimate decision making parameters from aggregate data.

3 - A System Dynamics Model To Investigate The Impacts Of Non-invasive Sensor Based Interventions

Mehmet Serdar Kilinc, Pennsylvania State University, 310 Leonhard Building, Department of Industrial Engineering, University Park, PA, 16802, United States, serdarmehmet@gmail.com, Jose Angel Castro, Linlin Ma, Harriet Black Nembhard

Non-invasive sensor based interventions promise opportunities to reduce the burden of Parkinson's disease (PD) on our healthcare system. These interventions can be implemented for various purposes such as early detection, remote monitoring of medication adherence, physical rehabilitation, and fall detection. To date, however, the US healthcare system has been slow to adopt these interventions. In this study, we use a system dynamics model to examine the long-term macro-level impacts of non-invasive sensor based interventions on the healthcare system. The model addresses both healthcare demand and supply by considering the prevalence and progress of PD with and without these interventions.

4 - Does The Office Of Patient Experience Matter In Improving Delivery Of Care? An Econometricstudy Of US Hospitals

Luv Sharma, Ohio State University, 601 Tuscarawas Court, Columbus, OH, 43210, United States, sharma.154@osu.edu, Aravind Chandrasekaran

We assemble a unique dataset regarding the presence of office of patient experience for 3250 US hospitals. We study the impact of this office on patient satisfaction. Results indicate that effectiveness of this office depends on the background of the chief experience officer, clinical complexity and its year of origin.

WA82

Broadway G- Omni

Networks and Graphs I

Contributed Session

Chair: Zhengyuan Zhou, Stanford University, 160 Comstock Circle - Unit 106002, Stanford, CA, 94305, United States, zyzhou@stanford.edu

1 - Facets And Valid Inequalities For The Pathwidth Problem

Tom Rihm, University of Bern, Schuetzenmattstrasse 14, Bern, Switzerland, tom.rihm@pqm.unibe.ch, Arie Koster

The pathwidth specifies the similarity between a given graph and a path, and is relevant for many algorithms in real-world applications. In general, the problem of determining the pathwidth of a given graph is NP-complete. We formulate this problem as an integer linear program. Furthermore, we provide classes of valid inequalities to tighten the linear programming relaxation, and we identify conditions under which these inequalities are facet-defining. Our computational results indicate that these inequalities improve the performance.

2 - Network Design Problem With Relays

Baris Yildiz, Assistant Professor, Koc University, Rumeli Feneri Yolu, Sariyer, Istanbul, Turkey, baris.yildiz@bilkent.edu.tr, Oya Ekin Karasan, Hande Yaman

We study the network design problem with relays and present a multi-commodity flow formulation and a branch-and-price algorithm to solve it. Motivated by the practical applications we investigate the special case where each demand has a common designated source. In this special case, we can show that there exists an optimal design that is a tree. Using this fact, we replace the multi-commodity flow formulation with a tree formulation enhanced with Steiner cuts. Employing a branch-and-price-and-cut schema on this formulation, we are able to further extend computational efficiency.

3 - A Sampling Strategy For Estimating Features Of Large Networks

Jingjing Zou, Columbia University, 434 W.120th St, Apt 3J, New York, NY, 10027, United States, jz2335@columbia.edu, Richard Davis, Gennady Samorodnitsky, Zhi-Li Zhang

We propose a sampling procedure with the goal of estimating certain population features of the entire network. Such features might include tail behavior of the in- and out-degree distributions. Our procedure is based on selecting some initial nodes and then following the path of linked nodes in a structured fashion. Targeted nodes with desired features will have a larger probability of being retained. In order to construct unbiased or nearly unbiased estimates of the quantities of interest, weights associated with the sampled nodes must be calculated. We will illustrate this procedure and compare it with multiple random walks on datasets including webpage network and Google+ social network data.

4 - Games On Influence Networks: Equilibria, Free Riding And Dynamics

Zhengyuan Zhou, Stanford University, 160 Comstock Circle, Unit 106002, Stanford, CA, 94305, United States, zyzhou@stanford.edu, Nicholas Bambos, Peter Glynn

An influence network consists of a set of interacting agents, each of whose actions produces effects on his neighbors' actions. In general, the effects can be arbitrary, inhomogeneous functions of the neighbors' joint action. Such effects capture the commonality of a variety of networks in economics and engineering. Therefore, the study of strategic interactions among agents in an influence network can be of great applicability. We formulate a simple game-theoretical model of influence networks that investigates strategic interactions among agents in light of such influence. We study the equilibria properties, the resulting free-riding phenomenon and the dynamics for reaching an equilibrium.

WA83

Broadway H- Omni

Supply Chain Optimization I

Contributed Session

Chair: Stewart Liu, PhD Candidate, Univeristy of California - Berkeley, 4141 Etcheverry Hall, MC 1777, Berkeley, CA, 94720, United States, stewart_liu@berkeley.edu

1 - A Newsvendor Problem With Multiple Unreliable Suppliers

Roshanak Mohammadivojdan, PhD Student, University of Florida, 303 Weil Hall, P.O. Box 116595, Gainesville, FL, 32611, United States, rmohammadivojdan@ufl.edu, Yasemin Merzifonluoglu, Joseph Geunes

We consider a single period (newsvendor) inventory planning problem in which the newsvendor must determine how much to order from each of a number of suppliers, and where each supplier may default on delivery with a certain probability. Our goal is to minimize total expected cost, including total ordering costs and overstocking and understocking costs. We characterize key structural properties of optimal solutions and provide algorithms for solving problems in this class.

2 - Topological Network Design Of Closed Finite Capacity Supply Chain Networks

Laoucine Kerbache, Professor, HEC Paris School of Management, Ops Mgmt & Information Systems, 1 Rue de La Liberation Jouy-En-Josas, 78351, France, kerbache@hec.fr, James Macgregor Smith

We wish to examine the layout, location, and general topological arrangement of queues in a closed queueing network environment for supply chains. Since our focus is on manufacturing environments, then maximizing throughput is a worthy performance measure objective. We are given a network topology G(V,E) with a finite set of nodes and edges and we wish to assign the queues to the nodes such that the maximum throughput is achieved. We examine the performance of the system in a closed queueing network environment. This is a nonlinear continuous optimization problem with implicit integer variables. We show that decentralization can have a major impact on the throughput of the supply chain.

3 - Vendor-buyer Cooperative Policy With Penalty For Late Delivery

Md Shahriar Jahan Hossain, Graduate Assistant, Louisiana State University, 2508 Patrick F. Taylor Hall, Baton Rouge, LA, 70803, United States, msjhossain1@gmail.com, Mohamed M. Ohaiba, Bhaba R Sarker

This research presents a single-vendor, single-buyer integrated inventory model under stochastic lead-time environment and late delivery penalty. The problem is formulated as a nonlinear cost model which is minimized to arrive at an optimal policy for reorder point, order quantity and number of shipments from the vendor to the buyer. The solution procedure involves both closed form solution and iterative search procedure. Numerical examples with potential industrial implications are presented for uniform, exponential and normally distributed lead-times.

4 - Two-step Gradient Search For Optimizing Biopharmaceutical Supply Chain Decision-making

Stewart Liu, PhD Candidate, Univeristy of California-Berkeley, 4141 Etcheverry Hall, MC 1777, Berkeley, CA, 94720, United States, stewart_liu@berkeley.edu, Philip Kaminsky

Motivated by our success in solving stochastic supply chain optimization problems in the biopharmaceutical industry using retrospective optimization, we present a two-step retrospective optimization-stochastic gradient search algorithm that in initial empirical testing is both fast and effective. This method also allows us to optimize policy parameters of complex supply chains with an assembly or distribution structures subject to random demand, lead time and quality control disruptions between stages.

■ WA84

Broadway J- Omni

Supply Chain, Risk I

Contributed Session

Chair: Iris Luan, Tongji University, Rm 611, Tongji Building A, No.1500 Siping Road, Shanghai, 200092, China, luanxiaoxi@163.com

2 - Political Risk In Supply Chain And Operations Management: A Conceptual Model

Remi Charpin, PhD Candidate, Clemson University, 100 Sirrine Hall, Box 341305, Clemson, SC, 29634, United States, rcharpi@clemson.edu, Aleda Roth

Political risk has been overlooked in the supply chain and operations management literature while it remains one of the environmental factors that influences the most operations and supply chains for foreign firms operating abroad. We review the literature and propose an original conceptual model that links risk causes to their potential consequences at the operational and supply chain levels.

3 - The Impact Of Responsiveness On Supply Chain Risk A Heuristic Method With Adaptive Genetic Algorithm

Seyed Vahid Reza Nooraie, NC A&T State University, Greensboro, NC, United States, snooraie@aggies.ncat.edu, Mahour Mellat parast, Paul M Stanfield, Saeed Zamiri Marvizadeh

This paper examines the relationship between responsiveness, cost and supply chain risk of disruptions. A conceptual model is developed to address flexibility, agility, Internal Integration, visibility and responsiveness relationships, which are further, examined using hypotheses testing. A heuristic algorithm based on adaptive GA will be developed to solve NP hard problem.

4 - Financial And Order Strategies In A Supply Chain With Option Contracts

Shengya Hua, Peking University, Room 121, Building 1, ChangChun Xin Yuan, Peking University, Yiheyuan Road No.5, Haidian District, Beijing, 100871, China, huasy@pku.edu.cn, Xin Zhai

We study a supply chain consisting of one supplier and one budget constraint retailer who purchases from the supplier via an option contract. To satisfy the stochastic customer demand, the retailer will order before the sales season and if needed, she can a take bank credit financing (BCF) or trade credit financing (TCF) to get enough working capital. After the sales season, the retailer should repay the credit loan and interests with all the money in hand. To study the financial and order strategies in the supply chain, we establish a Stackelberg game with the supplier as the leader. The results show that the retailer's order quantity is affected by her wealth and both the supplier and retailer prefer the TCF.

5 - Structural Equation Model Of The Association O2O Platform Between Service Supply Chain Risk And Vulnerability

Iris Luan, Tongji University, Rm 611, Tongji Buildding A, No.1500 Siping Road, Shanghai, 200092, China, luanxiaoxi@163.com

Abstract: Compared with the traditional supply chain, service supply chain is possessed with the feature of intangibles and difficult to store, thus service supply chain is more vulnerable. The present study used structural equation model based on a large number of data to analyze which kind of service supply chain risk would affect vulnerability typically. Studies have revealed that: demand risk having a significant impact on the vulnerability of the service supply chain, operational risk on service supply chain vulnerabilities affect the effect is not significant. This study may provide theoretical guidance for service supply chain risk and vulnerability relationship is of great significance.

■ WA85

Broadway K- Omni

Sustainability I

Contributed Session

Chair: Jen-Yi Chen, Assistant Professor, Cleveland State University, 1860 E. 18th Street, Bu 545, Cleveland, OH, 44114, United States, j.chen27@csuohio.edu

1 - Impact Of Official Regulation Policies On Chinese Power Plant's Reusable Environmental Investments And Sustainable Operations

Xiang Ji, School of Management, University of Science and Technology of China, Hefei, China, signji@mail.ustc.edu.cn, Jiasen Sun

We analyze how Chinese coal-fired power plant's reusable environmental investments and sustainable operations would be influenced by different official environment regulation policies. An empirical study of 27 mainland China's major million-KW coal-fired power plants is presented. With this empirical analysis, we have answered following three questions: (1) what kind of reusable environmental investment should be chosen by the coal-fired power plant, (2) how to choose the "best" reusable environmental investment, and (3) what kind of policy is better in China.

2 - Design Of Rainwater Harvesting And Greywater Recycling Systems For Urban Areas

Juliana Arango, Graduate Student, Universidad de los Andes, Bogotá, 111711, Colombia, j.arango905@uniandes.edu.co

In urban areas, rainwater harvesting and greywater recycling systems provide additional water supplies for houses, buildings, and industries, and mitigate flooding events and pollution. This work proposes an optimization model for the design of rainwater harvesting and greywater recycling systems (RHGRS) in residential construction projects. Our methodology provides an optimal design of the RHGRS, considering rainwater variability via stochastic programing. We apply the model for a case study of low-income housing in Bogota (Colombia) with 696 apartments.

3 - Supply Chain Sustainability: A Case Study Based On The Triple-bottom-line Perspective

Mei Cao, University of Wisconsin-Superior, Belknap & Catlin, P.O. Box 2000, Superior, WI, 54880-4500, United States, mcao1@uwsuper.edu, Qingyu Zhang

As the pressure of global energy conservation and public awareness of environmental and social responsibility increase, sustainable development has become a core problem of any manufacturing firm in managing their supply chain. A case study was conducted to analyze the relationships among supply chain exchange hazards, governance mechanisms, sustainability practices, and the triple-bottom-line performance.

4 - Leadership And Collaboration For Supply Chain Sustainability

Jen-Yi Chen, Assistant Professor, Cleveland State University, 1860 E. 18th Street, Bu 545, Cleveland, OH, 44114, United States, j.chen27@csuohio.edu

We analyze a firm's decision on how to collaborate for more sustainable operations by exploring the following two questions: What collaborative strategy should the firm adopt? and How external market factors affect internal supply chain strategic decisions? Managerial implications are discussed.

■ WA86

Glbson Board Room-Omni

Telecommunications Modeling and Analysis

Sponsored: Telecommunications

Sponsored Session

Chair: Dimitri Papadimitriou, Nokia Bell Labs, Antwerp, Belgium, Belgium, dimitri.papadimitriou@nokia.com

1 - Reducing The Internet Adoption Gap Between Rich And Poor Through Auction Mechanisms

Sergio Cabrales, Universidad de los Andes, Bogota, Colombia, s-cabral@uniandes.edu.co, Luis Andrés Marentes, Yezid Donoso, Tilman Wolf, Anna B Nagurney

The latest Millennium Development Goals Report by the United Nations has found that poor populations are behind in their internet adoption due to high prices relative to available budgets. We design an auction mechanisms to suit the allocation of bandwidth to user needs and their budgets. The article develops another dimension to the topic of dynamic pricing models design, which is resource allocations to favor target groups by finding Nash Equilibria of underlying games using extreme value theory and a self-discrimination induced on users. Results indicate the auction mechanism let increase allocation for the population being part of the target group during peak periods.

2 - An Efficient Sampling-based Algorithm For Chance-constrained Two-stage Problems

Jianqiang Cheng, Sandia National Laboratories, Livermore, CA, United States, jianqiang.cheng@gmail.com, Richard Li-Yang Chen

We consider a chance constrained version of two-stage stochastic optimization problems which minimizes the sum of the first-stage costs and the p-quantile of the second-stage random costs. To solve this problem, we first apply sampling-based approximation techniques, precisely, the partial sample average approximation, to obtain an approximate deterministic formulation. Then, we develop decomposition algorithms to solve the approximation problems. Computational results on a stochastic network design show the strength of our proposed approximation approach.

3 - On The Convex Piecewise Linear Unsplittable Multicommodity Flow Problem

Bernard Fortz, Université Libre de Bruxelles, Brussels, Belgium, bernard.fortz@ulb.ac.be, Luis Gouveia, Martim Joyce-Moniz

We consider the problem of finding the cheapest routing for a set of commodities over a directed graph, such that: i) each commodity flows through a single path, ii) the routing cost of each arc is given by a convex piecewise linear function of the load i.e. the total flow) traversing it. We propose a new mixed-integer programming formulation for this problem. The linear relaxation of this formulation gives an optimal solution for the single commodity case, and produces very tight linear programming bounds for the multi-commodity case. We also derive new valid inequalities for the compact basic model based on the projection of the extended formulation.

4 - Mixed-integer Programming Model For The Joint Function Placement And Assignment Problem

Dimitri Papadimitriou, Bell Labs, dimitri.papadimitriou@alcatel-lucent.com

Function-oriented networks take as input demands described by unsplittable finite sequences of operations and perform by executing at each node at most one out of the n possible operations part of the sequence. The problem consists of selecting the subset of nodes where to jointly place function operators and assigning demands to paths crossing these nodes without exceeding both their processing and arc capacity. Following the objective of minimizing the sum of location, allocation and routing cost, we formulate the corresponding mixed-integer program. Numerical experiments are conducted to evaluate the performance tradeoffs with different placement and routing schemes/constraints.

■ WA87

Broadway A-Omni

Production and Scheduling

Contributed Session

Chair: Rasaratnam Logendran, Oregon State University, School of Mech lndustrial & Mfgr Engr, Rogers Hall Rm 204, Corvallis, OR, 97331-6001, United States, logen.logendran@oregonstate.edu

1 - A Scheduling Algorithm For Additive Manufacturing

Kai-Oliver Zander, PhD Student, Texas Tech University, Box 43061, Lubbock, TX, 79409-3061, United States, Kai-Oliver.Zander@ttu.edu, Milton Louis Smith

Recent studies have shown that additive manufacturing (AM) can enable an increase in efficiency and generate an enhanced customer value. The increased utilization of AM will lead necessarily to practical problems regarding production scheduling. This presentation introduces a new scheduling method specifically designed for an AM production environment with multiple machines. Based on existing research, a new algorithm has been developed to allow an efficient scheduling and batching of jobs for AM machinery. A simulation study shows the effectiveness of the developed algorithm.

2 - Hybird Robust And Stochastic Production Planning On The Shop Floor Considering Real Time Information

Zhengyang Hu, Research Assistant, Iowa State University, 100 Enrollment Services Center Ames, Ames, IA, 50011, United States, zhengya@iastate.edu, Guiping Hu

Assembly and fabrication factories are universally challenged with the need to continually reduce costs and improve efficiency while simultaneously becoming increasingly flexible to meet ever-changing customer demand. A hybrid decision making model is proposed to address the uncertainties on the shop floor considering real time information. Stochastic programming is adopted to deal with unexpected machine breakdown. Robust optimization is utilized to address the demand uncertainty considering the worst-case scenario. The goal is to minimize the total production cost and the worst-case cost associated with unmet demand. A case study based on a manufacturing shop floor is presented.

3 - Quantifying The Performance Of The Tabu Search/Path Relinking Algorithm For Batch Scheduling In Hybrid Flow Shops

Rasaratnam Logendran, Professor, Oregon State University, School of Mech lndustrial & Mfgr Engr, Rogers Hall Rm 204, Corvallis, OR, 97331-6001, United States, logen.logendran@oregonstate.edu, Omid Shahvari

We address a batching and scheduling problem in hybrid flow shops with the objective of simultaneously minimizing total weighted completion time and total weighted tardiness. It is assumed that dynamic job release and machine availability times exist, batch sizes can have desired lower bounds, and jobs can skip one or more stages. The performance of the tabu search/path relinking algorithm is evaluated based on tight lower bounds identified by the column generation technique.

■ WA88

Broadway B-Omni

Military Applications I

Contributed Session

Chair: Ali Pala, PhD Student, University at Buffalo, SUNY, 271 Palmdale Drive, Apt 5, Buffalo, NY, 14221, United States, alipala@buffalo.edu

1 - Military Modeling Of Unconventional Conflict

Dean S Hartley, Principal, Hartley Consulting, 106 Windsong Lane, Oak Ridge, TN, 37830, United States, DSHartley3@comcast.net

Unconventional conflict refers to conflicts involving at least one nation state and which is not dominated by conventional combat. There is significant overlap between unconventional conflict and operations other than war (OOTW) and irregular warfare (IW). While unconventional conflict needs a whole of government approach, the military is the only organization that is organized and staffed to undertake large and long-term modeling efforts in this domain. This presentation will investigate many of the issues in modeling unconventional conflict.

2 - The Expanding Search Ratio Of A Graph

Thomas Lidbetter, London School of Economics, Houghton Street, London, WC2A 2AE, United Kingdom, t.r.lidbetter@lse.ac.uk Thomas Lidbetter, Rutgers Business School, Newark, NJ, 07102, United States, t.r.lidbetter@lse.ac.uk, Spyros Angelopoulos, Christoph Dürr

We study the problem of searching for a hidden target in an edge-weighted graph. We use a recently introduced search paradigm called expanding search, where a sequence of edges is chosen starting from a given root vertex such that each edge is adjacent to a previously chosen edge. We define the search ratio of an expanding search as the max. over all vertices of the ratio of the time taken to reach the vertex and the shortest-path cost to it from the root. We seek the randomized expanding search with minimum expected search ratio, which is equivalent to solving a zero-sum game between a Searcher and a Hider. We solve the problem for certain classes of graphs, and obtain constant-factor approximations for others.

3 - Modeling Short Range Missile Defense And Iron Dome

Michael J Armstrong, Associate Professor, Brock University, Dept of FOIS Faculty of Business, St Catharines, ON, L2S 3A1, Canada, michael.armstrong@brocku.ca

This paper develops a model of short range ballistic missile defense and uses it to study the performance of the Israeli Iron Dome system. The deterministic model allows for inaccurate missiles, unsuccessful interceptions, and civil defense. Model enhancements consider the trade-offs in attacking the interception system, the difficulties faced by militants in assembling large salvos, and the effects of imperfect missile classification by the defender. A stochastic model is also developed. Analysis shows that system performance is highly sensitive to the missile salvo size.

4 - United States Coast Guard Reduced Staffing Simulation

Chad A Long, United States Coast Guard, FAA Technical Center Building 350, Atlantic City International Airport, Atlantic City, NJ, 08234, United States, chad.a.long@uscg.mil

Under the current schedule, Air Station Atlantic City pilots are averaging 17 flight hours per month, which is below the United States Coast Guard requirement. A new schedule, with decreased staffing was simulated in Arena, to determine if it would increase flight time and be robust enough to staff the unit year-round.

5 - Behavioral Analysis Of Illegal Fishery In The Gulf Of Mexico

Ali Pala, PhD Student, University at Buffalo, SUNY, 271 Palmdale Drive, Apt 5, Buffalo, NY, 14221, United States, alipala@buffalo.edu, Vineet Madasseri Payyappalli, Jun Zhuang

Illegal fishery activities in the Gulf of Mexico pose a threat to U.S. national security, as well as damage to the economy. The U.S. Coast Guard estimates over 1,100 incursions annually by Mexican fisherman into U.S. regulated waters in the Gulf of Mexico. In this research, we study the behavior of illegal fishermen and analyze how that is affected by various factors such as weather, fish habitats, seasonal effects, and others. We use data mining techniques and mathematical models to propose optimal patrolling strategies that improve the chances of interdicting illegal fishery.

■ WA89

Broadway C-Omni

Innovations in Connected and Autonomous Vehicles

Sponsored: TSL, Intelligent Transportation Systems (ITS)

Sponsored Session

Chair: Peiheng Li, Arizona State University, 1, Tempe, AZ, 6, United States, peihengl@asu.edu

1 - A Distributed Framework For Network-Wide Traffic Monitoring And Platoon Information Aggregation Using V2V Communications

Peiheng Li, Arizona State University, Tempe, AZ, United States, peihengl@asu.edu, Yingyan Lou

This study explores an innovative framework for distributed traffic monitoring and information aggregation using vehicle-to-vehicle communications alone. Distributed protocols that run on individual vehicles are developed and tested through simulation. A new concept of micro-discontinuity is proposed for identifying platoons, and initiating and terminating traffic information aggregation. The impact of market penetration rate is also analyzed.

2 - Development Of Adaptive Forward Collision Warning Algorithm Incorporating Prediction Uncertainty To Reduce False Alarms

Yong Hoon Kim, Purdue University, West Lafayette, IN, United States, kim523@purdue.edu, Shubham Agrawal, Srinivas Peeta

This study proposes an adaptive forward collision warning (FCW) algorithm that adjusts its warning threshold according to the uncertainty in vehicle trajectory prediction. The prediction uncertainty is modeled by kinematic information of surrounding vehicles obtained through vehicle-to-vehicle communication. Numerical experiments show that the proposed adaptive FCW algorithm can provide early warning while reducing the rate of false/nuisance alarms.

3 - Integrating The Operations Perspective Into Planning Of Automotive Vehicle Platforms

Paul Jana, Research assistant, Technische Universität Muenchen, Arcisstr 21, Munich, 80333, Germany, paul.jana@tum.de, Martin Grunow

To address the mass customization trade-off many automotive OEMs moved towards a multi-platform based product portfolio. One major benefit is the reduced internal variety in operations. So far, the multi-platform problem is mostly approached from the product perspective without adopting the operations perspective. We present a mixed-integer linear programming approach integrating network design, capacity configuration, and further operations requirements into automotive multi-platform planning and show the superiority of an integrated approach in a numerical study based on an industry setting.

■ WA90

Broadway D-Omni

Health Care, Modeling XII

Contributed Session

Chair: Yang Zhan, Shanghai Jiao Tong University, Shanghai, 200030, China, zhanyangjy@sjtu.edu.cn

1 - A Stochastic Stackelberg-Nash-Cournot Equilibrium Model For Long-term Care Capacity Planning

Ashkan Hassani, Texas A&M University, 4050 ETB, College Station, TX, 77840, United States, ashkanhassani@tamu.edu, Mark Alan Lawley, Nan Kong

Long-term care (LTC) is needed by people who have limitations in activities of daily living. In general, there are two types of LTC delivery: nursing home care and home- and community-based service (HCBS). We develop a stochastic Stackelberg-Nash-Cournot (SNC) equilibrium model to determine the optimal capacities for nursing home and HCBS. The capacity of HCBS will be determined by the public insurer who performs as a leader in a Stackelberg game. Nursing homes will be followers in the Stackelberg game with knowledge of the public insurer's policy, and they compete with each other and could reach Nash equilibrium in a Nash-Cournot game.

2 - Dynamically Tracking Multiple Types Of Risks Of Falls With Wearable Sensors via Data Association Problem

Alla Kammerdiner, Assistant Professor, New Mexico State University, Las Cruces, NM, United States, alla@nmsu.edu, Andre Nunes Guerrero

Wearable sensors are used in practice for detection of falls. We formulate the data association problem arising in dynamic tracking multiple types of risks of falls with wearable sensors as the multi-dimensional problem (MAP). Tracking of risks is done dynamically as data from multiple sensors arrive continually and are partitioned into frames. We consider multiple-frame risk-track initiation and risk-track maintenance for single-pane, double-pane, and multiple-pane sliding windows. Track maintenance include: extending existing risk-tracks, terminating existing tracks, and initiating new risk-tracks. The optimization models are applied to empirical data from wearable sensor system.

3 - A Simulation Model Of Glucose Metabolism For Predicting Blood Glucose Level

Buket Aydas, University of Wisconsin-Milwaukee, Milwaukee, WI, 53202, United States, baydas@uwm.edu, Mukul Goyal

We develop a human body glucose metabolism model for predicting blood glucose levels using discrete event simulation. The model estimates the glycated hemoglobin (HbA1c) level in the blood and predicts the impact, in terms of BGL and HbA1c levels, of a particular diet-exercise routine. Each organ in the human body that relates to glucose metabolism is modeled individually within the simulation. The results are validated by using reference glycemic index (GI) values of food.

4 - Two-level Optimization To Balance Value Flow And Patient Flow In Operating Room Block Scheduling

Wei Li, Assistant Professor, University of Kentucky, 414J CRMS Building, 147 Graham Avenue, Lexington, KY, 40506-0108, United States, wei.mike.li@uky.edu

Operating room (OR) block scheduling in the long term is important for OR scheduling in the medium term and OR control in the short term. Similar to the trade-off between production cost and holding cost in manufacturing systems, there is a trade-off between value flow and patient flow in OR scheduling. We use a two-level optimization model to balance the trade-off in OR scheduling, and test the robustness of the model through simulation.

5 - Home Health Care Routing And Appointment Scheduling With Stochastic Service Durations

Yang Zhan, Shanghai Jiao Tong University, Shanghai, 200030, China, zhanyangjy@sjtu.edu.cn, Zizhuo Wang, Guohua Wan

Motivated by the practice of home health care services, we consider an integrated routing and appointment scheduling problem with random service durations. The objective of the problem is to determine the visit route and appointment times to minimize the summation of the costs of traveling and idling of the health care team and the cost of waiting of the patients. To solve the intractable problem, we propose both exact and approximate algorithms. We conduct computational experiments to assess the performance of the proposed methods on problems of practical size.The computational results show that the methods work very well.

Wednesday, 10:00AM - 10:50AM

■ Keynote Wednesday

Davidson Ballroom A-MCC

The Goals of Analysis are Understanding, Decisions, and Influencing Policy

Invited: Keynote

Invited Session

Chair: Turgay Ayer, Georgia Institute of Technology, Atlanta, GA (Healthcare Analytics Chair; ayer@isye@gatech.edu

1 - The Goals Of Analysis are Understanding, Decisions, And Influencing Policy

Gerald G. Brown, Naval Postgraduate School, Monterey, CA, United States, gbrown@nps.navy.mil

While we are variously skilled at applying a diverse set of mathematical tools to analysis, we all share (or should share) the same goals: understand the problem at hand; advise decisions influencing that problem; and influence policy for dealing with entire classes of problems resembling the one we analyze. Sometimes, our answers are not welcomed by a client who brings us a problem, and we face significant obstacles to conveying good, convincing advice and thus contributing to good decision policy. There are a number of techniques that apply to such situations and cross all our various analysis domains. Few of these appear in textbooks or our open literature. These turn out to be vitally important for success.

■ Keynote Wednesday

Davidson Ballroom B-MCC

Can Prediction be Better than Cure? On Analytics in Health-Care

Invited: Plenary, Keynote

Invited Session

Chair: Walt DeGrange, CANA Advisors, Chapel Hill, NC, wdegrange@canallc.com

1 - Can Prediction be Better than Cure? On Analytics In Health-Care

Edmund Jackson, Clinical Services Group, HCA, Nashville, TN, United States, edmund.jackson@hcahealthcare.com

Healthcare is different: the intrinsic complexity, absolute moral imperatives and regulatory oversight of this business are unique. As such many of the technologies in healthcare differ from other industries. That said, the industry is entering a new regime where data is widely available, technology exists for analytics to run in real-time and the intention of bringing this intelligence into the workflow is widespread. Moreover, the advent of techniques such as diagnostic, predictive, and prescriptive analytics in other industries have ready applications in healthcare. The potential benefits of these activities to all stakeholders in the healthcare system, such as patients, providers and payers are enormous. In this talk Dr Edmund Jackson, Vice President and Chief Data Scientist of HCA will discuss this topic and provide a perspective of what has already been achieved and what is soon to come.

■ Keynote Wednesday

Davidson Ballroom C-MCC

SportSource Analytics

Invited: Plenary, Keynote

Invited Session

Chair: James Primbs, California State University Fullerton, 925 Berenice Dr, Brea, CA, 92821, United States, japrimbs@live.com

1 - SportSource Analytics

Stephen Prather, SportSource Analytics, Nashville, TN, United States, team@coachesbythenumbers.com

Think back about 15 years ago about how difficult it was for anyone to access large amounts of data on virtually any subject. Now, think about how easy it is today for virtually anyone to access enormous amounts of data with the click of a few buttons. We live in an extremely data rich world. We are surrounded by information and data in all walks of life. The problem with all of this “big data” is that we are really struggling in finding ways to make it small and more importantly make it USEFUL. My talk is going to be about how four guys all working full-time jobs and without a single advanced degree in any sort of statistical analysis between them were able to become the official analytic consultant to the college football playoff selection committee. This is a story of the pursuit of being useful and understanding that data is only as good as the analysis associated with it.

Wednesday, 11:00AM - 12:30PM

■ WB01

101A-MCC

Pattern Recognition Applications in Data Mining

Sponsored: Data Mining

Sponsored Session

Chair: Cory Stasko, Massachusetts Institute of Technology, 4 Garden Court, Apt 4, Cambridge, MA, 02138, United States, cstasko@mit.edu

1 - Auto Detection Of Tool Wear Using Sequence Alignment Technique

Cheng-Bang Chen, Penn State University, 445 Waupelani Dr., Apt K18, State College, PA, 16801, United States, czc184@psu.edu, Dika Handayani, Deepak Agrawal, Juxihong Julaiti

Tool wear is one common criteria used to measure the machinability of a material. Manual tool wear measurement, which is still widely done, raises an issue on how reproducibility and repeatability the measurements are. In order to reduce the variation of the measurement and speed up the process, we propose a new method using edge detection, sequence mapping, and area projection to measure the wear automatically.

2 - Mini-batch Proximal Semi-stochastic Gradient Descent In Signal Processing

Jie Liu, PhD Student, Lehigh University, 14 Duh Dr Apt 324, Bethlehem, PA, 18015, United States, jild13@lehigh.edu, Jakub Konecny, Peter Richtarik, Martin Takac

We propose the mini-batch proximal semi-stochastic gradient descent (mS2GD). First, we provide convergence results for mS2GD and show that it maintains a complexity of O((n+)log(1/)), comparable to modern stochastic gradient descent methods such as SVRG, SAG, SAGA. Second, we show that mS2GD benefits from both mini-batch speedup and the simple parallel implementation. In the numerical experiments, we first compare different algorithms on public available datasets; then, we compare mS2GD with different batch sizes to illustrate efficiency of mini-batching; last, we conduct experiments on one of the popular signal processing problems—a simple image deblurring problem.

3 - Deconstructing Va Procurement And Logistics Policy With Natural Language Processing

Cory Stasko, Massachusetts Institute of Technology, 4 Garden Court, Apt 4, Cambridge, MA, 02138, United States, cstasko@mit.edu

Over 120 policy documents of are involved in governing VHA procurement and logistics. This large volume of active policy makes it difficult for individuals to understand what exists, where, and how it affects them. Furthermore, the policy set includes redundancies, missing elements, and other weaknesses. This work investigates the value of natural language processing in deconstructing and mapping interrelated policy texts. We describe and organize the logical, linguistic, and substantive patterns within and between policy documents, thereby producing a dynamic map of policy evolution that highlights patterns, inter-dependencies, conflicts, ambiguities, and redundancies in the text.

■ WB02

101B-MCC

Data Mining in Healthcare 2

Sponsored: Data Mining

Sponsored Session

Chair: zihao Jiao, MD, United States, zihaobit@163.com

1 - Doctors Performance In Emergency Rooms

Amir Mousavi, George Washington University, 2700 Wisconsin Ave, Unit 305, Washington, DC, 20007, United States, ahmn00@gmail.com

Emergency Rooms are known as a vital ward in a hospital. Improving the efficiency in the ER has been a challenging question for researchers. Throughout the academic literature, people have defined different efficiency indexes in order to tackle this problem. This research aims to apply Data Envelopment Analysis technique in order to identify the performance (i.e. productivity) variation among doctors and use this result as a component for the optimization model in order to improve the efficiency of the system. The final goal will be to show how patient waiting time is affected by doctors' productivity and how the proposed scheduling model using this information can reduce patient wait times in the ER.

2 - A Deep Feature Selection Approach For Personalized Medicine

Milad Zafar Nezhad, PhD Student, Wayne State University, Wayne State Univesity, Detroit, MI, 48202, United States, fq3963@wayne.edu, Kai Yang

Personalized Medicine has been defined in different ways in the literature. A good interpretation for Personalized Medicine is "the use of combined knowledge (genetic or otherwise) about a person to predict disease susceptibility, disease prognosis, or treatment response and thereby improve that person's health". In this research, we propose a new deep feature selection method based on deep learning. Our method used stacked auto-encoders for feature representation in higher level abstraction. We applied our approach to a specific precision medicine problem. The results show that our feature learning and representation approach leads to better results in comparison with otherwise.

■ WB03

101C-MCC

Advances in Emergency Department Operations Management/Research

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Soroush Saghafian, Harvard Univeristy, 79 John F. Kennedy Street, Mailbox 37, Cambridge, MA, 02138, United States, soroush_saghafian@hks.harvard.edu

1 - Managing Emergency Operations

Eva Lee, Georgia Tech, eva.lee@isye.gatech.edu, William Wang

This is joint with Grady Health System, Children's Healthcare of Atlanta and Emory University School of Medicine. Most scheduling is done based on availability of physician's preference time. The patients are then offered the best possible time that may fit his/her doctor's schedule. This study will identify the needs of patients and develop a predictive model to estimate the individual needs (and thus LOS for the appointment). This information is then incorporated within a scheduling optimization framework for dynamic optimization. This allows for optimizing the scheduled service as well as unexpected emergency service.

2 - The Impact Of Health Information Exchanges On Emergency Department Length Of Stay

Jan Vlachy, Georgia Institute of Technology, Atlanta, GA, United States, vlachy@gatech.edu, Turgay Ayer, Mehmet U.S. Ayvaci, Zeynal Karaca

Health information exchanges (HIEs) are expected to improve information coordination in emergency departments (EDs), but their impact on ED operations remains poorly understood. We study the effect of HIE on ED length of stay (LOS) based on about 5.8 million ED visits in Massachusetts. We find that HIE a) reduces ED LOS overall by 11.1%, b) is even more effective in teaching hospitals, c) is less effective in crowded EDs, and d) its effectiveness depends on severity and complexity of the patients. Our findings have implications for the nationwide HIE adoption.

3 - Assignment Policy To Improve Emergency Department Boarding Time: A Safety And Quality Of Care Perspective

Derya Kilinc, Arizona State University, dkilinc@asu.edu, Soroush Saghafian, Stephen J Traub

One important reason for ED crowding problem is prolonged boarding time of admit patients. We study effective ways of reducing ED boarding times by focusing on the trade off between keeping patients in ED and assigning them to a secondary inpatient unit. We model the patient flow problem as a parallel queueing system and show that the optimal policy is a state-dependent threshold policy. Since the optimal policy is hard to implement, we use a simple and effective policy which we term penalty adjusted Largest Expected Workload Cost. Using simulation model, we show that implementing the proposed policy can improve patient safety by reducing the boarding times while controlling the overflow of patients.

4 - Robust Data-driven Emergency Department Management Via Percentile Optimization: Multi-class Queueing Systems With Model Ambiguity

Austin Bren, Arizona State University, Phoenix, AZ, United States, asbren@asu.edu, Soroush Saghafian

To help hospital Emergency Departments address overcrowding issues and increase patient safety, we implement a robust multi-class queueing model to overcome inherent ambiguities arising in parameter specification. Our technique, based on percentile optimization, is uniquely suited to incorporate both learning and the degree of optimism expressed by the manager. We demonstrate the benefits of using our framework for improving current patient flow policies using real-world data collected from a leading U.S. hospital and utilizing highly effective, easy-to-implement management strategies.

■ WB04

101D-MCC

Optimization Methods in Smart Grid

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Andrew Liu, Purdue University, 315 N. Grant Street, West Lafayette, IN, 47907, United States, andrewliu@purdue.edu

1 - Online Opf With Quasi-Newton Algorithm

Yujie Tang, California Institute of Technology, Pasadena, CA, United States, ytang2@caltech.edu, Krishnamurthy Dvijotham, Steven Low

Optimal power flow is a central problem in the operation of power systems. So far the majority of the literature deals with offline algorithms for traditional power system applications, but the proliferation of distributed energy resources and smart appliances in power networks motivates real-time, decentralized and scalable algorithms. In this talk we will introduce an online OPF algorithm based on quasi-Newton methods that is real-time and can track the optimal operation when the state of the network is changing.

2 - Power System State Estimation In The Presence Of Bad Data

Ramtin Madani, University of California, Berkeley, Berkeley, CA, United States, ramtin.madani@berkeley.edu, Javad Lavaei, Ross Baldick

This talk introduces a method for finding the unknown operating point of a power network based on a given set of potentially corrupted measurements including nodal active powers, nodal reactive powers, nodal voltage magnitudes and line flows. We propose a conic optimization problem in order to handle nonconvexity and deal with bad data simultaneously. The proposed convex program is guaranteed to recover the exact vector of complex voltages as long as the number of bad measurements is small. Numerical experiments on a large-scale European system are performed to demonstrate the efficacy of the proposed framework.

3 - Parallelized Interior Point Method For Security Constrained Optimal Power Flow Problem

Na Li, Assistant Professor, Harvard University, 33 Oxford St,, MD 147, Cambridge, MA, 02139, United States, nali@seas.harvard.edu, Ariana Minot, Yannick Meier

Solving the security constrained optimal power flow problem (SCOPF) is challenging due to the large size of the power system and large number of contingencies. However, in SCOPF, different contingencies are only coupled via the power injection control variables, yielding a sparse system. We design a domain decomposition technique based on this sparsity to parallelize the problem across different contingencies. For each subproblem associated with a contingency, we exploit the network structure through graph coloring techniques to enhance parallelism. In summary, we design an effective method to utilize two layers of parallelism: 1) across contingencies and 2) across buses in the network.

4 - Implement Real Time Pricing With Regret Based Learning
Andrew Lu Liu, Purdue University, andrewliu@purdue.edu
The situation where price-responsive consumers determine what to do in the near future (such as when to charge their PEVs) forms a dynamic and incomplete-information game, in which the consumers' collective actions will impact electricity prices, which in turn affect their payoffs. We propose a regret-matching-based algorithm for each consumer to learn their strategies, as opposed to naively responding to day-ahead prices. We will show convergence to a correlated equilibrium of the regret-matching approach, and study the price of anarchy of the regret-based learning approach.

■ WB05

101E-MCC

Forest management: Transportation and/or Collaborative Logistics

Sponsored: Energy, Natural Res & the Environment II Forestry

Sponsored Session

Chair: Mikael Ronnqvist, Universite Laval, Quebec, QC, Canada, mikael.ronnqvist@gmc.ulaval.ca

1 - Overlapping Coalitions In Collaborative Transportation Of Forest Biomass
Mario Guajardo, Norwegian School of Economics, Mario.Guajardo@nhh.no, Patrik Flisberg, Mikael Frisk, Mikael Ronnqvist
Given a set of companies, we address a collaborative transportation problem in which a same company can collaborate in more than one coalition. This problem corresponds to what in cooperative game theory is known as coalition configuration. We develop area-driven approaches and another approach that embeds the coalition configuration in the transportation problem. We report numerical results for a case in Sweden involving about 6 million tons of forest biomass. Collaboration in this case has not only the potential of cost savings, but also of increasing the use of bioenergy. The results improve substantially compared to a coalition structure and are competitive with the grand coalition.

2 - Bundle-based Auction For Timber Allocations
Sophie D Amours, Université Laval, Sophie.Damours@gmc.ulaval.ca, Marc-André Carle, Mikael Ronnqvist
Tenure of the public forest in Québec, Canada, includes the usage of an auctioning system to allocate the 25% of the commercial forest to industry. We have studied the system and explored new strategies to increase its performance. This includes using combinatorial auctions. The presentation will review the context, the literature and illustrate using a case study the potential and challenges of implementing a combinatorial auctioning system. These include higher efficiency in coordinating needs with supplies as well as the potential challenge of finding multiple optimal solutions and the need for discriminating criteria.

3 - Supply Network Planning Of Forest Fuel Using Robust Optimization
Jens Bengtsson, Norwegian University of Life Sciences, jens.bengtsson@nmbu.no, Patrik Flisberg, Mikael Ronnqvist
Fluctuating and uncertain temperature during the year will cause an uncertain demand at heating plants. These plants use district heating with an energy supply of forest fuel. Changed supply contracts with customers (heating plants) on a yearly frequency may result in very different optimal supply network. We use robust optimization to analyze where forests fuel storage points should be located and their capacities in order to take transportation cost and lead times into account. Critical is to ensure that there is enough supply and transport capacity available throughout the year.

4 - Collaborative Logistics
Mikael Ronnqvist, Universite Laval, mikael.ronnqvist@gmc.ulaval.ca
Collaborative logistics is an efficient approach to improve the logistics operations. In our presentation, we consider horizontal collaboration between several companies and larges savings have been reported in the literature. However, there is also a number of practical issues to deal with including sharing principles and how the joint planning is done without revealing sensitive information. We describe a number of practical applications and discuss their potentials and pitfalls.

■ WB07

102B-MCC

Simulation and Data Mining

Sponsored: Data Mining

Sponsored Session

Chair: Mohammad Ali Asudegi, UTK, 301 Woodlawn Pike, Apt G12, Knoxville, TN, 37920, United States, aliasudegi@gmail.com

1 - Discrete Event Simulations Of Urgent Care Resource Scheduling
Leyla Zhuhadar, Assistant Professor, Western Kentucky University, 1906 College Heights Boulevard, 226 Grise Hall, Bowling Green, KY, 42101, United States, leyla.zhuhadar@wku.edu, Evelyn Thrasher, Kirk Atkinson
Discrete-event simulation is used to estimate the average amount of time that a patient spends waiting to see a nurse and/or waiting to see a doctor. In addition, the model has been extended to estimate the effect on the waiting times if additional nurses or doctors are hired. In this presentation, a study of the value of multiple replications for discrete-event simulation models is discussed and factors to enable greater control on multiple design points with the experiment are defined. Finally, to control the simulation runs for easier model verification, random seeds are used.

2 - A Data Mining Approach For Evaluating Simulation Output
Thomas Robbins, East Carolina University, 3212 Bate Building, Greenville, NC, 27858, United States, robbinst@ecu.edu
We conduct a detailed simulation experiment to compare two different queuing models over a wide range of inputs with the goal of determining the conditions under which each model works best. We implement a data mining approach to characterize the outputs and evaluate the input conditions that best predict model superiority. Since performance can be evaluated across multiple measures we use a clustering approach to characterize output performance. We then investigate multiple classification techniques to isolate inputs that best predict model superiority.

3 - Performance Indicators And Operating Factors In A Complex Manufacturing System
Mohammad Ali Asudegi, UTK, 525 John D. Tickle Engineering Building, 851 Neyland Dr, Knoxville, TN, 37996, United States, aliasudegi@gmail.com, Rupy Sawhney
Reliability, Lead-Time and Cycle-Time are the first and most important key performance indicators, KPIs, of each manufacturing system. Understanding the relation between operating factors, system design factors and key performance indicators would help to be able to make better scheduling and run the system within its optimal specification.A simulation has been conducted to study the relation between the operating speed of each machine in a complex system with Lead-Time, Cycle-Time and the reliability of the whole system.

■ WB08

103A-MCC

Supply Chain Mgt, Green

Contributed Session

Chair: Jianan Sun, Doctoral Student, Xi'an Jiao Tong University, 28 Xianning Road, Shanxi Province, Xi an, 710049, China, sjn168@stu.xjtu.edu.cn

1 - Price Competition Induced By A Partially Green-sensitive Consumer Market In A Dual Manufacturer-single Retailer Channel
Arka Mukherjee, PhD Scholar, Concordia University, 1455 De Maisonneuve Blvd. W., Montreal, QC, H2G 1M8, Canada, ar_mukh@live.concordia.ca
In a marketing channel with two manufacturers and one retailer, price competition between green and non-green products is studied. Considering different market power structures Game theoretic models are developed.A simple Nash game, a cost-sharing contract and a scenario where manufacturers are the market leaders are considered. The results from the different power structures are compared analytically and numerically and interesting conclusions are drawn.

2 - Incentives For Fair Labor Practices In a Supply Chain
Susan A Slotnick, Professor, Cleveland State University, 1860 E. 18th Street, BU 542, Cleveland, OH, 44115, United States, s.slotnick@csuohio.edu, Matthew J Sobel
This paper investigates the tradeoffs involved in a firm's decision to implement policies and procedures to ensure that its products are not manufactured using unfair labor practices. We consider a firm that repeatedly sources a product from a single supplier, maximizes its own profit, and decides whether to cut its profit margins and/or expend resources to inspect the supplier, as well as to improve and/or maintain fair labor practices at that supplier. Retail demand for the product is influenced by reputation.

3 - Channel Choice For Closed-loop Supply Chain Under Government Replacement-subsidy

Jianan Sun, doctoral Student, Xi'an Jiao Tong University, 28 Xianning Road, Shanxi Province, Xi an, 710049, China, sjn168@stu.xjtu.edu.cn

This paper considered government replacement-subsidy policy to examine the channel choice of remanufacturer consisting of a single manufacturer and a single remanufacturer. Based on the replacement-subsidy and carbon emission, we constructed two CLSL channel models which the remanufacturer may cooperate or compete with the manufacturer through different channels. Then, we discussed the impacts of the replacement-subsidy on the channel choice decision of remanufacturer and profits of CLSC system and its members by the method of game theory. At last, the numerical analysis was adopted to emulate the optimal price, optimal quantity and emission quantity of each channel.

■ WB09

103B-MCC

Empirical Research on Sustainable Operations

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Priyank Arora, Georgia Institute of Technology, 800 W Peachtree St NW, Atlanta, GA, 30308, United States, priyank.arora@scheller.gatech.edu

1 - Responsible Customers

Brian Jacobs, Michigan State University, jacobsb@broad.msu.edu, Vinod R Singhal

Responsible sourcing is of increasing research interest. But what happens if your customer is not socially responsible? We examine the impact of the 2015 VW diesel emissions scandal on automotive suppliers.

2 - The Role Of Managerial Commitment On The Relationship Between Controversy And Environmental Practice Adoption

Rick Hardcopf, University of Minnesota, rhardcopf@gmail.com

The adoption of environmental management practices (EMPs) intended to reduce a firm's environmental footprint has increased steadily over the years. EMPs are also positively related to superior environmental, financial, and operational performance. But while the general drivers of EMP adoption have been evaluated extensively, no empirical research has evaluated whether a negative environmental event, such as an environmental spill or pollution event, impacts a firm's pattern of EMP adoption. We evaluate this relationship, and the moderating effect of managerial commitment, using a novel secondary dataset derived from 10k filings, sustainability reports, and other public sources.

3 - The Relationship Between Corporate Social Performance, Productivity, Financial Performance, And Risk

Richard Kraude, Michigan State University, kraude@broad.msu.edu, Sriram Narayanan, Brian W Jacobs

We employ DEA-based measures for productivity and corporate social performance to examine their relationship with multiple dimensions of financial performance and risk. We test our hypotheses in a panel that comprises 476 firms in nine US manufacturing industries during the period 1999-2009.

4 - Relationship Between Appointments Of Corporate Sustainability Leaders And Firm Performance

Priyank Arora, Georgia Institute of Technology, 800 W Peachtree St NW, Atlanta, GA, 30308, United States, priyank.arora@scheller.gatech.edu, Manpreet Singh Hora, Vinod R Singhal, Ravi Subramanian

With an increasing significance of sustainability as a corporate goal, firms have been establishing new positions in their top management teams - positions that we collectively term as Corporate Sustainability Leaders (CSLs). We empirically examine whether and under what conditions does the stock market react to announcements of CSL appointments. While we find that CSL appointments are overall value-neutral, interestingly, we find that under certain conditions, the stock market reaction is significantly more positive. Our findings evidence nuances in the market reactions to the various categories of announcements of CSL appointments considered in our work.

■ WB10

103C-MCC

Underground Mine Planning

Sponsored: Energy, Natural Res & the Environment, Natural Resources I Mining

Sponsored Session

Chair: Alexandra M Newman, Colorado School of Mines, 1104 Maple Street, Golden, CO, 80401, United States, anewman@mines.edu

1 - Sensitivity Analysis as a Tool For Improving Robustness Of Underground Mine Production Schedule

Tacio Vinicius Ferreira Lopes, South Dakota School of Mining and Technology, 501 E Saint Joseph Street, Rapid City, SD, 57701, United States, taciovinicius.ferreiralopes@mines.sdsmt.edu, Andrea Brickey

Underground mine production scheduling has long been a manual and time-consuming task performed by mining engineers. Recent research has shown that an integer programming formulation can be used to determine a large-scale underground mine production schedule. We perform sensitivity analysis of an underground mine production schedule model and the results are used in determining a more robust and operationally implementable schedule.

2 - Optimal Support Pillar Placement In An Underground Mine

Levente Sipeki, Colorado School of Mines, lsipeki@mymail.mines.edu

We determine support pillar placement for a top-down one-stope retreat mining operation to maximize the profit from ore extraction, subject to constrains on pillar stress, hydraulic radius, pillar length-to-width rations, and stope-to-pillar extraction rations depending on level depth. A heuristic produces a pillar placement design that increases the extraction capacity of the mine by (1) shifting the pillars to find the most profitable stopes to extract, (2) allowing less ore to be used as a pillar and (3) reducing the total cost of stope slotting by creating fewer pillars.

3 - Short And Medium-term Scheduling Model For Large Underground Mines

Louis-Pierre Campeau, PhD Student, Polytechnique Montreal, 2900 Edouard-Montpetit, Montreal, QC, H3T 1J4, Canada, louis-pierre.campeau@polymtl.ca, Michel Gamache

Applications of operations research to short-term underground mine scheduling are very few, mostly because of the complexity and specificity of its constraints. This presentation will discuss the advances made with a model for short- and medium-term scheduling in large underground mines. The results of the model application to real-world and fictional datasets will also be explained. Comment on future work and possibilities in this field will conclude the presentation.

4 - Underground Mine Plan Optimization

David Whittle, University of Melbourne, a, Melbourne, Australia, dwhittle1@Student.unimelb.edu.au

We present a new approach to the optimization of the design of an underground mine. Our algorithm determines the design and selection of stopes, the network of horizontal development and the selection of levels, in order to maximize undiscounted cashflows. In solving the mine planning problem we have devised a new method to solve the Node-Weighted Geometric Steiner Tree problem, which has potential applications in other fields.

■ WB11

104A-MCC

Transportation Network Analysis

Sponsored: Optimization, Network Optimization

Sponsored Session

Chair: Bahar Cavdar, Middle East Technical Univeristy, Atlanta, GA, United States, bcavdar@metu.edu.tr

1 - An Integrated Fleet Management Model Introducing Alternative Fuel Trucks

Ilke Bakir, PhD Candidate, Georgia Institute of Technology, Atlanta, GA, United States, ilkebakir@gatech.edu, Alan Erera

We generalize a fleet replacement problem in long-haul trucking by considering some infrastructural and operational decisions alongside with fleet replacement decisions. We propose an integrated fleet management model designed to be particularly helpful in situations where new truck types (alternative fuel trucks, as the main focus) are being introduced into existing fleet. To demonstrate the benefits of utilizing this computationally challenging model instead of simpler methods, we present a comparative computational study. Later, to ease the computational burden of solving this problem, we propose a Benders' decomposition framework.

2 - Solving The Split Delivery Vehicle Routing Problem With A Priori Split

Xingyin Wang, University of Maryland, College Park, MD, 20742, United States, wang_xingyin@yahoo.com, Ping Chen, Bruce L Golden, Edward Andrew Wasil

In the split delivery vehicle routing problem (SDVRP), a customer's demand is allowed to be delivered by more than one vehicle. From a practitioner's point of view, the state-of-the-art heuristics are often difficult to implement and usually take long computing times. We propose an efficient and easily implemented approach to solve the SDVRP using an a priori split strategy combined with a capacitated VRP solver. Our computational experiments show that our algorithm is overall much more efficient and produces results that are comparable to those from the state-of-the-art approaches.

3 - A Computation - Implementation Parallelization Approach For Computation - Time Limited Vehicle Routing Problem With Soft Time Windows

Bahar Cavdar, Middle East Technical Univeristy, Universiteler Mahallesi, Dumlupinar Bulvari No: 1, Ankara, 06800, Turkey, bcavdar@metu.edu.tr, Joel Sokol

Focusing on real-time and time-sensitive routing problems with soft time windows, we develop a new tabu search algorithm which uses a preprocessing step to eliminate unpromising moves and avoids exact computation of time window violations to speed up the computation. We also implement our algorithm using a Computation-Implementation Parallelization approach and show that almost all computation-time can be embedded into the implementation of the solution without hurting the solution quality.

■ WB12

104B-MCC

Polyhedral Methods in Combinatorial Optimization

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Carla Michini, University of Wisconsin, 330 North Orchard Street, Madison, WI, 53715, United States, michini@wisc.edu

1 - 2-level Polytopes: Recent Results And Open Problems

Yuri Faenza, Columbia University, New York, NY, United States, yuri.faenza@gmail.com

2-level polytopes are a generalization of stable set polytopes of perfect graphs. They naturally appear in several areas of mathematics, including polyhedral combinatorics, combinatorial optimization, and statistics. Those polytopes have received quite some attention in the last years because of their connections with the theory of extended formulations and the prominent log rank conjecture in communication complexity. Still, many questions about their structure have not been answered yet. In this talk, I will survey known results and present open problems and promising research directions.

2 - Approximation Algorithm For Structured Packing IPs

Qianyi Wang, Georgia Institute of Technology, qianyi.wang@gatech.edu, Santanu Subhas Dey, Marco Molinaro

In this talk, we present an approximation algorithm for sparse structured packing IPs. In order to apply this algorithm, we first solve a series of sub-IPs derived from the original instance. Next, we construct a feasible solution according to the sparsity structure of the constraint matrix. The performance guarantee of this algorithm is a graph-theoretical parameter that depends on the sparsity structure only.

3 - Totally Unimodular Congestion Games

Carla Michini, University of Wisconsin, Madison, WI, United States, michini@wisc.edu, Alberto Del Pia, Michael C Ferris

We define Totally Unimodular (TU) Congestion Games, where the players' strategies are binary vectors inside polyhedra with TU constraint matrices. In the symmetric case, we design strongly polynomial-time algorithms to (i) find a pure Nash equilibrium, and (ii) compute a socially optimal state, if the delay functions are weakly convex. We also show how to extend our technique to matroid congestion games. In the asymmetric case, we prove that for some combinatorial TU congestion games (i) it is PLS-complete to find a pure Nash equilibrium even in case of linear delay functions, and (ii) it is NP-hard to compute a socially optimal state, even in case of weakly convex delay functions.

4 - Learning To Dynamically Select Primal Heuristics In MIP Branch-and-bound

Elias B Khalil, Georgia Institute of Technology, Atlanta, GA, 30332, United States, lyes@gatech.edu, Bistra Dilkina, George L Nemhauser, Shabbir Ahmed

A variety of primal heuristics have been proposed in the MIP literature, with varying computational cost and effectiveness in finding good feasible solutions. At each node of a branch-and-bound search tree, the MIP solver must select some heuristics and run them, with the goal of finding a better feasible solution. We formalize this decision-making problem, and propose a theoretical framework for analyzing algorithms that solve it. Towards creating better decision-making policies for primal heuristics, we show how Machine Learning can be leveraged to predict whether a primal heuristic will find an incumbent at a given node. Promising experimental results on MIPLIB with SCIP will be presented.

■ WB13

104C-MCC

Advances in Integer Programming Software

Sponsored: Optimization, Computational Optimization and Software

Sponsored Session

Chair: Imre Polik, Optimization Solver Developer, SAS, SAS, Cary, NC, 27513, United States, Imre.Polik@sas.com

1 - A New Deterministic Parallel Framework For Mixed Integer Programs

Michael Perregaard, FICO, MichaelPerregaard@fico.com

We present a new framework for solving MIPs in parallel on modern CPUs with large core counts. It has been designed from the ground up to be deterministic, scalable and asymmetric. We provide computational results demonstrating its performance and scalability within the latest FICO Xpress-Optimizer release.

2 - The SAS MILP Solver: Current Status And Future Developments

Philipp M. Christophel, SAS Institute Inc., Mainz, Germany, philipp.christophel@sas.com

We give an overview of the current status of the SAS mixed integer linear programming (MILP) solver that is part of the SAS/OR product. The focus will be on describing recent development efforts such as presolver techniques and cutting plane generators.

3 - Performance Improvements And New Features In The Gurobi Optimizer

Zonghao Gu, Gurobi Optimization, gu@gurobi.com

This talk will cover the latest developments in the Gurobi Optimizer, which include conflict analysis, new cutting planes and improved separation, new and improved heuristics. These developments enhance the performance of our new Gurobi 7.0 release. The release also includes several major new features and we will give an overview of these features.

4 - Recent Advances In Ibm Ilog Cplex Optimizer

Andrea Tramontani, IBM Italy, Via Martin Luther King, 38/2, Bologna, 40132, Italy, andrea.tramontani@it.ibm.com

This talk will cover the latest developments in the CPLEX Optimizer. We will present some of the new features and algorithmic techniques recently added to CPLEX, and we will give benchmark results to assess the performance improvements achieved in the latest CPLEX version.

■ WB15

104E-MCC

Detection of Structure and Anomalous Patterns in Data

Sponsored: Artificial Intelligence

Sponsored Session

Chair: David Sungjun Choi, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, davidch@andrew.cmu.edu

1 - Efficient Discovery Of Heterogeneous Treatment Effects In Randomized Experiments Via Anomalous Pattern Detection

Edward McFowland, Assistant Professor, University of Minnesota, Minneapolis, MN, United States, emcfowla@umn.edu, Satya Venkata Somanchi, Daniel B Neill

There is a growing literature on the use of machine learning to estimate heterogeneous treatment effects across subpopulations in randomized experiments. However, each proposed method makes a set of restrictive assumptions about the intervention's effects, the underlying data generating processes, and which subpopulation-level effects to explicitly estimate. Moreover, the majority of the literature provides no guidance on identifying the most significantly affected subpopulations. Therefore, we propose a new method for automatically identifying the subpopulation which experiences the largest distributional change as a result of the intervention, while making minimal assumptions.

2 - Detecting Anomalous Patterns Of Care Using Health Insurance Claims

Satya Venkata Somanchi, University of Notre Dame, 344 Mendoza College of Business, Notre Dame, IN, 46556, United States, somanchi.1@nd.edu, Edward McFowland

In this work, we propose methods for detecting heterogeneous treatment effects in observational data. We apply these methods to the patient health insurance claims to improve clinical practice by analyzing patterns across patients and providing actionable insights. Our goal is to analyze this complex patient care data in order to identify interesting patterns in patient care that have led to anomalous health outcomes. Specifically, we detect treatments in the outpatient patient care that have significantly deviated from the regular treatment process and have affected health outcomes either negatively or positively. This can further help improve patient health and reduce health care costs.

3 - FastMemory-efficient Anomaly Detection In Streaming Heterogenous Graphs

Emaad Ahmed Manzoor, Carnegie Mellon University, Pittsburgh, PA, 19106, United States, emaad@cmu.edu

We present StreamSpot, a method to continuously track anomalous graphs as they evolve from a stream of edges with node and edge types. We introduce a graph similarity function that captures both node/edge types and temporal order, and a constant-space sketch that can be maintained incrementally to approximate this similarity in constant time. We show that when applied to detect malicious software from a stream of system call traces of executing processes, StreamSpot scales to over 10,000 edges/second and demonstrates an average precision of over 95%. Project website: http://bit.ly/streamspot

4 - Sequential Goodness Of Fit Testing With False Discovery Rate Control

Sangwon (Justin) Hyun, Carnegie Mellon, Pittsburgh, PA, United States, robohyun66@gmail.com, Max G'Sell

We consider sequential goodness-of-fit testing for sequential model selection procedures. This leads to a multiple hypothesis testing setting where the hypotheses are ordered and one is only permitted to reject an initial contiguous block, H_1, ..., H_k, of hypotheses. A rejection rule in this setting amounts to a procedure for choosing the stopping point k, corresponding to a particular selected model. We will discuss a multiple hypothesis testing procedure for FDR control in this setting. We will also introduce recent results for goodness-of-fit testing for clustering and the graphical lasso as an illustration of this approach.

■ WB16

105A-MCC

Optimal Learning and Optimization via Simulation

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Peter Frazier, Cornell University, 410 Thurston Ave, Ithaca, NY, United States, pf98@cornell.edu

1 - Optimal Learning With Discrete Priors

Weidong Han, Princeton University, whan@princeton.edu

We consider an optimal learning problem with a random parameter following a discrete prior distribution. We formulate the problem into a dynamic program, and propose several applicable polices. We consider both finite-horizon and infinite-horizon problems, provide a lower bound on a well-known heuristic policy in the former case, and prove asymptotic convergence properties of the proposed policies in the latter case. We also present comparisons against an optimal learning policy for selected problem instances. Empirical experiments show that the proposed policies achieve near-optimal performances.

2 - Parallel Knowledge Gradient For Global Optimization Of Expensive Functions

Jian Wu, Cornell University, Ithaca, NY, 14850, United States, jw926@cornell.edu, Peter Frazier

In this talk, we will introduce parallel knowledge gradient (pKG) algorithm for batch Bayesian optimization. The method chooses to evaluate the one-step Bayes optimal batch of points. We demonstrate empirically that the method can find global minima significantly faster than previous batch Bayesian Optimization methods on both synthetic functions and tuning hyperparameters of complex machine learning algorithms. Especially, the method provides most value in noisy setting.

3 - Secant Tangents-averaged Stochastic Approximation (STAR-SA)

Marie Chau, Virginia Commonwealth University, mchau@vcu.edu

We present new theoretical results for Secant Tangents-AveRaged stochastic approximation (STAR-SA) and extend it to higher dimensions using simultaneous perturbation stochastic approximation. Under a setting where both direct and indirect gradients are available, STAR-SA and STAR-SPSA (for the multidimensional case) combine direct and indirect gradients using a convex weight. We derive deterministic weights to minimize the MSE of the gradient and of the estimate, both of which are lower than the classical Robbins-Monro and Kiefer-Wolfowitz SA methods. We prove convergence, show asymptotic normality, and investigate their empirical performance against well-known SA algorithms.

4 - Optimal Learning For Nonlinear Parametric Belief Models With Continuous Alternatives

Xinyu He, Princeton University, Princeton, NJ, United States, xinyuhe@princeton.edu, Warren B Powell

We consider the optimal learning problem for nonlinear parametric belief models, where our goal is to find the optimal alternative through a series of noisy and expensive measurements. This problem has been studied when the number of alternatives is finite. Our work presents an algorithm that extends the optimal learning framework to the case with continuous alternatives. Experiments show that our algorithm on the continuous framework exhibits significant performance improvements, especially in higher dimensions.

■ WB17

105B-MCC

Distributed Consensus Optimization

Sponsored: Optimization, Nonlinear Programming

Sponsored Session

Chair: Necdet Serhat Aybat, The Pennsylvania State University, 310 Leonhard Building, University Park, PA, 16802, United States, nsa10@psu.edu

1 - DQM: Decentralized Quadratically Approximated Alternating Direction Method Of Multipliers

Aryan Mokhtari, University of Pennsylvania, 200 South 33rd Street, Room 203 Moore Building, Philadelphia, PA, 19104, United States, aryanm@seas.upenn.edu, Wei Shi, Qing Ling, Alejandro Ribeiro

The decentralized alternating method of multipliers (DADMM) is a well-established iterative method for solving consensus optimization problems; however, implementation of DADMM requires solving an optimization subproblem at each iteration for each node which can be computationally costly. We propose a decentralized quadratic approximation of ADMM (DQM) that reduces the computational complexity of DADMM by minimizing a quadratic approximation of the objective function. We show that DQM converges to the optimal argument at a linear rate which is identical to the convergence rate of DADMM. Moreover, as time passes the coefficient of linear convergence for DQM approaches the one for DADMM.

2 - A Geometrically Convergent Method For Distributed Optimization Over Time-varying And Directed Graphs

Wei Shi, Postdoctoral Research Associate, Coordinated Science Laboratory, University of Illinois at Urbana-Champaign, Urbana, IL, 61801, United States, wilburs@illinois.edu, Angelia Nedich, Alex Olshevsky

In this presentation, we introduce a class of first-order algorithms, referred to as DIGing and its variants, for distributed optimization over time-varying and/or directed graphs. The algorithms employ fixed step-sizes and, yet, drives all the agents' iterates to a global and consensual minimizer. Under the strong convexity assumption, we show that the algorithms all converge at some explicit global R-linear (geometric) rates as long as the step-sizes are no greater than some explicit bounds. We also show that the rate for DIGing scales polynomially in the number of agents. Numerical experiments demonstrate the efficacy of the introduced algorithms and validate our theoretical findings.

3 - Distributed Admm-like Methods For Cooperative Multi-agent Optimization Over Conic Constraints

Erfan Yazdandoost Hamedani, Penn State University, Department of Industrial Engineering, 310 Leonhard Bldg. University Park, State College, PA, United States, evy5047@psu.edu, Necdet Serhat Aybat

We consider the sharing problem over an undirected (dynamic) network of agents, where only those agents connected by an edge can directly communicate. The objective is to minimize the sum of agent-specific composite convex functions subject to a conic constraint coupling all agents' local decisions. An ADMM-like primal-dual distributed algorithm is proposed. We examine the convergence rate in terms of suboptimality, and infeasibility; study the effect of underlying network topology on the rates; and show how to extend this method to handle communication networks with time-varying topology.

WB18

106A-MCC

DMA General

Contributed Session

Chair: Jose M. Merigo, Full Professor, University of Chile, Av. Diagonal Paraguay 257, Santiago, 8330015, Chile, jmerigo@fen.uchile.cl

1 - Cyber Attacker Choices In A Three-way Behavioral Security Game

Jinshu Cui, University of Southern California, 3620 McClintock Avenue, # 501, Los Angeles, CA, 90089, United States, jinshucu@usc.edu, Richard S John, Heather Rosoff

This study focuses on cyber attackers' choices in a security game involving attackers, defenders, and users. An attacker can choose to attack the defenders or the users. Deterrence is measured by the third option of the attacker - no attack. Conversely, the defenders and users can select either a standard or enhanced security level. We conducted a behavioral experiment in which 497 subjects played as attackers over 30 rounds of the game and were incentivized based on their performance. Defenders' and users' joint strategies were manipulated. Results indicated that subjects were more likely to hack database when EV(database) was higher, and were more deterred when both EVs were negative.

2 - Sequential Decisions Following Near Misses

Jinshu Cui, University of Southern California, 3620 McClintock Avenue, # 501, Los Angeles, CA, 90089, United States, jinshucu@usc.edu, Richard S John

Prior near miss experiences have been identified as a contributing factor in responses to risks of disasters. Researchers found a near miss event could lead individuals to interpret the risk as either "vulnerable" or "resilient", while had no conclusions on what could lead to different interpretations. The current study hypothesizes that responses to near miss events are determined by psychological distance. We conducted a behavioral experiment in which 100 subjects were exposed to a sequence of 20 events. Results indicated that subjects were less likely to engage in protective measures when a near miss event is psychological distant to the decision maker and when more near misses were experienced.

3 - Column Generation For Airline Crew Rostering: Practical Considerations In A Production System

Andreas Westerlund, Optimization Expert, Jeppesen, Odinsgatan 9, Gothenburg, 411 03, Sweden, andreas.westerlund@jeppesen.com

Jeppesen's crew rostering optimizer is today used by around 40 airlines to produce monthly schedules for their flying crew. The optimizer allows the user to configure various kinds of business logic and it solves monthly schedules for problem instances with above 20k crew-members and 100k activities.

In this presentation we will start by defining the rostering optimization problem in general. Then we will describe our column generation framework that is used to deal with it. Finally we will look at the specific problem of having an efficient fixing process in the presence of high degree of symmetry.

4 - The Internet Of Things: Preliminary Research Results

Gary D Scudder, Vanderbilt University-OGSM, 401 21st Avenue South, Nashville, TN, 37203-2422, United States, gary.scudder@owen.vanderbilt.edu, Sal March

In this research, we look at the emerging field of the Internet of Things and develop a research agenda for managerial issues. In addition, we will discuss research in IoT for preventive maintenance. IoT is shown to be beneficial in reducing costs and increasing profits.

5 - The Ordered Weighted Average Division

Jose M. Merigo, Full Professor, University of Chile, Av. Diagonal Paraguay 257, Santiago, 8330015, Chile, jmerigo@fen.uchile.cl, Sigifredo Laengle, Ronald R Yager

The ordered weighted average division is an aggregation operator that aggregates a set of divisions providing a parameterized family from the minimum to the maximum division. The work considers a wide range of particular cases including the average division, the median division and the weighted average division. It also develops some further extensions including the weighted ordered weighted average division and the generalized weighted ordered weighted average division. This approach can be applied in a wide range of problems dealing with the aggregation of divisions including decision making and computational intelligence.

WB19

106B-MCC

Future of Disease Modeling in Clinical and Public Health

Sponsored: Computing

Sponsored Session

Chair: Zeynep Ertem, University of Texas-Austin, University of Texas-Austin, Austin, TX, United States, zeynepsertem@gmail.com

1 - Pandemic Influenza Preparedness

David Morton, Northwestern University, david.morton@northwestern.edu

We describe three data-driven optimization models that inform resource allocation in preparing for an influenza pandemic. In particular, we optimize: the mix of central and regional stockpiles of ventilators, accounting for stochastic peak-week demand; the spatial allocation of antivirals, considering under-insured populations and hard-to-reach locations; and, the spatial allocation of multiple types of vaccines with differing suitability for each prioritized target population. We discuss challenges and extensions.

2 - Role Of Operations Research In Chronic Disease Management

Mariel Lavieri, University of Michigan, lavieri@umich.edu

I discuss past and future challenges encountered in managing chronic diseases.

3 - Mathematical Models for Cancer Screening

Fatih Safa Erenay, University of Waterloo, ferenay@uwaterloo.ca

My talk will provide an overview of models proposed for the optimal cancer screening problem from societal and personal perspectives. I will start with the classical models that schedule screening interventions over a planning horizon, and describe the evolution of the literature towards more dynamic, partially observable, and personalized models over examples from colorectal cancer screening. The talk will also highlight the current challenges and recent trends in cancer screening literature.

WB20

106C-MCC

Assets and Structured Hedges in Energy Markets Severe Incompleteness and Methods for Dealing with It

Invited: Tutorial

Invited Session

Chair: Glen Swindle, Scoville Risk Partners, 405 Lexington Avenue, 21st Floor, New York, NY, 112, United States, glenswindle@scovilleriskpartners.com

1 - Assets And Structured Hedges In Energy Markets – Severe Incompleteness And Methods For Dealing With It

Glen Swindle, Scoville Risk Partners, 405 Lexington Avenue, 21st Floor, New York, NY, 12, United States, glenswindle@scovilleriskpartners.com

Risks in energy markets are inherently high dimensional due to large numbers of delivery locations and physical attributes, stochastic demand, and seasonality. In contrast, the number of instruments with sufficient liquidity to support hedging activities is relatively small, and has never been able to span the set of risks sustained by market participants. This mismatch has spawned an interesting and arguably unique set of challenges related to the valuation and hedging of energy portfolios. Here we will survey examples of such, including variable quantity swaps, generation and structured asset hedges.

■ WB21

107A-MCC

Emerging Methods for Healthcare Analytics and Visualization

Sponsored: Health Applications

Sponsored Session

Chair: Rahul C Basole, Georgia Institute of Technology, 85 Fifth Street NW, Atlanta, GA, 30332, United States, basole@gatech.edu

1 - A Semi-supervised Learning Approach To Enhance Health Care Community-based Question Answering

Papis Wongchaisuwat, Northwestern University, Evanston, IL, United States, papiswongchaisuwat2013@u.northwestern.edu, Diego Klabjan, Siddhartha R Jonnalagadda

Community-based Question Answering (CQA) sites play an important role in addressing health information need. We developed an algorithm to automatically answer health-related questions based on past questions and answers. Our algorithm uses information retrieval techniques to identify candidate answers from resolved QA. In order to rank these candidates, we implemented a semi-supervised learning algorithm that extracts the best answer to a question. On our dataset, the semi-supervised learning algorithm has an accuracy of 86.2% while UMLS-based (health-related) features used in the model enhance the algorithm's performance by approximately 8%.

2 - Visual Analytics For Population Level Health Analysis

Rahul C Basole, Georgia Institute of Technology, 85 Fifth Street, Atlanta, GA, 30332, United States, basole@gatech.edu, Mark L. Braunstein, Hyunwoo Park, Dhruv Mutturaju, Myung Choi, Richard Starr

We present the design, implementation, and use cases of a FHIR-centric population health analysis and visualization platform.

3 - Double Sided Network Externalities In Healthcare Information Exchanges

Emre Muzaffer Demirezen, School of Management, Binghamton University, School of Management Binghamton University, State University of New York AA278, Binghamton, NY, 13902, United States, edemirezen@binghamton.edu, Subodha Kumar, Arun Sen

Based on our interactions with different healthcare information exchange (HIE) providers, we develop models to study participation levels and sustainability of HIEs. We examine how heterogeneity among healthcare practitioners (HPs) affects participation of HPs in HIEs. We find that, under certain conditions, low-gain HPs choose not to join HIEs. Hence, we explore several measures that can encourage more participation in HIEs and find that it might be beneficial to: (i) establish a second HIE in the region, (ii) propose more value to the low-gain HPs, or (iii) offer or incentivize value-added services. We present several other interesting and useful results.

■ WB22

107B-MCC

Empirical Analysis of Resource Utilization

Sponsored: Health Applications

Sponsored Session

Chair: David Anderson, CUNY Baruch, 55 Lexington Ave, New York, NY, 10010, United States, davidrybberganderson@gmail.com

1 - Comprehensive Prediction Models For Colorectal Cancer Mortality

David Anderson, CUNY Baruch, David.Anderson@Baruch.Cuny.Edu

Having accurate, unbiased prognosis information can help patientsand providers make better decisions about what course of treatment to take.Using a comprehensive dataset of all colorectal cancer patients in California, wegenerate predictive models that estimate short-term and medium-term survivalprobabilities for patients based on their clinical and demographic information.Our study addresses some of the contradictions in the literature about survival rates and signicantly improves predictive power over the performance of anymodel in previously published papers.

2 - Slow First, Fast Later: Temporal Speed-up In Service Episodes Of Finite Duration

Aditya Jain, CUNY Baruch, Aditya.Jain@baruch.cuny.edu, Sarang Deo

Many services comprise repeated episodes of finite duration wherein customers must be served before the end of that episode leading to non-stationary operational dynamics. We hypothesize and empirically validate (using data from a high volume tertiary care outpatient department) the presence of a ``slow first, fast later" work speed pattern in such environments. This pattern allows sufficient build-up of inventory earlier for more efficient utilization of faster work speed later. As a natural corollary of this pattern, we also find that greater anticipated workload, which causes faster inventory build-up, leads to a greater increase in work speed earlier during the service episode.

3 - The Impact Of Reminder Calls For A Pediatrics Practice

Kiatikun Louis Luangkesorn, Assistant Professor, University of Pittsburgh, 1028 Benedum Hall, 3700 Ohara St, Pittsburgh, PA, 15261, United States, lluangkesorn@pitt.edu, Tricia Pil

Primary care practices often use reminder phone calls to reduce missed appointments. The same factors that make reminder calls useful can also be used for improving patient engagement in the form of well child visits and vaccinations. However, studying the impact in a clinical setting can be difficult because it may not be practical or ethical to conduct random control trials on patients. We present two studies, one in the context of a series of interventions to inprove human papillomavirus (HPV) vaccination and to increase the fraction of patients who meet the recommendation of annual well child visits within a multi-practice pediatrics network.

■ WB23

108-MCC

Optimal Treatment & Screening of Chronic Care Patients

Sponsored: Health Applications

Sponsored Session

Chair: Huaiyang Zhong, Stanford University, 475 Via Ortega, Stanford, CA, 94305, United States, hzhong34@stanford.edu

1 - Optimal Statin Therapy Plan For Diabetic Patients

Saeideh Mirghorbani, University of Alabama, Tuscaloosa, AL, United States, smirghorbani@crimson.ua.edu

The importance of cardiovascular risks in diabetic patients has been emphasized because of their high cardiovascular mortality rate. Statins are a class of medicines used to lower blood cholesterol levels and mitigate the risk of heart problems. In this research, we address the optimal time to initiate and terminate statin therapy considering patient adherence as well as the influence of statin side-effects. We develop a finite horizon, discounted Markov decision process in which patients transition through health states. The objective is to maximize the expected quality-adjusted life years.

2 - Fairness In Down Syndrome Screening

Jia Yan, Georgia Institute of Technology, Atlanta, GA, United States, jyan40@gatech.edu, Turgay Ayer, Pinar Keskinocak

Detection and false positive rates of prenatal screening for Down syndrome depend on the selected risk cutoff values. In current practice, one-size-fit-all type cut off values are being used, which may lead to suboptimal outcomes and unfairness among different age groups. We first propose a Monte Carlo simulation model to capture prevalence and test outcomes in the population. Then, we combine this simulation model with an optimization modeling framework to identify the optimal age-specific risk cutoff values by taking fairness among different age groups into account. Our findings indicate that age-specific cutoff values significantly improve health outcomes and fairness.

3 - Improving The HIV Care Cascade Via Mental Health Interventions

Huaiyang Zhong, Stanford University, hzhong34@stanford.edu

The UNAIDS' 90-90-90 targets having 90% of HIV-infected people aware of their status, 90% of diagnosed HIV-positives on antiretroviral therapy (ART), and 90% of those on ART virally suppressed. In most sub-Saharan African countries, these percentages are far lower. Developing effective and cost-effective approaches to improve the HIV care cascade is critical. We focus on one potential opportunity for improving the HIV care cascade: the provision of antidepressant therapy (ADT) for HIV-infected individuals with depression.

WB24

109-MCC

Optimization in Radiation Therapy

Sponsored: Health Applications

Sponsored Session

Chair: Omid Nohadani, Northwestern University, 2145 Sheridan Road, Room M233, Evanston, IL, 60208-3119, United States, nohadani@northwestern.edu

1 - Designing Radiation Therapy Criteria With Data-driven Robust Optimization

S. Nastaran Shojaei, Northwestern University, 2145 Sheridan Road Room C210, Evanston, IL, 60208, United States, nastaranshojaei@u.northwestern.edu, Seyed M.R. Iravani, Omid Nohadani

Radiation therapy planning is an iterative process of optimization and evaluation, making it both time consuming and not reproducible. Often feasibility is not attainable for which planners relax some of the criteria. We present a data-driven robust optimization approach that can provide a new and less sensitive set of criteria which warrant high quality plans despite some constraint violations within a realistic range. A large set of clinical data is used to inform the method.

2 - Multicriteria Optimization For Brachytherapy Treatment Planning

Victor Wu, University of Michigan, vwwu@umich.edu, Marina Epelman, Michael Herman, Kalyan Pasupathy, Mustafa Sir, Christopher Duefel

High Dose Rate Brachytherapy (HDR-BT) has become a popular mode of radiation therapy for its ability to deliver high dose localized to the tumor, resulting in lower risk of side effects. The goal is to allow the physician to explore trade-offs via an intuitive GUI with respect to multiple dose-volume criteria (also known as value-at-risk) among high quality plans. The underlying problem is non-convex and therefore is not practically solvable. The desire to generate plans quickly, i.e., within the 30 minutes while the patient is under anesthesia, motivates solving convex approximations (based on conditional value-at-risk) instead. Our method is retrospectively tested on various cancer sites.

3 - Automated IMRT Treatment Planning For SBRT Paraspinal Case Using Prioritized Optimization

Masoud Zarepisheh, Assistant professor/attending, Memorial Sloan Kettering Cancer Center, New York, NY, United States, zarepism@mskcc.org, Linda Hong, James Mechalakos, Margie Hunt, Gikas Mageras, Joseph Deasy

Treatment planning is a patient specific and time consuming task, with plan quality heavily dependent on planners' skills. In this study, we are employing prioritized optimization (PO) to automate the planning process. PO is a step-wise technique where the highest priority goal (e.g., tumor coverage) is optimized first. At each iteration step the previous objectives are turned into constraints and a new goal is optimized. We integrate our optimization package with the commercial treatment planning system called Eclipse.

4 - Time-dependent Radiation Therapy Optimization

Arkajyoti Roy, Bowling Green State University, 4154 Moser Ln, Bowling Green, OH, 43551, United States, aroy@bgsu.edu, Omid Nohadani

Low oxygen concentration reduces the radio-sensitivity of cells. Re-oxygenation leads to temporal changes during treatment. However, the re-oxygenation trajectory is unpredictable, leading to uncertain radio-sensitivity. We develop a time-dependent uncertainty set that models the evolution of radio-sensitivity. To reduce over conservativeness at later time-periods, a two-stage robust optimization approach is proposed that can incorporate such uncertainties. For a clinical prostate cancer case, the robust method is compared to current clinical methods.

WB25

110A-MCC

Logistics II

Contributed Session

1 - Coordination Between Shipper And Carrier In City Logistics

Gitae Kim, Hanbat National University, Dept. of Industrial Management Engineering, School of Engineering, Daejeon, 34158, Korea, Republic of, gitaekim@hanbat.ac.kr, Juncheul Park

In a decentralized system in city logistics, two stakeholders such as shipper and carrier have different their own objectives. Coordination is necessary to obtain the win-win strategy for two parties. This paper investigates contract models between a shipper and a carrier to achieve the coordination in city logistics. Quantity flexibility (number of transportation services) and revenue sharing contract types are formulated by stochastic programming model using options. From the experimental results, we find the efficient frontier for two stakeholders.

2 - An Optimization Framework For Simultaneous Space Logistics Mission Planning And Spacecraft Design

Hao Chen, University of Illinois at Urbana-Champaign, 310 E. Springfield Ave, Champaign, IL, 61820, United States, hchen132@illinois.edu, Koki Ho

This paper proposes a network modeling and optimization method for human space exploration campaign-level mission planning. The interplanetary space is discretized into nodes and the space missions are modeled as generalized multi-commodity network flows, where payload, propellant, and spacecraft are considered as separate commodities. This problem results in a mixed-integer nonlinear programming, and we solve this problem with branch-and-bound and gradient-based method (e.g., SQP). The proposed framework enables us to optimize the space mission and its spacecraft design concurrently at a mid-fidelity.

WB26

110B-MCC

Information Systems I

Contributed Session

1 - Designing Referral Policies For Optimal Membership Growth: A Real World Randomized Experiment In An Exclusive Online Dating Site

Rodrigo Belo, Assistant Professor, Erasmus University, Mandeville Building T09-20, Burgemeester Oudlaan 50, Rotterdam, 3062 PA Rotterdam, Netherlands, rbelo@rsm.nl, Ting Li

We use data from a real-world randomized experiment in an exclusive online dating site to study the effect of member-get-member referral policies on membership growth and online user activity. We find that stricter policies, i.e., policies that require members to invite more friends so that they can continue using the service for free, are more effective at fostering growth in multiple dimensions, including invitations, online user activity, and paid memberships. We discuss the mechanisms that may be at play and implications for business.

2 - Agent Based Simulation For Social Support Networks

M. Gisela Bardossy, University of Baltimore, 1420 N. Charles Street, Baltimore, MD, 21201, United States, mbardossy@ubalt.edu, Stefano Za, Eusebio Scornavacca

Support networks have benefited from digital and networking tools. In an interconnected world, people depend on each other to achieve their personal and group goals. We model this inter dependency using agent based simulation and test various hypothesis regarding rules of engagement, dissipation of information in the network, discrepancy between reality and beliefs and the updating and correction of beliefs. This information can inform the design of social platforms as the implications of choice characteristics are better understood. Some preliminary results are analyzed and discussed.

3 - Multi-homing Within Platform Ecosystems: The Strategic Role Of Human Capital

Vijayaraghavan Venkataraman, Georgia Institute of Technology, 800 West Peachtree NW, Atlanta, GA, 30308, United States, vijayaraghavan.venkataraman@scheller.gatech.edu, Marco Ceccagnoli, Chris Forman

Even though there has been considerable research on platform ecosystems, prior literature has focused mostly on the platform owners and their strategies. In this paper, I look at the complementor firms, instead, and try to understand why the incidence of multi-homing, a strategy in which a complementor firm chooses to join multiple platforms rather than one, is often quite low. I build a capability framework based on human capital and test it on micro-level data from the ERP platform ecosystem. The study has important implications for our understanding of platform growth and innovation and contributes toward the literature on platform ecosystems as well as strategic human capital.

4 - The Impact Of Sharing Markets On Product Durability

Maryam Razeghian, Ecole Polytechnique Federale de Lausanne, ODY 4.16, Station 5, Lausanne, 1015, Switzerland, maryam.razeghian@epfl.ch, Thomas A. Weber

This paper studies the effects of sharing markets on the prices for new products and on product design in terms of durability. In a dynamic economy with overlapping generations, consumers take strategic purchasing decisions, anticipated by a durable-goods monopolist. Without sharing, the optimal durability increases in the production cost. In the presence of sharing, the firm prefers to limit durability for low-cost products, effectively disabling a secondary sharing market. However, all else equal, a peer-to-peer economy never decreases the incentives to provide durability.

5 - Are All Data Thieves Created Equal? An Empirical Analysis Of Customer Response To Identity Theft

John N Angelis, Elizabethtown College, 100 Farmhouse Lane, Mountville, PA, 17554, United States, angelisj@etown.edu, Joseph C Miller

The popular press tends to report on data hacking and identity theft instances as if all such crimes are relatively equal in business impact and public perception. To challenge this assertion, we exposed independent study panels to four unique recent real-world instances of identity theft. Analysis reveals that the extent to which thieves, the business, and customers are blamed for their role in the crime is highly dependent on both parameters of the localization of the breached firm and the uniqueness of the identity of the customers affected, as well as perceived cleverness of said thieves. In certain cases, the public will assign equivalent blame to both affected customers and the hacked business.

■ WB27

201A-MCC

Information and Consumer Behavior in Supply Chain Management

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Hyoduk Shin, UC-San Diego, La Jolla, CA, United States, hdshin@ucsd.edu

1 - Loss Aversion And The Uniform Pricing Puzzle For Media And Entertainment Products

Javad Nasiry, Hong Kong University of Science and Technology-HKUST, nasiry@ust.hk

The uniform pricing puzzle for vertically differentiated media and entertainment products (movies, books, music, mobile apps, etc.) is that a firm with market power sells high- and low-quality products at the same price even though quality is perfectly observable and price adjustments are not costly. We resolve this puzzle by assuming that consumers have an uncertain taste for quality and accounting for consumer loss aversion in monetary and consumption utilities. The novelty of our approach is that the so-called reference transactionis endogenously set as part of a “personal equilibrium” and is based only on past purchases of same-quality products.

2 - Generalized Reverse Auctions: Efficiency And Credibility Under Information Asymmetry

Hedayat Alibeiki, McGill University, 1001 Sherbrooke Street West, Desautels Faculty of Management, Montreal, QC, H3A 1G5, Canada, hedayat.alibeiki@mail.mcgill.ca, Mehmet Gumus

Non-price factors such as product quality and reliability can be even more important than bidding prices for the buyers when selecting the winner of an e-Auction. In practice, buyers usually evaluate and assign an originally-private “quality score” to each supplier that determines the relative position of the supplier toward its competitors. In this paper, we study whether or not and in what fashion the buyer can credibly share suppliers’ quality scores with them.

3 - Incentives For Sharing Cyber-security Breaches Among Competing Firms

Noam Shamir, Tel Aviv University, nshamir@post.tau.ac.il

Presidential Executive Order 13691, which was issued by President Obama, characterizes cyber threats as a “national emergency”. This executive order calls for increased cooperation and information sharing on such threats. A main concern regarding this initiative is related to the companies’ incentives to pool cyber threat information. Although policy makers claim that the companies will benefit from a shared database of threat assessment information, each company must find it beneficial to share its cyber-threat information. In this work we evaluate the incentives of companies that operate in a competitive environment to share such information.

■ WB28

201B-MCC

Product Recalls

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Harish Krishnan, University of British Columbia, Vancouver, BC, Canada, krishnan@sauder.ubc.ca

Co-Chair: Juan Camilo Serpa, Assistant Professor, McGill University, 1001 Rue Sherbrooke O, Montreal, QC, H3A 1G5, Canada, juan.serpa@sauder.ubc.ca

1 - Cover-up Of Safety Hazards: Delays In Voluntary Product Recalls

Woonam Hwang, Assistant Professor, HEC Paris, Paris, France, hwang@hec.fr, Soo-Haeng Cho, Victor DeMiguel

Product safety regulators often have to rely on manufacturers’ voluntary disclosure of information when investigating product defects, because manufacturers have better information about safety hazards through internal testing and warranty claims. However, manufacturers may not always truthfully report all safety hazard information. For instance, several automakers including GM and Toyota have been recently accused of deliberately hiding safety hazards from regulators and delaying product recalls, putting the public in danger. In this paper, we investigate how regulators can induce manufacturers to truthfully report any safety issues in a timely manner.

2 - Board Composition And Firm Responsiveness To Product-harm Crises

George Ball, Indiana University, Kelley School of Business, gpball@indiana.edu, Kaitlin Wowak, Corinne Post

Even though firms are subjected to the same regulatory, consumer protection, and market pressures, they vary considerably in how swiftly they issue recalls in product-harm situations. In this study, we explore how firm responsiveness to product recalls is impacted by several Board of Director characteristics, including female board representation and board independence. We study these questions using over 5,000 recalls from a 12-year panel covering all recalls in industries regulated by the U.S. Food and Drug Administration (e.g., Food, Medical Devices, and Pharmaceuticals).

3 - Why Do Automakers Initiate Recalls? A Structural Econometric Study

Ahmet Colak, Northwestern University, Evanston, IL, United States, a-colak@kellogg.northwestern.edu, Robert Louis Bray

We model a manufacturer’s and regulator’s joint recall decisions as a dynamic discrete choice game. We estimate our model with 14,124 U.S. auto recalls and 976,062 defect reports over the period 1994—2015. We find that (i) automakers initiate recalls mainly to avoid field failure costs, and (ii) automakers don’t preempt the regulator’s interventions in 86% of our sample.

■ WB29

202A-MCC

Managing Responsibility in Supply Chains

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Jing-Sheng Jeannette Song, Duke University, Durham, NC, United States, jssong@duke.edu

1 - Cooperative Approaches To Managing Social Responsibility In Supply Chains: Joint Auditing And Information Sharing

Soo-Haeng Cho, Carnegie Mellon University, soohaeng@andrew.cmu.edu, Xin Fang

This paper investigates two cooperative approaches of firms’ managing social responsibility violations of suppliers: auditing a common supplier jointly or sharing independent audit results with other firms. We develop a model based on a cooperative game in partition function form, and show that: (1) competing firms have incentives to cooperate when the negative externality of one firm’s social responsibility violation on other firms is high; and (2) neither cooperative approach necessarily improves social responsibility, especially when one firm can benefit from others’ social responsibility violations (i.e., the positive externality is high).

2 - Improving Supplier Compliance Through Joint And Shared Audits With Collective Penalty

Prashant Chintapalli, UCLA, Los Angeles, CA, United States, prashant.chintapalli.1@anderson.ucla.edu, Felipe Caro, Kumar Rajaram, Christopher S Tang

Motivated by the Accord on Fire and Building Safety in Bangladesh we study the effectiveness of buyer consortiums in supply chains . Using a game-theoretic model, we show that while a consortium improves supplier compliance and buyers' profits, it puts supplier at a disadvantage. We identify a few sufficient conditions for the existence of a Pareto improving transfer-payment mechanism that a buyer consortium can offer the supplier.

3 - Testing By Competitors In Enforcement Of Product Standards

Terry Taylor, University of California Berkeley, Berkeley, CA, 94720, United States, taylor@haas.berkeley.edu, Erica Plambeck

This paper explores a novel mechanism to encourage compliance with and identify violations of safety and environmental standards: Firms testing competitors' products.

■ WB30

202B-MCC

Management of Critical Care

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Vedat Verter, McGill University, Montreal, QC, Canada, vedat.verter@mcgill.ca

Co-Chair: Michael Klein, McGill University, Montreal, QC, Canada michael.klein2@mail.mcgill.ca

1 - Specialist Care In Rural Hospitals: From Emergency Department Consultation To Inpatient Ward Discharge

Michael G. Klein, McGill University, Montreal, QC, Canada, michael.klein2@mail.mcgill.ca, Vedat Verter, Hughie F. Fraser, Brian G. Moses

Patients often wait in the Emergency Department for admission to inpatient wards, resulting in crowding and adverse health outcomes. In rural hospitals, Internal Medicine Specialists (Internists) take on a dual role as ICU physician and Internist on call. We study the workflow decisions of Internists at two hospitals in Nova Scotia, Canada. We propose a stochastic dynamic programming model to analyze current practice and identify strategies for improvement.

2 - Effects Of Admission And Discharge Delays On Intensive Care Unit Patient Outcomes

Elisa Long, Assistant Professor, UCLA Anderson School of Management, Los Angeles, CA, 90095, United States, elisa.long@anderson.ucla.edu, Kusum Mathews

Patients admitted to the ICU often endure excessive delays for bed assignment due to capacity shortages, and prolonged ICU boarding following receipt of care. Using 2 years of data for 2 academic hospitals, we estimate that each hour of admission delay increases in-hospital mortality by 4%. We also examine whether simultaneous ICU and ward occupancy surges affect length of stay. Unlike prior studies we find that service time (when critically ill patients are stabilized) is unaffected by occupancy, yet ICU boarding accelerates during periods of high ICU occupancy and slows when ward occupancy is high. We find no adverse effects of occupancy on ICU bouncebacks or 30-day readmissions.

3 - A Delay-differential Equation Model Of An Intensive Care Unit

Eman Almehdawe, University of Regina, Regina, SK, Canada, Eman.Almehdawe@uregina.ca, Armann Ingolfsson

We investigate a fluid approximation model of an intensive care unit, in which patients are discharged at an adjustable speed, which influences the proportion of patients that are readmitted after a delay. We formulate the model as a delay-differential equation. We study the transient and steady-state behavior of the system occupancy in four different regimes and we obtain conditions under which speedup reduces average occupancy.

■ WB31

202C-MCC

Service Operations in a Modern Economy

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Serguei Netessine, INSEAD, 1 Ayer Rajah Avenue, Singapore, 138676, Singapore, serguei.netessine@insead.edu

1 - Ethics, Bounded Rationality And Ip Sharing In Knowledge-based Outsourcing

Manu Goyal, University of Utah, Salt Lake City, UT, United States, manu.goyal@eccles.utah.edu, Krishnan S Anand

Our dynamic model of knowledge-based outsourcing integrates (i) its major impediments— incomplete contracts, moral hazard and adverse selection, and (ii) its major facilitators— ethics, IP sharing and reputations. We show that, under bounded rationality, an ethical firm can obtain strictly greater profits than a profit-maximizing firm unconstrained by ethics. We find a novel explanation, rooted in ethics, for IP sharing, which arises as a strategic imperative even when it lowers firms' profits. Our results explain why (a) a commitment to ethics can boost profits, (b) IP sharing is widespread, and (c) knowledge-based outsourcing is booming despite several formidable impediments.

2 - Accurate Estimation Of Retail Store Traffic From People Counters To Achieve Better Conversion

Anup Hanamant Walvekar, INSEAD, anup.walvekar@insead.edu

Conversion rate is an important KPI for retail store manager that captures fraction of sales opportunities that store was able to capture. As group of customers seldom have multiple transactions, #groups of customers visiting the store is more appropriate measure of sales opportunities than #customers. #Groups of customers visiting the store is not readily available from traffic counters. In this paper, we model the customer arrival process. We derive five different estimators of #groups of customers using customer arrival data and analyse their performance in different traffic profiles.

3 - Mitigating Digital Discrimination With Reviews In The Sharing Economy: Field Evidence From Airbnb

Dennis Zhang, Kellogg School of Management, Northwestern University, Evanston, CA, 60201, United States, zjj1990228@gmail.com, Jun Li, Ruomeng Cui

This project studies how agents may discriminate each other based on demographic information in the sharing economies. We conduct several field experiments on the Airbnb platform to quantify the impact of such discrimination on the platform's revenue and provide several recommendations to mitigate it.

4 - Impact Of Operational Risks In Financial Organizations

Yuqian Xu, New York University, 44 West 4th Street, New York, NY, 10012, United States, lillian.xyq@gmail.com, Fangyun Tan, Serguei Netessine

We analyze extensive data from a Chinese bank which contains information on operational risks in retail banking. We find that workload affects incidence of risks in this service setting.

■ WB32

203A-MCC

Risk Analysis II

Contributed Session

Chair: David Menachof, Peter Thompson Chair in Port Logistics, The University of Hull, Logistics Institute, Hull University Business School, Kingston upon Hull, HU6 7RX, United Kingdom, d.menachof@hull.ac.uk

1 - Macroscopic Look At The Equity Market

Abdullah Alshelahi, PhD Student, University of Michigan, 2410 Leslie Circle, Ann Arbor, MI, 48105, United States, shelahi@umich.edu, Romesh Saigal

The aim of this research is to investigate the existence of sensors which may aid in the monitoring of Equity Markets. While the classical approach consists of studying the stock market following the evolution of individual stocks, we use a so-called macroscopic viewpoint by considering a global view of the equity markets. This way, we see the market within the context of the principles of mass and momentum conservation and the variables such as density, pressure, average velocity, etc. We can then define `sensors' that can monitor some of these variables in the market. Finally, we propose a model that predicts and provides alerts in the case of abnormal events.

2 - The Analytics Of A Business Traveler's Alert System

Fletcher Lu, Associate Professor, University of Ontario Institute of Technology, Faculty of Business and IT, 2000 Simcoe Street North, Oshawa, ON, L1H 7K4, Canada, fletcher.lu@uoit.ca

An insurance company is minimizing its business clients' exposure to dangerous and risky environments by providing a dynamic mobile travel alert system. I present the analytics of this alert system, which gathers world-wide current information using big data analytics to rank alerts regarding dangerous situations and matches the alert information to clients' relevant travel information such as location, travel time, health issues, etc. to send to the clients. Included in the system's alerts are safety recommendations and instructions.

3 - Risk Sharing Between The Insured And The Insurer

Christopher Gaffney, Drexel University, 3141 Chestnut St, LeBow College of Business, Philadelphia, PA, 19104, United States, ctg39@drexel.edu

Risk reduction is a key benefit of insurance. We derive many of the properties that govern the way in which risk is shared, with a particular focus on the properties of insurer and insured variance and covariance. Additionally, we consider the conception of optimal risk sharing, and discuss how an insurance contract can constitute such an arrangement.

4 - Filtering For Risk Assessment Of Interbank Network

Majeed Simaan, PhD Student, RPI, 110 8th Street, Pittsburgh Building, TROY, NY, 12180, United States, simaam@rpi.edu, Aparna Gupta, Koushik Kar

We develop a framework for risk assessment in an interbank network, where banks interact with each other via short-term debt contracts. Focusing on the demand side of liquidity and omitting credit rationing, the framework identifies the interbank network structure and its degree of interconnectedness. Identification is facilitated by a statistical learning procedure that reverse engineers signals (transactions) observed in the interbank market and conducts inference about banks' individual and network-level characteristics. The results from the simulation study undermine the value of integration, even when the network is identified in its simplest forms.

5 - Decision Making Under Uncertainty Using Monte Carlo Simulation: Case Of The Offshore Wind Industry Supply Chain

David Menachof, Peter Thompson Chair in Port Logistics, The University of Hull, Logistics Institute, Hull University Business School, Kingston upon Hull, HU6 7RX, United Kingdom, d.menachof@hull.ac.uk, Negar Akbari

Offshore wind energy has emerged as an emission free source of energy globally, especially across Northern European countries. The projects are now moving further from shore and into deeper waters, which in turn increases the levelized cost of energy (LCOE) and related risks. Furthermore, government support schemes are also subject to uncertainties that influence investment in such projects. A Monte Carlo Simulation model is proposed that aims to consider the risks within the project and suggests ways that risks can be incorporated in the project evaluation phase including port selection. An offshore wind project case is considered and the results are reported.

■ WB33

203B-MCC

Production and Scheduling II

Contributed Session

Chair: Jorge Pereira, Universidad Adolfo Ibáñez, Avda. Padre Hurtado 750, office 216-C, Viña del Mar, 2530852, Chile, jorge.pereira@uai.cl

1 - Sequencing In Mixed Model Assembly Lines

Mary Beth Kurz, Clemson University, 271 Freeman Hall, Clemson, SC, 29634-0920, United States, mkurz@clemson.edu, Anas Alghazi

Mixed model assembly lines are used by manufacturers to satisfy customer's demand for products' customization while keeping the cost down. Since customization is available via different options, some orders that include labor-intensive options require more time to be assembled. In order to minimize work overload throughout the assembly line, a sequencing decision must be taken to sequence customer's orders such that work overload is minimized. We investigate this problem which is tackled in two different ways in the literature; the car sequencing problem and the mixed model sequencing problem.

2 - A Systematic Literature Review Of Rolling Methods For Production Planning

Reha Uzsoy, North Carolina State University, Dept. of Industrial & Systems Engg, 300 Daniels Hall Camps Box 7906, Raleigh, NC, 27695-7906, United States, ruzsoy@ncsu.edu, Rafael Gumaraes Wollmann, Raimundo de Sampaio

The effective implementation of production plans over time requires them to be updated a new information becomes available. This motivates the extensive use of rolling methods in both industry and academia. Rolling methods for production planning can be implemented in different ways and terminology is not always well-defined in the literature. The objective of this paper is to characterize rolling methods, focusing on the quality of the resulting production planning decisions, using the Systematic Literature Review methodology and suggest unifying themes and directions for future research.

3 - A Simulated Annealing Approach For Scheduling Jobs On Identical Parallel Machines

Pravin Tambe, RCOEM, Katol Road, Nagpur, 440013, India, tambepp@gmail.com, Makarand Kulkarni

Identical parallel machine scheduling problem for minimizing the total tardiness is a very important scheduling problem, but there have been many difficulties in solving large size identical parallel machine scheduling problem with too many jobs and machines. Metaheuristic approach like Simulated Annealing(SA) has shown efficient results in solving the combinatorial optimization problem. In this paper, a hybrid approach of a SA algorithm combined with backward-forward heuristic has been proposed for solving identical machine scheduling problem for minimizing the total tardiness. A numerical example of scheduling jobs on identical high pressure die casting machines is presented.

4 - Cross-training Policies For Team Cost And Robustness

Jordi Olivella, Assistant professor, Universitat Politecnica de Catalunya, Avda. Diagonal 647, Barcelona, 08028, Spain, jorge.olivella@upc.edu, David A Nembhard

We assess alternative cross-training policies for work-teams considering cost, and levels of cross training. The policies are assessed with respect to their robustness to demand-mix variation and absenteeism coverage. We employ simulation to examine instances where cross training can be used to help meet a fixed demand scenario, and with instances where cross-training can help to meet demand mix variability. Current results indicate that when minimizing cross-training costs, policies related to equalizing the cross-training level among the workforce, may provide improvement in terms of robustness without additional cost.

5 - The Robust Simple Assembly Line Balancing Problem

Jorge Pereira, Universidad Adolfo Ibáñez, Avda. Padre Hurtado 750, office 216-C, Viña del Mar, 2530852, Chile, jorge.pereira@uai.cl

In this work we consider the simple assembly line balancing problem (SALBP) with uncertainty on the operation time of the tasks. In order to deal with the uncertainty, we put forward a robust version of the problem in which the solution can handle a limited number of disruptions. Several new lower bounds as well as adaptations of the current state-of-the-art procedures for the SALBP are proposed. These methods are tested on a computational experiment, and the results show that the method is able to solve large-sized instances within reduced running times, outperforming available procedures in the literature.

■ WB34

204-MCC

Operations Analysis in Healthcare

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Tinglong Dai, Johns Hopkins University, Baltimore, MD, United States, dai@jhu.edu

Co-Chair: Daniel Ding, University of British Columbia, 2053 Main Mall, Vancouver, V6T 1Z2, Canada, daniel.ding@sauder.ubc.ca

1 - Allocation Of ICU Beds During Periods Of High Demand

Huiyin Ouyang, University of North Carolina, ouyanghuiyin@gmail.com

We formulate an MDP model for admission decisions in an ICU where patients' health conditions changeover time according to Markovian probabilities. We find that the optimal decision can depend on the mix of patients in the ICU and provide an analytical characterization of the optimal policy. We also identify conditions under which the optimal policy is state-independent.

2 - Late-onset Neonatal Sepsis Prediction Using Supervised Learning Techniques

Nadia Aly, College of William and Mary, naaly@email.wm.edu

In this study, we derive features from the R-R intervals (distance between R peaks) and apply novel machine learning algorithms to predict if an infant will be diagnosed with a sepsis infection within the next twelve hours. The dataset used in this study consisted of the R-R intervals recorded by monitoring electrodes in the NICU for approximately 3,000 infants. A Support Vector Machine model, outperformed all other models with a 0.07% false alarm rate and a 91.70% classification accuracy. These encouraging results imply potential clinical applications for the NICU to implement this algorithm on real-time heart rate data to influence decisions on when to proceed with diagnostic procedures.

3 - Price Discrimination In a Regulated Healthcare Market: Role Of Government Subsidy And Price Cap

Jianpei Wen, Peking University, Founder Building, No.298 ChengFu Rd, HaiDian District., Beijing, 100871, China, wenjianpei@pku.edu.cn, Frank Y Chen, Jie Song

The long waiting times in the public health sector in many countries has motivated the government to shift health authority waiting lists to the private sector, by setting a price cap and subsidizing switching patients in private services. We propose a novel queuing model incorporating choice behavior of heterogeneous time-sensitive customers. The optimal pricing policy with price discrimination to maximize the private sectors' revenue will exam the effect of subsidy and price cap in a government regulated market.

4 - A Reservation Policy For Medical Diagnostic Resource Allocation

Weifen Zhuang, Xiamen University, wfzhuang@xmu.edu.cn

We study the problem of the resource allocation of medical diagnostic facilities, accessed by three types of patients. Both inpatients and outpatients have to make appointments in advance, and emergency patients walk in directly. We formulate a dynamic programming model of the resource allocation problem and study the structural properties, based on which we fully characterize the optimal reservation policy. An upper bound and a lower bound to the DP value are created and proved to be asymptotically optimal. Numerical studies show that the performance of bounds works very well, and our heuristic policy outperforms the hospital's target policy significantly.

■ WB36

205B-MCC

Supply Chain Analytics

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: A Serdar Simsek, University of Texas-Dallas, 800 W. Campbell Rd, SM 30, Richardson, TX, 75080, United States, serdar.simsek@utdallas.edu

1 - Dynamic Selling Mechanisms For Exploring Markets With Customer- And Time-heterogeneity

Meng Li, University of Massachusetts, Dartmouth, MA, United States, meng.li@umassd.edu, N. Bora Keskin

Consumers are often heterogeneous in their preferences for product quality, and firms usually face uncertainty about consumer preferences when they sell vertically differentiated products to such heterogeneous consumers. We study this problem in a setting where a firm can dynamically optimize its prices.

2 - Consumer Choice Models With Endogenous Network Effects

Ruxian Wang, Johns Hopkins Carey Business School, Baltimore, MD, 21202, United States, ruxian.wang@jhu.edu, Zizhuo Wang

Network externality arises when the utility of a product depends not only on its attributes, but also on the number of consumers who purchase the same product. We first characterize the choice probabilities under such models and conduct studies on comparative statics. Then, we show that a new class of assortments, called quasi-revenue-ordered assortments, which consist of a revenue-ordered assortment plus at most one additional item, are optimal under mild conditions. An empirical study on a mobile game dataset shows that our proposed model can provide better fits for the data, increase the prediction accuracy for consumer choices and potentially increase revenue.

3 - Two Echelon Distribution Systems With Random Demands And Storage Constraints The Multi-product Case

Awi Federgruen, Columbia University, af7@columbia.edu, Daniel Guetta, Garud N Iyengar

We address a general model for a two-echelon system with arbitrarily many retailers and products, joint storage constraints and joint order costs.. We develop an approach to compute a tractable lower bound dynamic program (DP) for the optimal system-wide costs, along with a novel order, withdrawal and allocation policy that is derived from the strategy which is optimal in the lower bound DP. The lower bounds are based on a combination of relaxation methods, Lagrangian and others. Based on an extensive numerical study, the lower bound is found to be very accurate, and the proposed system-wide policy is close to optimal. We also show how the model can be used to make strategic, e.g., assortment decisions.

4 - An Expectation-maximization Algorithm To Estimate The Parameters Of The Markov Chain Choice Model

A Serdar Simsek, The University of Texas at Dallas, Naveen Jindal School of Management, 800 W Campbell Road, Richardson, TX, 75080, United States, serdar.simsek@utdallas.edu, Huseyin Topaloglu

We develop an expectation-maximization algorithm to estimate the parameters of the Markov chain choice model. The parameters of the Markov chain choice model are the probability that the customer arrives into the system to purchase each one of the products and the probability that she transitions from the current product to another one for each pair of products. We give computational experiments on multiple data sets, one of which uses real hotel data from the literature. Markov chain choice model, coupled with our expectation-maximization algorithm, yields better predictions of customer choice behavior when compared with other commonly used alternatives.

■ WB37

205C-MCC

Supply Chain Structure and Sustainability

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Greys Sosic, University of Southern California, Los Angeles, CA, United States, sosic@marshall.usc.edu

Co-Chair: Hailong Cui, Marshall School of Business, University of Southern California, CA, United States, Hailong.Cui.2019@marshall.usc.edu

1 - Ensuring Corporate Social And Environmental Responsibility Through Vertical Integration And Horizontal Sourcing

Adem Orsdemir, University of California Riverside, adem.orsdemir@ucr.edu, Bin Hu, Vinayak V Deshpande

Inspired by Taylor Guitars' vertical integration with its supplier to ensure corporate social and environmental responsibility (CSER), we investigate vertical integration as an alternative strategy for ensuring CSER in a competitive setting. We find that demand externality due to violation exposures and the possibility of supplying the competitor may fundamentally change firms' behaviors and CSER outcome. Furthermore, we find that high probability of violation exposure may discourage responsible sourcing under strongly negative demand externalities. Our findings suggest guidelines for firms interested in ensuring CSER, and for NGOs' violation scrutiny and reporting policies.

2 - Peer-to-peer Product Sharing: Implications For Ownership, Usage, And Social Welfare

Guangwen Kong, University of Minnesota, 111 Church Street, Minneapolis, MN, 55455, United States, gkong@umn.edu, Saif Benjaafar, Xiang Li

We consider a two-sided market consisting of product owners and renters, mediated by an online platform. Individuals decide on whether to be owners or renters. Owners are able to generate income from renting their products to non-owners while non-owners are able to access these products through renting on as needed basis. The platform decides on rental prices, commission rates, and membership fees. We characterize equilibrium outcome and compare product ownership and product usage with and without sharing.

3 - Capacity Allocation For A Green Farm

Dong Li, Singapore University of Technology and Design, Singapore, Singapore, dong_li@sutd.edu.sg, Saif Benjaafar, Niyazi Taneri

Much of the farmland in the United States is leased to farmers by landlords through a crop-sharing agreements. Consumers are willing to pay a premium for green produce and some even more for locally sourced green produce. However, yields for green farming are typically lower than conventional farming. We model the strategic interaction between a farmer and a landlord, the capacity allocation decision of the farm across conventional and green produce, and the decision of the farm to allocate its green produce across a global market and a local market under a crop-sharing agreement.

4 - Design Of Public Warning System

Saed Alizamir, Yale University, saed.alizamir@yale.edu, Francis E De Vericourt, Shouqiang Wang

We study the design of public warning systems in a multi-period model. In each period, the sender (she) receives an imperfect signal about the true state of the world (dangerous or safe), and has to decide whether to warn the receiver to act. Depending on the true realization of the random event, the receiver updates his belief about sender's credibility. The sender, therefore, has to dynamically manage her reputation over time, while also incentivizing the receiver to act on her warnings. We characterize the optimal warning policy, and gain insights into why it may sometimes be optimal for the sender to distort her signal.

WB38

206A-MCC

Opt, Robust

Contributed Session

Chair: Alberto Costa, NUS, Singapore, Singapore, isealc@nus.edu.sg

1 - On The Sample Compexity Of Multistage Robust Convex Optimization Problems

Francesca Maggioni, Assistant Professor, University of Bergamo, Via dei Caniana n 2, Bergamo, 24127, Italy, francesca.maggioni@unibg.it, Fabrizio Dabbene, Marida Bertocchi, Roberto Tempo

In this talk probabilistic guarantees for constraint sampling of multistage robust convex optimization problems are derived. The dynamic nature of these problems is tackled via the scenario-with-certificates approach. This allows to avoid the conservative use of explicit parametrizations through decision rules, and implies a significant reduction of the sample complexity to satisfy a given level of reliability. An explicit bound on the probability of violation is then given. Numerical results show the efficacy of the proposed approach.

2 - Conditions Under Which Adjustability Lowers The Cost Of A Robust Linear Program

SeyyedAli Haddadsisakht, Iowa State University, Ames, IA, 50011, United States, alihadad@iastate.edu, Sarah M Ryan

The adjustable robust counterpart (ARC) of an uncertain linear program lets some decision variables of the robust counterpart (RC) adjust to uncertainty. It may produce a less conservative solution than the RC does but cases are known in which it does not. The affinely adjustable RC (AARC) is a tractable compromise between RC and ARC. Numerical conditions under which the AARC optimal cost is lower than the RC optimal cost provide insight into problem structures where adjustability is valuable.

3 - Robust Optimization For The Transportation Problem Under Boundedly Rational User Equilibrium

Guanxiang Yun, PhD Student, University of Central Florida, 12800 Pegasus Drive, PO Box 162993, Orlando, FL, 32816, United States, ygx8822@gmail.com, Qipeng Zheng

We proposed a model for the static transportation path problem when the evacuation happens. We supposed that all the users in the system will obey the bounded rational principle. In real world instances, people will feel just fine even if they do not reach the best utility they can achieve but only attain a certain level. We proposed totally four conditions for our static models with two of them having the pricing strategy. By using the pricing strategy, we have a robust optimization model, we solve it by using the column and constraint generation method. For transportation path problem, it is also a large scale problem. In order to solve it, we use the branch and price method.

4 - A Robust Optimization Framework For Electric Power Grid Protection

Alberto Costa, NUS, Singapore, Singapore, isealc@nus.edu.sg

We consider a flow problem on oriented network, where the decision maker wants to send a quantity of goods from a source to a destination node, and an enemy can destroy the arcs of the network at a given cost. The decision maker can use a fortification budget to increase the cost to destroy the arcs, with the goal of maximizing the total price that the enemy must pay to disrupt the network. We model the optimal allocation of the fortification budget as a multistage robust optimization problem, and we propose an algorithm to find an -approximation of the global optimum. Computational results show that the algorithm is scalable and can solve efficiently instances with a few hundred nodes and arcs.

WB39

207A-MCC

Joint Session APS/MSOM: Service Systems in Applied Probability I

Sponsored: Applied Probability/MSOM

Sponsored Session

Chair: Song-Hee Kim, USC Marshall School of Business, 3670 Trousdale Parkway, Los Angeles, CA, 90089, United States, songheek@marshall.usc.edu

1 - Optimal Appointment Schedules

Mor Armony, New York University, marmony@stern.nyu.edu, Rami Atar, Harsha Honnappa

We consider the problem of optimally scheduling a finite, but large, number of customers over a finite time horizon at a single server FIFO queue, in the presence of ‘no-shows’. We study the problem in a large population limiting regime as the number of customers scales to infinity and the appointment duration scales to zero. We show that in the fluid scaling heavy-traffic is obtained as a result of asymptotic optimization. We also characterize the diffusion-scale optimal schedule.

2 - Efficient Transition To Post-acute Care

Alex Mills, Indiana University, Bloomington, IN, United States, millsaf@indiana.edu, Sean Yu, Jonathan Helm

Many hospital patients are discharged to a skilled nursing facility (SNF) for post-acute care. A shortage of SNF beds can lead to expensive discharge delays. Using a queueing model, we show that a hospital may want to contract with a SNF to reserve some capacity. However, when hospitals compete for capacity at multiple SNFs, such contracting leads to an equilibrium where total SNF capacity is de-pooled. Although this de-pooling hurts system performance overall, it benefits the hospital with the lower discharge rate, who becomes the market leader. Under the de-pooled scenario, the hospital with the higher arrival rate has an incentive to finance SNF expansion, even if it leads to free-riding.

3 - Steady-state Diffusion Approximations For Discrete-time Markov Chain In Hospital Inpatient Flow Management

Jiekun Feng, Cornell Universtiy, Ithaca, NY, United States, jf646@cornell.edu, Pengyi Shi

Motivated by the recent development of steady-state approximation via Stein’s method for Erlang-A and Erlang-C models, we apply the framework to a discrete-time Markov chain (DTMC), which is motivated from studying hospital inpatient flow and captures the dynamics of the midnight census in the inpatient department. We develop diffusion models to approximate the stationary distribution of the DTMC, and characterize the convergence rate of the approximations.

4 - A Queueing Model For Internal Wards

Jing Dong, Northwestern University, Evanston, IL, United States, jing.dong@northwestern.edu, Ohad Perry

Hospital queues have unique features, which are not captured by standard queueing assumptions. In this project we propose a queueing model that takes into account the most salient features of queues associated with large Internal Wards (IW’s). We characterize the maximum long-run workload that the IW can handle. We also introduce a deterministic (fluid) approximation for the non-stationary dynamics. The fluid model is shown to converge to a unique periodic equilibrium, so that long-run performance analysis can be carried out by simply considering that equilibrium.

WB40

207B-MCC

Queueing in Applied Probability I

Sponsored: Applied Probability

Sponsored Session

Chair: Harsha Honnappa, Purdue University, 315 N. Grant St., West Lafayette, IN, 47906, United States, honnappa@purdue.edu

1 - Randomized Load Balancing With General Service Distributions

Kavita Ramanan, Brown University, kavita_ramanan@brown.edu

Randomized algorithms are used in a variety of applications to balance load to improve performance. Randomized load balancing algorithms with exponential service distributions have received much attention, but in practice job sizes have been observed to be non-exponential. We characterize equilibrium properties of fluid limits of several randomized load balancing algorithms, including the well-known “power of two choices” algorithm in the presence of general service distributions. This is joint work with Pooja Agarwal.

2 - Beyond Heavy-traffic Regimes: Universal Bounds And Controls For The Single-server Queue

Itai Gurvich, Kellogg School of Management, i-gurvich@kellogg.northwestern.edu, Junfei Huang

Brownian approximations provide tractability in the analysis of queues. Their stationary distributions are used as proxies for those of the original queues and the convergence of suitably scaled primitives and processes provides mathematical support for the use of these Brownian models. From a heuristic viewpoint, however, there is an immediate Brownian analogue of the queueing model that is derived directly from the primitives. For the M/GI/1+GI queue, this direct (limitless approach) works: the Brownian model is universally accurate. It maintains the tractability and appeal of the limit approximations while avoiding many of the assumptions that facilitate them.

3 - The Bravo Effect For Brownian Queues

Rob J Wang, Stanford University, robjwang@stanford.edu,
Peter W Glynn

In queueing theory, departure processes play a fundamental role. Indeed, for single-station queues, they provide insights into system performance; for feedforward networks, departures from one station constitute arrivals into the next. Recently, there has been much interest in the asymptotic variability of departure processes. The "BRAVO" (Balancing Reduces Asymptotic Variance of Outputs) effect has been shown to manifest itself in many systems. This talk will discuss BRAVO in the context of Brownian queues, which are tractable approximations for various systems in heavy traffic. In particular, we will discuss the timescales at which BRAVO appears, and offer explanations for its occurrence.

4 - Optimal Driver Routing In Crowdsourced Transportation Systems

Anton Braverman, Cornell University, Ithaca, NY, United States,
ab2329@cornell.edu, J.G. Dai, Xin Liu, Lei Ying

We consider a queueing network that models the flow of drivers in a crowdsourced transportation system such as Lyft or Uber. Each time a driver drops off a passenger at their destination, a routing decision needs to be made. Should the driver stay and wait for the next customer at their current location, or should they drive empty to another part of town to try their luck there?

The way this decision is made greatly affects the supply of drivers across a city, and can even cause extreme driver shortages in certain regions. We analyze the fluid model corresponding to our network to develop a centralized routing policy for drivers.

■ WB41

207C-MCC

Stochastic Control and Quantitative Finance

Sponsored: Financial Services

Sponsored Session

Chair: Xianhua Peng, Hong Kong University of Science & Technology, Hong Kong, maxhpeng@ust.hk

1 - Leverage, Market Liquidity, And Systemic Risk

Nan Chen, Chinese University of Hong Kong,
nchen@se.cuhk.edu.hk

We present a macroeconomic model with a financial intermediary sector subject to a leverage constraint. The model allows us to examine the transition from "normal" states to systemic risk states. An amplification effect through the liquidity channel, both market and funding, can be characterized.

2 - Recursive Utility With Narrow Framing: Existence And Uniqueness

Xuedong He, Chinese University of Hong Kong,
xdhe@se.cuhk.edu.hk

We study the utility of an agent in a model of narrow framing with constant elasticity of intertemporal substitution and relative risk aversion degree and with infinite time horizon. In a finite-state Markovian setting, we prove that the utility uniquely exists when the agent experiences nonnegative utility of gain and loss incurred by holding risky assets and that the utility can be non-exist or non-unique otherwise; in the latter case, we prove the existence and uniqueness with further conditions. Moreover, we prove that the utility, when uniquely exists, can be computed by a recursive algorithm with any starting point. Finally, we solve a portfolio selection problem with narrow framing.

3 - Diversification Of Portfolio Tail Risk

Qi Wu, Chinese University of Hong Kong, qwu@se.cuhk.edu.hk

We develop explicit and accurate asymptotic expansions of the portfolio VaR and portfolio Expected Shortfall (ES) for a large family of multivariate elliptical distributions. We show that while the tail heaviness of joint asset distribution dictates how much larger portfolio ES is comparing to VaR, it is the tail dependence structure that determines the diversification benefits when sub-portfolios are merged together for joint portfolio margining.

4 - An Empirical Likelihood Method Of Combining Stock And Option Prices

Xianhua Peng, Hong Kong University of Science and Technology,
maxhpeng@ust.hk, Steven Kou, Tony Sit, Zhiliang Ying

As discussed in the finance literature, option prices may contain information about the dynamics of the underlying asset returns including the drift. In this paper, we confirm this viewpoint by showing that the options information leads to shorter confidence intervals for the parameters of the returns dynamics and more efficient ways to reflect current market information. We propose an empirical likelihood based method that can combine the stock return and the associated derivative prices. Our empirical analysis of the S&P500 index and options suggest that inclusion of option prices provides a more seasonable estimates that can reflect the market conditions during the 2009 financial crisis.

■ WB42

207D-MCC

RM in Practice II

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Xiaodong Yao, SAS Institute, Inc., SAS Campus Drive, Cary, NC, 27513, United States, xiaodong.yao@sas.com

1 - Single-resource Capacity Control In The Presence Of Cancellations, No-shows And Overbooking

Jason Chen, Principal Operations Research Specialist, SAS
Institute, Inc., Cary, NC, 27513, United States,
Jason.Chen@sas.com

Single-resource capacity control problem is one of the most basic and well-studied problems in quantity-based revenue management. Both exact methods and efficient heuristic methods exist when cancellations and no-shows are ignored. Dynamic-programming models have been proposed to solve the problem with cancellation, no-show, and overbooking. But the DP model is only tractable for small size problems. We present an efficient and highly scalable heuristic and analyze its performance.

2 - Evolution Of Revenue Management Systems At Intercontinental Hotels Group

Chanjoo Lee, InterContinental Hotels Group,
chanjoo.Lee@ihg.com

IHG's PERFORM Price Optimization project started in 2005 to drive key strategic priorities such as brand performance enhancement and excellent hotel returns. The project was a large-scale enterprise implementation of price optimization in the hospitality industry and provided a 2.7% increase in revenue as verified in the IHG 2009 Annual Report. In this talk, we will discuss how the IHG Revenue Management Systems including PERFORM Price Optimization evolved to increase user acceptance from the hotels and drive revenue improvement over the years.

3 - Pricing And Revenue Management Of Function Space In Hotels

Xiaodong Yao, SAS Institute, Cary, NC, 27513, United States,
Xiaodong.Yao@sas.com, Altan Gulcu

Function space sales may provide significant contribution to the bottom line of hotels, but implementing revenue management principles comes with additional challenges. In this presentation, we review pricing and revenue management techniques used for planning and management of function space in hotels.

■ WB43

208A-MCC

Decision Making with Incentives

Sponsored: Decision Analysis

Sponsored Session

Chair: Andrea Hupman Cadenbach, University of Missouri - St. Louis, St Louis, MO, United States, cadenbach@umsl.edu

1 - Consider The Alternatives: New Ways To Finance Early-stage Entrepreneurs

Samuel E Bodily, University of Virginia, bodilys@virginia.edu

A startup business is ready for launch, yet the entrepreneur is unwilling to take the considerable financial and potentially career-debilitating personal risk. We compare game-changing alternatives to the usual equity model a backer may use to finance the start-up: revenue contracts, derivative swaps, incentive gifts, and insurance. We answer which best reduces the risk to the entrepreneur and provides the best incentives, at a given cost to the backers, and without moral hazard. Risk analysis models are used to compare certainty equivalents of these financing alternatives.

2 - Nudging Vaccination With A No-fault Insurance

Emmanuel F Drabo, University of Southern California,
Los Angeles, CA, 90089-3333, United States, drabo@usc.edu,
Neeraj Sood, Joel W Hay, Jason N Doctor

Loss aversion in prospect theory and the K szegi-Rabin utility theory predicts that insurance will be preferred to its expected value, hence implying that insuring small risks of vaccine side effects can incentivize vaccine uptake. We test this prediction through a discrete choice experiment with 1257 MTurk subjects randomized into an insurance and a subsidy (expected value of insurance) group to make choices among hypothetical vaccination scenarios. Vaccine uptake was 1.5 percentage points greater among non-female respondents in the insurance arm relative to the subsidy arm. This suggests that a no-fault insurance against vaccine side effects can be an effective vaccine incentive strategy.

3 - Operations Decisions With Target Based Incentives

Andrea Hupman Cadenbach, University of Missouri - St. Louis, cadenbach@umsl.edu

Supply chains represent complex systems in which numerous performance measures are used and in which responses to incentive structures can change system performance. One type of incentive is a fixed target in which performance above a threshold is rewarded. The literature shows that high targets tend to induce risk taking while low targets tend to induce the selection of safer decision alternatives, but this talk examines the effects of setting targets on different types of performance measures in addition to the magnitude of the target.

4 - Team Incentives In Multi-level Principal Agent Problems

Aditya Umesh Kulkarni, PhD Candidate, Virginia Tech, 11700 Cardinal Court, Apt E, Blacksburg, VA, 24060, United States, aditya88@vt.edu, Christian Wernz

Existing literature on relational contracts typically does not account for the interdependency of stochastic performance outcomes across multiple levels of superior-subordinate interactions in organizations. We use multiscale decision theory to derive relational, that is, trust-based, contracts for teams while accounting for the aforementioned influences. We derive the optimal job design for employees, which is a function of rewards and performance influence. Our results extend agency theory by accounting for cascading and team-based incentives in organizations.

■ WB44

208B-MCC

Behavioral Decision Analysis

Sponsored: Decision Analysis

Sponsored Session

Chair: Matthias Seifert, IE Business School, Maria de Molina 12, 5, Madrid, Spain, matthias.seifert@ie.edu

1 - Exploring The Consistency Of Higher-order Risk Preferences

Timo Heinrich, IN-EAST School, Universität Duisburg-Essen, Duisburg, Germany, timo.heinrich@ibes.uni-due.de, Alexander Haering, Thomas Mayrhofer

We measure higher-order risk preferences and explore their consistency across orders. We analyze the role of (i) country differences between China, Germany, and the US, (ii) differences in stake size, and (iii) differences through displaying reduced rather than compound lotteries. We replicate the finding of mixed risk-averse and mixed risk-loving behavior by Deck and Schlesinger (2014) in the US and identify a similar pattern in Germany and in China. Moreover, we observe an increase in risk aversion when stakes are increased tenfold. Finally, in reduced lotteries there is only weak evidence for prudence and no evidence for temperance.

2 - Regime Shift Detection In The Domain Of Losses

Matthias Seifert, Associate Professor of Decision Sciences, IE Business School, Madrid, 28006, Spain, matthias.seifert@ie.edu, Sara Farooqi

We extend Massey and Wu's (2005) work on regime shift detection by studying the influence of system neglect on trading behavior in experimental markets. We show in a series of laboratory experiments how patterns of probabilistic over- and underreaction translate into investment decisions under risk and use Prospect Theory to explain systematic differences between buyers/sellers as well as gains/loss domains.

4 - Risky Choice Following Near Miss Events In Sequential Tasks Under Ambiguity

Florian Federspiel, IE Business School, Madrid, Spain, fmfederspiel@faculty.ie.edu, Matthias Seifert

Studies have shown that near miss events can lead to inconsistent risk perceptions. Yet near misses are often clouded in ambiguity, allowing for hubris and misattribution of what caused success or prevented failure. We provide an analytical model of near misses and investigate the experience of such an event on risk taking in a real options task. We show that increases in risk taking following a near miss occur mainly under ambiguity. We further find that this effect depends on the decision maker's prior expectation. Only those with an expectation of failure fall prey to the near miss bias.

3 - The Reasonability Of Behavioral Assumptions Made In Complex Systems Models

Allison C Reilly, University of Michigan, Ann Arbor, MI, United States, allison.reilly@gmail.com, Seth Guikema

Improved capture of human behavior in complex systems modeling has significantly advanced in recent decades and proffers a more cohesive approach to understanding how these systems may operate, fail, or evolve. The behavioral assumptions have significant implications on the insights derived from these models, though these implications are rarely explored. In this work, we address frequently confused decision science terminology used in systems models - from rationality to strategy - the reasonability of the behavioral assumptions, and their implications via case studies.

■ WB45

209A-MCC

Simulation for Performance of Non-Stationary Queues

Sponsored: Simulation

Sponsored Session

Chair: John Shortle, George Mason University, Fairfax, VA, United States, jshortle@gmu.edu

1 - A Performance Algorithm For Periodic Queues

Ni Ma, Columbia University, nm2692@columbia.edu, Ward Whitt

An efficient algorithm is developed to calculate the steady-state distribution of virtual waiting time in a general Gt/G/1 queue with a periodic arrival-rate function. We first approximate the Gt/G/1 model by an associated GIt/GI/1 model based on a recent heavy-traffic functional central limit theorem, and then compute the exact tail probabilities of the virtual wait by exploiting a modification of the classic exponential change of measure. That algorithm is then applied to compute related performance measures, such as the mean and variance of the virtual wait.

2 - Fourier Trajectory Analysis For Identifying System Congestion

Russell R Barton, Pennsylvania State University, 210 Business Building, University Park, PA, 16802, United States, rbarton@psu.edu, Xinyi Wu

We examine the use of the Fourier transform to discriminate dynamic behavior differences between congested and uncongested systems. Simulation continuous time statistic 'trajectories' are converted to time series for Fourier analysis. We use this knowledge to explore statistical process control methods to monitor nonstationary systems for transition from uncongested to congested state and vice versa.

3 - Staffing To Stabilize Blocking In Loss Models With Time-varying Arrival Rates

Jingtong Zhao, Columbia University, jz2477@columbia.edu, Ward Whitt

It is not possible to find a time-varying staffing policy to stabilize blocking probabilities in a multiserver loss model with a time-varying arrival rate to the same extent as in corresponding delay models, because the blocking probabilities necessarily change dramatically after each staffing change, but nevertheless a variant of the established modified-offered-load staffing algorithm performs well if we randomize appropriately.

4 - Effects Of Arrival Variability on Delays at Congested Airports

John Shortle, George Mason University, jshortle@gmu.edu

More precise spacing of flight arrivals into airports has the potential to increase capacity and reduce delays. However, even with precise spacing, delays can also result from the variability in the mean arrival rates throughout the day (i.e., the non-stationary nature of the arrival process) due to banking of flights at hub airports. This talk presents a queueing simulation of an airport and investigates the relative impact of reducing the uncertainty in the spacing of arrivals versus reducing the schedule variability. Under conditions of high utilization, reducing the arrival variability has limited impact on delays unless also accompanied by reduced schedule variability.

■ WB46

209B-MCC

Networks and Games in Operations

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Kimon Drakopoulos, Marshall School of Business, 3670 Trousdale Pkwy, Los Angeles, CA, 90089, United States, kimondr@mit.edu

1 - Information Obfuscation In Strategic Experimentation

Kimon Drakopoulos, Massachusetts Institute of Technology, kimondr@mit.edu

In our work we model a continuous time strategic experimentation problem against an informed opponent (incumbent) who can take actions to obfuscate learning. We show that the unique (weak) perfect Bayesian equilibrium of this dynamic game takes the form of the "delayed war of attrition" where over a range of beliefs of the experimenter, both players use mixed strategies — for the entrant, to determine when to stop experimenting and for the incumbent, to determine when to stop obfuscating. The uniqueness of the outcome gives rise to many questions such as market design in order to maximize fairness for the entrants, or consumer surplus.

2 - Coordination And Social Value Of Information In Networks

Gowtham Tangirala, Columbia Business School, 3022 Broadway, 4th Floor West, New York, NY, 10027, United States, gtangirala18@gsb.columbia.edu, Alireza Tahbaz-Salehi

This paper studies the social and equilibrium value of information in network games. We provide a complete characterization of conditions under which equilibrium is efficient under incomplete information and study the impact of varying the commonality of information across agents and the network structure, on equilibrium welfare. In particular, we find that when social conformity is desirable (undesirable), the more interconnected the network is, the lesser (greater) its equilibrium welfare.

3 - The Effect Of Information On Traffic Congestion

Ali Makhdoumi, Massachusetts Institute of Technology, makhdoum@mit.edu

We study the implications of additional information about routes provided to certain users (e.g., via GPS-based route guidance systems) in a traffic network. We formulate the question in the form of Informational Braess' Paradox (IBP), which extends the classic Braess' Paradox in traffic equilibria, and asks whether users receiving additional information can become worse off. We provide a necessary and sufficient condition for the occurrence of this paradox in terms of network characteristics.

4 - Optimal Promotion Period Of Products With Network Externality

Ningyuan Chen, HKUST, Hong Kong, Hong Kong, nc2462@columbia.edu, Saed Alizamir, Vahideh Manshadi

Many products exhibit network externality: a customer who has purchased the product makes his/her neighbors or friends more likely to buy the same product. This includes eco-friendly products such as electronic cars and solar panels. The government subsidizes customers to promote such products. We find that it is optimal for the government to stop the subsidy when the total externality of the owners reaches a threshold, which depends on the spectrum of the externality matrix. The optimal stopping time is not monotone in the strength of the externality between customers. We investigate how the structure of the network affects the stopping time and the optimal reward of the government.

■ WB47

209C-MCC

Applications of RM and Pricing

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Maxime Cohen, Google NYC, 110 Bleecker Street Apt 6F, New York, NY, 10012, United States, maxccohen@gmail.com

1 - Simple Pricing Schemes For Consumers With Evolving Values

Balasubramanian Sivan, Research Scientist, Google Research, New York, NY, United States, balusivan@google.com, Shuchi Chawla, Nikhil R. Devanur, Anna Karlin

We consider a pricing problem where a buyer is interested in purchasing/using a good, such as an app or music or software, repeatedly over time. The consumer discovers his value for the good only as he uses it, and the value evolves with each use as a martingale. We provide a simple pricing scheme and show that its revenue is a constant fraction of the buyer's expected cumulative value.

2 - Strategic And Proactive Pricing Optimization In The Airline Industry

Michael Benborhoum, British Airways, New York, NY, United States, michael.benborhoum@ba.com, Maxime Cohen

Pricing in the airline industry has become increasingly competitive, with a strong emphasis on reactive fare matching, arguably to the detriment of more strategic and proactive decision frameworks. Setting the right price in a strategic and proactive fashion raises at least three questions: (i) when is the right time and what is the right level for a proactive fare change; (ii) what is the right fare ladder structure leading to optimal sell-ups and fare rule segmentation; and (iii) how non-pricing factors should affect pricing decisions. In this talk, we propose an original approach to the strategic and proactive pricing problem in the airline industry.

3 - Dynamic Pricing With Heterogeneous Patience Levels

Ilan Lobel, NYU Stern, ilobel@stern.nyu.edu

We consider the problem of dynamic pricing in the presence of patient consumers. We call a consumer patient if he is willing to wait a certain number of periods for a lower price, but will purchase as soon as the price is equal to or below her valuation. We allow for arbitrary joint distributions of patience levels and valuations. We propose a dynamic-programming-based polynomial-time algorithm for finding optimal pricing policies. Our findings suggest that pricing for patient consumers is a more challenging problem than pricing for strategic consumers, in the sense that the dynamic program requires a larger state-space.

4 - Overcommitment In Cloud Services – Bin-packing With Chance Constraints

Maxime Cohen, NYU Stern, New York, NY, 10012, United States, maxime.cohen@stern.nyu.edu, Phil Keller, Vahab Mirrokni, Morteza Zadimoghaddam

A cloud provider needs to decide how many physical machines to purchase in order to accommodate the incoming virtual jobs efficiently. This is typically modeled as a bin-packing optimization problem. Overcommitting servers clearly improves the bin-packing objective, but induces a risk for the provider. In this work, we show that the bin-packing with chance constraints can be solved using a class of simple online algorithms that guarantee a constant factor from optimal. We explicitly model job size uncertainty to motivate new algorithms and evaluate them on realistic workloads.

■ WB48

210-MCC

Business Applications in Social Media Analytics

Invited: Social Media Analytics

Invited Session

Chair: Michel Ballings, University of Tennessee, 255 Stokely Management Center, Knoxville, TN, 37996, United States, michel.ballings@utk.edu

1 - Identifying New Product Ideas: Waiting For The Wisdom Of The Crowd Or Screening Them In Real-time

Steven Hoornaert, Ghent University, Ghent, Belgium, steven.hoornaert@ugent.be, Michel Ballings, Edward C Malthouse, Dirk Van den Poel

This article studies idea ranking in innovation communities using the contributor's history of submitting ideas and comments, the Content of the idea suggestion, and the Crowd's feedback on the idea.

Results show that contributor and content variables improve ranking between 22.6% and 25.8% over exhaustive idea selection across classifiers.

2 - Evaluating The Importance Of Different Communication Types In Tie Strength Prediction On Social Media

Matthias Bogaert, Ghent University, matthias.bogaert@ugent.be, Michel Ballings, Dirk Van den Poel

The purpose of this paper is to evaluate which communication types on social media are most indicative of tie strength. To ensure that we have the best possible model we benchmark several classifiers. The results indicate that we can predict tie strength with very high accuracy. The top performing classification algorithm is adaboost with an AUC of 0.976. The top five communication predictors are the recency of commenting on links, posts, videos, the frequency of liking post comments and the recency of commenting on albums. To the best of our knowledge, this study is the first to provide such an extensive analysis of tie strength in social media.

3 - Evaluating Prediction Models For Targeting Product Reviewers

Michel Ballings, Assistant Professor, University of Tennessee, 249 Stokely Management Center, Knoxville, TN, 37996, United States, michel.ballings@utk.edu, Rachel Van Deventer, Ryan Erwin, Miller Moore, Dirk Van den Poel

As customers increasingly rely on product reviews while making their purchases, businesses must take action and make obtaining high review volume a priority. The purpose of this study is to develop a predictive model that identifies if an online reviewer is likely to write a review for a selected product. To develop our model, we extracted product reviewer data from Amazon.com. We find that the model accurately predicts if an individual will review the focal product. Businesses can target that population and obtain high review volume for their investment. While a large body of research has been published on product reviews we have focused on the individuals behind the reviews.

4 - Behavioral Engagement In Social Media: Measurement, Drivers And Impact On Purchase Behavior

Welf H. Weiger, University of Goettingen, Platz der Goettinger Sieben 3, Goettingen, D-37073, Germany, welf.weiger@wiwi.uni-goettingen.de, Wendy W Moe, Hauke A Wetzel, Maik Hammerschmidt

In this study, we focus on understanding and measuring behavioral consumer engagement in social media. Our research combines three sources of individual-level user data (i.e., matched survey, social media behavior and purchase behavior data) collected in the context of an online fashion retailer's social media site. We develop a composite engagement measure and we identify its motivational drivers and consequences for purchase behavior. Our results reveal different drivers for the incidence (i.e., the "whether") and the nature (i.e., the "how") of engagement. As a counterintuitive finding, our results further show that complaining users buy more than complimenting users.

WB49

211-MCC

Panel: Publishing in INFORMS Transactions on Education

Sponsored: Education (INFORMED)

Sponsored Session

Moderator: Jeroen Belien, KU Leuven, Brussel, Belgium, jeroen.belien@kuleuven.be

1 - Informs Transactions On Education (ITE): A General Overview

Jeroen Belien, KU Leuven, jeroen.belien@kuleuven.be

The panelists include ITE editors and authors who have published recently in ITE. The authors will discuss their experiences with submitting articles to ITE. The editors will provide suggestions to authors who wish to submit their work to ITE—in particular, articles about case studies and about educational games.

2 - Publishing Classroom Games In Ite

Stefan Creemers, IESEG School of Management Lille, s.creemers@ieseg.fr

3 - Ite Author Experiences

Vera Tilson, University of Rochester, vera.tilson@Simon.Rochester.edu

4 - Informs Transactions On Education Author Experiences

Maureen Lojo, California State University, lojom@skymail.csus.edu

WB50

212-MCC

SpORts: Sports Analytics IV

Sponsored: SpORts

Sponsored Session

Chair: Sean Barnes, Univ of Maryland-College Park, Robert H. Smith School of Business, College Park, MD, 20742, United States, sbarnes@rhsmith.umd.edu

Co-Chair: Margret Bjarnadottir, University of Maryland, College Park, College Park, MD, 2, United States, margret@rhsmith.umd.edu

1 - A Predictive Modeling And Robust Optimization Framework For Prioritizing Major League Baseball Free Agent Acquisitions

Margrét Bjarnadóttir, Univ of Maryland-College Park, College Park, MD, United States, margret@rhsmith.umd.edu, Sean Barnes, Aurelie Thiele

Major League Baseball teams are tasked with constructing rosters of players that can compete successfully against other teams. This process involves making decisions about which players to acquire via free agency. We propose a predictive modeling and robust optimization framework for supporting these free agent acquisition decisions. Specifically, we develop predictive models for expected player performance, and optimize free agent acquisitions (robustly) for a given budget. We demonstrate the effectiveness of this approach across several scenarios of budget levels and free agent markets.

2 - An Optimization-based Approach For The National Football League Tiebreaking Procedure

Matias Siebert, Georgia Institute of Technology, Atlanta, GA, United States, msiebert6@gatech.edu, George L Nemhauser, Joel Sokol

When the NFL regular season is in its final weeks, teams, fans and media want to know which teams have clinched a place in the playoffs, which one are eliminated and which teams still have the chance to make the playoffs. Given the number of possible scenarios and the intricacies of the tiebreaking procedures, simple enumeration approaches to solve this problem become highly inefficient in practice. We propose an optimization-based approach to determine the current situation and the possibilities for each team to make the playoffs.

3 - Sporting: A Large Applied Research Project In Sport Scheduling

Tomas Nordlander, SINTEF ICT, Trondheim, Norway, Tomas.Nordlander@sintef.no

Sports leagues and tournaments are scheduled daily around the world. Although the underlying problem is a hard mathematical problem, most end-users resort to manual scheduling. In 2005, SINTEF's optimisation developed CupCom for Profixio AS. This is an optimisation engine for tournament scheduling, which last year scheduled around 150,000 matches of handball, football and volleyball in Norway and Sweden. We have also been helping the Norwegian Football Federation with scheduling their top professional leagues for several years. I will talk about this and our new large research-based innovation project together with PROFIXIO AS.

4 - Automating The Scheduling Of A Softball League

Kent J Kostuk, Federated Co-Operatives Limited, kent.kostuk@usask.ca, Keith Willoughby

A local minor softball league was finding it difficult to manually develop and publish league schedules in the short time window available between when teams were formed and when a published schedule was required. Early prototypes were developed to demonstrate proof of concept as prior attempts to automate had not been successful. A complete solution was developed allowing the league to produce and publish league schedules with significantly less work and eliminating the need to transcribe manually generated schedules into electronic documents.

WB51

213-MCC

Education I

Contributed Session

Chair: Jay Parsons, Associate Professor, University of Nebraska - Lincoln, 103B Filley Hall, P.O. Box 830922, Lincoln, NE, 68583-0922, United States, jparsons4@unl.edu

1 - A Holistic Conceptual Framework For Assessing The Effectiveness And Viability Of an Academic Program

munir majdalawieh, Associate Professor, zayed university, Mirdif, Dubai, 19282, United Arab Emirates, munir@themajd.com

Many aspects of the accreditation process focus on the past and the present (prove), the "program review" assessment is "forward-looking assessment" (improve) and thus transforms the process into a continuing assessment activity rather than a periodic event. The aim of this paper is to propose a conceptual framework for "program review" to assess the effectiveness and viability of an academic program and to improve the academic program and the education of the students. The proposed framework and the program review measurement matrix will provide an opportunity to colleges and universities to undertake a robust and targeted approach to proactively and continuously review their academic programs.

2 - Experience With A New Online Game To Teach Sourcing In A Supply Chain Management Course

Samuel C Wood, President, Responsive Learning Techologies, 4546 El Camino Real, #243, Los Altos, CA, 94022, United States, wood@responsive.net, Mozart Batista de Castro Menezes

The Gleacher Sourcing game is a new online competitive simulation from the developers of Littlefield Technologies and the Supply Chain Game. In the game, students compete and collaborate in ad hoc supply chains to maximize cash position or earnings. After an overview of the game this paper will discuss the use of the game in a Masters level Supply Chain Management course. In a 2-hour game, students managed the interplay between double marginalization, sourcing agreements, pricing, and working capital management.

3 - A Closer Look At Underrepresented Women In Engineering: A Classroom Study Exploring The Effects Of Anonymity On Student Peer Reviewers

Jacqueline Ng, PhD Candidate, Northwestern University, 2145 Sheridan Road, C-230, Evanston, IL, 60208, United States, jacqueline.ng@northwestern.edu, Bruce Ankenman, Seyed Iravani

The underrepresentation of women in STEM is a complex problem with few answers. We conduct a classroom study investigating the effects of anonymity on the critical nature of peer feedback. Using NLP and machine learning, we find that women are more sensitive than men to anonymity. Specifically, anonymous women provide more negative feedback than non-anonymous women, but less constructive feedback. Moreover, the negative sentiment is directed mainly at their male peers. In contrast, we do not find such dissimilarities between anonymous and non-anonymous men. This study suggests that STEM women may benefit from greater opportunities to support and mentor each other, outside of the classroom.

4 - Simple Tools To Help Agricultural Decision Makers Think About Risk

Jay Parsons, Associate Professor, University of Nebraska - Lincoln, 103B Filley Hall, P.O. Box 830922, Lincoln, NE, 68583-0922, United States, jparsons4@unl.edu, Jim Jansen

The focus of this talk will be on experiences in developing and using simple tools to help agricultural producers think about and manage risk. Using a simulation scenario and a Risk Scenario Planning tool, we focused on helping producers to think about managing market risk from the standpoint of controlling the distribution of possible outcomes. Marketing alternatives and risk have been difficult topics to education common producers about in the past and continue to be so. However, our approach has shown significant growth in audience commitment to action in managing market risk better in the future.

■ WB52

214-MCC

New Advances in Operating Room (OR) Scheduling

Sponsored: Public Sector OR

Sponsored Session

Chair: Gino J Lim, University of Houston, E206 Engineering Building 2, Houston, TX, 77204, United States, ginolim@uh.edu

1 - Integrated Anesthesiologist And Room Scheduling For Surgeries

Sandeep Rath, UCLA Anderson School of Management, Sandeep.Rath.1@anderson.ucla.edu, Kumar Rajaram

At large hospitals the assignment and scheduling of anesthesiologists and operating rooms is a complex resource allocation decision undertaken daily by the managers of operating room suites. We validate and implement a data-driven decision support system at the UCLA Ronald Reagan Medical Center. We also conduct analyses related to capacity expansion and process improvement efforts.

2 - A Discrete Event Simulation Evaluation Of Distributed Operating Room Scheduling

Vahid Roshanaei, PhD Candidate, University of Toronto, 5 King's College Road, Toronto, ON, M5S3G8, Canada, vroshana@mie.utoronto.ca, Shuo Wang, Dionne Aleman, David Urbach

We use discrete event simulation to assess the performance of deterministically optimized OR schedules in a network of collaborating hospitals with shared resources, called distributed OR scheduling (DORS), in the face of uncertain surgical durations, emergency arrivals, and limited downstream resources. We quantify the individual and combined disruptive impact of these stochastic factors on the DORS schedule, using real data obtained from the University Health Network (UHN) in Toronto, Canada. We show that the schedule constructed by DORS results in higher OR utilization and lower average surgery cost compared to UHN's current schedule.

3 - Scheduling Of Multi-priority Patients With Preference, Cancellation, No Show And Capacity Uncertainty

Deepak Agrawal, Penn State University, dua143@psu.edu, Guodong Pang, Priyantha Devapriya, Soundar Kumara

Reasons of No-shows and how to stop them, has been focus of the research since more than a decade. No-show adds up to the increases healthcare waste. Therefore, motivated by this we aim to develop advanced scheduling models which can reduce No-shows by scheduling appointments at patients' preferred day and time with their preferred physicians while simultaneously maximizing the profit for clinics. Patient choices are modeled as mixed-logit model. The dynamic scheduling process is modeled as a Markov decision process. We conduct numerical experiments to test the performance of the dynamic model in comparison to several heuristics proposed in the literature.

4 - A Lagrangian Relaxation Algorithm For Solving Surgery Scheduling Problem Under Uncertain Durations

Amirhossein Najjarbashi, University of Houston, amirhossein.najjarbashi@gmail.com, Gino J Lim

We studied a surgery scheduling and resource allocation problem by considering uncertain durations. A mixed integer programming formulation is developed in order to maximize throughput and minimize overtime. A Lagrangian Relaxation algorithm is applied to solve large-scale problems efficiently. Having a risk-averse attitude, we applied Conditional Value-at-Risk to tackle uncertainty.

■ WB53

Music Row 1- Omni

Opt, Stochastic VI

Contributed Session

Chair: Tugce Isik, Clemson University, 277D Freeman Hall, Dept. of Industrial Engineering, Clemson, SC, 29634, United States, tisik@clemson.edu

1 - Valuing A Portfolio Of Systemic Urban Infrastructure Investments Using Approximate Dynamic Programming With Decision Dependent Uncertainties

Sebastian Maier, Imperial College London, Imperial College Road, Skempton Building, London, SW7 2AZ, United Kingdom, s.maier13@imperial.ac.uk, John W Polak, David M Gann

We present a new portfolio-based framework for the application of approximate dynamic programming to the valuation and risk-management of urban infrastructure investments with decision dependent uncertainties. We use this framework to formulate a multistage stochastic optimisation model in which the value function is approximated by linear regression using both simulation and the modelling of decision dependent uncertainties. Using the real-world case of district heating network investments in London, we investigate the effects of the consideration of decision dependent uncertainties on both the optimal portfolio value and the underlying optimal strategic and operational decisions.

2 - A Stochastic Program For Debris Collection Problem

Derya Ipek Eroglu, Research and Teaching Assistant, Middle East Technical University, Dumlupinar Street N:1, Ankara, 06400, Turkey, eipek@metu.edu.tr, Duygu Pamukcu

Our aim is to develop a stochastic program for debris collection problem, which enables us to make decisions regarding different disaster types or different scenarios that can take place for a disaster type. Debris collection is important for human health since uncollected debris may lead to pollution. We develop stochastic programs using appropriate decomposition methods which will be compared in terms of computational efficiency, test the program with different variants, compare the model with pre-developed deterministic model(Celik et al.) and analyse related performance measures. We present results of our computational studies and analysis.

3 - Management Of Scarce Blood Supplies Accounting For Cross-matching Characteristics

Nooshin Valibeig, Northeastern University, 360 Huntington Ave, Boston, MA, 02115, United States, n.valibeig@neu.edu, Jacqueline Griffin

For blood transfusion, availability of blood of a compatible type is crucial to patient treatment and reductions in mortality rate. In isolated environments, such as in the aftermath of a disaster or combat environment, demand for blood is unpredictable and timing and quantity of stock replenishment is unreliable. Correspondingly, the risk and the cost of blood shortages is high. We develop a stochastic optimization model to develop threshold policies to prevent from blood shortages considering proactive allocation, accounting for cross-matching criteria, to satisfy the requests for various blood types. We assess the effectiveness of these real-time allocation policies via simulation method.

4 - Multistage Power Generation Capacity Expansion Models With Different Risk Measures

Shu Tu, lehigh university, 200 West Packer Avenue, Bethlehem, PA, 18015, United States, sht213@lehigh.edu, Boris Defourny

When it comes to the multistage problems, the stochastic programming models rely on the convexity property of the problems and the solution approaches usually rely on the stage independence assumption, with Markov decision processes being advantageous from these aspects. Therefore, we adapts the "good-deal" generation capacity expansion model to the form of Markov decision processes and will implement it with C++ which can make use of parallel computing and ILOG Concert Technology.

5 - Control Policies For Queueing Systems With Time Sensitive Jobs

Tugce Isik, Clemson University, 277D Freeman Hall, Dept. of Industrial Engineering, Clemson, SC, 29634, United States, tisik@clemson.edu, Bahar Cavdar

We consider a queueing system where each job has a preferred time window for service. We assume that all jobs must be served and the jobs are outsourced when the capacity is insufficient. Costs are incurred for both outsourced jobs and early service. For systems with short time windows and a single class of jobs, we show that a class of threshold service policies are optimal. For general systems, we devise heuristic policies based on similar threshold structures.

■ WB54

Music Row 2- Omni

Service Science: Uncertainty in Business Processes

Sponsored: Service Science

Sponsored Session

Chair: Genady Grabarnik, St. John's University, St. John's University, Queens, NY, United States, genadyg@gmail.com

1 - Continuity Of The Lyapunov Exponenets Under Continuity Of Measures In Sl (2, R)

Genady Grabarnik, St. John's University, genadyg@gmail.com

In the business processes composition of processes results in special type of product of the appropriate distributions. In this case it corresponds to product of random matrices. It is well know that behavior of random matrices controlled by its Lyapunov exponents. We are investigating stability of the top Lyapunov exponent under perturbation of defining measure in weak topology.

2 - IT Processes Improvement

Larisa Shwartz, IBM, lshwart@us.ibm.com

With the advent of cognitive computing, new generations of cognitive systems and services are being conceived. In IT service management, cognitive approaches used for optimization and automation of IT Service management processes. We discuss an integrated framework for problem resolution that enables an automated discovery of informative phrases from IT incident tickets which are later used to construct knowledge and facilitate automation of IT service management. The effectiveness and efficiency of our framework are evaluated by an extensive empirical study of a large scale real ticket data.

3 - Business-driven Optimization Of It Service Configuration In Public And Hybrid Clouds Based On Performance Forecasting

Genady Grabarnik, St. John's University, Queens, NY, Mauro Tortonesi, Larisa Shwartz

Modern Cloud environments are rapidly evolving, leading to a growing adoption of dynamic pricing for virtual resources and of speedier deployment tools and to the emergence of hybrid Cloud scenarios. The need to address these challenges is paving the way to a new generation of Cloud services, capable of adapting to changes in their operating conditions and deployment environments by dynamically realigning their configuration. However, their management will require new and more sophisticated tools. This paper presents a new optimization solution for Cloud-based IT services, that tries to address these issues by using queuing analysis of the services' workflows and ILP optimization.

■ WB55

Music Row 3- Omni

Inventory Management VIII

Contributed Session

Chair: Yue Zhang, Duke University, 5507 Butterfly Ln Apt 207, Durham, NC, 27707, United States, yueyue.zhang@duke.edu

1 - Deep Learning For Newsvendors

Afshin Oroojlooyjadid, Lehigh University, 200 West Packer Ave, Bethlehem, PA, 18015, United States, afo214@lehigh.edu, Martin Taká , Lawrence Snyder

We study a newsvendor problem in which each demand observation also has a set of features. We propose an algorithm based on deep learning that optimizes the order quantity based on the features. It integrates the forecasting and inventory-optimization steps, rather than solving them separately. The algorithm does not require probability distributions. Numerical experiments on real-world data suggest that our algorithm outperforms approaches from the literature, including data-driven and SVM approaches, especially for volatile demands.

2 - Inventory Repositioning In Product Sharing Networks

Xiang Li, University of Minnesota, 2508 Delaware St SE, Apt 473A, Minneapolis, MN, 55414, United States, lixx1315@umn.edu, Saif Benjaafar, Xiaobo Li

We study a product sharing network in which customers can pick up a product without reservation, and are allowed to keep the product for as long as they want, without committing to a specific return time or location. We model the periodic inventory re-positioning as a Markov decision process. We characterize the qualitative properties of the optimal policy .

3 - Dynamic Inventory And Price Control In The Face Of Unknown Demand

Tingting Zhou, Rutgers university, Newark, NJ, 07102, United States, tingzhou@rutgers.edu, Michael N Katehakis, Jian Yang

We study adaptive policies that combat unknown demand in a dynamic inventory and price control setting. Inventory control is achieved by targeting newsvendor ordering quantities for empirical demand distributions learned over time. On top of that, demand-affecting prices are selected in a fashion that balances between exploration and exploitation. When burdened with the task of selecting the most profitable price, bounds for the regret can range between the orders of T1/2and those of T2/3. Simulation studies are conducted as well.

4 - Approximating Optimal Inventory Policies For Assemble To Order Manufacturing Systems

Levi DeValve, Duke University, 716 Turmeric Lane, Durham, NC, 27713, United States, levi.devalve@duke.edu, Yehua Wei, Sasa Pekec

We study the classical one-period assemble-to-order problem, modeled as a two stage stochastic integer program with recourse. We leverage a primal-dual approach to develop several approximation methods based on newsvendor solutions. We identify co-monotone demand and symmetric hierarchy systems as special cases where a component newsvendor solution is optimal under a constant mark-up assumption, and provide closed-form bounds on sub-optimality for more general cases. Further, we establish closed-form bounds for systems where components serve many products and show asymptotic optimality.

5 - Serial Inventory Systems With Markov-modulated Demand: Derivative Bounds, Asymptotic Analysis, And Insights

Yue Zhang, Duke University, 5507 Butterfly Ln Apt 207, Durham, NC, 27707, United States, yueyue.zhang@duke.edu, Li Chen, Jing-Sheng Jeannette Song

We consider the inventory control problem for serial supply chains with continuous, Markov-modulated demand. We perform a derivative analysis and develop general, analytical solution bounds for the optimal policy. We further derive a simple procedure for computing near-optimal heuristic solutions. We next perform asymptotic analysis with long replenishment lead time. We show that the relative errors between our heuristics and the optimal solutions converge to zero as the lead time becomes sufficiently long, with the rate of convergence being the square root of the lead time.

■ WB56

Music Row 4- Omni

Predictive Analytics in eBusiness

Sponsored: EBusiness

Sponsored Session

Chair: Ajit Sharma, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA, 15213, United States, ajits1@andrew.cmu.edu

1 - Online Assortment Optimization at Scale

Deeksha Sinha, MIT ORC, deeksha@mit.edu, Theja Tulabandhula

We revisit the problem of assortment optimization in retail and consider a setting where (a) the product universe is large, (b) there are time constraints in offering an assortment, and (c) the user choice model can be personalized. In this setting, we propose an offline algorithm based on the theory of locality sensitive hashing (LSH) that computes approximately optimal assortments quickly. We also perform a sensitivity analysis of the optimal assortment to the choice model used. We then propose an online learning setup where we get feedback on the quality of assortments offered in each round. We come up with new online algorithms based on our offline solutions that can learn the user choice model quickly.

2 - Crowd-driven Competitive Intelligence: Understanding The Relationship Between Local Market Structure And Online Rating Distribution.

Dominik Gutt, Paderborn University, Dominik.gutt@upb.de, Philipp Herrmann, Mohammad Saifur Rahman

Crowdsourced information, such as online ratings, are increasingly viewed as a critical source for understanding local market dynamics. A key aspect of utilizing online ratings to derive competitive market intelligence is to delineate the systematic relationship between local market structure and distributional properties of online ratings. Using restaurant review data from Yelp.com for 372 isolated markets in the U.S., our empirical findings suggest that an increase in competition leads to a broader range of ratings and to a decrease in the average mean rating in a market. Moreover, we present evidence in support of both the internal and external validity of Yelp's crowdsourced online ratings.

3 - Networks And Income: Evidence From Individually Matched Income And Mobile Phone Metadata

Guillaume Saint-Jacques, MIT Sloan School Of Management, Cambridge, MA, 02142, United States, gsaintja@mit.edu, Eaman Jahani, Pål Roe Sundsøy, Johannes Bjelland, Bjørn-Atle Reme, Sinan Aral, Alex "Sandy" Pentland

Measuring the relationship between income and various properties of one's social network has proven difficult because it requires data on income and social ties to be matched at the individual level. We offer the first large-scale investigation of this question using data that is both large scale and individually matched. How are ego-networks different across income levels? Are there measurable differences in degree, reciprocity, diversity and centrality? We use a dataset of Call Detail Records from an Asian country of over 100M individuals and income surveys sent to over 110,000 individuals. We use location data to control for location effects, rather than rely on it to match incomes.

■ WB57

Music Row 5- Omni

Behavioral Aspects of Managing Innovation

Sponsored: Behavioral Operations Management

Sponsored Session

Chair: Evgeny Kagan, Ann Arbor, MI, United States, ekagan@umich.edu

Co-Chair: Stephen Leider, University of Michigan, Ann Arbor, MI, United States, leider@umich.edu

1 - When To Hire The First Employee? Behavioral Evidence And Insights

Anton Ovchinnikov, Queens University, Kingston, ON, Canada, anton.ovchinnikov@queensu.ca, Beatrice Boulu-Reshef, Charles J Corbett

Effectively any entrepreneur shifts from doing all the work him/herself to hiring someone to do part of that work. We use an analytical model and behavioral experiments to study when entrepreneurs should and do hire their first employee. Understanding both the optimal timing/conditions of hiring and the deviations of the hiring patterns from optima have the potential to provide insights to a very broad spectrum of entrepreneurs at the critical early stage of their new venture formation process.

2 - Managing The Dynamics Of Delegated Search

Karthik Ramachandran, Scheller College of Business, Georgia Institute of Technology, karthik.ramachandran@scheller.gatech.edu, Morvarid Rahmani

Firms often delegate search for solutions to challenges such as product design, advertisement creation, executive search, etc. We study the dynamics of delegated search. We identify conditions under which the client should use a committed or open-ended approach to evaluating solutions.

3 - Incentives In Startups: Form And Timing Of Equity Contracting

Evgeny Kagan, Ross School of Business, University of Michigan, ekagan@umich.edu, William S Lovejoy, Stephen Leider

We explore theoretically and experimentally how form and timing of equity contracting affects contribution behavior to the startup. Our experimental findings are consistent with the empirical evidence that equal division is associated with reduced contributions. However, the differences in contributions are mainly driven by self-selection of low-contributors into equal contracts, rather than by the incentive effects of the contracts. We also find that the negotiation process itself may be an important driver of contribution behavior in collaborative work settings.

4 - An Experimental Investigation Of Favour Exchange Under Monetary And Non-monetary Incentives

Kyle Hyndman, Naveen Jindal School of Management, UT Dallas, Richardson, TX, United States, KyleB.Hyndman@utdallas.edu, Matthew Embrey, Rudolf Muller

We experimentally study a the situation in which subjects must trade favors - costly actions by one person which only benefits another. We are interested in the role of monetary incentives in promoting efficient exchange. Our results show that monetary exchange achieves the most efficient outcome, but that non-monetary exchange can do as well or better provided that the group scores highly on “social value orientation”.

■ WB58

Music Row 6- Omni

Energy XIII

Contributed Session

Chair: Mohammad Majidi-Qadikolai, Graduate Research Assistant, University of Texas-Austin, 3373 Lake Austin Boulevard, Apt D, Austin, TX, 78703, United States, majidi.mohammad@gmail.com

1 - A Hybrid Top-down, Bottom-up Approach For Saudi Arabia

Hossa Almutairi, King Abdullah Petroleum Studies & Research Center (KAPSARC), King Abdullah Petroleum Studies & Research Ce, Airport Road, Riyadh, 11672, Saudi Arabia, hossa.mutairi@kapsarc.org

We show how to combine a CGE-like top-down model with a technology-rich bottom-up energy model in a single Mixed Complementarity Problem (MCP). Calibrated on Saudi Arabia’s data, this hybrid model will be used to study the interaction between energy and non-energy sectors and to get insights on the effects of energy policies on the whole Saudi economy.

2 - A Convex Relaxation Approach To Strategic Bidding In Nodal Electricity Markets

Hamed Mohsenian-Rad, Associate Professor, University of California - Riverside, 900 University Ave, Department of Electrical Engineering, Riverside, CA, 92521, United States, hamed@ee.ucr.edu, Mahdi Ghamkhari, Ashkan Sadeghi

Strategic bidding problems in electricity markets are formulated by bi-level optimization problems which are often translated to mixed-integer linear programs (MILPs). In this paper, we instead propose convex programming to solve the strategic bidding problem in nodal electricity markets. Our approach guarantees a feasible and accurate bidding solution, with 99% optimality. While the computation time of the MILP approach grows exponentially as the scheduling horizon or number of random scenarios increases, the computation time of our approach increases rather linearly.

3 - Optimization In Smart Grid With Limited System Observability

Sunil K Vuppala, INFOSYS/IIITB, 309, Elil Abode, Mahadevapura, Outer Ring Road, Bangalore, 560048, India, sunil.vuppala@iiitb.ac.in, Srinivasa Prasanna

We present optimization of energy management in smart grid in the presence of limited system observability and controllability. We assume at least % of the scheduled demand is followed by the consumers. Remaining (1-)% is arbitrary, assumed adversarial. Bounds are found with min-min / max-max formulations which is LP/ILP problem. Robust bounds are obtained using heuristics. The initial results indicate adversarial bounds of 200% in 10,000 consumer example which is equal to price ratio.

4 - Handling Dynamic Constraints In Power System Optimization

Francois Gilbert, Postdoctoral Appointee, Argonne National Laboratory, 9700 S. Cass Avenue, Lemont, IL, 60439, United States, fgilbert@anl.gov, Shrirang G Abhyankar, Hong Zhang, Mihai Anitescu

The inclusion of dynamic stability constraints is the nominal objective of many optimization-based power system analyses. In current practice, this is typically done off-line. We present an approach for the on-line inclusion of dynamic constraints in power grid optimization problems. The approach is based on an encapsulation that allows for a loose coupling between the optimization and the numerical simulations. We demonstrate the benefits of the approach on a 118 bus systems, for which we solve an economic dispatch with transient constraints.

5 - Integrating Short-term And Long-term Transmission Expansion Planning

Mohammad Majidi-Qadikolai, Graduate Research Assistant, University of Texas-Austin, 3373 Lake Austin Boulevard, Apt D, Austin, TX, 78703, United States, majidi.mohammad@gmail.com, Ross Baldick

For long-term transmission expansion planning (LTEP), 10 + years is usually selected as a planning horizon; however short-term planning (STEP) is limited to less than 5 years. Common practice is to run these two planning studies separately. On one hand, the impact of long-term load and generation growth on STEP is ignored, and on the other hand, LTEP cannot represent network configuration changes as a result of STEP that makes LTEP results less realistic. In this paper, we integrate these two planning studies into a single multi-stage TEP and discuss modeling and computational challenges.

■ WB59

Cumberland 1- Omni

Drone-Based Logistics

Sponsored: TSL, Facility Logistics

Sponsored Session

Chair: Sudipta Chowdhury, Mississippi State Univ, MSU, Starkville, MS, 39762, United States, sc2603@msstate.edu

Co-Chair: Mohammad Marufuzzaman, Mississippi State University, PO Box 9542, Starkville, MS, 39762, United States, marufuzz@dasi.msstate.edu

1 - Drone Routing And Optimization For Wildlife Surveillance

Adindu Emelogu, PhD Student, Mississippi State University, 260 McCain Engineering Building, Mississippi State, MS, 39762, United States, aae39@msstate.edu, Sudipta Chowdhury, Mohammad Marufuzzaman, Linkan Bian, Brian Smith

The drone is one of the leading edge technologies developed for military applications with the potential of evolving into useful public and private uses. In this study, we investigate the use of drones in the surveillance and monitoring of wildlife population. Such operation is important for several wildlife conservation and animal health infrastructural initiatives. We formulate the surveillance problem as a mixed-integer linear programming model that determines the location of the drone launching stations and the optimal routing of the drone’s to safely survey the target area and minimize the total location, transportation, and energy costs of the system.

2 - Efficient And Reliable Package Delivery Path Planning For Drones

Mohannad Kabli, Mississippi State University, mrk297@msstate.edu, Sudipta Chowdhury, Mohammad Marufuzzaman

The development of efficient and reliable path for drones is becoming crucial in today's world due to its potential applicability in many commercial purposes. This research focuses on designing an efficient and reliable path planning for the delivery of packages by considering power requirement, collision, altitude, and other related factors into account. The characteristics of the optimal path are expressed in terms of a multi-objective cost function which we solved by using an Adaptive Large Neighborhood Search (ALNS) heuristic.

3 - A Continuum-approximation Approach To Optimize Routing Decisions For Drones Under Extreme Events

Sudipta Chowdhury, Mississippi State University, sc2603@msstate.edu, Adindu Emelogu, Mohammad Marufuzzaman, Linkan Bian

Application of drones in various sectors is becoming common place day by day, and it has got huge potential in humanitarian logistics. This research pertains to optimization of logistics management of drones under extreme events. The key decisions investigated in this study is where to locate the transportation centers, how to assign demand points at each transportation center, and what should be the inventory policy such that the total network cost is minimized. Continuous Approximation (CA) approach is used to solve this problem. As a test bed for computational experiments, coastal region of Mississippi is selected due to its long history of getting affected by various natural disasters.

■ WB60

Cumberland 2- Omni

Routing Optimization Problems

Sponsored: TSL, Freight Transportation & Logistics

Sponsored Session

Chair: Ahmed Ghoniem, Associate Professor, University of Massachusetts Amherst, 121 Presidents Dr., Amherst, MA, 01002, United States, aghoniem@isenberg.umass.edu

1 - A Branch-and-cut-and-price Algorithm For The Generalized Vehicle Routing Problem

Mohammad Reihaneh, University of Massachusetts Amherst, Amherst, MA, 01002, United States, mreihaneh@som.umass.edu, Ahmed Ghoniem

We consider the Generalized Vehicle Routing Problem in which customers are partitioned into mutually exclusive clusters, each with a specific demand. The goal is to construct cost minimizing tours such that exactly one customer is visited in every cluster, subject to vehicle capacity constraints. The proposed specialized branch-and-cut-and-price algorithm compares favorably against state-of-the-art exact algorithms in the literature and closes several open benchmark instances.

2 - A Two-level Optimization Approach For Robust Aircraft Routing And Retiming

Mohamed Haouari, Qatar University, mohamed.haouari@qu.edu.qa

We address the robust aircraft routing and flight retiming problem, and we propose a two-level solution strategy that embeds a simulation-optimization procedure within an evolutionary algorithm. The proposed approach requires inserting buffer times prior to the flight departure times in order to improve the robustness of both aircraft and passengers connections. We present the results of extensive computational experiments that were carried out on a set of real data.

3 - Resource Constrained Arc Routing For Snow Plowing

Joris Kinable, Carnegie Mellon University, Pittsburgh, PA, United States, jkinable@cs.cmu.edu, Willem-Jan Van Hoeve, Stephen F Smith

This work considers a Resource Constrained Arc Routing Problem for snow plowing, a fundamental problem faced by many cold-weather cities. In RC-ARP, routes for a heterogeneous set of vehicles must be computed such that they collectively cover a network of streets, while adhering to various resource (salt) usage and replenishment constraints. We contrast exact and heuristics approaches, as well as a decomposition method. The performance is demonstrated on real-world data from the city of Pittsburgh, PA.

4 - Vehicle Routing Problems With Drone Delivery

Ahmed Ghoniem, University of Massachusetts Amherst, aghoniem@isenberg.umass.edu, Mohamed Haouari, Mohammad Reihaneh

We study a Vehicle Routing Problem with drone delivery. In this setting, a customer is directly visited by a vehicle or his/her demand is indirectly delivered from a neighboring customer using a drone. A mixed-integer formulation is presented along with a branch-and-price algorithm. Alternative solution approaches are investigated for the column generation pricing subproblem and computational results are presented.

■ WB61

Cumberland 3- Omni

Railway Analytics

Sponsored: Railway Applications

Sponsored Session

Chair: Qing He, SUNY Buffalo, Buffalo, NY, United States, qinghe@buffalo.edu

1 - Estimating The Probability And Impact Of Track Defects In Railroad Operations And Maintenance Planning

Alexander Lovett, University of Illinois at Urbana-Champaign, alovett2@illinois.edu

Slow orders and spot maintenance and are used by railroads to mitigate the impact of track defects and ensure safe train operations between capital maintenance actions. Individually, slow orders and spot maintenance do not appear to have a significant cost impact, but in aggregate, they can reduce efficiency and increase costs over the rail network. This presentation will discuss probabilistic methods to predict when slow orders and spot maintenance will be required to allow for more efficient objective track maintenance planning.

2 - Predictive Switch Health

Casey Jen, CSX, Jacksonville, FL, United States, Casey_jen@csx.com, Bob Gutman, Aihong Wen

Among all the Communication and Signal (C&S) components, switches cause biggest number of train delays on line of road. In this study, we leveraged cutting-edge Big Data and Predictive Analytics techniques and developed a set of prediction models to assess future switch health. Taking information from multiple data sources, such as Computer Aided Dispatching System (CADS) event logs, switch inspection records, switch incidents records, and many others, these prediction models will enable CSX to proactively maintain our vital assets and better plan C&S workforce.

3 - Data-driven Optimization Of Railway Track Inspection And Maintenance Using Markov Decision Process

Qing He, University at Buffalo, SUNY, Buffalo, NY, United States, qinghe@buffalo.edu, Siddhartha Sharma, Yu Cui, Zhiguo Li

This paper develops a data-driven condition-based maintenance policy for track inspection. This paper will help in maintaining high service level of the railway tracks which is a difficult task to accomplish. Dataset is two-year track geometry inspection data which contains a variety of geometry measurements for every foot. We employ Markov Chain to model track deterioration, and build a Markov Decision Process for track maintenance decision making and optimize it using value iteration algorithm. By comparing with existing maintenance policy with Markov Chain Monte Carlo simulation, the new maintenance policy developed in this paper can save nearly 10% maintenance costs.

■ WB62

Cumberland 4- Omni

Aviation Economics Decision-making

Sponsored: Aviation Applications

Sponsored Session

Chair: Ricard Gil, Johns Hopkins Carey Business School, 100 International Drive, Baltimore, MD, 21202, United States, ricard.gil@jhu.edu

1 - A Profit Maximizing Integrated Model Of Fleet Assignment And Aircraft Routing With Considerations Of Flight Schedule Disturbances

Muhammed Sutcu, Assistant Professor, Abdullah Gul University, Sumer Campus, Erkilet Bulvari, Kayseri, 38060, Turkey, muhammed.sutcu@agu.edu.tr, Baris Yildiz, Yeliz Yoldas

Airline schedule disturbances are one of the most critical problems due to the unpredictable disruptions such as technical failures and severe weather conditions. In this work, a mixed-integer mathematical model integrating fleet assignment and aircraft routing is proposed to select from among a set of flights and to assign the selected flights to appropriate aircraft for a profitable daily schedule with as minimum delay and idle time in total as possible. The uncertainties of demand, failures of the aircraft and delays arising from adverse weather conditions are also integrated to the corresponding model. To propose a solution methodology for this model is another purpose of this paper.

2 - Prescriptive Analytics In Airline Operations: Cost Index Optimization Through Improved Arrival Time Prediction

Anna Achenbach, PhD Candidate & Research Assistant, WHU - Otto Beisheim School of Management, Burgplatz 2, Vallendar, 56179, Germany, anna.achenbach@whu.edu

Facing enduring cost pressure, the European airline industry has turned to machine learning to enhance their operations. In this paper, we develop a prescriptive model which improves the prediction of an aircraft's flight time taking as inputs different speed levels, flight and weather information. Through a more accurate flight time prediction an optimal cost index can be determined by considering increased fuel burn against cost of time. The study is based on random forest regression combined with convex optimization of the cost index using actual flight data of a European airline.

3 - Adaptation And Relational Contracting In The US Airline Industry

Ricard Gil, Johns Hopkins Carey Business School, 100 International Drive, Baltimore, MD, 21202, United States, ricard.gil@jhu.edu, Myongjin Kim, Giorgio Zanarone

In the airline industry, ex-post adaptation of flight schedules is necessary in the presence of bad weather. When major carriers contract with independent regionals, conflicts over adaptation decisions typically arise. This paper analyzes the importance of relational adaptation in the airline industry. Our model shows that the long-term value of the major-regional relationship must be at least as large as the regional's total cost of adaptation across joint routes. Thus, the major is more likely to preserve routes outsourced to regional airlines that have higher adaptation costs. Using the 2008 financial crisis as exogenous shock, we find consistent evidence with our theoretical predictions.

■ WB63

Cumberland 5- Omni

Location Models in Humanitarian Logistics

Sponsored: Location Analysis

Sponsored Session

Chair: Kayse Lee Maass, University of Michigan, 1205 Beal Avenue, Ann Arbor, MI, 48109-2117, United States, Leekayse@umich.edu

1 - Emergency Shelter Location Analysis And Logistics For Hurricane Preparedness

Nicholas E. Lownes, University of Connecticut, nlownes@engr.uconn.edu

Deterministic and stochastic location models are presented as decision support tools for emergency shelter planning in the state of Connecticut. Several scenarios are evaluated, including local and statewide evacuation strategies. Jurisdictional boundary and backup power generation constraints are also examined in the context of evacuation strategy.

2 - Perishable Commodity Allocation In Humanitarian Supply Chains With Multiple Demand Types

Melih Celik, Middle East Technical University, cmelih@metu.edu.tr, Ozlem Ergun, Julie L Swann

In this study, we consider the allocation of a perishable item in a humanitarian supply chain, which consists of a capacitated warehouse and distribution locations (DLs). Each DL serves multiple demand classes with varying benefits for satisfying the uncertain demand, and applies a usage policy (prioritization of the higher classes or first-come, first-served). We develop algorithms that maximize the expected net benefit of the system. When demand arrivals are Poisson, we establish structural results on relative performance of usage policies and centralization of the DLs. These results are extended using computational experiments based on the H1N1 vaccination campaign in the state of Georgia.

3 - Time-variant Adaptive Robust Optimization For Hurricane Preparedness

Xinfang Wang, Georgia Southern University, Statesboro, GA, 30460, United States, xfwang@georgiasouthern.edu, Jomon A Paul

We propose an adaptive robust model for determining the stockpile location and capacities and impacts of these decisions on social costs (logistic, deprivation and fatality), given time-variant hurricane characteristics. Uncertainty set size is adjusted according to storm advisory released every six hours, making the model adaptive to time-variant uncertainty realization.

■ WB64

Cumberland 6- Omni

Representations and Approximations in Multiobjective Optimization

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Serpil Sayin, Koc University, Istanbul, Turkey, ssayin@ku.edu.tr

1 - On Measures Of Quality For Representations And Approximations

Serpil Sayin, Koc University, ssayin@ku.edu.tr

We revisit the definition of discrete representations of the nondominated set in multiobjective optimization. We focus on the coverage error as a measure of quality, review some related measures and investigate relationships among them. We note that the computational features of a measure become critical while building algorithms that deliver representations that conform to given quality expectations. We report on our computational experience with a lower bound on the coverage error as embedded in a recent algorithm that delivers representations. Finally we analyze the output of our algorithm in relation to an approximation of the nondominated set.

2 - On The Existence Of Ideal Solutions In Multi-objective Binary Programming And Its Applications: Preprocessing, Valid Inequalities, And Probing

Hadi Charkhgard, University of South Florida, Tampa, FL, United States, hadi.charkhgard@gmail.com, Natashia Boland, Martin Savelsbergh

Studying objective functions of multi-objective binary problems (MBPs) can be helpful in detecting MBPs that can be solved in polynomial time. This talk shows that in addition to this important fact, studying this topic can also result in developing some preprocessing, valid inequalities, and probing techniques that can be incorporated in any solver of MBPs. More precisely, this talk focuses on studying objective functions to show that under which conditions a MBP has an ideal solution. Based on that, it shows that (1) how the number of objectives may be reduced; (2) how some classes of valid inequalities may be generated; and (3) how the size of a MBP may be reduced by eliminating some certain variables.

3 - A Novel Multi-criteria Optimization Method For Volumetric Modulated Arc Therapy (vmat) Treatment Planning

Gokhan Kirlik, University of Maryland School of Medicine, Baltimore, MD, 21201, United States, gokhankirlik@umm.edu, Warren D. D'Souza, Hao Howard Zhang

Volumetric modulated arc therapy (VMAT) is one of the radiation therapy techniques for cancer patients. In VMAT, the main goal is to deliver right amount of radiation dose to the tumor while sparing the normal tissue. Therefore, VMAT requires considering several conflicting objectives, which is called multi-criteria optimization (MCO). In MCO, efficient solutions are used instead of the optimal solution. In this study, we use achievement scalarization to obtain efficient solutions for VMAT. We tested our approach on 10 locally advanced head-and-neck cancer cases. We demonstrated that the proposed MCO method was able to obtain VMAT plans with significant improvement in dosimetric plan quality.

■ WB65

Mockingbird 1- Omni

Digital Innovation & Analytics

Sponsored: Information Systems

Sponsored Session

Chair: Eun Ju Jung, George Mason University, George Mason University, Fairfax, VA, 22030, United States, ejung6@gmu.edu

1 - Promotion Strategy, Operating Mechanism, And Economic Value Of Digital Platform For Consulting Services: A Two-sided Market Perspective

Tae Hun Kim, Michigan State University, East Lansing, MI, United States, thkim@broad.msu.edu, Kyung Ho Song, Daegon Cho

A platform plays as a two-sided market by matching clients with consultants in a digitized way for consultancy. To show its value, we focus on promotion strategy, operating mechanism, and economic impact. The success depends on its attraction for potential customers initially and IT-mediated operation for existing clients over time. Its economic value is explained for both client and consultant sides. We first explore possible ways to promote the digitized services. Second, specific IT features are identified to enable user engagement and interactions. Finally, economic value is analytically proved by a pricing model for the two-sided market and a synergy between online and offline services.

2 - Justification And Justice Matter: Organizational Attention To Ideas On Digital Innovation Platforms

Inchan Kim, University of New Hampshire, Durham, NH, United States, i.kim@unh.edu, John Qi Dong

Digital innovation platforms allow crowdsourcing of ideas, in effect generating big data for organizations. Then, to which ideas do organizations direct their focus? Based on the six logics of justification together with the four justice principles, we use qualitative comparative analysis (QCA) to analyze the configurational impacts of justification and justice reflected in ideas from MyStarbucksIdea.com on organizational allocation of attention.

3 - Domain Specific Lexicon For Clinical Trial Subject Eligibility Analysis

Euisung Jung, University of Toledo, Euisung.Jung@utoledo.edu

It is well understood that an NLP application requires sophisticated lexical resources to support its processing goals. Different solutions have been proposed to identify multi-gram disease named entities in the healthcare informatics literature. In this study, we develop a domain-specific lexicon for n-gram Named Entity Recognition (NER) in the breast cancer domain. The domain-specific dictionary was evaluated by comparing it with Systematized Nomenclature of Medicine—Clinical Terms (SNOMED CT). The results showed that it add significant number of new terms which is very useful in effective natural language processing.

■ WB66

Mockingbird 2- Omni

Graph Analytics for Complex Systems - II

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Hoang Tran, Texas A&M University, Address, College Station, TX, United States, tran@tamu.edu

Co-Chair: Satish Bukkapatnam, Texas A&M University, College Station, College Station, TX, United States, satish@tamu.edu

1 - Generalized Graph Shortest Path For Calibration Of Computer Simulations.

Babak Farmanesh, Oklahoma State University, farmane@ostatemail.okstate.edu

Calibration refers to the process of adjusting parameters of a computer simulation so that the simulation responses match the corresponding physical responses. Calibration can be interpreted as a curve to surface matching problem. We propose a graph-theoretic non-isometric matching approach to solve this problem using the graph shortest path algorithm in one-dimensional spaces. For higher dimensional spaces, we introduce the generalized shortest path concept to solve the matching problem.

2 - Spectral Graph Theoretic Sensor Fusion

Prahalad Rao, Binghamton University, prao@binghamton.edu

The central theme of this talk is motivated from the compelling need for sensor-based in situ quality assurance approaches in complex systems and processes, such as additive manufacturing (AM). The key research question is: how to fuse information from multidimensional sensor signals for monitoring and prognosis? The proposed approach maps a multidimensional signal as an un-weighted undirected network graph. Through this talk, it is demonstrated that graph theoretic signal processing has the potential to monitor complex systems in a data rich environment.

3 - Learning Data Association Graph

Chiwoo Park, Florida State University, 2525 Pottsdamer St., Tallahassee, FL, 32310, United States, cpark5@fsu.edu, Taylor J. Woehl, James E. Evans, Nigel Browning

We presents a general formulation for a minimum cost data association problem which associates data features via one-to-one, m-to-one and one-to-n links with minimum total cost of the links. A motivating example is a problem of tracking multiple interacting targets imaged on video frames. Many existing multitarget tracking methods are capable of tracking non-interacting targets or tracking interacting targets of restricted degrees of interactions. The proposed formulation solves a multitarget tracking problem for general degrees of inter-object interactions.

4 - Measuring Redundancy Of State Estimators In Large Networks By Combining L1-minimziation And Integer Programming

Vishnu Vijayaraghavan, Texas A&M University, College Station, TX, 77843, United States, vishnunitr@tamu.edu, Kiavash Kianfar, Yu Ding, Hamid Parsaei

Finding the degree of redundancy for structured linear systems is proven to be NP-hard. Bound-and-decompose, 0-1 mixed integer programming (MIP) and hybrid algorithms embedding 0-1 mixed integer programming within a bound-and-decompose framework have all been studied and compared in the literature. In this paper we take advantage of the computational efficiency of linear programs to present an l1 minimization approach combined with mixed integer programming to address this problem. This approach proves to be very effective in measuring redundancy of state estimators in large networks.

■ WB67

Mockingbird 3- Omni

Joint Session QSR/DM: Process Monitoring for Diverse Types of Data

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Youngseon Jeong, Annandale, VA, United States, youngseonjeong@gmail.com

Co-Chair: Myong K Jeong, Rutgers University, Piscataway, NJ, United States, mjeong@rci.rutgers.edu

1 - Bayesian Based Distribution Free Procedure For Fault Identification

Mehmet Turkoz, Rutgers University, 16 Rachel Terrace, Piscataway, NJ, 08854, United States, turkoz@scarletmail.rutgers.edu, Sangahn Kim, Youngseon Jeong, Myong K Jeong, Elsayed A. Elsayed, A.M.S. Hamouda, Khalifa Al-Khalifa

Many real life process control problems do not follow multivariate normal distribution. In a process with unknown underlying distribution, identifying fault variables of an out-of-control signal is a challenging issue for quality problems. In this research, we present a new Bayesian fault identification method that does not assume any specific probability distribution.

2 - Modeling And Shape Control Of Large Composite Components For Section-to-fuselage Joints

Yuchen Wen, Gatech, ycwen@gatech.edu

Shape control of large composite components is important in aerospace industry. The current method of shape control has limitations of low efficiency and non-optimal. We propose a surrogate-model based optimal shape control strategy in order to achieve dimensional variation reduction and efficient shape adjustment in large composite parts assembly process. The objective is accomplished by (i) Investigating a surrogate model to achieve good prediction performance; (ii) Conducting multi-objective optimization to determine the control actions from the Pareto solutions; (iii) Implementing the sensitivity analysis to determine the best number and positions of the locators.

3 - Process Tracking And Monitoring Based On Discrete Jumping Model

Chao Wang, University of Wisconsin-Madison, Madison, WI, United States, cwang436@wisc.edu, Shiyu Zhou

Jumping model has been used as an effective tool in tracking and detecting changes for continuous statistics in various applications. In this paper, we extend the current jumping model from the continuous case to the discrete case to track and monitor the changes in attribute data. The jumping model based posterior distribution of the process mean is constructed with attribute data and prior knowledge of the process. Using the posterior distribution, a control chart is then developed to monitor the attribute data process.

4 - A New Bayesian Classification Model For Uncertain Data

Young-Seon Jeong, Chonnam National University, Gwangju, Korea, Republic of, youngseonjeong@gmail.com, Byunghoon Kim, Myong K Jeong, Jeongsub Choi, Soonmok Kwon, Jihoon Kang

This talk presents a new Bayesian classification model which considers the correlation among uncertain features. Even though several classifiers for uncertain data have been developed, they did not consider the dependency among uncertain features, which have a critical effect on classification accuracy. Experimental results with simulated data and real-life data show that the proposed approach for uncertain data is more accurate than existing approaches.

■ WB68

Mockingbird 4- Omni

Spatiotemporal Data based Quality Control Methods in Manufacturing

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Mohammed Saeed Shafae, Virginia Tech, 112 Durham Hall, 1145 Perry Street, Blacksburg, VA, 24061, United States, shafae1@vt.edu

Co-Chair: Lee Wells, Assistant Professor, Western Michigan University, E-208 Floyd Hall, 1903 W Michigan Ave, Kalamazoo, MI, 49008, United States, lee.wells@wmich.edu

1 - Spatial Discrete Model For Clustered Defects On Wafer Maps

Hao Wang, Tsinghua University, w-h14@mails.tsinghua.edu.cn

Yield, which contributes to increase the process quality, is a key concern in the fabrication of semiconductor wafers. In this paper, we propose a novel discrete spatial model based on discrete spatial defects data on wafer maps for analyzing and predicting the yields at different chip locations. Based on the Bayesian framework, we adopt a generalized linear model that considers both the spatial coordinates and random spatial error, thereby significantly improving the performance of the model. The experimental results show that the generalized linear Poisson model that considers both the spatial coordinates and random spatial error offers an improved fit to spatially correlated wafer map data.

2 - Spatial Models In Metal Additive Manufacturing

Bianca Maria Colosimo, Politecnico di Milano, Milano, Italy, biancamaria.colosimo@polimi.it, Marco Grasso

Additive manufacturing is more and more often moving from prototyping to production and this is why new methods and tools for quality inspection and monitoring are needed. In order to model shapes and internal defects, spatial models can be used. This talk shows how spatial modeling can be used to model complex shapes and internal defects (e.g., porosity) in metal additive manufactured products.

3 - Reduced-dimension Mcusum Chart For Spatio-temporal Surveillance

Junzhuo Chen, Georgia Institute of Technology, Atlanta, GA, United States, jz.chen@gatech.edu, Seong-Hee Kim, Yao Xie

In spatiotemporal surveillance, control chart with scan statistics is a powerful method. Usually calculating monitoring statistic requires observations from the whole monitoring area and the full covariance matrix inversion. However, if the dimensionality is high, implementation can be challenging. First, it is hard to estimate the full covariance matrix. Second, the computation of matrix inversion is expensive. Finally, collecting data from all the sensors may be costly. To address such issues, we propose the Reduced-Dimension MCUSUM chart that constructs the monitoring statistic using measurements from a small group of locations. We conduct simulations to study performance of the method.

■ WB69

Old Hickory- Omni

Network Design and Optimization

Sponsored: Telecommunications

Sponsored Session

Chair: Richard Li-Yang Chen, Sandia National Laboratories, 7011 East Ave, Livermore, CA, 94550, United States, rlchen@sandia.gov

1 - Modulation Design For MIMO HARQ Channel

Hans Mittelmann, Arizona State University, mittelma@asu.edu, Wenhao Wu, Zhi Ding

Modulation diversity (MoDiv) is a simple and practical transmission enhancement technique that utilizes different modulation mappings to reduce packet loss rate and achieve higher link throughput. MoDiv is particularly meaningful and effective in hybrid-ARQ systems. We study the deployment and optimization of MoDiv for HARQ in a MIMO-coordinated multi-point (MIMO-CoMP) scenario to mitigate packet loss. We formulate the design optimization of MoDiv into a quadratic three-dimensional assignment problem (Q3AP), then solve it using a modified iterated local search (ILS) method. Numerical results demonstrate clear performance gain over simple retransmissions and over a heuristic design.

2 - A Robust Optimization Approach For Network Interdiction

Amelia Musselman, Georgia Institute of Technology, Atlanta, GA, United States, amusselman@gatech.edu, Richard Li-Yang Chen, Janson Wu

Networks arise in many systems that play an integral role in our daily lives, from the internet to the national electric grid. It is important to protect these networks from potential attacks. However, oftentimes the budget for network security is limited, and the effectiveness of various defense mechanisms may be uncertain. In this research we develop a robust optimization algorithm for selecting defense options to strengthen network security with a limited budget. We use a bi-level programming model, where the adversary's goal is to maximize damage to the system while the defender's goal is to minimize this damage. We test our method on a large synthetic problem of the U.S. supply chain network.

■ WB70

Acoustic- Omni

Transportation, Ops II

Contributed Session

Chair: Antoine Petit, U of Illinois at Urbana-Champaign, 205 N Mathews Avenue, # B156, Urbana, IL, 61801, United States, apetit@illinois.edu

1 - Travel Time Estimation Based On Complex Networks Within A DTA Framework

Rui Chen, Tsinghua University, Shunde building of Tsinghua University, Beijing, China, chenruiest@163.com, Satish Ukkusuri

Data-driven estimation based on complex networks is a most important one of new methods which could deal with DTA for both associated mathmatical properties and computational ability. Therefore, we proposed a data-driven travel time estimation model based on Complex Networks within a DTA framework.

2 - System Optimal Traffic Signal Control Under Dynamic User Equilibrium

Rui Ma, Postdoc Scholar, University of California, Davis, 1001 Ghausi Hall, One, Davis, CA, 95616, United States, drma@ucdavis.edu, Hao Yu, Michael Zhang

Dynamic user equilibrium (UE) introduces nonlinear constraints with time-varying state-dependent delay terms. An optimal traffic signal control framework is proposed to find the signal control settings that minimize the total travel time in a road network, as well as maintaining the UE condition and other realistic spillback constraints. In this study, a heuristic solution method is proposed to solve the nonlinear problem with time-varying, state-dependent delays. The resulting solution satisfies the desired properties, which suggests the proposed solution algorithm is better than the previous introduced method with approximation by constant time delays.

3 - Managing The Daily Operations Of A Bike Sharing System Using Portable Stations

Rahul Swamy, PhD Student, University of Illinois Urbana-Champaign, Champaign, IL, 61820, United States, rahulswa@illinois.com, Jose Luis Walteros

This research aims to provide an integrated mathematical framework for operating a bike-sharing system using portable stations. We propose solving a sequence of MILPs to optimally determine the locations of portable stations across a time period in order to minimize redistribution logistics. A Bender's decomposition based solution strategy is presented. Existing work in this area treat this problem separate from the bike station location problem. We propose an integrated approach.

4 - The Impact Of Demand Uncertainty On Subsidy Design In BOT Road Projects

Zhuo Feng, Dalian University of Technology, No. 2 Linggong Road, Dalian, 116024, China, zhfeng@dlut.edu.cn, Yiwen Zhang

The private investor faces substantial demand uncertainty in BOT (Build-Operate-Transfer) road projects, which depresses her participation. To attract private investors, the government often offers subsidies in some BOT road projects. In this paper, we will mainly consider usage-based subsidy. We first examine the impact of demand uncertainty on the government's subsidy design by considering the private investor's response in designing toll price and road capacity. We further make two extensions by locating the project in a road network and by considering the private investor's information advantage of her operating cost, respectively.

5 - An Optimized Insertion Method To Prevent Bus Bunching: Simulation And Comparisons

Antoine Petit, U of Illinois at Urbana-Champaign, 205 N Mathews Avenue, # B156, Urbana, IL, 61801, United States, apetit@illinois.edu, Yanfeng Ouyang

Bunching is an inherent problem in transit systems, due to the randomness of passengers arrival and traffic conditions. Because maintaining regular bus headways is critical for providing a satisfactory service to the passengers, transit agencies developed strategies to mitigate this problem. Although convenient, those methods fall short if they were not optimized. This work proposes an optimized bus insertion approach to prevent bus bunching, by minimizing the in-vehicle travel time and the agency costs. Managerial decisions will include the location and size of the idling fleet, and the headway threshold to put the extra buses in service.

■ WB71

Electric- Omni

Game Theory II

Contributed Session

Chair: Meilin He, University at Buffalo, SUNY, 4291 Chestnut Ridge Rd. Apt 5, Buffalo, NY, 14228, United States, meilinhe@buffalo.edu

1 - Cooperative Game Theory Applied To Clusters Competitive Value

Dionicio Neira, Universidad de la Costa, CUC, Barranquilla, Colombia, dneira1@cuc.edu.co, Daniela Carolina Landinez, Diana Gineth Ramirez-Ríos, Luis Eduardo Ramirez

This research is based on the analysis of supply chains in clusters, where it is known that the competitiveness of the company participating in the cluster contributes to the cluster's competitive value as a whole. This paper proposes cooperative game theory to suggest the contribution of these companies, which is based not only on its individual competitiveness but also on its willingness to cooperate. Shapley value was calculated to obtain a solution that is both stable and feasible for the companies involved.

2 - An Evolutionary Stochastic Multi Agent Game To Forecast The Procurement Of Food Grains From Farmers In a Public Distribution System

Sankaranarayanan G, Research Scholar, IIT-Kharagpur, B-121 Sir Acharya Jagadish Chandra Bose, IIT-Kharagpur Campus, Midnapore, 721302, India, samhara23@gmail.com, Sri Krishna Kumar, Manoj Kumar Tiwari

A stochastic multi-agent evolutionary game is proposed to obtain forecast of the procurement of food grains in a public distribution system for effective decision making in supply chain planning and ensuring preparedness in presence of Interdictions.

3 - Regret-optimal Strategies For Playing Repeated Games With Discounted Losses

Vijay Kamble, Stanford University, Stanford, CA, United States, vijaykamble.iitkgp@gmail.com

The regret-minimization paradigm has emerged as a powerful technique for designing algorithms for online decision-making in adversarial environments. But so far, designing exact minmax-optimal algorithms for minimizing the worst-case regret has proven to be a difficult task in general, with only a few known results in specific settings. In this paper, we present a novel set-valued dynamic programming approach for designing such exact regret-optimal policies for playing repeated games with discounted losses. As an illustration of our approach, we design the first known near-optimal strategy for prediction using expert advice for the case of 2 experts and discounted losses.

4 - An Attacker-defender Resource Allocation Game With Complementary Or Substituting Effects

Meilin He, University at Buffalo, SUNY, 4291 Chestnut Ridge Rd. Apt 5, Buffalo, NY, 14228, United States, meilinhe@buffalo.edu, Jun Zhuang

This work develops a game-theoretical model for the government's resource allocations facing with strategic attackers, with consideration of the complementary or substituting effects. We study how the joint effectiveness and the uncertainty of the interactions between different security programs influence the defender's and the corresponding attacker's strategies. Then we explore the dynamics between defender and attacker. We provide numerical illustrations using real data, then compare the results of the models with and without the joint effectiveness coefficient. Finally, we conduct the sensitivity analysis. This research helps provide new insights into security budget allocation.

■ WB72

Bass- Omni

Supply Chain Mgt XIV

Contributed Session

1 - The Effect Of Store-Induced Returns on Warehouse Store Supply Chain

Hao-Wei Chen, San Jose State University, San Jose, CA, 95125, United States, hao-wei.chen@sjsu.edu, Wen-Ya Wang

In a warehouse clubs supply chain, the suppliers are usually responsible for any cost induced by merchandise returns. When a product has a higher than usual return rate, a store may strategically ask other customers to return their same purchases voluntarily in order to maintain store reputation. We study how such a strategy affect the quality of the product provided by the supplier and the profits of the supplier and the retailer.

2 - The Impact Of 3D Printing On Spare Parts Management

Jakob Heinen, PhD Candidate, Kühne Logistics University, Großer Grasbrook 17, Hamburg, 20457, Germany, johannes.jakob.heinen@the-klu.org, Kai Hoberg

Based on logistical decision parameters and supply chain performance criteria, the research aims to identify spare parts that offer a potential for 3D printing. A theoretical model is developed contrasting subtractive (conventional) production with inventories against a production using 3D printers with no or highly reduced inventories. In calculating the optimal inventory policies for both manufacturing approaches, we identify cost settings where additive manufacturing is preferable over traditional manufacturing. In addition, a large data set of spare part inventory and demand data is utilized to provide a use case for the introduced model.

3 - Outsourcing With Learning-by-doing: The Case Of Two Oems

Min Wang, Drexel University, 3220 Market Street, Philadelphia, PA, 19104, United States, mw638@drexel.edu, Wenjing Shen

In this paper, we consider two OEMs outsourcing to a single powerful CM, and both OEMs and CM can learn from production to reduce future cost. We show that even if the two OEMs do not compete with each other, the presence of another OEM outsourcing to the same CM can have a significant impact on an OEM.

4 - Robust Optimization Of The Beer Distribution Game Incorporating Uncertainties In Forecasted Customer Demand

Adarsh Elango, Application Engineer, ESTECO North America, 39555 Orchard Hill Place, Suite 457, Novi, MI, 48375, United States, elango@esteco.com, Saket Kansara, Zhendan Xue

This paper introduces a novel concept of adding uncertainty over the customer demand cycle to the well-known theoretical example - Beer Distribution Game. The added uncertainties make the model a closer representation of the real market dynamics. A robustness assessment as well as a robust optimization approach is used to determine the best ordering policies across an entire supply chain. Various optimization formulations such as single objective and multi-objective have been compared using traditional and robust optimization approaches.

■ WB73

Legends A- Omni

Operations Management VI

Contributed Session

Chair: Xiaochun Feng, Dalian University of Technology, No.2 Linggong Road, Ganjingzi District, Dalian, 116024, China, fxc11011@126.com

1 - Coauthor Network Analysis Of Operations Management Journals

Bonie(He) Zhang, PhD Candidate, Rutgers University, 1 Washington Park, # 196 Mailbox, Newark, NJ, 07102, United States, boniezhang331@gmail.com, Yao Zhao

We study the co-author network of flag-ship INFORMS journals in operations management such as Management Science and Operations Research. We present our modeling approach and our empirical exploration characterizes the changing patterns of the co-author network and provides insights to authors on how to improve productivity through exploitation of the academic social network.

2 - Hybrid Flow Shop Scheduling Problem With Parallel Lines

Arshad Ali, PhD Student, University of Manitoba, Winnipeg, MB, Canada, alia@myumanitoba.ca, Yuvraj Gajpal, Tarek Y. El Mekkawy

This paper considers the special case of hybrid flow shop problem where machines are arranged in parallel lines. Each line has multiple stages but the number of stages in each line are same. A job is required to go through only one of the lines to become final product. One job can be assigned to only one line. The problem involves finding job sequence for each line to minimize the total competition time of jobs. Three heuristics has been developed to solve the problem. A new benchmark problem instances has been created to evaluate the performance of the proposed heuristics.

3 - A Three-stage Intelligent Solution Approach To Order Picking Scheme For Vegetables Under B2c Direct Sale In China

Xiaochun Feng, Dalian University of Technology, No.2 Linggong Road, Ganjingzi District, Dalian, 116024, China, fxc11011@126.com, Xiangpei Hu

The paper focuses on the 'farm-to-door' order picking problem of organic vegetables in online direct sales, with the objective of enhancing the scientific, efficient and on-time processing level. Taking online order picking scheme generation as a breakthrough point, by applying the theories of fuzzy clustering artificial intelligence and operational research, this paper presents a three-stage solution approach to order picking problem that aims to significantly reduce the solution's state space. Finally, a numerical example is used to demonstrate the efficiency of the intelligent solution approach.

■ WB74

Legends B- Omni

Ops Mgt/Marketing II

Contributed Session

Chair: Jiahua Wu, Imperial College Business School, Office 382, Tanaka Building, Imperial College London, London, SW7 2AZ, United Kingdom, j.wu@imperial.ac.uk

1 - Selective Newsvendor Problem With Dependent Lead Time And Marketing Decisions

Jianing Zhi, Penn State Erie The Behrend College, Eire, PA, 16509, United States, jzz5296@psu.edu, Burcu B Keskin

We consider a company that experiences quantity-dependent lead times from the supplier. Due to a limited sales force and lead time issues, the company may not be able to meet all customer demands. We develop mixed integer nonlinear programming model to maximize the total expected profit by determining order quantity, demand satisfaction percentage, and agent-customer match up. We evaluate the model with varying parameters, including demand, lead time, capabilities of agents, and waiting time tolerance of customers to estimate their impacts on total expected profit, ordering policies and marketing strategies.

2 - The Impact Of Consumer Quality Target On Product Line Design

Lucy Gongtao Chen, National University of Singapore, NUS Business School, Biz 1 Mochtar Riady Building, #8-60, Singapore, 119245, Singapore, bizcg@nus.edu.sg, Qingshan Kong

In this paper, we study a firm's product line design when consumers care about not only the offered product quality but also the difference between the offered quality and their target quality level. In a market where consumers have heterogeneous quality targets, we find that targets have a significant impact on the product line offering strategy. In particular, both single product line strategy and full product line strategy can be optimal and when a full product line is offered, both the downward distortion of the low quality level and the upward distortion of the high quality level can be possible.

3 - Big Data vs Small Data: Consumer Profiling With Data Requirements

Jiahua Wu, Imperial College Business School, Office 382, Tanaka Building, Imperial College London, London, SW7 2AZ, United Kingdom, j.wu@imperial.ac.uk, Tommaso Valletti

We consider a model where a monopolist can profile consumers in order to price discriminate among them, and consumers can take costly actions to protect their identities and make the profiling technology less effective. We show that the optimal investment level from the monopolist is closely related to the flexibility of consumers to conceal their identities as well as to data requirements.We also show that the monopolist has a tendency to invest excessively.

■ WB75

Legends C- Omni

Economics II

Contributed Session

Chair: Lorena Alexandra Berumen, Universidad Panamericana, Augusto Rodin 498, Ciudad de Mexico, Mexico, laberumen@up.edu.mx

1 - information Aggregation In Markets With Heterogenous Traders

Yaarit Even, Columbia Business School, 601 W 113th Street, Apt 2k, New York, NY, 10025, United States, yeven18@gsb.columbia.edu, Alireza Tahbaz-Salehi

We study a rational expectations model, consisting of heterogenous traders with private information. We show that the extent of heterogeneity in the market determines the extent of information revelation via prices and equilibrium inefficiency. In particular, we show that as the heterogeneity in trader valuations is increased, the rational expectations equilibrium would reveal less information about agents' private information. Furthermore, this reduction in the extent of information revelation leads to more inefficient equilibria.

2 - Is The Chinese Macro Financial System More Resistant To Outside Shocks

Yunfei Cao, Beijing Institute of Technology, Beijing, China, caoyunfei1986@163.com, Youzong Xu, Yi Zhang

Using the flow data in the macroeconomic accounts of China's macro-financial system from 1998 to 2012, we develop a dynamic network of the interdependent macro sectors that depicts the connections between the main financial and non-financial sectors in the Chinese economy. Based on this network, we examine the evolution and weakness of China's macro-financial system by investigating the shock propagation processes. We find that even though by absolute value the foreign sector plays a much smaller role than all the other sectors in China's macro-financial system, a shock to the foreign sector causes larger loss to the whole Chinese macro-financial system than shocks to other sectors do.

3 - Foreign Direct Investment In Mexico: A Spatial Approach

Lorena Alexandra Berumen, Universidad Panamericana, Augusto Rodin 498, Ciudad de Mexico, Mexico, laberumen@up.edu.mx, Roldán Andrés-Rosales, Margarita Hurtado

Foreign Direct Investment (FDI) has played an important role in the growth and development of the Mexican economy. The main contribution of this work is the analysis of FDI by sector and of its spillover effect in the different regions in which FDI has been concentrated. Using spatial panel data and a spatial Durbin Model to assess the direct and indirect effects of FDI, we find that in some regions there are positive or negative impacts depending on the sectors.

■ WB76

Legends D- Omni

Applied Probability II

Contributed Session

Chair: Amod Basnet, University of North Carolina-Charlotte, 9201 University City Blvd, Fretwell, Charlotte, NC, 28262, United States, abasnet@uncc.edu

1 - Optimal Capacity Management With Limited Buffer

Melda Ormeci Matoglu, University of New Hampshire, University of New Hampshire, 10, Durham, NH, 03824, United States, melda.ormecimatoglu@unh.edu

We use a Brownian motion to model the problem of managing capacity and determining optimal buffer size in a BTO environment. The controller can change the processing rate as well as reject orders or idle the system. We seek a policy that minimizes long-term average cost of control and holding cost. We show that a simple control band policy is optimal and determine its parameters.

2 - Efficient Markov Chain Decomposition Algorithm Based On The Total Expectation Theorem

Katsunobu Sasanuma, Assistant Professor, Stony Brook University, Stony Brook, NY, 11794, United States, katsunobu.sasanuma@stonybrook.edu, Stephen Roehrig, Robert Hampshire, Alan Scheller-Wolf

We propose an efficient decomposition algorithm for solving large Markov Chains, based on the total expectation theorem (the law of total expectation) applied in a Markov Chain setting. Tests of our algorithm on several examples show that it possesses an exponential speed of convergence in terms of the number of iterations. We also discuss potential Markov chain structures that could cause a slowdown of convergence and propose the means to overcome these issues.

3 - How The Swine Flu Epidemic Spread: Lessons From The Data

Jussi Keppo, National University of Singapore, Mochtar Riady Building, BIZ 1 8-69, 15 Kent Ridge Drive, Singapore, 119245, Singapore, keppo@nus.edu.sg, Elena Quercioli, Lones Smith

Contagious diseases are passed on when contagious and susceptible individuals meet. This paper introduces and explores a new matching game, characterized by individuals meeting pairwise, possibly unwittingly passing along a disease in a contagion-like fashion. We assume that individuals can expend costly effort to avoid acquiring it. In this population game, efforts are strategic substitutes: The harder other individuals try, the more lax one can be. We solve for the unique Nash equilibrium when individuals are heterogeneous. We then estimate this structural model and argue that it improves on the explanation of the data without endogenous behavior.

4 - An Unbiased Measure Of Integrated Volatility In The Frequency Domain

Fangfang Wang, University of Illinois at Chicago, 601 South Morgan Street, Chicago, IL, 60607, United States, ffwang@uic.edu

This work studies the effect of market microstructure noise on volatility estimation in the frequency domain. We propose a bias-corrected periodogram-based estimator of integrated volatility. We show that the new estimator is consistent and the central limit theorem is established under a general assumption of the noise. We also provide a feasible procedure for computing the bias-corrected estimator in practice. As a byproduct, we extract a consistent frequency-domain estimator of the long-run variance of market microstructure noise from high-frequency data.

5 - A Parallel Computation Of Characteristics Of Markov Chains With “Islands” And “Ports”

Amod Basnet, University of North Carolina-Charlotte, 9201 University City Blvd, Fretwell, Charlotte, NC, 28262, United States, abasnet@uncc.edu, Isaac M Sonin

We present a new algorithm to calculate the invariant distribution of a large Markov chain (MC) whose state space is partitioned into “islands” and “ports”. An island is a group of states with potentially many connections inside of the island but a relatively small number of connections between islands. The states connecting different islands are called “ports”. Our algorithm is developed in the framework of the “state reduction approach”, but the special structure of our MCs allows for computations to be performed in parallel. Additional problems for such MCs, including computation of a Fundamental matrix, optimal stopping, and the case of small transitions between islands are also analyzed.

■ WB77

Legends E- Omni

Opt, Integer Programing VI

Contributed Session

Chair: Andrea L. Arias, Graduate Student, Texas Tech University, 4425 82nd Street, Apt 2258, Lubbock, TX, 79424, United States, andrea.arias@ttu.edu

1 - A Branch And Price Approach For Deployment Of Multi-tier Software Services In Clouds

Bjorn Nygreen, Retired, Dept. of Ind. Econ. & Techn. Management, NTNU, Trondheim, NO 7491, Norway, bjorn.nygreen@iot.ntnu.no, Anders Nordby Gullhav

This talk considers a problem of a cloud service provider (SP) that offers a set of applications to its end-users. In short, the SP seeks to find the minimum cost deployment of its services on an infrastructure consisting of a private and public cloud, while maintaining a certain quality of service. We propose to solve the problem using branch and price, where the sub problem is solved both by a MIP solver and a heuristic label-setting algorithm. Our results show the benefits of using the heuristic in addition to the exact MIP solver.

2 - Project Scheduling And Multi-skill Workforce Assignment For Property Management Applications

Anthony Vatterott, Assistant, University of Missouri Saint Louis, 1 University Boulevard, Saint Louis, MO, 63121, United States, anthonygvatterott@gmail.com, Haitao Li, Norman Keith Womer

We present a new optimization framework to schedule, assign and route maintenance tasks with a multi-skilled workforce. Mixed integer programming methods are applied to obtain effective and efficient solutions to advance the state-of-the-art of property management. Practical emphasis on job priority, skill development and knowledge transfer are considered to form the temporal, spatial and resource constraints while minimizing the total cost of project delivery.

3 - Optimal Selection Of Parsimonious Arima Forecasting Models

George G Polak, Professor, Wright State University, 227 Rike Hall, Raj Soin College of Business, Dayton, OH, 45435, United States, george.polak@wright.edu, Bogdan C Bichescu

In a parsimonious ARIMA Forecasting model the total number of terms chosen is constrained, and treatment for nonstationarity is limited to differencing of a pre-specified order. Accordingly, a term for non-stationary variation is included along with autoregressive, moving average and white noise terms in a decomposition of the time series. Mixed integer quadratic optimization problems are then formulated for prescribing model parameters. Walsh functions and Haar wavelets are employed to represent white noise and non-stationary variation, respectively.

4 - A Comparative Analysis Of MILP Formulations For The Multi-family Capacitated Lot-sizing Problem (MFCISP)

Andrea L. Arias, Graduate Student, Texas Tech University, 4425 82nd Street, Apt 2258, Lubbock, TX, 79424, United States, andrea.arias@ttu.edu, Andrea L. Arias, Graduate Student, P. Universidad Católica de Valparaíso, Valparaíso, Chile, andrea.arias@ttu.edu, Ricardo A. Gatica

The MFCLSP is a variant of the CLSP with setup times in which items are organized into families. We present three MILP models for the MFCLSP (TRAD, LI and RC), and develop a comparative analysis in order to evaluate their performance using Cplex. Since solving large-scale problems has been shown to consume a great amount of computational time (very unviable for application purposes), we examine the performance of the formulations under solving time constraints. The results show a major advantage for both LI and RC regarding to linear relaxation bounds, and that RC performs much better in terms of computational time to obtain the first feasible solution, yielding at the same time, very good optimality gaps.

■ WB78

Legends F- Omni

Opt, Metaheuristics II

Contributed Session

Chair: Clara Novoa, Associate Professor, Texas State University, 601 University Dr, San Marcos, TX, 78666, United States, cn17@txstate.edu

1 - Information Supply Chain Optimization With Bandwidth Limitations

Michael Hirsch, ISEA TEK, LLC, 3283 Hickory Lane, Longwood, FL, 32779, United States, mhirsch@iseatek.com, Hector Juan Ortiz-Pena

Workflow management systems allow for visibility, control, and automation of many business processes. Recently, non-business domains have taken an interest in the management of workflows, and the optimal assignment and scheduling of workflow tasks to users across a network. This research aims at developing a rigorous mathematical programming formulation of the workflow optimization problem. The resulting formulation is non-linear, but a linearized version is produced. Three heuristics are developed to find solutions efficiently. Computational experiments are presented and analyzed, comparing solutions to the original linearized formulation with the three heuristics.

2 - An Intelligent Production Control System For Automotive Parts Manufacturing With A CPS Approach

Jun Kim, Sungkyunkwan University, Suwon, Korea, Republic of, tomatoes10@skku.edu, Hyun Jung Kim

This paper examines an intelligent production control system for automotive parts manufacturing based on a cyber-physical systems (CPS) approach. We propose a CPS-based operations monitoring platform that helps decision-making processes in production management such as predicting undesirable events and reacting to such problems in advance. Various issues in designing and implementing a CPS platform for engine piston manufacturing processes are addressed.

3 - An Efficient Heuristic For The Capacitated Lot Sizing Problem With Setup Carryover And Splitting

Srimathy Mohan, Associate Professor, Arizona State University, Department of Supply Chain Management, W.P. Carey School Of Management, Phoenix, AZ, 85069-7100, United States, srimathy@asu.edu, Cheng-Lung Chen, Muhong Zhang

We present a new formulation for the Capacitated Lot Sizing Problem with Setup Carryover and Setup Splitting. Setup carryover transfers a completed machine setup from one period to the next. Setup splitting completes a setup across period boundaries. We present a Fix-and-Optimize heuristic that is easy to adapt for model extensions. Our extensive experimentation shows that the heuristic produces results within 6% and 8% of optimality for problems without and with demand backlogging, respectively.

4 - Biased Randomization: Heuristics In Transportation, Logistics, And Production

Alex Grasas, EADA Business School, C/ Arago 204, Barcelona, 08011, Spain, agrasas@eada.edu, Angel A Juan, Javier Faulin, Jesica De Armas, Helena Ramalhinho

This paper reviews heuristics that contain biased-randomized procedures (BRPs). A BRP is a procedure that uses a biased probability distribution to select the next constructive movement at each algorithm's iteration. BRPs can be categorized into two main groups according to how choice probabilities are computed: (i) BRPs using an empirical bias function; and (ii) BRPs using a skewed probability distribution. This paper analyzes the second group and reviews the use of these BRPs in some applications in transportation, logistics, and production problems.

5 - A Parallel Dynamic Programming Solution For The Dynamic Facility Layout Problem

Clara Novoa, Associate Professor, Texas State University, 601 University Dr, San Marcos, TX, 78666, United States, cn17@txstate.edu, Apan Qasem, Chandra Kolla

We develop a parallel approximate dynamic programming solution to the Dynamic Facility Layout Problem (DFLP) using OpenMP. We experiment with data sets from Dr. Balakrishnan's repository. Including a relatively small set of feasible solutions, the accuracy and speed of our method is very satisfactory if contrasted to simulated annealing, hybrid genetic algorithm, and ant systems. In the DFLP, the flow of materials between departments is known but it varies over time due to changes in demand and introduction of new products. The trade-off costs are material handling and relocation costs.

■ WB79

Legends G- Omni

Opt, Convex

Contributed Session

Chair: Churlzu Lim, Associate Professor, University of North Carolina at Charlotte, Systems Engineering & Engineering Management, 9201 University City Boulevard, Charlotte, NC, 28223, United States, clim2@uncc.edu

1 - A Fast Socp-based Method For Optimal Selection Problem In Tree Breeding

Makoto Yamashita, Associate Professor, Tokyo Institute of Technology, W8-29 2-12-1 Oh-Okayama, Meguro, Tokyo, 152-8552, Japan, makoto.yamashita@c.titech.ac.jp, Tim J Mullin, Sena Safarina

One of new frontiers for optimization methods is to solve practical problems arising from breeding. A purpose of an optimal selection problem in tree breeding is to determine the contributions of candidate genotypes that attains the highest profit subject to a constraint on genetic diversity. We propose a fast numerical method based on second-order cone programming by exploiting the structural sparsity in the problem. The proposed method reduced the computation time from 39,000 seconds of an existing method to just 2 seconds.

2 - Shape Constrained Data Smoothing With Penalized Splines

Yu Xia, Professor, Lakehead University, Business Administration, 955 Oliver Rd, Thunder Bay, ON, P7B 5E1, Canada, yxia@lakeheadu.ca, Farid Alizadeh

We consider fitting noisy data to a smooth function by penalized B-splines. The underling function is assumed to have some shape properties, such as non-negative, monotonic, convex. We solve the data smoothing problem by convex optimization methods.

3 - On The Convexity Of Optimal Decentralized Control Problem And Sparsity Path

Salar Fattahi, PhD Student, University of California, Berkeley, 4141 Etcheverry Hall, Berkeley, CA 94720-1777, Berkeley, CA, 94702, United States, fattahi@berkeley.edu, Javad Lavaei

This talk is about an important special case of the optimal stochastic decentralized control problem, where the objective is to design a static structured controller for a stable stochastic system. We show that if either the noise covariance or the input weighting matrix is not too small, the problem is locally convex. In the case where these conditions are not satisfied, we modify the problem by a penalization term to convexify it, leading to a near-global solution. We also study the problem of designing a sparse controller using a regularization technique. Under some genericity assumptions, we prove that this method is able to design a controller with any arbitrary sparsity level.

4 - Snug Circumscribing Simplexes For Convex Hulls

Ghasemali Salmani Jajaei, PhD Student, Virginia Commonwealth University, 1015 Floyd Avenue, Harris Hall, Richmond, VA, 23284-3083, United States, salmanijajaeg@vcu.edu

We propose procedures for enclosing convex hulls of finite m-dimensional point sets with simplexes. These are snug in since they intersect the hull in some way. We report on experimental results.

5 - Volume Allocation Optimization For Space Mission Tasks

Churlzu Lim, Associate Professor, University of North Carolina at Charlotte, Systems Engineering & Engineering Management, 9201 University City Boulevard, Charlotte, NC, 28223, United States, clim2@uncc.edu, Simon M Hsiang, Sherry Thaxton, Maijinn Chen, Jerry G Myers

Volume in space missions is costly and often must be traded with competing resources and mission needs, such as launch mass, systems/hardware requirements, and consumables. Spacecraft and habitat designers must allocate sufficient volume for different tasks without incurring excessive cost penalties or failure modes. How a volume can be optimized should be based on a balancing of risk and benefits. In this talk, we present a mathematical optimization model that maximizes the total value of tasks of astronauts given a limited volume in the spacecraft. An illustrative example will be demonstrated.

■ WB80

Broadway E- Omni

Health Care, Public II

Contributed Session

Chair: Samantha Meyer, Assistant Professor, Ross School of Business, 701 Tappan Ave., Ann Arbor, MI, 48109, United States, srmeyer@umich.edu

1 - How Much Sleep Do You Need?: Evidence From Public Health

Philip F. Musa, Associate Professor and Programs Director, University of Alabama-Birmingham, PO Box 55544, Birmingham, AL, 35255, United States, musa@uab.edu

Could the amount of sleep people get be associated with hypertension? This presentation outlines an epidemiological cross-sectional study to shed some light on this important Public Health chronic matter. We present a background from the literature using a population based sampling. Our proposed study will employ the previously validated Pittsburgh Sleep Quality Index and Berlin questionnaire. The inclusion/exclusion criteria and the strengths and limitations are presented.

2 - A Little Empathy Goes A Long Way In Disease Dynamics On A Network Game

Ceyhun Eksin, Georgia Tech, 85 5th St. NW, Atlanta, GA, 30332, United States, ceyhuneksin@gatech.edu, Jeff S Shamma, Joshua Weitz

Individuals change their behavior during an epidemic in response to whether they and those they interact with are healthy or sick. Healthy individuals may utilize protective measures while sick individuals may adopt preemptive measures to stop disease spread to their contacts. Yet, in practice both protective and preemptive behavior come with costs. We propose a stochastic network disease game that captures the self-interests of individuals during disease spread on a network. We show that there is a critical level of concern, i.e., empathy, by the sick individuals that eradicates the disease fast while the protective measures cannot eradicate the disease without the preemptive measures.

3 - Spatial Evolutionary Game For Changes Of Human Behaviors In Epidemic

Songnian Zhao, Kansas State University, 2037 Durland Hall, Manhattan, KS, 66502, United States, songnian@ksu.edu, Yan Kuang, John C Wu, David Ben-Arieh

Spatial evolutionary game, used to study multiple players' behaviors in a spatial structure, was incorporated into the epidemic models for sake of evaluating spontaneous changes of human behaviors when individuals acquire information about the spread of infectious disease and make a tradeoff between costs and benefits. Through the comparison between two different mechanisms, a spatial game model in epidemic is validated to generate the consistent results with the traditional dynamic systems in this paper.

■ WB81

Broadway F- Omni

Health Care, Strategies II

Contributed Session

Chair: Michelle M. Alvarado, Visiting Assistant Professor, Texas A&M University, 3131 TAMU, College Station, TX, 77843, United States, michelle.alvarado@tamu.edu

1 - Nursing Home Rating System Inspection And Audit

Xu Han, Research Assistant, University of Connecticut School of Business, 2100 Hillside Road, Storrs, CT, 06269, United States, xu.han@business.uconn.edu

CMS's nursing home rating system gives ratings by combining inspection and self-reported measures, which are subject to inflation. In this paper, we optimize CMS's inspection and audit mechanism to control inflation and improve system performance. We formulate the inspection problem by using an innovative graph-based method, and test it with CMS data. Our result shows that the measure currently being inspected is optimal only if an effective audit mechanism is in place. We then add nursing homes' reactions to audit into consideration and conduct a simulation to study the optimal parameter settings. Our result suggests that CMS should set a moderate extensiveness of audit, and a high punishment rate.

2 - Calling For Care? The Risky Proposition Of Teletriage In Healthcare Demand Management

Ozden Engin Cakici, Assistant Professor, American University, 4400 Massachusetts Avenue, NW, Washington, DC, 20016, United States, cakici@american.edu, Alex Mills

A major challenge in healthcare is the need to match the patient's medical condition to the right provider. Patients are medically inexperienced, so their decision can lead to costly service mismatches. We model the effect of adding telephone triage by a "nurseline" on the patient's decision as a POMDP. We examine the effect of adding a free or low cost nurseline on the patient's decision and on accessibility to an appointment. We show that a patient's choice is a threshold policy based on her belief about her illness severity. We also show that nurseline may reduce cost and increase quality of care for a risk-neutral patient, but it may lead to an opposite behavior for a risk-seeking patient.

3 - Association Between Reserve Capacity And Surge Event Resiliency In Community Hospitals

Raymond L Smith, Doctoral Candidate, North Carolina State University, 318 Weycroft Grant Drive, Cary, NC, 27519, United States, rlsmith5@ncsu.edu

This paper explores the association between the reserve capacity maintained by a community hospital and the operational recovery period following a patient surge event. The study examines whether increasing the ready reserve bed capacity results in greater benefits over other alternatives that include clinical area expansion. A model of a community hospital is used to explore the effects of varied unit capacity on congestion and recovery duration. Results indicate that increasing the ready reserve bed capacity and contingency surge capacity can provide the most competitive outcomes; however, outcomes are demonstrated to be vulnerable to resource activation responsiveness.

4 - A Multi-method Simulation Model Of Hospital Readmission Reduction Strategies

Michelle M. Alvarado, Visiting Assistant Professor, Texas A&M University, 3131 TAMU, College Station, TX, 77843, United States, michelle.alvarado@tamu.edu, Mark Alan Lawley

In 2012 the Centers for Medicare and Medicaid Services implemented a penalty-only system to reduce the rate of hospital readmissions. We develop a multi-method simulation model to assess the impact of alternative readmission reduction strategies, including an incentive-only reimbursement model. The multi-method model combines agent-based simulation of the patient population with system dynamics of the healthcare reimbursement system. Impact is assessed by improvements in the quality of care and reduction in 30-day hospital readmission rates. Results indicate that the incentive-only model is preferred to the penalty-only model under certain conditions.

■ WB82

Broadway G- Omni

Networks and Graphs II

Contributed Session

Chair: Christopher Claypool, Louisiana State University, 1315 Woodcliff Drive, Baton Rouge, LA, 70815, United States, cclayp1@lsu.edu

1 - Modelling And Simulation Of The Formation Of Social Networks

Song Chew, Associate Professor, Southern Illinois University-Edwardsville, SIUE, Edwardsville, IL, 62026, United States, schew@siue.edu

The objective of this study is to determine the distribution of the degree of a node in a social network formed when a newborn node connects to a fixed number of randomly chosen existing nodes and any pair of chosen nodes are connected if they are not already connected.

2 - Exact And Heuristic Algorithms For Finding An Efficient Theme Park Tour

Richard Forrester, Associate Professor of Mathematics, Dickinson College, Department of Mathematics, College and Louther Street, Carlisle, PA, 17013, United States, forrestr@dickinson.edu, Danny Rivers, James Midkiff, Elizabeth Bouzarth, Kevin Hutson

The problem of efficiently touring a theme park is an instance of the well-known Time-Dependent Traveling Salesman Problem (TDTSP). In this talk we describe a mixed-integer programming method and two different metaheuristic approaches (genetic algorithm and tabu search) that can be used to find an efficient solution to the TDTSP. We provide computational experience for when our algorithms are utilized to find tours of Disney World and Hershey Park.

■ WB83

Broadway H- Omni

Supply Chain Optimization II

Contributed Session

Chair: Wang Shukun, Huazhong University of science and technology, Luoyu Road 1037, Wuhan, 430074, China, wsk17951@163.com

1 - Optimization Of Lignocellulosic Biomass To Biofuel Supply Chains With Mobile Pelleting

Nibal Albashabsheh, PhD Student, Kansas State University, 1604 Roof Drive, Apt 101, Manhattan, KS, 66502, United States, nibal15@ksu.edu, Jessica Heier Stamm

The low density of lignocellulosic biomass (LB) results in high costs associated with biomass transportation, storage, and handling in the biomass-to-biofuel supply chain (BBSC). Mobile pelleting machines provide an as-yet-unexplored opportunity to increase LB density. A comprehensive BBSC optimization model that integrates mobile pelleting is developed to minimize the overall cost of producing ethanol from LB. The proposed model addresses the unique challenges of having different baling forms of LB and of the potential to use mobile pelleting machines. A sensitivity analysis is conducted to identify the impact of important parameters on decisions related to biomass densification.

2 - Supply Chain Coordination Under Price Sensitive Demand: A Game Theoretic Approach

Barbara Venegas Quintrileo, Penn State University, University Park, PA, 16802, United States, bbv105@psu.edu, Jose Antonio Ventura

This research explores the coordination between a supplier and a buyer within a decentralized supply chain, through the use of quantity discounts in a game theoretic model. We propose both non-cooperative and cooperative approaches considering that the product traded experiences a price sensitive demand, uniquely defined by an elasticity coefficient. In the first case we study the dynamics of the game from the supplier's perspective as the leader obtaining a Stackelberg equilibrium. In the second case we formulate a cooperative model where decisions are taken jointly, emulating a centralized decision making process.

3 - Flexible Production Resources And Capacity Utilization Rates: A Robust Optimization Perspective

Aldis Jakubovskis, University of Missouri - St. Louis, Saint Louis, MO, United States, jakubovskisa@missouri.edu

We apply robust optimization in the context of optimal choices of product-dedicated and flexible capacities in a spatial setting under demand uncertainty. Total capacity may not be fully utilized because of the distinction between largest and costliest demand realizations. More flexible capacity can increase utilization; however, our results report less than full capacity utilization even using flexible capacity only.

4 - Robust Data Collaboration Application For Large Teams

Haraldur Haraldsson, Optimization Specialist, AIMMS inc, 11711 SE 8th Street, #303, Suite 1780, Bellevue, WA, 98005, United States, Haraldur.Haraldsson@aimms.com

For most analytic teams, collaboratively working with centralized data, data conflicts and version control issues can substantially impact the team's performance. We will introduce a new application enabling robust collaborative data management which controls multi-dimensional data, (backed up by a central data repository) that enables large teams to make supply chain plans using the latest up to date data, as well as exploring multiple scenarios without corrupting the main data. This new way of working streamlines data management, saves time, and improves team productivity.

5 - Reliable Biomass Supply Chain Design Under Feedstock Seasonality

Wang Shukun, Huazhong University of science and technology, Luoyu Road 1037, Wuhan, 430074, China, wsk17951@163.com

We consider design of a reliable supply chain for biomass networks against seasonal variations of feedstock and the risk of disruptions for collection facility in which the disruption probability varies seasonally.We identify location,inventory,biomass quantity and collection routing in a multiperiod planing horizon setting.A variety of approaches (e.g,Lagrangian relaxation and Benders decomposition)to solving the problem are assessed. Computational results are provided to test the performance of the solution approach and realistic case in Henan China are developed to offer managerial insights.

■ WB84

Broadway J- Omni

Supply Chain, Risk II

Contributed Session

Chair: Wenpo Huang, Post-Doctor, Shanghai Jiao Tong University, 1954 Huashan Rd., Xuhui, Shanghai, 200030, China, bobhuang09@gmail.com

1 - Loan Guarantee And Subsidy For Small And Medium Suppliers

Boray Huang, Eindhoven University of Technology, PO Box 513, School of Industrial Engineering, Eindhoven, 5600MB, Netherlands, b.huang@tue.nl, Lei Jing

We investigate the the pros and cons of loan guarantee and subsidy for SME suppliers in supply chains.

2 - Currency Exchange Rate Flexibility Contracts In Global Supply Chain

Leke Ogunranti, PhD Student, Drexel University, Gerri C. Lebow Hall 734, Decision Sciences, Philadelphia, PA, 19104, United States, gao32@drexel.edu, Avijit Banerjee, Oben Ceryan

This paper investigates a decentralized supply chain under a newsvendor setting, in which a supplier produces and delivers a single product to buyer, subsequently receiving payment. We analyze the effect of random currency exchange rate fluctuation on the order quantity of a risk neutral buyer, through a contract involving mutually agreed upon thresholds on exchange rate variation. These thresholds are designed to limit the potential loss incurred by either party.

3 - On The Structural Properties Of Wholesale Price Contracts Within Random Yield Supply Chains

Guang Xiao, Assistant Professor, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, xiaoguang@wustl.edu, Panos Kouvelis

We consider a bilateral supply chain with supply random yield and propose three variants of wholesale price contracts, which induce different risk allocations between the supply chain parties. We completely characterize the Pareto set of any contract type combination to fully explore the price negotiation possibilities and profit improvement opportunities within the supply chain.

4 - Suboptimal Capacity Investments Under Information Asymmetry

Junhyun Bae, Student, Cornell University, Ithaca, NY, 14850, United States, jb2258@cornell.edu, William Schmidt

We investigate imperfect demand information sharing in a supply chain with an external investor. We identify conditions under which firms will invest sub-optimally in capacity, thereby exposing themselves and the supply chain to disruption. We introduce an equity-sharing contract which can mitigate the impact of the firm's capacity choices. Our results show that supplier's risk can be reduced by sharing a portion of equity, and supplier's involvement helps to mitigate supply chain inefficiency due to information asymmetry.

5 - The Optimal Decision Of Dual Sourcing System Under Lead-time And Price Uncertainties

Wenpo Huang, Post-Doctor, Shanghai Jiao Tong University, 1954 Huashan Rd., Xuhui, Shanghai, 200030, China, bobhuang09@gmail.com, Wei Jiang, Wenhui Zhao

We setup a dynamic programming model to study the sourcing decision of an MTO manufacturer who decides whether to order a key component from a contract supplier with fixed wholesale price but random lead-time and/or purchase from spot market with fixed lead time but stochastic price. We show there are at most two stop-waiting thresholds and the manufacturer purchases from the spot market if the spot price is within the two thresholds and keeps on waiting otherwise. We further establish the conditions under which only one threshold exists and increases monotonically in time. Interestingly, we show the spot price volatility in fact benefits the manufacturer.

■ WB85

Broadway K- Omni

Sustainability II

Contributed Session

Chair: Anthony Craig, Iowa State University, Ames, IA, tcraig@iastate.edu

1 - Life Cycle Assessment For The Sustainable Supply Chain – A Case Study

Chao Wen, Eastern Illinois University, 600 Lincoln Avenue, Lumpkin Hall, Charleston, IL, 61920, United States, cwen@eiu.edu

Sustainable supply chain requires not only a competitive financial performance, but better management of environmental and social impacts. Life cycle assessment (LCA) is used to find the full range of environmental impact of the product from cradle to grave. This study investigated the implication of LCA through a case analysis of an organization in energy sector.

2 - Sustainable Product Development Based On Innovative Product Opportunity Gap

Mohammad Hessam Olya, Wayne State University, 4815 Fourth Street, Detroit, MI, 48202, United States, h.olya@wayne.edu, Hamed Fazlollahtabar, Kai Yang

New product development (NPD) is significant to sustain market share and satisfy customer needs. Different approaches proposed to handle NPD were mostly focused on the customer and design requirements. In this work, with respect to product opportunity gap (POG) concept, innovation analysis for a product is performed based on market, design and process aspects. A dynamic programming approach has been used to model our multi-dimensional problem. This integrated approach provides sustainability for product design and development.

3 - Supply Chain Emissions And Firm Performance

Anthony Craig, Iowa State University, 3236 Gerdin Business Building, Ames, IA, 50011, United States, tcraig@iastate.edu, Sachin B Modi

We present a method to evaluate corporate carbon disclosures in relation to the overall carbon impact of the supply chain. We also explore the firm performance implications of publicly disclosed supply chain emissions.

■ WB88

Broadway B-Omni

Military Applications II

Contributed Session

Chair: Michael Atkinson, Naval Postgraduate School, 1411 Cunningham Road, Building 302, Monterey, CA, 93943-5219, United States, mpatkins@nps.edu

1 - Critical Resources

Richard F Deckro, Professor of Operations Research, Air Force Institute of Technology, Afit/ENS; Bldg 641, 2950 Hobson Way, Wright Patterson AFB, OH, 45433-7765, United States, richard.deckro@afit.edu

Resources are the key to any operation. The question of criticality of a resource or resources can be characterized in relation to timing, availability, scarcity, and replacement sources, among other factors. This study focus on approaches to investigate the impact of resource availability on the delay, diversion, disruption, and destruction of required resources where those resources may be commodities, personnel, or intangibles.

2 - A Multi-level Approach To Network Attack Graph Interdiction

David Joseph Myers, Research Engineer, Air Force Research Laboratory, AFRL/RISB, Attn: David Myers, Rome, NY, 13441-4505, United States, david.djm.myers@gmail.com

Attackers have a distinct advantage in the cyber domain, having unlimited time to perform reconnaissance on an enterprise system. A key component of the defender's ability to protect their system is a situational awareness about the system attack graph. The defender's goal is to minimize the potential damage through the exploitation of vulnerabilities. This presentation will explore the development of these attack graphs, and then the consideration of three approaches to interdicting this graph.

3 - Evaluating Basing Options For Optimizing Accessibility For Global Response Force

Jeremy Eckhause, Operations Researcher, RAND Corporation, 1200 S. Hayes St., Arlington, VA, 22202, United States, eckhause@rand.org, Katharina Ley Best, Christopher Pernin, Michael Schwille, Katherine Pfrommer

For a global response force to achieve its mandate, rapid access to almost any point on the globe is essential. Since the long-term presence of the US is difficult to predict, using of a set of intermediate bases may be required for establishing fast and sustainable access to large numbers of contingency locations. We present an approach and results for identifying a robust set of intermediate bases for ensuring global access and a methodology for identifying new bases as infrastructure requirements change.

4 - Predicting Future World Conflict Using Factor Sample Paths

Darryl K Ahner, Air Force Institute of Technology, 135 Eastwick Court, Dayton, OH, 45440-3647, United States, darryl.ahner@afit.edu, Nicholas Jerred Shallcross

The prediction and forecasting of nation conflict is of vital importance. This paper discusses the formulation and construction of a suite of region-specific conditional logistic regression models that predict nation-state transitions into and out of violent conflict. This approach allows for the accurate modeling of complex regional environments with parsimonious and operationally interpretable models. The conditional logistic regression models proposed in this study achieve conflict transition prediction accuracies of 84.67% for 182 of the world's nations. Several predictor variable paths are explored and their effect on probability of nations being in a state of conflict are analyzed.

5 - Assignment Of UAVs To Search And Communication Roles

Michael Atkinson, Naval Postgraduate School, 1411 Cunningham Road, Building 302, Monterey, CA, 93943-5219, United States, mpatkins@nps.edu, Ezra Akin, Kevin D Glazebrook

Once a search UAV detects a target, the UAV must transmit the target's position to a shooter who will fire on the target. If the shooter is far away from the search area in a communication-degraded scenario, we may need several communication UAVs in intermediate positions to relay the message from the search UAV to the shooter. We examine the assignment of UAVs to tasks in real-time. On one hand we want as many UAVs searching so they can quickly detect as many targets as possible. On the other hand we need a sufficient number of communication UAVs to ensure a robust communication network. We formulate an MDP that provides optimal solutions for small problems and develop heuristics to use on larger problems.

■ WB89

Broadway C-Omni

Maritime Transportation

Sponsored: TSL, Intelligent Transportation Systems (ITS)

Sponsored Session

Chair: Harilaos Psaraftis, Technical University of Denmark, Department of Transport, Lyngby, 2800, Denmark, hnpsar@dtu.dk

Co-Chair: Dario Pacino, Technical University of Denmark, Denmark, darpa@dtu.dk

1 - The Ship Loading Problem With Straddle Carrier Assignment And Scheduling

Dario Pacino, Technical University of Denmark, Ostrigsgade 28, Copenhagen, Denmark, darpa@dtu.dk

The maritime shipping sector is under pressure to provide reliable and cheap services. Operations research techniques have caught the interest of the industry as can be seen from the increasing number of publications in e.g. liner shipping network design and terminal optimization. In this paper we proposed the Ship Loading Problem, a novel collaboration approach to integrate shipping line and container terminal cost optimizations. We present a novel mathematical formulation and a heuristic approach which demonstrates the benefits of this collaboration.

2 - Containership Deployment On A Liner Service

Shuaian Wang, Hong Kong Polytechnic University, Department of Logistics and Maritime Studies, Hong Kong, China, hans.wang@polyu.edu.hk

This study proposes an important ship voyage management problem (SVMP) that aims to minimize the bunker fuel consumption of a containership. To address the SVMP, we first develop a tailored method to build two robust artificial neural network (ANN) models using ship voyage report data to quantify the synergetic influence of sailing speed, displacement, trim, and weather/sea conditions on ship fuel efficiency. We proceed to put forward three viable solution countermeasures for the SVMP by means of dynamic programming and simulation-based optimization techniques.

3 - A Metaheuristic For a Multi-product Maritime Inventory Routing Problem

Marielle Christiansen, Norwegian University of Science & Technology, Industrial Economics & Technology Mgmt, Trondheim, Norway, Marielle.Christiansen@iot.ntnu.no

We consider a multi-product maritime inventory routing problem where an actor is responsible for both the inventory management of the various products at the ports and the ships' routing and scheduling. In addition, we take the allocation of products to undedicated compartments into account. A mixed integer programming model is formulated, and it can be solved to optimality for small instances only. A matheuristic, exploiting the two sub sets of constraints related to the routing and inventory management, is developed. The computational study shows promising results for the matheuristic.

■ WB90

Broadway D-Omni

Health Care, Modeling XIII

Contributed Session

Chair: Masoud Kamalahmadi, Doctoral Student, Indiana University, 1309 E Tenth St, Bloomington, IN, 47405, United States, maskamal@iu.edu

1 - Inventory Policies For Platelet Management At Hospitals Under Demand Uncertainty

Suchithra Rajendran, PhD Candidate and Research Assistant, The Pennsylvania State University, 310 Leonhard Building, University Park, PA, 16802, United States, sur205@psu.edu, Arunachalam Ravindran

Demand uncertainty at hospitals leads to a significant wastage of blood platelets. Hence, a stochastic mixed integer linear programming (SMILP) model is developed with the objective of minimizing platelet wastage and shortage. Due to the complexity of the SMILP, five different heuristic approaches are developed using historical data such as mean and variance of platelet demand. Real-life data from a Regional Medical Center is used to evaluate the different methods. In addition, sensitivity analysis is performed to evaluate the robustness of the proposed heuristics. The results indicate that the heuristic approaches on average, provide a solution within a gap of 10% from the optimal solution.

2 - An Optimization Framework To Improve Patient Safety In Radiation Therapy

Pegah Pooya, PhD Candidate, North Carolina State University, 304 Ravenstone drive, Raleigh, NC, 27518, United States, ppooya@ncsu.edu, Osman Ozaltin, Julie Ivy, Lukasz Mazur, Lawrence Marks, Katharin Deschesne, Prithima Mosaly, Gregg Tracton

The use of safety barriers (SB) in radiation therapy (RT) is a widely recognized method for detecting potential human and non-human errors before they reach patients. We develop an optimization framework to determine the reliable design of SBs to improve patient safety considering SB implementation costs.

3 - A Theoretical Agent-based Framework To Evaluate The Anticompetitive Implications Of Accountable Care Organizations

Abdullah Alibrahim, PhD Candidate, University of Southern California, 344 Hauser Blvd Apt 219, Los Angeles, CA, 90036, United States, alibrahi@usc.edu, Shinyi Wu

In the wake of Affordable Care Act, two initiatives have seemingly counteracting effects. Market share shifts due to coordinating healthcare provision (Accountable Care Organizations -ACOs) might negate the effects of concentrating purchasing for care and coverage (Health Exchanges). This study justifies characterizing healthcare markets as a complex adaptive system and outlines a framework to assess competitive implications of ACOs in private healthcare markets. The theoretical, structural, behavioral, and iterative relationships of the system are outlined. An agent-based simulation model will then be used to assess competitive effects of ACOs to inform antitrust policies.

4 - Tractable Approximations Of Distributionally Robust Chance Constraints In Radiation Therapy

Azin Khabazian, Research Assistance, University of Houston, 5465 Braesvalley Dr. Apt 566, Houston, TX, 77096, United States, akhabazian@uh.edu, Maryam Zaghian, Gino J. Lim

Quadratic approximations of the distributionally robust chance constraints are developed for treatment planning to guarantee the probabilistic constraint when only partial information of the random dose contribution is known. Robust chance constraints can be conservatively approximated by second-order cone programming. In this study, we explore the condition in which the constraints depend quadratically on the random parameter, and develop more precise approximations for robust chance constraints. We evaluate these approximations in the context of a radiation therapy treatment planning problem and numerically demonstrate its superiority over the affine assumption of the constraints.

5 - Hospitalist's Service Mix And Impacts On Length Of Stay

Masoud Kamalahmadi, Doctoral Student, Indiana University, 1309 E Tenth St, Bloomington, IN, 47405, United States, maskamal@iu.edu, Kurt Bretthauer, Alex Mills, Jonathan Helm

Hospitalists are physicians that specialize in caring for hospital inpatients, replacing a primary care physician who may only make rounds once per day and thereby reducing delays. Given a limited number of hospitalists in a hospital, we seek to determine their optimal service mix (workload and patient types).

Wednesday, 12:45PM - 2:15PM

■ WC01

101A-MCC

Data Mining in Aviation

Sponsored: Data Mining

Sponsored Session

Chair: Nima Safaei, Bombardier Aerospace., Unit 701, 23 Rean Dr., Toronto, ON, M2K 0A5, Canada, nima.safaei@aero.bombardier.com

1 - Multivariate Analysis Of Flight En Route Efficiency

Yulin Liu, University of California - Berkeley, 107 McLaughlin Hall, Berkeley, CA, 94709, United States, liuyulin101@berkeley.edu, Michael O Ball, Mark M Hansen

We apply clustering and regression techniques to a large flight level trajectory dataset that includes associated traffic management initiative (TMI) data. The results quantify how TMIs, weather and other factors impact en route flight efficiency. We further evaluate the variations of en route efficiency across city pairs and over time.

2 - Data Clustering Using A Network Flow Problem To Study The Aircraft Component Failure

Nima Safaei, Senior Specialist, Bombardier Aerospace., Unit 701, 23 Rean Dr., Toronto, ON, M2K 0A5, Canada, nima.safaei@aero.bombardier.com

An integer programing model based on the network flow problem is proposed to cluster the categorical variables and their attributes. The variables are related to the age-related and -unrelated factors affecting the aircraft component failure. The proposed model split the variables' attributes into a number of clusters with maximum transitive dependencies within each cluster

3 - Improving Airline Fuel Burn Predictions Using Super Learner

Lei Kang, Graduate Student Researcher, University of California-Berkeley, 107 McLaughlin Hall, Berkeley, CA, 94720, United States, lkang119@gmail.com, Yulin Liu, Mark M Hansen

Accurate flight fuel burn predictions are crucial in the aviation industry. By levering a large flight level fuel consumption dataset provided by a major US airline, we propose to use integrated LASSO selection and Adaboost algorithm to combine various machine learning algorithms into a super learner which can help significantly reduce the fuel burn prediction error compared to our study airlines flight planning system. The potential benefit of improved fuel burn predictions will be quantified in terms of fuel savings.

■ WC02

101B-MCC

Data Mining Applications in Health Care

Sponsored: Data Mining

Sponsored Session

Chair: Eric Swenson, US Army, 643 Belmont Circle, State College, PA, 16803, United States, eswen75@gmail.com

1 - Identification Of Flu Hubs Using A Scale Free Network Of Flu Distance

Hootan Kamran, PhD Candidate, University of Toronto, Department of Mechanical and Industrial Engin, Room RS 311, Toronto, ON, M5S 3G8, Canada, hootan@mie.utoronto.ca, Michael W Carter, Dionne Aleman, Kiearn Moore

Influenza is among the leading causes of death in the world. Rapid changes in influenza virus make permanent immunity through vaccination an unviable solution, and signify the importance of surveillance systems. Current systems aggregate data based on predefined geopolitical divisions, and neglect historically significant inter-regional time connections. We have devised a network structure to model historic inter-regional flu distances in Ontario. We show that the resulting network is not a random network and in fact, exhibits behaviours of a scale-free network. The scale-free property helps us identify highly-connected regions as flu hubs, which can be prioritized in containment policies.

2 - Children Segmentation Based On Risk Of Chronic Diseases

Nooshin Hamidian, Resaerch Assistant, University of Tennessee at Knoxville, 301 Woodlawn Pike, Apt A5, Knoxville, TN, 37920, United States, nhamidia@vols.utk.edu, Jafar Namdar, Rapinder Sawhney

Type 2 diabetes and obesity has increased among children during the last 3 decades. The main purpose of this study is to provide a framework that identifies children who are at risk of diabetes and obesity. We explore a group of demographic and behavioral characteristics, which increase the chance of these diseases. Once the risk factors have been determined we develop a preventive model. This model determines who is at risk of these diseases. Preventing chronic diseases not only is beneficial for patients and their families, but also from the hospital point of view, it can be a solution for cutting cost and increasing hospitals' revenue.

3 - Health Market Segmentation And Classification Of Total Joint Replacement Surgery Patients

Eric Swenson, PhD Student, US Army, 643 Belmont Circle, State College, PA, 16803, United States, ers187@psu.edu
Eric Swenson, PhD Student, Pennsylvania State University, University Park, PA, 16802, United States, ers187@psu.edu, Nathaniel Bastian, Harriet Black Nembhard

Understanding healthcare consumers' behaviors and attitudes is critical information when it comes to delivering patient-centered care. We apply a two-stage methodology using supervised and unsupervised machine learning methods to a 21 month sample of total joint replacement patient data. Patients cluster into 6 distinct market segments from which the cluster assignment is used as the response variable in supervised learning to classify patients. The classification model accurately predicts the cluster assignment for out-of-sample patients, while offering insight into patient behaviors and attributes to help clinicians, health marketers, and consumers enhance patient-centered care.

■ WC03

101C-MCC

Big Data III

Contributed Session

Chair: Mahamaya Mohanty, Research Scholar, IITDelhi, Shaheed Jeet Singh Marg, New Delhi, 110016, India, mahamayamohanty@gmail.com

1 - Establishing A Big Data Analysis Framework For Computing Nash Equilibrium With Vehicle Data

Lee Yu-Ching, National Tsing Hua University, Hsinchu, Taiwan, yclee@ie.nthu.edu.tw, Ciou Si-Jheng, Huang Yi-Hao

This paper provides scalable framework to handle the data unable to be dealt with by the general software. The aim is to generate a quantifiable value to represent the customers' willingness to buy products. Finally, the proposed method is further validated by the real data of vehicles.

2 - Incremental Methods For Additive Convex Cost Optimization

Mert Gurbuzbalaban, Postdoctoral Researcher, MIT, 176 Elm St #1, Building 32, Cambridge, MA, 02140, United States, mert.gurbuzbalaban@gmail.com, Asuman Ozdaglar, Pablo Parrilo

Motivated by machine learning problems over large data sets and distributed optimization over networks, we consider the problem of minimizing the sum of a large number of convex functions. We develop and study incremental methods for solving such problems, in particular for the random reshuffling method we provide a sharp convergence result that answers an open question.

3 - Virtual Casted Supply Chain For Information Sharing

Mahamaya Mohanty, Research Scholar, IITDelhi, Shaheed Jeet Singh Marg, New Delhi, 110016, India, mahamayamohanty@gmail.com, Ravi Shankar

Cloud computing creates a multiplier effect in IT, supply in service chain management with an intersection of virtualization and cloud where both fit together. The cloud is a virtualization of resources that maintains and manages itself as well as plays a vital role in making the overall system cost-effective, enhanced flexibility, and sharing information with availability of resources thus improving agility and enhancing flexibility. This article focuses on designing a virtualized environment that is used to address a variety of business goals aimed at improving efficiency and reducing costs of operation and maintenance of physical servers.

■ WC04

101D-MCC

Power System Operation Models for Ramping Scarcity Mitigation

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Masood Parvania, University of Utah, 50 S. Central Campus Drive, Salt Lake City, UT, 84112, United States, masood.parvania@utah.edu

1 - Ramping Deliverability Enhancement Through Flexible Transmission

Mostafa Ardakani-Sahraei, University of Utah, Salt Lake City, UT, United States, mostafa.ardakani@utah.edu

Proxy reserve constraints are employed within electricity market models in an attempt to attain reliability in the face of uncertain load and element failures. However, due to the complexities of the transmission network, the available reserve, and specifically ramping capabilities, may not be deliverable to the desired location. This talk discusses how flexibilities of the transmission network can be exploited to enhance ramping deliverability. The results confirm the effectiveness of the proposed method in improving reliability and reducing reliability costs.

2 - Explicit And Implicit Mechanisms For Ensuring Reserve And Ramping Capability

Erik Ela, EPRI, eela@epri.com

In this presentation, we will present the central needs for operating reserve which are used to meet variability and uncertainty. We compare the performance of explicitly scheduled reserve, which is done through reserve inequality constraints to meet the associated impact, with the implicitly scheduled operating reserve, that in which the reserve is scheduled inherently by advanced scheduling applications. We review case studies to compare performance in terms of efficiently procuring sufficient capacity and ramp capability.

3 - Definition And Valuation Of Continuous-time Ramping Trajectory In Power Systems Operation

Masood Parvania, University of Utah, masood.parvania@utah.edu

The current discrete-time power system operation models imply that generating units shall follow piecewise constant generation trajectories. This means that the units' ramping is modeled as the finite difference between the consecutive generation samples. The discrete-time generation schedules and the resulting rampings do not fully utilize the units' flexibility to compensate the faster variations of net-load, which may lead to ramping scarcity events. In this presentation, we introduce a novel unit commitment model that schedules for continuous-time generation and ramping trajectories, opening the door for continuous-time valuation of ramping trajectories in power system operation.

4 - Wind Ramping Product For Power System Ramping Scarcity Mitigation

Venkat Krishnan, NREL, Venkat.Krishnan@nrel.gov Golden, CO, 80401, United States, Venkat.Krishnan@nrel.gov, Bri-Mathias Hodge, Anthony Florita

This talk will investigate the potential of wind power to provide ramping service and the importance of ramp event forecasting. Forecasting mid-term (day-ahead and intra-day) and short-term wind ramp events efficiently will be the basis of managing and dispatching wind in a co-optimized energy and ramp service markets. There are two aspects to this: 1) efficient wind forecasting platforms- developed using big-data information processing technologies; and 2) wind ramp event forecasting algorithm- based on optimized swinging door algorithm (OpSDA) and dynamic programming.

■ WC05

101E-MCC

Spatial optimization

Sponsored: Energy, Natural Res & the Environment II Forestry

Sponsored Session

Chair: Nahid Jafari, University of Florida, Gainesville, FL, United States, jnahid@hotmail.com

1 - Fine-scale Spatial Targeting Of Surveillance To Minimize Costs Of Invasive Species Introduction Across Large Landscapes

Rebecca Epanchin-Niell, Resources for the Future, Epanchin-Niell@rff.org

Early detection of new invasive species populations can reduce costs and damages by allowing control when populations are smaller and less costly. This talk presents a bioeconomic modeling approach to optimally target invasive species surveillance at fine spatial scales (1 km2) to minimize total costs from invasions and surveillance. The model accounts for spatial-temporal interdependencies arising from invasion spread and surveillance costs. We apply the model to surveillance for gypsy moth in the northwestern US.

2 - Analyzing Trade-offs Between Fire Prevention And Suppression In The Republic Of Korea

Yohan Lee, Yeungnam University, yohanlee76@gmail.com

This study explores the spatial tradeoff between the number of initial attack firefighting resources and the level of fire prevention efforts mitigating the probability of human-made fires in the Republic of Korea. To examine the spatial trade-off, we utilize a hybrid system that combines a scenario-based, standard-response optimization model with a stochastic simulation model. A mixed policy that includes fire suppression and fire prevention efforts works better than a single dominant policy such as a strong fire suppression policy, in particular, with the consideration of spatial allocations because returns to effort in fire prevention policy is dependent on the location of fires.

3 - Spatial Control Of The Argentine Black And White Tegu. An Approach Using Linear Programming

Julien Martin, United States Geological Survey, 7920 NW 71 Street, Gainesville, FL, 32653, United States, julienmartin@usgs.gov, Mathieu Bonneau, Fred A. Johnson, Brian Smith, Christina M. Romagosa

We propose to frame spatial control of tegu in south Florida as a linear programming optimization problem. This formulation with a discrete reaction-diffusion model permits calculation of an optimal control strategy that minimizes the remaining number of tegus for a fixed cost or that minimizes the control cost to achieve containment. We compute the optimal strategy for a range of possible model parameters and discuss the best strategy to use in practice as a function of the risk attitude of the decision maker.

4 - Robust Spatial Optimization For The Invasive Species Management

Nahid Jafari, University of Florida, nahid.jafari@ufl.edu

The problem of invasive species management concerns modeling the pattern of spread of the invasive, estimation of control costs, spatial design of the control effort, and accounting for uncertainties in model parameters. Robust optimization constructs a solution that is feasible for any realization of the uncertainty in a given uncertainty set (achieves the best worst-case objective function value). Given the computational efficiency of robust optimization, we are developing a spatial-optimization model to select sites for efficiently controlling invasive species to minimize their ecological damage, as well as to minimize the costs given limited financial resources.

WC06

102A-MCC

Big Data 2

Sponsored: Data Mining

Sponsored Session

Chair: Milton Soto-Ferrari, Western Michigan University, 4601 Campus Drive, Parkview Campus Building I, Kalamazoo, MI, 49008-5336, United States, miltonrene.sotoferrari@wmich.edu

1 - Disease Detection Analytics: Comparing And Contrasting The Performance Of Popular Predictive Models For Breast Cancer And Diabetes Data Sets

Subhashish Samaddar, Professor, Business Analytics and Operations, Georgia State University, Managerial Science, P.O. Box 4014, Atlanta, GA, 30302-4014, United States, s-samaddar@gsu.edu, Somnath Mukhopadhyay

Disease detection based on clinical data of the patient can save health care costs. Consequently, data mining in disease detection is fast gaining popularity. Our study applies popular predictive modeling algorithms such as random forest, linear programming classifiers, and, neural network to two examples data sets of clinical data: Breast cancer and Diabetes. The former data set has been bench marked in the literature - so comparison with prior results was possible. The data set on Diabetes can be used as new benchmark for future research. The article reports compares and contrasts results from each method.

2 - Characterization Of Breast Cancer Patients Receiving Unexpected Treatments

Milton Soto-Ferrari, Western Michigan University, 4601 Campus Drive, Parkview Campus Building I, Kalamazoo, MI, 49008-5336, United States, miltonrene.sotoferrari@wmich.edu, Diana Prieto

In 2016, approximately 40,450 women in the US are expected to die from breast cancer. Medical treatments are mainly driven by clinical factors including cancer staging, tumor size, histology, and age. This research aims to propose a systematic methodology to identify the clinical and non-clinical features that influence the receipt of an unexpected treatment in breast cancer patients. We extend the factor exploration and characterization of patients through a Bayesian Network breakdown methodology that allows the analysis of conditional probabilities to relate patient features with treatment receipt. We use registers of the SEER program from Detroit area considering the period 2007-2012.

WC07

102B-MCC

Process Modeling

Sponsored: Data Mining

Sponsored Session

Chair: Najibe Sadatijafarkalaei, Wayne State University, 4815 Fourth Street, Detroit, MI, 48202, United States, fv0017@wayne.edu

1 - An Efficient Nonparametric Fault Variable Identification Method

Mehmet Turkoz, Rutgers University, 16 Rachel Terrace, Piscataway, NJ, 08854, United States, turkoz@scarletmail.rutgers.edu

In a process, identifying which variables cause an out-of-control signal is a challenging issue for quality problems. If the distribution of the process is unknown, existing parametric methods are not suitable for identification of changed variables. In this paper, we propose a new nonparametric method to identify the fault variables and demonstrate its performance through various simulation studies.

2 - A Hybrid Genetic Algorithm With Tabu List For Generating a Stochastic Process Tree Model Based on Event Logs

Jin Young Choi, Ajou University, Worldcup-ro 206, Yeongtong-gu, Suwon, 16499, Korea, Republic of, choijy@ajou.ac.kr, Woo-Min Joo, Do Gyun Kim

We present an efficient hybrid algorithm integrating genetic algorithm and tabu search for generating a stochastic process tree model using event logs. It is examined for its performance by considering some example event logs in literature, evaluating four fitness measure such as simplicity, precision, replay, and generalization.

3 - Observational Data Driven Modeling And Optimization Of Manufacturing Processes

Najibe Sadatijafarkalaei, PhD Student, Wayne State University, 4815 Fourth Street, Detroit, MI, 48202, United States, fv0017@wayne.edu, Ratna Babu Chinnam

The main objective of this study is to rely on observational data to achieve robust parameter design of manufacturing processes. Controlled experiments can be challenging in production environments and this paves for an effective alternative approach to attain robust process parameter conditions. The proposed framework relies on an integrated feature selection, response surface modeling, and optimization methodology. We also report illustrative results from a tire compound production process.

WC08

103A-MCC

Technology Mgt

Contributed Session

Chair: Mahmut Sonmez, Senior Lecturer in Management Science & Statistics, University of Texas at San Antonio, College of Business, San Antonio, TX, 78249-0631, United States, maho.sonmez@utsa.edu

1 - Wearable Technology In Fitness – Fitbit

Hongwei Du, Professor, California State University-East Bay, 25800 Carlos Bee Boulevard, Hayward, CA, 94542, United States, hongwei.du@csueastbay.edu

One trending of wearable technology is Fitness Devices. This paper focuses on wearable technology for fitness tracking and the FitBit Company. It identifies and presents wearable technology behind the FitBit products, the pros and cons of the FitBit, and the role that FitBit plays in the Internet of Things. Last, the future of the FitBit Company and product is discussed.

2 - Dominant Design, Sequential Product Categories, And Product Innovation

Hyunwoo Park, Postdoctoral Fellow, Georgia Institute of Technology, 85 5th St NW, Atlanta, GA, 30332, United States, hwpark@gatech.edu, Rahul C Basole

We study the impact of dominant design in sequential product categories on product innovation using a dyadic perspective in the context of mobile phone industry. Our results indicate that dominant design accelerates incremental product innovation and causes temporary adverse shift in product category focus.

3 - Technological Innovation, International Patenting And National Economic Development: A Multinational Multi-year Study

Kelvin Wayne Willoughby, Professor, Innovation and Intellectual Property, Skolkovo Institute of Science and Technology, Skolkovo Innovation Center, 3 Nobel Street, Moscow, 143026, Russian Federation, kelvin@skoltech.ru, Alexander Vidiborskiy

This paper reports the results of a study of the inbound and outbound patenting activity of 78 countries for which reliable data were obtained over the 14 years from 2000 to 2013. Several new indicators of the international patenting proclivities of inventors were utilized in multiple phases of statistical analysis and data vizualization to investigate the relationship between domestic inventive activity, international patenting profiles and changes in the relative per capita wealth levels of countries. The results suggest that the economic benefits countries may gain from investing in technological innovation may be enhanced by emphasizing the international patenting of domestic inventions.

4 - The D-day, V-day, And Bleak Days Of A Disruptive Technology: A New Model For Ex-ante Evaluation Of The Timing Of Technology Disruption

Chialin Chen, Professor, National Taiwan University, Taipei, 10617, Taiwan, cchen026@ntu.edu.tw, Jun Zhang, Ruey-Shan Guo

We conduct theoretical and empirical analyses to evaluate the timing of technology disruption. We conceptualize the ease and network factors as key determinants of performance improvement for a disruptive technology. A dynamic consumer model is developed to identify two critical times, termed D-Day and V-Day, of technology disruption. We also show that there may exist some “bleak days” during which a firm would discontinue a “promising” technology that will eventually disrupt. Empirical tests are conducted with data of hard disk drives, semiconductor technologies, and CPU performance for mobile devices to verify key model assumptions and to show how to estimate the ease and network factors.

■ WC10

103C-MCC

Designing Energy and Water Supply Chains for Prosperity

Sponsored: Energy, Natural Res & the Environment, Energy

Sponsored Session

Chair: Yao Zhao, 1 Washington Street, Newark, NJ, 07102, United States, yaozhao@andromeda.rutgers.edu

1 - Distressed Selling By Farmers: Policy Recommendations

Shivam Gupta, University of Texas Dallas, sxg104920@utdallas.edu, Milind Dawande, Ganesh Janakiraman, Ashutosh Sarkar

In many developing countries, farmers sell a significant portion of their produce at prices much lower than the guaranteed support price offered by the government. We build a dynamic programming model to analyze this practice and illustrate how it can serve as a useful decision making tool for policy recommendations.

2 - Designing Hydro Supply Chains For Water, Food, Energy And Flood Nexus

Kwon Gi Mun, Assistant Professor, Fairleigh Dickinson University, Teaneck, NJ, United States, kgmun@fdu.edu, Raza Ali Rafique, Yao Zhao

The interconnected issues of water, food, energy and flood are among the most formidable challenges faced by developing countries. We apply SCM principles to water resource development and provide the end-to-end and dynamic perspectives needed in the expansion of hydropower network, and also identify the unique features and economies of hydropower systems and construct an integrated location optimization model to capture the conflicts of these issues, to explore the synergy among different sectors, and to maximize the overall benefit. With the real-life situation of Pakistan, we provide solutions that outperform common practices in all aspects of energy, irrigation, and flood control.

3 - Agricultural Support Prices In Developing Economies: Operational Analysis And Its Use In Policy-making

Harish Guda, University of Texas Dallas, hxg131530@utdallas.edu, Tharanga Kumudini Rajapakshe, Milind Dawande, Ganesh Janakiraman

The Guaranteed Support Price (GSP) scheme has been adopted in several developing economies. Through this scheme, the government promises to procure a crop from farmers at a guaranteed (and attractive) price announced ahead of the selling season, and then distributes the procured amount to the underprivileged population. The goal of this scheme is twofold: (a) as a supply-side incentive, to ensure high output from farmers, and (b) as a demand-side provisioning tool, to subsidize the consumption of the poor. In this talk, I present our work on the operational decisions of the farmers and the government under the GSP scheme, its impact on social welfare, and the use of our analysis to policy-makers.

4 - Coordinating And Sharing Demand-side Energy Resources – A Conceptual Design

Wei Qi, Lawrence Berkeley National Laboratory, WQi@lbl.gov, Bo Shen, Hongcai Zhang, Zuo-Jun Max Shen

We present a coordination scheme for shared use of demand-side energy resources (e.g. distributed generation, electric vehicles, etc.). Multiple users form a sharing community within which trading electricity improves economic efficiency. We develop a cost splitting scheme to ensure the participation of the aggregator and the users.

■ WC11

104A-MCC

Decision Making Under Multistage Uncertainty

Sponsored: Optimization, Linear and Conic Optimization

Sponsored Session

Chair: Kartikey Sharma, Northwestern University, 2145 Sheridan Rd, Evanston, IL, 60208, United States, kartikeysharma2014@u.northwestern.edu

Co-Chair: Omid Nohadani, Northwestern University, Northwestern University, Evanston, IL, 60208, United States, nohadani@northwestern.edu

1 - Adjustable Robust Optimization Via Fourier-motzkin Elimination

Jianzhe Zhen, Tilburg University, Tilburg, Netherlands, J.Zhen@tilburguniversity.edu, Melvyn Sim, Dick den Hertog

We demonstrate how adjustable robust optimization (ARO) problems with fixed recourse can be casted as static robust optimization problems via Fourier-Motzkin elimination (FME). Through the lens of FME, we characterize the structures of the optimal decision rules for a broader class of ARO problems. A scheme based on a blending of classical FME and a simple Linear Programming technique, that can efficiently remove redundant constraints, is used to reformulate ARO problems. This generic reformulation technique, contrasts with the classical approximation scheme via linear decision rules, enables us to solve adjustable optimization problems to optimality.

2 - Distributionally Robust Inventory Control When Demand Is A Martingale

Linwei Xin, U of Illinois at Urbana-Champaign, lxin@illinois.edu, David Goldberg

Independence of random demands across different periods is typically assumed in multi-period inventory models. In this talk, we consider a distributionally robust model in which the sequence of demands must take the form of a martingale with given mean and support. We explicitly compute the optimal policy and value, and shed light on the interplay between the optimal policy and worst-case martingale. We also compare to the analogous setting in which demand is independent across periods, and identify interesting differences between these two models.

3 - Robust Optimization With Decision Dependent Uncertainty Sets

Kartikey Sharma, Northwestern University, kartikeysharma2014@u.northwestern.edu, Omid Nohadani

Robust optimization is increasingly used to solve multistage optimization problems. In most such problems, the uncertainty sets are fixed. However in many cases, these sets can be influenced by decision variables. We present a two-stage robust optimization approach in which future uncertainty sets can be affected by the decisions made in the first stage. We illustrate the advantages of this model on a shortest path problem with uncertain arc lengths.

4 - Adaptive Probabilistic Satisficing Models

Zhi Chen, National University of Singapore, National University of Singapore, Singapore, Singapore, chenzhi@u.nus.edu, Melvyn Sim

In this paper, we study adaptive probabilistic satisficing models that can be used for multi-stage decision making. We introduce the finite adaptability into probabilistic satisficing models to overcome the difficulties of incorporating recourse decisions as arbitrary functions of unfolded uncertain parameters. For two-stage problems, we show that the complete adaptability is exact to the finite adaptability, under a mild monotone condition. We propose an iterative scheme for increasing the level of probabilistic satisficing. We discuss extensions of our results for multi-stage problems. Our computational studies present that the probabilistic satisficing solutions can be competitive.

■ WC12

104B-MCC

Recent Advances in Decision Diagrams for Optimization

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Andre Augusto Cire, University of Toronto Scarborough, Toronto, ON, Canada, acire@utsc.utoronto.ca

1 - A Generic Approach To Solving Sequencing Problems With Time-dependent Setup Times

Joris Kinable, Carnegie Mellon University, Pittsburgh, PA, United States, jkinable@cs.cmu.edu, Andre Augusto Cire, Willem-Jan Van Hoeve

Tailoring dedicated solution approaches to solve scheduling and routing problems is often complex and time consuming. This work presents a flexible framework based on Constraint Programming, Mixed Integer Programming and Decision Diagrams to solve hard scheduling problems including the Time-Dependent (TD) TSP, TD-SOP and TD-TSP with Time Windows. The proposed method is sufficiently generic to render it applicable to a variety of related sequencing problems. Moreover, experiments indicate significant performance improvements over pure MIP or CP approaches.

2 - Decision Diagram Bounds For Integer Programming Models

Christian Tjandraatmadja, Carnegie Mellon University, Pittsburgh, PA, United States, ctjandra@andrew.cmu.edu, Willem-Jan Van Hoeve

Decision diagrams are capable of generating strong bounds in practice for discrete optimization problems when a certain structure is present. However, generalizing decision diagram techniques to integer programming can be challenging due to the lack of clear structure to exploit. We propose a framework to generate decision diagram bounds that aims to overcome this issue. We start with a set of base constraints that are well suited for decision diagrams and progressively incorporate further constraints via strengthening and Lagrangian relaxation. We discuss computational experiments on a set of binary optimization problems.

3 - An MDD-based Approach For The Time-dependent TSP

Tallys Yunes, University of Miami, tallys@miami.edu,
David Bergman, Andre Augusto Cire

The Time-Dependent Traveling Salesman Problem (TDTSP) is a variant of the classical Traveling Salesman Problem in which arc-traversal times vary over time, a typical real-life example being rush-hour traffic. We describe a solution approach for the TDTSP using Multivalued Decision Diagrams (MDDs) and present preliminary computational results for a set of known benchmark instances.

4 - Branching With Less Repetition

Thiago Serra, Carnegie Mellon University, Pittsburgh, PA, 15213, United States, tserra@cmu.edu, John Hooker

When branching to solve a problem on discrete variables, we may reach nodes that will root isomorphic subtrees. Hence, the subproblem from each of such nodes has the same solutions. If we merge those equivalent nodes after they are explored, we get a reduced decision diagram. But if we can anticipate that a new node is equivalent to an explored node, then we keep a reduced decision diagram and prevent redundant work. In this paper, we generalize previous results on constructing a reduced decision diagram for linear contraints, and we extend those results to discrete problems on multiple constraints. We characterize node states and we provide some sufficient conditions to check node equivalence.

■ WC13

104C-MCC

Computational Approaches to Large-scale/Exact Optimization

Sponsored: Optimization, Computational Optimization and Software

Sponsored Session

Chair: Ilbin Lee, Georgia Tech, Georgia Tech, Atlanta, GA, 30332, United States, ilee79@gatech.edu

1 - Solving Large Batches Of Linear Programs

Ilbin Lee, Georgia Institute of Technology, Atlanta, GA, 30332, United States, ilee79@gatech.edu, Stewart Curry, Nicoleta Serban

Solving a large number of linear programs (LPs) with varying parameters is needed in stochastic programming and sensitivity analysis among other modeling frameworks. The common approach is solving each individual LP, called the brute-force approach, which can be computationally infeasible when the parameter space is high-dimensional and/or the underlying LP is computationally challenging. We introduce a computationally efficient approach for solving a large number of LPs in batches and suggest a data-driven version of our algorithm. The experimental results show that our approach can be more efficient and scale better in the number of LPs than the brute-force that uses MATLAB solver.

2 - Bilinear Optimization And Its Application In Robust Optimization

Wei Wang, University of Pittsburgh, Pittsburgh, PA, United States, w.wei@pitt.edu, Anna Danandeh, Bo Zeng, Brian Buckley

We derive exact and approximated methods to compute bilinear optimization. And we show applications of bilinear optimization in robust optimization.

3 - Efficient Validation Of Basic Solutions Via The Roundoff-error-free Factorization Framework

Adolfo R Escobedo, Assistant Professor, Arizona State University, Tempe, AZ, 85281, United States, adolfo.escobedo@asu.edu, Erick Moreno-Centeno

The Roundoff-Error-Free (REF) factorization framework solves systems of linear equations without accruing roundoff errors or excessive entry growth, thereby permitting LPs and MIPs to be solved exactly and efficiently. This work discusses results showing that the integer-preserving REF framework is up to two orders of magnitude quicker than the standard-use rational arithmetic LU factorization method while requiring half the memory. Moreover, we adapt Edmond's integer-preserving Q-Matrices to validate basic solutions, and summarize additional experiments that demonstrate the REF factorization framework remains superior in terms of memory requirements and computational effort.

4 - Computational Study Of Valid Inequalities For A Semidefinite Relaxation Of Maximum-k-cut

Miguel F. Anjos, Professor and Canada Research Chair, GERAD & Polytechnique Montreal, Montreal, QC, Canada, miguel-f.anjos@polymtl.ca, Vilmar Rodrigues de Sousa, Vilmar Rodrigues de SousaLe Digabel

We present the results of a computational study to identify the best inequalities to tighten a semidefinite relaxation of the maximum-k-cut problem. We focus on four families of inequalities (Clique, General clique, Wheel and Bicycle wheel) and tested them for different values of k using a set of 147 benchmark instances (with nearly equal numbers of dense and sparse). Our results suggest that Bicycle wheel and Wheel are the strongest inequalities for k = 3, and that for k > 3 the Wheel inequalites are the strongest by far.

■ WC14

104D-MCC

Transportation and Disaster Analytics

Sponsored: Analytics

Sponsored Session

Chair: Samiul Hasan, CSIRO, Highett, Australia, samiul.hasan@gmail.com

1 - Analyzing Complex Social Contagion During Hurricane Sandy Using Social Media Communication Data

Arif Mohaimin Sadri, Purdue University, West Lafayette, IN, United States, asadri@purdue.edu, Samiul Hasan, Satish Ukkusuri, Manuel Cebrian

Hurricane Sandy was one of the strongest and costliest in the history of hurricanes. Many people used social media to communicate during this period while lacking access to traditional information sources. In this study, we analyzed raw data (~52 M tweets, ~13 M users, Oct 14 -Nov 12, 2012) obtained from Twitter. First, we identify different communities from the subgraph of Twitter that was active before, during, and after Sandy's landfall. Then, we extract the topics evolved in this subgraph over time. Finally, we examine the relationship between network topology and user activity.

2 - Short-term Taxi Demand Forecasting Accouting For Spatio-temporal Correlations

Xinwu Qian, Purdue University, qian39@purdue.edu

To improve efficiency of taxi market, we may dispatch taxicabs to specified locations or framing dynamic pricing policies before the reveal of passenger demand. This requires knowledge on spatial taxi demand in immediate future, and is less prone to prediction errors. In this study, we develop a Gaussian Conditional Random Field model to forecast the short-term taxi demand using history time series. The model captures spatio-temporal dependencies, and generates multiple steps ahead probabilistic estimations of short-term taxi demand. The results suggest the superiority of the GCRF model over other methods, with best overall MAPE of 0.117 and being robust for predicting demand under anomalies.

3 - Traffic State Estimation For Arterial Networks Using License-plate Recognition Data

Xianyuan Zhan, Purdue University, zhanxianyuan@purdue.edu

This study proposes a statistical modeling framework to estimate the network-wide real-time traffic states using License-plate recognition (LPR) data from a subset of intersections. The model operates in two steps: first, the cycle maximum queue lengths are estimated for monitored links (downstream intersections equipped with LPR cameras); second, a Hybrid Dynamic Bayesian Network model is developed to infer the queue length states for unmonitored links as well as the average link travel times for the entire network. A week's LPR data from 13 intersections in a small road network from Langfang, China are used to test and validate the model.

■ WC15

104E-MCC

Exploiting Sparse and Low Rank Structures for Inference

Sponsored: Artificial Intelligence

Sponsored Session

Chair: Meisam Razaviyayn, Stanford University, 275 Ventura Ave, Apt 27, Palo Alto, CA, 94306, United States, meisamr@stanford.edu

1 - Understanding Non-convex Optimization For Matrix Completion

Ruoyu Sun, Stanford University, ruoyus@stanford.edu

Low-rank matrix completion is usually solved by machine learning practitioners using the non-convex factorization formulation. A natural question is whether a non-convex formulation for matrix completion can be solved to global optima. We provide an affirmative answer to this question by showing that under mild conditions, many standard optimization algorithms converge to the global optima of a factorization formulation, and recover the true low-rank matrix. The high level idea is that the problem exhibits a nice geometrical property, which is why we can provide recovery guarantee for a wide variety of algorithms including SGD (stochastic gradient descent) and BCD (block coordinate descent).

2 - Covariance Thresholding And Sparse Pca

Yash Deshpande, Stanford University, yashd@stanford.edu

In sparse principal components analysis (PCA), we wish to infer a sparse, low-rank matrix from noisy data. Johnstone and Lu proposed the popular "spiked covariance" model, where the data is n samples with population covariance $I + vv^t$. Assuming that the spike v is sparse, they proposed the diagonal thresholding scheme to estimate its support. Despite considerable work, there was no computationally efficient procedure that provably improved over this scheme. We analyze a simple "covariance thresholding" algorithm and show that it outperforms the diagonal thresholding scheme. In fact, assuming hardness of the hidden clique problem, it is impossible to significantly improve this guarantee.

3 - Vanishing Duality Gap In Nonconvex Optimization

Mengdi Wang, Princeton University, mengdiw@princeton.edu

Consider the optimization problem that involves multiple participants driven by self interests and common goods. We focus on the nonconvex problem which is often NP-hard. We analyze the nonconvex duality and show that it often vanishes to zero as the number of participants goes to infinity. Moreover, we show that there exists an approximate optimum by solving the dual problem and provide a coordinative dual algorithm to achieve the optimum in polynomial time. We demonstrate the application of the proposed method in estimating large spatial graphical model with sparsity constraints, and show that the dual solution is statistically optimal for large graphs.

4 - Nestt: A Nonconvex Primal Dual Splitting Method For Distributed And Stochastic Optimization

Davood Hajinezhad, Iowa State University, dhaji@iastate.edu, Mingyi Hong, Zhaoran Wang, Tuo Zhao

We study a stochastic and distributed algorithm for a nonconvex problem, whose objective consists a sum of N nonconvex L_i-smooth functions g_i, plus a nonsmooth regularizer. The proposed algorithm splits the nonconvex problem into N subproblems, and utilizes an augmented Lagrangian based primal-dual scheme to solve it in a distributed and stochastic manner. Further, we reveal a fundamental connection between the proposed {\it primal-dual splitting} methods and a few {\it primal only} methods such as IAG/SAG/SAGA.

■ WC16

105A-MCC

Optimization and Learning in Supply Chain Systems

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Huanan Zhang, University of Michigan, 1205 Beal Avenue, Ann Arbor, MI, 48109, United States, zhanghn@umich.edu

Co-Chair: Cong Shi, University of Michigan, 1205 Beal Avenue, Ann Arbor, MI, 48109, United States, shicong@umich.edu

1 - Closing The Gaps: A Learning-while-doing Algorithm For Lost-sales Inventory System With Lead Times

Huanan Zhang, University of Michigan, Ann Arbor, MI, 48108-1094, United States, zhanghn@umich.edu, Xiuli Chao, Cong Shi

We develop an improved nonparametric learning algorithm for periodic-review lost sales inventory systems with positive lead time, where the firm does not know the demand distribution a priori but makes the replenishment decision in each period based only on the past sales (censored demand) data. It is known that the optimal policy is hard to compute even with full information, hence in this paper we focus on finding the best base-stock policy. We establish a square-root convergence rate of the proposed learning algorithm, which is the best possible rate for this class of problems.

2 - Nonparametric Data-driven Algorithms For Capacitated Inventory Systems

Weidong Chen, University of Michigan, aschenwd@umich.edu, Cong Shi, Izak Duenyas

We propose data-driven algorithms for the management of stochastic inventory systems with fixed ordering capacity and random ordering capacity. We consider a single-product, periodic-review inventory system with backlogging. We assume that the manager has no prior information on the demand distribution nor the capacity distribution and only has access to past demand and supply data . In our model, we propose cyclic gradient-descent type of algorithms whose running average holding and backlogging cost asymptotically converges to the cost of the optimal. We prove the rate of convergence guarantee of our algorithm is O(1/sqrt(T)) for both cases.

3 - Primal-dual Algorithm For Online Transportation Problem

Yuchen Jiang, University of Michigan, Ann Arbor, MI, United States, ycjiang@umich.edu, Cong Shi, Siqian Shen

In this paper, we study a transportation problem in which customers come one by one in an online manner. The retailer chooses a particular warehouse from which a shipment is made to meet the current customer's demand without knowing the information of subsequent customers. We design a Primal-dual Algorithm for the retailer to maximize the total revenue under the uncertainty of those customers who have not yet arrived. We also compare our online policy with the offline optimal policy and obtain a competitive ratio which guarantees the performance of our Primal-Dual Algorithm.

4 - Preservation Of Additive Convexity And Its Applications In Stochastic Optimization Problems

Xiting Gong, The Chinese University of Hong Kong, xtgong@se.cuhk.edu.hk, Tong Wang

In this paper, we establish a new preservation result of additive convexity for a class of multi-dimensional optimization problems. We demonstrate the applications of this result and and its variant to several important stochastic optimization problems, including stochastic inventory control problems with remanufacturing, dynamic inventory rationing with multiple demand classes, and dynamic capacity management with general upgrading.

■ WC17

105B-MCC

Nonlinear Optimization Algorithms I

Sponsored: Optimization, Nonlinear Programming

Sponsored Session

Chair: Daniel Robinson, Johns Hopkins University, 3400 N. Charles Street, Baltimore, MD, 21218, United States, daniel.p.robinson@gmail.com

Co-Chair: Frank Edward Curtis, Lehigh University, 200 West Packer Avenue, Bethlehem, PA, 18015, United States, frank.e.curtis@gmail.com

Co-Chair: Andreas Waechter, Northwestern University, 2145 Sheridan Road, Evanston, IL, 60208, United States, waechter@iems.northwestern.edu

1 - An Active-set Algorithm For Chance-constrained Nonlinear Optimization

Andreas Waechter, Northwestern University, waechter@iems.northwestern.edu, Frank Edward Curtis, Victor M Zavala

A new algorithmic framework for the solution of nonlinear chance-constrained optimization problems is proposed. Similar to Fletcher's Sl1QP algorithm, the method computes trial points from the minimization of a piece-wise quadratic model subject to a trust region. Theoretical convergence results and numerical experiments will be presented.

2 - Logical Benders Decomposition For Binary-constrained Quadratic Programs With Complementarity Constraints

Francisco Jara-Moroni, Northwestern University, Evanston, IL, United States, franciscojaramoroni2013@u.northwestern.edu, Andreas Waechter, Jong-Shi Pang, John E Mitchell

We study a Benders decomposition approach to solving Binary Constrained Quadratic Programs with Linear Complementarity Constraints. It formulates a satisfiability master problem with feasibility cuts are added by solving primal and dual subproblems for chosen complementarity pieces and binary variables. Our method strengthens the feasibility cuts by solving L0-norm or L1-norm problems, and guides the satisfiability problem solution by means of a convex piecewise linear approximation of the objective function.

3 - Trust Region Methods With Optimal Complexity For Nonconvex Functions

Mohammadreza Samadi, Lehigh University, Bethelehem, PA, United States, mos213@lehigh.edu, Frank E. Curtis, Daniel Robinson

We present a trust region method for unconstrained nonconvex optimization that, in the worst-case, is able to drive the norm of the gradient of the objective below a prescribed threshold eps > 0 after at most O(eps^(-3/2)) iterations. This complexity bound has been shown to be optimal with respect to a wide class of methods. Our algorithm (called TRACE) is modeled after a traditional trust region algorithm, but employs modified step acceptance criteria and a novel trust region updating mechanism that allows it to achieve this desirable property. As an extension, we discuss the implications of our new algorithm on equality constrained problems. Numerical results are presented.

WC18

106A-MCC

DMA Healthcare

Contributed Session

Chair: Kaiye Yu, Tsinghua University, Room 615,Shunde Building, Tsinghua University, Beijing, BJ100084, China, yky15@mails.tsinghua.edu.cn

1 - Optimal Reimbursement Schemes For Maternity Care Safety And Quality

Cheng Zhu, McGill University, 701-801 Sherbrooke Est, Montreal, QC, H2L 0B7, Canada, cheng.zhu@mail.mcgill.ca, Beste Kucukyazici

The amount of unnecessary C-Sections, which expose proven higher postpartum complications of mothers and newborns as well as heavy economic burden, has been increasing constantly and this growth raises great concerns for the policy makers. This research focuses on optimizing payment mechanisms to reimburse obstetricians, in order to reduce unnecessary C-sections while retain it for those who need it, resulting in enhanced birth quality with alleviated economic burden for overall health care system. The optimal reimbursement schemes are further verified empirically with large datasets.

2 - Using Policy Flight Simulator To Evaluate Scalability Of Evidence Based Practices

Zhongyuan Yu, Research Assistant Professor, Stevens Institute of Technology, Hoboken, NJ, 07030, United States, zyu7@stevens.edu, William B Rouse, Michael Pennock, Kara Pepe

Numerous evidence-based practices have demonstrated reduced medical costs, improved patient experiences and better quality of life. However, concern from stakeholders in health system seems to be holding back adoption. Policy flight simulator is proposed to find out what affects scalability of these practices, and assess what needs to be adjusted in order to increase confidence of senior administrators to expand these practices. Policy flight simulators fuse aspects of traditional scientific analysis, engineering, social science, and visualization to provide decision makers an immersive experience to increase comfort level with simulation-based data-driven decision making processes.

4 - Modeling And Assessment Of The Risk Of Colorectal Polyp

Kaiye Yu, Tsinghua University, Room 615,Shunde Building, Tsinghua University, Beijing, BJ100084, China, yky15@mails.tsinghua.edu.cn, Jie Xing, Wenying Zhou, Shutian Zhang, Xiaolei Xie, Nan Kong

Most colorectal cancer (CRC) arise from polyps. We identify colorectal polyps risk factors and develop risk stratification model using machine learning approaches. The individualized risk assessment tool could offer decision support to both clinicians and patients.

WC19

106B-MCC

Open-Source Tools for Operations Research

Sponsored: Computing

Sponsored Session

Chair: Matthew J Saltzman, Clemson University, Clemson University, Clemson, SC, 29634, United States, mjs@clemson.edu

1 - New Developments In Pyomo

William E Hart, Sandia National Laboratory, wehart@sandia.gov

Pyomo is a Python-based open-source software package that supports a diverse set of optimization capabilities for formulating, solving, and analyzing optimization models. In this presentation, we describe new capabilities in Pyomo, including support for new versions of Python, installation with conda, and updates for modeling capabilities (bilevel, sp, dae, etc). This talk will also highlight new documentation resources for users.

2 - Jmarkov: An Integrated Java Framework For Stochastic Modeling

Daniel F Silva, Georgia Institute of Technology, Atlanta, GA, United States, dfsi3@gatech.edu, Julio C Goez, Juan F Perez, German Riano

jMarkov allows users to define stochastic models from the basic rules underlying the system dynamics and then solve the models to obtain performance measures. It is composed of four modules: (i) the main module supports Markov Chain models with a finite state space; (ii) jQBD enables the modeling of Quasi-Birth-and-Death processes; (iii) jMDP offers the capabilities to model and solve Markov Decision Processes; and (iv) jPhase supports the manipulation and inclusion of phase-type variables. In addition, jMarkov is highly extensible, allowing the users to introduce new modeling abstractions and solvers. In this talk we give an overview of jMarkov, as well as some examples.

WC20

106C-MCC

Understanding the US Index Futures Stock Market using Research

Invited: Tutorial

Invited Session

Chair: William T. Ziemba, University of British Columbia, 1, Vancouver, BC, 2, Canada, wtzimi@mac.com

1 - Understanding The US Index Futures Stock Market Using Research

William T. Ziemba, University of Bristish Columbia, Vancouver, BC, 2, Canada, wtzimi@mac.com

I begin with five views or camps of beliefs concerning the US stock market. There are efficient markets where prices are correct except for transactions costs, risk premium where excess returns can be made only by bearing additional risk, efficient markets is hogwash, great investors exist but you cannot tell who they are in advance and the study of anomalies and other research. Edges arise from cash flows, institutional practices and behavioral biases. These include the turn of the year effect, the turn of the month effect, presidential election effects and mispriced options. I describe the effects and explain why they exist and then discuss their use in trading considering operational risks, the effect of volatility, prediction of stock market crashes, slippage, risk management, and optimal betting sizing. I won the 2015 futures trading contest of the Battle of the Quants in New York and have been able to obtain very good risk adjusted returns during July 2013 to May 2016 in the Alpha Z Futures Fund.

WC21

107A-MCC

Healthcare Operations and Capacity Planning

Sponsored: Health Applications

Sponsored Session

Chair: Sukriye Nilay Argon, University of North Carolina, Hanes Hall CB# 3260, Chapel Hill, NC, 27599, United States, nilay@unc.edu

Co-Chair: Serhan Ziya, University of North Carolina, 356 Hanes Hall, CB#3260, Chapel Hill, NC, 27599, United States, ziya@unc.edu

1 - Admission, Routing And Early Discharge Decisions In A Hospital Setting

Lerzan E Ormeci, Koc University, lormeci@ku.edu.tr, Nermin Kurt, Amin Khoshkenar

We consider the problem of bed management in a hospital. The patients stay at the hospital for a random length of time to recover after a surgery. Hence, the operation schedule has a long-term effect on the occupancy levels, which significantly affect the quality of care for the patients. To control the occupancy levels, hospital management has a number of options: 1) New patients may be rejected at high levels of occupancy, 2) Patients operated by a certain department may stay in the ward of another department, 3) Patients staying at the hospital may be discharged early. In this study, we analyze the effects of these decisions on the hospital performance by modeling the system via Markov decision processes.

2 - Ambulance Redeployment And Dispatching Under Uncertainty With Personnel Workload Limitations

Shakiba Enayati, North Carolina State University, Raleigh, NC, United States, senayat@ncsu.edu, Osman Ozaltin, Maria Esther Mayorga

Emergency Medical Services managers are concerned with providing maximum possible coverage in a service area. Redeployment refers to dynamic relocation of idle ambulances to compensate for the coverage loss due to busy ambulances. Unsystematic redeployments, however, impose superfluous workload on the personnel. We propose a two-stage stochastic programming model to redeploy and dispatch ambulances to maximize expected coverage. Our model includes personnel workload restrictions in a shift. We develop a decomposition algorithm to determine an upper bound and apply a branch and bound algorithm to find the optimal solution. We evaluate the performance using a largescale real dataset.

3 - An Optimization Approach For Coordinating Clinic And Surgery Appointments To Meet Access Delay Service Levels

Esmaeil Keyvanshokooh, University of Michigan, Ann Arbor, Ann Arbor, MI, United States, keyvan@umich.edu, Mark P. Van Oyen

Providing timely access to surgery is crucial for patients with high acuity diseases like cancer. In this paper, we present an optimization approach for coordinating clinic and surgery appointments to meet access delay service levels in Colorectal surgery (CRS). The methodology is applied to historical patient data for CRS to show its better performance than the current scheduling policy.

4 - Optimizing Admission And Discharge Decisions In Icu With Flexible Bed Allocation

Xuanjing Li, Tsinghua University, Room 519A,Shunde Building,Tsinghua Univ, Beijing, Beijing, 100084, China, lixj15@mails.tsinghua.edu.cn, Dacheng Liu, Xiaolei Xie, Ye Wang

This paper studies the admission and premature discharge policy in the intensive care unit (ICU) at Peking University Third Hospital. Patients are classified into two categories based on their survival benefit and discharge cost. A Markov Decision Process (MDP) model is established to strike balance between those two factors. Structural properties are obtained and a new admission policy is proposed.

■ WC22

107B-MCC

Appointment Scheduling Models and Analytics

Sponsored: Health Applications

Sponsored Session

Chair: Nan Liu, Columbia University, 722 W. 168th. St, New York, NY, 10032, United States, nl2320@columbia.edu

Co-Chair: Zhankun Sun, Eyes High postdoctoral scholar, University of Calgary, 2500 University Dr. NW, Calgary, AB, T2N 1N4, Canada, zhankun.sun@haskayne.ucalgary.ca

1 - Improving Patient Satisfaction: Customizing Patient Appointment

Yutian Li, University of Miami, 421 Jenkins Building, 5250 University Drive, Coral Gables, FL, 33124, United States, ytli@umiami.edu, Joseph Johnson, Yu Tang

In this paper, we develop a Bayesian logit model which improves no-show prediction accuracy over the widely-used simple logit model. The accuracy gain arises from the individual patient-level coefficients provided by the Bayesian approach. Comparison of model fit on 12-months of appointment data shows the Bayesian model outperforms the simple logit model. In simulation studies, our results show that applying Bayesian model's prediction to scheduling algorithm can reduce patient's waiting time and physician's idle time and increase clinic's profit.

2 - Managing Appointment-based Services In The Presence Of Walk-in Customers

Shan Wang, Shanghai Jiao Tong University, 1954 Huashan Road, Shanghai, 200030, China, wangshan_731@sjtu.edu.cn, Nan Liu, Guohua Wan

Walk-in customers are accepted in many service industries and especially in healthcare. Motivated by practice in and data collected from two large community health care networks in New York City, we study how to coordinate scheduled patients in a clinic session in anticipation for random walk-ins. We use a Poisson regression framework to analyze the temporal pattern of walk-in patients based on 3-year data, and propose data-driven optimization models to identify the optimal appointment schedule. Our models can incorporate other practical aspects of appointment scheduling such as patient no-shows, patient preferences and restricted walk-in windows.

3 - Physician Scheduling To Improve Patient Flow Through Emergency Rooms

Farzad Zaerpour, PhD Candidate, Haskayne School of Business, University of Calgary, Calgary, AB, T3A 2E1, Canada, farzad.zaerpour@haskayne.ucalgary.ca, Zhankun Sun, Marco Bijvank

Emergency department (ED) crowding has become a serious concern worldwide. Hours of waiting is the main consequence of crowding in emergency departments. In this study, we develop a mixed-integer stochastic program for scheduling physicians to improve patient flow through an emergency department. The operational performance of an emergency department is vulnerable to mismatch between demand and supply. Therefore, the proposed model takes into account the stochastic natures of both demand and supply. We use physician productivity to evaluate the performance of each physician in the emergency department.

4 - When Waiting To See A Doctor Is Less Irritating: Understanding Patient Preferences And Choice Behavior In Appointment Scheduling

Nan Liu, Columbia University, 722 W. 168th St., Room 476, New York, NY, 10032, United States, nl2320@columbia.edu, Stacey Finkelstein, Margaret Kruk, David Rosenthal

This talk examines patient preferences and choice behavior in scheduling medical appointments. We conduct four discrete choice experiments on two distinct populations and identify several operational attributes that affect patient choice. We observe an interesting gender effect with respect to how patients tradeoff speed (delay to care) vs. quality (doctor of choice), and demonstrate that risk-attitudes mediate the impact of gender. As many operational strategies aim to improve patient experience by making tradeoffs between speed and quality, we make suggestions for when managers should intervene and how such interventions might look based on the patient mix and current delay level.

■ WC23

108-MCC

Optimization in Radiation Therapy Treatment Planning

Sponsored: Health Applications

Sponsored Session

Chair: Victor Wu, University of Michigan, 1205 Beal Avenue, Ann Arbor, MI, 48109, United States, vwwu@umich.edu

1 - Deriving Imrt Treatment Plans From Dvh Curves

Aaron Babier, University of Toronto, Toronto, ON, Canada, ababier@mie.utoronto.ca, Justin James Boutilier, Andrea McNiven, Michael Sharpe, Timothy Chan

Plan quality is often assessed using dose volume histograms (DVHs), which are a high level representation of a dose distribution. Clinical quality DVHs can be accurately predicted, however their corresponding treatment plans are more challenging to determine. We present an inverse optimization model that can produce treatment plans from DVH curves, with minimum treatment complexity. The model is applied to several clinical head and neck treatment plans, and the outcomes are compared to their corresponding clinical plans.

2 - Evaluation Of Multi-source Treatments For Prostate Brachytherapy Optimized Using An Interior Point Constraint Generation Algorithm

Dionne Aleman, University of Toronto, Toronto, ON, Canada, aleman@mie.utoronto.ca, Rachel Mok Tsze Chung, William Song

A novel approach to treat prostate cancer using multi-source high-dose-rate brachytherapy is investigated. The effectiveness of different combinations of the radionuclides 192Ir, 60Co, and 169Yb is analyzed. We use an inverse planning interior point algorithm to generate treatment plans for every possible combination of the three sources, and then compare treatment quality to the 192Ir plan. Overall, for the same target coverage, double- and triple-source plans provided better organ-at-risk sparing than the 192Ir plan.

3 - Threshold-driven Optimization For Reference-based Auto-planning

Troy Long, University of Texas Southwestern, Dallas, TX, United States, troy.long@utsouthwestern.edu, Steve Jiang, Mingli Chen, Weiguo Lu

We study the procedure of reference-based auto-planning for treatment plan optimization. We develop a threshold-driven optimization methodology for automatically generating an intensity-modulated radiation therapy treatment plan that is motivated by a reference dose-volume histogram. The commonly used voxel-based quadratic penalty objective functions have three components: an overdose weight, and underdose weight, and some target dose threshold. The proposed methodology directly relates reference information to threshold values, which influence the optimization in an effective, intuitive way.

4 - Optimal Fractionation With Two Modalities

Sevnaz Nourollahi, University of Washington Seattle, sevnaz@uw.edu

We introduce an optimal fractionation problem with two modalities. This involves finding the number of treatment sessions and the dose per session administered via each modality. The goal is to maximize the biological effect of such bimodal treatment on the tumor while keeping the toxic effects on nearby normal tissue within tolerable limits. We formulate this problem as a nonconvex quadratically constrained quadratic program. We show that the KKT conditions for this problem reduce to solving a quartic equation. We are thus able to provide an analytical solution to the KKT system. We study properties of the resulting solutions via numerical experiments.

■ WC24

109-MCC

Scheduling Providers and Patients

Sponsored: Health Applications

Sponsored Session

Chair: Nadia Lahrichi, Ecole Polytechnique de Montreal, 2900 Boul. Édouard-Montpetit, A-520.20, Montreal, QC, H3T 1J4, Canada, nadia.lahrichi@polymtl.ca

1 - Adaptive Appointment Scheduling For Patient Centered Medical Homes

Ali Kemal Dogru, OM PhD Student, University of Alabama, Tuscaloosa, AL, 35487, United States, akdogru@crimson.ua.edu, Sharif Melouk

Incorporating patient centered medical home (PCMH) principles, we develop an adaptive appointment scheduling model for a primary care setting. We propose a simulation optimization approach to sequentially schedule appointments to provide desirable schedules from the perspective of both patients and the medical practice. Our data-driven algorithm is efficient and takes patient preferences into account. We benchmark against myopic and optimal algorithms. Computational results show that the adaptive scheduling approach provides significant value.Key Words: Appointment Scheduling, Simulation, Patient Centered Medical Home

2 - Elective Surgery Scheduling Considering Patient Health Condition

Joonyup Eun, Vanderbilt University Medical Center, Nashville, TN, 37212, United States, joonyup.eun@vanderbilt.edu, Sang-Phil Kim, Yuehwern Yih

Surgery scheduling considering patient health condition can contribute to preventing patients from being exposed to the risk of sentinel events. This research describes an operating room planning problem that considers uncertainty in patient health condition. In addition, overutilization of operating rooms is restricted to reduce a hospital's surgical costs. We employ the sample average approximation to identify the optimal assignment of surgeries and analyze the assignment based on Ceteris Paribus.

3 - Scheduling Physicians To Improve Patient Flow In Radiotherapy Centers

Nadia Lahrichi, Ecole Polytechnique de Montreal, nadia.lahrichi@polymtl.ca

When a patient is referred to a radiotherapy center, a sequence of tasks (consultation with the physician, a CT scan and the treatment planning) take place. This phase is referred to as the pre-treatment and is followed by the treatment per se. Bottlenecks in such centers are often related to the unavailability of one of the human resources. Here, we focus on improving the flow of patients during the pre-treatment phase through physician scheduling. We consider uncertainty related to the arrival rate of patients and their profiles. To solve this problem, we develop a stochastic Tabu search algorithm. It appears to provide very high quality solutions when compared to the solutions obtained by CPLEX.

■ WC25

110A-MCC

Logistics III

Contributed Session

Chair: Chun Hung Cheng, Associate Professor, Chinese University of Hong Kong, Rm 607 William MW Mong Eng Bldg, Shatin NT, Hong Kong, chcheng@se.cuhk.edu.hk

1 - Identifying Collaborative Shipping Opportunities

Jeroen Belien, KU Leuven, Warmoesberg 26, Brussel, 1000, Belgium, jeroen.belien@kuleuven.be, Stefan Creemers, Robert Boute

Collaborative shipping, where companies bundle their transport loads, is a growing trend in logistics. We present a tool that enables the quick identification of potential partners based on their geographical compatibility, even when the database of shipment lanes is very large. The tool allows the detection of bundling, backhauling, and roundtrip opportunities, as well as “collect-and/or-drop” opportunities where shipments are collected and/or dropped off en route. The tool is currently being used (among others) by Tri-Vizor, a facilitator and orchestrator of horizontal logistics partnerships, but is also applicable for any company that is looking for collaborative shipping partners.

2 - A Multilocation Distribution System With Resupply And Vehicle Routing

Stefan Minner, Technical University of Munich, Arcisstrasse 21, Munich, 80333, Germany, stefan.minner@tum.de, Belma Turan, Richard F. Hartl

We analyze the problem of delivering perishable products from a depot to stores with the option of a second delivery per day. We determine initial delivery quantity, timing and quantity of resupply and the sequence of visiting stores. The stochastic inventory optimization problem is solved by stochastic dynamic programming, while the tour problem is solved using variable neighborhood search. The algorithm is tested on randomly generated test instances and a real-world scenario is investigated. The results show a considerable improvement compared to the “single-order” model.

3 - Minimizing Fuel Consumption And Gas Emissions In Urban Distribution With An Instantaneous Energy Model

Hugo Tsugunobu Yoshida Yoshizaki, Associate Professor, University of Sao Paulo, Av. Almeida Prado Trav 2, 128, Cidade Universitaria, Sao Paulo, 05508-900, Brazil, hugo@usp.br, Anderson Oliveira Paschoal

Route optimization is an important tool for reducing fuel consumption and green house gas emissions. This paper show test results from a Pollution Routing Problem (PRP) model applied to an actual problem of urban distribution in the city of São Paulo. An instantaneous energy model (CMEN) has been used to obtain objective function parameters considering road slopes (using Graphhopper maps), vehicle speed, payload, time windows, and traveled distances, showing 2 to 10% savings. Potential operational strategies been also been evaluated, as dropping first the heaviest delivery.

4 - Optimal Design For Block Stacking Warehouses

Shahab Derhami, PhD Candidate, Auburn University, 3301 Shelby Center, Auburn, AL, 36849, United States, sderhami@auburn.edu, Jeffrey Smith, Kevin Gue

Storing pallets of SKUs on top of one another on a warehouse floor is known as block stacking. The arrangement of lanes in the layout of this system significantly impacts utilization of the storage space. We present a new approach to measure waste of storage space for block stacking and develop a model to calculate the optimal lane depth with respect to space utilization for a layout-free storage area. We, also propose a mixed integer programming model to design the optimal layout for the warehouses using block stacking. Several effective solution techniques are developed to solve the model.

5 - A Location Based System For Managing Cart Operations At A Mail Facility

Chun Hung Cheng, Associate Professor, Chinese University of Hong Kong, Rm 607 William MW Mong Eng Bldg, Shatin NT, Hong Kong, chcheng@se.cuhk.edu.hk, Yong-Hong Kuo

We have developed a location based system for managing cart operations at a mail facility. The RFID-tag attachments to carts and reader mounts at the top of the building allows the facility operators to locate target carts quickly. We have also conducted an initial analysis of data collected using this technological infrastructure to understand issues on cart movements and operational efficiency.

■ WC26

110B-MCC

Information Systems II

Contributed Session

1 - Why Do Firms Outsource Empirical Evidence For Resource Constraint And Slack Mechanisms

Shivom Aggarwal, IE Business School, Instututo de Empresa S.L., CIF B82334319, Calle de Maria de Molina, 12 Bajo, Madrid, 28006, Spain, dr.shivom@gmail.com, Kiron Ravindran, Gautam Ray

Why do firms outsource Information Technology (IT)? The literature is divided on whether IT Outsourcing is a cost-reduction strategy or a growth strategy. We argue that organizations can do both, depending on the degree of resource constraint and slack availability under certain environmental conditions (competition). We found empirical evidence of these underlying mechanisms using a longitudinal dataset on IT outsourcing contracts. We provide important implications for IS scholars working on IT Outsourcing and practitioners from outsourcing firms as well as IT vendors.

2 - Developing A Non Invasive Tool To Diagnose Diabetic Retinopathy

Saeed Piri, PhD Student, Oklahoma State University, School of Industrial Engineering & Management, Engineering North, Stillwater, OK, 74078, United States, saeed.piri@okstate.edu, Tieming Liu, Dursun Delen

Diabetic retinopathy is the leading cause of vision loss in the US. In this study a non-invasive tool is developed to detect this disease. The demographic and lab data of more than 1.4 million diabetics has been analyzed and four sets of predictive models have been developed. The first set encompasses the models that have been developed using lab and demographic data. In the second set, comorbidity data was included in addition to basic data. Third set consists of models that are built using the oversampled data by applying SMOTE method. Fourth set includes ensemble models that have been developed using the outputs of different single predictive models. The accuracy of the best model is close to 90%.

3 - Call For Bids To Improve Matching Efficiency: Evidence From Online Labor Markets

Xue Guo, Doctoral Student, Temple University, Fox School of Business, 1801 North Broad Street, Philadelphia, PA, 19122, United States, xueguo@temple.edu, Jing Gong, Pavlou Paul

In online labor markets, Call for Bids (CFB) plays an important role in affecting the efficiency and quality of labor matches. In this study, we analyze the text of CFBs and examine five attributes associated with the clarity of CFBs that may affect the contracting success rate and post-project satisfaction—codifiability, uncertainty, complexity, flexibility and monitoring. We propose to use deep learning algorithms to analyze large unstructured textual data and test our model using archival data from one of the largest online labor platforms.

4 - An Empirical Investigation Of Online Marketplace Users

Yuanyuan Shen, Stanford University, Stanford, CA, 94305, United States, yyshen@stanford.edu, Haim Mendelson, Kenneth Moon

We develop a simple Markovian model of user behavior which incorporates user learning and social value on an online marketplace. We test the model and analyze additional tradeoffs and market characteristic. We use data from Kiva, a non-profit lending marketplace. Consistent with the predictions of our model, we find evidence of user engagement begetting greater engagement. Meanwhile, an engaged user's tenure is negatively correlated with his lending rate while the correlation turns to be positive when the user has no loans. We also identify significant differences in the behaviors of user acquired directly and those acquired virally.

■ WC27

201A-MCC

Innovations in Retail Operations

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Nicole DeHoratius, University of Chicago, 58071 S Woodlawn Ave., Chicago, IL, 60637, United States, Nicole.DeHoratius@ChicagoBooth.edu

1 - Retail Inventory Liquidation Value: Local Economic Factors

Nathan Craig, OSU, craig.186@osu.edu

The liquidation value of a firm's assets is an input to numerous models. Our research characterizes liquidation values in practice and identifies factors that affect liquidation value. In the context of retail inventories, we analyze data from multiple sources to identify economic features of a store's local market that significantly impact inventory liquidation value.

2 - Here Comes The Sun: Measuring And Exploiting Weather Shocks In Fashion Retailing

Victor Martinez-de-Albeniz, Professor, IESE Business School, Barcelona, 08034, Spain, valbeniz@iese.edu, Abdel Belkaid

We model and empirically study the impact of weather variables on the operations of a large apparel retailer. Specifically, we focus on traffic store and the conversion of traffic into product category sales. We find that rain increases traffic but decreases conversion in shopping mall stores, while the opposite is true in street stores. Lower temperatures increase traffic and increase conversion of sales of the "appropriate" categories (summer vs. winter). Finally, we demonstrate how to exploit weather variations to improve profits.

3 - Optimizing Prepacks To Ship Products In Retail Supply Chains

Stephen A Smith, Santa Clara University, Omis Lucas Hall 216h, 500 El Camino Real, Santa Clara, CA, 95053-0382, United States, ssmith@scu.edu, Naren Agrawal

We present recent results from the analysis of shipping and inventory policies in retail supply chains when multiple pre-packs are permissible. We compute exact solutions to a dynamic stochastic programming formulation and derive insights based on numerical analysis of a sample case study.

4 - Package Size And Pricing Decisions With A Bulk Sale Option

Ismail Kirci, University at Texas at Dallas, ismail.kirci@utdallas.edu

We investigate the package size and pricing decisions of a retailer selling a perishable product that can be offered in packages or in a container that allows consumers to buy as much as they want (Bulk Sale). We show how the existence of a bulk sale option affects the optimal package size, the optimal price and product waste at the consumer level.

■ WC29

202A-MCC

Mechanisms to Enhance the Value of Used and Returned Products

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Eda Kemahlioglu-Ziya, Poole College of Management at North Carolina State University, 2801 Founders Dr, Raleigh, NC, 27695, United States, ekemahl@ncsu.edu

1 - Impact Of Recycling Standards On E-waste Recovery In The Presence Of Secondary Market

Gokce Esenduran, Ohio State University, esenduran.1@osu.edu, Yen-Ting (Daniel) Lin, Wenli Xiao, Minyue Lin

There are two voluntary certification programs for e-waste recyclers: e-Stewards and R2. While both provide assurance of proper e-waste handling, e-Stewards is much stricter than R2, resulting in a higher processing cost. With the aim of identifying when a recycler should adopt e-Stewards versus R2, we model the competition between two recovery channels; each consisting of a recycler and a collector who can sell collected e-waste either in the secondary market or to its recycler. We find that devoid of competition, a recycler always chooses R2; whereas under competition, recyclers may choose either one. We also examine how secondary market and scale economies affect recyclers' decisions.

2 - Design For Reusability And Product Reuse Under Radical Innovation

Michael Galbreth, University of South Carolina, galbreth@moore.sc.edu

Many industries, including consumer electronics and telecommunications equipment, are characterized by short product lifecycles, constant technological innovations, rapid product introductions, and fast obsolescence. Firms in such industries need to make frequent design changes to incorporate innovations, and the effort to keep up with the rate of technological change often leaves little room for the consideration of product reuse. In this paper, we study the design for reusability and product reuse decisions in the presence of both a known rate of incremental innovations and a stochastic rate of radical innovations over time.

3 - Extracting Maximum Value From Consumer Returns

Cerag Pince, Kuhne Logistics University, Cerag.Pince@the-klu.org, Mark Ferguson, Beril L Toktay

Consumer returns constitute a substantial fraction of sales in the consumer electronics industry and often cannot be re-sold as new due to litigation concerns. Therefore, identifying the best joint pricing and disposition strategy is a challenging but important decision for consumer electronics OEMs. This paper investigates how an OEM should price new and refurbished products while allocating consumer returns between remarketing and warranty coverage options over the product's short life cycle.

4 - Truth-inducing Mechanism For Medical Surplus Products Allocation

Can Zhang, Georgia Institute of Technology, Atlanta, GA, 30309, United States, czhang2012@gatech.edu, Atalay Atasu, Turgay Ayer, Beril L Toktay

We study a product allocation problem faced by a Medical Surplus Recovery Organization (MSRO) that recovers and manages reusable medical products to fulfill the needs of under-served healthcare facilities in developing countries. We focus on designing truthful mechanisms to elicit the recipients' needs information, and we prove that the optimal truthful mechanism has a very simple structure. We further show that our mechanism significantly improves the MSRO's total value provision compared with the current practice and previously proposed recipient-driven models.

WC30

202B-MCC

Data-Driven Models in Healthcare

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Yichuan Ding, University of British Columbia, 2053 Main Mall, Sauder School of Business, Vancouver, BC, V6T1Z2, Canada, daniel.ding@sauder.ubc.ca

1 - Bundled Payments And Value Based Delivery

Jillian B Jaeker, Boston University, jjaeker@bu.edu

This study aims to understand the care pathways, both inpatient and outpatient (i.e. end-to-end), for congestive heart failure (CHF) patients, and how these pathways impact the costs and quality of care. Specifically, our objective is to identify pathways that are associated with lower or higher than normal readmission rates, and the associated financial costs of these pathways. Moreover, we work with hospitals that are participating in the Bundled Payments for Care Improvement (BPCI) initiative and explore if any recent interventions on behalf of these hospitals affects the probability of 30 day readmission and total episode costs.

2 - Dynamic Allocation Of Vaccine Stocks For Pandemic Influenza Mitigation

Ozden O Dalgic, University of Waterloo, Waterloo, ON, Canada, oodalgic@uwaterloo.ca

Vaccination is our best response against influenza pandemics. However, finding effective vaccine allocation strategies with current modeling technics can be challenging. In this study, we propose a hybrid approach combining simulation and analytical modeling. We employ a model based on a chain-binomial transition scheme calibrated to an existing agent-based simulation model. The proposed approach efficiently evaluates the performance of a given vaccine allocation strategy by reducing the number of random variates. Numerical experiments show that the proposed approach results in effective dynamic vaccine allocation strategies.

3 - Designing Personalized Anticoagulation Therapy

Rouba Ibrahim, University College London, rouba.e.ibrahim@gmail.com, Vedat Verter, Beste Kucukyazici, Michel Gendreau, Mark Blostein

We develop an analytical framework for personalizing the anticoagulation therapy of patients who are taking warfarin, and present results from a case study using data collected at the anticoagulation clinic of the Jewish General Hospital in Montreal.

4 - Do Patients From Rural Areas Get Proper Referral For Surgical Care

Yichuan Ding, University of British Columbia, 2053 Main Mall, Vancouver, BC, V6T1Z2, Canada, daniel.ding@sauder.ubc.ca

We examined surgical records throughout 98 hospitals in British Columbia during year 1995-2004, and had two interesting observations: (1) hospitals in rural areas are correlated with smaller likelihood of post-surgical complications, possibly because those hospitals have less risky case mix groups; (2) patients from rural areas, however, are correlated with lower risk of post-surgical complications. We conduct further investigation and find that the reason for (2) to happen might be the inefficient communication between the referral hospital and the one that the surgery takes place.

WC31

202C-MCC

Consumer Behavior in Services

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Qiuping Yu, Assistant Professor, Kelley School of Business, Indiana University, 1275 E 10th St, Bloomington, IN, 47401, United States, qiupyu@indiana.edu

1 - Rational Abandonment From Observable Priority Queues

Philipp Afèche, Rotman School of Management, University of Toronto, Toronto, ON, Canada, afeche@rotman.utoronto.ca, Vahid Sarhangian

The literature on customer behavior in queueing systems largely focuses on customers' joining decisions and ignores their subsequent abandonment decisions. Such abandonment behavior is important in priority queues, which are prevalent in practice. We characterize the equilibrium joining and abandonment behavior of utility-maximizing customers in an observable priority queue. We then discuss how the abandonment process in our equilibrium model compares to that under the standard exogenous abandonment model, and to its empirical counterpart in a real system.

2 - Learning Quality Through Service Outcomes

Senthil Veeraraghavan, The Wharton School, University of Pennsylvania, senthilv@wharton.upenn.edu, Laurens G Debo

We study a new firm whose service value is unknown to arriving customers. Service outcomes are random depending on the quality of the service provider. Customers decide whether patronize the service based on the limited service outcomes/reviews that they observe. We consider how service policies influence consumer learning and social welfare.

3 - Design Of Discretionary Service Lines: An Operational Driver Of Variety

Laurens Debo, Tuck School of Business, Dartmouth College, 100 Tuck Drive, Hanover, NH, 03755, United States, Laurens.g.Debo@tuck.dartmouth.edu, Cuihong Li

For discretionary services, the longer the service time, the more value is created for the customer. In the presence of variability, longer service times also create more congestion. Hence, a service firm needs to trade off congestion costs with value creation in service line design. We find that it is optimal to offer a service line with multiple varieties (that differ in duration and price), even when customers are homogeneous.

4 - Linking Customer Behavior And Delay Announcements: Are Customers Really Rational?

Eric Webb, Kelley School of Business, Indiana University, Bloomington, IN, United States, ermwebb@indiana.edu, Qiuping Yu, Kurt M Bretthauer

We empirically explore customer abandonment behavior in the presence of delay information using data from a call center. Previous work has assumed that customers are at least partially rational in responding to announcements. In contrast, we relax all rationality assumptions. Our findings indicate that customers exhibit loss aversion behavior. In addition, customers may update their announcement-induced reference point as they hear subsequent announcements. Our results also indicate that customers may fall for the sunk cost fallacy while waiting in the queue. We show the impact of these effects on staffing decisions using a classic staffing model.

WC32

203A-MCC

Risk Analysis III

Contributed Session

Chair: Dexiang Wu, Stockholm University, Stockholm Business School, Stockholm, 106 91, Sweden, dexiang.wu@sbs.su.se

1 - Modeling Behavior Of Attackers Against The Uncertainty Of Cascading Failure

Sinan Tas, Assistant Professor, University of Wisconsin-Platteville, 1 University Plaza, Platteville, WI, 53818, United States, tass@uwplatt.edu

Cascading failure is a common phenomenon in capacity-constrained networks such as power grids. What if attackers consider manipulating the additional impact of cascading failure to enhance the damage to the network? We analyze various attacker types and corresponding defensive investments when cascading failure is modeled stochastically in a game-theoretic setting.

2 - Analysis Of Intraday Data Effects On Two-stage Risk-averse Portfolio Optimization

Sitki Gulten, Stockton University, School of Business, 101 Vera King Farris Drive, Galloway, NJ, 08205, United States, sitki.gulten@stockton.edu

This study examines the application of risk-averse optimization techniques to daily portfolio management. First, I develop efficient clustering methods for scenario tree construction. Then, I construct a two-stage stochastic programming problem with conditional measures of risk, which is used to re-balance the portfolio on a rolling horizon basis, with transaction costs included. Finally, I present an extensive simulation study on both interday and high-frequency intraday real-world data of the methodology.

3 - Exploring Multi-stage Recovery Resilience

Daniel Hernando Romero, University of South Florida, 4411 Shady Terrace Ln, Unit A, Apt 212, Tampa, FL, 33613, United States, danielromero@mail.usf.edu, Alex Savachkin, Alvaro Sierra, Weimar Ardila

Multi-stage recovery models enable resilience measurement in the scenarios where the recovery time is long, so it is estimated en months or years. High magnitude disruptive events severely affect communities and generate long lasting consequences. These scenarios require model flexibility to capture different recovery rates and transitions between recovery stages.

4 - Cardinality Constrainted CDS Portfolio Optimization

Dexiang Wu, Stockholm University, Stockholm Business School, Stockholm, 106 91, Sweden, dexiang.wu@sbs.su.se, Desheng Dash Wu

We study the Credit Default Swap (CDS) market from the portfolio perspective. CDS-based portfolios are constructed through incorporating solvency and cardinality constraints for the purpose of decentralization. Portfolio size is controlled exactly and therefore mixed integer quadratic and linear programs that consider different risk measurements are studied. We found that moderate size can generally obtain better performance in terms of portfolio Sharpe ratio and other metrics. Moreover, due to the specific structure of CDS correlation matrix, a cluster simplification process is applied to speed up the computation.

■ WC33

203B-MCC

Production and Scheduling III

Contributed Session

Chair: Steffen T. Klosterhalfen, BASF SE, Ludwigshafen, Germany, steffenklosterhalfen@googlemail.com

1 - Fitting Clearing Fun Actions Using Generalized Regression Methods

Reha Uzsoy, North Carolina State University, Dept. of Industrial & Systems Engg, 300 Daniels Hall Camps Box 7906, Raleigh, NC, 27695-7906, United States, ruzsoy@ncsu.edu, Karthick Gopalswamy

Clearing functions are widely used in production planning models to capture the nonlinear relationship between workload and output. Traditionally least squares methods have been used to fir the data, which weight the errors of both signs equally and assume errors to be iid normally distributed. In this work we relax the assumption of normality and provide a generalized regression approach to fit the data taking into consideration that the data is not balanced. Computational experiments evaluate the performance of the proposed methods for fitting clearing functions.

2 - A Two-stage Stochastic Programming Model For Lot-sizing And Scheduling Under Uncertainty

Zhengyang Hu, Research Assistant, Iowa State University, 100 Enrollment Services Center Ames, Ames, IA, 50011, United States, zhengya@iastate.edu, Guiping Hu

Lot-sizing and scheduling is one of the medium-term production planning problems in manufacturing. In this study, demand uncertainty has been considered and a robust production plan has been proposed with a two-stage stochastic programming framework. A case study proves that uncertainty has a significant impact on production planning.

3 - Managing Product Transitions In Semiconductor Wafer Fabrication Facilities

Reha Uzsoy, North Carolina State University, Dept. of Industrial & Systems Engg, 300 Daniels Hall Camps Box 7906, Raleigh, NC, 27695-7906, United States, ruzsoy@ncsu.edu, Atchyuta B. Manda, Sukgon Kim, Karl Kempf

We consider the problem of managing the introduction of new products into a wafer fabrication facility when the new product is subject to higher levels of process uncertainty than the current one. We propose a model for the impact of the new product on the cycle time of the fab using queueing concepts, and illustrate the behavior of the model with computational experiments.

4 - Scheduling With Batching Decisions And Energy Constraints For Steelmaking Continuous Casting Production

Wenjie Xu, Northeastern University, NO. 3-11, Wenhua Road, Heping, Shenyang, 110819, China, xuwenjie.neu@outlook.com, Lixin Tang

We study a novel scheduling problem with batching decisions of steelmaking continuous- casting (SCC) production. The energy constraints in this problem represent the conversion process from the Linz-Donawitz process gas (LDG) to electricity. The problem uses the minimum makespan as the scheduling objective and the minimum total electricity cost as the energy objective. A multi-objective optimization framework which incorporates an improved epsilon-constraint method is proposed to solve the problem. Preliminary results show the effectiveness of the multi-objective optimization framework and demonstrate the tradeoffs between minimum makespan and energy cost.

5 - Integrated Production And Safety Stock Planning In The Process Industry

Steffen T. Klosterhalfen, BASF SE, Ludwigshafen, Germany, steffenklosterhalfen@googlemail.com, Stefan Minner, Dariush Tavaghof Gigloo

We develop and apply a new approach for integrated production lot-sizing and safety stock planning in the process industry where high demand uncertainty and large production campaigns are the rule. Our approach is based on mixed-integer linear programming and benchmarked with common sequential lot-sizing and safety stock planning frameworks characterized by different levels of sophistication in optimization methodology and parameter updating.

■ WC34

204-MCC

Joint Session HAS/MSOM-HC: Advances in Healthcare Operations

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Van-Anh Truong, Columbia University, 500 120th Street, New York, NY, 10027, United States, vt2196@columbia.edu

1 - A Pomdp For Reducing Readmissions Through Inpatient Outpatient Joint Control

Xiang Liu, University of Michigan, liuxiang@umich.edu, Jonathan Helm, Mariel Sofia Lavieri, Ted Skolarus

Hospital readmissions affect hundreds of thousands of patients, placing a tremendous burden on the healthcare system. We develop a two-stage POMDP that spans the inpatient stay and the post-discharge outpatient monitoring to reduce readmission. By learning and reducing readmission risk in the inpatient stage, and monitoring and intervening patient's health condition in the second stage, our model jointly optimizes both discharge and post-discharge decisions to reduce readmissions.

2 - A Fluid Model For An Overloaded Bipartite Queueing System With Scoring Based Priority Rules

Yichuan Ding, Assistant Professor, University of British Columbia, 2053 Main Mall, Vancouver, BC, V6T1Z2, Canada, daniel.ding@sauder.ubc.ca, Mahesh Nagarajan, S. Thomas McCormick

We consider an overloaded bipartite queueing system (BQS) with multi-type customers and service providers. A service provider assigns each customer a score based on customer type, waiting time, and server type. Service is always provided to the customer with the highest score. We approximate the behavior of such a system using a fluid limit process, which has two important features: (1) the routing flow rates at a transient state coincide with the maximal flow in a parameterized network; (2) the routing flow rates in the steady state coincide with the minimal-cost maximal-flow in a capacitated network. We illustrate the application of our machinery via an example of public housing assignment.

3 - Routing Shared Vehicles With Matching Constraints For Medical Home Care Delivery

Miao Yu, University of Michigan, 1205 Beal Avenue, Ann Arbor, MI, 48109, United States, miaoyu@umich.edu, Viswanath Nagarajan, Siqian Shen

In this paper, we study a vehicle routing problem variant for medical home care delivery. A health care provider assigns multiple vehicles to transport homecare devices and/or medical staff to patients' home locations given that each patient can only be served by a subset of vehicles. We construct an integer-programming model solved by column generation, to minimize the total traveling distance of all the vehicles. We also propose an approximation algorithm that yields fast assignment, and conduct out-of-sample simulation to numerically evaluate the performance of the proposed methods.

4 - A Periodic Little's Law And Its Application To Emergency Department Data

Xiaopei Zhang, Columbia University, 1 Morningside Drive, Apt. 1710, New York, NY, 10025, United States, xz2363@columbia.edu, Ward Whitt

We establish a new periodic discrete-time version of Little's law and apply it to explain the remarkable fit of a data-driven stochastic process model, which is periodic over a week, of the emergency department occupancy over time in the Israeli Rambam hospital.

■ WC36

205B-MCC

Economic Models in Supply Chains

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: Gizem Korpeoglu, University College London, Gower Street, London, WC1E 6BT, United Kingdom, c.korpeoglu@ucl.ac.uk

1 - Supply Chain Expansion And Integration

C Gizem Korpeoglu, University College London, c.korpeoglu@ucl.ac.uk, Ersin Korpeoglu, Soo-Haeng Cho

This paper studies expansion and integration of supply chains under uncertain consumer demand. We show that when a supply chain expands to include more suppliers or more retailers, the supply chain profit and efficiency increase. We then consider the integration of two local supply chains (e.g., an economic union such as the European Union (EU) Single Market), and show that the integration may reduce total profit of firms in a supply chain with a smaller ratio of suppliers to retailers. Our analysis suggests that the United Kingdom, which has a smaller ratio of suppliers to retailers than the EU, could enjoy greater supply chain profits after disintegrating from the EU, while the EU may incur profit losses.

2 - Pricing And Inventory Management For An Online Retailer

Rui Yin, Arizona State University, ryin@anderson.ucla.edu

We consider two selling mechanisms for an online retailer: price markdown and inventory disclosure, and examine the impacts of these mechanisms on the retailer's sales and profits.

3 - Decentralization And Outsourcing In A Global Supply Chain Under Arm'S Length Principle On Transfer Pricing

Kun Soo Park, KAIST, kunsoo@kaist.ac.kr, Bosung Kim, Seyoun Jung, Sang-Hun Park

We consider a multinational firm's (MNF) production and procurement decisions of global supply chain under a regulation on its transfer pricing, i.e., the arm's length principle. We analyze when it is beneficial for the MNF to open the local division considering the tax rate differential. We also further consider if the local division should seek for outsourcing from the 3rd party instead of the manufacturing division of the MNF.

■ WC37

205C-MCC

Topics in Sustainable Operations

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Vishal Agrawal, Georgetown University, Washington, DC, United States, Vishal.Agrawal@georgetown.edu

Co-Chair: Isil Alev, Boston College, Boston, MA, United States, isil.alev@bc.edu

1 - The Value Of Product Returns: Intertemporal Product Management With Strategic Consumers

Narendra Singh, Indian School of Business, Hyderabad, India, narendra_singh@isb.edu, Karthik Ramachandran, Ravi Subramanian

We study the impact of consumer product returns and their potential refurbishing on the intertemporal product strategy of a firm facing strategic consumers, who anticipate future availability and prices of products and time their purchases to maximize net utility. Using a two-period model, we show that returns may act as a commitment device for a firm selling durable products and thereby mitigate the time inconsistency problem. Specifically, a sufficiently high return rate coupled with the firm's incentive to refurbish the returns allows the firm to credibly commit that the new product will be offered exclusively in the first period. As a result, firm profit could even increase with the return rate.

2 - Lemons, Trade-ins, And Remanufacturing

Ximin Huang, Georgia Institute of Technology, 800 West Peachtree Street, NW, Atlanta, GA, 30308, United States, ximin.huang@scheller.gatech.edu, Atalay Atasu, Beril L Toktay

Trade-in programs have been shown to partially mitigate the lemons problem in secondary markets. In this paper, we show when and how remanufacturing traded-in products can further improve the efficiency in secondary markets.

3 - Trade-in Remanufacturing, Customer Purchasing Behavior, And Government Policy

Renyu Zhang, Assistant Professor of Operations Management, New York University Shanghai, 1555 Century Ave, Shanghai, 200122, China, renyu.zhang@nyu.edu, Fuqiang Zhang

We study the impact of customer purchasing behavior on the value of the widely used trade-in remanufacturing program to the firm and the environment. We find a brand new value of trade-in remanufacturing that helps exploit the forward-looking behavior of strategic customers. The value of trade-in remanufacturing is sensitive to customer purchasing behavior. Under intensive strategic customer behavior, trade-in remanufacturing creates a tension between profitability and sustainability: It significantly improves the firm profit but also significantly hurts the environment. We also characterize the government policy that can induce the social optimum under different customer behaviors.

4 - Extended Producer Responsibility (epr) And Export Bans

Isil Alev, Boston College, Chestnut Hill, MA, 02467, United States, isil.alev@bc.edu, Vishal Agrawal, Atalay Atasu

We focus on the ongoing global debate about the export of electronics to developing countries for recycling under EPR-based legislation. To prevent such practices, the US and the EU introduced partial export bans that only allow the export of electronics with remaining useful life. We compare these bans with no and full export ban scenarios and show that they may lead to exacerbated environmental harm in both developing and developed countries.

■ WC38

206A-MCC

General Session I

Contributed Session

Chair: Hedayat Alibeiki, McGill University, 1001 Sherbrooke Street West, Desautels Faculty of Management, Montreal, QC, H3A 1G5, Canada, hedayat.alibeiki@mail.mcgill.ca

1 - Teaching And Learning Of Decision Making In Complex Projects Under Uncertainties

K Jo Min, Iowa State University, 3004 Black Engineering, Department of Industrial &, Ames, IA, 50011-2164, United States, jomin@iastate.edu, John Jackman, Michelle Zugg

How best to teach and learn decision making under uncertainties for complex projects has become a critical topic in operations research and management science education. In this paper, we show how a module in an introductory engineering economy course and an experimental advanced course are used to facilitate this aim. Data-driven results are analyzed and lessons will be shared.

2 - When To Introduce An Online Channel, And Offer Money Back Guarantees And Personalized Pricing?

Jing Chen, Professor, Dalhousie University, 6100 University Avenue, Halifax, NS, B3H 4R2, Canada, JChen@dal.ca, Bintong Chen

Retail sales through an online channel is increasingly popular in the retailing industry. Customers, however, cannot touch or feel a product before they purchase online. This leads to much higher rates of customer returns in the online channel, which in turn leads to significant costs to retailers. In this paper, we develop a model of a dual-channel structure with an online and a retail channels to examine when a retailer should introduce an online channel and how it should offer returns policy for two channels.

3 - Retail Power Impacts On Assortment Decisions By Power Retailers

Hedayat Alibeiki, McGill University, 1001 Sherbrooke Street West, Desautels Faculty of Management, Montreal, QC, H3A 1G5, Canada, hedayat.alibeiki@mail.mcgill.ca

Using several game-theoretic models, this paper examines potential impacts of different sources of retail power on the assortment choice of a power retailer. We find that assortment decisions of power retailers are strongly connected to their pricing power in the market, which suggests that pricing and assortment decisions are two different sides of the same coin for power retailers in a competitive market. On the other hand, product cost advantage seems to play a secondary role in comparison with market pricing leadership. We also find that larger market share in all scenarios amplifies the retailer's control over the market and can have a significant impact on pricing and assortment decisions.

4 - Education Engineering [SIC]

Kingsley Anthony Reeves, University of South Florida, Tampa, FL, Contact: reeves@usf.edu

The craft of engineering has been applied to numerous industries, especially the manufacturing-oriented industries such as automotive, pharmaceuticals, and petroleum. In more recent history we have seen the application of engineering approaches to the service sector; examples include financial services and healthcare. A notable exception (and area of great need) is the application of engineering to education. While there is currently significant momentum in the growth of engineering education programs across the nation, this paper calls for the creation of education engineering as a discipline and explores the opportunities that exist particularly for industrial engineering.

5 - Operational Performance Of Retail Stores

Andreas Holzapfel, Catholic University of Eichstaett-ingolstadt, Ingolstadt, Germany, andreas.holzapfel@ku.de, Heinrich Kuhn2, Michael Sternbeck

We study which factors drive instore operations efficiency. For this purpose we develop explanatory models that quantify the impact of operational circumstances on working hours required in the stores and financial performance. The results are valuable input for store and logistics planning as well as for staff assignment planning.

■ WC39

207A-MCC

Joint Session APS/MSOM: Service Systems in Applied Probability II

Sponsored: Applied Probability/MSOM

Sponsored Session

Chair: Jing Dong, Northwestern University, Evanston, Evanston, IL, United States, jing.dong@northwestern.edu

1 - When The Past Does Not Predict The Future: Delay Announcements With Customer Priorities

Rouba Ibrahim, University College London, rouba.ibrahim@ucl.ac.uk, Mor Armony, Achal Bassamboo

Motivated by the problem of making delay announcements, we study the accuracy of announcements based on the history of delays in a system with multiple customer classes and a priority service discipline. We present ways of exploiting this historical information to design new and improved announcements.

2 - Managing Overstaying Electric Vehicles In Park-and-charge Facilities

Ragavendran Gopalakrishnan, Research Scientist, Xerox Research Centre India, Bangalore, India, Ragavendran.Gopalakrishnan@xerox.com, Arpita Biswas, Partha Dutta

With the increase in adoption of Electric Vehicles (EVs), ensuring proper utilization of the charging infrastructure is a key emerging challenge. Overstaying by EVs after charging is complete can be discouraged by imposing penalties, but the upfront uncertainties in parking and charging durations render higher penalties riskier, which might turn prospective users away, leading to decreased utilization (and revenue). We develop a framework that integrates models for realistic user behavior into queueing dynamics to locate the optimal penalty from the points of view of utilization and revenue, and discover a surprising alignment between the “green” objective and the “commercial” objective.

3 - The Superposition-traffic Game

Harsha Honnappa, Purdue, 315 N. Grant St., West Lafayette, IN, 47906, United States, honnappa@purdue.edu, Ashish R. Hota, Shreyas Sundaram

Motivated by ride-sharing and online-platform systems, we consider a model of a single-server service system where a finite number of traffic sources compete for service. The presence of a large, but finite, number of traffic sources is assumed to have positive network effects, but also causes an increase in congestion. The goal of the sources is to choose the traffic rate, trading-off these two effects. We present an analysis of the generalized Nash equilibrium (GNE), and discuss implications on pricing and mechanism design for such service systems.

4 - Finite-size Effects In Critically Dimensioned Emergency Departments

Britt Mathijsen, Eindhoven University of Technology, PO Box 513, MetaForum 4.086, Eindhoven, 5600MB, Netherlands, b.w.j.mathijsen@tue.nl, Johan van Leeuwaarden, Foekje Sloothaak

Motivated by the desire to determine staffing levels in an emergency department, we study a queueing model in which patients alternate between being in need of direct care from a nurse and being stable, while the total number of patients present in the ED is limited. We identify a two-fold scaling policy for which the system exhibits quality-and-efficiency-driven (QED) type behavior as it grows large, and approximate its performance through a fixed-point method. Building upon the asymptotic results, we ultimately propose a dimensioning scheme for the number of nurses and beds necessary to ensure good quality of care in both stationary and time-varying environments.

■ WC40

207B-MCC

Queueing Systems

Sponsored: Applied Probability

Sponsored Session

Chair: Guodong Pang, Penn State University, University Park, University Park, PA, 16801, United States, gup3@psu.edu

1 - Parameter Uncertainty In Naor’s Model

John Hasenbein, University of Texas-Austin, jhas@mail.utexas.edu, Ying Chen

We examine the classical Naor’s model when the arrival rate is not known with certainty by either the system controller or the customers. Rather, only the arrival rate distribution is known. We analyze the system in the observable and unobservable queue length regimes from the point of view of individuals, a social optimizer, and a revenue maximizing firm.

2 - Strong Approximations For General Time Varying Queues

Jamol Pender, Cornell University, jamol.pender@gmail.com

We present a novel methodology for approximating the queue length distributions of non-Markovian and time varying queueing systems. The first step is to approximate the general distributions with phase type distributions and second step is to use strong approximations to construct fluid and diffusion limits for the phase type queueing process. We show that our approximations are quite accurate in a variety of parameter settings.

3 - Pull-based Load Distribution Among Heterogeneous Parallel Servers: The Case Of Multiple Routers

Aleksandr Stolyar, Lehigh University, sasha.stolyar@gmail.com

We consider a heterogeneous service system, consisting of several large server pools and multiple ‘routers’. Each router receives equal fraction of the customer arrival flow, and assigns each customer to a server immediately upon arrival. The asymptotic regime is considered such that the total arrival rate and pool sizes scale to infinity simultaneously, while the system load remains subcritical. We introduce a ‘multi-router’ version of the ‘pull-based’ routing scheme and prove that, under this scheme and certain assumptions, both waiting times and blocking probabilities asymptotically vanish.

4 - The Method Of Chaining For Many Server Queues

Yuhang Zhou, Penn State University, YXZ197@psu.edu, Guodong Pang

We discuss how the method of chaining can be applied to prove two-parameter process limits for many server queues. It provides useful maximal inequalities for two-parameter processes. The method is universal for models with general i.i.d. and dependent service times, and with general time-varying service times (e.g., arrival dependent services or entering-service-time dependent services).

■ WC41

207C-MCC

Real Options

Sponsored: Financial Services

Sponsored Session

Chair: Kuno Huisman, Tilburg University, Best, Netherlands, kuno.huisman@gmail.com

1 - Predatory Pricing Under Uncertainty: Revisiting The Deep Pocket Argument

Maria Lavrutich, Tilburg University, mlavrutich@gmail.com

In this paper we develop a stochastic model of predatory pricing. When profits evolve stochastically, a negative demand shock can lead to bankruptcy for firms, that cannot immediately raise external capital. This creates incentives for market incumbents to use predatory pricing strategies in order to keep new players out of the industry. We show that firms may use a large cash reserve as a war chest to initiate a price war that could drive the opponent out of the market. Because of uncertainty the new player may wish to take a chance and enter based on the probability of success. Therefore, the realized market structure may vary for different sample paths of the stochastic process.

2 - Optimal Timing Of Technology Adoption By Incumbents: War Of Attrition Versus Preemption

Nick Huberts, Tilburg University, N.F.D.Huberts@uvt.nl

I consider two incumbent firms with an option to adopt a differentiated technology. The firms decide upon both the investment moment and the investment size. I find that adoption kills the old technology only when innovation is radical. When the degree of innovation is small and when the products are not close substitutes a war of attrition arises. Otherwise the firms end up in a preemption equilibrium. When a second-mover advantage is present, firms either want to stay alone on the old market or want to set a larger capacity as Stackelberg follower. Market uncertainty increases the first-mover advantage and at the same time makes it more attractive for the endogenous follower to forego adoption.

3 - Disruptive Innovation In A Declining Market

Kuno Huisman, Tilburg University, kuno.huisman@gmail.com

The paper considers the problem of a firm operating in a declining market. The firm has an option to innovate and has to derive the right time to do so, if at all. We find that it can be optimal for the firm to innovate because of two reasons. The first reason is that a new technology is available with which the firm can achieve high profits. The second reason is that, due to demand saturation, profits of the established product have become so low that the firm will adopt a new technology even if the newest available innovation has not improved for some time.

■ WC42

207D-MCC

Behavioral Considerations in Pricing and Revenue Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Monire Jalili, The University of Oregon, 488 Lillis, Lundquist College of Business, Eugene, OR, 97403, United States, mjalili@uoregon.edu

1 - Dynamic Pricing And Learning In Prediction Markets

Adam Schultz, University of Chicago-Booth School of Business, Chicago, IL, United States, adam.schultz@chicagobooth.edu, John Birge, N. Bora Keskin, Yifan Feng

We consider a market maker who operates a prediction market for an event with an uncertain outcome (e.g., government election, sporting event, etc.) and must dynamically select a control (i.e., price) over time. We characterize the market maker's optimal policy when the market includes only myopic agents and show how a myopic policy exhibits near-optimal performance. We also consider a market including a strategic agent who knows the event outcome (e.g., an insider trader) and demonstrate that the market maker's policies are robust to the presence of a strategic agent in the market.

2 - Try Before You Buy Pricing. Should Rental Fees Apply To Purchases?

Monire Jalili, The University of Oregon, mjalili@uoregon.edu, Michael Pangburn

When a product has uncertain value or is used repeatedly over time, customers may opt to rent the product before purchasing. In some instances, sellers entice purchase conversions by offering part of the already-paid rental fee as a discount towards purchase. But, another common pricing tactic is for the seller to apply no such credit towards conversion to purchase. In this paper, we analyze the optimal pricing and discounting policy for a monopolist selling to a market of consumers facing uncertain product valuation, and derive the conditions under which a firm should optimally apply some of the rental price towards the product purchase.

3 - Analysts Decisions In Airline Revenue Management – An Experimental Study

Claudia Schuetze, M.Sc., RWTH Aachen University, Aachen, Germany, claudia.schuetze@rwth-aachen.de, Catherine Cleophas

Revenue management could, in theory, fully rely on automated systems to predict demand and optimize revenue. In practice, analysts play a crucial role for revenue management. They influence the system given additional information about market changes and the firm's strategic objectives. We present a range of behavioural experiments to test how analyst decisions are affected by factors such as demand complexity and decision variables. Our analysis considers achieved revenue, learning effects, and decision biases. The aim is to prepare the ground for an improved decision support for revenue management analysts.

■ WC43

208A-MCC

Information Elicitation

Sponsored: Decision Analysis

Sponsored Session

Chair: Majid Karimi, Waterloo, ON, Canada, mk.majidkarimi@gmail.com

1 - Accept-reject Mechanisms For Team Formation

Yevgeniy Vorobeychik, Vanderbilt University, Nashville, TN, United States, eug.vorobey@gmail.com, Jian Lou, Martin van der Linden, Gregory Leo, Pranav Batra, Chen Hajaj, Myrna Wonders

Team (coalition) formation has been studied from a number of perspective. However, treatment of this problem from the point of view of mechanism design has received relatively little attention, with few concrete and general mechanisms proposed. We describe and motivate a class of accept-reject mechanisms for this problem, and demonstrate their theoretical properties (both positive and negative). These mechanisms are computationally very challenging, and we describe several algorithmic approaches to these.

2 - Prediction Market Equilibria Via Substitutes And Complements

Bo Waggoner, Harvard University, Computer Science, bwaggoner@fas.harvard.edu

Based on joint work with Yiling Chen. I will propose definitions for when pieces of information, modeled as signals, can be considered substitutes or complements. We will see that substitutes (respectively, complements) characterize cases where prediction market participants rush to truthfully report (respectively, delay as long as possible). I will try to give a geometric picture for how probabilistic structure of signals and choice of scoring rule interact to produce substitutes or complements, and discuss implications for designing markets.

3 - Arbitrage-free Combinatorial Market Making Via Integer Programming

Christian Kroer, Carnegie Mellon University, ckroer@cs.cmu.edu, Miroslav Dudík, Sébastien Lahaie, Sivaraman Balakrishnan

We present a new combinatorial market maker that operates arbitrage-free combinatorial markets specified by integer programs. Although the problem of arbitrage-free pricing with bounded loss is #P-hard, we posit that the typical case might be amenable to modern integer programming (IP) solvers. At the crux of our method is the Frank-Wolfe algorithm which is used to implement a Bregman projection aligned with the market maker's cost function, using an IP solver as an oracle. We demonstrate the tractability and improved accuracy of our approach on real-world prediction market data from combinatorial bets placed on the 2010 NCAA Men's Division I Basketball Tournament.

4 - Making Science Of "Black Art": Risk Bias In Market Scoring Rules

Majid Karimi, University of Waterloo, Faculty of Engineering, mk.majidkarimi@gmail.com, Stanko Dimitrov

We study market scoring rules (MSRs) prediction markets (PMs) in the presence of risk averse or risk seeking agents. We show that agents' submitted reports always deviate from their beliefs. This means, in most cases it is impossible for a MSR PM to elicit an agent's belief. We introduce a measure to calculate the deviation between an agent's report, and her personal belief. We find that the deviation of a MSR PM is related to the amount of market depth provided by the MSR's cost-function PM. We use the relation between deviation and market depth to present the first systematic approach to determine the optimal amount of market depth, an activity that has been described as "black art" in the literature.

■ WC44

208B-MCC

Strategic Management Decision Making

Sponsored: Decision Analysis

Sponsored Session

Chair: Dharma Kwon, University of Illinois at U-C, Champaign, IL, United States, dhkwon@illinois.edu

1 - Dynamic Sourcing Decisions In Presence Of Technology Spillover Risks

Yunke Mai, Duke University, yunke.mai@duke.edu, Sasa Pekec

We study optimal dynamic sourcing decisions of a serial innovator. There are two types of manufacturers: competitive ones who might pose technology spillover risks, and non-competitive ones. Manufacturers' production capabilities are uncertain, impacting success of innovations. Single period contracts allow learning about the uncertainty by observing the production outcome. Long-term contracts lock the innovator with one manufacturer but guarantee a low wholesale price. We describe optimal strategies and show that contracting with a competitive manufacturer could be attractive as it allows for sharing the innovation risk in exchange for the technology spillover exposure.

2 - When Suppliers Climb Value Chain: A Theory Of Value Distribution In Vertical Relationships

Zhixi Wan, University of Oregon, Eugene, OR, United States, zwan@uoregon.edu, Brian Wu

Offshore outsourcing gives rise to the phenomenon of value chain climbing - suppliers in emerging markets can develop capabilities by supplying, with aspirations to compete with the buyers in the product market. We build an analytical model to study the impact of value chain climbing on value distribution in vertical relationships. The analysis identifies a set of dominant relationships, characterizes how the buyer's optimal choice among these relationships depends on firms' relative competitiveness in the product market and the supplier's speed of capability development, and shows how the optimal choice evolves with the dynamics of the supplier's capability development.

3 - Strategic Investment In Common Assets Under Uncertainty

Dharma Kwon, Associate Professor, University of Illinois at Urbana-Champaign, Champaign, IL, United States, dhkwon@illinois.edu, Youngsoo Kim, George Georgiadis

We investigate the game of investment in common assets under uncertainty as a two-player stochastic war of attrition in continuous time. We characterize the equilibrium when there are indefinitely many opportunities of investment. We focus on the impact of stochasticity and the asymmetry between the two players.

4 - Playing A Dominated Strategy In A Simple Bankruptcy Case: Field And Experimental Data

Steven A Lippman, Univ of California-Los Angeles, slippman@anderson.ucla.edu, Sushil Bikhchandani

We consider a real life bankruptcy case in which the judge asked unsecured creditors the least they would accept in full satisfaction of their claims. Even when real money is at stake, creditors play dominated strategies. An even greater percentage of MBAs play dominated strategies.

■ WC45

209A-MCC

Network Economics I

Sponsored: Simulation

Sponsored Session

Chair: Bruno Tuffin, INRIA, Rennes Cedex, France, bruno.tuffin@inria.fr

Co-Chair: Patrick Maillé, Telecom Bretagne, 2, rue de la Cha^taigneraie, Cesson Sévigné, 35576, France, patrick.maille@telecom-bretagne.eu

1 - Auctions For Online Ad Space Among Advertisers Mixing Pay-per-view And Pay-per-click

Bruno Tuffin, INRIA, bruno.tuffin@inria.fr, Patrick Maillé

Advertisement in dedicated webpage spaces or in search engines sponsored slots is usually sold using auctions, with a payment rule that is either per view or per click. But advertisers can be both sensitive to being viewed and being clicked. We generalize the auction mechanism by including both pricing components. Applying VCG auctions, we show how to compute payments to ensure incentive compatibility from advertisers as well as maximize the total value of the advertisement slot(s). We provide bounds for the loss of efficiency due to applying only pay-per-click (or pay-per-view) pricing instead of our scheme. We also describe how the generalized second price auction can be extended to this context.

2 - Investment And Competition With Shared Spectrum

Randall Berry, Northwestern University, rberry@eecs.northwestern.edu

Meeting the exploding demand for wireless data services will require access to new wireless spectrum. This in turn has led to much interest in approaches for sharing spectrum among different users. These approaches raise not only technical challenges but also can fundamentally change the economic interactions among wireless service providers. We consider such effects by adapting models for price competition with congestible resources. We also study how such sharing can impact a service provider's incentives to invest in shared spectrum bands.

3 - Data Bundling And Pricing In The Internet Of Things

Maurizio Naldi, University of Rome Tor Vergata, Roma, Italy, naldi@disp.uniroma2.it, Luis Guijarro, Vicent Pla, José Ramon Vidal

The upcoming Internet of things will generate a massive amount of data. Much of them will be distributed and traded in a marketplace. Brokering third-parties may ease the relationship between data producers and data consumers. Brokers take care of bundling data coming from different sources and delivering them to consumers within a single commercial offer. In this context, pricing data is an extremely important decision, impacting both the broker's role feasibility and the success of the distributing scheme. Optimal pricing strategies are derived and discussed, considering their impact on all the stakeholders.

■ WC46

209B-MCC

Demand Learning with Strategic Customers

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Xi Chen, New York University, Stern, New York, NY, United States, xchen3@stern.nyu.edu

Co-Chair: Zizhuo Wang, University of Minnesota, Minneapolis, MN, United States, zwang@umn.edu

1 - Nonparametric Algorithms For Joint Pricing And Inventory Control With Lost-sales And Censored Demand

Beryl Boxiao Chen, University of Illinois at Chicago, Chicago, IL, United States, boxchen@umich.edu, Xiuli Chao, Cong Shi

We consider the classical joint pricing and inventory control problem with lost-sales and censored demand in which the customer's response to selling price and the demand distribution are not known a priori, and the only available information for decision-making is the past sales data. A major difficulty lies in the fact that the estimated profit function from observed sales data is multimodal even when the expected profit function is concave. We develop a nonparametric data-driven algorithm and show that the algorithm converges to the optimal policy as the planning horizon increases, and obtain the convergence rate of regret.

2 - Bayesian Dynamic Learning And Pricing With Strategic Customers

Xi Chen, New York University, xchen3@stern.nyu.edu, Zizhuo Wang

In this talk, we study a pricing problem when the customer is aware of the seller's policy, and thus may behave strategically when making a purchase decision. We first show that a naive myopic Bayesian policy (MBP) by the seller may lead to incomplete learning —- the seller may never be able to ascertain the true type of the customer and the regret may grow linearly in time. To resolve this issue, we propose a randomized Bayesian policy (RBP), which updates the posterior belief of the customer in each period with a certain probability. We show that the seller can learn the customer type exponentially fast with the RBP even if the customer is strategic, and the regret is bounded by a constant.

3 - Operational Implications Of Choice Paralysis

Srikanth Jagabathula, New York University, sjagabat@stern.nyu.edu, Rene A Caldentey, Anisha Patel

We consider the operational implications of the "choice paralysis" effect, which states that customers are less likely to choose as the number of choices becomes large. The choice paralysis effect has been established in various lab studies, but so far has received little attention in the operations community. To address that, we first carry out an empirical study with supermarket data and observe that, at the aggregate-level, the choice paralysis effect varies across different product categories. Based on this evidence, we propose a modification to the multinomial logit (MNL) model to capture the choice paralysis effect. In the context of the model, we discuss the operational implications.

■ WC47

209C-MCC

Unique Applications in Pricing and Revenue Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Jon A Higbie, Revenue Analytics Inc, Atlanta, GA, United States, jhigbie@revenueanalytics.com

1 - Emerging Topics In Revenue Management For The Cruise Industry

Gregory Vogel, Holland America Line, gvogel@hollandamerica.com

Much research has been done in traditional travel and hospitality industries such as Airlines, Hotels, Resorts, Casinos etc. Very little has been done in regards to the specific problem that are cruise lines. In this talk we discuss similarities and differences between traditional OR research into these industries and the cruise industry and then delve into the problems that the industry is most interested in solving along with an overview of problems that are currently being investigated.

2 - Pricing Strategies For Sustainable Green Marketing

Thunyarat Bam Amornpetchkul, Faculty member, NIDA Business School, Bangkok, Thailand, thunyarat.a@nida.ac.th

This study investigates the potential of using pricing strategies to improve the sustainability of businesses, environments, and the society. Different scenarios, in terms of manufacturer's cost structure and customer valuation of the green product, are analyzed. Under each scenario, we propose an optimal pricing strategy which could bring about a larger profit to the manufacturer as well as reduced consumption of the non-green product. Based on the findings, we suggest measures to help create a market situation where green products are likely to thrive.

3 - Driving Organic Revenue Growth With Ancillaries

Dan Iliescu, Revenue Analytics, diliescu@revenueanalytics.com

The application of Pricing and Revenue Management principles beyond traditional revenue streams are generating organic revenue growth opportunities for companies. Among recent developments in this area, analytical solutions that incorporate ancillary offerings were first introduced in industries such as airlines, travel and hospitality, and car rental. This presentation focuses on presenting a high level overview of key design considerations while implementing Ancillary Pricing and Revenue Management solutions. In addition, this presentation outlies practical examples of successful applications, while uncovering and identifying opportunities for future research.

■ WC48

210-MCC

Intelligent Applications in Social Media Analytics

Invited: Social Media Analytics

Invited Session

Chair: Victor Benjamin, University of Arizona, 1130 E Helen St, Tucson, AZ, 85719, United States, vabenji@email.arizona.edu

1 - Is Weight Loss Social Contagious?

Chunxiao Li, Arizona State University, chunxiaoli@asu.edu, Bin Gu

The recent IT innovation invokes the emergence of weight intervention mobile apps, in which massive users share their weight loss achievements to their peers. Except for monetary incentive, the social networking may provide extra incentive for weight loss behavior, and therefore results in better outcomes. This paper studies how users' weight loss behavior can be affected by both monetary reward and behavior of their followees, controlling for personal characteristics and experience with the app. Moreover, we examine the interplay between the two incentives. We suggest that app designers should better use social contagion together with monetary incentive to motivate health related behavior.

2 - A Sentiment Breakdown Approach For Dissecting The Dna Of Medical Social Media Posts

Anwar Chutoo, University of Utah, anwar.chutoo@utah.edu, Olivia R Liu Sheng

Many medical social forums allow a user to rate their experience with a drug according to different criteria. While these ratings have high correlations, we propose to dissect differences between them according to the sentiments in different types of sentences within the post. We test a series of hypotheses regarding the relationships between sentiments of different types of sentences and ratings. We also demonstrate that the texts in user reviews can successfully explain the variations between the ratings. We introduce a novel method to describe qualitative aspects of drugs using texts from user reviews and sentiments rather than ratings.

3 - Understanding Malicious Tools In Underground Hacker Communities

Sagar Samtani, University of Arizona, sagars@email.arizona.edu

As many modern facilities are becoming reliant upon computing technology, cybersecurity is becoming a societal concern. Many cyber-attacks are executed using tools like Zeus Trojans or Point of Sale Malware. These tools, also known as hacker assets, are often accessible in online, hacker forums. However, collecting and analyzing such tools is a non-trivial task. This study demonstrates a web, data, and text mining framework leveraging techniques such as SVM, LDA, and social network analysis to analyze and identify hacker assets and key hackers in underground hacker forums. The results of this study indicate that emerging forum assets are consistent with root causes of recent cyber-attacks.

■ WC49

211-MCC

Teaching Analytics

Sponsored: Education (INFORMED)

Sponsored Session

Chair: Thomas G Groleau, Carthage College, Kenosha, WI, United States, tgroleau@carthage.edu

1 - Topics And Goals For An Introductory Business Intelligence Course Offered To Business Majors

Wendy Swenson-Roth, Georgia State University, wroth@gsu.edu

Analytics skills are in demand by business. Business schools are seeking to provide classes to address this need. In an introductory course for business students, what topics need to be covered to provide a foundation in this field. Also, what methods can be used to improve student understanding.

2 - Back To Basics: Framing The Foundations Of Analytics

Patrick S. Noonan, Goizueta Business School, Emory University, Atlanta, GA, United States, patrick.noonan@emory.edu

Analytics represents substantial new opportunities for INFORMS researchers & educators. The good news: "Analytics" remains hot. The bad news: Few people can explain exactly what it is. The worse news: Opinions vary widely, so the word is becoming meaningless mush. By asserting a better framework for "analytics," INFORMS educators can create wins all around: sharpening the definition for researchers and practitioners; increasing the impact of our courses on student understanding, skill, and ability to apply to real problems; and heightening visibility for our fields in the analytics boom. The keys to coherent integration of the modeling & data science worlds: decision-making & decision analysis.

3 - Alternate Framework For Analytics Education

Thomas G Groleau, Carthage College, tgroleau@carthage.edu

The Descriptive, Predictive, and Prescriptive Analytics framework for analytics has become widely accepted. At the same time, the terms "analytics" and "data analytics" are often used interchangeably and students can get the impression that all analytics is based on data. For educational purposes, we should consider an alternate framework that simply distinguishes between data based and model based analytics so that students get a more accurate view of the field.

■ WC51

213-MCC

Education II

Contributed Session

Chair: Narasimhan Ravichandran, Indian Institute of Management-Ahmadabad, Wing 2 D, Vastrapur, Ahmedabad, 380015, India, nravi@iimahd.ernet.in

1 - Tailgating Games As Teaching Tools

Matthew Bailey, Associate Professor, Bucknell University, School of Management, Taylor Hall, Lewisburg, PA, 17837, United States, matt.bailey@bucknell.edu

Many students are familiar (some too much so) with common tailgating and backyard games such as cornhole and ladderball. I will present an activity to exploit this experience and solidify student understanding of data collection and analysis, modeling, and Monte Carlo simulation. This activity is sufficiently flexible and scalable to be used as a single project or as a set of small scaffolding activities culminating in a comprehensive project. The presenter will share his experience with this activity in an undergraduate business analytics course with associated student feedback.

2 - Understanding The Impact Of In-class Undergraduate Research In Engineering Education For Non-traditional Students: An Adaptive Guide

Justin Yates, Assistant Professor, Francis Marion University, PO Box 100547, Florence, SC, 29501, United States, jyates@fmarion.edu, Lorna Cintron-Gonzalez, Rahul Renu

Engineering students with non-traditional backgrounds face significant challenges during their early years in engineering. This talk discusses the adaptation of Freshman-Sophomore curriculum to include early and frequent exposure to research-based course assignments and examines the impact of these practices on student efficacy and academic performance. The model used is adapted from colleagues in Sociology who have implemented such practices for 14 years in a rural, public university in South Carolina and consistently see 30% or higher graduate school enrollment within their Senior class.

3 - Awesome A Women In Stem Student And Faculty Organization For Small Universities And Colleges

Stephany Coffman-Wolph, Assistant Professor, West Virginia University Institute of Technology, 105 Silver Maple Ridge, #5, Charleston, WV, 25305, United States, sscoffmanwolph@mail.wvu.edu

AWESOME (Association for Women Engineers, Scientists, Or Mathematicians Empowerment) was started 2 years ago at WVU Tech to bring together female students and faculty for a variety of activities including: networking, outreach, speaker events, and professional development. AWESOME was designed specifically for smaller universities/colleges that may be unable to support several field-specific female organizations. This presentation describes the structure of the organization, previous and future activities, and the challenges/advantages of an inclusive and diverse STEM organization.

4 - Managing Transport Concession To Senor Citizens

Narasimhan Ravichandran, Indian Institute of Management-Ahmadabad, Wing 2 D, Vastrapur, Ahmedabad, 380015, India, nravi@iimahd.ernet.in

We present by a case study the challenges in administering a transport concession scheme in India for senor citizens and means to deal with them .The case can be used in a MBA class to illustrate the use of formal methods in structuring a managerial context.The teaching approach is documented as apart of the case study.Some general abstraction as how subsidy can be handled is also discussed.

■ WC53

Music Row 1- Omni

DEA

Contributed Session

Chair: Hamed Kianmehr, PhD Student, Binghamton University, 142 1/2 Beethoven, Binghamton, NY, 13905, United States, hkianme1@binghamton.edu

1 - A Non-discretionary Dea Methodology For Competitive Environment Analysis In Retailing

Yeming Gong, Em Lyon Business School, Building B, Office 1018, 23 Avenue Guy De Collongue, Ecully, 69134, France, gong@em-lyon.com, Jiawen Liu

Competitive environment analysis is critical to global operations strategy research. We develop a non—discretionary two-stage DEA model, allowing supply chain capability as inter-temporal effects in efficiency measuring, to assess the corporate performance in retailing industry and verify the influence of the environment. Using first-hand and second-hand data of more than 100 organizations from 32 countries and regions in retailing industry, we provide a new method using non—discretionary DEA integrated with econometric analysis in competitive environment analysis for retailing supply chain strategy.

2 - Hospital Performance Evaluations In New York State Using Data Envelopment Analysis

Kelly Ann Stickle, Stony Brook University, 120 Sound Beach Blvd., Sound Beach, NY, 11789, United States, Kelly.Stickle@stonybrook.edu, Thomas Raymond Sexton, Christine Pitocco

With the healthcare system focused on improving quality, measuring hospital performance is essential in order to maximize efficiency and to implement improvements system wide. We use DEA to evaluate hospitals in New York State. Inputs include number of deaths, number of readmissions, and average length of stay. The sole output is the number of survivors. Site characteristics take into account the expected length of stay and total number of patients.

3 - Assessing China's Healthcare Service Efficiency Using Improved Dynamic Data Envelopment Analysis

Tao Du, Beijing Institute of Technology, Beijing, China, dutao0608@163.com

We propose a DtSBM model, which has improved the existing Dynamic DEA model DSBM and more accordant with the practical situation. The model is applied for measuring the healthcare service efficiencies of China's 31 provinces through panel data from 2008 to 2013. By measuring the DMUs' term efficiencies and overall efficiencies, we proves the china's new medical and health system reform, which was acted in 2009, has obvious effect. This research also results that the efficiency scores of eastern region is highest, western region is second, and the central region is lowest. According to the analysis of the inefficiency DMUs, we also figures out the improved orientations and objectives.

4 - The Use Of Spatial Traffic Data For Traffic Signal Control At Signalized Intersections

Pei-Shan Hsieh, Univerisy of Arizona, Tucson, AZ, 85721, United States, phsieh@email.arizona.edu, Wei-Hua Lin, Zeng Wang

In this study, we consider the use of spatial data for traffic signal control at signalized intersections, replacing the conventional data sources, those generated from the existing stationary traffic surveillance systems. Time-dependent location coordinates obtained from individual vehicles are processed into information key to traffic control at signalized intersections for determining the optimal green time allocation and cycle length.

5 - A Dynamic Model of Antibiotic Prescribing for Acute Respiratory Tract Infection

Hamed Kianmehr, PhD Student, Binghamton University, 142 1/2 Beethoven, Binghamton, NY, 13905, United States, hkianme1@binghamton.edu

The emergence of antimicrobial resistant diseases has reawakened dangers of a pre-antibiotic era. The issue is largely tied to the decreased production of new classes of antibiotics and antibiotic misuse in agriculture, etc. Compounding this issue are changing guidelines for killing these evolving organisms as well as the need for greater vaccine compliance. This imminent risk highlights past and fomenting structural failures contributing to nosocomial and community associated antibiotic resistant infections. This paper seeks to evaluate the physician decision making process as a focal site for reversing antibiotic resistance trends.

■ WC55

Music Row 3- Omni

Inventory Management VX

Contributed Session

1 - A Synthesis And Generalization Of Structural Results In Inventory Management: Generalized Convexity Properties

Zhe Liu, Columbia University, 511 W 112th Street, Apt 24C, New York, NY, 10025, United States, zliu18@gsb.columbia.edu, Awi Federgruen, Lijian Lu

Since the initiation of stochastic inventory theory, 65 years ago, a multitude of papers have addressed problems with three principal complications: (a) fixed in addition to variable order costs; (b) orders are subject to capacity limits and (c) possibly bilateral adjustments of inventories. Different papers cover a specific subset thereof, under specific restrictions. This paper addresses the fully general model, characterizing the structure of an optimal policy and identifying an associated solution method. We thus provide a unifying structure that synthesizes and generalizes a seemingly disparate set of structural results.

2 - Incorporating Parcel Transportation Costs Into Lot Sizing Decisions

Matthew J Drake, Associate Professor of Supply Chain Management, Duquesne University, School of Business, 925 Rockwell Hall, Pittsburgh, PA, 15282, United States, drake987@duq.edu, Adam Wenger

For the past century, researchers have created and studied variants of the EOQ model. One consideration that has been left relatively untouched has been the inclusion of parcel transportation costs into the lot sizing decision. Examination of the parcel rate tables for UPS and FedEx Ground shows that the rates are not linear with respect to the shipment weight. We have developed linear approximations for these rates and have examined the performance of this approximate model compared to the cost of the global optimal order quantity. We have also extended the model to consider the new dimensional pricing based on the volume of the shipment that parcel carriers have introduced in recent years.

3 - Monitoring Inventory Control Forecasting System Under Non-normal Input Noise Distributions

Hoda Sabeti, West Virginia University, 390 Gilmore St., Morgantown, WV, 26505, United States, hoda.sabeti@gmail.com, Omar Ahmed Al-Shebeeb, Majid Jaridi

In quantitative forecasting models and tracking signal methods, the input noise is often assumed to be normally and independently distributed. The goal in this paper is to study the distribution of tracking signal and build new monitoring schemes when the input noise distribution is not necessarily normal. To perform the analysis, we simulate a demand process in Wilson inventory model, using several input noise distributions. The effectiveness of the proposed tracking signal model is evaluated and compared to existing methods using an inventory cost model.

■ WC57

Music Row 5- Omni

Disaster and Emergency Management II

Contributed Session

1 - Dynamic Resource Allocation For Effective Distribution Of In Kind Donations

Merve Ozen, PhD Student, University of Wisconsin-Madison, 602 Eagle Heights, Apt I, Madison, WI, 53705, United States, mozen@wisc.edu, Ananth Krishnamurthy

In the aftermath of a disaster, victim demands for relief items exceed the immediate supply. In-kind donations sent to the affected region help reduce the gap. In most cases, large amounts of cargo of various degrees of priority arrive at a disaster site with in a short period of time. To sort, grade and distribute the critical resources; prioritization and staffing decisions must be made. We model this problem as a discrete time, discrete state space, finite horizon decision problem where the number of resources to be dedicated to sorting operations is decided. We investigate the structure of the optimum policies and provide managerial insights for humanitarian organizations.

2 - Robust Ambulance Allocation Using Risk-based Metrics

Kaushik Krishnan, Graduate Research Assistant, University of Illinois at Urbana-Champaign, Urbana, IL, United States, kkrishn3@illinois.edu, Lavanya Marla

We present robust location strategies for an ambulance fleet in order to maximize service levels under unexpected demand patterns. Our work is motivated by the fact that when small parts of networks incur large emergencies (modeled as a heavy-tailed distribution), the entire system behaves in a heavy-tailed manner. We achieve robust allocations by including risk metrics that account for tail behavior as well as average performance. We build an efficient data-driven algorithm that optimizes based on risk metrics. Our computations show that our solutions account for spatiotemporal patterns and prevent the extent of delay cascades that are typically seen in heavy-tailed arrival distributions.

3 - Identifying And Monitoring International Shipments Of Hazardous Materials And Waste

Haibo Wang, Killam Distinguished Professorship, Texas A&M International University, 5201 University Boulevard, Laredo, TX, 78045, United States, hwang@tamiu.edu

This project will develop a decision support system for identifying and monitoring international shipments of hazardous materials and waste using service-oriented platform, and provide participants with a U.S. domestic and international cross-border pilot program.

■ WC58

Music Row 6- Omni

Finance II

Contributed Session

Chair: Phillip J Lederer, Professor, University of Rochester, Simon School of Bus Admin, Rochester, NY, 14627, United States, Lederer@simon.rochester.edu

1 - Toward A Firm Inefficiency Risk Factor Of Stock Returns: Model And Empirical Analysis

Daqi Xin, PhD Student, Rensselaer Polytechnic Institute, 110 8th St, Troy, NY, 12180, United States, xind@rpi.edu, Chanaka Edirisinghe

Relative operational inefficiency of a firm in responding to supply/demand competition manifests in high distress risk and vulnerability to economic shocks. A set of firm financial variables are used to compute the inefficiency, relative to its competition, having a positive lagged correlation and negative synchronous correlation with stock returns. The proposed new inefficiency risk factor for the market is robust to size, value and momentum risk factors.

2 - Review And Evaluation Of Operations Capital Projects

Phillip J Lederer, Professor, University of Rochester, Simon School of Bus Admin, Rochester, NY, 14627, United States, Lederer@simon.rochester.edu

A major interface between finance and operations is a firm's capital justification process by which are set of activities to evaluate and approve a project proposal, and to tie the its performance to managers' incentives. We study a principal-agent model where the agent is a manager who designs and proposes a project and, if approved, oversees its execution, and where the principal is general management. A unique aspect of this research is the agent's choice of project, its effort to manage risk and private information project riskiness. The magnitudes of economic losses due to mis-designed compensation structure, observability of effort, and information asymmetry are presented.

■ WC59

Cumberland 1- Omni

Location of Energy-Efficient Facilities

Sponsored: TSL, Facility Logistics

Sponsored Session

Chair: Mohannad Kabli, Mississippi State Univ, MSU, Mississippi State, MS, 39762, United States, mrk297@msstate.edu

Co-Chair: Mohammad Marufuzzaman, Mississippi State University, PO Box 9542, Starkville, MS, 39762, United States, marufuzz@dasi.msstate.edu

1 - Stochastic Model For Locating Multiple Type Recharging Station Under Flow Uncertainty

Sushil Raj Poudel, PhD Candidate, Mississippi State University, Department of Industrial & Systems Engineering, P.O. Box 9542, Starkville, MS, 39762, United States, srp224@msstate.edu, Md Abdul Quddus, Sudipta Chowdhury, Mohammad Marufuzzaman, Linkan Bian

This study presents a two-stage stochastic mixed-integer programming model to formulate capacitated multiple-recharging station location problem under flow uncertainty. We solve the problem using a hybrid decomposition algorithm combining sample average approximation with an enhanced progressive hedging algorithm We use Washington DC as a testing ground to visualize and validate the modeling results. The computational experiments provide the geographical distribution for multiple types of recharging stations to ensure the completion of overall tours of multiple type of electric vehicles in each path.

2 - Biorefinery Location And Green Perspectives

Javier Faulin, Full Professor, Public University of Navarra, Los Magnolios Bdg. 1st floor, Campus Arrosadia, Pamplona, 31006, Spain, javier.faulin@unavarra.es, Adrian Serrano-Hernandez, Alejandro Garcia del Valle, Javier Belloso

The concern about sustainability is gaining importance leading to seek for renewable energy sources to reduce greenhouse gas emissions (GHG) in transportation. Therefore, this work proposes a procedure to determine a biorrefinery location considering its supply chain environmental impact (including, among others, crop selection and stock policy). A Mixed Integer Linear Programming model, coded in GAMS, was solved giving promising results. Thus, some meaningful sensitivity analysis were run in order to have the environmental criteria met at an affordable cost. Finally, a case study of location of a Biorefinery in Navarre, Spain has been solved.

3 - Chance-constrained Stochastic Programming Model For Locating Charging Stations Under Uncertainty In Green Power Availability

Sudipta Chowdhury, Mississippi State University, sc2603@msstate.edu, Mohannad Kabli, MD Abdul Quddus, Mohammad Marufuzzaman

Due to the scarcity and negative consequences the use of fossil fuel brings, green energy sources are being increasingly used as an alternative clean source of electricity. Electric vehicles are a part of the solution, and their spread is imminent as the technologies of batteries are advancing faster than ever. This calls for plans that regulates the potential increase in the number of charging stations, which will lead to an increase in the demand for electricity. This work presents a chance-constrained stochastic programming model that plans for the expansion of charging stations with limited power supply and chance-constrained green energy availability.

4 - A Stochastic Programming Approach For Ev Charging Station Expansion Plans

Mohannad Kabli, MSU, mrk297@msstate.edu, MD Abdul Quddus, Mohammad Marfuzzaman

This paper presents a two-stage stochastic programming model that helps making the decisions for expanding and connecting power in anticipation the increase of electric vehicle charging stations under demand uncertainty . We solve the model using a hybrid algorithm that combine Sample average algorithm with an enhanced Progressive hedging (PH) algorithm. Along with SAA and Progressive hedging we applied some heuristics such as Rolling Horizon (RH) algorithm, variable fixing technique to enhance the PH algorithm. We choose Washington DC as a testing ground to visualize and validate the modeling results.

■ WC60

Cumberland 2- Omni

Prescriptive Analytics for Transportation and Inventory

Sponsored: TSL, Freight Transportation & Logistics

Sponsored Session

Chair: Wesley Dyk, Revonos, Lone Tree, CO, United States, wesley.dyk@revonos.com

Co-Chair: Alexander Engau, University of Colorado Denver, NA, Denver, CO, United States, alexander.engau@ucdenver.edu

1 - Stochastic Liquid Inventory Management For Transportation And Logistics

Alexander Engau, Associate Professor, University of Colorado Denver, Denver, CO, United States, aengau@alumni.clemson.edu, Wesley Dyk

This talk presents a recent case study with an independent energy provider in the Denver-Julesburg Basin in Northeastern Colorado, one of the largest natural gas deposits in the United States. In contrast to related exploration and production operations in other geographic locations, for this present case, the inherent logistics of liquid products including crude oil and waste water is limited to distribution and transportation primarily using trucks which require the careful management of their generally uncertain load inventories and qualities. These challenges will be addressed in some detail and their current solutions using stochastic optimization outlined for questions and discussion.

2 - Network Flow Relaxations For Batched Transportation Models

Wesley Dyk, Revonos, wesley.dyk@revonos.com, Alexander Engau

We present a new approach to solve mixed-integer batched transportation models using a new class of network flow relaxation for actual use in real-time applications. This approach has been implemented in actual practice for inventory management and liquid hauling of crude oil and waste water using trucked transportation in the petroleum exploration and production sector to give directive insights to decision makers in short timeline scenarios.

3 - Adaptive Robust Optimization For Tactical Vehicle Routing Problems

Anirudh Subramanyam, Carnegie Mellon University, Pittsburgh, PA, United States, asubramanyam@cmu.edu, Frank Mufalli, Jose M Pinto, Chrysanthos E Gounaris

It is fairly common during the tactical planning of multi-period vehicle routing operations that customer requests arrive dynamically over a planning horizon. This is the case in settings where customer service is provided by appointment. In such settings, the dispatcher must incorporate enough flexibility in the routing plan to accommodate potential customers who have not yet called in to place their order. Failure to do so may result in insufficient fleet capacity to serve future requests. We shall describe an adaptive robust optimization approach to solve this problem and illustrate the tradeoffs in using an adaptive strategy over a static strategy in terms of computational time and cost savings.

4 - Analytics For Logistics Supply Chain: An Overview And Research Outlook

M. Ali Ulku, Rowe School of Business, Dalhousie University, Halifax, NS, Canada, ulku@dal.ca

There are myriad of opportunities, and thereby challenges, for research and education in supply chain management. This talk comprises of an overview of the current literature and practices and an outlook as to how companies can employ analytics for logistics supply chains so as to gain a competitive edge.

■ WC61

Cumberland 3- Omni

Yard and Terminal Operations

Sponsored: Railway Applications

Sponsored Session

Chair: Tyler Dick, University of Illinois, Urbana, IL, United States, ctdick@illinois.edu

1 - Switch-it; A New Yard Modeling Tool

Chip Kraft, Transportation Economics & Management Systems, Inc., ckraft@temsinc.com

SWITCH-IT simulates any type of rail yard, tracking each car movement as trains arrive and depart and cars are sorted, inspected, repaired and flat switched. Command scripts give the user total control over the simulation. The model supports fixed block-to-track assignment, dynamic block “swinging” and matrix sorting; pull and cut, shove and couple, and push back to clear from either end of the yard. It simulates lead confliction, crossovers and ladder tracks. Animation uses a “console” presentation which accepts, but does not require detailed track network coding. Its simple yet powerful approach to modeling complex yard operations provides quick feedback and a simple user interface.

2 - Animation Of Switch-it Analysis Using Anylogic

Roger William Baugher, President, TrAnalytics, LLC, 100 Villamoura Way, Johns Creek, GA, 30097, United States, rwbaugher@aol.com

In an earlier presentation, the features and capabilities of the SWITCH-IT program were described and demonstrated. While the program provides an animation capability, a richer animation environment was desired. Using a newly developed interface, data were fed to AnyLogic’s Rail Library, resulting in new and enhanced animation capabilities, which will be described and demonstrated.

3 - Blocking Capacity, Throughput Volume And Level Of Service In Hump Classification Yards

Tyler Dick, University of Illinois, ctdick@illinois.edu

This presentation summarizes simulation research on fundamental hump classification yard capacity relationships. In particular, simulation experiments have been conducted to quantify the relationship between level of service and throughput volume of railcars as a function of the number of blocks assembled in the yard.

4 - Boston North Terminal District: Infrastructure Demand Modeling And Improvements

Bradford Kippen, University of Illinois, Urbana, IL, 61801, United States, kippen2@illinois.edu

Boston’s Tower A Interlocking connects all of the MBTA’s North Side commuter rail lines with North Station terminal and has over 260 daily scheduled trains. Proposed replacement of the Charles River Drawbridges, critical interlocking appliances, catalyzed development of Infrastructure Demand Models which quantify minute to minute demand for infrastructure at key locations given a proposed plan of operations and conditional infrastructure constraints. This presentation outlines the project background, modeling methodology, proposed improvements, and potential applications.

■ WC63

Cumberland 5- Omni

New Objectives and Solution Concepts in Location Analysis

Sponsored: Location Analysis

Sponsored Session

Chair: Dmitry Krass, University of Toronto, 105 St. George St., Toronto, ON, M5S 3E6, Canada, krass@rotman.utoronto.ca

1 - Correct Discounted Costs In Hub Location Models

Vladimir Marianov, Pontificia Universidad Catolica de Chile, marianov@ing.puc.cl, H.A. Eiselt, Armin Luer-Villagra

Frequently, traditional single allocation hub location models incorrectly apply discounted costs to trip legs without enough traffic to economies of scale to apply. Conversely, discounts are not applied to some legs with high traffic. We develop a model and a heuristic to correct this flaw. The assumptions are the same as in the usual models. Computational experience is presented.

2 - Multi-objective Single Median Models

Joyendu Bhadury, University of North Carolina-Greensboro, NC, j_bhadur@uncg.edu, HA Eiselt

This talk will focus on one median problems in location theory with multiple objectives. The goal is to find Pareto-Optimal Set of solutions in each case. Solved models will be discussed and new ones will be presented along with their applications in practice.

■ WC65

Mockingbird 1- Omni

Health IT

Sponsored: Information Systems

Sponsored Session

Chair: Changmi Jung, Johns Hopkins University, Johns Hopkins University, Baltimore, MD, 21202, United States, changmi@jhu.edu

1 - Analyzing Interactions Between Social And Technical Systems: A Retrospective Study In The Pediatric Environment

Yi-Chin Kato-Lin, Hofstra University, Hempstead, NY, United States, YiChin.Lin@hofstra.edu

Using the lens of Socio-technical theory, we examine the effect of digitization of individual pain plans (IPP) on process outcomes of care delivery for patients with sickle cell disease, and the interactions between digitized IPP and care delivery teams. We found improved care coordination and satisfaction, unaltered usage behavior among physicians, and an unexpected, negative opinion among nurses that might explain the neutral/negative process outcomes after the digitization. Our results provide new insights into the important and inconclusive debate about the diverse impacts of HIT.

2 - Dynamics Of Social Influence On New Employees' Use Of Volitional Is: m-EHR Case In Hospital Setting

Sanghee Lim, The Johns Hopkins University Carey Business School, 100 International Drive, Baltimore, MD, United States, lim.sanghee@jhu.edu, Juntae Kim, Byungtae Lee, Jae-ho Lee, Yura Lee

We investigate the effect of social influences on m-EHR usage by new doctors who recently began working at a hospital. Drawing upon the concept of organizational socialization and social influences, we hypothesize that coworkers' m-EHR usage is positively associated with one by new doctors, and the strength of this association varies by the coworkers' type of usage, by the hierarchical rankings of coworkers, and by the stage of socialization process in which the new doctors are situated. Our analyses using longitudinal m-EHR usage data generally support our hypotheses.

3 - Does Health Information Technology Change The Prospect Of Continuity Of Care?

Changmi Jung, Johns Hopkins University, changmi@jhu.edu

Continuity of care has long been the core element in healthcare discussion particularly concerning the improvement of care quality and patient health outcome. However, the emergence of healthcare information technology (HIT) is changing the landscape. As an enabler to comprehensive data storage and immediate information retrieval, HIT is filling the gap in the degree of available information, and thus, empowers more seamless care from end to end. In this study, we examine the effect of HIT on the patient health outcome and the extent of continuity of care in the hospitals in Maryland. Also, we explore the impact of the change in the degree of continuity of care on the patient health outcome.

■ WC66

Mockingbird 2- Omni

Novel Approaches in Reliability Modeling and Analysis

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Tugce Martagan, Eindhoven University of Technology, P.O. Box 513 5600 MB, Eindhoven, N/A, Netherlands, t.g.martagan@tue.nl

Co-Chair: Murat Kurt, Merck & Co., Inc., TBD, North Wales, PA, 19454, United States, murat.kurt7@gmail.com

1 - Reliability Sensitivity Analysis Based On Kriging Metamodel And Importance Sampling

Juan Wang, Nanjing University of Science and Technology, dongzao1115@gmail.com

Due to the lack of the gradient information, the reliability sensitivity analysis can't be implemented in an analytical manner.Therefore we proposed a simulation-based sensitivity method. It is suggested to compute the failure probability by the combination of Kriging model and importance sampling at first, and then the estimator of failure probability is differentiated through the score function approach. The calculation of failure probability resort to the construction of an accurate Kriging surrogate of the limit state function, and score function approach enables the estimation of the gradient of the failure probability without any additional evaluation to the limit state function.

2 - Optimize The Prognostic Performance Of Data-level Fusion Approach

Changyue Song, University of Wisconsin - Madison, Madison, WI, United States, csong39@wisc.edu, Kaibo Liu

Multiple sensors have been widely employed to monitor the degradation status of a unit. Since each sensor signal contains partial and dependent information, data-level fusion methods have been proposed to combine the information and make decision on the remaining useful life. Existing data-level fusion methods are mainly based on experience and still lack theoretical basis to ensure their prognostic performance. To fill the literature gap, this paper proposes a novel data-level fusion approach with the following features: 1) It ensures the prognostic performance; 2) It allows varying parameters for different units; 3) The training and testing procedures are integrated.

3 - Optimal Reliability And Commonality In Component Design: A Service Logistics Perspective

Geert-Jan van Houtum, Eindhoven University of Technology, Eindhoven, Netherlands, G.J.v.Houtum@tue.nl, Joni Driessen, Joachim Jacob Arts

An Original Equipment Manufacturer sells multiple types of machines to groups of customers under full service contracts. For one component, we consider the design choice between one common component for all machine types and a dedicated component per machine type. We compare the Life Cycle Costs and find general conditions for the optimality of choosing a common and dedicated component, respectively. For a third area, numerical work has to show what is optimal. We also show how these areas behave as a function of numbers of sold machines and the commonality cost factor.

4 - Economic Design Of Run To Failure Binary State K Out Of N Systems With Identical Components And Geometrically Distributed Lifetimes

Tugce Martagan, Eindhoven University of Technology, t.g.martagan@tue.nl, Murat Kurt

K-out-of-N systems represent integrated collection of N individual units of which at least K of them are required to function for the system to survive; and have broader ability to model the operating structure of complex industrial systems. We consider the design of run-to-failure K-out-of-N systems consisting of identical components with geometrically distributed lifetimes under total and average cost criteria. We propose exact and faster approximate approaches to minimize the total cost due to operation, design and failure of the system and derive managerial insights from numerical analyses.

■ WC67

Mockingbird 3- Omni

Decision Models in Risk, Reliability and Maintenance

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Adiel T. de Almeida-Filho, Assistant Professor, Universidade Federal de Pernambuco, Caixa Postal 7471, Cordeiro, Recife, 50630971, Brazil, adieltaf@googlemail.com

1 - Data Fusion For Degradation Modeling In Multi-edged Machining Processes

Wenmeng Tian, Virginia Tech, 250 Durham Hall, Blacksburg, VA, 24061, United States, tian0414@vt.edu, Jaime Camelio

Tool wear is a widely used direct degradation measure of machining process, and can be measured from the cutting edges using machine vision system. Though there are methods available for single-edge machining process, degradation modeling for a multi-edged machining process using mixed-type data is still a challenge. This work proposes a novel scheme for degradation modeling and prognostics of multi-edged machining process by fusing mixed-type sensor data, including images and process signals. A broaching process is used as a case study to illustrate the effectiveness of the proposed approach.

2 - An MCDM Model For Maintenance Outsourcing

Felipe Macedo de Morais Pinto, Universidade Federal de Pernambuco, Recife, 50630971, Brazil, felipe_mmp94@hotmail.com, Adiel Teixeira De Almeida Filho

This work presents an MCDM approach for a maintenance outsourcing decisions, which including contract selection and supplier selection. Given the MCDM nature of maintenance outsourcing, models to address this problem include maintainability, dependability, quality of repair besides cost, which are detailed in the reference Multicriteria and Multiobjective Models for Risk, Reliability and Maintenance Decision Analysis.

3 - A Multicriteria Decision Model To Support Maintenance Planning In An Electrical Power Distribution Company

Adiel Teixeira de Almeida-Filho, Assistant Professor, Universidade Federal de Pernambuco, Recife, 50630971, Brazil, adieltaf@cdsid.org.br, Rodrigo J Ferreira, Ana Paula Cabral Seixas Costa, Adiel Teixeira de Almeida

This work presents a decision model built for an electrical power distribution company to aid the decision regarding maintenance planning and establishing the priority amongst maintenance orders to be accomplished. The problem approached is similar to most of the electrical power distribution companies, once there is a complex distribution network with different types of customers leading to consider multiple criteria such as income losses, the probability of service interruption, national regulation criteria, and others.

■ WC68

Mockingbird 4- Omni

Design and Modeling for Quality Improvements

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Hongyue Sun, Virginia Tech, Blacksburg, VA, United States, hongyue@vt.edu

1 - Economic Parameter Design In Laser Micro-Drilling Process Considering Quality Loss And Rejection Cost

Jianjun Wang, Nanjing University of Science and Technology, wangjj0818@163.com

An intractable issue in the fabrication of laser micro-drilling array is to achieve high product quality with the minimum cost through economic parameter design. A new Bayesian modeling method is developed in this paper. Firstly, Bayesian seemingly unrelated regression (SUR) models are utilized to develop the relationship models between input factors and output responses in the laser micro-drilling process. Secondly, the rejection cost function and the quality loss function are constructed by using simulated responses. Finally, an optimization scheme is implemented to find the optimal economic parameter settings of laser micro-drilling process.

2 - Experimental Design And Parameter Optimization Of Multi-extremum Process

Qing'an Cui, Professor, Zhengzhou University, Zhengzhou, 455000, China, cuiqa@zzu.edu.cn

Firstly, Least squares support vector regression model is selected as the basic model for multi-extrimum process; Secondly, a sequential experimental design method is proposed considering the significance of Lagrange multipliers of sample points in different sub-domains of the process. Finally, by taking the geometric cluster centers of sample points as initial points, the multi-extremum of the response are found through concurrent SQP optimization. Simulation and empirical studies show that the approach can find multi-extremum of the process and therefore get better optimization of parameters under a relative smaller sample size.

3 - Service Quality Variation And Customers Behavior Intention

Jianlan Zhong, Fujian Agriculture and Forestry University, Fuzhou, China, zhongjianlan_29@163.com

We investigate the effect of variation in service quality on customers behaviors intention. Variation, stemming from manufacturing industry, refers to difference and deviation. In the service context, it wouldn't be wise to drive out all variation. Customers themselves are key inputs to the service process. In this interaction process, customers expect how much variation that they introduce is accommodated, not how sternly it is eliminated. Therefore, based on the prospect theory, we postulate a mechanism involving risk aversion and learning, and propose the propositions about the impact of service quality variation (positive and negative variability) on customer behaviors.

■ WC69

Old Hickory- Omni

Telecommunications Modeling

Sponsored: Telecommunications

Sponsored Session

Chair: Michael R. Bartolacci, Associate Professor of IST, Penn State University - Berks, 2080 Tulpehocken Road, Reading, PA, 19610, United States, mrb24@psu.edu

Co-Chair: Stanko Dimitrov, University of Waterloo, Waterloo, ON, Canada, sdimitrov@waterloo.ca

1 - Modeling Dense Human Centric Iot Networks

Albena Mihovska, Aalborg University, albena@es.aau.dk

The current Internet of Things (IoT) concept is characterized with billions of devices interworking through a myriad of technologies for the delivery of smart personalized services and applications. At the center of these is the human user who drives his/her own interconnected cluster. In the future the number of such clusters will grow exponentially, leading to an ultra-dense environment of interconnected devices belonging to the same or different clusters with the human user the center point for the information being sensed, gathered and processed. This concept is known as "human center sensing (HCS)". We propose a new model for handling the complexity of large-scale and dense HCS connectivity.

2 - Generalized Local Branching: An Application To Capacitated Ring Tree Problems

Stefan Voss, Professor, Director Institute of Inf. Systems, University of Hamburg, IWI - Von-Melle-Park 5, Hamburg, 20146, Germany, stefan.voss@uni-hamburg.de, Alessandro Hill

Generalized local branching is a heuristic framework based on mathematical programming. In an iterative strategy an existing solution is refined by solving restricted mixed integer programs (MIPs) to optimality. Similar to the corridor method, we introduce generalized local branching cuts using two parameters: the number of considered variables and the number of allowed variable flips. This concept implies an efficient algorithm for the capacitated ring tree problem (CRTP) on top of a branch and cut algorithm for the CRTP. Results for literature instances shows a considerable improvement over existing best results for the CRTP outperforming pure refinement or local branching.

3 - A Satellite Detection And Ranging System For Diurnal Atmospheric Survey

Yupo Chan, University of Arkansas - Little Rock, Little Rock, AR, United States, yxchan@ualr.edu, A. S. M. Sarwar Zahan, Po-Hao Adam Huang, Edmond W. Wilson

A satellite detection-and-ranging system is proposed. Using a pair of CubeSats flying in formation, the paired system consists of a light Emitter, followed by a Chaser. The combination provides new, non-existing monitoring capabilities. This includes atmospheric cooling on the ecliptic side of an orbit by using a reference provided by the Emitter, with a spectrometer hosted on the Chaser. Being a 1-unit CubeSat, the Emitter will follow a regular orbit, while the 2-unit Chaser will experience drag, which can throw the it out of orbit. The tracking algorithm, consisting of signal- and image-processing routines, helps to monitor the orbit of the Chaser and identify its location at all time.

■ WC70

Acoustic- Omni

Transportation, Ops III

Contributed Session

Chair: Luis J. Novoa, The George Washington University, 2201 G Street, NW, Funger Hall, Washington, DC, 20052, United States, ljnovoa@gwu.edu

1 - Beating Reservation Anxiety: Flexible Online Location-based Service Reservation

Xin Wang, University of Wisconsin-Madison, 1513 University Avenue, 3258 Mechanical Engineering Bldg, Madison, WI, 53706, United States, xin.wang@wisc.edu, Xiaotian Wang

A flexible online location-based service reservation system, like those for public vehicle parking or charging, is established. We focus on addressing the "reservation anxiety", where customer late arrivals are priced and service slots are assigned within a neighborhood at a discount rather than to a specific location. Jointly considering both time and location flexibilities at reservation, a game-theoretic model under continuum approximation is developed to analyze the system equilibrium and provide managerial insights.

2 - Monthly-card Management Policy For Office Building Parking Under Different Commuting Traffic Characteristics In Metropolises Of China

Kaifeng Ji, Phd Candidate, Tsinghua University, Graduate School in Shenzhen of Tsinghua University, Shenzhen, 518000, China, 359067080@qq.com

Due to the limited parking spaces and fast-growing vehicle trips in metropolises of China, the intensive management of parking is necessary for office buildings, especially under the traffic restriction policy such as Beijing. In this paper, using license data collected in Beijing and Shenzhen from parking companies, we identify the characteristics of parking vehicles under different traffic restriction policies. Two models are built to analyze the maximum benefit and the maximum capacity of monthly-cards for one garage under different traffic restriction policies and dynamic monthly-card management policy (monthly-cards for free parking but not appointed to one specific parking space).

3 - Revenue Management In Synchromodal Container Transportation

Rommert Dekker, Professor of Quantitative Logistics, Erasmus University-Rotterdam, Burg. Oudlaan 50, Po Box 1738, Rotterdam, 3000 DR, Netherlands, rdekker@ese.eur.nl, Bart Riessen

In order to obtain a balanced cargo load in time, booking classes are introduced for hinterland intermodal container transport. We consider the case of two classes and two destinations. The first class of containers is transported the same day, while the second class can be delayed one day. We use daily booking limits to control the demand for both classes, while demand outside the classes is trucked to the destination which is more expensive. Using Markov chains we determine expected costs for each pair of limits and determine the optimal ones. We show the application of the model using a real case.

4 - Loss Aversion And Subsidy Design In Bot Road Projects

Yiwen Zhang, Tianjin University, 92 Weijin Rd, Nankai District, Tianjin, P.R., 300072, China, zhangyiwen@tju.edu.cn, Shuibo Zhang, Zhuo Feng

Government subsidy plays an important role in attracting private investors in BOT projects. Previous studies only consider the material surplus of the government and the private sector with their psychological losses ignored. As a result, an inappropriate subsidy design may be proposed that prevents efficient renegotiation afterwards. In this paper, by taking the initial subsidy design as the reference point and considering loss aversion of both the government and the private sector, we investigate the optimal government subsidy to maximize social surplus in the whole concession period. This project provides decision support for the government in designing the optimal government subsidy.

5 - Optimizing Daily Service Routes For Major Grocery Chains

Luis J. Novoa, The George Washington University, 2201 G Street, NW, Funger Hall, Washington, DC, 20052, United States, ljnovoa@gwu.edu, Ahmad I Jarrah, Jonathan F Bard, Sifeng Lin, Xinhui Zhang

We develop a customized column generation algorithm to solve industrial-scale instances of a retail route design problem. This problem extends the capacitated vehicle routing problem with time windows by including order loading constraints, order-dependent vehicle capacity, material handling at the warehouse, time limits and idle time costing. Routes are iteratively generated by solving parallel dynamic programs which implement novel efficiency procedures. Considerable cost reductions are found when evaluating against current solutions from a major grocery chain.

■ WC71

Electric- Omni

Game Theory III

Contributed Session

Chair: Ying Zhang, University of North Carolina-Chapel Hill, 116 Saint Andrews Ln., Chapel Hill, NC, 27517, United States, Ying_Zhang@kenan-flagler.unc.edu

1 - Applicability Of The Proportional Nucleolus In Cooperative Games Based Highway Cost Allocation

Saurav Kumar Dubey, PhD Student, University of Tennessee, 1615 Laurel Avenue, Box 203, Knoxville, TN, 37916, United States, skumardu@vols.utk.edu, Alberto Garcia-Diaz

A highway cost allocation (HCA) problem is formulated as a Least-Core model with Aumann-Shapley Values defining the characteristic function of the game. For such a game, the nucleolus offers a unique and stable solution. However, the nucleolus concept is non-monotonic because any marginal increase in total highway cost is distributed unevenly among vehicle classes. A derivative of the least-core model, known as Proportional Nucleolus, and known to be unique and monotonic will be considered.

2 - Locating Warehouse In An Emerging Country A Win Win Proposition

Ying Zhang, University of North Carolina-Chapel Hill, 116 Saint Andrews Ln., Chapel Hill, NC, 27517, United States, Ying_Zhang@kenan-flagler.unc.edu, Jayashankar M Swaminathan

We investigate the trend of warehouse outsourcing in offshore business where a retailer in a developed country sources from a supplier in an emerging country. The retailer can deliver products directly to the developed country or use a warehouse in the emerging country to hold second-tier safety stock. The supplier and the retailer negotiate over the wholesale price and batch size conditional on the retailer's warehouse outsourcing decision. We explore when the retailer prefers the emerging-country warehouse and show that the emerging-country warehouse can be beneficial even without cost advantage.

■ WC72

Bass- Omni

Supply Chain Mgt XV

Contributed Session

Chair: Ping Su, Assistant Professor, Hofstra University, Frank Zarb School of Business, Hofstra University, Hempstead, NY, 11549, United States, Ping.Su@hofstra.edu

1 - Towards Supply Chain Information Flow Theory

Abdurrezzak Sener, PhD Student, Wichita State University, 1845 Fairmount St, Wichita, KS, 67260, United States, axsener@wichita.edu, Mehmet Barut, Mehmet B Yildirim

Information sharing and coupling have been interest of researchers for decades. Empirical studies focused to understand the impact of information sharing to operational and organizational performance. A few studies focused on developing integration matrices to measure coupling. In this study we are taking initiative steps towards developing information flow theory.

2 - Debt Financing And Supply Chain Competition

Ping Su, Assistant Professor, Hofstra University, Frank Zarb School of Business, Hofstra University, Hempstead, NY, 11549, United States, Ping.Su@hofstra.edu, Joice (Qiaohai) Hu

Existing literature has concluded that debt financing causes two firms that engage in a Cournot game to compete more aggressively, each expanding its product supply level. However, both firms are worse off than if they are purely equity financed, resulting in the so-called prisoner's dilemma. Introducing two supply chain structures, distributional and parallel, we examine whether this prisoner dilemma persists if the firms' upstream could influence their competition. We find that the answer is positive because the upstream benefits from the intensified downstream competition. Moreover, the supply expansion effect varies in different supply chain structures.

■ WC73

Legends A- Omni

Operations Management VII

Contributed Session

1 - Seller Response To Customer-driven Substitution

Secil Savasaneril, Associate Professor, Middle East Technical University, Orta Dogu Teknik Universitesi End. Muhendisligi, Dumlupinar Bulvari No:1, Dumlupinar Bulvari No:1, 06800, Turkey, ssecil@metu.edu.tr, Nursen Tore

We study how seller (producer or retailer) sets inventory and price in the presence of customer driven substitution. We assume the seller can affect the substitution behavior by price and availability of the products. Demand for each product is stochastic, and spills over due to cross-price effects. If one product stocks out then this also results in spillovers to the other product. The products are sold in two periods, where in the second, seller may markdown price to exploit stockout based substitution. We determine optimal stock levels, initial and markdown prices. Then, through numerical analysis, we quantify the value of exploiting price- and stockout-based substitution.

2 - Mechanism Design With Heterogeneous Agent Demand Profiles: Applications To Carbon Capture And Storage(ccs)

Wenbo (Selina) Cai, New Jersey Institute of Tech, Mec 308, University Heights, Newark, NJ, 07102, United States, cai@njit.edu, Dashi Singham

Classic mechanism design problems optimize contracts offered to different types of agents, where the agents have private information on some of their characteristics, such as demand. We consider heterogenous agent demand distribution profiles and apply our results to analyzing contracts for carbon capture and storage systems, where the demand of emissions sources for transporting and storing carbon varies based on the type of emitter, and each type having its own distribution of emissions month to month.

■ WC74

Legends B- Omni

Ops Mgt/Marketing III

Contributed Session

Chair: Xiuli He, Associate Professor, UNC-Charlotte, 1207 Doughty Place, Sugar Land, TX, 77479, United States, xhe8@uncc.edu

1 - Selling To An Off-price Retailer To Ration Inventory For Strategic Consumers

Moutaz J Khouja, University of North Carolina-Charlotte, BISOM Department, College of Business, Charlotte, NC, 28223, United States, mjkhouja@uncc.edu, Jing Zhou, Xin Liu

Strategic consumers are likely to delay purchases when retailers have large inventory. Retailers can reduce this inventory by selling some of it to off-price retailers. If an off-price retailer has many bargain-hunters, such a strategy may be beneficial to the retailer in mitigating the effects of strategic consumer behavior.

2 - Multi-agent Salesforce Compensation With Supply Chain Considerations

Sandra Transchel, Kuehne Logistics University, Grosser Grasbrook 17, Hamburg, 20457, Germany, Sandra.Transchel@the-klu.org, Kristoph Kurt Reinhard Ullrich, Ruud Teunter, Jasper Veldman

We study the impact of limited inventory on sales force incentive contracts and the induced efforts of firms which employ multiple sales agents. We show that if demand is censored by inventory levels, pooling inventory may lead to a free-riding problem of the sales agents. This implies that, on the one hand, firms face reduced cost by pooling inventory, but on the other hand, they may face lower sales because of lower efforts exerted by their agents.

3 - Vegetable Equity: Insights From Agri-food Supply Chain Innovations In Emerging Economies

Fei Qin, Assistant Professor, Oakland University, 2200 North Squirrel Road, Rochester, MI, 48309-4401, United States, qinfei99@gmail.com, Saibal Ray, Mehmet Gumus

We build an analytical model to examine the impact of VK Agri-food supply chain intervention on fruits and fresh vegetables prices and social welfares. We find that while a supply chain innovation like VK may be good for consumers or even for bringing more farmers into the market system, one of its main goals - improving the financial condition of all farmers - may not be true. We explore sample data to test a list of hypotheses, and in this regard, elicit the impact of VK intervention on the prices and sales as well as farmer's welfare.

4 - Personal Fabrication

Nagarajan Sethuraman, PhD Student, University of North Carolina, Chapel Hill, NC, 27514, United States, Nagarajan_Sethuraman@kenan-flagler.unc.edu, Ali Kemal Parlakturk, Jayashankar M Swaminathan

We study the idea of personal fabrication and its implications for firms. We propose and analyze a mechanism, through which, firms can benefit from personal fabrication.

5 - Product Quality Strategy With Consumer Heterogeneity Of Technology Platform

Xiuli He, Associate Professor, UNC-Charlotte, 1207 Doughty Place, Sugar Land, TX, 77479, United States, xhe8@uncc.edu, Yong Zha, Subodha Kumar, Lu Zhang

We study the firm's optimal quality strategy when selling a base product and a complementary platform. We consider two cost structures of platform quality and two consumer valuations along the platform quality.

■ WC75

Legends C- Omni

Economics III

Contributed Session

Chair: Dowon Kim, KAIST, Guseng Dong, Daejeon, Korea, Republic of, kimdowon@kaist.ac.kr

1 - Optimal Subsidy And Tax Policy And Consumer Environmental Awareness

Jie Zhang, University of Texas, 701 South West Street, Arlington, TX, 76019, United States, jiezhang@uta.edu, Linghong Zhang

This paper investigates the optimal subsidy and tax policies in response to different consumer environmental awareness (CEA) and firms' product selection (generic, green or both), plus quality and pricing decisions. We investigated all the equilibria under different policy combinations and derived the analytical and numerical solutions.

2 - The Effect Of Agricultural Subsidy Policy on The Land Scale Management Of Farmers

Xuechen Meng, Tongji University, 1239 Siping Road, Shanghai, China, xuechenmeng@126.com

Based on the Nerlove adaptive expectations model and the dynamic panel GMM model, this paper studies the impact of subsidies on farming land scale operation. Results show that when controlling for other factors that influence the conditions of land scale, agricultural subsidies only has a slight positive impact on expanding land scale, the effect mainly reflects in the main producing area while negative on the sales areas. This paper also examines the impact of main producing subsidies on difference kinds of crops and finds that the effect of subsidies on wheat plantings are greater than corn and rice, indicating the importance of precisely target subsidies in the future.

3 - Discounting Long-term Public Investments Under Model Uncertainty

Dowon Kim, PhD Student, KAIST, Guseng Dong, Daejeon, Korea, Republic of, kimdowon@kaist.ac.kr, Kyoung-Kuk Kim, Jiwoong Lee

This paper proposes a new approach to deal with social discount rates for long-term public investments. Using the recursive-utility framework, we explicitly account for consumption inequality aversion, risk aversion, and ambiguity aversion. In addition, the proposed approach overcomes limitations of two-period models in the literature. As an illustration, estimation results are presented based on binomial lattices and IPCC emission scenarios data.

■ WC76

Legends D- Omni

Applied Probability III

Contributed Session

Chair: Kaan Kuzu, Assistant Professor, Univ of Wisconsin - Milwaukee, Sheldon B Lubar School of Business, P.O. Box 742, Milwaukee, WI, 53201-0742, United States, kuzu@uwm.edu

1 - Non Stationary Gaussian Process Bandits

Ankur Mani, University of Minnesota, 808 Berry St. Apt. 410, St. Paul, MN, 55114, United States, amani@umn.edu, Ashish Kapoor, Eric Horvitz

We study the non-stationary version of the correlated multi-armed bandit problem where the correlations between the rewards from different bandits and at different times are captured by a Gaussian process. We identify the rate at which the optimal regret grows and provide an algorithm that achieves the optimal regret.

2 - Valuing Optimal Switching Options With The Moving-boundary Method

Arun Chockalingam, Eindhoven University of Technology, Hoog Gagel 62, Eindhoven, 5611BG, Netherlands, a.chockalingam@tue.nl, Taimaz Soltani, Shaunak Dabadghao, Jan C Fransoo

The contribution of this paper is extending the Moving Boundary Method to tackle the optimal-switching problem. The Moving Boundary Method has been successfully applied to optimal-stopping problems. Optimal-switching problems can be thought of as sequences of optimal-stopping problems and possess complicating features, making an extension of the Moving-Boundary Method to tackle such problems non-trivial. The method is then applied to problems in the sourcing and energy domains.

3 - Random Dimensional Spaces

Kemal Gursoy, Professor, Rutgers University, 100 Rockafeller Road, Room 5146, Piscataway, NJ, 08854, United States, kgursoy@rci.rutgers.edu

In this work, a probability law for random dimensional spaces was investigated. Where points could appear and disappear randomly. Consequently, the dimension of a space would be continuously translated from a real number to another one. Therefore, the main interest is to identify persistent properties of the space, under all possible continuous transformations.

4 - Analysis Of Customer Abandonment In Ticket Queues: A Bayesian Approach

Kaan Kuzu, Assistant Professor, Univ of Wisconsin-Milwaukee, Sheldon B Lubar School of Business, P.O. Box 742, Milwaukee, WI, 53201-0742, United States, kuzu@uwm.edu, Refik Soyer

Ticket queue systems collect interval censored data for customer abandonment. The abandonment of a customer is only realized when the ticket for that customer is called for service and the customer does not show up. We present a modulated Poisson process model to analyze customer abandonments in ticket queues. A Bayesian analysis of the model is developed considering covariates such as branch and weekday. The proposed model and the methodology are implemented using real ticket queue data. We show the heterogeneity in customer abandonments and provide insights on server allocation policies.

■ WC77

Legends E- Omni

Opt, Large Scale I

Contributed Session

Chair: Gerdus Benade, Carnegie Mellon University, 6235 Fifth Avenue, Apt B17, Pittsburgh, PA, 15232, United States, gerdusbenade@gmail.com

1 - An Agglomerative Clustering Based Large-Scale Minimum Cost Flow Algorithm

Yuan Zhou, PhD Candidate, University of Memphis, 174 Windover Cove, Apt 3, Memphis, TN, 38111, United States, yuanzhou0924@gmail.com, Stephanie Ivey

When the size of an input network exceeds computer hardware capabilities, minimum cost flow (MCF) becomes problematic in terms of computational and memory requirements. This research focuses on the large-scale MCF problem by adopting a divide-and-conquer policy during the optimization process. We propose an agglomerative clustering based tiling strategy which can ensure consistency between local and global optimum solutions, decomposes the input network into sub-networks, and then solves MCF in each sub-network independently to reduce peak memory consumption and improve efficiency.

2 - Large Scale Scheduling Problems On Internet Of Things

Carlos Eduardo De Andrade, Senior Inventive Scientist, AT&T Labs Research, 200 S Laurel Avenue, Room A5-1E33, Middletown, NJ, 07748, United States, cea@research.att.com

The number of connected devices has been increasing exponentially over past years. Such devices do not only use the network for their main purposes, such as collect and share data but also in the maintenance mode for updates. We present a scheduling problem to deal with massive download updates on millions of devices connected to radio networks. One of the main challenges of this problem is the fact of the devices are mobile and can connect to several access points in the network over the time, and the server usually can not control the download process other than suggesting a start time to the download. The problem also includes other constraints such as network and server capacities, and devices limitations.

3 - Optimum Product Introduction And Strategic Capacity Planning Including Demand And Price Cannibalization

Gorkem Yilmaz, Assistant Professor, Ozyegin University, Cekmekoy, Istanbul, 34794, Turkey, gorkem.yilmaz@ozyegin.edu.tr, Amaia Lusa Garcia, Ernest Benedito

In literature, product introduction and strategic capacity planning typically address optimal timing, pricing decisions and capacity management independently regardless of demand and price cannibalization effects. We develop a Mixed Integer Linear Program (MILP) model for solving strategic capacity planning and product introduction problems, simultaneously, including demand and price cannibalization. With dynamic demand and pricing senario, we analyze several numerical examples to display the interaction between demand and price.

4 - Benders Decomposition And Column-and-row Generation For Solving Large-scale Linear Programs With Column-dependent-rows

Kerem Bulbul, Associate Professor, Sabanci University, Faculty of Engineering & Natural Sciences, Orhanli, Tuzla, Istanbul, 34956, Turkey, bulbul@sabanciuniv.edu, Ilker S Birbil, Ibrahim Muter

We study a general class of LP problems - known as problems with column-dependent-rows (CDR-P). These LPs feature two sets of constraints with mutually exclusive groups of variables in addition to a set of structural linking constraints, in which variables from both groups appear together. The number of linking constraints grows very quickly with the number of variables, which motivates generating both columns and their associated linking constraints simultaneously on-the-fly. The structure of CDR-P is amenable to Benders decomposition and leads to an effective approach. The unavailability of a full description of the Benders subproblem over the iterations is our main theoretical challenge.

5 - The Branching Dual Of A Discrete Optimization Problem

Gerdus Benade, Carnegie Mellon University, 6235 Fifth Avenue, Apt B17, Pittsburgh, PA, 15232, United States, gerdusbenade@gmail.com, John Hooker

We formulate the branching dual of a discrete optimization problem as maximizing an inferred lower bound over the space of partial search trees. We identify a class of optimization problems with limited information transfer for which a greedy node selection rule is approximately optimal. A computational study compares the efficiency of the branching dual with other methods for proving bounds on the minimum bandwidth problem. It is found that the branching dual requires significantly fewer nodes than the alternatives to prove a given bound.

■ WC78

Legends F- Omni

Health Care, Modeling

Contributed Session

Chair: Harshal Lowalekar, Indian Institute of Management-Indore, Prabandh Shikhar, Rau-Pithampur Road, Indore, 453331, India, lwlherschelle@gmail.com

1 - A Microsimulation Cost-effectiveness Analysis Of Nalmefene To Reduce Heavy Alcohol Consumption In An Alcohol-dependent Canadian Population

Estefania Ruiz Vargas, Ivey Business School, 1255 Western Rd, London, ON, N6G 0N1, Canada, eruizvar@uwo.ca, Richard Zur, Greg Zaric

Nalmefene is an opioid antagonist believed to reduce the analgesic and positive reward effect of alcohol. A microsimulation of alcohol consumption was developed to determine if nalmefene combined with psychosocial support is cost-effective for reducing alcohol consumption in an alcohol-dependent Canadian population. We considered a number of different nalmefene treatment approaches, and evaluated the public health benefit of implementing nalmefene as a pharmacological intervention for alcohol dependence in Canada.

2 - Managing A Multi-physician Clinic With Heterogeneous Patients

Wen-Ya Wang, San Jose State University, San Jose, CA, United States, wenya.wang@sjsu.edu, Hao-Wei Chen

This paper focuses on the physician panel design problem of determining the patient composition (i.e. panel size and types of patient) for physician panels. In particular, we investigate how clinics would allocate a given pool of two types of patient flows that have different appointment patterns (i.e. low frequent/routine service vs. high frequent/complex care needs). We identify the characteristics of patient and capacity allocation strategies from the perspectives of the clinics and the patients

3 - A Markovian Model For Blood Components Production System

Harshal Lowalekar, Indian Institute of Management-Indore, Prabandh Shikhar, Rau-Pithampur Road, Indore, 453331, India, lwlherschelle@gmail.com

We develop a Markovian model for the production of major components such as red blood cells, platelets and plasma from whole blood at a blood bank. The supply quantity of whole blood is assumed to be a random variable. Using the Markovian approach we determine the optimal target collection level for whole blood and the percentage of whole blood to be separated into components.

■ WC79

Legends G- Omni

Opt, Combinatorial I

Contributed Session

Chair: Christopher John Wishon, Ph.D. Candidate, Arizona State University, Tempe, AZ, United States, cwishon@asu.edu

1 - Reformulation-linearization Technique Application On Integer Programming Models For Organ Exchange Program

Seokhyun Chung, Korea University, Seoul, Korea, Republic of, tcheong@korea.ac.kr, Junsang Yuh, Taesu Cheong

Kidney exchange allows a potential living donor whose kidney is incompatible with the intended recipient to donate a kidney to another patient so that the donor's recipient receives a compatible kidney from another donor. This can be modeled as maximum weight cycle packing problems in a directed graph. In this study, we verify relationship between existing models via reformulation-linearization technique (RLT), and develop a new integer programming model for kidney exchange program by implementing the RLT. In addition, we devise new integer programming model for liver exchange program, which has distinct character. Moreover, we enhance the integer programming model by applying RLT.

2 - Solution Approaches To Network Design Problems With Decision Dependent Uncertainty

Nathaniel Richmond, University of Iowa, 446 4th Avenue, Iowa City, IA, 52241, United States, nathaniel-richmond@uiowa.edu, Pavlo A Krokhmal, Dmytro Matsypura

Robust network design problems have many important practical applications, and for this reason are well-represented in the operations research literature. However, until the last decade very little research has examined stochastic robust network design problems in which the user's decisions affect the underlying probability distribution of the random outcome. In this talk, we present a model for the stochastic network design problem with decision-dependent uncertainties. We discuss computational challenges and explore different solution approaches. In particular, we present a metaheuristic algorithm that draws from strengths of GRASP and genetic algorithms.

3 - A New Mathematical Formulation For Choice-based Optimization Problems

Shadi Sharif Azadeh, Ecole Poloytechnique Federale de Lausanne, 38 Route de la Condemine, Lausanne, 1030, Switzerland, shadi.sharifazadeh@epfl.ch, Meritxell Pacheco, Michel Bierlaire

The mathematical modeling of choice behavior has been an active field of research. Their complexity leads to mathematical formulations that are highly non convex in the explanatory variables especially when they are integrated inside an MILP to take into account both supply and demand constraints. We propose a new mathematical modeling that can simplify nonlinear and nonconvex choice-based optimization models with the help of simulation inside an MILP framework. We have tested the model on a real case study and computational results testify the goodness of this modeling approach.

4 - Microsoft Excel Evolutionary Solver And Resource Constrained Project Scheduling

Norbert Trautmann, Professor, University of Bern, FM Quantitative Methoden, Schuetzenmattstrasse 14, Bern, 3012, Switzerland, norbert.trautmann@pqm.unibe.ch, Mario Gnägi

We discuss how to apply the evolutionary solver contained in Microsoft Excel's Solver Add-in to the resource-constrained project scheduling problem (RCPSP). Combining a novel spreadsheet-based implementation of an appropriate schedule-generation scheme with the evolutionary solver provides surprisingly good schedules.

5 - An Exact Algorithm For The Demand Constrained 0-1 Knapsack Problem

Christopher John Wishon, PhD Candidate, Arizona State University, Tempe, AZ, United States, cwishon@asu.edu, J. Rene Villalobos

The demand constrained KP is a variant of the binary KP in which a weighted summation of the variables must exceed a given threshold in addition to the standard KP constraint. The first exact algorithm for solving this variant is presented which utilizes a reduction routine prior to a breadth-first expanding core approach for determining the remaining variables. A polynomial time solution to the continuous relaxation is employed such that high quality, integer Lagrangian and surrogate relaxations are solved to obtain tight upper bounds. Performance is tested using computational experiments with results demonstrating that the algorithm can outperform commercial software.

■ WC80

Broadway E- Omni

Health Care, Public III

Contributed Session

Chair: Philip F. Musa, Associate Professor and Programs Director, The University of Alabama at Birmingham (UAB), P.O. Box 55544, Birmingham, AL, 35255, United States, musa@uab.edu

1 - Micro-decision Patterns In Prescription Data: An Investigation Of Local And Non-communicable Diseases Among Vertically Differentiated Social

W. Art Chaovalitwongse, University of Arkansas, Fayetteville, AR, Contact: artchao@uark.edu, Praowpan Tansitpong, Apirak Hoonlor

This study explores electronic healthcare database in defining decision patterns in prescribed medicines among government-subsidized benefit schemes in Thailand. The analysis focuses on three major non-communicable diseases (diabetes, cancer, and cardiovascular) and three local diseases located in inpatient and outpatient database. The study separates uniform prescription patterns in all three schemes from non-uniform patterns and predicts brand and amount of dosage to be prescribed to other diseases. The findings also suggest prescription priority in medicine inventory control.

2 - Minimizing Radiology Error By Improving Staff Scheduling

Mahdi Nasereddin, Penn State- Berks, Tulpehocken Road, P.O. Box 7009, Reading, PA, 19610-6009, United States, mxn16@psu.edu, Michael Bartolacci, Michael Bruno

Errors are sometimes made when reading radiology charts. A 2001 study reported that depending on the area, the radiology error rate is between 2 - 20%. A team of researchers at the Penn State University is currently studying how to minimize radiology error rate. In this study, the relationship between under-staffing and radiology errors is being investigated.

3 - Evaluating Policy Options For Improving Access To Dental Care For Children In Georgia

Benjamin Johnson, Georgia Institute of Technology, 3245 Wellbrook Drive, Loganville, GA, 30052, United States, benjohnson@gatech.edu, Nicoleta Serban, Paul Griffin, Susan Griffin

Policies regulating dental providers differ by state. Policies in Georgia are compared to similar policies in other states to estimate the impact of each policy on access to dental care. Policy changes are then evaluated to show the impact a new policy could have on improving access to children in Georgia.

4 - Obesity In Africa: The Ultimate Black Belt Region Bursting At The Seams

Philip F. Musa, Associate Professor and Programs Director, The University of Alabama at Birmingham (UAB), P. O. Box 55544, Birmingham, AL, 35255, United States, musa@uab.edu

What are the root causes of obesity as a Public Health epidemic across Africa? We present comparisons of demographics of those most predisposed to this precursor to chronic comorbidities in developed countries such as the United States and the least developed regions such as Sub-Saharan Africa. It was only fairly recently that mortality rates due to chronic diseases surpassed those due to infectious diseases in industrialized countries. While that has not yet occurred in Africa, there is evidence that the burden due to chronic diseases associated with obesity may soon eclipse those affiliated with infectious diseases. Public Health interventions are suggested in this paper.

■ WC81

Broadway F- Omni

Opt, Integer Programming I

Contributed Session

Chair: Vishnu Vijayaraghavan, Texas A&M University, 400 Nagle Street, College Station, TX, 77840, United States, vishnunitr@tamu.edu

1 - A Branch-and-cut Algorithm Using Two-period Relaxations For Big-bucket Lot-sizing Problems

Kerem Akartunali, Senior Lecturer, Strathclyde Business School, Dept. of Management Science, University of Strathclyde, Glasgow, G4 0GE, United Kingdom, kerem.akartunali@strath.ac.uk, Mahdi Doostmohammadi, Ioannis Fragkos

We study the polyhedral structure of the two-period subproblem proposed by Akartunali et al. (2016). Based on two relaxations of the subproblem, we propose new families of valid inequalities and present facet-defining conditions. These inequalities are lifted to the original space of the two-period subproblem, and they also inspire the derivation of a new family of inequalities defined in the original space. We exploit the structural similarities of the different families in order to design an efficient separation algorithm, and embed it in a modern branch-and-cut solver.

2 - Prescriptive Analytics To Improve E-warehouse Operations

Fatma Gzara, Associate Professor, University of Waterloo, 200 University Avenue W, Waterloo, ON, N2V 2N1, Canada, fgzara@uwaterloo.ca

We use data for an e-commerce warehouse characterized with high order volumes, significant seasonality, and a large number of SKUs. Based on extensive descriptive data analysis, the packing operation is identified as a major cause for long order completion times. We develop an optimization model and solution methods based on decomposition and heuristics to optimize order packing. We validate our results using industry data.

3 - Finding Optimal Solutions For Emergency Evacuation By A Dynamic Programming Approach Based On State-space-time Network Representation

Lei Bu, Institute for Multimodal Transportation, Jackson, MS, United States, leibu04168@gmail.com, Feng Wang, Xuesong Zhou

Based on a representation of state-space-time network, a formulation is proposed to optimize dynamic vehicle routes strategy in an emergency evacuation. The proposed integer linear programming formulation could effectively build the modeling representation of time status, evacuation demand, node capacity and traffic volume change constraints through a multi-dimensional network with an objective function to minimize total travel cost of visiting all nodes. Bellman-Held-Karp algorithm working as a dynamic programming algorithm is utilized to solve the problem. Two scale levels of networks in Mississippi State are tested using the model and algorithm proposed to verify the effectiveness.

4 - A Modified Cutting Plane Algorithm For Inverse Mixed Integer Linear Programming Problems

Vishnu Vijayaraghavan, Texas A&M University, 400 Nagle Street, College Station, TX, 77840, United States, vishnunitr@tamu.edu, Kiavash Kianfar, Andrew J Schaefer

Given a feasible solution to an optimization problem, the purpose of an inverse optimization problem is to minimally perturb the cost vector to make this feasible solution an optimal one. Inverse optimization for mixed integer programming is particularly challenging and previously a cutting plane algorithm has been proposed. In this paper we present a modification of this algorithm which significantly reduces the number of iterations, and hence run-time, until termination.

WC82

Broadway G- Omni

Networks and Graphs III

Contributed Session

Chair: Monica Gentili, IPAT, Georgia Institute of Technology, 75 5th Street NW, Suite 600, Atlanta, GA, 30308, United States, mgentili@unisa.it

1 - The Impact Of Visual Aesthetics On The Utility, Affordance, And Readability Of Network Graphs

Patrick Michael Dudas, Faculty Research Associate, Pennsylvania State University, 691 Wiltshire Drive, State College, PA, 16803, United States, pmd19@psu.edu

Network visualizations facilitate the understanding of relationships, where research classically focuses more on readability. While existing studies are mostly concerned with the readability of topological mapping (based on different layouts), this work focuses on how visual aesthetics affect users' understanding of network structures by both readability (direct utility) and perceived affordance (indirect utility). Accompanied with these measures are eye-tracking data and retrospective think-aloud protocol to provide qualitative context to these visual strategies. Our study contributes to the understanding of visual aesthetics in network visualization design.

2 - An Algorithm To Design LDPC Codes With Low Error Floor In Communication Systems

Banu Kabakulak, Bogazici University, Istanbul, Turkey, banu.kabakulak@boun.edu.tr, Z. Caner Ta kın, Ali Emre Pusane

In a digital communication system, information is sent from one place to another over a noisy communication channel using binary symbols (bits). Original information is encoded by adding redundant bits, which are then used by low-density parity-check (LDPC) codes to detect and correct the errors. Error correction capability of an LDPC code is severely degraded due to harmful structures such as cycles in its bipartite graph representation (Tanner graph). Hence, we can achieve a low error floor when there are no small cycles in Tanner graph. We introduce an integer programming formulation for maximizing the smallest cycle size in Tanner graph. We propose a branch-and-cut algorithm for its solution.

3 - Critical Effect Of Dependence Clusters On Cascading Failures In Network Systems

Jian Zhou, PhD Student, Rutgers University, Bevier Road, Buell Apt, 0378, 2145 Bpo Way, Piscataway, NJ, 08854, United States, zhoujian977913@gmail.com, Ning Huang, David W Coit

Current failure models focusing on network load dynamics provide powerful approaches to analyze cascading failures in networks. However, previous studies don't take the impacts of dependencies among network nodes beyond network connection into account. Recent research show that dynamics of networks considering dependencies differ greatly from that with only connectivity links. Based on a mixed cascading failure model for networks including load dynamics and dependencies, we analyze numerically the influences of dependence clusters of nodes on failure mechanism in networks subjecting to random failures. How network topology affects the robustness of such networks are also investigated.

4 - The Interval Transportation Problem

Monica Gentili, Associate Professor, University of Louisville, 132 Eastern Parkway, Louisville, KY, 40205, United States, monica.gentili@louisville.edu, Raffaele Cerilli, Ciriaco D'Ambrosio

The basic transportation problem (TP) deals with the transportation of goods from a set of supply points to a set of demand points so as to minimize linear transportation costs. The interval transportation problem extends TP to take into consideration uncertainty in the supply and demand when they are expressed in interval forms. We analyze the set of the optimal solutions of the problem and apply a heuristic algorithm to explore it.

WC83

Broadway H- Omni

Supply Chain Optimization III

Contributed Session

Chair: Ethan Malinowski, University at Buffalo, 8 Affinity Lane, Apt 251E, Buffalo, NY, 14215, United States, ejmalino@buffalo.edu

1 - Stochastic Models For Strategic Sourcing In Energy Industry

Ashesh Kumar Sinha, University of Wisconsin-Madison, 1402 Regent St Apt 731A, Madison, WI, 53711, United States, ashesh.sinha24@gmail.com, Ananth Krishnamurthy

We analyze the supply chain in oil and gas industries that manufacture custom-engineered equipment. We consider a multi-period centralized system and decentralized system where the product can be made either at the in-house manufacturing facility or at dedicated facilities of the external supplier. At each time period, the manufacturer and the supplier decide their capacity levels and the production quantity to satisfy a random demand. Using stochastic models, we analyze optimal production and capacity investment decisions, and also analyze the inefficiencies in the decentralized system.

2 - A Joint Supplier Selection And Lot-sizing Problem With Quality Constraint Under An All-unit Discount Environment

Xin Li, Pennsylvania State University, University Park, PA, 16802, United States, xzl118@psu.edu, Jose Antonio Ventura, M. Jeya Chandra

This paper considers a joint supplier selection and lot-sizing problem, where suppliers are capacitated and offer all-unit discounts. The product's perfect rate differs among suppliers and a minimum overall acceptable perfect rate exists. A cyclic order schedule is employed and the set of selected suppliers, and corresponding order quantities and frequencies are determined accordingly so that the total cost per time unit is minimized. A mixed-integer nonlinear mathematical model is presented and analyzed. A dynamic programming algorithm is proposed to solve the discretized version of the model.

3 - Liquid Helium Global Supply Chain Modeling And Optimization

Ethan Malinowski, University at Buffalo, 8 Affinity Lane, Apt 251 E, Buffalo, NY, 14215, United States, ejmalino@buffalo.edu, Mark Karwan, Banu Gemici-Ozkan, Jose M Pinto

The global supply chain for liquid helium presents a complex structure due to increasing foreign demand, elaborate recovery techniques, and costly forms of distribution. Although the task contains parallels to the vehicle routing and traveling salesmen problems, supply requirements and problem-specific network constraints require a unique optimization model. We develop a large-scale discrete time, path-based integer-programming model which solves optimally using CPLEX. Computational results implementing a rolling horizon structure and testing against historical data are presented.

WC84

Broadway J- Omni

Supply Chain, Risk III

Contributed Session

Chair: Irina Dolinskaya, Northwestern University, 2145 Sheridan Road, Tech Institute, M235, Evanston, IL, 60208-3119, United States, dolira@northwestern.edu

1 - A Robust Decision-Making In a Supply Chain Under Disruption Risks

Tadeusz J Sawik, Professor and Chair, AGH University of Science & Technology, Al. Mickiewicza 30, Krakow, 30059, Poland, sawik@zarz.agh.edu.pl

A robust decision-making in a supply chain under local and regional disruption risks is considered. The robustness refers to an equitably efficient average and worst-case performance, which reflects the decision-makers common requirement to maintain an equally good performance of a supply chain under different conditions. The problem objective is to select suppliers of parts and schedule customer orders for products to equitably optimize average and worst-case cost or service level. The robust solution is obtained using the ordered weighted averaging aggregation of the expected value and the conditional value-at-risk.

2 - Investigating WOMs Behind Crisis: Contingent Negative Spillover Effect In Supply Chain Partnership

Xiaolun Wang, PhD Candidate, Fudan University, 670 Guoshun Road, Yangpu District, Shanghai, 200433, China, wangxiaolun@fudan.edu.cn, Cenying Yang, Cheng Zhang

This paper aims to investigate mechanism that governs the vertical spillover effect of crisis from stricken firm to its supply chain partners. Based on Accessibility-Diagnosticity theory, we explain why and when WOM could contribute to the negative spillover, that is, guilt by association mechanism for large downstream partners and information asymmetry mechanism for small upstream partners. Based on a merged, multi-sources, and longitudinal dataset from Capital IQ, and Sina Microblog, we apply PVAR model with GMM estimators to capture the dynamic interactions between WOM attributes (volume/valence/dispersion) and abnormal return of the supply chain partners.

3 - Supplier Assessment Policies In Total Cost Auctions

Karca Aral, Asst. Professor, Syracuse University, 721 University Avenue, Syracuse, NY, 13244, United States, kdaralwa@syr.edu

We address the trade-off between compulsory and voluntary supplier assessments in a procurement auction. Compulsory assessments enable buyers to learn the total cost of ownership (TCO) before selecting a supplier; however, this leads to decreased supplier competition. In contrast, voluntary assessments increase supplier competition, however provide less information on the TCO.

4 - A Data Driven Approach To Managing Food Safety In Global Supply Chains

Amine Anoun, PhD Student, Massachusetts Institute of Technology, 273 Cardinal Medeiros Ave, Apt 2, Cambridge, MA, 02141, United States, aanoun@mit.edu

Economically motivated adulteration poses a serious threat to public health. Prevention is achieved by sampling food shipments. However, the sampling resources are limited. In an effort to mitigate risk in the shipping supply chains, we develop a data-driven approach to identify risky manufacturers. We obtained over 850,000 shipment records of shrimp to the U.S. from the FDA. We determine structural features of shipping supply chains that correlate with risk of adulteration, at the global scale and in China. We use a Bayesian approach to model both the risk of adulteration, and the sampling procedure of the FDA, and show that our model predicts high risk manufacturers with high accuracy.

5 - Humanitarian Medical Supply Chain In Disaster Response: Role And Challenges

Irina Dolinskaya, Northwestern University, 2145 Sheridan Road, Tech Institute, M235, Evanston, IL, 60208-3119, United States, dolira@northwestern.edu, Maria Besiou, Sara Guerrero-Garcia

In this talk we study the humanitarian medical supply chain (HMSC) aspect of disaster response. More specifically, we describe HMSC in the case of disaster response, and identify the challenges encountered in the setting, especially focusing on the challenges that are unique to medical aspect of the humanitarian supply chain.

■ WC85

Broadway K- Omni

Sustainability III

Contributed Session

Chair: Lu Xu, MBA, Doctoral Student, UNT, 1307 West Highland Street, Denton, TX, 76201, United States, lu.xu@unt.edu

1 - Dynamic Eco-efficiency Assessment For Supplier Selection And Monitoring

Aineth Torres-Ruiz, Tecnológico de Monterrey, Guadalajara, Mexico, atorresr@itesm.mx

In this study, we propose a methodology that integrates multiple factors into a single performance measure to allow a more complete evaluation of supplier eco-efficiency. Particularly, our model investigates the joint application of Data Envelopment Analyses (DEA) and Malmquist analyses for supplier evaluation, selection and monitoring of actual supplier progress. Single and multiple sourcing strategies are applied and goal programming is used in the allocation of orders to integrate different preferences for budget and eco-efficiency performance targets. For illustrative purposes, we have applied our methodology to an autoparts manufacturer located in central Mexico.

2 - Research In Corporate Social Responsibility: A Bibliometric Analysis

Jose M. Merigo, University of Chile, Av. Diagonal Paraguay 257, Santiago, 8330015, Chile, jmerigo@fen.uchile.cl, Verónica Pizarro, Leslier Valenzuela

This study develops a bibliometric analysis of the research carried out in corporate social responsibility (CSR) during the last twenty-five years. The aim of the article is to identify and analyze the most productive and influential journals where CSR is published. The work presents a general overview of the leading journals, a temporal classification and the citation structure of these journals. The study also maps the bibliographic material through the VOS viewer software developing bibliographic coupling and co-citation of journals in CSR. The Journal of Business Ethics is the most active journal in this field although the Academy of Management Review is the most influential one.

3 - How Social Image Investment Pays Off In A Supply Chain

Wenqing Zhang, University of Minnesota - Duluth, 1318 Kirby Drive, Labovitz School of Business and Economics, Duluth, MN, 55812, United States, zhangwenqing@gmail.com, Chiang Chung-Yean

In a mature consumer market, the social image of a company plays, as well, a more and more important role in developing or maintaining the competitive edge. This paper studies the pricing and sourcing choices in a two-echelon supply chain selling a procure-to-stock product to a price-sensitive and social welfare conscious market. We illustrate the significance of the social image in a company's sourcing decision.

4 - A Model For Integrating Remanufacturing And Product Service System (PSS) During Product Development Stage

Johnson Adebayo Fadeyi, Wayne State University, 690 Martin Luther King Jr. Blvd-Apt 2005, Detroit, MI, 48201, United States, kontaktjohnson@gmail.com, Leslie Monplaisir

Remanufacturing has been identified as the most viable strategy among the product end-of-life (EOL) management approaches. However, over 80% of manufactured products currently end up as wastes. Meanwhile, some of the bottlenecks of product remanufacturing could be remedied by PSS. Therefore, the integration of remanufacturing and PSS is an improved product offering. The factors that are most critical for the success of remanufacturing and PSS have been identified. In this work, two essential criteria-core cleaning operations and product serviceability are considered. These criteria are optimized to make improved product modularity decisions during product development.

5 - Environmentally Friendly Car Purchase Intention In The United States

Lu Xu, MBA, Doctoral Student, UNT, 1307 West Highland Street, Denton, TX, 76201, United States, lu.xu@unt.edu, Victor R Prybutok

The purpose of this study is to incorporate self-image and quality with individual environmental awareness to assess the impact on the consumers' intention of purchasing the environmental friendly car. Does individual environmental awareness has some role when formatting purchase intention? Partial least squares structural equation modeling (PLS-SEM) allowed testing the posited model and associated hypotheses.

■ WC88

Broadway B-Omni

Military Applications III

Contributed Session

Chair: Nelson Christie, Rutgers University, Princeton, NJ, 8540, United States, christie.l.nelson.phd@gmail.com

1 - End-of-life Inventory Control Of Aircraft Spare Parts Under Performance Based Logistics Environment

Mansik Hur, Visiting Researcher, The University of Alabama, Tuscaloosa, AL, 35487, United States, mhur@crimson.ua.edu, Burcu Keskin, Charles Schmidt

We consider an inventory control problem of aircraft spare parts during the end-of-life (EOL) phase of fleet operation. An algorithm computes optimal stock levels according to aircraft availability over the EOL period under a budget constraint, which is a common scenario in PBL environment. As opposed to the previous research, we take a 'system approach' by incorporating the aircraft availability in simultaneously determining final order sizes of multiple items. The optimization algorithm is applied to the operational data of an F-16 aircraft systems in Korea Air Force and finds optimal stock levels for given budget level with reasonable accuracy and in reasonable amount of time.

2 - Game-Theoretic Models For Locating Camera Towers In Urban Areas And Scheduling Surveillance

Javier Salmeron, Naval Postgraduate School, Operations Research Dept, Monterey, CA, 93943, United States, jsalmero@nps.edu, Kevin Wood

We develop optimization models for location of tower cameras and surveillance scheduling used by a military force in an urban setting. With a game-theoretic foundation we seek to minimize the worst-case expected damage from undetected events. A mixed-integer program approximates detection probability; then, column generation creates an implementable distribution of camera assignments, making the approximation exact. Realistically sized computations find high-quality solutions quickly in most cases. An alternative game-theoretic model may produce better solutions when limitations arise.

3 - Air And Missile Defense Integration Challenges

George E Mayernik, Raytheon Integrated Defense Systems, 235 Presidential Way, Mailstop 26/5445, Woburn, MA, 01801, United States, George_E_Mayernik@raytheon.com, Christopher M Menard

Many allied countries are in the process of defense modernization. A top priority is expanding Air and Missile Defense capability, and incorporation of the new systems into the military force structure which involves many integration challenges. Some key integration categories and challenges are: Technical & Interoperability, Organizational & Force Structure, Operations & Sustainment, and Programmatic. This paper provides some potential integration solutions, however is more intended to stimulate discussion that will benefit the planning needed to guide deployment.

4 - The Impact Of Data Quality: A Study On The Coast Guard's Data

Nelson Christie, Rutgers University, Princeton, NJ, 08540, United States, christie.l.nelson.phd@gmail.com

We report our findings with the US Coast Guard on a project designed to identifying errors in a large operational database. We combined interview results with statistical algorithms to identify a large number of errors in the data. We then examine the impact that data quality has on operational planning.

■ WC89

Broadway C-Omni

Large-Scale Optimization in Transportation

Sponsored: TSL, Intelligent Transportation Systems (ITS)

Sponsored Session

Chair: Velibor Misic, Massachusetts Institute of Technology, Massachusetts Avenue, Cambridge, MA, 02139, United States, vvmisic@mit.edu

1 - Planning Optimization For Integrated Transportation Systems

Bradley Sturt, Massachusetts Institute of Technology, Massachusetts Avenue, Cambridge, MA, 02139, United States, bsturt@mit.edu, Dimitris Bertsimas, Sebastien Martin, Yee Sian Ng, Julia Yan

Passengers move through large cities via various public transportation systems, such as subway and bus systems. City operators need to decide how to schedule the trains and buses throughout the day. Prior work has addressed making the decisions for each transportation system in isolation, which may result in a suboptimal citywide transportation system. This work proposes an optimization approach for holistically and cooperatively optimizing the decisions for decision makers for the subway, bus systems and the city.

2 - From Physical Properties Of Transportation Flows To Demand Predictions: An Optimization Approach

Julia Y. Yan, Massachusetts Insitute of Technology, Massachusetts Avenue, Cambridge, MA, 02139, United States, jyyan@mit.edu, Dimitris Bertsimas

Transportation system management requires accurate demand data. The main data sources are often aggregated datasets such as entry/exit data, and one must recover the original demand. Such problems are generally underspecified. We present an optimization framework to recover origin-destination matrices under minimal assumptions, enforcing reasonable physical constraints such as flow conservation, smoothness, and sparsity. We evaluate this on real-world datasets and show 6-7% improvement in R2 over a baseline.

3 - Online Taxi Routing In New York City

Sebastien Martin, Massachusetts Institute of Technology, Massachusetts Avenue, Cambridge, MA, 02139, United States, semartin@mit.edu, Dimitris Bertsimas, Patrick Jaillet

Taxi dispatching used to have little room for optimization. However, more and more customers request cabs from their cellphone. This gives transportation network companies prior information that can be leveraged to achieve a better efficiency. Large-scale taxi routing has usually been done with simple rules or heuristics. Our work proposes ways to scale optimization-based online routing algorithms to the largest instances of vehicle routing with real data. We use historical taxi trip data in New York City to dispatch in real time thousands of taxis and serve tens of thousands of customers.

4 - A Modern Optimization Approach To The Airlift Planning Problem For The United States Transportation Command (USTRANSCOM)

Velibor Misic, Massachusetts Institute of Technology, Massachusetts Avenue, Cambridge, MA, 02139, United States, vvmisic@mit.edu, Dimitris Bertsimas, Allison An Chang, Nishanth Mundru

USTRANSCOM plans missions globally, the majority traveling by air. These missions are challenging to plan due to their combinatorial nature and complex constraints. We propose a novel solution approach that combines local search, mixed-integer optimization and column generation, and show that it provides high quality solutions. This material is based upon work supported by USTRANSCOM under Air Force Contract No. FA8721-05-C-0002. Any opinions, findings, conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of USTRANSCOM.

■ WC90

Broadway D-Omni

Health Care, Modeling XV

Contributed Session

Chair: Shanshan Wang, PhD Candidate, Beijing Institute of Technology, 5 southstreet Zhongguancun, Haidian District, Beijing, 100081, China, shshwang_bit@163.com

1 - Safety Stock For Blood Products With Short Shelf Life

Christine Pitocco, Research Professor, Stony Brook University, 202 Harriman Hall, Harriman Hall Room 202, Stony Brook, NY, 11794-3775, United States, christine.pitocco@stonybrook.edu, Katsunobu Sasanuma

Poorly managed inventory of apheresis platelets in a blood bank can result in a loss of revenue and safety issues for patients in need. A safety stock of platelets must be available, but higher levels of safety stock may cause wastage if not utilized. We discuss how the safety stock level should change according to the change in demand and shelf life. We propose an optimal inventory control policy based on a simulation of blood bank operations.

2 - Facility Location Problem For Stochastic Mixed-integer Programming In Healthcare

Mengnan Chen, University of Central Florida, 12800 Pegasus Drive, PO Box 162993, Orlando, FL, 32816-2993, United States, cmn891127@knights.ucf.edu, Qipeng Zheng

This paper considers a facility location problem with patients' appointment and physician scheduling. We model this problem as a two-stage optimization problem. In the first stage, depending on the patients' choices, which is relative to their characteristics and physicians/clinics' attributes, physicians will be scheduled to the different clinics. In the second stage, the central hospital will match patients' choices and physicians' scheduling. Using discrete choice model, we estimate the probability for patient's choice. Let the scenario is the different combination of patients' choices, then we can develop a stochastic mixed-integer programming to solve the facility location problem.

3 - Test Modality Capacity Simulation: A Nuclear Medicine Radiology Assessment

Haris Ackerman, Management Engineer, Virtua Health, 303 Lippincott Drive, Marlton, NJ, 08053, United States, hackerman@virtua.org, Mojisola Otegbeye, Hala Sweidan

Significant delays in the nuclear medicine radiology department of a 433 bed acute-care hospital increases patient length of stay resulting in patient dissatisfaction and reduced reimbursement rates. Simulation modeling deployed to show a budget neutral increase in daily stress test fulfillment rate from 80% to 99.9% while maintaining current staffing roster by utilizing optimal staff scheduling patterns.

4 - Outpatient Appointment Scheduling And Sequencing Model With Uncertain Service Time And Correlation

Shanshan Wang, PhD Candidate, Beijing Institute of Technology, 5 Southstreet Zhongguancun, Haidian District, Beijing, 100081, China, shshwang_bit@163.com, Jinlin Li, Chun Peng

As the window of hospital, outpatient appointment scheduling and sequencing plays a critical role in the allocation of healthcare resources. We take different jobs and uncertain service time into consideration. Based on support and moment of service time distribution, we employ mean absolute deviation to capture its correlation, propose distributionally robust models, and can be reformulated them as tractable counterparts. Numerical results show that when sequence is fixed, it's optimal to allocate time allowances with a decreasing pattern. When considering "New" and "Repeat" patients, optimal outpatient sequence of repeat patients is in the front of new patients.

Wednesday, 2:45PM - 4:15PM

■ WD01

101A-MCC

Data Mining Application in Business

Sponsored: Data Mining

Sponsored Session

Chair: Parvaneh Jahani, University of Louisville, 781 Theodore Burnett Court, Apt 2, Louisville, KY, 40217, United States, parvaneh.jahani@louisville.edu

1 - Machine Learning And Cognitive Pricing

Zhengliang Xue, IBM Research Center, 1101 Kitchawan Road, Route 134, Yorktown Heights, NY, 10598, United States, zxue@us.ibm.com, Markus Ettl

We study a method to price personalized configuration of software and services. The seller has to deal with a customized configuration without any similar records in history. A data-driven approach is applied to estimate the purchase probability for any unique configuration based on historical trading data. In addition, client relationship and firmographic information need to be incorporated to the pricing decision. We establish a utility model to evaluate the configuration and recognize the impact of relationship. The business impact of optimal pricing is justified by the actual data.

2 - Investigating Sparse Demand Models To Support The Assortment Planning Decision

Matthew Lanham, Purdue University, West Lafayette, IN, 47905, United States, malanham@gmail.com, Ralph D Badinelli

We present research examining the performance of substitution-based multi-classification models currently being researched and employed in practice by major retailers, versus more naïve binary classification models to understand purchase propensity. We discuss how these models would yield different assortments for sparse demand products.

■ WD02

101B-MCC

Decision Analysis in Health Care Data Mining

Sponsored: Data Mining

Sponsored Session

Chair: Diego Martinez, Johns Hopkins University, 1, Baltimore, MD, 212, United States, dmart101@jhmi.edu

1 - Multiscale Decision Making Based on Variational Evidential Reasoning For Medical Record Label Recommendation

Haiyan Yu, Lecturer, Chongqing University of Posts and Telecommunications, 2 Chongwen Road, Nan'an District, Chongqing, P.R.C, 400065, China, yhy188@tju.edu.cn
Haiyan Yu, Lecturer, University of Electronic Science and Technology of China, Chengdu, China, yhy188@tju.edu.cn, Man Xu, Jiang Shen

Due to the characteristics of fragmentation and uneven distribution of the clinical data, the issues of reducing its misdiagnosis and improving the system discrimination ability arises in evidential reasoning. To solve these issues, the model of belief propagation was constructed based on the hierarchical Dirichlet process, achieving the confidence fusion of fragmented evidence. Through parameter learning, the recommendation of indentifying the lables of medical instances were achieved with the control trajectory of the reasoning model. Finally, simulation study verified the effectiveness and resilience of the reasoning models, improving the efficiency and quality of medical services.

2 - Using Matrix-based Multi-criteria Decision Method For Assessing Risk Of Harm Of Alert-overridden Intravenous Infusions

Wan-Ting Su, PhD Student, Purdue Univeristy, West Lafayette, IN, United States, su33@purdue.edu, Poching DeLaurentis, Mark Lehto

Hospital medication safety teams regularly review and analyze infusion drug alert reports to evaluate infusion performance. Previously an Intravenous (IV) medication harm index was developed to help clinicians assess the potential patient harm of each alert-overridden infusion. We aim to apply a matrix-based multi-criteria decision method to improve the existing harm index. The improved index can help medication safety teams better identify the medication and care unit combinations of high risk and further prioritize the targets for improvement on nursing practice, workflows and drug limit settings.

3 - Control System For Electronic Triage In The Emergency Department: Integrating The User Into Development Loop

Diego A. Martinez, Johns Hopkins School of Medicine, Baltimore, MD, 21201, United States, dmart101@jhmi.edu, Scott R Levin

The potential for machine learning systems to improve via exchange of information with knowledgeable users has yet to be explored in much detail. In a pilot study in an emergency department of a large hospital, nurses were presented with triage level predictions, and they were able to provide feedback through a real-time communication system. The types of some of this feedback seem promising for assimilation of clinical gestalt by machine learning systems. The results show that to benefit from clinical gestalt; machine learning systems must be able to absorb information in a graceful manner and provide clear explanations of their predictions.

■ WD03

101C-MCC

Big Data IV

Contributed Session

Chair: Wenbo Sun, University of Michigan, 2013 Medford Rd Apt 161, Ann Arbor, MI, 48104, United States, sunwbgt@umich.edu

1 - A Revaluation Of The Relationship Between Environmental Management And Financial Performance – A Multilevel Longitudinal Analysis

Zuoming Liu, Lynchburg College, 1501 Lakeside Drive, School of Business & Economics, Lynchburg, VA, 24501, United States, lzuoming@gmail.com

This study employs a multilevel cross-lagged model to investigate the causal relationships between a corporation's environmental performance and financial returns by using a 4-year dataset of the largest US500 companies. The goal is to identify variation of relationship due to different features at various levels. By conducting multilevel analyses, the relationship between environmental performance and financial returns is demystified into three levels, intra-firm dynamic variations over time, inter-firm variations, as well as variations across industries.

2 - A Class Of First Order Methods That Do Not Rely On Any Norm

Haihao Lu, PhD Student, MIT, 60 Wadsworth St, Apt 8B, Cambridge, MA, 02142, United States, haihao@mit.edu, Yurii Nesterov, Robert Michael Freund

This work generalizes the notion of smoothness, strong convexity, and Lipschitz continuity of a convex function by introducing a reference function, and uses the reference function to derive convergence rates for generalized first-order methods for convex optimization. The approach yields clear intuition behind convex optimization with composite functions as a corollary. We also developed a first-order interior-point method using a weak definition of self-concordance.

3 - A Method For Developing Confidence Bands For Multiple Dimensional Functional Responses

Wenbo Sun, University of Michigan, 2013 Medford Rd Apt 161, Ann Arbor, MI, 48104, United States, sunwbgt@umich.edu, Jionghua Jin

The standard method for specifying target responses' variabilities involves developing a confidence band for a set of empirical mechanical responses. These responses are multiple-dimension signals obtained from identical trials of different subjects. The existing methods commonly normalize responses with respect to subject characteristics, point-wisely generate confidence bands ignoring times and direction's correlation. A new method was developed in the structure of mixture models based on basis-representation and Gaussian process and provided an approach for outlier detection. It is applied to the kinematic response data collected in Children's Hospital of Philadelphia.

WD04

101D-MCC

Robust and Stochastic Optimization for Energy Systems

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Andy Sun, Georgia Institute of Technology, 755 Ferst Dr, Atlanta, GA, 30312, United States, andy.sun@isye.gatech.edu

1 - Robust Optimization For The Alternating Current Optimal Power Flow Problem

Alvaro Lorca, Georgia Institute of Technology, alvarolorca@gatech.edu, Andy Sun

We present an adaptive robust optimization model for the alternating current optimal power flow problem (ACOPF) under uncertainty in renewable power availability and the active and reactive power injections at demand nodes. We will discuss solution methods and the performance of the approach proposed through computational experiments.

2 - Comparison Of Stochastic Programming And Robust Optimization For Risk Management In Energy Generation

Ricardo M Lima, KAUST, Thuwal, Saudi Arabia, ricardo.lima@kaust.edu.sa, Sabique Langodan, Ibrahim Hoteit, Omar Knio, Antonio J. Conejo

In this talk, we address the optimal self-scheduling and market involvement of a virtual power plant (VPP) by using three different methods. The VPP faces a decision-making problem with uncertainty in the wind power and electricity prices forecast. We define this problem using a risk-averse stochastic programming model, a robust optimization model, and with a new hybrid robust-stochastic formulation. We analyze these methods from the point of view of formulations, uncertainty quantification and risk, decomposition algorithms, and computational performance. Furthermore, we compare the impact of the risk measures and their parameterizations on the results obtained with the three methods.

3 - Risk-constrained Optimal Power Flow With Moment And Unimodality Information

Bowen Li, University of Michigan, Ann Arbor, MI, United States, libowen@umich.edu, Ruiwei Jiang, Johanna Mathieu

We propose a risk-constrained optimal power flow (OPF) problem with uncertain renewables. Using historical data and domain knowledge, we incorporate moments of the renewable forecast errors and assume unimodality to derive reformulations and approximations based on semidefinite programs and second-order cone programs, and evaluate them on IEEE test systems.

4 - An Efficient Robust Solution To The Two-stage Stochastic Unit Commitment Problem

Ignacio Blanco, PhD Student, Technical University of Denmark, Kgs. Lyngby, 2800, Denmark, igbl@dtu.dk, Juan M Morales Gonzalez

This paper proposes a reformulation of the scenario-based two-stage unit commitment problem under uncertainty that allows finding unit-commitment plans that perform reasonably well both in expectation and for the worst case realization of the uncertainties. The proposed reformulation is based on partitioning the sample space of the uncertain factors by clustering the scenarios that approximate their probability distributions. It is, furthermore, very amenable to decomposition and parallelization using a column-and-constraint generation procedure.

WD05

101E-MCC

Wildland Fire Management I - Suppression

Sponsored: Energy, Natural Res & the Environment II Forestry

Sponsored Session

Chair: Eghbal Rashidi, Mississippi State University, Industrial & Systems Engineering, Mississippi State University, MS, 39762, United States, er442@msstate.edu

1 - Vulnerability Analysis Of The Initial Attack In Suppressing The Worst Case Wildfires

Eghbal Rashidi, Mississippi State University, er442@msstate.edu, Hugh Medal

In this research, we perform a quantitative gap analysis between available capacity for responding to wildfires and the estimated capacity needs for responding to a worst case scenario wildfire. We model the problem as a Stackelberg game using a bilevel max-min MIP model. We use the model to evaluate the impact of the worst-case wildfire, i.e., the arrangement of ignition points that causes the maximal damage. We then investigate the relationship between fire response capacity and the rate of spread, fire ignition location and number of fire ignitions in the landscape.

2 - An Optimization Model For Wildfire Suppression

Andres L Medaglia, Professor and Chair, Universidad de los Andes, Cr 1 este #19 A 40, ML708, Bogota, Cundinamarca, 111711, Colombia, amedagli@uniandes.edu.co

An effective early attack is essential to control wildfires. In this work, we propose an MIP to support decisions related to the planning and response phases of fire management. For the planning phase, the MIP addresses the decisions related to the location of facilities and how much inventory to store. In the response phase, decisions are concerned to the location of coordination centers and how to allocate available resources. The model includes a risk measure to limit the downside risk of different scenarios. We apply this methodology in a setting that resembles wildfires nearby the city of Bogotá (Colombia).

WD06

102A-MCC

Optimization in Data Mining 1

Sponsored: Data Mining

Sponsored Session

Chair: Orestis Panagopoulos, 9303 Nelson Park Circle, Apt 204, Orlando, FL, 32817, United States, ore.pan@hotmail.com

1 - New Developments Of L1 Splines: Fast Computation And Shape-preserving Capability

Ziteng Wang, Assistant Professor, Northern Illinois University, DeKalb, IL, United States, th2168@gmail.com

Cubic splines are widely used for data interpolation and approximation in terrain surface fitting, computer aided design, and numerical control. Conventional L2-norm based splines often show undesired oscillation and do not preserve shape, especially for irregular or multiscale data. L1 splines, by minimization of the L1-norm based metrics, have shown superior and robust shape-preserving performances and enjoyed increasing application potentials. We introduce the development of L1 splines over the past decade, present the latest research on the fast computing strategy and the quantitative measure of shape-preserving capability, and discuss future opportunities.

2 - Probing The Pareto Frontier Of Computational Statistical Tradeoffs

Zhaoran Wang, Princeton University, Princeton, NJ, 08540, United States, zhaoran@princeton.edu

In this talk, we discuss the fundamental tradeoffs between computational efficiency and statistical accuracy in big data. Based on an oracle computational model, we introduce a systematic hypothesis-free approach for developing minimax lower bounds under computational budget constraints. This approach mirrors the classical Le Cam's method, and draws explicit connections between algorithmic complexity and geometric structures of parameter spaces. Based on this approach, we sharply characterize the computational-statistical phase transitions that arise in a broad class of learning problems.

WD07

102B-MCC

Predictive Analysis and Applications in Data Mining

Sponsored: Data Mining

Sponsored Session

Chair: Juxihong Julaiti, Penn State University, 445 Waupelani Drive, Apt J1, State College, PA, 16801-4445, United States, juxihongjulaiti1225@gmail.com

1 - Proactive Data: A Rich Source Of Occupational Accident Prediction

Jhareswar Maiti, Professor, IIT, Kharagpur, Kharagpur, 721302, India, jhareswar.maiti@gmail.com, Sobhan Sarkar, Saicharan Pardhu, Rutwick Ayi

The proactive data (e.g., inspection reports) is a source of rich information for prediction of occurrence of accidents. The main aim of the study is to use the proactive data properly along with reactive data (e.g., incident reports) retrieved from an integrated steel industry in building a prediction model to predict the occurrences of future incidents. Decision tree algorithms like C5.0, CART, CHAID, exhaustive CHAID, and ensemble techniques i.e., boosting have been implemented in order to predict the accidents. Results show that the C5.0 outperforms all other algorithms in terms of higher accuracy.

2 - Detecting Node Propensity Changes In Dynamic Degree-corrected Stochastic Block Model

Lisha Yu, City University of Hong Kong, Hong Kong, lishayu2-c@my.cityu.edu.hk, Kwok-Leung Tsui

Many real-world data can be represented as dynamic networks which are the evolutionary networks with timestamps. Studying the evolution of node propensity over time is significant to exploring and analyzing networks. In this paper, we propose a multivariate surveillance plan to monitor node propensity in dynamic social networks based on the degree-corrected stochastic block model (DCSBM). Experiments on simulated and real social network streams demonstrate that our surveillance strategies can efficiently detect different types of node propensity change in dynamic DCSBM with different kinds of community structure.

■ WD08

103A-MCC

Dynamic Prog/Control

Contributed Session

Chair: Xiaodong Luo, Sabre Holdings Inc, 3150 Sabre Drive, Southlake, TX, 76092, United States, Xiaodong.Luo@sabre.com

1 - Adoptive Vehicle Cruise Control Using Real Time Data And A Dynamic Programming Model: A Web Based Application

Mohammad Ali Alamdar Yazdi, PhD Student, Auburn University, 354 W Glenn Ave, Auburn, AL, 36830, United States, mza0052@auburn.edu, Fadel Mounir Megahed

Recent investigations have included exploring the benefits of autonomous vehicle systems in improving a vehicle's miles per gallon (mpg) fuel-economy performance. This talk examines a new direction where large amounts of online data will be used to develop a fuel efficient cruise controller. More specifically, a dynamic programming model is constructed to capitalize on existing fuel consumption models and use real-time data collected from different Google APIs to minimize fuel efficiency. The minimization is based on dynamically optimizing the current speed and route based on forthcoming route conditions (traffic, elevation, etc.).

2 - Modeling Quality Of Care In Hospice Operations

Leela Nageswaran, Tepper School of Business, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, lnageswa@andrew.cmu.edu, Alan Scheller-Wolf, Aliza R Heching

We study a hospice manager's problem of controlling quality of care in light of recent regulatory changes mandating reporting of quality metrics. To explore the potential effects of such reporting, we develop an analytical Markov Decision Process model that incorporates how staffing - a primary determinant of quality - affects the rate at which patients join the hospice (due to quality reputation effects) and depart the hospice (due to quality of care effects). This in turn affects the hospice's revenues and costs. We solve our model to obtain properties and insights related to the optimal quality control policy.

3 - Decision Facing Ambiguity MDP POMDP And Beyond

Mohammad Rasouli, University of Michigan, 430 South Fourth Ave, Ann Arbor, MI, 48104, United States, rasouli@umich.edu

While most of the decision making tools are developed for a Bayesian framework where the decision maker knows full stochastic description of uncertainties in the environment, decision facing ambiguity (model uncertainty and non-stochastic uncertainty) is a better approach for modeling a lot of practical situations. We discuss how decision making tools including MDP, POMDP, learning (e.g. Multi-armed bandit) and team decision making can be extended for environments with ambiguity. We discuss robustness and bounded rationality in this framework.

4 - Iterative Methods For Large Markov Decision Problems

Xiaodong Luo, Sabre Holdings Inc, 3150 Sabre Drive, Southlake, TX, 76092, United States, Xiaodong.Luo@sabre.com

We propose a new unified LP formulation for the Infinite Horizon Markov Decision Problem (MDP), both with the total discounted reward criteria and the long-run expected average reward criteria (assuming the gain is constant). We embed a column generation scheme into a multiplier method to solve the new formulation. Our algorithm can solve large randomly generated MDPs faster than commercial solvers. It scales up linearly for MDPs with hundreds of millions of nonzero. It uses much less memory than Barrier method, easy to warm start and is highly parallelizable.

■ WD09

103B-MCC

Spatial Optimization and Conservation Reserve Design

Sponsored: Energy, Natural Res & the Environment I Environment & Sustainability

Sponsored Session

Chair: Bistra Dilkina, Georgia Institute of Technology, 266 Ferst Drive, Klaus Bldg 1304, Atlanta, GA, 30332-0765, United States, bdilkina@cc.gatech.edu

1 - Density Based Design: A Spatial Optimization Model For Protecting The Fisher

Richard Church, University of California, Santa Barbara, church@geog.ucsb.edu

We discuss the necessary elements of home range core areas in supporting female fishers during the key natal-maternal season. We propose an integer linear programming model that schedules harvests and spatially tracks and meets needed habitat elements over time and present preliminary results for an industrial forest in California.

2 - Optimizing Conservation Designs With Home Range And Connectivity Criteria

Bistra Dilkina, Georgia Institute of Technology, Atlanta, GA, United States, bdilkina@cc.gatech.edu

We develop a wildlife reserve design approach that takes into account both the number of individuals supported and the accessibility of the whole design to those individuals. In particular, a spatial capture-recapture model based on ecological resistance distance gives rise to three estimated quantities of interest (density, potential connectivity and density-weighted connectivity) that can be used to evaluate the ability of a reserve design to support individuals. We formulate a set of optimization problems to examine the use of these three quantities for selecting land parcels for conservation.

3 - Delaying Invasive Spread: Is Effective Control Possible Without Effective Prediction?

Gwen Spencer, Smith College, gwenspencer@gmail.com

Some (continuous) models of species spread yield impossibly-clean analytical results. Productive mathematical exchange with ecologists must acknowledge and attempt to capture disciplinary knowledge and critiques, even if this means sacrificing analytical traction. We will discuss computational work motivated by experimental and statistical papers in the invasive-species literature, making the case for discrete methods that acknowledge landscape heterogeneity and objectives that go beyond expected value.

4 - Avicaching: A Two Stage Game For Bias Reduction In Citizen Science

Yexiang Xue, Cornell University, yexiang@cs.cornell.edu

The data collected in citizen science projects are often biased, more aligned with the citizens' preferences rather than scientific objectives. We introduce a novel game for reducing the data bias in which the organizer, a citizen-science program, incentivizes the agents, the citizen scientists, to visit under-sampled areas. We provide a novel way to encode this two-stage game as a single optimization problem, cleverly folding the agents' problems into the organizer's problem. We apply our methodology to eBird, a well-established citizen science program, as a game called Avicaching. Since its deployment, Avicaching has been very successful, surpassing the expectations of the eBird organizers.

■ WD11

104A-MCC

Various Aspects of Second Order Cone Optimization

Sponsored: Optimization, Linear and Conic Optimization

Sponsored Session

Chair: Sertalp Bilal Cay, Lehigh University, 200 W Packer Ave, Bethlehem, PA, 18015, United States, sertalpbilal@gmail.com

1 - On Disjunctive Conic Cuts When They Exist When They Cut

Mohammad Shahabsafa, Lehigh University, 200 West Packer Ave, Bethlehem, PA, Bethlehem, PA, 18015, United States, mos313@lehigh.edu, Tamas Terlaky

The development of Disjunctive Conic Cuts (DCCs) for MISOCO problems has recently gained significant interest in the optimization community. Identification of cases when DCCs do not exist, or are not useful, saves computational time. In this study, we explore cases where either the DCC methodology does not derive a DCC which is cutting off the feasible region, or a DCC does not exist. Additionally, we work on extending the DCCs to other conic optimization problems such as Mixed Integer p-order Cone Optimization and Mixed Integer Semidefinite Optimization.

2 - Effects Of Disjunctive Conic Cuts Within A Branch And Conic Cut Algorithm

Sertalp Bilal Cay, Lehigh University, sertalpbilal@gmail.com

Recently, Mixed Integer Second Order Cone Optimization (MISOCO) has gained attention. This interest has been driven by the availability of efficient methods to solve second order cone optimization (SOCO) problems and the wide range of applications of MISOCO. In this work, we experiment with the recently developed methodology of Disjunctive Conic Cuts (DCC). In particular, we test it on variations of portfolio optimization problems within a Branch and Conic Cut (BCC) framework. Our experiments show that our proposed methodology using DCCs is effective in practical settings.

3 - A Rounding Procedure For A Maximally Complementary Solution Of Second Order Conic Optimization

Ali Mohammad Nezhad, Lehigh, alm413@lehigh.edu

The concept of optimal partition was originally introduced for linear optimization, and later the concept was extended to second-order conic optimization. In this paper, we present a rounding procedure, which uses optimal partition information to generate a pair of maximally complementary optimal solutions. The rounding procedure starts from a strictly interior solution, close to the optimal set. It either gives an exact maximally complementary optimal solution in strongly polynomial time, or provides a fast iterative procedure to approximate a maximally complementary optimal solution.

■ WD12

104B-MCC

Recent Advances in Discrete Optimization

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Andres Gomez Escobar, University of California, Berkeley, CA, United States, a.gomez@berkeley.edu

1 - Final Point Generalized Intersection Cuts

Aleksandr Mark Kazachkov, Carnegie Mellon University, akazachk@cmu.edu

We introduce a new class of cuts for mixed-integer programming called final point cuts. Generated from arbitrary valid disjunctions, this class is an extension of the generalized intersection cut paradigm. We present theoretical and computational results demonstrating the strength of these cuts as compared to both standard intersection cuts and previous types of generalized intersection cuts.

2 - Generating Cuts From The Ramping Polytope For The Unit Commitment Problem

Jim Ostrowski, University of Tennessee, jostrows@utk.edu

We present a perfect formulation for a single generator in the unit commitment (UC) problem. This generator can have characteristics such as ramping constraints, time-dependent start-up costs, and start-up/shut-down ramping. The perfect formulation is polynomially large, so we use it to create a cut-generating linear program for a single generator. We test the computational efficacy of these cuts in a utility-scale UC MIP model, based on the FERC generator set and 2015 hourly data from PJM. These cuts may also beneficial for the more complex UC models used by ISOs today because they reduce the enumeration needed to enforce a generator’s technical constraints.

3 - Conic Quadratic Program With Indicator Variables

Hyemin Jeon, University of California Berkeley, hyemin.jeon@berkeley.edu, Alper Atamturk

We investigate a conic quadratic mixed 0-1 programming problem with on-off constraints that arises from mean risk optimization. Analysis is conducted on the properties of the optimal solutions of the problem and its relaxation. A class of linear valid inequalities is derived by lifting the extended polymatroid inequalities that are known to be highly effective for the pure 0-1 case. We report the result of computational experiments to demonstrate the impact of the inequalities on strengthening the continuous relaxation.

4 - Polymatroid Inequalities For Mixed-integer Second Order Cone Programming

Andres Gomez, University of California Berkeley, a.gomez@berkeley.edu, Alper Atamturk

We propose valid inequalities for mixed-integer second order cones programs. We show that the proposed inequalities completely describe the convex hull of a single second order cone constraint. Moreover we show how to strengthen the inequalities using other constraints of the optimization problem. We report computational experiments on mixed-integer second-order cone programs, using the proposed valid inequalities as cutting planes.

■ WD13

104C-MCC

Computational Optimization and Software

Sponsored: Optimization, Computational Optimization and Software

Sponsored Session

Chair: Robert J Vanderbei, Princeton University, Princeton, NJ, 08544, United States, rvdb@princeton.edu

Co-Chair: Hande Benson, Drexel University, LeBow College of Business, Philadelphia, PA, 19104, United States, benson@drexel.edu

1 - Cubic Regularization For Conjugate Gradient Minimization And Symmetric Rank-one Methods

Hande Benson, Drexel University, benson@drexel.edu

Regularization techniques have been used to help existing algorithms solve “difficult” nonlinear optimization problems. Over the last decade, regularization has been proposed to remedy issues with equality constraints and equilibrium constraints, bound Lagrange multipliers, and identify infeasible problems. In this talk, we will focus on the application of cubic regularization in the context of the symmetric rank-one and conjugate gradient methods for nonlinear programming.

2 - Two New Efficient Algorithms For Compressed Sensing

Robert J Vanderbei, Princeton University, rvdb@princeton.edu

We present two new approaches for solving large-scale compressed sensing problems. The first approach uses the parametric simplex method to recover very sparse signals by taking a small number of simplex pivots while the second approach reformulates the problem using Kronecker products to achieve faster computation via a sparser problem formulation. Numerical studies show that each of these two algorithms are about 10 times faster than current state-of-the-art methods.

3 - Using A Fast Projected Gradient Method To Solve Large Scale Nonlinear Optimization Problems.

Igor Griva, George Mason University, igriva@gmu.edu

Some modern nonlinear optimization problems have a large number of variables and dense Hessians that makes challenging or impossible using second order methods. We discuss how the fast projected gradient method can be used for addressing optimization problems in machine learning, nonnegative least squares and positive emission tomography reconstruction.

■ WD14

104D-MCC

Facility Location I

Contributed Session

Chair: David Mendez, Graduate Student, University of Tennessee, 2621 Morgan Circle, Knoxville, TN, 37996, United States, dmendez@vols.utk.edu

1 - The Price Of Deception In Social Choice

James Patrick Bailey, Georgia Institute of Technology, 755 Ferst Drive, NW, Unit 2401, Atlanta, GA, 30332, United States, james.bailey@gatech.edu, Craig Aaron Tovey

Classic impossibility theorems rule out strategy-proofness for all popular voting rules, but is it wise to always settle for nothing with respect to manipulation? We introduce a measure, the price of deception, of how much strategic voting could alter an election outcome with respect to the winning criterion. We analyze this measure for several standard voting rules and find significant differences among them. We also analyze several standard cost functions for facility location, and again find large differences. These results give good evidence that the price of deception, like computational complexity, does offer finer distinctions of manipulability than between ”yes” or ”no”.

2 - A Comprehensive Model For Location/allocation Of Maritime Search And Rescue Vessels

Amin Akbari, PhD Candidate, Dalhousie University, 1104-1094 Wellington Street, Halifax, NS, B3H 2Z9, Canada, amin.akbari@dal.ca, Ronald P Pelot, H A Eiselt

The general methodology utilized in this study is building a mathematical model to optimize the Location/Allocation of Maritime Search and Rescue Resources with regard to several criteria such as primary and backup coverage, mean access time and service equality. A multi-objective model is built to optimize the location and response allocation of SAR resources with simultaneously taking several objectives into account in order to achieve greater responsiveness and resource utilization. Atlantic Canada serves as the area of the study. Sensitivity analyses are performed on variable objective weights and other parameters to examine their impact on the optimal solution.

3 - A Study on Optimal Locations Of Public Facilities To Maximize Social Benefit”

Hyunhong Choi, PhD Student, Seoul National University, 1 Gwanak-ro Gwanak-gu, Seoul, 08826, Korea, Republic of, hongchoi@snu.ac.kr, Misuk Lee, Yoonmo Koo

Economic feasibility analysis on the public facility construction is widely being studied. However, studies concerning the optimal location of these facilities has not been fully explored yet. In this study, we estimated consumers’ willingness to pay depending on the distance to non-market goods(i.e., arboretums) by using the contingent valuation method. Then, we utilized nested partitions method, one of the categorical optimization methods, to find optimal locations maximizing social benefit among numerous alternatives.

4 - Location Determination Of A Milk Condensing Plant In Tennessee

David Mendez, Graduate Student, University of Tennessee, 2621 Morgan Circle, Knoxville, TN, 37996, United States, dmendez@vols.utk.edu

Given the increasing popularity of local foods and the desire to reduce shipping costs and carbon footprint, Tennessee-based dairy product processors are likely interested in sourcing condensed milk from an in-state milk condensing plant. Based on dairy farmer surveys, distances, and transportation costs, this study uses a mixed integer linear programming model to determine the optimal location for a condensing plant that minimizes transportation costs from farms to the condensing plant and the condensing plant to further processors.

■ WD15

104E-MCC

Intelligent Information Systems

Sponsored: Artificial Intelligence

Sponsored Session

Chair: Victor Benjamin, University of Arizona, 1130 E Helen St, Tucson, AZ, 85719, United States, vabenji@email.arizona.edu

1 - Using Big Data And Analytics To Enable Smart Mobility

Yun Wang, University of Arizona, Tucson, AZ, 85716, United States, yunw@email.arizona.edu, Faiz Currim, Sudha Ram

In this work we introduce a three-layer management system to support smart urban mobility with an emphasis on bus transportation. In Layer-1, we apply novel Big Data techniques to efficiently compute bus travel times and passenger demands using universal data streams. Layer-2 contains two analytic components: network analysis of passenger transit patterns and causal relationship analysis for bus delays. The third layer provides interactive visualization tools for decision support. Our system is developed in cooperation with the city of Fortaleza in Brazil. The use of generally available urban transportation data makes our methodology adaptable and customizable for other cities.

2 - Analyst Language In Quarterly Earnings Calls: Comparing Interactions With Fraudulent And Non-fraudulent Managers

Lee Spitzley, University of Arizona, lspitzley@email.arizona.edu

Corporate financial fraud damages investors, the public, and the companies involved. Fraudulent managers must convince investment analysts who study the company that what they say is accurate and represents the true state of the business. I will examine the content of analyst utterances when they are interacting with the managers during earnings calls. If analysts suspect abnormalities, they may modify their questioning strategies. This study will test for differences in the topic composition of all analysts on a call, and for differences within analysts who follow both fraudulent and non-fraudulent companies in the same industry.

3 - An Empirical Study Of Venders’ Profit Under Different Mechanisms On Online Crowdsourcing Platforms

Xiao Han, Shanghai Jiao Tong University, Shanghai, China, hanxiao@sjtu.edu.cn, Pengzhu Zhang

Online crowdsourcing markets not only allow buyers of any size to tap into a large talented pool of workforce but also expand the market reach for vendors. Prior studies on crowdsourcing markets have mainly focused on buyers, and there is a lack of understanding of how vendors survive and evolve in the crowdsourcing markets. This paper aims to fill this gap by taking the perspective of vendors and ask how vendors benifit in crowdsourcing markets under different mechanisms.

4 - The Dark Side Of The Singularity: Can OR/MS Help?

John D Little, Massachusetts Institute of Technology, Sloan School of Management, Room E62-534, Cambridge, MA, 02142, United States, jlittle@mit.edu

The “Singularity” is the point in time when artificial intelligence (AI) exceeds human intelligence. This may occur by putting AI on computers, by biological creation, or by a mixture of both. Some of the people writing about this or developing advanced AI are Victor Vinge, Ray Kurzweil (the Singularity is Near), Tom Malone, Ben Goertzel and Hugo de Garis. The dark side is that most people in this room will be left far behind. Kurzweil notes that AI develops exponentially, whereas most of us extrapolate linearly.

■ WD16

105A-MCC

Optimization and Learning in Urban Delivery

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Lei Zhao, Tsinghua University, Qinghua West Road, Beijing, 100084, China, lzhao@tsinghua.edu.cn

1 - Robust Inventory Management Under Supply And Demand Uncertainties

Jie Chu, McMaster University, Hamilton, ON, Canada, chuj6@mcmaster.ca, Kai Huang

We simultaneously consider demand and supply uncertainties in a robust optimization framework. We first consider a single-station case, then we extend to a multi-echelon network case. The resulting robust counterpart of the network case does not maintain the same difficulty as its nominal problem. Nonetheless, we present an approximation and thus it can be solved more efficiently. We demonstrate the effectiveness of proposed models numerically.

2 - Learning In Multi-stage Rollouts

Saul Toscano-Palmerin, Cornell University, Ithaca, NY, United States, st684@cornell.edu, Peter Frazier

We consider a transportation company choosing routes on which to offer service. Each route has an unknown parametric demand distribution, and we wish to choose routes subject to a budget constraint to maximize total demand. We propose a two-stage optimal learning algorithm, where first we offer service on some routes, and learn from observed demand about demand distributions on other similar routes. Then in a second stage, we offer service on additional routes suggested to be good by the first stage. We demonstrate that this two-stage optimal learning approach captures more demand than a one-stage approach that does not leverage the opportunity to learn.

3 - Optimal Learning In Urban Delivery Resource Allocation

Yixiao Huang, Tsinghua University, 530 Shunde Building, Beijing, 100084, China, huangyx12@mails.tsinghua.edu.cn, Lei Zhao, Warren B Powell, Ilya O Ryzhov

We study knowledge gradient (KG) based optimal learning methods to optimize the urban delivery resource allocation decisions, when the evaluation of such decisions is expansive.

■ WD17

105B-MCC

Nonlinear Optimization Algorithms II

Sponsored: Optimization, Nonlinear Programming

Sponsored Session

Chair: Daniel Robinson, Johns Hopkins University, 3400 N. Charles Street, Baltimore, MD, 21218, United States, daniel.p.robinson@gmail.com

Co-Chair: Frank Edward Curtis, Lehigh University, 27 Memorial Dr, Bethlehem, PA, 18015, United States, frank.e.curtis@gmail.com

Co-Chair: Andreas Waechter, Northwestern University, 2145 Sheridan Road, Evanston, IL, 60208, United States, waechter@iems.northwestern.edu

1 - A Geometry Driven Active-set Method For Elastic-net Minimization

Daniel Robinson, Johns Hopkins University, daniel.p.robinson@gmail.com

We propose an efficient and provably correct active-set based algorithm for solving the elastic net problem. The proposed algorithm exploits the fact that the nonzero entries of the elastic net solution fall into an oracle region, which we use to define and efficiently update an active set. The proposed update rule leads to an iterative algorithm which is shown to converge to the optimal solution in a finite number of iterations. We present experiments on computer vision datasets that demonstrate the superiority of our method in terms of both clustering accuracy and scalability.

2 - A Reduced-space Algorithm For Minimizing L1-regularized Convex Functions

Tianyi Chen, Johs Hopkins University, tchen59@jhu.edu

We present a new method for minimizing the sum of a convex function and an l1-norm regularizer. The main features of the new method include: (i) an evolving set of indices corresponding to variables that are predicted to be nonzero at a solution; (ii) a reduced-space subproblem defined in terms of the predicted support; (iii) conditions that determine how accurately each subproblem must be solved; (iv) a computationally practical condition that determines when the predicted support should be updated; and (v) a reduced proximal gradient step that ensures sufficient decrease. We prove a convergence guarantee for our method and demonstrate its efficiency on a large set of model prediction problems.

3 - R-linear Convergence Rate Of A Limited Memory Steepest Descent Method

Wei Guo, Lehigh University, weg411@lehigh.edu

We provide some theoretical convergence results for a limited memory steepest descent (LMSD) method, proposed by Fletcher, when minimizing strictly convex quadratics. First, we show a finite termination property for the algorithm when there are duplicate eigenvalues. However, our main result shows an R-linear convergence rate for the algorithm when minimizing a strictly convex quadratic of any dimension with any limited memory history length. This extends the R-linear convergence rate of the Barzilai Borwein “two-point step size” method which uses information from only the previous iteration.

■ WD18

106A-MCC

Business Apps

Contributed Session

Chair: Kiel Michael Martin, USAF, 8940 Rochester Dr, Colorado Springs, CO, 80920, United States, c05kielmartin@gmail.com

1 - An Operational Model To Support Cotton Trade In India

Sundaravalli Narayanaswami, I I M, Ahmedabad, 380015, India, sundaravallin@iima.ac.in, Narasimhan Ravichandran

Cotton Corporation of India (CCI) is a government agency created to regulate the market dynamics of cotton trade in India, (a cotton surplus country) to promote and protect the economic interest of cotton growing farmers in India. When there is a demand supply imbalance, CCI operates by appropriate price intervention and procurement of the quantity available to stabilize price. The procured quantity is sold by CCI at an appropriate time to maximize the economic value. The operational expenses are reimbursed by the Union Government. We develop and present simulation based models to facilitate negotiation between the government and CCI on this activity.

2 - Internet Of Things And Smart City

Michael Chuang, SUNY New Paltz, 1 Hawk Drive, New Paltz, NY, 12561, United States, chuangm@newpaltz.edu

Internet of Things have emerged as an enabler in various domains for facilitating business or operations such as its application in smart cities. In this preliminary study, we will review various scenarios where internet of things show potentials in smart city applications, and also opportunities and challenges for Internet of Things to be developed in this area.

3 - Connected Vehicle Analytics For In Vehicle Air Quality Management

Yimin Liu, Mobility Analytics Manager, Ford Motor Company, One American Road, Dearborn, MI, 48121, United States, yliu59@ford.com, Yu Chen, Jinjing Yang, Oleg Gusikhin, Omar Makke, Jeff Yeung

This talk presents a concept of cloud-based system for in-cabin air quality management. It leverages SmartDeviceLink technology to seamlessly integrate smartphone apps with Ford SYNC infotainment system and allow programmatically manage vehicle HVAC (Heating, Ventilation and Air Conditioning) settings. This approach allows integrating advanced connected car technologies, portable after-market sensors and cloud-based analytics into climate control loop.

4 - Sustaining The Drone Enterprise

Kiel Michael Martin, Assistant Professor, USAF, 8940 Rochester Dr, Colorado Springs, CO, 80920, United States, c05kielmartin@gmail.com, Dan Richmond, John Swisher

The Remotely Piloted Aircraft (RPA), colloquially labeled the “drone,” has become iconic of American military campaigns this century. The most salient question concerning these aircraft at the Pentagon today is operational, not ethical: given increasing global demand, how can the United States Air Force (USAF) produce and retain sufficient numbers of pilots to fly these aircraft? As part of a recent effort by the Secretary of Defense to stabilize the RPA enterprise, we developed a dynamic manpower projection model, quantifying the potential impact of myriad initiatives and directly informing new, Air Force-wide RPA policy.

■ WD19

106B-MCC

Advances in Mixed-Integer Programming Theory and Algorithms

Sponsored: Computing

Sponsored Session

Chair: Adolfo Raphael Escobedo, Arizona State University, Brickyard Engineering (BYENG) 553, 699 S Mill Ave, Tempe, AZ, 85281, United States, adolfo.escobedo@asu.edu

1 - Extensions Of Subadditive Duality For Conic Mixed-integer Programs

Diego Moran, Universidad Adolfo Ibañez, dmoran@gatech.edu, Burak Kocuk

In a recent paper it was proven that the subadditive dual for mixed-integer conic program is a strong dual under a strict feasibility requirement. In this paper, we generalize this result by exploring alternative sufficient conditions when strict feasibility is not present. In particular, we prove that in the case of essential strict feasibility and in the case of bounded feasible region, the subadditive dual has zero duality gap. Moreover, we show that the dual is solvable when essential strict feasibility holds while the solvability of the dual problem cannot be guaranteed for bounded feasible regions. Finally, we discuss a relationship between strong duality and cut generating functions.

2 - The Hamiltonian P-median Problem: Complexity And Algorithms

Erick Moreno-Centeno, Department of Industrial and Systems Engineering, Texas A&M University, emc@tamu.edu, Ahmed Mohamed Marzouk, Halit Uster

Given an undirected graph, G, the Hamiltonian p-median problem is to find p cycles partitioning G with minimum cost. This problem is NP-hard for any given value of p; however, the problem’s actual difficulty depends on the value of p. Similarly, the state-of-the-art algorithms outperform each other (or fail altogether) depending on the value of p. We give some insights on these observations. This work is in collaboration with Halit Uster and Ahmed Marzouk, both from Southern Methodist University.

3 - A Quadratic Relaxation For A Dynamic Knapsack Problem With Stochastic Item Sizes

Daniel Blado, H. Milton Stewart School of Industrial and Systems Engineering, Georgia Institute of Technology, deblado@gatech.edu

We examine the stochastic knapsack problem with random item sizes that are realized upon each attempted insertion. The process aims to maximize expected profit and ends after a failed insertion. We investigate dynamic programming-based LP bounds and their gap with the optimal adaptive policy. Our relaxation involves a quadratic value function approximation that encodes interactions between remaining items. We compare the bound to the best known pseudopolynomial bound and contrast their corresponding policies with two greedy policies. We conclude that the quadratic bound is theoretically more efficient than the pseudopolyomial bound yet empirically competitive in value and runtime.

4 - Routing Optimization With Time Windows Under Uncertainty

Yu Zhang, Northeastern University, Shenyang, China, waltyuzhang@gmail.com, Roberto Baldacci, Melvyn Sim, Jiafu Tang

We study an a priori Traveling Salesman Problem with Time Windows under uncertain travel times. We propose a decision criterion for articulating service levels that takes into account both the probability of lateness and its magnitude, and can be applied in contexts where either the distributional information of the uncertain travel times is fully or partially known. The criterion has the computationally attractive feature of convexity that enables us to formulate and solve the problem more effectively. Particularly, we obtain in some cases closed-form solutions to the Benders subproblems.

■ WD21

107A-MCC

Predictive Modeling for Healthcare Applications

Sponsored: Health Applications

Sponsored Session

Chair: Ozgur M Araz, University of Nebraska-Lincoln, CBA 260 1240 R Street, P.O. Box 880491, Lincoln, NE, 68588-0491, United States, oaraz2@unl.edu

1 - Predicting Hospital Admissions From Emergency Department

Ozgur M Araz, University of Nebraska-Lincoln, oaraz2@unl.edu

Emergency departments (EDs) are critical for healthcare services delivery and coordination between EDs and inpatient units are essential for higher quality of service in hospitals. In this study, we are investigating the predictive factors of hospital admissions from the emergency department (ED) in order to inform resource capacity planning for the ED boarding process. We used ED visits data which include demographic and administrative variables from a major hospital in Omaha Metro area and performed analyses using several predictive models, e.g., logistic regression and artificial neural network, to predict admissions from the ED. The predictive accuracy of these models are discussed.

2 - Seasonal Forecasting For Infectious Disease From Multiple Data Sources

Zeynep Ertem, University of Texas at Austin, zeynepsertem@gmail.com, Lauren Meyers, Kai Liu, Ravi Srinivasan

Epidemics of contagious diseases may cause widespread loss in terms of mortality, morbidity, and economic burden. There have been several studies about forecasting focusing on one data source. However, there can be other more data sources that are correlated with an important data source. I will show a problem formulation of forecasting a target data source related to an epidemic using multiple other data sources. I will also present preliminary results for forecasting when no data is available for the target data source in the current season. Furthermore, I will relax this assumption and show results for forecasting when partial data is available for the target data source in the current season.

3 - Psa Screening For Prostate Cancer: A Dynamic Feedback Model To Understand Long Term Trends In Population Screening

Ozge Karanfil, Massachusetts Institute of Technology, Sloan School of Management, Cambridge, MA, United States, karanfil@mit.edu, Hazhir Rahmandad, Jack Homer, John D Sterman

Practice guidelines for routine screening have changed significantly over time and often not followed, with significant over-screening for some tests and under-screening for others. In this study we develop a behaviorally realistic simulation model to explore reasons of this phenomenon. The model is firmly grounded in empirical evidence through collection of quantitative and qualitative data. Our formal theory includes a decision theoretic core around costs and benefits, cognitive and social feedbacks. The model can be used as a guide to understand future effects of policy scenarios and be tested in a systematic fashion to find ways to overcome the policy resistance seen in population screening.

4 - A Queueing Model For Nurse Staffing In Critical Care Outreach Team And Intensive Care Unit

Ali Haji Vahabzadeh, The University of Auckland Business School, Auckland, New Zealand, a.vahabzadeh@auckland.ac.nz, Valery Pavlov

We propose a queueing model of CCOT to examine the effects of this team on the ICU performance and patient outcomes. To gain more insights into the effectiveness of the role of critical care nurses on the ICU utilisation rate and patient outcomes, we analyse different nurse allocation policies between ICU and CCOT. To validate the proposed queueing model, a discrete-event simulation and accordingly an optimisation study have been performed. Finally, the study provides recommendations to hospitals on the functionality of the CCOT and the nurse staffing policy.

■ WD22

107B-MCC

Modeling Organ Allocation System

Sponsored: Health Applications

Sponsored Session

Chair: Naoru Koizumi, George Mason University, 3351 N. Fairfax Drive, MS#3B1, Arlington, VA, 22201, United States, nkoizumi@gmu.edu

1 - Mathematical Optimization And Simulation Analyses For Optimal Liver Allocation Boundaries

Monica Gentili, University of Louisville, Louisville, KY, 40205, United States, monica.gentili@louisville.edu, Naoru Koizumi, Rajesh Ganesan, Chun-Hung Chen

This study combines mathematical programming models and Discrete Event Simulation to advance existing research on organ allocation system and geographic equity and efficiency in liver transplantation system. The main objectives of the study are: (i) to identify key factors determining geographic disparity in kidney transplantation; (ii) to identify optimal locations for both existing and new liver transplant centers (iii) to identify new OPO boundaries and (iv) to test whether the mathematically produced liver allocation system can perform better than the actual system. We will show the results of our combined approach when applied to liver transplantation in USA.

2 - Small Representations Of Big Kidney Exchange Graphs

John Dickerson, Carnegie Mellon University, Pittsburgh, PA, United States, dickerson@cs.cmu.edu, John Dickerson, University of Maryland, College Park, MD, United States, dickerson@cs.cmu.edu, Aleksandr Mark Kazachkov, Ariel Procaccia, Tuomas W Sandholm

Kidney exchanges are organized markets where patients swap willing but incompatible donors. We observe that if the kidney exchange compatibility graph can be encoded by a constant number of patient and donor attributes, fundamental problems in kidney exchange are solvable in polynomial time. We give conditions for losslessly shrinking the representation of an arbitrary compatibility graph. Then, using data from the UNOS nationwide kidney exchange, we show how many attributes are needed to encode real compatibility graphs. The experiments show that, indeed, small numbers of attributes suffice. This has application to optimal pre-transplant immunosuppression policies.

3 - Offer Batching For Organ Placement

Tinglong Dai, Assistant Professor, Johns Hopkins University, 100 International Drive, Baltimore, MD, 21202, United States, dai@jhu.edu, Sommer Gentry, Sommer Gentry, Sridhar R Tayur, David Axelrod, Dorry Segev, Dorry Segev

In this study, we consider an organ procurement organization's problem of determining the optimal batch size of simultaneous offers made to transplantation centers. We model the strategic interaction among transplant centers both within and across batches, leading to structural properties and computational insights.

4 - Redistricting Liver Allocation: Challenges And Extensions

Sommer Gentry, United States Naval Academy, gentry@usna.edu Sommer Gentry, Johns Hopkins University, Baltimore, MD, United States, gentry@usna.edu, Josh Pyke, Eric K Chow, Dorry Segev

Livers for transplant in the U.S. are distributed within eleven regions, and are much more available in some geographic areas, leading to dramatic disparities in transplant rates. We have used redistricting to design novel sharing districts which significantly reduce these geographic disparities. The improved districts might be implemented soon, if concerns about increased transport time for organs and about the variability of organ supply and demand can be addressed. We will explore the efficient frontier of the policy space, trading off organ transport for disparity reduction. We will also discuss a robust formulation of the redistricting problem.

■ WD23

108-MCC

Socially-responsible Healthcare Operations

Sponsored: Health Applications

Sponsored Session

Chair: Priyank Arora, Georgia Institute of Technology, 800 West Peachtree, NW, Atlanta, GA, 30308, United States, priyank.arora@scheller.gatech.edu

1 - Ambulance Routing In Resource Constrained Settings

Milind G. Sohoni, Indian School of Business, milind_sohoni@isb.edu, Lavanya Marla, Achal Bassamboo, Chandrasekhar Manchiraju

Using real-world data we look at optimal dispatch policies and compare those with current best practices. We develop insights and guidelines for practicing managers.

2 - Healthcare Payment Model Impact On Hospital Readmissions

Jon M Stauffer, Texas A&M University, College Station, TX, United States, jstauffer@mays.tamu.edu, Jonathan Helm, Kurt M Bretthauer

We examine the transition from Fee-for-Service (FFS) to pay-for-performance (P4P) reimbursement plans, such as bundled payments and the Hospital Readmission Reduction Program (HRRP). We use a game theory approach to understand how healthcare providers interact to improve their individual contribution margins. Results show that P4P plans do motivate extra readmission reduction effort, but that misalignments can occur between the player's efforts and the minimum total system cost effort. We find that the smaller post-discharge player can be over-motivated to reduce readmissions and that HRRP is not necessary with well-designed bundled payment plans.

3 - Delivering Long Term Surgical Care In Underserved Communities

Ujjal Kumar Mukherjee, University of Illinois at Urbana–Champaign, Champiagn, IL, United States, ukm@illinois.edu, Emily J. Kohnke, Kingshuk K Sinha

How can international NPOs enable the long-term delivery of surgical care in underserved communities? We report findings from a longitudinal field study spanning 11 years conducted at Gansu province of China. We triangulate insights from qualitative and quantitative data analyses to develop and validate an integrative framework that demonstrates how an international NPO's efforts related to affordability, provider-awareness, and access are interdependent, and how the efforts interact and impact the volume and quality of surgeries in underserved communities.

4 - Improving Societal Outcomes In The Organ Donation Value Chain

Priyank Arora, Georgia Institute of Technology, 800 W Peachtree St NW, Atlanta, GA, 30308, United States, priyank.arora@scheller.gatech.edu, Ravi Subramanian

Our paper studies the operational actions of supply-side players in an organ donation value chain (ODVC), namely, the Organ Procurement Organization that coordinates organ recovery activities, and the hospital, where potential cadaveric donors arrive. The main contributions of our work are two-fold: First, while the majority of the literature focuses on the demand side of an ODVC, we develop an analytical model to study the effects of contextual parameters and decisions of the supply-side entities in an ODVC on their respective payoffs and societal outcomes. Second, we recommend Pareto-improving contracts that a social planner can use to help the ODVC achieve socially-optimal performance.

■ WD24

109-MCC

Topics in Resident and Medical Student Scheduling

Sponsored: Health Applications

Sponsored Session

Chair: Amy Cohn, University of Michigan, 1205 Beal Avenue, Ann Arbor, MI, 48109-2117, United States, amycohn@umich.edu

1 - Using Maximally Feasible And Minimally Infeasible Request Sets To Construct Resident Schedules

Brian Lemay, University of Michigan, Ann Arbor, MI, United States, blemay@umich.edu, Amy Cohn, Marina Alex Epelman

When scheduling healthcare providers, it is frequently not possible to satisfy every scheduling request. Multi-criteria objective functions provide one method for overcoming this challenge, but can result in undesirable schedules. We discuss an alternative method for resolving conflicting requests that identifies maximally feasible and minimally infeasible sets of scheduling requests by solving a sequence of optimization problems. We present results based on a resident scheduling problem at a major teaching hospital.

2 - A General Model For Medical Resident Rotation Scheduling

William Pozehl, University of Michigan, pozewil@umich.edu, Amy Cohn

Building annual rotation schedules for medical residents is often extremely challenging for program directors and chief residents. Scheduling requires a complex tradeoff of resident needs, service needs, and a multitude of preferences and requests. We present a general model for automatically constructing these schedules using linear programming and explore algorithms for iteratively improving the measures of schedule quality.

3 - Creating Resident Shift Schedules Under Multiple Objectives By Generating And Evaluating The Pareto Frontier

Young-Chae Hong, University of Michigan, hongyc@umich.edu, Amy Cohn, Marina A Epelman

Preparing a schedule for residents is a complex task, which requires considering a large number of complex rules and multiple conflicting metrics at the same time: patient safety, educational requirements, and resident satisfaction. However, it is not easy for chief residents to quantify weights to trade off metrics or to provide a single objective function. Thus, it is better to provide a set of Pareto schedules to the chief residents and make them choose the most preferable one. This research uses integer programming and a recursive algorithm for generating Pareto schedules to reduce the solution space for chief residents to review and to help elicit their preferences.

4 - A Linear Programming Model For Scheduling Medical School Clinical Experiences

Roshun Sankaran, University of Michigan, Ann Arbor, MI, United States, roshuns@umich.edu, Amy Cohn, Anna Munaco

The University of Michigan Medical School unveiled a new curriculum in 2015 aimed at providing medical students with a sustained balance of science coursework and clinical exposure over their four years via the Initial Clinical Experience (ICE) and M4 Pilot programs. Building schedules for these programs are multi-criteria objective problems that consider constraints unique to each course. Easy-to-use scheduling tools using Open Solver were developed to create optimal group and clinic assignments for each program in order to streamline the scheduling process in the future.

■ WD25

110A-MCC

Logistics IV

Contributed Session

Chair: Jafar Namdar, University of Tennessee, 2109 Laurel Avenue, Knoxville, Knoxville, TN, 37916, United States, jafer.namdar@gmail.com

1 - Designing Robust Beef Supply Chain With Environment And Animal Welfare Costs: Small Or Large Slaughter Facilities

Faisal M. Alkaabneh, Huaizhu Oliver Gao, Cornell University, Ithaca, NY, Contact: fma34@cornell.edu

We consider the problem of designing robust beef supply chain for some regions in New York State by simulating supply and demand side shocks. We developed a Mixed Integer Programming model that decides simultaneously the assignment of beef slaughter facilities to beef feedlots, locating slaughter facilities, and routing of trucks from slaughter facilities to a set of customers. The problem under consideration takes into account environmental costs and animal welfare. We show how the structure of the supply chain changes when considering environmental cost and animal welfare and how the promotion of small slaughter facilities provides more agile and robust network under different scenarios.

2 - Smart Logistic Management

Mostafa Ghafoorivarzaneh, Student, University of Tennessee-Knoxville, 851 Neyland Drive, Room 511, Knoxville, TN, 37996, United States, mghafoor@utk.edu, Roshanak Akram, Rupy Sawhney

In this study, a smart logistic management approach will be introduced. First a set of KPIs will be discussed for logistic management, which are mostly in tactical level of supply chain. At the second step information needed for smart logistic management will be collected and visualized automatically. In the third step a time dependent Periodic VRP will be introduced based on collected information in second step using a meta-heuristic approach. In the last section a heuristic rerouting method will be introduced based on collected information in second and third steps.

3 - A Robust Model Predictive Control Approach For Logistics Planning In Response To An Earthquake

Yajie Liu, Associate Professor, National University of Defense Technology, Changsha, 410073, China, liuyajie@nudt.edu.cn, Hongtao Lei, Jianmai Shi

Making transportation plans usually faces many challenges in response to earthquakes, especially when the post-disaster environment is dynamic and uncertain. This study provides a model predictive control (MPC) approach combined with robust optimization (RO) to the problem of efficiently transporting both commodities to affected areas and injured people to hospitals in post-disaster stage, in which the MPC approach is utilized to adjust to frequent updated information and RO is used to deal with uncertainties on each decision making point. At the end, a numerical example demonstrates the feasibility and effectiveness of our proposed approach.

4 - Designing A Resilient Supply Chain Network

Jafar Namdar, University of Tennessee, 2109 Laurel Avenue, Knoxville, Knoxville, TN, 37916, United States, jafer.namdar@gmail.com, Rapinder Sawhney, Nooshin Hamidian

This paper investigates different sourcing strategies to achieve supply chain resilience under disruptions aiming for a deeper understanding of how supply chain characteristics are related to resilience and how to better support disruption planning and mitigation. Specifically, we consider different coping strategies, including a single sourcing versus multiple sourcing, signing contract with backup supplier, spot purchasing, collaboration and visibility.

■ WD26

110B-MCC

Information Systems III

Contributed Session

Chair: Benjamin Schooley, Assistant Professor, University of South Carolina, 1301 Gervais Street, Columbia, SC, 29201, United States, schooley.ben@gmail.com

1 - Digital Ecosystem Competition, To Open Or To Close?

Chao Ding, Assistant Professor, KK Leung 807, The University of Hong Kong, Pok Fu Lam, Hong Kong, chao.ding@hku.hk

IT firms are currently striving to build their own digital empire of ecosystem that profit from sales of both hardware/system and content/service. This study sets under the context of duopoly ecosystems and examines their content/service offering strategies and pricing strategies.

2 - A Quasi Experiment Using Social Network Approach To Effects Of Trust Building In Sharing Economy

Shivom Aggarwal, Instututo de Empresa S.L., Instututo de Empresa S.L., IE Business School, Calle de Maria de Molina, 12 Bajo, Madrid, 28006, Spain, dr.shivom@gmail.com, Gautam Ray

Trust is inherent in the success of Sharing economy business models, but how building trust affects such success poses a crucial issue for firms competing with sharing economy business models. We analysed a longitudinal data of bike sharing systems across several cities using a social network approach. We found that trust helped in increasing the overall revenues of a given station, but the average revenue per bike decreased significantly. The study discusses the implications and remedial possibilities based on the results.

3 - The Effect Of Ambidextrous Developers On Open Source Project Success

Orcun Temizkan, Ozyegin University, Istanbul, Turkey, orcun.temizkan@ozyegin.edu.tr, Ram Kumar

Open Source Software (OSS) development is an important, yet poorly understood type of software development with high project failure rates. We analyze a sample of real OSS projects to better understand project success. We argue that there are different types of developers and study their effects on success. We argue that developers can be classified into non-ambidextrous and different types of ambidextrous developers. Our results illustrate direct and interaction effects that ambidextrous developers have on project success and the importance of having multiple types of ambidextrous developers in projects.

4 - Effects Of Health Information Exchange On The Process Of Care, Patient Care Delivery, Administrative Productivity, And Population Health Outcomes

Benjamin Schooley, Assistant Professor, University of South Carolina, 1301 Gervais Street, Columbia, SC, 29201, United States, schooley.ben@gmail.com, Sue Feldman, Neset Hikmet

Health information exchange (HIE) is expected to transform the U.S. healthcare system through access to patient data from electronic health records across organizational boundaries - for the purpose of supporting care provision to improve care quality and population health. However, relatively few of the more than 100 operational U.S. HIE's have been the subject of published evaluations. We surveyed Virginia healthcare providers to assess perceived value of HIE, including impacts on the process of care, patient care delivery, information quality, and population health outcomes. Perspectives differ based on organizational, medical specialty, and prior experience characteristics.

■ WD27

201A-MCC

Empirical Healthcare Operations

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Diwas S KC, Emory University, Atlanta, GA, United States, diwas.kc@emory.edu

1 - The Effects Of Discrete Workshifts On Non-terminating Queues

Robert Batt, University of Wisconsin, bob.batt@wisc.edu, Diwas S KC, Bradley R Staats, Brian W Patterson

While an emergency department is a non-terminating queue, it is staffed by care providers working discrete workshifts. We examine how productivity changes over the workshift. Further, because care providers work fixed-duration shifts, they sometimes must hand off care of in-process patients to another provider. We examine the impact these handoffs have on treatment time and revisit rate. Using simulation, we show that policies that prohibit starting new patients near the end of the shift can lead to improved system throughput.

2 - A Near-term Mortality Indicator For Terminal Cancer Patients Using High Frequency Medical Data

Donald Lee, Yale University, New Haven, CT, United States, donald.lee@yale.edu, Edieal J Pinker

Although end of life cancer care accounts for a significant portion of the costs of all cancer care, it often fails to improve quality or quantity of life. Yet, oncologists consistently overestimate the chances of survival, leading to suboptimal delays in the transition to hospice care. To more accurately assess mortality risk, we develop a bedside statistical tool that utilizes high frequency EMR data to predict near term mortality. Projected savings from averting excessive curative interventions suggest significant inefficiencies in current practice. Joint work with the Smilow Cancer Centre.

3 - A Machine Learning Approach For Personalized Health Care Outcome Analysis

Guihua Wang, Ross School of Business, University of Michigan, Ann Arbor, MI, United States, guihuaw@umich.edu, Jun Li, Wallace J Hopp

Using a patient-level data set across 35 hospitals for cardiovascular surgeries in New York, we first provide empirical evidence that the quality gaps between hospitals are heterogeneous for subgroups of patients. We then use a machine learning approach to identify subgroups of patients that have large or small quality gaps. After that, we estimate the quality gaps between a hospital and the state average for each subgroup of patients to derive patient-centric information. Lastly, we show that providing patient-centric information not only helps patients choose providers but also helps hospitals identify areas for improvement and payers design cost-effective payment programs.

4 - Are Patients Patient? The Effect Of Universal Healthcare On Emergency Department Visits

Diwas KC, Emory University, diwas.kc@emory.edu

We study a natural policy experiment to examine the impact of universal healthcare on emergency departments. We find that the policy has differential effects on hospitals. Compared to EDs with high pre-policy workloads, we observe a relative increase in volume at EDs with lower levels of pre-policy workload.

■ WD28

201B-MCC

Product Strategies and Channel Structure in Supply Chain Management

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Laurens G Debo, Dartmouth College, Hanover, NH, United States, laurens.g.debo@tuck.dartmouth.edu

Co-Chair: Cuihong Li, University of Connecticut, Storrs, CT, United States, cuihong.li@uconn.edu

1 - Salesforce Incentives For Managing Product Returns

Rashmi Sharma, Pennsylvania State University, University Park, PA, 16802, United States, rashmi.sharma@psu.edu, Aydin Alptekinoglu

We study a setting where product sales and returns are effort-dependent and the selling activity is conducted by a salesforce. We investigate the effect of salesforce behavior on net sales and compare different incentive schemes to identify optimal incentive strategies.

2 - Returns Policies For Overstock And Consumer Returns In Distribution Channels

Meng Li, University of Massachusetts, Amherst, MA, United States, meng.li@umass.edu, Yunchuan Liu

This paper studies the interactions between an upstream manufacturer and competing downstream retailers on offering returns policies to retailers and end-consumers respectively. The effects of channel structure, demand uncertainty, and retail competition are studied in a unified model covering both overstock returns and consumer returns.

3 - Retail Market Power: A Supplier-side Perspective

Shuya Yin, University of California at Irvine, Irvine, CA, United States, shuya.yin@uci.edu, Yuhong He, Saibal Ray

Does a supplier prefer that its downstream retailers are more balanced in terms of their market power or that one of them is dominant, especially when the market power might be correlated to their bargaining powers? In this paper we address this issue and establish the supplier's preference for a monopoly value chain as well as when there is value chain competition.

4 - Discretionary Service Line Design With Heterogeneous Customers

Cuihong Li, University of Connecticut, cuihong.li@uconn.edu, Laurens G Debo

We study discretionary service line design facing heterogeneous customers. For discretionary services, the longer the service time, the higher is the quality of the service. In the presence of variability, longer service times also create more congestion. Hence, a service firm needs to trade off congestion costs with value creation. We find that self-selection of heterogeneous customer might lead to distortion of the high-quality service, contrary to the classic product line design result of Moorthy (1984).

■ WD31

202C-MCC

Services in the Sharing Economy

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Laurens Debo, Dartmouth College, Tuck School of Business, Hanover, NH, 03755, United States, Laurens.G.Debo@tuck.dartmouth.edu

Co-Chair: Luyi Yang, University of Chicago, Booth School of Business, Chicago, IL, 60637, United States, luyi.yang@chicagobooth.edu

1 - When Is Capacity Trading Among Consumers A Win-win To Consumers And Service Providers?

Behrooz Pourghannad, University of Minnesota, Minneapolis, MN, United States, behrooz@umn.edu, Saif Benjaafar, Jian-Ya Ding

We study a setting where consumers can trade among themselves unused capacity they purchased from a service provider (e.g., excess data on a mobile data plan). We examine implications for service provider profits and consumer surplus.

2 - Allocating Capacity In Bikeshare Systems

Daniel Freund, Cornell University, Ithaca, NY, 14850, United States, df365@cornell.edu, Shane Henderson, David B Shmoys

A Bikeshare system (BSS) allows users to rent and return a bike at any station within the system. The amount of usage data BSSs collect has increased greatly in the last decade, allowing us to develop data-driven methods to support their operations. In this talk we extend a continuous-time Markov chain model to allocate docks within a BSS so as to minimize the expected number of out-of-stock (OOS) events. We compute that quantity & efficiently find the allocations of bikes and docks that minimize it both over a finite horizon & at steady-state. Our work is used by NYC Bikeshare to redistribute bikes & (re-)allocate docks.

3 - Skill Screening In Large-scale Service Marketplaces

Eren Basar Cil, University of Oregon, erencil@uoregon.edu, Gad Allon, Achal Bassamboo

We consider a large-scale service marketplace where the moderating firm can run two skills tests on agents to assess if their skills are above certain thresholds. Our main objective is to evaluate the effectiveness of skill screening as a revenue maximization tool. We find that skill screening leads to negligible revenue improvements in marketplaces where agent skills are highly compatible. As the compatibility of agent skills weakens, we show that the firm starts to experience as much as 25% improvement in revenue from skill screening. Apparently, the firm can reap the most of these substantial benefits when it runs only one test.

■ WD32

203A-MCC

Risk Analysis

Contributed Session

Chair: David S Kim, Professor, Oregon State University, 204 Rogers Hall, School of Mech., Industrial and Mfg Eng., Corvallis, OR, 97331-2407, United States, david.kim@oregonstate.edu

1 - Uncertainty, Entropy, And Ambiguity As Risk Measures In Decision Modeling For Portfolio Optimization

David F. Rogers, University of Cincinnati, Department of Operations, Business Analytics, and Information Systems, Carl H. Lindner College of Business, 2925 Campus Green Drive, Cincinnati, OH, 45221-0130, United States, David.Rogers@UC.edu, George G Polak

For a portfolio optimization setting, the risk from uncertain outcomes is typically considered. Other risk measures, including the choice of how to best employ the state-space probabilities and how to consider alternative probability functions are also important. Information entropy is incorporated for measuring the risk associated with the stratification of state-space probabilities resulting in convex integer optimization models with entropy employed as either the objective to minimize or as a constraint with a maximum return objective.

2 - Quantifying The Contribution Of Seawalls To Mitigating Tsunami Damage

Tom M Logan, PhD Pre-Candidate, University of Michigan, 1205 Beal Avenue, Ann Arbor, MI, 48109, United States, tomlogan@umich.edu, Jeremy D Bricker, Seth Guikema

Seawalls are commonly used to defend against tsunamis, making it is essential we understand whether they truly mitigate damage. The north-east of Japan has been stuck by four tsunamis in the past 110 years. A model combining a cellular automaton and hydrodynamic models simulates how land development hypothetically changes with time and under different seawall height options. The insights will indicate which scenarios they provide physical protections and which scenarios require alternative action.

3 - Sample Sut Of Sample Inference Based On Wasserstein Distance

Yang Kang, PhD Candidate, Columbia University, 1255th Amsterdam Ave SSW, RM901, New York, NY, 10027, United States, yangkang@stst.columbia.edu, Jose Blanchet

We present a novel inference approach which we call Sample Out-of-Sample (or SOS) inference. Our motivation is to propose a method which is well suited for data-driven stress testing, in which emphasis is placed on measuring the impact of (plausible) out-of-sample scenarios on a given performance measure of interest (such as a financial loss). The methodology is inspired by Empirical Likelihood (EL), but we optimize the empirical Wasserstein distance (instead of the empirical likelihood) induced by observations. From a methodological standpoint, our analysis of the asymptotic behavior of the induced Wasserstein-distance profile function shows dramatic qualitative differences relative to EL.

4 - Destructive Testing Gauge Capability Analysis

David S Kim, Professor, Oregon State University, 204 Rogers Hall, School of Mech., Industrial and Mfg Eng., Corvallis, OR, 97331-2407, United States, david.kim@oregonstate.edu, Xinyu Luo

This research examines the current state-of-the-art in gauge capability analysis for destructive testing. Results are then presented that extend the specific destructive testing situations where gauge repeatability can be estimated.

■ WD35

205A-MCC

Retail Analytics & Optimization

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Tulay Flamand, University of Massachusetts Amherst, Isenberg School of Management, Amherst, MA, 01003, United States, varol@som.umass.edu

1 - Store-wide Shelf Space Analytics To Optimize Impulse Buying

Tulay Flamand, University of Massachusetts Amherst, Amherst, MA, United States, varol@som.umass.edu, Ahmed Ghoniem, Bacel Maddah

We address a store-wide retail shelf space allocation problem with the objective of promoting impulse buying. Basket data analysis is conducted using real data in order to calibrate a predictive model of in-store traffic. This predictive model is then embedded in a non-linear mixed-integer model in order to prescribe shelf space solutions that maximize impulse buying.

2 - Pricing And Inventory Decisions Of an Assortment Under Equal Profit Margins

Bacel Maddah, American University of Beirut, Bliss Street, Beirut, Lebanon, bacel.maddah@aub.edu.lb, Hussein Tarhini, Melanie Jabbour

We consider the interdependent decisions on inventory and pricing of substitutable products in an assortment. Within a newsvendor-type supply setting, we analyze the joint pricing and inventory decision problem of the retailer under the assumption that all products have equal profit margins. We derive several concavity and monotinicity results under two common consumer choice models, the logit and the nested-logit. We also present an extensive numerical study testifying to the near-optimlity of equal-margin pricing.

3 - Online Assortment Optimization When Customers Refine Their Search

Zhichao Feng, The University of Texas at Dallas, Richardson, TX, 75080, United States, zxf140830@utdallas.edu, Dorothee Honhon, Shengqi Ye

When shopping online, a consumer often searches a keyword and checks the products displayed by the retailer. In many cases, the retailer has numerous products matching the keyword, with different features and functionalities, but is only able to show a subset of them due to limited displaying space. The assortment shown by the retailer influences the consumer's decision to buy or not. In addition, when the consumer is not familiar with the product category, the assortment may trigger interest in a specific product feature, leading the consumer to refine her search, and focus only on products with this feature. Taking this into consideration, we study the online retailer's optimal assortment decision.

4 - Flexible Break Assignment Problem For Ground Handler Shift Scheduling

Youngbum Hur, Graduate Research Assisstant, The University of Texas at Austin, 1 University Station C2200, United States, youngbum.hur@utexas.edu, Jonathan F Bard, Ferdinand Kiermaier, Markus Frey

The purpose of this paper is to investigate the benefits that flexibility offers in daily shift scheduling. The different forms of flexibility considered include shift start times, the number of breaks, break lengths, and break placement. Four related mixed-integer programming models are developed and used to compare break scheduling in advance and in real-time for various shift and break profiles. Tests were performed using demand data for ground handlers at a major European airport.

■ WD36

205B-MCC

Payment Models in Healthcare

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: Hamed Mamani, University of Washington, Seattle, WA, United States, hmamani@uw.edu

Co-Chair: Shima Nassiri, University of Washington, ISOM, Foster School of Business, Seattle, WA, 98195, United States, shiman@uw.edu

1 - The Impact Of Reimbursement Policy On Patient Welfare, Readmission Rate And Waiting Time In A Public Healthcare System: Fee-for-service Vs. Bundled Payment

Yulan Wang, Hong Kong Polytechnic University, yulan.wang@polyu.edu.hk, Christopher S Tang, Pengfei Guo, Ming Zhao

We examine two commonly used reimbursement schemes: Fee-For-Service (FFS) and Bundled Payment (BP) from aspects of congestion (waiting times patients incur) and service quality (measured by readmission rate). We consider a three-layer public health care system including a funder who decides the reimbursement payment, a representative health care provider who decides the service rate (affecting service quality) and patients who decide to join or balk based on their net utility. We determine equilibrium outcomes and find that, in general, BP scheme improves patient welfare and service quality but FFS scheme results in less congestion. Under certain conditions, the two are equally efficient.

2 - Bundled Payment Vs. Fee-for-service: Impact Of Payment Scheme On Performance

Shima Nassiri, University of Washington, Seattle, WA, United States, shiman@uw.edu, Elodie Adida, Hamed Mamani

Healthcare reimbursements in the US have been traditionally based upon a fee-for-service (FFS) scheme, providing incentives for high volume of care. The new healthcare legislation tests new payment models that remove such incentives, such as the bundled payment (BP) system. Our interest is in analyzing the effect of different payment schemes on outcomes such as the presence and extent of patient selection, the treatment intensity, the provider's utility and financial risk, and the total system payoff. We design two payment systems, hybrid payment and stop-loss mechanisms, that alleviate the shortcomings of FFS and BP and may induce system optimum decisions in a complementary manner.

3 - Bundled Payment Implementation via Market Segmentation

Ruben Proano, Rochester Institute of Technology, rpmeie@rit.edu

This talk illustrates the opportunities of applying market segmentation and tiered pricing to the implementation of bundled payments in replacement of fee-for-service for the reimbursement of healthcare expenses. Relying on a cluster-based episode construcion approach, the study shows how market segmentation and tiered pricing can reduce the risks of over- and under- paying for claims facilitating the adoption ob bundled payment by providers and payers.

4 - Incentive Design For Coordination In Care Of Chronic Patients

Sasa Zorc, INSEAD, Singapore, Singapore, sasa.zorc@insead.edu, Stephen E Chick, Sameer Hasija

We consider contracting issues in care of chronic patients. The government contracts with several healthcare providers in effort to maximise public health minus the cost. We model the decision of whether to contract with individual providers or alliances of providers, as well as which contract type to use. We show that with risk neutral agents, first best can be achieved with both options by using outcomes adjusted capitation or per-patient contracts. We also examine adverse effects arising from fragmentation of care: free riding within an alliance and collusion between individual providers. We show that individual outcomes-adjusted capitation contracts perform best under these effects.

■ WD37

205C-MCC

Topics in Sustainable Operations and the Role of Information

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Leon Valdes, Massachusetts Institute of Technology, 77 Massachusetts Ave, Cambridge, MA, 02139, United States, lvaldes@mit.edu

1 - To Recycle Or Not: An Analysis Of The Environmental And Financial Impact Of Recycling

Hailong Cui, University of Southern California, Los Angeles, CA, United States, Hailong.Cui.2019@marshall.usc.edu, Greys Sosic

We evaluate the impact of recyclability on the emissions through the products' life cycle and derive conditions for reduction of long-run average emissions. We investigate the underlying costs imposed on the supply chain and on the society to understand optimal decisions for decentralized (manufacturer or government-driven recycling) and centralized cases.

2 - How Do You Pay Your Electricity Bill? Payment Methods And Energy Conservation

Christian Blanco, University of California-Los Angeles, Los Angeles, CA, 90095, United States, cblanco@anderson.ucla.edu, Magali Delmas

We explore whether different payment methods may make electricity cost more or less salient. We then look at whether the introduction of smart meters can complement different payment methods and lead to changes in electricity consumption. We explore this using data from the largest electric utility company in the US.

3 - Are Hazardous Substance Rankings Effective? An Empirical Investigation Of Changing Assessments Of The Relative Hazards Of Chemicals And Voluntary Emissions Reductions

Wayne Fu, Georgia Institute of Technology, Atlanta, GA, 30308, United States, wayne.fu@scheller.gatech.edu, Basak Kalkanci, Ravi Subramanian

Governmental organizations such as the ATSDR provide extensive information on potential hazards of industrial chemicals to public. We investigate the link between such information dissemination and voluntary environmental efforts of firms and the implications of firms' operational characteristics on the extent and the nature of the efforts. Finding that increases in assessed hazard level are associated with greater reductions in emissions, we suggest that the effect of information dissemination is significant. We also find evidence that operational leanness may limit the ability of facilities to reduce emissions in response to increases in assessed levels of hazard.

4 - Investing In Supplier Social Responsibility And Supply Chain Visibility

Leon Valdes, Massachusetts Institute of Technology, lvaldes@mit.edu, Tim Kraft, Yanchong Zheng

We study a manufacturer's decisions when the social responsibility (SR) performance of her supplier cannot be perfectly observed and where only the supplier can directly impact SR. However, the manufacturer can: (i) increase her visibility into the supplier's performance; and (ii) invest in the supplier's capabilities to improve SR. A third party may disclose SR information to consumers, affecting demand. Our results provide insights into the impact of supply chain visibility on the supplier's and the manufacturer's strategies. We identify conditions under which the manufacturer is more likely to invest in visibility and we show that higher visibility does not always translate into greater SR.

■ WD38

206A-MCC

General Session II

Contributed Session

Chair: Gang Wang, University of Massachusetts Dartmouth, 285 Old Westport Rd, Room 214, North Dartmouth, MA, 2747, United States, gwang1@umassd.edu

1 - Pricing Decision Model For New, Upgraded And Remanufactured Short-life Cycle Products

Che-Wei Yeh, PhD Student, National Taiwan University, Floor 9, No.1, Sec. 4, Roosevelt Road, Taipei, Taiwan, d99741008@ntu.edu.tw

Despite remanufacturing short life cycle products is rewarding economically as well as environmentally, very little is known about modeling upgraded decisions for products with short life cycle. In this paper, we develop a closed loop supply chain model that optimizes the price for new, upgraded and remanufactured products where demands are time-dependent and price sensitive. Using numerical analysis, the findings give reasonable results and have important implications for the impact of demand's speed of change to the optimal prices.

2 - Effects Of The Adopting Distillers Grain In The Feed Ration For Swine Industry In Argentina

Maria Celeste De Matteis, Graduate Assistant, University of Tennessee, Knoxville, TN, United States, mdematt1@vols.utk.edu, Tun-Hsiang Edward Yu

Driven by the Biofuels Law enacted in 2006, the production of corn-based ethanol in Argentina has surged over the past decade. Distillers grain, a co-product of corn ethanol, is expected to become an important feedstuff in Argentine livestock feed ration because of its high content of protein and other nutrition. Our study aims to evaluate the potential impact of adopting this emerging feedstuff in the feed ration for Argentine hog industry. A multi-objective model will be developed incorporating both feedstuff cost and animal performance in the decision criteria.

3 - Integrated Operations Scheduling Under Different Penalty Terms

Gang Wang, University of Massachusetts Dartmouth, 285 Old Westport Rd, Room 214, North Dartmouth, MA, 02747, United States, gwang1@umassd.edu

This paper studies an integrated operations scheduling problem under service level contracts over a capacitated supply chain and considers three different scheduling sub-problems in terms of the types of service level: 1) The first sub-problem takes into account no specified service level (e.g., one-time transaction in spot contracts); 2) the second is regarding single service level contracts, where penalty function is convex; and 3) the third deals with multiple service level contracts.

■ WD39

207A-MCC

Learning and Model Uncertainty in Stochastic Systems

Sponsored: Applied Probability

Sponsored Session

Chair: Yuan Zhong, Columbia University, New York, NY, 10025, United States, yz2561@columbia.edu

1 - Staffing Service Systems With Distributional Uncertainty

John Hasenbein, University of Texas-Austin, jhas@mail.utexas.edu, Ying Chen

We examine the problem of staffing service systems in which either the exact arrival rate or even the arrival rate distribution is unknown. The decision maker's goal is to minimize staffing costs while satisfying quality-of-service constraints on the probability that a customer is delayed. We use bounds related to the Halfin-Whitt approximation and prove asymptotic optimality of the proposed methods.

2 - Ambiguous Partially Observable Markov Decision Processes

Soroush Saghafian, Harvard University, Cambridge, MA, United States, soroush_saghafian@hks.harvard.edu

We present a generalization of Partially Observable Markov Decision Processes (POMDPs) termed Ambiguous POMDP (APOMDP), which allows the decision maker to take into account inevitable model ambiguities. We establish various structural results, and discuss new opportunities for superior decision-making in applications such as machine replacement, medical decision-making, inventory control, revenue management, optimal search, bandit problems, and dynamic principal-agent settings.

3 - How Being Distributionally Robust Can Improve Learning In High Dimensions?

Karthyek R Murthy, Columbia University, New York, NY, United States, karthyek@gmail.com, Jose Blanchet, Yang Kang

In learning problems where the number of training samples is smaller than the ambient dimension, usual empirical risk minimisation may not be enough to find the best fit. We introduce RWPI, a novel learning methodology that is aimed at enhancing out-of-sample performance in such settings. By casting the learning problem as an optimization problem in the presence of model uncertainty, we recover a wide range of regularisation procedures (such as generalized Lasso, SVM) as particular cases. Further, an asymptotic analysis of a suitably defined profile function allows to optimally select the regularisation parameter. We shall discuss this optimality in the context of generalized Lasso.

4 - Learning And Hierarchies In Service Systems

Michail Markakis, Universitat Pompeu Fabra, Barcelona, Spain, mihalis.markakis@upf.edu

We consider a service systems with servers that have different capabilities and tasks whose types are ex-ante unknown. Information about a task's type can only be obtained while serving it. We show that the system's stability region depends on the entire distributions of service times, and that heavier tails cause greater performance loss. We also consider endogenizing the servers' capabilities, and find that optimal designs have a "hierarchical" structure: all tasks are initially routed to the least skilled servers and progressively move to more skilled ones, if necessary. Comparative statics show that uncertainty in task types leads to higher training costs and less specialized server pools.

■ WD40

207B-MCC

Applied Probability and Machine Learning III

Sponsored: Applied Probability

Sponsored Session

Chair: Daniel Russo, Northwestern University, 2001 Sheridan Road, Evanston, IL, 60208-2009, United States, dan.joseph.russo@gmail.com

1 - Collaborative Filtering With Low Regret

Guy Bresler, MIT, Cambridge, MA, United States, guy@mit.edu, Devavrat Shah, Luis Voloch

Empirical evidence suggests that item-item collaborative filtering (CF) works well in practice. Motivated to understand this, we provide a framework to design and analyze recommendation algorithms. The setup amounts to online binary matrix completion, where at each time a user requests a recommendation and the algorithm chooses an entry to reveal in the user's row. The goal is to maximize the number of +1 entries revealed at any time. We analyze an item-item CF algorithm that can achieve fundamentally better performance as compared to user-user CF. Good "cold-start" performance is achieved by quickly making good recommendations to new users about whom there is little information.

2 - Predicting The Unseen Mutations Provides A Roadmap For Precision Medicine.

James Zou, Stanford University, Palo Alto, CA, 02139, United States, jamesyzou@gmail.com

A fundamental question in genomics is to estimate the frequency distribution of all the genetic variants in a population. This is a challenging task because we have sequenced the genomes of relatively few individuals, and most existing mutations are not observed in our samples. We give a non-parametric algorithm to estimate the frequency distribution of all the variants, including the ones that not seen in the sequenced individuals. We prove that also algorithm has strong finite-sample convergence guarantees, and applied it to one of the largest human sequencing data. Our estimates provide a roadmap for the discovery rate of large sequencing efforts, including the Precision Medicine Initiative.

3 - Causal Inference With Random Forests

Stefan Wager, Stanford University, Stanford, CA, United States, swager@stanford.edu

Many scientific and engineering challenges, ranging from personalized medicine to customized marketing recommendations, require an understanding of treatment heterogeneity. We develop a non-parametric causal forest for estimating heterogeneous treatment effects that extends Breiman's widely used random forest algorithm. Given a potential outcomes framework with unconfoundedness, we show that causal forests are pointwise consistent for the true treatment effect, and have an asymptotically Gaussian and centered sampling distribution. We also propose a practical estimator for the asymptotic variance of causal forests.

■ WD41

207C-MCC

Risk in Financial Markets

Sponsored: Financial Services

Sponsored Session

Chair: Daniel Mitchell, University of Minnesota, University Avenue, Minneapolis, MN, 55455, United States, damitche@umn.edu

1 - Systemic Risk Of High-frequency Trading

Agostino Capponi, Columbia University, ac3827@columbia.edu

We introduce a dynamic high-frequency trading model which accounts for the costs of overnight inventory. The HFT optimally and continuously chooses bid and ask prices in order to maximize end-of-day expected profits, net of inventory costs. The model pits the HFT's profit maximizing motives against its desire to avoid carrying inventory overnight, which effectively generates a tradeoff. We show that the tradeoff, which is unique to the business model of HFTs, leads to destabilizing price dynamics.

2 - Determining Estimation Risk Using Distributional Properties Of Portfolio Weights

Luis Chavez-Bedoya, Esan Graduate School of Business, lchavezbedoya@esan.edu.pe

Using the expected loss function of Kan and Zhou (2007), we find closed-form expressions to determine the impact of parameter uncertainty on the performance of the minimum-variance and the optimal mean-variance portfolio but when these portfolios are fully invested in risky assets. The mathematical proofs of the closed-form expressions are based on distributional properties of the portfolio weights instead of distributional properties of the sample mean and covariance matrix. In the numerical experiments, we assess the impact on estimation risk when the risk-free asset is not included in the portfolio construction.

3 - Modeling Limit Order Books With Neural Networks

Justin Sirignano, Stanford, jasirign@gmail.com

This paper develops a new neural network architecture for modeling spatial distributions (i.e., distributions on R^d) which is computationally efficient and takes advantage of local spatial structure. We find statistical evidence for local spatial structure in limit order books, motivating the new neural network's application to limit order books. The neural network is trained and tested on nearly 500 stocks. The neural network uses information from deep into the limit order book (i.e., many levels beyond the best bid and best ask). Techniques from deep learning such as dropout are employed to improve performance. Due to the computational challenges associated with the large amount of data, GPU clusters are used for training. The "spatial neural network" is shown to outperform other models such as the naive empirical model, logistic regression (with nonlinear features), and a standard neural network architecture.

4 - Liquidation Risk

Daniel Mitchell, University of Minnesota, damitche@umn.edu, Jingnan Chen

We examine risk management in a portfolio liquidation setting. We consider a model of market and limit order execution and investigate trading profiles of risk averse traders. Our primarily interest is to determine when market orders are preferred to limit orders in execution. Market orders can reduce variation in price but also come at a higher expected cost.

■ WD42

207D-MCC

Sharing Economy, Mechanism Design and Networks II

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Ozan Candogan, University of Chicago, Chicago, IL, United States, ozan.candogan@chicagobooth.edu

Co-Chair: Santiago Balseiro, Duke University, Durham, NC, United States, sbalseiro@gmail.com

1 - The Impact Of Platform Control Capabilities On The Performance Of Rideshare Networks

Zhe Liu, Columbia Business School, 511 W 112th Street, Apt 24C, New York, NY, 10025, United States, liuzhe821@gmail.com, Costis Maglaras, Philipp Afeche

We are motivated by the rise of rideshare platforms such as Uber and Lyft, that match service providers (drivers) with demand (riders) over a network. A key challenge is that such platforms face supply/demand imbalances. To manage performance, the platforms have several control capabilities, specifically, they can decide a) which demand requests to accept at each location, and b) which capacity to reposition from one location to another. This paper studies within a stylized network model the impact of these control levers on key performance measures, including the revenue rate, congestion, lost demand (riders), and idleness time (drivers), taking into account the network's flow dynamics.

2 - Competitive Equilibrium And Trading Networks: A Network Flow Approach

Ozan Candogan, University of Chicago, ozan.candogan@chicagobooth.edu, Markos Epitropou, Rakesh Vinay Vohra

In trading networks where agents exchange indivisible goods (or indivisible contracts), recent literature has established that under a full substitutability condition on agents preferences, a competitive equilibrium exists. Moreover, competitive equilibria of trading networks are also stable outcomes, which is equivalent to the seemingly weaker chain stability condition. This paper's contribution is to show that under the full substitutability assumption, all these results can be obtained simply and directly from the optimality conditions of a generalized submodular flow problem in an appropriately defined network.

3 - Mean Field Equilibria For Competitive Exploration In Resource Sharing Settings

Krishnamurthy Iyer, Cornell University, kriyer@cornell.edu, Pu Yang, Peter Frazier

Inspired by crowdsourced transportation services and other location-based activities, we consider a model comprising of a group of nomadic agents and a set of locations each endowed with a dynamic stochastic resource process. Each agent derives a periodic reward based on the overall resource level at her location, and the number of other agents there. Each agent is free to move between locations, and at each time decides whether to stay at the same location or switch to another one. We study the equilibrium behavior of the agents as a function of dynamics of the stochastic resource process and the nature of resource sharing in the limit where the number of agents and locations increase proportionally.

4 - On The Efficacy Of Static Prices For Revenue Management In The Face Of Strategic Customers

Yiwei Chen, Singapore University of Technology and Design, Singapore, Singapore, ywchen@mit.edu, Vivek Farias

We consider a revenue management problem wherein a monopolist seller seeks to maximize revenues from selling a fixed inventory of a product to customers who arrive over time. Customers are forward looking and strategize their times of purchase. We consider a general class of customer utility models that allow for multi-dimensional customer types. We also allow for a customer's disutility from waiting to be positively correlated with his valuation. We show that static prices are asymptotically optimal. We further show that irrespective of regime, an optimally set static price captures at least 63.2% of revenue under an optimal dynamic mechanism.

■ WD44

208B-MCC

Advances In Risk Modeling Theory: Nonlinear Systems

Sponsored: Decision Analysis

Sponsored Session

Chair: Ghorbanmohammad Komaki, Case Western Reserve University, Cleveland, OH, United States, gxk152@case.edu

Co-Chair: Behnam B Malakooti, Case Western Reserve University, Cleveland, OH, United States, bxm4@po.cwru.edu

1 - Storage Impact On Micro-grids With Renewable Energy Sources

Shaya Sheikh, New York Institute of Technology, 1855 Broadway, New York, NY, United States, ssheik11@nyit.edu

Integrating renewable energy sources and energy storages in micro-grid has captured the attention of researchers in recent years. We investigate the impact of energy storages on energy costs and thermal comfort in a micro-grid with heterogeneous buildings. Our proposed model features two electricity generators (e.g., wind and solar). Due to the stochastic nature of both renewable energy sources and energy demand, a simulation approach is proposed to analyze this model. The proposed model reduces total energy cost while it achieves the thermal comfort requirements of residents.

2 - A Brief Survey Of Recent Decision-making Models And Experiments

Mohammad Komaki, Case Western Reserve University, komakighorban@gmail.com, Behnam Malakooti

Decision-making under risk has a long history and is one of the challenging areas in many fields including economics, finance and engineering. Technically, decision-making is the selection of an alternative among group of alternatives. Several models have been developed to assist decision-makers (DMs) in the presence of risk, for instance, Expected Utility Theory, Cumulative prospect theory and so on. Recently, several models have been proposed. In this study, we investigate these models and their properties. Also, we investigate their performances in term of resolving the well-known paradoxes.

■ WD45

209A-MCC

Network Economics II

Sponsored: Simulation

Sponsored Session

Chair: Bruno Tuffin, INRIA, TBD, Rennes Cedex, France, bruno.tuffin@inria.fr

Co-Chair: Patrick Maillé, Telecom Bretagne, 2, rue de la Cha^taigneraie, Cesson Sévigné, 35576, France, patrick.maille@telecom-bretagne.eu

1 - On Revenue-oriented Content Delivery Networks And Their Impact On Net Neutrality

Patrick Maillé, Telecom Bretagne, Rennes, 35510, France, patrick.maille@telecom-bretagne.eu, Gwendal Simon, Bruno Tuffin

We investigate the decisions made by a CDN actor willing to maximize revenue through the management of its cache servers. Through simple models, we highlight that revenue-oriented management policies can affect the user-perceived quality of experience, impacting the competition among content providers (and also among network access providers) in favor of the incumbent. Since this goes in the opposite direction to the one aimed by net neutrality proponents and it seems that CDNs are not discussed much in the net neutrality debate, we wonder about the need for a definition of what a “neutral” CDN should look like.

2 - An Optimization Approach For Long-term Network Planning With Protection Constraints

Nicolas Stier-Moses, Facebook, Menlo Park, CA, United States, nicostier@yahoo.com, Josue Kuri

We present an optimization approach for strategic, long-term network planning. We forecast supply (network assets), demand (network traffic) and possible failures, and employ a robust optimization approach to optimize which assets to use and how much capacity must be turned up in each of them. A key element of this model is its dynamic nature which allows us to consider inter-temporal constraints (e.g., turned up capacity is monotone over time) and the amortization of fixed costs.

3 - Profit, Welfare, And Consumer Surplus Implications Of Sponsored Data Plans

Jialin Song, University of Illinois at Urbana-Champaign, 117 Transportation Building, 104 S Mathews Ave, Urbana, IL, 61801, United States, jsong83@illinois.edu, Qiong Wang

Major Mobile Service Providers are now offering sponsored data plans that allow Content Providers to pay for the access of their contents by end users. How such practice affects profit, social welfare, and consumer surplus is a critical question in the network neutrality debate. We address this issue from the perspective of commodity bundling: without a sponsored data plan, users purchase data blocks to access all contents, which corresponds to pure bundling; sponsored data plans separate some contents from the bundle. We develop a two-stage model, involving both Nash bargaining solution and Nash equilibrium, to analyze and compare the two situations.

■ WD46

209B-MCC

Revenue Management and Marketing

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Denis Saure, University of Chile, Beaucheff 851, Santiago, Chile, dsaure@dii.uchile.cl

Co-Chair: Juan Pablo Vielma, Massachusetts Institute of Technology, 30 Memorial Dr, Cambridge, MA, 02142, United States, jvielma@mit.edu

1 - Ellipsoidal Methods For Choice-based Conjoint Analysis

Denis Saure, Universidad de Chile, Republica 701, Santiago, 8370439, Chile, dsaure@dii.uchile.cl, Juan Pablo Vielma

In this talk we introduce a variant of the polyhedral method by Toubia, Hauser and Simester (2004) that uses ellipsoids instead of polyhedral. This change allows the method to (1) include approximate Gaussian priors on the parameters, (2) explicitly consider respondent error, and (3) perform quick approximate posterior updates whose quality nearly matches a full Bayesian update. We also introduce a practical question selection method that is optimal with respect to the D-efficiency criterion for one question, and leads to an extremely effective one-step look-ahead policy for multiple questions.

2 - Capturing Multitaste Preferences: A Machine Learning Approach

Daria Dzyabura, New York University, ddzyabur@stern.nyu.edu, Liu Liu

In diverse product categories, a consumer’s preferences may include several tastes. For example, one may enjoy cooking American and Chinese recipes, with different specific criteria for each. We propose a model that allows for multiple tastes and an efficient estimation algorithm. In a numerical study, we simulate multi-taste consumers and demonstrate the proposed algorithm accurately recovers parameters, while benchmark models underfit. We test the algorithm on recipe texts, after extracting attributes from recipe text using text mining. We achieve significant improvements in prediction over single-taste benchmarks.

3 - Estimating Customer Spillover Learning Of Service Quality: A Bayesianhierarchical

Andres I Musalem, Universidad de Chile, Beauchef 851, Santiago, 8370456, Chile, amusalem@duke.edu, Yan Shang, Jeannette Song

We propose a Bayesian framework for estimating customer “spillover learning,” — the process by which customers’ learn from previous experiences of similar but not necessarily identical services. We apply our model to a data set containing shipping and sales historical records provided by a world-leading third-party logistics company.

■ WD47

209C-MCC

Various Pricing Topics for Revenue Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Elcin Ergin, McGill, 3465 Hutchison Street, Apt 905, Montreal, QC, H2X 2G3, Canada, elcin.ergin@mail.mcgill.ca

1 - Better Late Than Now: Delayed Vs. Instantaneous Price Discounts With Repeat Customers

Monire Jalili, PhD Student, University of Oregon, 1455 East 25th Ave, Eugene, OR, 97403, United States, mjalili@uoregon.edu, Michael Pangburn

In this paper, we contrast the delayed versus instantaneous discounting policies in a repeat purchase setting with rational and forward-looking consumers. We first establish that if consumer spending is consistent over time, then there is no benefit to the firm (or consumers) from delayed discounts. With varied spending, we prove that when the firm can target individual consumers with their optimal discount percentage, delaying discounts increases profits only for a limited range of transition shoppers. However, when the same discount percentage applies to all customers, delayed discounting outperforms the instantaneous discounting, thus motivating the prevalence of this policy in practice.

2 - Competitive Pricing With Stockouts And Satisficing Customers

Varun Gupta, Penn State Erie, The Behrend College, 5101 Jordan Rd, Burke 281, Penn State Erie, The Behrend College, Erie, PA, 16563, United States, vxg15@psu.edu, Metin Cakanyildirim

Stockouts for high inventory turnover products lead to loss of sales as customers may substitute their preferred product (stocked out) with another product (available). We study single period equilibrium prices for competing retailers selling to satisficing customers with stockout-based substitution under lost sales and backorders.

3 - Pricing Decisions In Fast Fashion Retailing Using Discrete Choice Dynamic Programming Model

Elcin Ergin, McGill, 3465 Hutchison Street, Apt 905, Montreal, QC, H2X 2G3, Canada, elcin.ergin@mail.mcgill.ca, Mehmet Gumus

We study the pricing decisions in fast-fashion retailing firms under a forward-looking setting utilizing the dynamic nature of the problem. In this context, we consider a discrete choice dynamic programming model to estimate the optimal pricing decisions throughout the life cycle of a product. We develop decomposition approaches based on different functional forms and assess their performances in terms of computational complexity and objectives of the problem on a large real-life dataset taken from a fast-fashion company.

■ WD48

210-MCC

Social Media and Marketing Analytics

Invited: Social Media Analytics

Invited Session

Chair: Amir Gandomi, Ryerson University, 350 Victoria Street, Toronto, ON, M5B 2K3, Canada, agandomi@ryerson.ca

1 - Big Data And Marketing Analytics In Practice: Key Skills And Competencies

Amir Gandomi, Ryerson University, 350 Victoria Street, Toronto, ON, M5B 2K3, Canada, agandomi@ryerson.ca, Morteza Mashayekhi, Margaret Osborne, Michael Sparling

Several recent studies report a significant talent gap in analytics. This study aims to address this gap by establishing a body of knowledge for marketing analytics professionals. We perform a large-scale empirical study using the data from a professional social network. By analyzing the unstructured textual data, we specify the required skills and competencies in different domains of marketing.

2 - Ranking Cuisines And Customers From Geosocial Restaurant Data

Syagnik Banerjee, University of Michigan-Flint, syban@umflint.edu

We mine location based check-ins and tweets from 40 types of restaurants and 400 visitors across San Francisco, Chicago, Boston, New York, DC and Seattle to fit a 2 parameter IRT model that estimates the cuisine conspicuity of the restaurant and the palate diversity of the visitors.

3 - Learning Product Attribute Embedding Model From Online Reviews

Feng Mai, Stevens Institute of Technology, Hoboken, NJ, United States, feng.mai@stevens.edu, Xin (Shane) Wang, David J Curry, Roger Chiang

Online reviews provide a valuable source of information to help identify the latest attitudes, opinions, and preferences circulating among consumers. We propose a product attribute embedding model that uses a deep learning approach to learn computable semantic vectors from online reviews. The dimensions of the vector space correspond to latent consumer needs, while product attributes are indexed by their capacity to meet these needs. We demonstrate the implications of the model in market structure analysis and conjoint analysis.

■ WD49

211-MCC

Teaching Analytics Using Teradata University Network Resources

Sponsored: Education (INFORMED)

Sponsored Session

Chair: Ramesh Sharda, Oklahoma State University, Stillwater, OK, United States, ramesh.sharda@okstate.edu

1 - Teaching Analytics Using Teradata University Network Resources

Ramesh Sharda, Oklahoma State University, ramesh.sharda@okstate.edu

Teradata University Network (TUN) is a group of academics supported by Teradata to develop and share teaching and learning resources for analytics. Several thousand faculty and students around the world are using TUN resources. These resources include cases, assignments, software such as SAS Visual Statistics, Teradata Aster, and others. The panelists will describe how they use various TUN resources in their analytics courses. Sharda will introduce TUN and the Aster platform for teaching Big Data technologies. Nestler will describe how he has used sports analytics material. Delen will cover SAS Visual statistics. Bhaskar will discuss how marketing analytics can be taught using TUN resources.

2 - Panelist:

Scott Nestler, University of Notre Dame, snestler@nd.edu

3 - Panelist:

Dursun Delen, Oklahoma State University, dursun.delen@okstate.edu

4 - Panelist:

Rahul Bhaskar, California State University-Fullerton, rbhaskar@fullerton.edu

■ WD50

212-MCC

Opt, Nonlinear Programming I

Contributed Session

Chair: Harsha Nagarajan, Postdoctoral Research Associate, Los Alamos National Laboratory, 3000 Trinity Drive, Apt 8, Los Alamos, NM, 87544, United States, harsha@lanl.gov

1 - On Broyden-Conjugate Gradient Methods For Solving Unconstrained Optimization Problems

Idowu Ademola OSINUGA, Federal University of Agriculture, Abeokuta, Department of Mathematics, Alabata Road, Abeokuta, 234, Nigeria, osinuga08@gmail.com

An hybrid methods known as BFGS-CG plays an importatnt role in solving large-scaled optimization problems. Hence, we carried out computational experiments on standard BFGS-CG methods (BFGS-FR, HS & PR). In comparison with the newly introduced hybrid methods BFGS-BAN and BFGS-IMW, the hybrid method BFGS-IMW shows significant improvement in the total number of iterations and CPU time required to solve large-scaled optimization problems.

2 - Fast Solutions With Performance Guarantee For Operational Decisions In Real Time Industrial Gas Network Problems

Pelin Cay, Lehigh University, Department of Industrial and Sys Engineering, 200 W Packer Ave, Bethlehem, PA, 18015, United States, pec212@lehigh.edu, Robert H Storer, Luis Zuluaga, Camilo Mancilla

In the gas distribution industry, meeting customer demand in real time while meeting the physical constraints in a gas pipeline network leads to complex and challenging optimization problems. We study the performance of different approaches in the literature to either find global optimality or determine the optimality gap between the best local optimum and a valid lower bound. In industry-sized problem instances significant improvements are possible using a better reformulation compared to solving the standard formulation of the problem.

3 - Convex Hulls Of Graphs Of Bilinear Functions On The Unit Cube

Fabian Rigterink, University of Newcastle, University Dr, Callaghan, 2308, Australia, fabian.rigterink@uon.edu.au, Natashia Boland, Akshay Gupte, Thomas Kalinowski, Hamish Waterer

In his 1989 seminal paper, The boolean quadric polytope: Some characteristics, facets and relatives, Padberg introduced five classes of valid inequalities for the boolean quadric polytope: triangle, clique, cut, generalized cut and odd cycle inequalities. These inequalities outer-approximate the convex hull of a bilinear function. In this talk, we study classes of bilinear functions where some of the Padberg inequalities characterize the convex hull. Furthermore, we study which of the inequalities are strongest, i.e., outer-approximate the convex hull best. We then apply the strong inequalities to (QC)QP instances from the literature to find good lower bounds fast.

4 - A Spatiotemporal Radiotherapy Planning Approach For Cancer Treatment

Ali Adibi, PhD Student, Wichita State University, 7413 E 18th Street N, Wichita, KS, 67206, United States, aliadibi.ie@gmail.com, Ehsan Salari

Radiotherapy is one of the main modalities for cancer treatment. This research aims at developing a spatiotemporal radiotherapy planning optimization approach and evaluating the potential benefit of varying radiotherapy plans and thus the spatial dose distribution over the treatment course. The proposed approach is applied to a phantom cancer case to test its computational performance.

5 - Tightening McCormick Relaxations For Nonlinear Programs Via Dynamic Multivariate Partitioning

Harsha Nagarajan, Postdoctoral Research Associate, Los Alamos National Laboratory, 3000 Trinity Drive, Apt 8, Los Alamos, NM, 87544, United States, harsha@lanl.gov, Mowen Lu, Emre Yamangil, Russell Bent

In this work, we propose a two-stage approach to strengthen piecewise McCormick relaxations for mixed-integer nonlinear programs with multi-linear terms. 1st stage exploits constraint programing techniques to contract the variable bounds. In 2nd stage, we partition the variable domains using a dynamic multivariate partitioning scheme via sparse addition of binary variables, which is independent of the size of variable domains. We demonstrate the performance of the proposed algorithm on well-known MINLPLIB problems and discuss the computational benefits of CP-based bound tightening procedures.

WD51

213-MCC

Education III

Contributed Session

Chair: Sinan Tas, Assistant Professor, University of Wisconsin-Platteville, 1 University Plaza, Platteville, WI, 53818, United States, tass@uwplatt.edu

1 - A Course Timetabling Problem In A University

Gulsah Hancerliogullari, Assistant Professor, Istanbul Technical University, Macka Campus Faculty of Management, Istanbul, Turkey, ghancerliogullari@itu.edu.tr, Ozlem Pehlivan, Emrah Koksalmis

Course timetabling has received much attention in the literature over the years. Each university has specific constraints, rules and objective function. Therefore, studies in the literature cannot be adapted to our course scheduling problem, which motivates us to conduct this research. The course timetabling problem involves assigning predetermined courses to available timeslots and classrooms. The aim of this study is to develop a mathematical model to assign the courses of each department to the propose timeslots for a week. We validate our model using the data collected from the university, show that our model is tractable in practice and can be solved in a reasonable amount of time.

2 - How To Advise Business Students Choose An Appropriate Concentration?

Bhushan Kapoor, Professor and Chair, California State University -Fullerton, Fullerton, CA, 92831, United States, bkapoor@fullerton.edu, Sinjini Mitra, Zvi Goldstein

We study Business students' characteristics and factors they consider while selecting a concentration, and how well they perform in their chosen concentrations, via statistical tools and models. We look at some key demographic and academic background characteristics such as age, ethnicity, GPA, and grades, to determine which ones are important in these respects. Moreover, we conduct a survey among students in three different concentrations in our College to understand why they chose a certain concentration, and their experience. Our proposed models will be used to advise future students for selecting suitable Business concentrations, and can easily be adapted for other disciplines as well.

3 - Creative Storytelling And Choreography For Senior Design

Elif Akcali, University of Florida, Dept of Industrial and Systems Engineering, 303 Weil Hall PO Box 116595, Gainesville, FL, 32611-6595, United States, akcali@ise.ufl.edu, Tzveta Kassabova, Tom Hart, Leela Corman

Creative Storytelling and Choreography Lab was developed to teach some creative processes to industrial and systems engineering students to help them develop engaging and informative presentations to communicate goals, execution, and results of engineering projects to engineering and general audiences. Throughout the semester, students were systematically introduced to a host of tools for creative processes in graphic and performance arts by a multi-disciplinary instructor team were asked to utilize these tools to develop and deliver engaging narratives in the form of graphic stories or dance works.

4 - Applying Gamification In Engineering Classrooms

Sinan Tas, Assistant Professor, University of Wisconsin - Platteville, 1 University Plaza, Platteville, WI, 53818, United States, tass@uwplatt.edu

Gamifying classrooms can make your classes more interesting, fun, and engaging. In this talk, I will provide an example of gamification, a game called "SPOT-it!", which consists of four mini games: Spy it!, Pop it!, Operate it! and Top it! I will also discuss the additional benefits of gamification including participation, classroom management, and grading.

WD52

214-MCC

Planning for Humanitarian Operations

Sponsored: Public Sector OR

Sponsored Session

Chair: Gina Galindo, Universidad del Norte, Universidad del Norte, Barranquilla, 111, Colombia, ggalindo@uninorte.edu.co

1 - Using Mobile Clinics To Address Equity In Pharmaceutical Supply Chains In Low-resource Settings

Rajan Batta, University at Buffalo (SUNY), Buffalo, NY, United States, batta@buffalo.edu, Biplab Sudhin Bhattacharya

Low-resource rural settings are challenged with sparse drug availability at medicine outlets. Medicine outlets, being cash constrained, are strapped to keep up with demand. This results in people from the served community having to commute from one provider to another to avail the required drugs. A mobile-outlet location-tour model can address this issue. The first phase of the model identifies optimal candidate locations to maximize equitable coverage and the second phase is to identify an optimal closed loop for minimize distance travelled by the mobile-outlet.

2 - A Multi-modal Vehicle Routing Model For Post-disaster Relief Supply In Inaccessible Mountainous Regions

Abhinav Khare, University at Buffalo (SUNY), Buffalo, NY, United States, abhinavk@buffalo.edu, Rajan Batta, Jee Eun Kang

Earthquake in mountainous regions pose a great logistics challenge for the relief-providing agencies. A large part of the affected population is located in remote areas putting pressure on the humanitarian community to design a response enabling access to these areas. We present a multi-modal vehicle routing model for such a scenario. In our model, we supplement regular air transport with porters/animal packs for last mile deliveries to villages accessible only by mountain trails. The helicopters carrying relief are routed through the Helicopter Landing Zones which form the depots for the porters performing last mile delivery. The model is tested on data collected from the 2015 Nepal earthquake.

3 - Contending With Material Convergence After A Disaster Impacting Nashville, Tennessee: An Optimal Donations Information Management System

Miguel Jaller, University of California Davis, mjaller@ucdavis.edu, Jose Holguin-Veras, Luk N Van Wassenhove, Johanna Amaya

This presentation discusses an optimal donations information management system to contend with unsolicited donations after a large disaster impacting Nashville, Tennessee. The analyses are based on empirical disaster donation generation models, and a mathematical formulation that minimizes total social costs.

4 - Searching For Entities Under Dynamic Emergencies

Gina Galindo, Universidad del Norte, ggalindo@uninorte.edu.co, Jose Betancourt

In this research we address the problem of searching for a missing entity under an emergency or disaster setting. Our problem considers events such as wildfires, with dynamic affected regions where some areas gradually become consumed by the event. We approach the problem by means of a bi-objective model which seeks to maximize the probability of finding the missing entity while trying to cover as soon as possible those areas in risk of becoming consumed by the event.

WD53

Music Row 1- Omni

Business Applications in Social Media Analytics

Contributed Session

Chair: Oscar Albeiro Herrera-Restrepo, PhD Industrial and Systems Engineering, Virginia Tech, 4339 Taney Avenue, Apt 401, Falls Church, VA, 22304, United States, oscar84@vt.edu

1 - The Impact Of Implementing Full Capacity Protocol On The Operational Performance In An Emergency Department

Lu Wang, PhD Student, University Of Kansas, 2406 Alabama St Unit 7C, Lawrence, KS, 66046, United States, lu.wang@ku.edu, Mazhar Arikan, Suman Mallik

Full capacity protocol (FCP) is a set of guidelines that coordinates the patients flow when the emergency department (ED) is overcrowded. Utilizing data from a large urban teaching hospital, we show that the operational performance of the study ED is improved after the implementation of FCP. Furthermore, we find additional improvement when the FCP is triggered. We propose recommendations to further improve the operational outcomes under FCP.

2 - Dynamic Time Warping For Cold Start Problems In Digital Advertising

Pavan Murali, Research Scientist, IBM Research, 1101 Kitchawan Road, Rt 134, 04-024, Yorktown Heights, NY, 10598, United States, pmurali@usc.edu

In digital advertising, a real-time decision has to be made to bid on a set of ad impressions daily to reach as much of the audience group as possible, while being restricted by the daily campaign budget. When a new campaign begins, there is insufficient information about click or conversion events to optimize budget allocation. We propose dynamic time warping algorithm to compare temporal characteristics of two campaigns to identify a similar campaign with significantly more data, which can serve as a proxy to estimate win and conversion rates and to optimize temporal budget allocation.

3 - Bank Branch Operational Performance Through a Robust Multivariate And Fuzzy Clustering Approach

Oscar Albeiro Herrera-Restrepo, PhD. Industrial and Systems Engineering, Virginia Tech, 4339 Taney Avenue, Apt 401, Falls Church, VA, 22304, United States, oscar84@vt.edu, Konstantinos P Triantis, William L. Seaver

We propose a multi-step procedure that integrates fuzzy clustering analysis and data envelopment analysis (DEA) to group bank branches into managerial clusters and to investigate their operational performance. We build and expand on previous research by including fuzzy clustering. We look for changes in clustering composition due to branches belonging to multiple clusters, and changes in operational efficiency performance due to fuzzy clustering. All this while looking at influential branches. Our premise is that fuzzy clustering allows differentiating clusters beyond scale/size, and that it affects operational efficiency performance.

■ WD54

Music Row 2- Omni

Smart Services: Design, Development, and Measurement

Sponsored: Service Science

Sponsored Session

Chair: Robin Qiu, Penn State, 30 E. Swedesford Road, Malvern, PA, 19355, United States, robinqiu@psu.edu

Co-Chair: Hi-Hun Kim, Pohang University of Science and Technology, Pohang, Korea, Democratic People's Republic of, kh_kim@pohang.ac.kr

1 - Identifying New Service Opportunities For Driving Safety Enhancement Based On Driving Behavior Analysis: Commercial Vehicle Case In Korea

Chang-Ho Lee, Pohang University of Science and Technology, 77 Cheongam-Ro. Nam-Gu., Pohang, Korea, Republic of, dlckdgh@postech.ac.kr, Min Jun Kim, Young-Mok Bae, Kwang-Jae Kim

The goal of this research is to identify service opportunities for enhancing driving safety for commercial vehicles (including intra-city buses, express buses, and trucks). Based on an analysis of vehicle operational data in conjunction with accident data, new service opportunities for enhancing driving safety are identified. The service opportunities would contribute to developing new services for commercial vehicle companies and related authorities in Korea.

2 - Development Of A Daily Health Behavior Index For College Students

Ki-Hun Kim, Pohang University of Science and Technology, Pohang, Korea, Republic of, kh_kim@postech.ac.kr, Kwang-Jae Kim

Recently, a smart wellness service has been developed to support daily wellness management for college students. During a day, the service collects health behavior (activities, sleep, and diet) data of a student via smart devices. As part of the service, a daily health behavior index was developed to evaluate the student's health behaviors based on the collected data. Daily health behavior data of 47 college students were collected during a four-week experiment and used to develop the index. This talk presents how the index was developed and utilized in the service.

■ WD55

Music Row 3- Omni

E Business/Commerce I

Contributed Session

1 - On-site Personalized Product Recommendations: A Field Study

Dimitrios Tsekouras, Erasmus University, Burgemeester Oudlaan 50, 3062PA, Rotterdam, P.O. Box 1738, Netherlands, dtsekouras@rsm.nl, Ting Li

Consumers receive on-site personalized product recommendations about alternative products based on their past behavior. In this paper, we study the effectiveness (click and purchase) of these recommendations based on products (1) browsed, (2) put on wishlist, or (3) bought, using a large dataset from a major e-retailer. We examine the extent to which these effects differ for products with different price levels, in different product categories, as well as depending on how long after the initial interaction with the product source are the recommendations presented. The findings provide suggestions for improving the on-site recommendation for e-commerce websites.

2 - The Effect Of Direct Marketing On Online Purchases – An Empirical Study

Xingyue Zhang, Lehigh University, 621 Taylor Street, Bethlehem, PA, 18015, United States, xiz313@lehigh.edu, Yuliang Yao

Use a unique dataset collected from one of the largest classified ads website in China, we empirically examine the effect of offline call intensity on online customer purchase probability and the carryover effect of call intensity. We find that online customer purchase probability is increasing in call intensity but at a decreasing rate. In addition, there exists a strong carryover effect where the call intensity in the past 4 weeks does not fade away but have a positive effect on recent customer purchase. Our estimations show that both too much or too little call intensity will result in considerably worse outcomes.

3 - Product Recommendations In E-mail Marketing: A Randomized Field Experiment

Ting Li, Erasmus University, T09-14, Burg Oudlaan 50, Rotterdam, 3000DR, Netherlands, tli@rsm.nl, Dimitrios Tsekouras

Websites retarget their customers by sending e-mail with personalized product recommendations based on their past browsing behavior and preferences. In this study, we examine the effectiveness of such e-mail communication across two types of product recommendations: content-based recommendations and visual recommendations. We conducted a large-scale randomized field experiment to investigate how these effects vary depending on customers' purchase stage and the temporal distance between their last website visit and receiving the email. The study provides insights for e-commerce websites regarding the improvement of their e-mail retargeting campaigns.

■ WD56

Music Row 4- Omni

Decision Support Systems II

Contributed Session

Chair: Koki Ho, University of Illinois at Urbana-Champaign, 302F, Talbot Laboratory, 104 S. Wright St, Urbana, IL, 61801, United States, kokiho@illinois.edu

1 - A Decision Framework For Uber-like Transportation Platform

Peiyu Luo, PhD Student, University of Louisville, Louisville, KY, 40217, United States, p0luo002@louisville.edu, Lihui Bai

The rising platforms such as Uber, Lyft and Sidecar empower individuals to provide short-range point-to-point ridesharing services other than traditional transportation services (e.g. bus, subway, taxi). This paper aims to provide decision support tools for such peer-to-peer transportation businesses. We divide the business operations into three stages: resource identification, resource allocation and task assignment, and use optimization models and prospect theory in decision making to formulate the three stages. Computational results will be reported.

2 - Leveraging Machine Learning To Support Agricultural Decision-making

Emily Burchfield, PhD Candidate, Vanderbilt University, Nashville, TN, 37212, United States, emily.k.burchfield@vanderbilt.edu, John J Nay, Jonathan Gilligan

This project applies machine learning to remotely sensed imagery to train and validate predictive models of vegetation health. We processed eleven years of NASA MODIS data and applied gradient boosted machines to the lagged data to forecast future values of vegetation health. We assessed the predictive power of our model across space, time, and land use categories. Our models have significantly more predictive power on held-out datasets than simpler baselines. We constructed an open source tool that predicts per-pixel vegetation health in a user-specified region of interest at 16-day intervals. This tool is useful in regions where clouds prevent real-time monitoring of vegetation dynamics.

3 - Profit Optimization For Rare Earth Permanent Magnet Value Recovery Under Supply And Demand Uncertainties

Hongyue Jin, PhD Candidate, Purdue University, 2101 Cumberland Ave Apt 2107, West Lafayette, IN, 47906, United States, jin156@purdue.edu, Yuehwern Yih, John Sutherland

Rare earth permanent magnets (REPMs) play an essential role in green energy production and yet face a significant supply risk. To alleviate the risk, value recovery from end-of-life product is proposed. This research develops an inventory management strategy for REPM recovery under market supply and demand uncertainties. A linear programming (LP) model is then developed to find an upper bound for the proposed strategy. Several scenarios are evaluated with a hard disk drive (HDD) example. The proposed strategy helps increase the profit, and the performance is well comparable to the upper bound.

4 - Operations Research In Space Engineering

Koki Ho, University of Illinois at Urbana-Champaign, 302F, Talbot Laboratory, 104 S. Wright St, Urbana, IL, 61801, United States, kokiho@illinois.edu

This presentation provides a survey of the state-of-the-art of operations research (OR) in an unconventional application area: space engineering. Over the last 10-15 years, optimization, probability, and stochastic analysis have been successfully applied to various problems in space exploration, enabling more efficient space mission planning and more effective in-orbit platform design. This presentation reviews the representative theory and application development in this area and lays out the potential future research directions.

■ WD57

Music Row 5- Omni

Disaster and Emergency Management II

Contributed Session

Chair: Shaolong Hu, Ph.D candidate, Tongji University, 1 Zhangwu Road, Tongji building-A, Room 1706, Shanghai, 200092, China, shaolong.hu@hotmail.com

1 - Optimal Dispatching Policies For Donation Collection And Distribution

Robert Cook, University of Alabama, 201 Marina Drive, Tuscaloosa, AL, 35406, United States, Racook1@crimson.ua.edu, Emmett J Lodree

This study introduces a Markov decision process (MDP) model for collecting donations and distributing them to disaster survivors. Donations that accumulate over time at collection sites are periodically transported to a relief center where they are distributed to beneficiaries. The MDP model minimizes expected unsatisfied demand during a finite horizon.

2 - Flood Disaster Relief Services: A Research Agenda For Recovery

Niratcha Grace Tungtisanont, PhD Candidate, Clemson University, 100 Sirrine Hall, Management Dept, Clemson, SC, 29634, United States, ntungti@g.clemson.edu, Aleda Roth, Yann Ferrand, Bernardo F. Quiroga

We propose a research framework that covers the pre-, during- and post phases of natural disasters relief services. More specifically, we focus on the service operations strategies for improving the post-disaster recovery phase of flood disasters. We aim to answer the following research questions: where should we place our resources and efforts on the “pre- and during flood phases? Relatively, how much should we invest in the first two phases in order to improve the overall effectiveness in the recovery phase? We apply rigorous econometric analyses that provides managerial and policy implications for improving the resilience of communities and individuals affected by flood disasters.

3 - A Network Model For Relief Distribution In Emergency Response Phase

Shaligram Pokharel, Professor, Qatar University, Doha, Qatar, shaligram@qu.edu.qa, Rojee Pradhananga, Fatih Mutlu, Jose Holguin-Veras

A relief distribution model that minimizes the total cost while considering the supply and transportation capacities constraints is developed. the distribution network structure presented here considers distribution of the supplies through pre-selected district bases that are reachable by land from the supply collection points. Air-lifting is dedicated to end distribution of the supplies from the district bases to the affected regions. Results and analysis are discussed based on model performance in the context of a real-case network from recent disaster “Nepal Earthquake 2015”. (This research is funded through Qatar/QNRF/NPRP Project: 5-200-5-027)

4 - A Multistage Stochastic Approach For Disaster Response In Humanitarian Relief

Shaolong Hu, PhD Candidate, Tongji University, 1 Zhangwu Road, Tongji Building-A, Room 1706, Shanghai, 200092, China, shaolong.hu@hotmail.com

This paper focuses on a transshipment problem with consideration of uncertain road network capacity and vehicles coordination. Scenario tree is employed to demonstrate the multi-stage stochastic decision process. A multi-stage stochastic program model is developed to coordinate vehicles and scheduling of a transportation plan with the objectives of minimizing rental, transportation, handling, and penalty costs. Progressive hedging algorithm (PHA) is proposed for solving large scale problems. Based on the real-world case of an earthquake, numerical experiments are presented to study the applicability of the proposed model, and the effectiveness of the proposed PHA is illustrated.

■ WD58

Music Row 6- Omni

Finance III

Contributed Session

Chair: Yi-Ting Hsin, National Chi Nan University, Nantou, Taiwan, s100213024@mail1.ncnu.edu.tw

1 - Human Capital Of President Of Venture Capital Firm And Investment Performance

Cong Chen, PhD Candidate in SEM, THU, Tsinghua University, Haidian Dstrict, 708A, 14# Zijing Apartment, Tsinghua University, Beijing, 100084, China, thuchencong@163.com, Jizhen Li

This paper examined the effects of human capital of president of the venture capital firm (VCF) on investment performance. We concerned two key demographic characteristics, education and experience. In this paper, we proposed several hypotheses about the relationship between human capital and performance of VCF. Then we conducted empirical analysis to examine the hypotheses, using data from 107 VCFs in China. We find that education background in technology and business, finance experience, venture capital experience and entrepreneurial experience of presidents of VCFs increase investment performance.

2 - The Generalized Little’s Law And an Asset Picking System To Model And Maintain an Investment Portfolio: A Working Model

Maria Luisa Ceprini, Professor, Massachusetts Institute of Technology, E62-534 Cambridge, MA 02139 United States, Cambridge, MA, 02139, United States, mceprini@mit.edu, John D.C. Little

In this second phase of our research project we are testing the Generalized Little’s Law-Asset Picking System (GLL-APS) model, in order to tailor a customized investment portfolio for the investor. We use more advisers, customers, a wider selection of financial institution portfolios and our customized portfolios. We plan an orderly rollout of our model in multiple sectors. These include private and public investors, supplemental and social security funds. At the end the model will be assessed.

3 - Trust Evolution Dynamics In The Venture Capital Syndicate Network: An Analysis Based On A Wright-Fisher Process

Heyin Hou, Southeast University, School of Economics and Management, Nanjing, 211189, China, heyinhou@hotmail.com, Jun Yin

Venture Capital Syndicate Network (VCSN) derives from syndicate investments and relies on trust evolutions between venture capitalists (VCs). Based on a Wright-Fisher process, we introduce a general model of trust evolution dynamics with multi-strategy and protection mechanism in the VCSN. Then, we explore influences of the protection mechanism on evolutionary stability conditions for the two-strategy and the four-strategy models. Finally, we construct the global profit function for the VCs and adopt simulation experiments to verify the trust evolution dynamics for the two-strategy and the four-strategy models.

4 - Optimizing The Omega Ratio In Portfolio With Floating Return Threshold

Yi-Ting Hsin, National Chi Nan University, Nantou, Taiwan, s100213024@mail1.ncnu.edu.tw, Jing-Rung Yu, Wan-Jiun Paul Chiou, WenYI Lee

The omega ratio is the ratio of the expected upside deviation to the downside deviation of the threshold. The previous literature set the threshold fixed, which leads the portfolio (1) to overweight on risky assets, and (2) to lower risk-return efficiency. To better response the dynamics in market, we modify the threshold changing according to the recent returns. To improve the feasibility, we further model optimal asset short-selling, transaction cost, and buy-in limits in constructing portfolio. We use the daily data of a wide range of high-liquidity ETFs to analyze the effectiveness of the model. The empirical findings show that the proposed model demonstrates higher realized performance.

■ WD59

Cumberland 1- Omni

Facility Logistics - Potpouri

Sponsored: TSL, Facility Logistics

Sponsored Session

Chair: Debjit Roy, Indian Institute of Management - Ahmedabad, 34355, India, debzitt@gmail.com

1 - Retrieving Multiple Loads In Very High Density Storage Systems

Masoud Mirzaei, Erasmus University, mirzaei@rsm.nl, Masoud MirzaeiB.M. De Koster, Nima Zaerpour

Compact storage systems aim to utilize the available space more efficiently than conventional aisle-based storage systems. The most compact system has only one open space available to perform the retrieval and storage requests. More open locations, reduce space usage, but can reduce the retrieval time. However, in both situations, much space and time can be saved by performing multiple-load retrieval using a limited number of open locations. Current models for such systems study retrieving loads one at a time. We develop optimal models to do this for two loads and propose heuristics for more loads. Results show savings of 20% can be achieved compared to single-load retrieval.

2 - Loading And Unloading Trains And Trucks At Container Terminals

Debjit Roy, Indian Institute of Management - Ahmedabad, Ahmedabad, 380015, India, debjit@iima.ac.in, Jan-Kees Van Ommeren, Amir Gharehgozli

We first develop a closed queuing network with a fixed number of Automated Guided Vehicles that continuously circulate in the network during train loading or unloading process and interact with truck arrivals at the stacking cranes. We develop exact solutions for the case with one automated stacking crane by using an imbedded Markov chain approach. We then use these results to develop a semi-open queuing network model to analyse and approximate the expected throughput times for handling containers that arrive via trains (bulk arrivals) and trucks (single arrivals).

3 - A Fluid Model For Optimal Lot Selection And Dispatching Policies In Semiconductor Wafer Fabs

Dima Nazzal, Georgia Institute of Technology, Atlanta, GA, 30332, United States, dima.nazzal@gatech.edu, Shabbir Ahmed, Kelly Bartlett, Haejoong Kim, Junho Lee, George L Nemhauser, Matias Siebert Sandoval, Joel Sokol

In semiconductor manufacturing, congestion in an automated material handling system may negatively impact production throughput. For a prototype facility, we identify optimal lot selection and dispatching policies for various WIP levels and workload conditions. We propose a fluid-model lot selection policy that iteratively optimizes selection based on current WIP distribution.

■ WD60

Cumberland 2- Omni

Time-Sensitive Delivery Planning and Routing

Sponsored: TSL, Freight Transportation & Logistics

Sponsored Session

Chair: Okan Orsan Ozener, Ozyegin University, Istanbul, Turkey, orsan.ozener@ozyegin.edu.tr

1 - A Lagrangian-based Approach For Consolidating Freight Of Perishable Products

Christine Vi Nguyen, Northern Illinois University, DeKalb, IL, United States, cnguyen@niu.edu, Alejandro Toriello, Maged M Dessouky

We study a supply chain with small suppliers of perishable products, where shipping via a shared consolidation center allows for more economical FTL rates versus LTL or courier rates. We propose a Lagrangean relaxation of the center's inventory capacity to decompose the problem by destination, and develop a related heuristic that balances consolidated shipping costs and inventory costs.

2 - Same-day Delivery Planning With Store Fulfillment

Ming Ni, University at Buffalo, mingni@buffalo.edu, Qing He, Jose Walteros, Xuan Liu, Arun Hampapur

This study presents a same-day delivery planning with store fulfillment problem, which can be characterized by three main factors, the store selection, the delivery fleet sizing, and the multi-commodity distribution for online shoppers. It develops a mix integer programming model to represent the problem and use a Benders decomposition based approach to solve it efficiently. The numerical examples are derived from same day delivery from a real-world retailer store network.

3 - A Partially Time-expanded Network-based Solution Approach For The Traveling Salesman Problem With Time Windows And Its Variants

Minh Duc Vu, Quinlan School of Business, Loyola University Chicago, 16 E. Pearson, Chicago, IL, 60611, United States, dvu3@luc.edu, Natashia Boland, Mike Hewitt, Martin Savelsbergh

We present an exact approach for solving the Traveling Salesman Problem with Time Windows (TSPTW) that is based on repeatedly solving a mixed integer programming formulation of the problem over partially time-expanded networks. We show that the same algorithmic framework can be applied to different objectives for the problem. We develop new speed-up techniques for the algorithm and with an extensive computational study we are able to outperform many of the state-of-the-art approaches. Finally, we show how the algorithm can be adapted to variants of the TSPTW wherein the makespan is the objective or travel times are time dependent.

4 - Minimizing Routing Costs In Blood Supply Chain

Okan Orsan Ozener, Ozyegin University, orsan.ozener@ozyegin.edu.tr

We study the routing of blood collection vehicles for managing the platelet supply in blood supply chain. In order to extract platelets, donated blood has to be processed at a central processing facility within six hours of donation time. Blood collection organizations have to dispatch collection vehicles and schedule pickups from the donation sites so that the donated units can be used in platelet production. The objective is to collect and process a pre-specified number of donations for platelet production via a limited number of vehicles at minimum transportation cost. In our analysis, motivated by the practices in real-life, we cluster the donation sites so that a single vehicle serves the donation sites in each cluster. We propose a solution method based on route generation/selection and test the performances of the proposed method on randomly generated instances.

■ WD61

Cumberland 3- Omni

Scheduling in Passenger-Oriented Railway Networks

Sponsored: Railway Applications

Sponsored Session

Chair: Nikola Besinovic, Delft University of Technology, Mekelweg 2, Deflt, 2628, Netherlands, N.Besinovic@tudelft.nl

1 - Functional Relationship Between Primary And Secondary Delays On Railway Lines

Steven Harrod, Technical University of Denmark, stehar@dtu.dk, Fabrizio Cerreto, Otto Anker Nielsen

Performance, robustness, and punctuality of railway lines are most commonly evaluated with simulation software. This research proposes a cubic relationship between aggregate train delays over the planning horizon and identifiable primary delays. This relationship provides a heuristic for reducing the number of simulation instances. The method is presented in the context of ongoing research into robustness and punctuality on the Danish railways under the IPTOP research project. In addition, the presentation will discuss the identification of cause and effect between primary and secondary delays in a very large data set.

2 - Passenger Train Service Network Design Based On A State-space-time Network

Lingyun Meng, Beijing Jiaotong University, menglingyun2001@hotmail.com, Xuesong Zhou

We propose a solution framework for matching passenger travel demand to vehicle transport services and vehicles to infrastructure in a railway system based on a triple-layer (state-space-time) network. Following a method for carefully constructing the triple-layer network, we present an integer programming formulation and a lagrangian relaxation solution framework. Numerical experiments are conducted for validating the proposed approach.

3 - Towards Operationally Feasible And Robust Railway Timetables

Nikola Besinovic, Delft University of Technology, Stevinweg 1, Delft, Netherlands, n.besinovic@tudelft.nl, Rob M.P. Goverde

Railway timetabling has been a focus of research over the years and multiple approaches have been proposed. However, most of the existing models for timetabling focus on a macroscopic level of detail, taking stations as nodes and tracks between as arcs, and disregard changes in operational aspects. We propose an optimization approach that integrates a macroscopic model with microscopic details. The objective is to find a robust timetable that is also operationally feasible and ready to be implemented in practice. In addition, the model allows for optimal use of infrastructure capacity and reduces wasted resources. We present computational results on real-life cases from the Dutch railways.

■ WD62

Cumberland 4- Omni

Optimization in Crew Planning and Crew Leave Planning

Sponsored: Aviation Applications

Sponsored Session

Chair: Norbert Lingaya, Kronos Incorporated, 3535 Queen Mary Rd, Suite 500, Montreal, QC, H3V 1H8, Canada, nlingaya@kronos.com

1 - Bulk Annual Leave Slot Generator: A Two-phase Approach

Luc Charest, Operations Research Specialist, AD OPT, A Kronos Division, 3535 chemin Queen-Mary Ouest, bureau 500, Montréal, QC, H3V 1H8, Canada, luc.charest@kronos.com

AD OPT has enriched its Man Power Planning tool, namely "Altitude Insight", with a new component: the Leave Solver. This new component solves the problem of generating, awarding and assigning Long Service Leave and Bulk Annual Leave slots to crew member. With this presentation, we cover how the two-phase approach of the Leave Slot Generator is effective at generating slots in order to meet the first optimization requirement of leveling the gap related to the operational requirement while attaining the second objective of controlling the distribution and variety of generated slots.

2 - A Satisfaction Distribution Approach For Airline Crew Rostering Problems

Babacar Thiongane, AD OPT, A Kronos Division, 3535 Queen-Mary, Bureau 650, Montreal, QC, H3V1H8, Canada, babacar.thiongane@kronos.com

The satisfaction distribution problem in airline crew rostering aims to have a fair distribution of the bids satisfaction among crewmembers. We propose a new approach to solve this problem that also provides good quality of global satisfaction.

3 - Integral Column Generation

Guy Desaulniers, GERAD, guy.desaulniers@gerad.ca
Guy Desaulniers, Polytechnique Montreal & GERAD, Montreal, QC, Canada, guy.desaulniers@gerad.ca

We introduce an integral column generation method, which is an adaptation of the integral simplex using decomposition algorithm to the column generation context. The new method finds an improved integer solution at each column generation iteration until reaching an optimal solution. We present results for some crew scheduling problems for which optimal solutions are often obtained in few iterations.

4 - Monthly Crew Pairing With 40 000 Flights

Francois Soumis, GERAD, francois.soumis@gerad.ca, François Lessard, Mohammed Saddoune

The crew pairing problem is modelled as a set-partitioning problem solved by columns generation. The Dynamic Constraints Aggregation speed-up the master problem and permit to solve a weekly window of 10 000 flights in few hours. The rolling horizon with weekly windows produces solutions improver by up to 5%.

■ WD63

Cumberland 5- Omni

Probabilistic Location Models

Sponsored: Location Analysis

Sponsored Session

Chair: Kayse Lee Maass, University of Michigan, 1205 Beal Avenue Ann Arbor, Westland, MI, 48109-2117, United States, Leekayse@umich.edu

1 - Robust Defibrillator Placement Under Cardiac Arrest Location Uncertainty

Auyon Siddiq, UC Berkeley, Berkeley, CA, United States, auyon@berkeley.edu, Timothy Chan, Zuo-Jun (Max) Shen

The placement of automated external defibrillators (AED) in public locations allows bystanders of cardiac arrest to administer treatment prior to the arrival of emergency medical responders. A key challenge in AED positioning is that cardiac arrest locations are unknown in advance. We address this by formulating the AED problem as a distributionally robust facility location model with uncertainty in the locations of the demand points. Numerical results demonstrate that hedging against demand location uncertainty has the potential to improve cardiac arrest survival outcomes by mitigating the risk of long response times.

2 - Reliable Sensor Deployment For Object Positioning And Surveillance In A Two Dimensional Space

Siyang Xie, U of Illinois at Urbana-Champaign, Urbana, IL, United States, sxie13@illinois.edu, Kun An, Yanfeng Ouyang

This paper formulates a mixed-integer non-linear mathematical model for the reliable sensor deployment problem considering site-dependent sensor failures, where at least three sensors are required to work together to locate an object in a two-dimensional plane. The non-linear program is first linearized and customized Lagrangian relaxation algorithm is then developed to effectively solve the model. Numerical examples are presented.

3 - Facility Location Planning Under Uncertainty In Disaster Management

Emilia Grass, Institute for Operations Research and Information Systems (ORIS), e.grass@tuhh.de

Establishing relief facilities and the pre-positioning of first aid supplies before the occurrence of natural disasters is one of the most important preparation strategies in disaster management. Such location and storage decisions have to be made under a high level of uncertainty since the magnitude, time and location of disasters are not known in advance. In this talk, two-stage stochastic programs are presented which are particularly valuable for these situations. This is due to their ability to model uncertainties and to take into account possible implications of location decisions on relief item distribution in the aftermath of a disaster.

4 - Comparison Of Various Chance Constraints On The Inventory Modulated Capacitated Location Problem

Kayse Lee Maass, University of Michigan, Ann Arbor, MI, United States, leekayse@umich.edu, Mark Stephen Daskin, Siqian Shen

Using diverse data instances, we compare three approaches to incorporating chance constraints into a stochastic capacitated facility location problem in which processing facilities are able to accept demands in excess of the capacity constraint for short periods of time. Each of the formulations simultaneously assesses a penalty cost for each unit of unprocessed demand and imposes limits on the amount of unprocessed demand allowed. We show how the different approaches affect the optimal solution in terms of the facility locations, demand allocations, amount of unprocessed demand, and overall cost.

■ WD64

Cumberland 6- Omni

Theory and Application of the Analytic Network Process

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Orrin Cooper, University of Memphis, Memphis, TN, United States, olcooper@memphis.edu

1 - Improving Coherency In The Anp With A Clustering Algorithm

Orrin Cooper, University of Memphis, olcooper@memphis.edu, Idil Yavuz

When incoherent priority vectors in an ANP Supermatrix are identified it can be costly to elicit new pairwise comparisons. The proposed method can save decision makers valuable time and effort by using the information and relationships that already exist in the weighted Supermatrix. There is also useful information in the linking estimates that were already calculated and used to measure the coherency of the Supermatrix. A dynamic clustering method is used to automatically identify a cluster of coherent linking estimates from which a new coherent priority vector can be calculated and used to replace an incoherent priority vector.

2 - Being Consistent With Ahp Consistency: Issues And Applications

Enrique Mu, Carlow University, emu@carlow.edu

Consistency has been a cornerstone of AHP theory and applications. The rule of thumb has been that any pairwise comparison matrix for which the consistency ratio (CR) is less or equal than 0.1 will yield an eigenvector which will diverge very little from the calculated eigenvector for the ideal case of CR=0. However, putting aside the theoretical need for a low inconsistency, we will discuss here what are the potential practical applications of this. Can we use it to screen out of the decision-making process, "irrational" decision-makers? What else can consistency tell us about the decision-maker or the decision-making process? In which situations may consistency take a greater degree of importance?

3 - How Understanding The Sensitivity And Stability Of Preferences Among Colorectal Cancer Screening Alternatives Could Lead To "better" Medical Decisions

M. Gabriela Sava, Assistant Professor, Clemson University, Clemson, SC, United States, msava@clemson.edu, Luis G Vargas, Jerrold H May, James G Dolan

Patients are faced with multiple alternatives when selecting the preferred method for colorectal cancer screening, and there are multiple criteria to be considered in the decision process. We model patients' choices using a multi-criteria decision model and propose a new approach for characterizing the idiosyncratic preference regions for individual and group of patients. We show how insights derived from the sensitivity and stability of patients' preferences could be used within the medical decision making process.

4 - Quick Anp - A New Approach To Anp Sensitivity Analysis

Elena Rokou, Chief Research Officer, Creative Decisions Foundation, Pittsburgh, PA, 15213, United States, erokou@creativedecisions.net, Bill Adams

The proposed approach consists of two phases, in the first one each decision maker fills out a very short version of the ANP questionnaire. This way the initial point of views are collected by the negotiator. The initial questionnaires give the needed input to define what are the points of greater conflict and which judgments have a primary role in the final decision outcome. In the second phase the team focuses only on those conflicting points that have great impact on the outcome. The focal point of this work is to present a new type of sensitivity analysis for single level ANP models.

■ WD66

Mockingbird 2- Omni

Data Analytics For System Improvement III

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Abdallah A Chehade, University of Wisconsin-Madison, Madison, WI, United States, chehade@wisc.edu

Co-Chair: Kaibo Liu, University of Wisconsin-Madison, 1513 University Ave, Madison, WI, 53706, United States, kliu8@wisc.edu

1 - Sensory-updated Failure Threshold Estimation For Remaining Useful Life Prediction

Abdallah A Chehade, University of Wisconsin-Madison, chehade@wisc.edu, Kaibo Liu

The rapid development of sensor technology led to significant research efforts in remaining useful life (RUL) prediction. Such efforts often consider that a unit fails when it crosses a failure threshold, which is estimated offline. Unfortunately, such failure threshold estimation may not be valid due to the stochastic nature of the underlying degradation mechanism. In this talk, we propose a novel data fusion model that combines the information from the degradation profiles of historical units and the in-situ sensory data from an operating unit to online estimate and update the failure threshold distribution of this unit in the field. This approach is expected to help better online predict the RUL.

2 - Hard Failure Prediction Based on Joint Models With Extended Hazard

Jianing Man, City University of Hong Kong, Kowloon, Hong Kong, jianinman2-c@my.cityu.edu.hk, Qiang Zhou

Remaining useful life (RUL) prediction is essential for the prognostics and health management (PHM) to guarantee the system performance. We use joint models for the individual units (or systems) which subject to hard failure, including the random effects model for degradation signals and the extended hazard (EH) model for time-to-event data. The EH model is a general model that includes the proportional hazards (PH) model and accelerated failure time (AFT) model as special cases. A two-stage method and a Bayesian updating scheme are used in the offline estimation and online prediction separately.

3 - To Integrate Or Not? Covariance Selection In Gaussian Process Modeling

Ran Yang, Northwestern University, RanYang2011@u.northwestern.edu, Daniel Apley

Power exponential, Gaussian, and Matern are the most commonly used covariances for Gaussian process modeling of simulation response surfaces. A recently proposed class of fundamentally different, integrated covariance functions has been shown to work remarkably well for simulation models of many real physical systems. We demonstrate that likelihood and leave-one-out cross validation can both reliably select the best covariance model for a given response surface and data set and, in particular, determine whether an integrated covariance function should be used.

4 - Diagnostic Monitoring And Fault Diagnosis In Large Scale Multivariate Process Via Compressive Sensing And Optimization Screening

Yan Jin, University of Washington, yanjin@uw.edu, Shuai Huang

Smart manufacturing has been an emerging concept in many industries that highlights unprecedented connectivity of manufacturing infrastructure and abundance of sensors for real-time monitoring of many system entities. While it provides a data-rich environment, how to effectively model the variations of system entities and synthesize decentralized information into global situational awareness have been challenging issues. To tackle these challenges, we propose an integrated framework that unifies multivariate statistical monitoring, compressive sensing, and convex optimization. The advantages of proposed method are demonstrated through both simulations and real world application.

■ WD67

Mockingbird 3- Omni

Dynamic Maintenance/Reliability Planning

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Anahita Khojandi, UTK, Address, City, TN, 00000, United States, khojandi@utk.edu

Co-Chair: Murat Kurt, Merck & Co., Inc., Addrress, Pittsburgh, PA, United States, murat.kurt7@gmail.com

1 - Combined Condition-based Maintenance And Repairman Routing Optimization

Bram de Jonge, University of Groningen, Groningen, Netherlands, b.de.jonge@rug.nl, Lisa M Maillart, Oleg A Prokopyev

Existing studies on maintenance optimization for multiple machines generally ignore the required travel times to move from one machine to another. We consider the problem of a single repairman who is responsible for the maintenance activities of a set of geographically distributed machines with condition monitoring. The problem is formulated as a Markov decision process and insights are obtained on when to relocate and when to carry out preventive and corrective maintenance activities.

2 - Maintenance Of Degrading Servers Stored In A Stack

Mahboubeh Madadi, Louisiana Tech, madadi@latech.edu, Lisa M Maillart, Charles Richard Cassady, Shengfan Zhang

Inspired by queueing systems in which the servers are stored in a stack and arriving customers are served by the server on the "top" of the stack, we consider an M/M/n/n queue under a Most Recently Busy (MRB) service discipline in which the operating cost of each server increases in its cumulative time-in-use. More specifically, we formulate a continuous time Markov model to characterize the transient utilization of each server and to determine optimal maintenance policies of various forms.

3 - Condition-based Repair Prioritization In Repairable Inventory Supply Chains

Chiel van Oosterom, Eindhoven University of Technology, Eindhoven, Netherlands, c.d.v.oosterom@tue.nl, Joachim Jacob Arts, Geert-Jan Van Houtum

We propose a model for exploiting condition information to dynamically prioritize repairs in a capacitated repair shop. The repair shop supports a system with a number of different repairable components. The system is down whenever a component fails and no ready-for-use spare part is available for that component. The objective in prioritizing repairs is to maximize the long-run availability of the system.

4 - Joint Optimization Of Replacement And Inspection Decisions For Two-unit Standby Redundant Systems With Non-silent System Failures

Anahita Khojandi, University of Tennessee, Knoxville, TN, United States, khojandi@utk.edu, Murat Kurt

We consider a two-unit standby redundant system in which individual unit failures are silent, but simultaneous unit failures cause system shutdown. We propose a Markov decision process to jointly determine inspection frequency and preventive repair decisions to minimize the total expected operational cost, including inspection, repair and failure costs. We analytically establish properties of the value function and the optimal policy, derive insights from a wide range of numerical examples, perform extensive sensitivity analysis, and discuss algorithmic enhancements.

■ WD68

Mockingbird 4- Omni

Complex Process Modeling, Monitoring and Optimization

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Youngseon Jeong, Chonnam National University, Korea, Republic of, youngseonjeong@gmail.com

Co-Chair: Myong K Jeong, Rutgers University, 96 Frelinghuysen Road, Piscataway, NJ, 08854, United States, mjeong@rci.rutgers.edu

1 - A Predictive Modeling Of Pump Breakdown For Semiconductor Fabrication Based On Sensor Data

Kil Soo Kim, Principal Engeneer, Samsung Electronics, SamsungJeonja-ro, Hwasung, Gyeonggi-do, 18448, Korea, Republic of, ks1.kim@samsung.com, Chanhwi Jung, Solmi Park, Hyung-Seok Kang, Dongkyu Jeon, Seung Hoon Tong

We present a method for predictive monitoring of pump breakdown failure which may result in wafer scrap or unnecessary main chamber stop loss based on secondly collected sensor data. The sensor data set that were collected massively during several months from pumps contains useful information to monitor and predict the condition of pump connected with main chamber. We developed the monitoring statistics and predictive model which can estimate the remaining useful life. The real-life case study is presented to illustrate our proposed procedures.

2 - Application For Modeling And Optimization Of A Crucial Parameter Identification

Shreya Gupta, University of Texas at Austin, Austin, TX, shreya.gupta@utexas.edu

We are working with Samsung Semiconductor on building a statistical optimization model that identifies equipment and parameters to rank best and worst routes for the purpose of scheduling and testing modified recipes. We are also employing data mining and statistical techniques to identify control spec to improve process capability and yield for semiconductor manufacturing. Finally, we are developing a prototype software to demonstrate the use and value of the proposed analysis and algorithms.

3 - Phase I Analysis Of Nonlinear Profiles Via Gaussian Process Models

Yang Zhang, Tianjin University of Commerce, No. 409, Guangrong Rd., Tianjin, China, yzhang@tjcu.edu.cn, Nini Gao, Qing Wang

In profile monitoring, process monitoring and diagnosis remains and important and challenging problem. Although the analysis of nonlinear profile data have been extensively studied in the literature, the challenges associated with diagnosis of nonlinear profiles with within-profile correlation are yet to be well addressed. In consideration of within-profile correlation, a Gaussian process model is applied to model the nonlinear profiles. A practical diagnosis scheme based on Schwarz's Bayesian information criterion is proposed to identify the outliers in Phase I. Simulation results show that the proposed method could effectively find outlying profiles in a historical dataset.

4 - Adaptive Variability Monitoring Procedure For High-dimensional Processes

Jinho Kim, Qatar University, jhkim04@gmail.com

Monitoring process variability of a multivariate process is crucial to ensure high quality of product. However, monitoring process variability in high-dimensional processes is considerably difficult due to the large number of variables and the limited number of samples. In this talk, we present a procedure based on an adaptive LASSO-thresholding for monitoring changes in the covariance matrix. The performance of the proposed chart, is evaluated for various shift patterns and compared with one of the existing penalized likelihood based methods. The results show the effectiveness of the proposed chart.

■ WD70

Acoustic- Omni

Transportation, Ops IV

Contributed Session

Chair: Emre Kirac, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States, ekirac@uark.edu

1 - Public Transit Regulation And Subsidization Under Asymmetric Information

Yanshuo Sun, PhD Candidate, the University of Maryland, College Park, MD, 20740, United States, yssun@umd.edu, Qianwen Guo, Zhongfei Li

This paper studies how to subsidize a monopolistic public transit operator with unknown production cost parameters. An incentive-compatibility regulatory mechanism which induces the operator to report its true parameter are design: government seeks to maximize social welfare by determining the transit service parameters and the subsidy to operator to induce its participation, and the operator implements the operation schedule to meet financial constraint. Comparison between complete and asymmetric information in terms of fixed cost and marginal cost are proposed. It will provide an effective tool for designing policies and evaluating practices regarding public transit subsidization.

2 - Effects Of Multiple Capacity Changes on Congestion Pricing Model To Handle "Day Of Operations" Airport Capacity Reduction

Abdul Qadar Kara, Asst. Professor, King Fahd University of Petroleum and Minerals, KFUPM Box 5067, Dhahran, 31261, Saudi Arabia, aqkara@kfupm.edu.sa

In an earlier work, a model was built on basic econometric principle of congestion pricing embedded within an optimization model. The model provided a mechanism to manage airport runway capacity reduction on "day of operations". The current work reports further analysis of the model, mainly its response towards the effect of multiple changes in runway access to arriving flights on both the schedule and the pricing.

3 - Price-compatible Matching Mechanisms For Carrier Collaboration

Su Xiu Xu, The University of Hong Kong, LG108, Composite Building, HKU, Pokfulam Road, Hong Kong, 999077, China, xusuxiu@gmail.com

This study is the first extending the existing market design theory to the field of supply chain and logistics management. It is known that money flow is not allowed in the matching markets like stable marriage, house allocation, and kidney exchange. In this study, we explore the potential of lane exchange among a number of self-interested truckload carriers in a collaboration network. We propose the (price-compatible) top trading cycles and deals (TTCD) mechanism and the price-compatible top trading cycles and chains (PC-TTCC) mechanism. Both mechanisms are effective in terms of the compatibility with money flow, strategy-proofness, the realized welfare of carriers, and budget balance.

4 - Dynamic Team Orienteering Problem

Emre Kirac, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States, ekirac@uark.edu, Ashlea Bennett Milburn

This study introduces the dynamic team orienteering problem (DTOP), which is a combinatorial optimization problem with many practical applications such as humanitarian relief logistics and tourist trip organizations. In DTOP, some locations are known at planning time while others are dynamic and each associated with a profit. The goal is to maximize collected profits by visiting a set of static and dynamic locations throughout a planning horizon within a specified timeframe. The multiple plan approach (MPA) is adapted to solve DTOP. Competitive ratio analysis using an offline algorithm is performed to assess the performance of MPA.

■ WD71

Electric- Omni

Game Theory IV

Contributed Session

Chair: Manxi Wu, Massachusetts Institute of Technology, 235 Albany Street, 3112B, Cambridge, MA, 2139, United States, manxiwu@mit.edu

1 - On Learning How Players Learn: A Mechanical Turk Experiment

Walid Krichene, University of California, Berkeley, Berkeley, CA, 94720, United States, walid@eecs.berkeley.edu

We consider a noncooperative game in which players compete for resources. In the online model, the game is played repeatedly and players update their strategies using an online learning algorithm. We study whether learning dynamics are descriptive of human behavior. We developed a web application to simulate the game, and used the Mechanical Turk platform to collect data on decision dynamics of human players. Using this data, we pose and solve a dynamics estimation problem, and show that a parameterized online model (based on the mirror descent method) can be descriptive of players' decision dynamics. We give qualitative insights, evaluate the predictive ability of this model, and discuss its limits.

2 - Better Bounds On Convergence Rates For First-order Methods In Sequential Games

Christian Kroer, Carnegie Mellon University, Computer Science Department, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, ckroer@cs.cmu.edu, Fatma Kılınç-Karzan, Kevin Waugh, Tuomas W Sandholm

First-order methods, are known to be very effective in solving large-scale two-player zero-sum extensive-form games. The convergence rates of these methods depend heavily on an associated distance-generating function. By introducing a new weighting scheme for the dilated entropy function, we develop the first distance-generating function for the strategy spaces of sequential games that has no dependence on the branching factor of the player. This significantly improves the convergence rate of several first-order methods. Numerical experiments further support the effectiveness of our new weighting scheme by demonstrating better practical convergence rates.

3 - Formulation Of A Continuous Equilibrium Mapping And A Simplicial Path-following Method For Approximating Proper Equilibria

Yabin Sun, City University of Hong Kong, Nam Shan Office-705, Hong Kong, yabinsun-c@my.cityu.edu.hk, Yin Chen, Chuangyin Dang

This paper formulates a continuous equilibrium mapping for a specifically defined perturbed game that deforms with an extra variable. As a result of this formulation, we develop a simplicial path-following method for approximating a proper equilibrium. The method follows a simplicial path that starts from any given totally mixed strategy profile and leads to a proper equilibrium. Numerical results further confirms the effectiveness of the method.

4 - Price Of Anarchy In Bayesian Congestion Games

Manxi Wu, Massachusetts Institute of Technology, 235 Albany Street, 3112B, Cambridge, MA, 02139, United States, manxiwu@mit.edu, Saurabh Amin

We study a new model of congestion games to understand the effects of asymmetric information on the equilibrium costs of individual players and the social cost. We present a full characterization of the Bayesian Wardrop Equilibrium (BWE) of the game by exploiting the properties of a weighted potential function. We compare the equilibrium cost in any BWE to the socially optimal costs under incomplete and perfect information structures. Our main result estimates the contribution to the price of anarchy (PoA) of the game due to two factors: selfish routing and information heterogeneity.

■ WD72

Bass- Omni

Supply Chain, Decision I

Contributed Session

Chair: Richard Titus, PhD Candidate at Penn State, Adjunct Lehigh Univ, The Pennsylvania State University, 310 Leonhard Building, University Park, PA, 16802, United States, rjt4@lehigh.edu

1 - Can A Buyer Benefit From Bounded Rationality?

Sha Luo, North Carolina State University, 4335 Avent Ferry Road, Apt 3, Raleigh, NC, 27606, United States, sluo3@ncsu.edu, Russell Edward King, Shu-Cherng Fang

Abstract: Bounded rationality takes into account that human decision makers are prone to biases and mistakes. General wisdom suggests that people fail to reap the highest level of benefits when they are not perfectly rational. In this study, we consider a supplier pricing game when the retailer is not a perfect optimizer. The decision model of bounded rationality is derived from the classical logit model. We apply the concept of Nash equilibrium to predict the rational outcome of the pricing game when two suppliers submit their wholesale prices simultaneously. It is found that bounded rationality can be advantageous to the buyer when her bounded rationality level is moderate.

2 - Using Point-of-sale Data To Improve Shelf Replenishment Performance

Suzanne de Treville, University of Lausanne, Anthropôle 3073, Lausanne-Dorigny, CH1015, Switzerland, suzanne.detreville@unil.ch, Valérie Chavez-Demoulin, Joerg S Hofstetter

Shelf replenishment for a retail chain is done once daily. Point-of-sale data lets us estimate the value of a second replenishment opportunity. We begin from a standard newsvendor approach with flexible second-replenishment capacity made available, and show that flexible capacity will often outperform capacity allocated at the level of single stock-keeping units. We define a “Demand at Risk” measure similar to Value at Risk in quantitative finance that captures the highest demand that might be reasonably encountered, and use machine-learning techniques to identify data features of the data that may signal increases in the Demand at Risk, warranting priority replenishment.

3 - A Structurally Enhanced Fuzzy Inference System Partner Selection Technique In Forming Virtual Enterprise

Shahrzad Nikghadam, PhD Student, Middle East Technical University, 425, graduate studies dorm,METU, Cankaya, Ankara, 06800, Turkey, shahrzad.nikghadam@metu.edu.tr, Hakki Ozgur Unver, Ahmet Murat Ozbayoglu, Sadik Engin Kilic

In this study we considered a partner selection problem of Virtual Enterprise in forming consortiums based on customer preferences. Previously, we have presented a Fuzzy Inference System (FIS) based methodology for the problem. Though, in this study, an enhanced form of the previous model is presented by editing the fuzzy rules and their reasoning structure. New rules are established by asking fewer questions from customer, yet the computational results show that it still gives the reasonable decisions by having less detailed information about the customer.

4 - Supplier Selection Models With Product Life Cycle Considerations

Richard Titus, PhD Candidate at Penn State, Adjunct Lehigh Univ, The Pennsylvania State University, 310 Leonhard Building, University Park, PA, 16802, United States, rjt4@lehigh.edu

This research examines the global supplier selection process and includes supplier attributes, determined by an empirical case study and product life cycle considerations. The empirical study examines the relationship of key supplier attributes to quality and delivery performance. Goal programming methodologies, including Preemptive, Non-preemptive, Chebycheff’s Min/Max and Fuzzy GP, are used to solve the multi-objective supplier selection problem for the four product life cycle phases. An illustrative example and an industrial case study are included in the testing of the supplier selection models.

■ WD73

Legends A- Omni

Operations Management VIII

Contributed Session

Chair: Donald Paul Warsing, North Carolina State University, College of Management, Campus Box 7229, Raleigh, NC, 27695-7229, United States, don_warsing@ncsu.edu

1 - Leveraging Suppliers To Calibrate Product Specification

Sha Liao, University of the Fraser Valley, Vancouver, BC, Canada, sha.liao@ufv.ca, Hao Zhang, Yimin Wang

We examine a two-period game between an Original Equipment Manufacturer (OEM) and his supplier during new product development. The supplier may detect specification problems during production. We first prove that it is strictly better for the OEM to design the contract so that the supplier will voluntarily point out specification problems. We then characterize the optimal contract for the OEM.

2 - Private Label Encroachment And Supply Chain Information Sharing

Xue Li, Tsinghua University, Beijing, China, xueli@mit.edu, Yanchong Zheng, Jian Chen

Our paper investigates the retailer’s private label encroachment strategy and its implications for the national brand manufacturer and the retailer in the environment where the national brand manufacturer may have private product intrinsic information. We consider information sharing via cheap talk in this setting, investigate the effects of private label encroachment on credible information sharing and show that the private label strategically introduced by the retailer may also benefit the national brand manufacturer.

3 - Supply Chain To Product Matching And Firm Performance

Donald Paul Warsing, North Carolina State University, College of Management, Campus Box 7229, Raleigh, NC, 27695-7229, United States, don_warsing@ncsu.edu, Mohamed Desoky, Russell Edward King, Mark Walker

We present an empirical analysis of Fisher’s (1997) conceptual model of supply chain-to-product matching. We use longitudinal COMPUSTAT data across several industries and develop proxies to measure Fisher’s characterizations of products (functional vs. innovative) and supply chains (efficient vs. responsive), and we find a strong, positive relationship between the strength of a firm’s market performance and the strength of the match between its product and supply chain characteristics.

■ WD74

Legends B- Omni

Ops Mgt/Marketing IV

Contributed Session

Chair: Zhenyu Gao, Tsinghua University, Room 430B, Zijing Department #14, Beijing, 100084, China, pjgzy1@163.com

1 - Omni-channel Retail In The Presence Of Operational Frictions

Xiaomeng Guo, Assistant Professor, The Hong Kong Polytechnic University, M628, Li Ka Shing Tower, Hung Hom, Kowloon, Hong Kong, xiaomeng.guo@wustl.edu, Panos Kouvelis, Danko Turcic

Some firms are implementing omni-channel strategies by offering consistent products and prices across their multiple channels, and some other firms essentially prevent seamless transition between different channels. Our paper provides a game-theoretical model to compare the traditional multi-channel and omni-channel strategies by focusing on product and price consistency.

2 - The Study About Crowdfunding Flight

Zihao Zhang, Master, University of Science and Technology of China, 96 Jinzhai Road, Management Research Building 613,Room, Hefei, 230026, China, zhangzih@mail.ustc.edu.cn, Liuyi Ling

Airline may have a loss when passenger load factor is very low due to high costs.So we try to solve the problem with crowdfunding.The study investigates the optimal pricing decision and other decisions about crowdfunding for OTA and airline with Stackelberg game.Results indicate that OTA can determines the optimal price and the lowest tickets sales to maximize its profit,in addition,we can get that lead time will be decided by rent and price. Airline will find the optimal rent according to decisions of OTA. The study also establish a contract to coordinate the supply chain consisting of OTA and airline.

3 - Equilibrium Power Structures In The Presence Of Stochastic Learning

Guowei Liu, Tianjin University, 92 Weijin Road, Nankai District, Tianjin, 300072, China, gwliu@tju.edu.cn, Yunchuan Liu, Jianxiong Zhang

This paper studies equilibrium power structures in a two-period model, where a manufacturer produces a product with stochastic batch learning and sells it to end consumers through a retailer facing a linear demand. The manufacturer and the retailer can implement a dynamic or commitment contract over both periods. We show that when the learning efficiency is sufficiently high, Vertical Nash and Retailer Stackelberg are the equilibrium power structures under the dynamic and commitment contracts, respectively. Meanwhile, the equilibrium power structures are beneficial to consumers. We also extend our main model to the continuous learning and non-linear demand cases.

4 - Storage Assignment In Mobile Fulfillment System

Zhenyu Gao, Tsinghua University, 14#430, Zijing Department, Beijing, 100084, China, gaozy14@mails.tsinghua.edu.cn, Chen Wang

In the thriving E-commerce market with expanding scale of customers and items, fulfilling large volume of small orders accounts for most of the operational cost. The mobile fulfillment system provided by Amazon dispatches large scale of robots to assemble multiple inventory pods with items needed simultaneously, which makes storage assignment more flexible by storing multiple items in one pod and saves cost significantly compared to traditional warehouses. We extract correlation information among items with factorization machines, which is then integrated into a clustering model for the assignment solution. Algorithms are developed both for the factorization machine and assignment model.

■ WD76

Legends D- Omni

Supply Chain Optimization

Contributed Session

Chair: Mohammad Komaki, Case Western Reserve University, 10900 Euclid Avenue, Cleveland, OH, 44106, United States, gxk152@case.edu

1 - Dynamic Decision Making In A Two Echelon Repairable Inventory System With Purchase And Order Options

Rana Afzali-Baghdadabadi, Operation Researcher, General Motors, 2462 John R Rd, # 107, Troy, MI, 48083, United States, rana.afzali@gm.com, Wooseung Jang

In this study, we consider a two echelon repairable parts inventory system, where emergency purchasing and ordering from a central warehouse are allowed to deliver high service levels to customers. A dynamic decision making model is developed that minimizes the system's operational costs, including transportation, stocking and purchasing. The numerical experiments show the benefits of purchasing and ordering options in the systems with high penalty costs and long repair times. The benefits are more significant in systems with tight inventories. Our analysis identifies the best inventory levels that minimize both the operational costs and the initial investments at the stock location.

2 - Procurement Under Price Uncertainty – An Analysis Of Operational Hedging Strategies

Ashutosh Sarkar, Associate Professor, Indian Institute of Management Kozhikode, IIM Campus, Kunnamangalam, Kozhikode, Kerala, Kozhikode, 673570, India, asarkar@iimk.ac.in, Goutam Sutar, Arun Kumar Misra

Consider a manufacturer procuring one of its raw materials from overseas sources. The manufacturer, while facing the risks of price uncertainty due to exchange rate fluctuations, needs to decide the timing, the source and the quantity of purchase. We modeled the manufacturer's decision problem as a multi-period inventory problem and showed that the (s, S) policy is optimal when the manufacturer buys only once during the planning horizon. We also evaluated various operational hedging strategies like, switching, postponement and switching with financial options.

3 - Additive Manufacturing In A Bio-medical Supply Chain: A Continuous Approximation Approach

Adindu Emelogu, PhD Student, Mississippi State University, Dept of Industrial & Systems Engineering, 479-2 Hardy Road, Mississippi State, MS, 39762, United States, aae39@msstate.edu, Sudipta Chowdhury, Mohammad Marufuzzaman, Linkan Bian

The fabrication of biomedical devices close to hospitals via Additive Manufacturing (AM) technology has been gaining popularity due to the many potential benefits it provides such as patient-customized parts, fast response, and reduced delivery cost. However, not much attention has been given to AM deployment methods which impact the supply chain and the amount reaped of these benefits. We propose a continuous approximation (CA) model that quantifies the supply chain network costs of AM-produced biomedical implants. We present an algorithm that optimizes the location of the AM centers and raw material inventory to satisfy the customers. We use hospitals in the southeastern USA as our case study.

4 - Considering Dynamic Demand On The Supply Chain Optimization Via Bargaining Models On A Common Replenishment Epochs Environment

José Velásquez, Universidad de los Andes, Calle 44D # 45-86 Int.1 Apto-503, Bogotá, 111321, Colombia, jl.velasquez1322@uniandes.edu.co, Jose Fidel Torres

In this work we present five different linear programing models to coordinate the supply chain inventories on a single-supplier, single-buyer environment for a variety of products. We considered the common replenishment epochs (CRE) approach on different scenarios where the demand faced by the buyer is dynamic. Depending on the case, one of the actors offers a compensation to the other, in order to accept a strategy for a fixed replenishment period. Finally, we conducted a numerical study to evaluate the benefits of the proposed coordination strategies.

5 - Heuristic Algorithm For Multi-criteria Procurement In Energy Systems

Mohammad Komaki, Case Western Reserve University, 10900 Euclid Avenue, Cleveland, OH, 44106, United States, gxk152@case.edu

Each distributed energy system has several agents, including customer, storage units, and energy source centers that produce energy. Each of these agents are connected to other agents either directly or through other agents and these connections form a network called energy distribution network. To find the optimal route, several heuristic algorithms have been developed. All of the developed algorithms are for a single objective function. However, in reality, decision-makers have to consider several criteria simultaneously. Therefore, the problem is a multi-criteria problem. In this study, we propose multi-criteria heuristic algorithm based on Dijkstra's algorithm.

■ WD77

Legends E- Omni

Opt, Large Scale II

Contributed Session

Chair: Helder Inacio, Sabre Holdings Inc, 3150 Sabre Drive, Southlake, TX, 76092, United States, Helder.Inacio@Sabre.com

1 - Inexact Block Coordinate Descent Methods For Symmetric Nonnegative Matrix Factorization

Haoran Sun, Iowa State University, Ames, IA, United States, hrsun@iastate.edu, Qingjiang Shi, Songtao Lu, Mingyi Hong, Meisam Razaviyayn

Symmetric nonnegative matrix factorization (SNMF) is equivalent to computing a symmetric nonnegative low rank approximation of a data similarity matrix. It inherits the good interpretability of the NMF technique and performs better on nonlinearly separable data. In this paper, we focus on the algorithmic aspect of the SNMF problem and propose simple inexact block coordinate decent methods, leading to both serial and parallel algorithms. The proposed algorithms have guaranteed stationary convergence and can efficiently handle large-scale and/or sparse SNMF problems. Extensive simulations verify the effectiveness of the proposed algorithms compared to recent state-of-the-art algorithms.

2 - Generalized Sparse Precision Matrix Selection For Fitting Multivariate Gaussian Random Fields To Large Data Sets

Sam Davanloo, The Ohio State University, Columbus, OH, United States, sdt144@vt.edu, Necdet Serhat Aybat, Enrique Del Castillo

This paper generalizes the Sparse Precision matrix Selection (SPS) algorithm, proposed by Davanloo et al. (2015),for estimating scalar Gaussian Random Field (GRF) models, to the multivariate, second-order stationary case under a separable covariance function. Theoretical convergence rates for the estimated covariance matrix and for the estimated parameters of the correlation function are established. Numerical simulation results validate our theoretical findings. Data segmentation is used to handle large data sets.

3 - Large Scale Distributed Hessian-free Optimization For Deep Neural Network

Xi He, Lehigh University, 837 Cedar Hill Drive, Allentown, PA, 18109, United States, xih314@lehigh.edu, Martin Takac

It is well known that the optimization problem derived from deep neural network is always in high dimension with high non-convexity. In this paper, we revisit Hessian-free optimization method for deep network and develop its distributed variant which can utilize computing cluster to train large models. Furthermore, we propose new algorithm to explore negative curvature direction by solving the subproblem with BICGSTAB method involving possible indefinite true batch Hessian information. We show that these techniques accelerate the training process of deep neural network and sharing considerable speed-up by increasing number of nodes.

4 - Comparing Different Approaches To Solve Airline Crew Recovery Problem

Helder Inacio, Sabre Holdings Inc, 3150 Sabre Drive, Southlake, TX, 76092, United States, Helder.Inacio@Sabre.com, Chunhua Gao, Ramakrishna Thiruveedhi

Airline Crew Recovery can greatly reduce impact caused by disruptions by assigning new rosters to crew. We compare different approaches that can be used to solve this problem. The first approach is optimization based and is focused on reducing overall cost by exploring all recovery options. Other heuristic approaches focus on obtaining fast solutions but have limited search space. We analyze the quality of solutions obtained by using different strategies. We compare the benefits and drawbacks of using these in real-time recovery. The comparisons are made on realistic scenarios of varying size and type of disruption.

■ WD78

Legends F- Omni

Opt, Metaheuristics

Contributed Session

Chair: Hasmukh Gajjar, Associate Professor, Indian Institute of Management Indore, Rau-Pithampur Road, C#208, Prabandh Shikhar, Indore - Madhya Pradesh, 453331, India, hasmukh@iimidr.ac.in

1 - Building And Exploring Multiple Time-to-target Plots (m-tttplots) To Compare Randomized Algorithms

Celso C Ribeiro, Full Professor, Universidade Federal Fluminense, Rio de Janeiro, Brazil, celso.ribeiro@gmail.com, Alberto Reyes

Time-to-target plots (tttplots) for each problem instance are a useful tool to characterize, evaluate, and compare the behavior of randomized heuristics for combinatorial optimization problems. Multiple time-to-target plots (m-tttplots) are their natural extension to sets of multiple instances. We show how to build an m-tttplot from the individual tttplots for each instance in the set and we illustrate several case studies to illustrate the applicability and usefulness of the newly proposed m-tttplots tool.

2 - Guided Tabu Algorithm For Parallel Optimization

Hesam Shams, PhD Student, University of Tennessee, 851 Neyland Drive, 525 John D Tickle Engineering Building, Knoxville, TN, 37996, United States, hshams@vols.utk.edu, Oleg Shylo

We consider a large class of optimization algorithms that explore solution space by moving from one solution to another via some local neighborhood structure. To enhance the performance of such techniques, we explore effective and scalable methods for storing information about visited solutions to guide future search steps. In particular, we investigate an extension of the tabu search methodology by integrating a long term memory with tabu list dynamics. The proposed algorithm and its parallel version was tested on well-established benchmark instances of job shop scheduling and max-cut problems revealing excellent computational performance.

3 - Heuristics For The Steiner Traveling Salesman Problem

Celso C Ribeiro, Universidade Federal Fluminense, Rio de Janeiro, Brazil, celso.ribeiro@gmail.com, Ruben Interian

Given a weighted undirected graph and a set of required vertices, the Steiner traveling salesman problem seeks a minimum weighted closed walk on the graph that visits all required vertices. Since a walk is sought, some vertices may be visited more than once. Similarly, some edges may be traversed more than once. We describe a set of benchmark instances and present numerical results obtained with a GRASP heuristic developed for this problem.

4 - Statistical Bounds For Grasp Heuristics Of Np-hard Problems

Mengjie Han, PhD, Dalarna University, Högskolan Dalarna, 791 88 Falun, Sweden, Falun, 791 88, Sweden, mea@du.se, Kenneth Carling

This work aims at providing statistical bounds for Greedy Randomized Adaptive Search Procedures (GRASP) to NP-hard problems. The quality of the solution to the NP-hard problems is always difficult to be evaluated due to the pre-set the number of iterations. The studies of suggesting statistical bounds as evaluation methods are rare. Thus, we propose the statistical estimator with confidence intervals for GRASP heuristics where four classical NP-hard problems are tested. We also suggest examining a new statistic SR for a stopping rule as a complimentary criteria when probabilistic stopping rules are used.

5 - Optimal Shelf Space Allocation And Inventory Planning For Fresh Produce In Retail Store

Hasmukh Gajjar, Associate Professor, Indian Institute of Management Indore, Rau-Pithampur Road, C#208, Prabandh Shikhar, Indore - Madhya Pradesh, 453331, India, hasmukh@iimidr.ac.in, Bhavin J. Shah

We consider the stock-dependent demand for fresh produce in a retail store. This paper formulates a mathematical model for joint optimization of shelf space allocation and inventory replenishment.

■ WD79

Legends G- Omni

Opt, Combinatorial II

Contributed Session

Chair: Prasanna Ramamoorthy, IIM Ahmedabad, Vastrapur, Ahmedabad, 380015, India, prasannar@iima.ac.in

1 - An Exact Algorithm For The Covering Capacitated Vehicle Routing Problem

Christopher John Wishon, Arizona State University, Tempe, AZ, United States, cwishon@asu.edu, J. Rene Villalobos

The Covering Capacitated VRP is similar to the traditional VRP except customers can have their demand serviced by a vehicle stopping at a nearby location assuming that the visited location is within the predetermined service radius of the customer seeking service. This problem is applicable to many VRP applications including the planning of emergency services and mobile retailers. An exact solution method is presented based on the set covering formulation. A branch-and-price methodology was employed and feasible covering routes were generated as needed. The algorithm was tested on existing data sets with the results demonstrating the technique was able to solve problems with up to 50 customers.

2 - Heuristics For The Covering Capacitated Vehicle Routing Problem

Christopher John Wishon, Arizona State University, Tempe, AZ, United States, cwishon@asu.edu, Guilherme Sproesser Ferreira, J. Rene Villalobos

The covering VRP is a variant of the traditional VRP in which a vehicle can satisfy a customer's demand by visiting one out of a set of predetermined alternate locations within the network. This variant is motivated by many practical applications including the routing of mobile retailers, urban bus lines, and emergency vehicles. In this work, the Greedy, Sweep, Savings, and Ant Colony Heuristics are adapted to solve the covering VRP. These techniques are employed to solve nearly 200 test instances and the results are compared to any known optimal solutions. These results demonstrate the superiority of the Ant Colony and Savings methods.

3 - New Formulations For The Hub Interdiction Median Problem

Prasanna Ramamoorthy, IIM Ahmedabad, Vastrapur, Ahmedabad, 380015, India, prasannar@iima.ac.in

In this work, we present new formulations for the hub interdiction median problem. We present a bi-level formulation and explore reducing it to a single level using KKT(Karush - Kuhn - Tucker) conditions and closest assignment constraints. We present new closest assignment constraints for the problem in addition to the existing ones in literature (Lei 2013). The new closest assignment constraints has some interesting properties which aids in solving the problem efficiently. We also present computational results highlighting the efficiency of the closest assignment constraints and the proposed model in solving the problem.

■ WD80

Broadway E- Omni

Retail Mgt I

Contributed Session

Chair: Kamal Lamsal, Assistant Professor, Emporia State University, Campus Box 4039, 1 Kellogg Circle, Emporia, KS, 66801, United States, klamsal@emporia.edu

1 - Efficient Workforce Scheduling In Retail Stores Considering Overtime Or Part-time Workforce

Peeyush Pandey, Doctoral Student, Indian Institute of Management, Indore, IIM Indore, Indore, 453331, India, f12peeyushp@iimidr.ac.in, Hasmukh Gajjar, Bhavin J. Shah

This paper deals with the problem of identifying optimal workforce size and their schedule to satisfy hourly and daily requirements of workers at the retail store. We consider a multiple day planning horizon divided into periods of equal length for the retail store that caters to daily requirement of customer and offers a wide variety of product. An optimization model is proposed for both overtime and part-time workers considering different shift lengths and different lunch and tea breaks during the working shift. A heuristic presented in the paper guarantees to obtain optimal number of workers and their schedule.

2 - Analyzing Impact Of Cardinality And Similarity Context-effects On Assortment Optimization

Uzma Mushtaque, Rensselaer Polytechnic Institute, 110 8th St, Troy, NY, 12180, United States, uzmamu@rpi.edu, Jennifer Pazour

Assortment planning problem in an online retail environment explicitly modeling no-choice behavior is presented. Difficulty of selecting an item under cardinality-context effects and the attraction due to underlying utility are modeled as the fundamental driver's behind opting for no-choice. Optimality conditions are developed for cardinality context effects and for an interaction of cardinality with similarity effects. Three different algorithms exploit the structure of the optimal solution under these two conditions.

3 - Assortment Planning And Replacement Under Attractiveness Decay Effect

Huiqiang Mao, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong, 000, Hong Kong, huiqiangm@gmail.com, Yanzhi Li

Inspired by assortment renewal strategies of many industries, we consider the capacitated assortment planning and replacement problem, where the attractiveness of the product decays over time. Based on Locational Choice Model, we characterize the structural properties of the optimal assortment. We also consider the assortment replacement problem, where the retailer is allowed to update the assortment over the horizon. We explore conditions under which the retailer should employ this replacement strategy.

4 - The Phantom Inventory Menace: The Effect Of Unobserved Stock-outs On Lost Sales

Fredrik Eng-Larsson, Postdoctoral Associate, MIT Center for Transportation and Logistics, Boston, MA, United States, frengl@mit.edu, Daniel Waymouth Steeneck

Based on retail audit data, we find retail inventory records are an unreliable indicator of out-of-stock (OOS) events. Worse yet, the records are rarely validated or corrected. As a result, many OOS event are never observed in the inventory record. We estimate the impact of the unobserved OOS events on lost sales via a novel demand estimation technique, which accounts for inventory uncertainty in the presence of scarce inventory record validation.

5 - Warehousing And Shipping Decisions For An Online Replacement Parts Retailer

Kamal Lamsal, Assistant Professor, Emporia State University, Campus Box 4039, 1 Kellogg Circle, Emporia, KS, 66801, United States, klamsal@emporia.edu, Amit Kumar Verma

Online replacement parts sellers offer big selection of products. These products are held in several locations. With every incoming order, the seller must decide whether to split the various items from one order or not and from where each item will ship. We work with an online OEM parts retailer which competes on customer service level. The retailer charges a flat shipping fee per product and promises a delivery time. We develop an Approximate Dynamic Programming (ADP) based algorithm that makes shipping decisions by minimizing the on hand shipping cost plus estimate of future shipping costs. We use the lessons from the exercise to decide which parts should be located in which warehouse.

■ WD82

Broadway G- Omni

Multicriteria Decision I

Contributed Session

Chair: Yuji Sato, Professor, Chukyo University, 101 Yagotohonmach, Showa, Nagoya, Aichi, 466-8666, Japan, ysatoh@1988.jukuin.keio.ac.jp

1 - Financial Decision-maker's Preferences Modeling Within Goal Programming Model

Belaid Aouni, Associate Dean, Qatar University, College of Business and Economics, Al Jamiaa Street, Doha, 2713, Qatar, belaid.aouni@qu.edu.qa

Goal Programming (GP) model has been applied to financial portfolio selection problem where several conflicting and incommensurable attributes are simultaneously aggregated, such as return, risk and liquidity . The aggregation of the conflicting attributes requires some compromises from the Financial Decision-Maker (FDM) based on his/her preferences. The aim of this paper is to present a new typology of the FDM's preferences modeling within the GP model for financial portfolio selection.

2 - Rethinking Sfpark'S Demand Response Pricing

Tayo Fabusuyi, Research Associate, University of Michigan, 5520 Baywood Street, Floor #3, Ann Arbor, MI, 15206, United States, Fabusuyi@umich.edu, Robert Hampshire

In an effort to eliminate circling and reduce parking search time and cruising, SFpark, an innovative demand-responsive pricing program was implemented by the City of San Francisco. Over a two year period, the program was piloted across seven San Francisco neighborhoods made up of 256 distinct parking blocks. The evaluation of the pilot program has however met with mixed reviews particularly with regards to the relationship between price changes and occupancy levels. These issues are addressed by employing a non-dominated sorting genetic algorithm approach from which figures of merit are generated that allow for an objective comparison between treatment and control blocks.

3 - Assets And Liabilities Management Within An Integral Risk Framework For A Microfinance Institution

Tayo Fabusuyi, Numeritics, Pittsburgh, PA, Contact: Tayo.Fabusuyi@numeritics.com

While the microfinance industry has recorded some success in providing financial services to the poor, it has also attracted criticism with regards to the quality of services offered and the lack of a robust risk framework observed across the industry. Using data over a period of a decade (2006-2016), our study addresses these concerns by employing a multiple-criteria decision analysis which provides management with a menu of measures of risk-return tuples that maintains fidelity to the bank's non-financial constraints. The approach is enumerated using Grameen Bank as a case study.

■ WD83

Broadway H- Omni

Supply Chain Mgt, General

Contributed Session

Chair: Mengyang Pan, PhD Candidate, The Ohio State University, Columbus, OH, United States, pan.295@osu.edu

1 - An Eco-urban Logistics Network Design Problem Based On Truck-related Greenhouse Gas Emissions

Mi Gan, Associate Professor, Southwest Jiaotong University, Jinniu District, 111 N 1st Erhuan Road, Chengdu, 610031, China, migan@swjtu.cn, chen si, Zhenggang He

Through multivariate regression analysis on greenhouse gas (GHG) emission rate and truck trajectory data, the GHG emissions function of various kind of logistics facility is obtained. Then, the eco-facility location problem is modeled by integrating pure facility location model and GHG emissions function. Through experiments on real case, the effectiveness of models and algorithms were verified. The eco-facility location model for ULN is tending to obtain the location decision environmentally friendly.

2 - The Interaction Of Forward And Reverse Supply Chains

Qiang Qiang, Penn State, Management Division, 30 E Swedesford Rd, Malvern, PA, 19355, United States, qzq10@psu.edu, Min Yu

In this paper, we study the interaction between a forward supply chain and a reverse supply chain network. In particular, we study the impact of the change in the forward supply chain on the reverse supply chain. Managerial insights are generated from numerical results.

3 - A Strategic Analysis Of a Green Manufacturer With a Risk Averse Retailer Under a Green Supply Chain

Yushan Jiang, Tianjin University, 92 Weijin Road, Tianjin, China, yshjiang@tju.edu.cn, Bo Li

The green manufacturer produces green products in a green supply chain. Considering the trade-off between the R&D investment and returns of green products, the manufacturer decides the wholesale price and the green innovation level. The manufacturer and the retailer adopt the Retail Price Recommendations policy. As the follower in the Stackelberg game, the retailer decides the order quantity. The Conditional value-at-risk (CVaR) criterion is used to evaluate the retailer's risk-averse behavior and we analyze the impacts of the risk-averse level and the innovation cost on member's decisions in both decentralized and centralized supply chain. Channel coordination is also investigated.

4 - Third-party Remanufacturing: Authorization Or Not?

Mingzhou Jin, Professor, University of Tennessee-Knoxville, 525D John D. Tickle Engineering Building, Industrial and Systems Engineering, Knoxville, TN, 37996, United States, jin@utk.edu

The high profit margin of remanufacturing has attracted many third party remanufacturers (TPRs). The presence of remanufactured products, authorized or not, has complex effects on the demand of new products. When an OEM authorizes a TPR, the presence of remanufactured products will lower the consumers' perceived value of new products but OEM can get authorization fee. Without authorization, the presence of remanufactured products will enhance the valuation for the new products. This studies investigates the impact of authorization on OEM and TPR's decisions and further discuss conditions under which OEM will authorize remanufacturing.

5 - When Should Small Firms Collaborate Externally on R&D? A Study Of NIH SBIR/STTR Awards

Mengyang Pan, PhD Candidate, The Ohio State University, Columbus, OH, United States, pan.295@osu.edu, Aravind Chandrasekaran, James Hill, Manus Rungtusanatham

Research on external R&D collaboration predominantly focuses on large firms. Small businesses face different challenges when collaborating externally on R&D. This study uses longitudinal data from the National Institute for Health (NIH) on how small businesses choose their levels of external collaboration, and how this choice affects their R&D commercialization capability.

■ WD84

Broadway J- Omni

Supply Chain, Risk IV

Contributed Session

Chair: Florian Lucker, EPFL, EPFL-Tom, Odyssea 416, Lausanne, 1015, Switzerland, florian.luecker@epfl.ch

1 - Risk Management Using Structural Controllability For Resilient Supply Networks

Amirhossein Khosrojerdi, University of Oklahoma, 1021 East Brooks Street, Norman, OK, 73071, United States, akhosrojerdi@ou.edu, Janet K. Allen, Farrokh Mistree

A resilient supply network is one that has the ability to recover quickly from disruptions and ensure customers are minimally affected. Designing the structure of supply networks to be controllable is a way toward resilience. A method is proposed to manage risk in supply networks under disruptions using design for resilience and design for structural controllability.

2 - Measuring The Supply Chain Risk In Global Sourcing

Hokey Min, James R. Good Chair in Global Supply Chain Strateg, Bowling Green State University, 1001 Wooster Street, College of Business 3008C, Bowling Green, OH, 43403, United States, hmin@bgsu.edu

In times of prolonged financial crisis across the globe, a growing number of MNFs have focused their attention on cost saving opportunities through offshoring in LCCs. However, an indiscreet strategy of sourcing from LCCs can do more harm than good, since invisible supply chain risks may increase hidden costs and subsequently more than offset cost saving opportunities. Considering the potential impact of these risks on global sourcing, this paper aims to identify risk factors that significantly hinder the efficiency of offshoring and then measure specific risks associated with offshoring in foreign countries.

3 - Preponement Instead Of Postponement: Two-echelon Disruption Risk Management Under Stochastic Demand

Florian Lucker, EPFL, EPFL-Tom, Odyssea 416, Lausanne, 1015, Switzerland, florian.luecker@epfl.ch Sunil Chopra, Ralf W Seifert, Ralf W Seifert

We consider the multi-echelon inventory problem in the presence of disruption risk and stochastic demand. We derive novel structural insights on optimal inventory levels for the three supply chain topologies: serial, assembly and distribution. We show that an early commitment of end-product inventories is beneficial, as opposed to a delayed differentiation of the end-product. We further provide conditions when risk diversification occurs for two-echelon distribution supply chains.

■ WD85

Broadway K- Omni

Sustainability IV

Contributed Session

Chair: Avijit Raychaudhuri, Doctoral Candidate, Nanyang Technological University, 50 Nanyang Avenue, South Spine S3-01B-73, Division of IT & Operations Management, Singapore, 639798, Singapore, avijit001@e.ntu.edu.sg

1 - The Role Of Social Planner In Closed-loop Supply Chain

Lan Wang, California State University at East Bay, 25800 Carlos Bee Blvd., Management Department, VBT 345, Hayward, CA, 94542, United States, lan.wang@csueastbay.edu, Tharanga Kumudini Rajapakshe, Asoo J Vakharia

In recent years, as remanufacturing has significantly increased all over states, recycling of the un-remanufactured products and disposal treatment become a hot potato. Our paper studies the problem of legislation practices on who should be responsible for recycling, and compares the existing mechanisms on the efficiency of environmental protection. In particular, we compare two models.Given different social objectives - prioritized consumer welfare, prioritized environmental benefit, or jointly social objective, we aim to provide roadmap to the social planner on legislation and incentives for remanufacturing and the end-of-life/use product recycling activities.

2 - Towards A Theoretical Framework Of Sustainable Operations Strategy

Yeming Gong, Em Lyon Business School, Building B, Office 1018, 23 Avenue Guy De Collongue, Ecully, 69134, France, gong@em-lyon.com

This paper conducts an integrated analysis of quantitative and qualitative data to study Sustainable Operations Strategy in retailing industry. (1) In quantitative study, using a sample of about 100 organizations we apply structural equation modeling to understand nonlinear relationship among cross-value integration, supply chain coordination and integration, and the performance of sustainable supply chain. (2) In qualitative study, we conducted case studies to validate quantitative results and conducted the archive qualitative analysis for about 50 organizations to provide additional management insights.

3 - Determinants For A Sustainable Relationship In Outsourcing – A Case Study

Mousumi Modak, PhD Student, IIT Kharagpur, Room No-1F-4, VGSOM, IIT Kharagpur, West Midnapore, West Bengal, Kharagpur, 721302, India, mousumimodak10@gmail.com, Khanindra Pathak, Kunal Kanti Ghosh

The growing dependence of firms on service providers for achieving competitive advantage has necessitated the development of long-term sustainable relationship with them. Opportunism has been recognized as one of the vulnerabilities affecting an enduring relationship. The objective of this paper is to examine the antecedents of opportunism and identify their effects on the exchange relationship in the context of outsourcing for the coal mining organization in India.

4 - Strategic Disclosure Of Environmental And Social Performance: Greenwashing In Supply Chains Under Activist Pressure

Avijit Raychaudhuri, Doctoral Candidate, Nanyang Technological University, Division of IT & Operations Management, 50 Nanyang Avenue, South Spine S3-01B-73, Singapore, 639798, Singapore, avijit001@e.ntu.edu.sg, S Viswanathan, Fang Liu

Economic gains derived by firms from voluntarily disclosing positive and negative environmental and social performances are generally complicated. Greenwashing occurs when a firm voluntarily discloses information about its performances in such a way that it portrays an overall greener image than what it actually is. We characterize a firm’s optimal policy for disclosure of environmental and social performances under non-linear and non-monotonic economic gains from disclosure derived by the firm. Further, we study the efficacy of activist power of penalizing a greenwashing firm in accordance with the magnitude of greenwashing, as opposed to penalizing according to a fixed penalty.

■ WD88

Broadway B-Omni

Military Applications IV

Contributed Session

Chair: Fikri Kucuksayacigil, Iowa State University, 610 Squaw Creek Drive, Unit 18, Ames, IA, 50010, United States, fksayaci@iastate.edu

1 - Finding A Hider By An Unknown Deadline

Kyle Y Lin, Associate Professor, Naval Postgraduate School, 1411 Cunningham Rd, Monterey, CA, 93943, United States, kylin@nps.edu, Dashi Singham

An object is hidden among several locations. Each search at the object’s location independently finds the object with some location-dependent probability. The goal is to find the object by a deadline, but the deadline is unknown. Assuming the worst-case scenario, where Nature knows the deadline and uses this knowledge to hide the object to hinder the search, this paper shows that there is a randomized search strategy that simultaneously maximizes the probability of finding the object by any deadline.

2 - Planning Effective Police Patrol Routes On Urban Road Networks

Ruben Dario Yie Pinedo, Universidad del Norte, Barranquilla, Colombia, ryie@uninorte.edu.co, Andrea Margarita Ditta Narváez

It is well-known that police patrolling is one of the best preventive practices for public safety against urban crimes. This work, deals with the problem of planning police patrol routes to minimize the overall risk at minimum cost. A specific mathematical formulation models the problem, under critical time constraints and resources. Algorithms of local search and evolutionary techniques, offers effective solutions for this model. A case study in Barranquilla (Colombia), allows validate the performance of our approach in real scenarios.

3 - Modeling Long Term Radiation Fatalities In The National Operational Environment Model

Venkat Venkateswaran, Rensselaer Polytechnic Institute, Room 725, RPI-Hartford, Hartford, CT, 06120, United States, venkav3@rpi.edu

The National Operational Environment Model is a systems dynamics model that recreates in software a model of any nation of interest. The goal is to capture the essential features of the nation so that an analyst can then simulate and analyze in software different intervention actions. We describe our models for estimating long term radiation fatalities arising from a nuclear explosion. They are based on the latest update of the long-running Life Span Study which we briefly describe. These long term fatalities appear in two disease groups: cancers and heart and circulatory diseases.

4 - Development Of Text Analytic Tools Focused On Application To Military Specific Corpora

Nathan L Parker, MAJ, TRADOC Analysis Center - Monterey, 700 Dyer Road, Room 178, Monterey, CA, 93943, United States, nparker@nps.edu, Theodore T Allen, Zhenhuan Sui

Large volumes of free text data present many challenges to analysts, especially when working in time-constrained environments. This research focuses on the development of text analytic tools, primarily topic model based, that can enable military analyst to quickly process large free text data sets. This presentation will discuss our research into text analytic tool development, including supporting visualizations, along with the application of the tools in several field use cases.

■ WD90

Broadway D-Omni

Health Care, Strategies

Contributed Session

Chair: Tuomas W Sandholm, Professor, Carnegie Mellon University, Gates Center for Computer Science, Carnegie Mellon University, Pittsburgh, PA, 15213, United States, sandholm@cs.cmu.edu

1 - Assessing The Long-term Value Of Non-clinical Prevention: Improving Life Paths Through Early Childhood Investments

George J. Miller, Institute Fellow, Altarum Institute, 3520 Green Court, Suite 300, Ann Arbor, MI, 48105, United States, george.miller@altarum.org, Charles Roehrig

We illustrate use of a life-path approach to estimate the long-term benefits of early childhood interventions such as perinatal home visits and preschool education. A life path describes an age cohort’s progression through the life course, as characterized by rates of morbidity, mortality, health care costs, earnings, incarceration, and public support. The approach represents the effects of an intervention as a shift from one multi-dimensional life path to a more favorable one and estimates the associated economic value to potential investors, including federal, state, and local governments.

2 - A System Dynamic Model Of Human Papillomavirus Vaccination

Nasser Sharareh, PhD Student, State University of New York at Binghamton, Binghamton, NY, United States, nsharar1@binghamton.edu, Nasim Sabounchi, A. Serdar Atav, Nicole Rouhana

Human papillomavirus (HPV) is a sexually transmitted infection (STI), with a 8.1% incidence rate among boys aged 13-17 years within United States. Although HPV vaccination is available, however the vaccination rate in 2014 was only 22% among boys. It is necessary to study the barriers and facilitators in increasing the uptake of the vaccine among this group of adolescents. In this paper we use a system dynamics simulation method to understand how psychological, socio-economic, and health system factors influence the completion of recommended series of HPV vaccination among adolescents boys.

3 - Hospital Payment Schemes Under Competition

Zheng Han, University of Kansas, Lawrence, KS, United States, hanzheng@ku.edu, Mazhar Arikan, Suman Mallik

We consider two hospitals competing for patients and operating under different payment schemes. Using a game-theoretic approach, we determine equilibrium operating parameters and develop intuitions for healthcare policies.

4 - Sequential Planning For Steering Immune System Adaptation

Tuomas W Sandholm, Professor, Carnegie Mellon University, Gates Center for Computer Science, Carnegie Mellon University, Pittsburgh, PA, 15213, United States, sandholm@cs.cmu.edu, Christian Kroer

Biological adaptation is a powerful mechanism that makes many disorders hard to combat. We study steering adaptation through sequential planning. We propose a general approach that leverages Monte Carlo tree search to compute a treatment plan, and the biological entity is modeled by a simulator. We apply the framework to a leading T cell simulator. We run experiments with two alternate goals: developing regulatory T cells or effector T cells. The former is key for preventing autoimmune diseases; the latter is associated with better survival rates in cancer patients. We show that for the development of regulatory cells, sequential plans yield significantly higher utility than the best static therapy.

Wednesday, 4:30PM - 6:00PM

■ WE01

101A-MCC

Data Mining in Manufacturing

Sponsored: Data Mining

Sponsored Session

Chair: Mojtaba Khanzadeh, Mississippi State University, 21 Ace Avenue, 21 Apartments, Starkville, MS, 39759, United States, mk1349@msstate.edu

1 - A Congestion Prediction-based Dynamic Routing Model In Automated Material Handling Systems

Sang Min Lee, Senior Researcher, Samsung Electronics, 816 ChanguiKwan, Korea Univ., 145 Anam-ro, Seongbuk-gu, Seoul, Korea, Republic of, smlee5679@gmail.com, Jee Hyuk Park

In automated material handling systems of semiconductor manufacturing, vehicular congestion is a persistent problem resulting in the reduction of production efficiency. In order to effectively route vehicles to reduce traffic congestion, this study presents a congestion-avoidance routing model based on congestion prediction. A congestion prediction model is proposed to predict the possibility of probable heavy congestion that can lead to significant production loss. The effectiveness of the proposed model is demonstrated by using real data supplied by a semiconductor fabrication plant in South Korea.

2 - Profile Monitoring And Fault Diagnosis Via Sensor Fusion For Multi-stream Data

Weihong Guo, Assistant Professor, Rutgers, The State University of New Jersey, 96 Frelinghuysen Rd, CoRE Rm 220, Piscataway, NJ, 08854, United States, wg152@rutgers.edu

When multiple signals are acquired from different sources, sensor fusion and data dimension reduction are two major issues to achieve a better comprehension of the process. Methods for analyzing multi-stream profiles based on multilinear discriminant analysis and ensemble learning are proposed in this research for the purpose of profile monitoring, fault detection, and fault diagnosis. The proposed methods are compared with state-of-the-art methods with both simulated and real data.

■ WE02

101B-MCC

Data Mining Applications

Sponsored: Data Mining

Sponsored Session

Chair: Leily Farrokhvar, West Virginia University, 395 Evansdale Drive, Morgantown, WV, 26506, United States, leily@vt.edu

1 - An Analysis Of Charitable Givings And Donor Behavior

Negar Darabi, Graduate Student Researcher, West Virginia University, Morgantown, WV, 26506, United States, nedarabi@mix.wvu.edu, Leily Farrokhvar, Azadeh Ansari

While charitable givings are typically a noticeable portion of the GDP and there is abundant data available through tax forms, there has been few systematic studies to identify contributing factors and predict donor behavior. Additionally, disasters are shown to have a significant temporary effect on charitable givings. In this study, we analyze the historic data using regression models to identify the most influential factors and analyze impact of natural disasters on donor behavior.

■ WE03

101C-MCC

Big Data I

Contributed Session

1 - Crew Assignment Subject To Flight Delay Risks

Hing Kai Chan, Associate Professor, University of Nottingham Ningbo China, 199 Taikang East Road, Room AB260, Ningbo, 315100, China, hingkai.chan@nottingham.edu.cn, Sai Ho Chung, Jing Dai

Crew cost ranks as the second highest cost of flight operations, but failure of assigning sufficient crew members to a flight will lead to flight disruption such as delay. The dilemma is obvious. This study adopts a big-data approach by utilizing historical flight arrival delay data and a learning algorithm to predict such risks for optimizing crew assignment. Numerical experiment demonstrates that the proposed algorithm can increase the flight stability, meanwhile minimize the total disruption cost induced.

2 - Developing A Dynamic Tool For Transplant Survival Analysis

Hamidreza Ahady Dolatsara, PhD Candidate, Auburn University, Suite 3301, 345 West Magnolia Ave., Auburn, AL, 36849, United States, hamid@auburn.edu, Ali Dag, Bin Weng, Fadel Mounir Megahed

This study present a toll developed for three types of survival analysis for the transplants. In the first type, it estimates if a patient could survive certain time windows which are integer multiples of one year. As the second type, it yield probability of survival. This tool also estimates expected survival time. Surgeons or other practitioners could utilize it based on their available data from their patients and donors. These data are collected during the registration, waiting list, operation, and after the operation. The tool utilizes machines learning methods to identify the importation features and then utilizes the features for model training and delivering a requested analysis.

3 - An Optimization Approach To Detection Of Epistatic Effects

Maryam Nikouei Mehr, PhD Student, Iowa State University, 3004 Black Engineering, Ames, IA, 50011, United States, mnmehr@iastate.edu, Lizhi Wang

Epistasis refers to the phenomenon where the interaction of multiple genes affects a certain phenotype more than they do separately. Similar epistatic effects are also ubiquitous in other application areas, where a certain effect is only observable when a particular combination of multiple factors is present. Due to the enormous solution space, it's hard to detect the epistatic effect. We propose an optimization model that attempts to detect epistatic effects where a large number of observations are available for a relatively small number of explanatory factors. We will share our preliminary results and discuss future research directions.

4 - Warehouse Process Improvement Through Data Analytics And Optimization

Vedat Bayram, Postdoctoral Research Fellow, University of Waterloo, 200 University Ave. West, Waterloo, ON, N2L 3G1, Canada, vbayram@uwaterloo.ca, Fatma Gzara, Samir Elhedhli

With the advance of the technologies on collecting and storing data, warehouses, from the most automated to the manual, generate large amounts of data. Warehouse management companies are seeking ways to get the full value from the massive amounts of data and use it as a competitive advantage in the marketplace. In this presentation, we report on data analytics solutions for a warehouse management and control systems company. We develop descriptive tools to analyze the big data of e-retailing warehouses and identify process improvement opportunities. We develop data driven optimization solutions and validate by comparing to real system operation.

■ WE04

101D-MCC

Capacity-Expansion Planning with Increasing Renewable Levels

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Ramteen Sioshansi, Ohio State University, 1971 Neil Avenue, Columbus, OH, 43210, United States, sioshansi.1@osu.edu

Co-Chair: Antonio J. Conejo, The Ohio State University, 1971 Neil Avenue, Columbus, OH, 43210, United States, conejonavarro.1@osu.edu

1 - Analyzing European Climate And Energy Policy Using Stochastic Optimization

Asgeir Tomasgard, NTNU, asgeir.tomasgard@iot.ntnu.no

The paper presents a modeling based analyses of decarbonization options for the European power sector. Different support schemes designed to incentive early development of CCS are studied, like public grants, feed-in premiums and emission portfolio standards are evaluated. As an alternative we study storage and transmission expansion in combination with a high renewable share. For the analysis we use the EMPIRE model, a multi-horizon stochastic investment model for the European power system that combines long-term capacity expansion with operational modeling under different load and generation scenarios.

2 - A Convex Optimization Model For The Combined Electricity And Natural Gas Expansion Planning Problem Under Gas-price Volatility Considerations

Conrado Borraz-Sánchez, Associate Postdoctoral Researcher, Los Alamos National Laboratory, Los Alamos, NM, United States, conradob@lanl.gov, Russell Bent, Pascal Van Hentenryck, Seth Blumsack, Hassan Lionel Hijazi

Recent trends towards installation of gas-fired power plants have increased the economic growth and mutual dependency of electric power and natural gas industries. These industries, however, have commercial, political and technical constraints that often force them to plan, operate and manage in isolation. As a result, adverse upshots may arise such as those experienced by both systems during the winter of 2013/2014 in the US Northeast. Here, we present a joint gas-grid elastic model to optimize required expansions to meet peak demand under consideration of gas-price volatility caused by congested areas. We conduct experiments on integrated test systems that include the New England area.

3 - Electricity Capacity Expansion And Cost Recovery With Renewables

Ramteen Sioshansi, The Ohio State University, Integrated Systems Engineering, 1971 Neil Avenue, Columbus, OH, 43210, United States, sioshansi.1@osu.edu, Yixian Liu

High levels of renewables can suppress electricity prices, reduce revenue for all generation resources, and lead to uneconomic retirements and failure to make needed investments. To analyze this problem quantitatively, two models are utilized: (1) a multi-stage stochastic model seeking an optimal investment plan with consideration of uncertainties and operating constraints; (2) a unit commitment model giving electricity and reserve prices based on the investments. Policies such as emission restrictions and renewable subsidies are considered in this analysis. The investment model is large in scale and solved effectively by the progressive hedging algorithm.

■ WE05

101E-MCC

Wildland Fire Management II

Sponsored: Energy, Natural Res & the Environment II Forestry

Sponsored Session

Chair: Matthew Thompson, U.S. Forest Service, 800 E Beckwith, Missoula, MT, 59801, United States, mpthompson02@fs.fed.us

1 - Filling Requests For National Interagency Hotshot Crews

Erin Belval, Colorado State University, Fort Collins, CO, United States, mccowene@gmail.com, David Calkin, Matthew Thompson, Yu Wei

Interagency Hotshot Crews are groups of 18 to 20 highly trained personnel used in the United States for fighting wildland fires. Dispatching criteria for these crews include minimizing travel distance and time, not taking crews away from areas with high levels of predicted near-term fire activity and balancing workloads across crews. We employ a simulation-optimization routine to examine the effects of these factors on dispatching decisions during a fire season. We compare our solutions with historical decisions using data from the Resource Ordering and Status System.

2 - Advancements In Spatial Fire Planning

Matthew Thompson, U.S. Forest Service, 800 E Beckwith, Missoula, MT, 59801, United States, mpthompson02@fs.fed.us, Yu Wei, Christopher Dunn, Christopher O'Connor, Greg Dillon, David Calkin

Pre-fire assessment and planning can support incident management decision making by dampening time pressures, reducing uncertainties, expanding options, and clarifying risk-benefit tradeoffs that unfold over different time horizons. This presentation will highlight the role of simulation and optimization in spatial fire planning on federal lands in the western US, with an emphasis on factors relating to cost, responder exposure, probability of success, and consequences.

3 - A Stochastic Optimization Model To Account For Climate Change In Forest Planning

Jordi Garcia-Gonzalo, Centre Tecnològic Forestal de Catalunya (CTFC)., Solsona, Spain, j.garcia@ctfc.es, Andres Weintraub, Cristóbal Pais

We consider a short/medium term multi-objective forest planning problem considering harvesting decisions in the presence of uncertainty due to climate change which impacts in the forest production. We introduce a multistage Stochastic model considering multiple climate change scenarios and including the corresponding non-anticipativity constraints. This enables the planner to make more robust decisions than using a single average scenario.

4 - Learning Optimal Mobility And Demand Pressure from Fire Resource Ordering Data

Alex Taylor Masarie, CSU and U.S. Forest Service, Fort Collins, CO, 80523, United States, alex.masarie@gmail.com, Yu Wei, Matthew Thompson, Michael Bevers, Iuliana Oprea, Erin Belval, David Calkin

An inverse partial differential equation model is used to evaluate how fire suppression resource allocation patterns vary with environmental and managerial factors. This presentation will convey the physical basis for the applied math technique demonstrating a finite difference approach to the spatial dynamics of allocation. A calibration case study will relate features of continuous optimization to operational research methodologies and present preliminary results.

■ WE06

102A-MCC

Optimization in Data Mining 2

Sponsored: Data Mining

Sponsored Session

Chair: Taghi Khaniyev, University of Waterloo, 200 University Ave., CPH 3669, Waterloo, ON, N2L 3G1, Canada, thanalio@uwaterloo.ca

1 - A Linear Separation Based MILP Model For Multi-class Data Classification Problem

Fatih Rahim, Koç University, Rumelifeneri Yolu, Sarıyer, stanbul, 34450, Turkey, frahim@ku.edu.tr, Metin Turkay

We address the multi-class data classification problem by a mixed integer linear programming model (MILP). We split each class's data set into subsets such that the subsets of different classes are separable by a hyperplane. The hyperplanes that separate a subset form a polyhedral region and the regions of different classes are disjoint. A MILP model is used to find the optimal separation by minimizing the total number of regions and misclassified data points. A preprocessing step is proposed to decompose or simplify the problem considering pairwise separation of classes. We evaluated two approaches for the testing phase, based on the convex hulls of subsets and the regions defined by the hyperplanes.

2 - Robust Multicategory Support Vector Machines Using Difference Convex Algorithm

Minh Pham, Postdoc Associate, University of Virginia, 1555 Montessori Ter, Charlottesville, VA, 22911, United States, ptuanminh@gmail.com

The Support Vector Machine (SVM) is one of the most popular classification methods in the machinelearning literature. In this paper, we focus on classification in the angle-based framework,which is free of the explicit sum-to-zero constraint, hence more efficient, and propose two robust MSVM methods using truncated hinge loss functions. We show that our new classifiers can enjoy Fisher consistency, and simultaneously alleviate the impact of outliers to achieve more stable classification performance. To implement our proposed classifiers, we employ the difference convex algorithm (DCA) for efficient computation.

3 - Scaling For Training Set Selection In Classification

Walter Dean Bennette, Air Force Research Lab, 7280 Lake View Dr, Ava, NY, 13303, United States, wdbennette@gmail.com

To allow for faster and better predictions from instance based classifiers such as k-Nearest Neighbors, Training Set Selection techniques can be used to intelligently select the classifier's training dataset. However, Training Set Selection techniques are limited in the size of datasets to which they can be practically applied. In this work scaling approaches are introduced that improve the execution time of Training Set Selection techniques. Results show that scaling methods maintain data reduction rates and achieve acceptable levels of accuracy for experimental datasets.

4 - Structure Detection In Mixed Integer Programs

Taghi Khaniyev, PhD Student, University of Waterloo, 200 University Ave., CPH 3669, Waterloo, ON, N2L 3G1, Canada, thanalio@uwaterloo.ca, Samir Elhedhli, Safa F. Erenay

Bordered block diagonal structure in constraint matrices of integer programs lends itself to Dantzig-Wolfe decomposition. We introduce a new measure of goodness to capture desired features in such structures. We then use it to propose a new approach to identify the best structure inherent in the constraint matrix. The main building block of the proposed approach is the use of community detection which alleviates one major drawback of the existing approaches in the literature: predefining the number of blocks. When compared against the state-of-the-art techniques, the proposed algorithm is found to identify very good structures, require shorter CPU time, and lead to comparable dual bounds.

■ WE07

102B-MCC

Data Mining in Decision Analytics

Sponsored: Data Mining

Sponsored Session

Chair: Roy Jafari Marandi, Mississippi State University, MD, United States, rj746@msstate.edu

1 - Next-generation Sequencing (NGS) Data Analysis: Developing A Scalable Framework For The Future

Michael Chuang, State University of New York, New Paltz, NY, 12601, United States, mikeychuang@gmail.com

NGS analysis presents a domain for biomedical and information technology professionals to explore. Due to the large amount of data involved and various constraints of technologies, we delineate issues to consider to develop a framework using parallel computing and NoSQL database service to greatly reduce the required time under less infrastructure investments while achieving satisfactory accuracy.

2 - The Magnificent 7- The Killer Data Mining Errors

Samuel Koslowsky, Senior Analytic Consultant, Harte Hanks, 2118 Ave T, Brooklyn, NY, 11229, United States, sam.koslowsky@hartehanks.com

Most managers agree that data mining plays a critical role in assuring a successful marketing campaign. At times, errors can creep in. While analytic and technical errors can certainly harm a data mining exercise, most of the problems that emerge in a modeling project have little to do with technical issues. Rather, basic reasoning, and marketing related issues are at fault. Errors emerge from all phases of an exercise. From establishing an appropriate objective, to allowing sufficient time for completion, to misinterpreting the results to deploying results incorrectly. A good data mining analysis requires qualified personnel, domain knowledge experts, analysts, and IT professionals.

3 - Estimating Distance Decay Functions For Arts & Culture Markets

Young Woong Park, Technical Professor, Southern Methodist University, 6212 Bishop Blvd. Fincher 303, Dallas, TX, 75275, United States, ywpark@smu.edu, Glenn Voss

Distance decay functions capture the effect of distance on interaction intensity. Unlike typical efforts that use distance as a sole independent variable, we estimate a model that uses organizational, market, and demographic characteristics to explain variance across geographic markets. We build the model using transaction data for 7M HHs in 6 geographic markets and investigate characteristics predicting decay function shape and market-level differences. The resulting model can estimate decay functions in the absence of interaction intensity data.

4 - Self Organizing And Error Driven (SOED) Artificial Neural Network For Smarter Classifications

Ruholla Jafari Marandi, Research Assistant, Mississippi State University, Starkville, MS, 39759, United States, rj746@msstate.edu, Mojtaba Khanzadeh, Brian Smith, Linkan Bian

Albeit Artificial Neural networks' high prediction power, the technique suffers from drawbacks such as intransparency. In this paper, motivated by learning styles in human brains, ANN's shortcomings have been assuaged and, its prediction power has also been improved. Self-Organizing Map and Feedforward ANN are hybridized to solidify their benefits and help remove their limitations. The proposed method, which we have named Self-Organizing Error-Driven (SOED) Artificial Neural network, showed significant improvements in comparison with usual ANNs. Through experiencing 5 different datasets, we showed SOED is a more accurate, more reliable and more transparent technique.

■ WE08

103A-MCC

Improving Electricity Grid Flexibility Under Uncertainty

Sponsored: Energy, Natural Res & the Environment, Energy I Electricity

Sponsored Session

Chair: Feng Qiu, Argonne National Laboratory, 9700 S. Cass Avenue, Lemont, IL, 60439, United States, fqiu@anl.gov

1 - Enhancing Flexibility Of Power Systems With Intelligent Periphery

Yunhe Hou, University of Hong Kong, yhhou@eee.hku.hk

Flexibility is a critical prerequisite for accommodating large-scale variable renewables before a clean, efficient, reliable, resilient, and responsive smart grid can be established. In this talk, the metrics for assessing flexibility of the systems with large-scale renewable integration will be discussed first. Second, a method for enhancing flexibility, entitled risk-limiting dispatch, will be introduced. Finally, the operating strategies of intelligent periphery with electric springs will be discussed as a powerful tool to enhance flexibility of systems.

2 - Robust Defense Strategy For Gas-electric Systems Against Malicious Attacks

Cheng Wang, Tsinghua University, Beijing, China, wangcheng525525@gmail.com, Wei Wei, Jianhui Wang, Feng Liu, Feng Qiu, Shengwei Mei

This talk proposes a methodology to identify and protect vulnerable components of connected gas and electric infrastructures from malicious attacks, and to guarantee a resilient and flexible operation by deploying valid corrective actions (while accounting for the interdependency of gas pipeline network and power transmission network). The proposed mathematical formulation reduces to a tri-level optimization problem. By reformulating the lower level problem as a mixed integer linear programming , a nested column-and-constraint generation algorithm is developed to solve the min-max-min model. Case studies demonstrate the effectiveness and efficiency of the proposed methodology.

3 - A Study Of Ramp Management And Its Compensation Schemes

Dane Andrew Schiro, ISO New England, Holyoke, MA, United States, dschiro@iso-ne.com, Eugene Litvinov, Tongxin Zheng, Feng Zhao

The integration of renewable generation could make it more difficult for U.S. ISOs to satisfy real-time power balance constraints. This talk will summarize the existing power balance issue, present the current solution of ISO New England, and explore two potentially better solutions: ramp products and multi-period market clearing. Formulations of these new methods will be presented along with discussions of their foreseeable issues. It is hoped that this talk will encourage rigorous investigation into these emerging ideas, thus aiding in future ISO market improvements.

4 - Provide Ramping Service With Wind To Enhance Power System Operational Flexibility

Qin Wang, National Renewable Energy Laboratory (NREL), Golden, CO, United States, qin.wang@nrel.gov, Bri-Mathias Hodge

Maintaining the power system balance requires controllable resources to adjust their power output to match the time-varying net load. This is becoming more challenging when the proportion of generation from variable and uncertain renewable resources in the system is high. This presentation will demonstrate the feasibility and approaches to rely on wind power to provide ramping service in the electricity markets. Advanced wind ramp forecasting methodologies are discussed. In addition, methods on how to quantify power system flexibility enhancement by using wind power to provide ramping service will be presented.

■ WE09

103B-MCC

Logistics of Biomass Feedstock for Liquid Fuel Production

Sponsored: Energy, Natural Res & the Environment I Environment & Sustainability

Sponsored Session

Chair: Daniela Gonzales, Texas A & M University, 3014 Jennifer Drive, College Station, TX, 77845, United States, danielasofiagonzales@gmail.com

1 - A Two-Stage Chance-constrained Stochastic Programming Model For a Bio-fuel Supply Chain Network With Uncertain Biomass Supply

Md Abdul Quddus, PhD Student, Mississippi State University, Department of Industrial & Systems Engineering, PO Box 9542, Starkville, MS, 39762, United States, mq90@msstate.edu, Sudipta Chowdhury, Mohammad Marufuzzaman

This study presents a two-stage chance-constrained stochastic programming model that captures the uncertainties due to feedstock seasonality in a bio-fuel supply chain network. The chance constraint ensures that, with a high probability, Municipal Solid Waste (MSW) will be utilized for bio-fuel production. To solve our proposed optimization model, we use a combined sample average approximation algorithm which is made faster by using star-inequalities. We use the state of Mississippi as a test bed to visualize and validate the modeling results. Our computational experiments reveal some insightful results about the impact of MSW utilization on a bio-fuel supply chain network performance.

2 - Optimization Of Large Scale Tennessee Bioenergy Production From Field To Blending Facility

Lixia He-Lambert, University of Tennessee, 2621 Morgan Circle, 310 Morgan Hall, Knoxville, TN, 37996, United States, llamber3@utk.edu, Burton C. English, James Larson, Tun-Hsiang Edward Yu, Bradly Wilson, Oleg Shylo

A large scale spatial-oriented mixed integer linear model was developed to maximize the net present value of the Tennessee switchgrass-based biofuel supply chain. Location of the production of feedstock within each five square-mile hexagon was determined along with the location of candidate preprocessing centers and biorefinaries. Shipping routes from field, and from biorefinary to biorefinary and to blending facilities were determined.

■ WE11

104A-MCC

Sequential Stochastic Optimization

Sponsored: Optimization, Optimization Under Uncertainty

Sponsored Session

Chair: Xiangyu Gao, University of Illinois, 04 Transportation Building, 104 S. Mathews Ave, Urbana, IL, 61801, United States, xgao12@illinois.edu

1 - A Transformation Technique For Stochastic Optimization With Decisions Truncated By Random Variables

Xiangyu Gao, UIUC, Urbana, IL, United States, xgao12@illinois.edu, Xin Chen, Zhan Pang

A common technical issue encountered in many operations management models is that decision variables are truncated by some random variables. The challenge arising from this problem is that the objective functions are not convex in the decision variables due to the truncation. To address this challenge, we develop a powerful transformation technique which converts a non-convex minimization problem to an equivalent convex minimization problem. We show that such a transformation enables us to prove the preservation of some desired structural properties,such as convexity, submodularity and L^natural-convexity, under optimization operations.

2 - Stochastic Optimal Control Based Rental Of Production Capacity Under Uncertain Production Requirements

Maurizio Tomasella, University of Edinburgh, Edinburgh, United Kingdom, Maurizio.Tomasella@ed.ac.uk, Artur Korinski

We model and analyse problems related to the optimal rental of manufacturing capacity, when requirements for both demand and product technical specifications evolve stochastically over time. We study a number of variants of business models of capacity rental. Adopting Stochastic Optimal Control based formulations, we derive the optimal closed-form policies that lead to choosing rental solutions with respect to the more established models of full ownership of manufacturing technology. A numerical case example involving high power fiber laser sources, one of the leading technologies in materials processing, shows the applicability of our optimal policies to real production environments.

■ WE12

104B-MCC

Recent Advances in Optimization and Related Topics

Sponsored: Optimization, Integer and Discrete Optimization

Sponsored Session

Chair: Sebastian Pokutta, Georgia Institute of Technology, Ferst Dr., Atlanta, GA, 30308, United States, sebastian.pokutta@isye.gatech.edu

1 - Structured Learning Revisited

Daniel Zink, Georgia Institute of Technology, Atlanta, GA, United States, daniel.zink@gatech.edu, Sebastian Pokutta, Gabor Braun

Frank-Wolfe techniques are popular due to their simplicity and more recently Frank-Wolfe algorithms also gained significant traction for online learning. We propose a new algorithm in the setting of online combinatorial optimization, where the underlying feasible region is a 0/1 polytope P (e.g., paths in a graph). We achieve the same regret bounds and convergence rates as Frank-Wolfe techniques both in the online case and offline case, while gaining a significant speed up in computation time. Moreover, our bounds hold in the online structured learning setting, only depending on the l1-diameter of P and independent of its actual (very large) dimension d.

2 - Approximate Hierarchical Clustering Via Lps

Aurko Roy, Georgia Institute of Technology, Atlanta, GA, United States, aurko@gatech.edu, Sebastian Pokutta

We study a cost function for hierarchical clusterings introduced by a recent work of Dasgupta for which a top-down algorithm was given that returns a hierarchical clustering of cost at most O(log1.5 n) times the optimal cost, using the ARV sparsest cut algorithm as a subroutine. We improve this by giving an O(log n)-approximation algorithm for this problem. Our main technical ingredients are a combinatorial characterization of ultrametrics induced by this cost function, deriving an IP formulation for this family of ultrametrics, and showing how to round an LP relaxation of this formulation by using the idea of sphere growing which has been extensively used in the context of graph partitioning.

3 - On The Computational Complexity Of Optimizing Over The Chvatal Closure Of A Polytope

Dabeen Lee, PhD Student, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, dabeenl@andrew.cmu.edu, Gerard P Cornuejols, Yanjun Li

In this paper, we study the computational complexity of some problems that arise when taking the Chvatal closure of a polyhedron. Given a rational polytope contained in the unit hypercube or a rational simplex that does not contain any integer point, we prove that deciding emptiness of its Chvatal closure is NP-complete. It has two implications; first, it is NP-hard to check whether a given rational polytope contained in the unit hypercube or a rational simplex has Chvatal rank 1; second, the optimization and separation problem over the Chvatal closure of a given rational polytope contained in the unit hypercube or a rational simplex is NP-hard as well.

■ WE13

104C-MCC

Disciplined Convex Programming for Nonconvex Problems

Sponsored: Optimization, Computational Optimization and Software

Sponsored Session

Chair: Miles Lubin, Massachusetts Institute of Technology-ORC, MIT, Cambridge, MA, 00000, United States, mlubin@mit.edu

1 - Polyhedral Approximation In Mixed-integer Convex Optimization

Miles Lubin, Massachusetts Institute of Technology, Cambridge, MA, United States, mlubin@mit.edu, Emre Yamangil, Juan Pablo Vielma, Russell Bent

We present recent developments in the polyhedral outer approximation algorithm for mixed-integer convex optimization derived from using disciplined convex programming to automatically generate extended formulations from a user's algebraic input.

2 - Disciplined Convex-concave Programming

Steven Diamond, Stanford University, Stanford, CA, United States, diamond@cs.stanford.edu, Xinyue Shen, Yuantao Gu, Stephen P Boyd

In this talk we introduce disciplined convex-concave programming (DCCP), which combines the ideas of disciplined convex programming (DCP) with convex-concave programming (CCP). Convex-concave programming is an organized heuristic for solving nonconvex problems that involve objective and constraint functions that are a sum of a convex and a concave term. By combining CCP with DCP, we obtain an automated system for applying CCP that correctly handles subtleties such as the domains of functions and nondifferentiability on the boundary of domains. We describe a Python implementation called DCCP, which extends CVXPY.

3 - Outer-approximation Techniques For Mixed-integer Semidefinite Optimization

Christopher Coey, Doctoral Student, Massachusetts Institute of Technology, Cambridge, MA, 02139, United States, coey@mit.edu, Miles Lubin, Emre Yamangil, Juan Pablo Vielma, Russell Bent

We will present an extension of the outer-approximation algorithm in Pajarito for mixed-integer semidefinite optimization problems, and test the new approach with computational experiments.

■ WE14

104D-MCC

Facility Location II

Contributed Session

Chair: Jianmai Shi, Associate Professor, National University of Defense Technology, Changsha, 410073, China, jianmaishi@gmail.com

1 - The Maximal Covering Location Problem With Minimization Of Cardinality Of Upper Average

Eric C Blair, PhD Student, University of Florida, Gainesville, FL, 32601, United States, ecblair@ufl.edu, Matthew Norton

We present a reformulation of the Maximal Covering Location Problem (MCLP) using the new concept of Cardinality of Upper Average (CUA). In the MCLP, a fixed number of facilities are located to minimize the number of customers that must travel farther than some maximum desirable distance to the nearest facility. In the new formulation utilizing CUA, the number of customers with the largest travel distances whose average travel distance to the nearest facility is equal to the maximum desirable distance is minimized. The resulting problem is reduced to a mixed-integer linear program. We demonstrate the advantages of the new formulation with a numerical example.

2 - The Optimal Planning Of Electric Vehicle Battery Swapping Network With Fuzzy Customer Satisfaction

Fang Guo, Huazhong University of Science and Technology, 1037 Luoyu Road, Hongshan District, WuHan,, WuHan, 430074, China, fang_guo@hust.edu.cn

Key to the mass adoption of electric vehicles is the establishment of sufficient battery service Infrastructure network based on customer behavior and psychology. We present an EV battery swapping network planning with fuzzy customer satisfaction, which aims to determine the location and service capacity strategy of stations simultaneously with the consideration of customer satisfaction. A heuristic algorithm is proposed to solve the problem. Furthermore, we conduct the parameter analysis when EVs are used in the practice of the City Cluster in the Middle Reaches of the Yangtze River in China.

3 - Logistics Service Network Design For Humanitarian Response In East Africa

Marie-Eve Rancourt, Université du Québec à Montréal, 2920 Chemin de la tour, CIRRELT, Montreal, QC, H3T 1J4, Canada, marie-eve.rancourt@cirrelt.ca, Émilie Dufour, Gilbert Laporte, Julie Paquette

The United Nations Humanitarian Response Depot (UNHRD) is an important humanitarian logistics service provider that manages a network of depots. This research project aims to analyze the potential benefits of adding a regional distribution center in Kampala, Uganda, to its existing network. To this end, we used fieldwork, simulation, optimization and statistical analyses to assess the costs of prepositioning relief items in Kampala and to propose a robust stocking solution. The UNHRD has already started to implement the solution proposed in this study, which should result in a mean cost reduction of around 21%.

4 - Joint Deployment Of Electric Car Charging Stations And Servers On A Road Network

Jianmai Shi, Associate Professor, National University of Defense Technology, Changsha, 410073, China, jianmaishi@gmail.com, Yue Wang, Zhong Liu, Yajie Liu

A joint charging station location and charging piles (servers) configuration problem for electric cars is studied, where the service capacity of the station depends on the number of servers. The problem is an extension of the Flow-Capturing location problem, and an integer programming model is proposed to maximize the overall car flow served, subject to a finite budget. A heuristic algorithm is developed to solve the problem, and the performance of the algorithm is tested by networks with different scales. We finally present a case study based on a practical road network in China.

■ WE15

104E-MCC

Text Mining II

Sponsored: Artificial Intelligence

Sponsored Session

Chair: Weifeng Li, University of Arizona, weifengli@email.arizona.edu

1 - Exploring Scada Devices And Their Vulnerabilities On The Internet Of Things

Sagar Samtani, The University of Arizona, sagars@email.arizona.edu

Much of modern society is reliant on critical infrastructure. Much of this infrastructure is controlled and managed by Supervisory Control and Data Acquisition (SCADA) systems. Recent years has seen an increase in internet connectivity of SCADA systems. While this has resulted in an increased level of convenience, it has also opened up the possibilities for devastating cyber-attacks. This study demonstrates a data and text mining approach to identify SCADA systems on Internet of Things. We also use state-of-the-art vulnerability assessment techniques to identify the vulnerabilities of these devices. The results of this study indicate that many SCADA vendors are vulnerable to various exploits.

2 - Key Conversation Trends And Patterns About Electronic Cigarettes On Social Media

Wenli Zhang, University of Arizona, Tucson, AZ, United States, wenlizhang@email.arizona.edu, Sudha Ram"

Electronic cigarettes (e-cig) usage has increased exponentially over the last few years and are perceived to be safer alternative to cigarettes use. In order to understand the public health impact of e-cig, a better understanding of population-wise use patterns, perceptions regarding the use and abuse liability of e-cig should be developed. However traditional survey is not adequate to get such information. The research objective of this study is to explore using social media data to identify key conversations, trends, and patterns about the usage of e-cig by using natural language processing, word embedding, topic modeling, content and sentiment analysis, and social network analysis.

3 - Stock Movements Prediction Using Textual And Technical Data

Juxihong Julaiti, The Pennsylvania State University, 445 Waupelani Drive, J01, State College, PA, 16802, United States, juxihongjulaiti1225@gmail.com

Predicting stock movements is one of the most appeal topics for researchers since an accurate predictive enables gain wealth, as well as the rapid progress of data acquisition has made the vast amount of data available. In this paper, we apply different machine learning techniques to predict the daily stock movement. In particular, we use the type, title of news articles of the current day that are related to the interested company from the Wall Street Journal, as well as its stock volume of the day. The result of predicting Google's stock changes indicates big drops or big growths are easier to capture, and the average AUC and accuracy of the Gaussian Naïve Bays are 0.83 and 0.97.

■ WE17

105B-MCC

Nonlinear Optimization Algorithms III

Sponsored: Optimization, Nonlinear Programming

Sponsored Session

Chair: Feng Qiang, Argonne National Laboratory, 9700 S Cass Avenue, Argonne, IL, 60439, United States, fqiang@anl.gov

1 - Analysis Of The Proximal Quasi Newton Algorithm In Solving Convex Composite Problems

Hiva Ghanbari, Lehigh University, Bethlehem, PA, 18015, United States, hig213@lehigh.edu, Katya Scheinberg

In this work, we analyze the convergence properties of an inexact proximal quasi-Newton algorithm to solve composite optimization problems in the case of strong convexity. We consider solving subproblems to the eps-optimality while an inexact sufficient decrease condition is checked to be satisfied at each iteration. Furthermore, we apply the Nesterov's accelerated scheme to present the accelerated proximal quasi-Newton algorithm. In addition to the theoretical properties of the resulting algorithm, the numerical results will be presented.

2 - Parallel Problem Generation For Nonlinear Programming Problems In Julia

Feng Qiang, Argonne National Laboratory, Lemont, IL, 60439, United States, fqiang@anl.gov, Joseph A Huchette, Miles Lubin, Cosmin Petra

Large scale optimization problems usually have rich structural properties. In this talk, we present StructJuMP, a parallel modeling environment for structured optimization problems. Built as a parallel extension to modelling language JuMP, StructJuMP offers additional syntax to specify blocks of the problems and an MPI-based parallelization of the model generation. We demonstrate StructJuMP capabilities for the specification of power grid optimization problems on an HPC cluster at Argonne National Lab.

3 - Regularized Primal And Dual Methods For Convex Quadratic Programming

Elizabeth Wong, University of California-San Diego, elwong@ucsd.edu

We discuss active-set methods for convex quadratic program with general equality constraints and simple lower bounds on the variables. In the first part of the talk, two methods are proposed, one primal and one dual. In the second part of the talk, a primal-dual method is proposed that solves a sequence of quadratic programs created from the original by simultaneously shifting the simple bound constraints and adding a penalty term to the objective function. Numerical results are presented for the combined primal-dual active-set method.

WE18

106A-MCC

DMA Machine Learning

Contributed Session

Chair: Hang Li, Pennsylvania State University, University Park, PA, United States, Huli80@psu.edu

1 - Risk Prediction On Life Insurance Lapse

Ceni Babaoglu, Dr., Ryerson University, Ryerson University, 350 Victoria Street, Toronto, ON, M5B 2K3, Canada, cenibabaoglu@ryerson.ca, Atakan Erdem, Ayse Bener

Lapse constitutes a material risk for life insurance companies and needs to be controlled and managed carefully. In this project, we study the risk prediction on life insurance lapse of an insurance company. The data that we mine includes demographics, household income, unemployment and geographical information of the clients. We build a model for the prediction of lapse by using machine learning techniques.

2 - Visualization Strategies For Prediction And Classification In Supervised Machine And Statistical Learning

Alexander Engau, Associate Professor, University of Colorado Denver, Denver, CO, United States, aengau@alumni.clemson.edu, Paola Gonzalez

Supervised machine and statistical learning is a key task in data mining and many areas of human decision making including finance, business and industry as well as health care, medicine and bioinformatics. To facilitate a better understanding of current classifiers for prediction whose performances are typically measured and compared only numerically using cross validation, here we present a novel idea for an additional and much more meaningful visualization. We also report its recent use in two financial and medical case studies for substantial new insights into several current state-of-the-art implementations of support vector machines, decision trees, boosting and discriminant analysis.

3 - An Anomaly Detection Algorithm Using Tree-based Phase Space Method

Cheng-Bang Chen, Penn State University, 445 Waupelani Dr., Apt K18, State College, PA, 16801, United States, czc184@psu.edu

The cost of out of control events is usually extremely high, but the anomaly patterns are sometimes hard to detect because of the nonlinear and the high dimensional signal. Current methods focus on single signal source or dimensionality reduction, but it decreases the accuracy and sensitivity. We propose an efficient method to detect the anomaly patterns in high dimensionality accurately, using the q-tree structure for phase space, and a tree structure indexing for the subsequence signals.

4 - Optimal Experimental Design On Non-euclidean Spaces For Active Learning

Hang Li, Pennsylvania State University, University Park, PA, United States, Huli80@psu.edu, Enrique Del Castillo, George Runger

An Active Learning (AL) strategy selects instances to label in order to improve a model with a relatively small number of queries, accelerating learning. In recent years a number of machine learning authors have noticed the similarities between AL used for linear models and the optimal experimental design problem. In this presentation we will discuss optimal experimental design for active learning in curved spaces. A double penalized least squares functions leads to a generalization of the notions of alphabetic optimality in classical optimal design. The impact of these penalization parameters on the designs are discussed. Extensions to other types of non-euclidean spaces will be discussed.

WE19

106B-MCC

Opt, Heuristic Programming

Contributed Session

Chair: McKenzie Worden, CUBRC, Inc., 4455 Genesee St., Suite 106, Buffalo, NY, 14225, United States, mckenzie.worden@cubrc.org

1 - Quay Crane Scheduling Problem With Considering Tidal Impact And Fuel Consumption

Yu Shucheng, Doctor, Shanghai University, Shang Da Road 99, Shanghai 200444, China, Shanghai, 200444, China, yushucheng2007@163.com

This study investigates a quay crane scheduling problem with considering the impact of tides in a port and fuel consumptions of ships. A mixed-integer nonlinear programming model is proposed. Some nonlinear parts in the model are linearized by approximation approaches. For solving the proposed model in large-scale problem instances, both a local branching based solution method and a particle swarm optimization based solution method are developed. Numerical experiments with some real-world like cases are conducted to validate the effectiveness of the proposed model and the efficiency of the proposed solution methods.

2 - A Cross Entropy Approach To The Single Row Facility Layout Problem

Xiu Ning, Tsinghua University, Shunde Building, Room 519A, Beijing, 100084, China, ningx13@mails.tsinghua.edu.cn

The single row facility layout problem (SRFLP) is to arrange a given number of facilities along a straight line so as to minimize the total cost associated with the interactions between the facilities. In this paper, a metaheuristic algorithm based on the cross-entropy (CE) method is developed to solve this problem. To speed up the convergence of the algorithm, we incorporated local search procedures and symmetry breaking techniques with the CE method. The proposed algorithm has been tested using the instances available in the literature. The computational results show that the proposed algorithm can find the best solutions obtained so far for instances with up to 100 facilities.

3 - Coordinated Dynamic Demand Lot Sizing And Delivery Scheduling Problem With Resource Restriction

Rui Liu, PhD, Huazhong University of Science and Technology, Wuhan, 430073, China, rliuhust316@gmail.com, Lin Wang

Coordinated strategy is often used to cut down cost and increase profit in supply chain management. A new coordinated dynamic demand lot sizing and delivery scheduling problem with resource restriction is proposed and formulated. The delivery policy is integrated into coordinated dynamic demand lot sizing problem with resource restriction. In fact, the proposed model is more practical.

4 - Optimal Communication Of Information For Warfighter Benefit

Azar Sadeghnejad, Buffalo, 157 Ranch Trail, Williamsville, NY, 14221, United States, azarsade@buffalo.edu, Michael Hirsch, Hector Juan Ortiz-Pena

There has been a significant increase in the number of sensors deployed to accomplish military missions. These sensors might be on manned or unmanned resources, and might collect quantitative and/or qualitative information important for mission success. Of critical importance for mission success is ensuring that the collected information is routed to the people/systems that need the information for the proper making of decisions. This research mathematically formulates the problem of information routing and collection on a temporally varying communication network, and discusses some heuristics for efficient solutions.

5 - Optimization Of Information Collection And Distribution Across A Limited Communications Network

McKenzie Worden, CUBRC, Inc., 4455 Genesee St., Suite 106, Buffalo, NY, 14225, United States, mckenzie.worden@cubrc.org, Azar Sadeghnejad, Chase Murray, Mark Henry Karwan, Hector Juan Ortiz-Pena

For this problem, we aim to develop a heuristic that defines information collection and exchange between unmanned resources and a control station. Decisions will be made determining the routes of each resource, as well as the areas from which their sensors will collect information. Considering bandwidth and communication range restrictions, the heuristic will determine when collected information will be sent back to the control station. We will also consider scenarios in which resources may send information amongst each other, as relays, prior to the ground station receiving the information.

WE20

106C-MCC

Health Care, Other I

Contributed Session

Chair: Jingyun Li, Assistant Professor, California State University - Stanislaus, 1 University Circle, Turlock, CA, 95382, United States, jli9@csustan.edu

1 - The Lag In Service Encounter: Indian Healthcare Insurance Context

Sudipendra Nath Roy, Fellow Program in Management, Indian Institute of Management, Indore, Prabandh Shikhar, Rau- Pithampur Road, Indore, 453331, India, f13sudipendrar@iimidr.ac.in, Bhavin J Shah, Hasmukh Gajjar

Indian healthcare service providers primarily operate through third party administrator (TPA) for bill settlement for the services that are covered under a paid medical insurance cover. Patients usually have to wait for more than acceptable time for final settlement because of coordination inefficiencies between TPA and hospital administration. This study explores the potential process improvement to overcome such delays in Indian tertiary hospital setting.

2 - Determinants Of Meaningful Usage Of Health Information Technology

Jingyun Li, Assistant Professor, California State University - Stanislaus, 1 University Circle, Turlock, CA, 95382, United States, jli9@csustan.edu, Indranil R Bardhan, Steves Ring

Meaningful use (MU) is a new, government-funded initiative to improve health care system via adoption and usage of HIT. The first stage of MU focuses on capturing and sharing of electronic patient health information. In this study, we explore the characteristics of hospitals that are likely to be associated with achievement of MU. Using archival, hospital-level data gathered from several sources, we observe that hospitals with greater IT leadership are more likely to achieve meaningful use. We also observe that standalone hospitals are less likely to achieve meaningful use. Our findings indicate that hospitals with greater levels of EMR support are also more likely to achieve meaningful use.

■ WE21

107A-MCC

Joint Session MSOM-HC/HAS: Healthcare Operations

Sponsored: Health Applications

Sponsored Session

Chair: Tolga Tezcan, London Business School, Regent's Park, O, London, TX, NW1 4SA, United Kingdom, ttezcan@london.edu

1 - The Role Of Non-clinical Workforce On Patient Service: Evidence From NHS Helpline

Bilal Gokpinar, UCL, London, United Kingdom, b.gokpinar@ucl.ac.uk, Emmanouil Avgerinos

Although non-clinical workers are vital in many healthcare delivery settings, their impact on efficiency and quality of patient service has not been examined in the OM literature. In this study, making use of a novel dataset based on NHS's 111 non-emergency helpline in England, we quantify and demonstrate trade-offs associated with employing non-clinical personnel in delivering patient service. Our results indicate that while non-clinical workforce increases the efficiency of patient service by reducing abandoned calls, it may lead to new inefficiencies through misuse of critical resources (i.e., unnecessary ambulance dispatches) and it may reduce the quality outcome of the patient service.

2 - Physiology-based Anticipative Icu Management

Yasin Ulukus, University of Pittsburgh, yasin.ulukus@gmail.com, Guodong Pang, Andrew J Schaefer, Gilles Clermont

The efficient operation of ICUs is crucial to providing high quality of care while controlling costs. We consider transfer operations from an ICU to a downstream unit. In current practice, downstream beds are requested only when a patient is clinically ready for transfer. We investigate anticipative bed requests that can be made before a patient is clinically ready for transfer, and show that such policy combined with effective use of clinical markers can significantly improve the system performance. We present a Markov Decision Process (MDP) model and solve it via approximations. We further investigate the sensitivity of policy change upon cost parameter estimation errors via robust models.

3 - New Empirical Evidence For The Clinical Effectiveness And Process Implications Of Managing Migraine Care Via Telemedicine: Interim Results

Abraham Seidmann, University of Rochester, Simon Business School, Dir of OR Dept, Rochester, NY, 14627, United States, avi.seidmann@simon.rochester.edu, Balaraman Rajan, Deborah Friedman

Telemedicine has been proved to increase access to patients and reduce travel burden. In the context of an ongoing pilot study of telemedicine for individuals with migraine, we completed in-person baseline assessments and follow-up visits via telemedicine to test the hypothesis that follow-up care delivered by telemedicine is as effective as with in-office visits. We then investigate ways in which telemedicine could add economic value to patients through convenience and better compliance, and benefit specialists through a higher productivity.

4 - Adaptive Monitoring Of Depression Treatment Population: A Data-driven Approach

Ying Lin, University of Washington, linyeliana.ie@gmail.com, Shan Liu, Shuai Huang

30 million Americans use antidepressant medication. Inadequate follow-up monitoring has been identified as a main challenge in managing the depression patient population. We developed a decision support algorithm to create patient-specific adaptive monitoring schedules and dynamically allocate limited sensing resources to detect high risk individuals of severe depression. The proposed method integrates depression trajectory modeling, prognosis, and selective sensing into a unified framework. The effectiveness of the proposed method is demonstrated on a depression treatment population.

■ WE22

107B-MCC

Joint Session MSOM-HC/HAS: Modeling and Optimization for Organ Allocation and Donation Networks

Sponsored: Health Applications

Sponsored Session

Chair: Murat Kurt, Merck Research Labs, 351 N. Sumneytown Pike, North Wales, PA, 19454, United States, murat.kurt7@gmail.com

Co-Chair: David Kaufman, Assistant Professor, University of Michigan-Dearborn, 19000 Hubbard Dr, Dearborn, MI, 48126, United States, davidlk@umich.edu

1 - Designing an Efficient And Fair Heart Allocation Rule For Transplantation

Farhad Hasankhani, Clemson University, 278 Freeman Hall, Clemson, SC, 29634, United States, fhasank@g.clemson.edu, Amin Khademi

The optimal allocation of limited donated hearts to patients on the waiting list is one of the top priorities in heart transplantation management. To design an efficient and fair system for allocating donor hearts to patients waiting for transplantation, we model the waiting list as a fluid model of overloaded queues. The fluid model is an optimal control problem with vector valued state variable defined as number of patients waiting for transplantation in each class and control variable defined as number of hearts to be allocated to patients of each class.

2 - Cherrypicking Kidneys And Patients: Incentives In Transplant Centers

Mazhar Arikan, University of Kansas, 931 Drum Dr, Lawrence, KS, 66049, United States, mazhararikan@hotmail.com, Baris Ata, Rodney Parker

In 2007 the Centers for Medicare and Medicaid Services implemented a set of regulations for transplant centers. These rules evaluate transplant centers based on one-year patient and organ survival rates post transplantation. Using actual transplant data, we empirically analyze some potential unintended consequences of these regulations such that more risk averse centers choose healthier patients and higher quality organs to transplant.

3 - Modeling Of The United States Liver Allocation System Policy To Reduce Disparity Using Novel Approaches

Sanjay Mehrotra, Northwestern University, mehrotra@northwestern.edu, Vikram Kilambi

We propose and study a DSA-centered linking approach for organ sharing. This approach was tested in and out-of-sample by using different demand generation procedures. We show that, under suitable conditions, the known redistricting and concentric circle approaches for organ sharing are retrievable from our more general modeling framework. We will present results comparing the proposed approach with alternatives.

4 - Redesigning The National Network For Deceased Donor Organ Extraction In The Netherlands

Joris van de Klundert, Erasmus University Rotterdam, vandeklundert@bmg.eur.nl, Kristiaan Michel Glorie, Thije Van Barneveld, Sylvia Elkhuizen, Kirsten Ooms

End Stage Renal Disease is a fatal condition, for which a choice of costly treatment exists. Kidney transplantation is the most cost-effective treatment. In The Netherlands, kidney extraction for transplantation is nationally coordinated to ensure high quality transplantation. This requires responsive deployment of highly specialized teams, which forms a costly service process in itself. In this talk, we consider the present regional structure and operating mode, and consider the problem of finding improved structures and operating procedures. We present results of the simulation analysis, and consider practical requirements taken into account in the implementation which starts in 2017.

■ WE23

108-MCC

Surveillance of Diseases with Big Data

Sponsored: Health Applications

Sponsored Session

Chair: Qingpeng Zhang, City University of Hong Kong, 83 Tat Chee Ave, Kowloon Tong, TX, 00000, Hong Kong, qingpeng.zhang@cityu.edu.hk

1 - Patient-specific Depression Monitoring By Selective Sensing

Ying Lin, University of Washington, linyeliana.ie@gmail.com, Shuai Huang, Shan Liu

Development of personalized health surveillance is enabled by sensing and information technologies. Scaling it up to large scale depression population needs a seamless combination of data analysis and sensing strategy design. We developed a selective sensing method to capture individual depression progressions from acquired health data and optimally allocate sensing resources to high-risk individuals by exploiting the similarities of their progression trajectories. The proposed method can lead to efficient and cost-effective monitoring of depression population.

2 - An Optimization Approach To Concussion Management

Gian Gabriel Garcia, University of Michigan, garciagg@umich.edu, Mariel Sofia Lavieri

We apply data-driven optimization to improve concussion diagnosis for athletes suspected of concussion and apply dynamic programming to solve the sequential decision-making problem of optimal return-to-play management for athletes who have concussions.

3 - Biosurveillance Of Climate Sensitive Mosquito-borne Diseases Using Online Social Media

Kusha Nezafati, University of Texas, Dallas, TX, United States, Kusha.Nezafati@utdallas.edu, Yulia Gel, L. Leticia Ramirez Ramirez

Chikungunya is a mosquito-borne virus that is transmitted by the same type of mosquito as dengue and zika. Chikungunya is relatively well documented in Asia, Africa, and the Indian subcontinent. In 2014 the first confirmed case of chikungunya virus has been reported in the Americas, and since then its spread has been attracting a lot of attention from the health care professionals. However, the data on chikungunya still remain relatively scarce which makes forecasting of its epidemiological curve a very challenging task. In this talk we discuss predictive utility and limitations of online social media, particularly, Google trend, as a proxy for unavailable data on chikungunya.

4 - Semantic Social Network Analysis Of Online Health Communities

Ronghua Xu, City University of Hong Kong, ronghuaxu2-c@my.cityu.edu.hk, Qingpeng Zhang

The understanding of how people use online health communities/groups (OHCs) to discuss health-related topics is critical to the the effective use of social media to provide social support. In this research, we collected a comprehensive dataset of mental health related OHC in China, and developed a set of methods to model and analyze the information spread and semantic patterns of users' discussions. The results unveiled the unique topological features and semantic patterns of mental health related OHCs, with managerial insights of how to utilize OHCs to provide social support to complement conventional offline approaches.

■ WE24

109-MCC

Operations Research in Healthcare Management in Chile

Sponsored: Health Applications

Sponsored Session

Chair: Jorge Vera, Professor, Pontificia Universidad Catolica de Chile, Vicuna Mackenna 4860, Macul, Santiago, 7820436, Chile, jvera@ing.puc.cl

1 - Physiotherapy Treatment Appointments Scheduling Using An MDP-based System

Sergio Maturana, Pontificia Universidad Catolica de Chile, smaturan@ing.puc.cl, Ignacio Lazo

Scheduling physiotherapy treatment appointments in a hospital faced with a very high demand is complex. The current system in a Chilean hospital results in many patients waiting long times before their treatments can begin. This hospital has three types of specialists: a physiatrist and two types of therapist. Before the therapy can begin, patients must see the physiatrist, who indicates the appropriate treatment. We propose a scheduling system, based on a Markov Decision Process (MDP), which determines how to assign the patients to the physiatrist and how to distribute the patient's sessions within a planning horizon in order to reduce waiting times and assure that sessions are evenly spread.

2 - Chemotherapy Treatment Scheduling In Public Health

Juan-Carlos Ferrer, Professor, Pontificia Universidad Catolica de Chile, Santiago, Chile, jferrer@ing.puc.cl

This research addresses a real scheduling problem for chemotherapy patients at a Chilean public Hospital. We divide the problem into two subproblems, scheduling patients on an infinite time horizon and daily patient scheduling. The benefits of both stages are evaluated for a real case in the Hospital s Chemotherapy Unit using simulation in the first stage and solving the model to optimality in the second one. We evaluate potential opportunities for efficiency through a sensitivity analysis of key resources.

3 - A Hierarchical Solution Approach For Bed Capacity Planning Under Uncertainty In The Healthcare Service Industry

Ana Celeste Batista, PhD Candidate, Pontificia Unversidad Catolica de Chile, Santiago, Chile, abatista@uc.cl, Jorge Vera

Effective capacity planning under uncertainty ensures robust and consistent plans in time. The health sector is a service system of great relevance to consider better methods for inter-temporal decisions, since poor planning affects directly the welfare of people. This work presents a hierarchical multistage model applied to beds planning. We propose a solution method based on the formulation and solved using stochastic optimization. The problem is to determine the availability of beds that minimizes overall patient welfare loss as a function of waiting time. From the solution we propose policies allowing better decisions in different planning horizons.

■ WE25

110A-MCC

Logistics V

Contributed Session

Chair: Tayo Fabusuyi, University of Michigan and Carnegie Mellon University, 5520 Baywood Street, Floor #3, Pittsburgh, PA, 15206, United States, Fabusuyi@umich.edu

1 - Minimizing Customer Waiting Time In A Unit-load Warehouse

Mahmut Tutam, PhD Student, UARK, 1359 N Leverett Avenue, Apt 31, Fayetteville, AR, 72703, United States, mtutam@uark.edu, John A White

Although the number of delivery trucks arriving at a unit-load warehouse per unit time may well be Poisson distributed, the time required to perform rectilinear round-trip travel between the dock and a uniformly distributed point in the storage region is not exponentially distributed. However, it can be approximated using a k-Erlang distribution. Using the Method of Moments, the value of k is determined. The analysis includes one or more docks distributed along one wall of a rectangular-shaped warehouse. The dimensions of the warehouse that minimize customer waiting time are determined for a given storage area.

2 - The Mode Most Traveled: Parking Implications And Policy Responses

Tayo Fabusuyi, University of Michigan and Carnegie Mellon University, 5520 Baywood Street, Floor #3, Pittsburgh, PA, 15206, United States, Fabusuyi@umich.edu, Robert Hampshire, Zhen Qian

Driving to work alone continues to be the travel mode most utilized by commuters. Using the US Census public use microdata sample (PUMS) dataset from the Pacific region of the U.S., we examine why this trend persists by generating travel mode profiles for representative individuals. In addition to the profiles, we examine the marginal effects on travel mode choice for selected explanatory variables at their representative values. The empirical exercise provides insights on the influence policy measures may have in shaping individuals' travel mode preferences and how this will impact on demand for parking spaces.

■ WE26

110B-MCC

Information Systems IV

Contributed Session

1 - Information System that Implements Shapley Algorithm For The Evaluation Of The Competitive Value at a Cluster And Enterprise Level

Miguel Jimenez, Information systems and technologies leader, Universidad de la Costa, Barranquilla, 08002, Colombia, mjimenez@fcimec.org, Luis Eduardo Ramirez, Luis Eduardo Ramirez, Lauren Castro, Lauren Castro, Diana Gineth Ramirez-Rios, Orlando Bustamante, Stefanie Cortina, Dionicio Neira, William Manjarres De Avila

Based on the strategic and financial valuation of enterprises that wish to participate in a cluster, we developed an information system that allows the enterprises evaluate their competiive value with or without their participation in the cluster, by implementing Shapley algorithm to solve a cooperative game model for supply chains.

2 - Advertising Competition With Third Party Cookies

Arslan Aziz, Carnegie Mellon University, 5624 Fifth Ave, Apt C16, Pittsburgh, PA, 15232, United States, arslan.aziz7@gmail.com, Rahul Telang

Tracking of online consumer behavior by third party data vendors has become ubiquitous. Data from such tracking is made available to advertisers to help increase the returns from targeting. However, such information may also increase competition among advertisers seeking to target the same consumers. We describe a duopoly model of brand advertisers competing for consumers with uncorrelated brand preferences in a second-price auction. We find the conditions under which availability of third party tracked data might reduce brand surplus by intensifying competition.

■ WE27

201A-MCC

DMA Business Analytics

Contributed Session

Chair: Byeong-Yun Chang, Ajou University, San5 Woncheon-dong, Yeongtong-gu, Suwon, 443-749, Korea, Republic of, bychang@ajou.ac.kr

1 - Relationship Between R2 And F Statistic In Linear Regression

Nizar Zaarour, Assistant Teaching Professor, Northeastern University, Boston, MA, 02115, United States, n.zaarour@neu.edu, Emanuel Melachrinoudis

There are several misconceptions in interpreting the value of R2 in Regression Analysis. R2 is heavily dependent on the sample size n while outliers may skew its value. In this paper, we comment on these observations and express the relationship between the R2 and the F statistic to derive the range of values of R2 that provide consistent results with the Hypothesis Testing of the slope. This analysis is done by considering the Simple Linear Regression case, where there is only one independent variable k.

2 - Heuristic Search For Good Decisions In Generalized Quadratic Assignment Problems

Steven Orla Kimbrough, Professor, University of Pennsylvania, 103 Bentley Avenue, Bala Cynwyd, PA, 19004, United States, kimbrough@wharton.upenn.edu, Monique Guignard-Spielberg, Frederic H Murphy

We discuss decision sweeping of optimization models, in which we collect a number of judiciously chosen decisions (feasible and infeasible settings of the decision variables) from the larger space of decisions. We focus on the resulting insights, especially with regard to Generalized Quadratic Assignment Problems with soft constraints. In particular, we explore alternative heuristics for generating decisions of interest.

3 - Predicting Urban Blight Using A Data Science Approach

Naveen Kumar, University of Memphis, Memphis, TN, United States, nkumar7@memphis.edu, William J Kettinger, Chen Zhang

The existence of blighted neighborhoods is detrimental to public health, safety, and economic growth of urban areas. Identifying properties where early blight interventions would result in improvement of neighborhoods can have tremendous value to property owners, policymakers, and society. However, understanding urban blight is a complex problem demanding advanced data science. A wide variety of evolving social, economic, and political factors interact with each other causing the problem. We propose to predict blight incidences using data analytics and recommend early interventions to reduce blight incidences in the City of Memphis.

4 - Does Information Transparency Help Retain Customers? Evidence From The Insurance Industry

Zhi Cheng, Temple University, Philadelphia, PA, United States, aaronzhi.cheng@gmail.com, Ting Li, Paul Pavlou

This work investigates whether and how information transparency affects customer churn. Two competing theories predict this effect, price elasticity (that induces churn) and high product informedness (that reduces churn). To address this tension, we use a unique dataset from a major European insurance company to show that customers acquired from channels with higher information transparency (a price comparison website) are less likely to churn than those from lower transparent channels by 3%, implying that information transparency helps reduce customer churn. Our findings suggest managers better allocate resources across channels to reduce churn by considering information transparency.

5 - A Study On Stock Prices Forecasting

Byeong-Yun Chang, Associate Professor, Ajou University, San 5 Woncheon-dong, Yeongtong-gu, Suwon, 443-749, Korea, Republic of, bychang@ajou.ac.kr, Yucong Chen

Stock price forecasting is a very popular issues in nowadays, which can make a contribution to the investing technologies and facilitate those who want to get a better understanding of stocks' trend line in the future so as to make their investment decisions. this research is going to use a modified two stage EWMA and classical method, ARIMA and MAR to do prediction for companies' stock price and electricity. For further work, we are going to propose a hybird model which combine TS-EWMA, ARIMA, and MARS.

■ WE28

201B-MCC

Retail Operations I

Sponsored: Manufacturing & Service Oper Mgmt

Sponsored Session

Chair: Jan C Fransoo, Eindhoven University of Technology, Eindhoven, Netherlands, j.c.fransoo@tue.nl

1 - Optimal Channel Choices Of Traditional Retail

Jiwen Ge, PhD Candidate, Eindhoven University of Technology, Eindhoven, Netherlands, j.ge@tue.nl, Dorothee Honhon, Jan C Fransoo, Lei Zhao

Nanostores are small retail stores which are prevalent in the mega-cities of emerging markets. We consider one CPG manufacturer selling one product to a cluster of nanostores either via the wholesale or the direct channel. We provide optimality conditions for each channel strategy when market demand is constant or grows deterministically within a finite time horizon.

2 - Coordinated Delivery To Nanostores In Megacities

Ruidian Song, Tsinghua University, Beijing, 100084, China, srd13@mails.tsinghua.edu.cn, Lei Zhao, Jan C Fransoo, Tom Van Woensel

In megacities in emerging economies, there exists a large amount of independently operated, traditional format, small grocery stores (nanostores). The limitation in store space and cash flow force them to order frequently with small order sizes, which results in high delivery cost. We study potential strategies to coordinate these deliveries and examine their impact.

3 - Demand Estimation Under Multi-store Multi-product Substitution In High Density Traditional Retail

Tianhu Deng, Tsinghua University, Beijing, China, deng13@tsinghua.edu.cn, Mingchao Wan, Lei Zhao, Jan C Fransoo

In large cities in emerging economies, traditional retail is present in a very high density, with multiple independently owned small stores in each city block. Consequently, when faced with a stockout, consumers may not only substitute with a different product in the same store, but also switch to a neighboring store. We study this problem using both Nested Logit Model and Exogenous Model. Furthermore, we estimate the parameters of the two models using a Markov chain Monte Carlo algorithm in a Bayesian manner. We numerically find that the Nested Logit model outperforms the Exogenous Substitution model in estimating substitution probabilities.

4 - A Structural Estimation Model Based On Socioeconomic Variables To Analyze The Evolution Of Retail Channels

Jan C Fransoo, Eindhoven University of Technology, School of Industrial Engineering, P.O. Box 513 Pav F4, Eindhoven, NL-5600MB, Netherlands, j.c.fransoo@tue.nl, Christopher Mejía-Argueta

Despite the prediction of many researchers that nanostores in the traditional retail channel would disappear, they continue to serve most of the world's population. We develop a structural estimation model to analyze current and future choice of clients among supermarkets, convenience stores and nanostores considering socioeconomic variables. Using data from two Latin American cities, we show that channel switching behavior is explained primarily by population density, income level, and the growth of stores. Furthermore, there are important reasons why nanostores will continue to retain their position as the largest retailing channel in big cities with large income differences.

■ WE29

202A-MCC

Empirical Research in Sustainable Operations

Sponsored: Manufacturing & Service Oper Mgmt, Sustainable Operations

Sponsored Session

Chair: Erin Cassandra McKie, University of South Carolina, 1014 Greene Street, Columbia, SC, 29208, United States, erin.mckie@grad.moore.sc.edu

2 - Sector, Industry, Firm, And Year Influence On Environmental Management Practice Adoption

Rick Hardcopf, University of Minnesota, 321 19th Avenue South, Minneapolis, MN, 55455, United States, hardc001@umn.edu, Rachna Shah, Ujjal Kumar Mukherjee

Firms take deliberate actions to reduce the impact of their operations, or supply chain, on the natural environment. While adoption of these practices has increased steadily over the years, firms within a common sector or industry vary greatly in their propensity to adopt. In this study, we use a novel secondary dataset to evaluate the relative influence of time, firm attributes, industry membership and sector participation in explaining heterogeneity in adoption across firms. We also evaluate several individual firm and industry characteristics to determine which specific aspects of the firm and industry are responsible for the variance explanation provided by the macro categories.

3 - Promoting Consumer Recycling: Effects Of EPR Legislation And Regional Traits

Erin Cassandra McKie, PhD Candidate, University of South Carolina, 1014 Greene Street, Columbia, SC, 29212, United States, erin.mckie@grad.moore.sc.edu, Mark Ferguson, Michael Galbreth

We will present results from consumer surveys about e-waste legislation from U.S. states that have different versions of e-waste legislation as well as from states with no e-waste legislation. Our findings indicate differences in customer awareness of e-waste policies and how they dispose of end-of-use electronic products.

■ WE30

202B-MCC

Systemic Issues in Healthcare and Humanitarian Logsitics

Sponsored: Manufacturing & Service Oper Mgmt, Healthcare Operations

Sponsored Session

Chair: Jonathan Helm, Indiana University, 1309 E. 10th St, Bloomington, IN, 47401, United States, helmj@indiana.edu

Co-Chair: Alex Mills, Indiana University - Bloomington, Bloomington, IN, United States, millsaf@indiana.edu

1 - Inventory Dispersion, Stock Mobilizing Speed And Fortification In Humanitarian Operations

Shabnam Rezapoor, PhD Candidate, University of Oklahoma, Norman, OK, United States, shabnam_rezapoor@yahoo.com, Reza Zanjiranifarahani, Alfonso Pedraza-Martinez

We study the impact of joint decisions of locating relief stockpiles and identifying amount of pre-positioned inventory on humanitarian logistics. We explore how pre-positioning inventory quantity can be reduced in relief networks. By using analytical and numerical methods we investigate the effect of inventory dispersion, stock mobilizing speed, and stock fortification on amount of the required inventory. Due to uncertainty in demand location, a scenario-based modeling approach based on graph and network concepts is used. Then, the findings are tested on a case problem in Florida including 18 regions facing hurricane and the related insights and observations are extracted.

2 - Surge Capacity Deployment In Hospitals: Preparation, Response, Recovery, And Mitigation

Alex Mills, Indiana University, Bloomington, IN, United States, millsaf@indiana.edu, Yu Wang

Major hospitals often experience demand surges, requiring a rapid increase in capacity. While practitioners deploy several different actions to respond to surges, mitigative actions are often ignored. We show that both response and mitigation can be improved using ideas found in Operations Management, and we suggest specific operational improvements based on hospital characteristics.

3 - Malaria Treatment Distribution In Developing World Health Systems And Application To Malawi

Jonathan Helm, Indiana Universtiy, helmj@indiana.edu

Efficient medication distribution is key in the fight against malaria in developing countries with severe resource constraints. We propose a new transshipment methodology by integrating a tactical 2-stage stochastic program with an optimal operational policy derived from a MDP model. We design a decomposition strategy that enables a tractable solution for the entire country, including government 290 centers. Our approach is shown to be robust to challenges of developing countries, including slow paper-based inventory review, uncertain transportation infrastructure, the need for equitable distribution, and seasonal and correlated demand associated with malaria transmission dynamics.

4 - Healthcare Inventory Management In The Presence Of Supply Disruption And A Reliable Alternative Supply Channel

Erhun Kundakcioglu, Ozyegin University, Faculty of Engineering, Istanbul, Turkey, erhun.kundakcioglu@ozyegin.edu.tr

In this study, we investigate the inventory review policy for a healthcare facility to minimize the impact of inevitable drug shortages when an alternative reliable supplier is present. A continuous-time stochastic process is used to calculate optimal inventory levels for the primary (unreliable) and secondary (reliable but costly) suppliers. We present optimal strategies for tractable instances, provide insights through supervised learning tools, and highlight how these results can be generalized. In particular, we provide business rules for inventory managers that would simultaneously minimize average inventory and secondary supplier usage.

■ WE31

202C-MCC

The On-Demand Economy: Matching, Capacity-Planning, and Incentives

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Amy Ward, University of Southern California, Marshall School of Business, Los Angeles, CA, 90089, United States, amy.ward@marshall.usc.edu

1 - Near-optimal Matching For Real-time Ridesharing

Erhun Ozkan, University of Southern California, Los Angeles, CA, United States, erhunozkan@gmail.com, Amy R Ward

Participants in real-time ridesharing services such as Uber, Lyft, etc. arrive stochastically over time and must be matched. One common heuristic myopically matches an arriving customer to the closest available driver. However, that heuristic does not account for differences in arrival rates across locations. We propose a linear programming based heuristic that does account for such differences, and prove it is asymptotically optimal in ridesharing systems with high volumes of demand, under the condition that drivers are in some sense "scarce".

2 - Product Support Forums: Customers As Partners In The Service Delivery

Konstantinos Stouras, INSEAD, konstantinos.stouras@insead.edu, Serguei Netessine, Karan Girotra

Online product support forums where customers can post complaints and questions, or report issues about a product or service of a firm abound. A large number of companies choose to crowdsource their product and service support back to their customers, employing a few dedicated service operators. We characterize the equilibrium behavior of such a novel business model for service and compare it with a call center model.

3 - Pricing And Optimization In Shared-Vehicle Systems

Siddhartha Banerjee, Cornell University, sbanerjee@cornell.edu

We propose a framework for data-driven pricing in shared vehicle systems in which customers can pick up and drop off vehicles in different locations. Compared to traditional pricing problems, pricing in shared vehicle systems is more challenging due to network externalities, wherein setting prices at one demand node may affect the supply at all other nodes in the network. Our framework provides efficient algorithms with rigorous approximation guarantees for a wide class of objective functions (including welfare and revenue, and also multi-objective problems such as Ramsey pricing), and under a variety of constraints on the prices. We achieve our guarantees by first projecting the problem to an infinite-supply setting, deriving optimal prices in this limit, and then bounding the performance of these prices in the finite-vehicle system; this technique may be of independent interest since it applies even more generally than the pricing problems that we consider.

4 - Managing Queues With A Self-scheduling Capacity

Rouba Ibrahim, University College London, rouba.ibrahim@ucl.ac.uk

Randomness in the number of servers often arises in practice, e.g., in virtual call centres with self-scheduling agents. We study the problem of staffing queueing systems with a random number of servers and impatient and costly customers. We characterize the optimal staffing policy and formulate related insights.

■ WE32

203A-MCC

Sports and Entertainment

Contributed Session

Chair: Kristopher Pruitt, Associate Professor, United States Air Force Academy, 2354 Fairchild Dr, Ste 6D222, USAFA, CO, 80840, United States, kristopher.pruitt@gmail.com

1 - Analysis Of World Baseball Softball Confederation Premier 12 Schedule

Seong Dae Kim, Associate Professor, University of Alaska Anchorage, 3211 Providence Drive, University Center, Room 155, Anchorage, AK, 99508, United States, sdkim2@uaa.alaska.edu, J.C. Kim

World Baseball Softball Confederation (WBSC) created the Premier12 tournament featuring the twelve best-ranked national baseball teams in the world. The first tournament was held in Taiwan and Japan in 2015. Questions were raised about the fairness of factors that can affect the team performance and the game result. This study analyzes the game schedule and other factors that might have unfairly affected the tournament and propose a better balanced schedule by formulating it as an OR problem. This study also discusses on what could have been done differently do make the tournament more successful.

2 - The Role Of Offensive System In The NBA Draft

Ryan Chen, Stanford University, 227 Ayrshire Farm Lane, Apt. 301B, Stanford, CA, 94305, United States, rdchen@stanford.edu, Eli Shayer, Travis Chen, Nicholas Canova

NBA teams look for every possible tool to help them decide which players to draft each year, avoiding "bust" players who perform much worse than expected and seeking out star players to become cornerstones of great teams. We propose an addition to this set of tools, using data describing the draft prospects' collegiate offensive systems to understand why players tend to outperform or underperform relative to their expected draft position and associated Win Shares. Our key contribution is a cluster analysis that shows the offensive play type distributions associated with star and bust players at each of the 5 on-court positions.

3 - Using Past Scores And Regularization To Create A Winning NFL Betting Model

Eric Webb, Kelley School of Business, Indiana University, Bloomington, IN, 47404, United States, ermwebb@indiana.edu, Wayne L Winston

Is the National Football League betting market efficient? We have devised a profitable betting model that would win 52.7% of the 7,705 bets against the spread it would have made over 34 seasons. Scores from previous weeks are used to estimate the point value of each team's offense and defense. These values predict next week's scores, and a bet is placed against the advertised spread. The sum of squares of offensive/defensive point values are constrained to be less than a regularization constant.

4 - An Optimal Pacing Strategy For Ultramarathons

Kristopher Pruitt, Associate Professor, United States Air Force Academy, 2354 Fairchild Dr, Ste 6D222, USAFA, CO, 80840, United States, kristopher.pruitt@gmail.com, Justin Hill

We present an optimization model designed to prescribe ideal pacing and nutrition strategies for athletes competing in ultramarathon races. The mixed-integer nonlinear program determines the level-of-effort and carbohydrate intake for the athlete during each kilometer in order to minimize the total completion time subject to the altitude, terrain, and distance of the race, as well as the fitness of the athlete. Our presentation includes modeling techniques required to linearize the problem and a numerical case study.

■ WE33

203B-MCC

Procurement & Purchasing Management

Contributed Session

Chair: Vandit Shah, California State University - Fullerton, Fullerton, CA, United States, vandit_2293@csu.fullerton.edu

1 - Geography Still Matters: Examine The Role Of Location In Online Markets For Foreign Branded Products

Xia Zhao, Associate Professor, University of North Carolina at Greensboro, 479 Bryan Building, PO Box 26170, Greensboro, NC, 27402, United States, x_zhao3@uncg.edu, Kexin Zhao, Jing Deng

Internet technologies and e-commerce have significantly reduced communication costs and facilitated trade between distant parties. Conventional wisdom holds that the world becomes flat and geographic divisions are gradually irrelevant. This study investigates whether and how geographic location affects online sellers' pricing strategies and sales for foreign branded products using a large data set collected from a brand owner's website and an e-commerce retail platform. Our research provides empirical evidences that origin bias exists and geography still matters in the online platform.

2 - Value For Money Assessment Using Fuzzy Logic

Deepak Kanhaiyalal Sharma, Assistant Professor, California State University - Fullerton, 800 N State College Blvd, Dept. of Civil & Environmental Eng., Fullerton, CA, 92831, United States, dsharma@fullerton.edu, Baig Jufain Mirza

Value for Money (VfM) assessment is the gateway analysis for adopting the Public Private Partnerships (PPPs) for project delivery. Review shows that PPPs have evolved significantly but the VfM assessment has remained almost unchanged. Throughout the world, practitioners and researchers have voiced their concerns about the limitations of VfM assessment. Fuzzy Logic (FL) enables decision makers to assign degrees of truthfulness on the basis of "awareness" of the qualitative part of VfM and getting a single comprehensive VfM result. Using a case study this research also presents use of fuzzy decision analysis tools to supplement the existing VfM practice.

3 - Decision Science Tools For Value For Money (vfm) Analysis

Deepak Kanhaiyalal Sharma, California State University - Fullerton, 800 N State College Blvd, Dept. of Civil & Environmental Eng., Fullerton, CA, 92831, United States, dsharma@fullerton.edu, Vandit Shah, Baig Mirza

Value for Money (VfM) assessment is the gateway analysis that allows use of Public Private Partnerships (PPPs) for project delivery. Review shows that PPPs have evolved significantly but the VfM assessment has remained almost unchanged, mandating enhancement of the process. This research presents application of Bayesian Networks (BN), Fuzzy Logic (FL) and Data Envelopment Analysis (DEA) to supplement the VfM by seamlessly integrating the qualitative and quantitative results of the assessment. A case study has been included to demonstrate the application of these methods along with advantages and disadvantages of each method.

4 - Contracting For Services In Multiple Industries: An Empirical Analysis

Yuan Ye, PhD Candidate, University of Houston, 4800 Calhoun Rd, Houston, TX, 77004, United States, yye@bauer.uh.edu, David Xiaosong Peng

Service contracting is a prevalent business practice to reduce costs, improve quality, access external knowledge and enhance innovation. Yet, many services are highly specialized or unique, making service contracting a challenge for both the buyer and the supplier. Based on the strategic sourcing processing, we develop an empirical study to investigate the practices in service contracting. We intend to benchmark the practices in different industries (e.g., healthcare, oil and gas, and manufacturing) and identify the best practices that drive success outcomes in service contracting.

5 - Factors Affecting Public Private Partnership Acceptance

Vandit Shah, California State University, Fullerton, Fullerton, CA, United States, vandit_2293@csu.fullerton.edu, Deepak Kanhaiyalal Sharma

Many highway projects have been successfully implemented as Public Private Partnership (PPP) projects. The PPP projects, also known as toll roads, have been beneficial to the public but have received varying level of acceptance across the US. This research focuses on identifying the factors that differentiates the US States on the basis of PPP acceptance. We have used Principal Component Analysis (PCA) to identify education, gender, congestion (traffic volume) and daily vehicle mile traveled as the most influential factors influencing PPP acceptance. The results of this research will be useful for agencies to develop outreach programs for better PPP project implementation.

■ WE35

205A-MCC

On-demand Service Platforms

Sponsored: Manufacturing & Service Oper Mgmt, Service Operations

Sponsored Session

Chair: Itai Gurvich, Kellogg School of Management, Northwestern University, Evanston, IL, 60208, United States, i-gurvich@kellogg.northwestern.edu

1 - On-demand Service Platforms

Terry Taylor, University of California - Berkeley, Berkeley, CA, 94720, United States, taylor@haas.berkeley.edu

An on-demand service platform (e.g., Uber, Instacart) connects waiting-time sensitive customers with independent service providers. This paper characterizes how two defining features of an on-demand service platform – congestion-driven delay and service provider independence—impact the platform's optimal per-service price and wage.

2 - The Efficacy Of Incentives In Scaling Up Marketplaces

Ashish Kabra, INSEAD, Boulevard de constance, Fontainebleau, 77305, France, ashish.kabra@insead.edu, Elena Belavina, Karan Girotra

Marketplaces spend billions in incentives to achieve scale, which is key to the efficacy and survival of marketplaces. Using detailed transaction data from a leading transportation marketplace, we estimate and compare the effects of incentives given to the "buyer" side and "seller" side of the marketplace as well as the effect of threshold and linear incentives.

3 - Labor Welfare In The Sharing Economy

Guangwen Kong, University of Minnesota, Minneapolis, MN, United States, gkong@umn.edu, Saif Benjaafar, Jian-Ya Ding, Terry Taylor

We consider an online service platform that relies on a self-employed and self-scheduled workforce to provide a service. Workers vary in their availability and their valuation of their time. The platform decides on wages and prices. We examine the resulting labor profile and labor surplus.

4 - Perception Of Dynamic Pricing In On-Demand Services

Nil Karacaoglu, Northwestern University, Kellogg, Evanston, IL, United States, n-karacaoglu@kellogg.northwestern.edu, Antonio Moreno-Garcia

Ride-sharing services such as Uber and Lyft adjust their prices using opaque dynamic-pricing algorithms that take demand and supply into account. In this research, we focus on how customers perceive and react to nontransparent dynamic pricing practices in ride-sharing services.

■ WE36

205B-MCC

Sustainable Operations for Farmers

Sponsored: Manufacturing & Service Oper Mgmt, Supply Chain

Sponsored Session

Chair: Ming Hu, University of Toronto, Toronto, ON, Canada, ming.hu@rotman.utoronto.ca

1 - Distressed Selling By Farmers: Model And Analysis

Shivam Gupta, University of Texas-Dallas, sxg104920@utdallas.edu, Milind Dawande, Ganesh Janakiraman, Ashutosh Sarkar

In many developing countries, farmers sell a significant portion of their produce at prices much lower than the support price offered by the government. Using a dynamic programming model, we identify a near optimal policy to quantify distressed sales and show that the model predictions are reasonably accurate using real data.

2 - Knowledge Sharing And Learning Among Smallholders In Developing Economies: Implications, Incentives, And Reward Mechanisms

Shihong Xiao, HKUST, Hong Kong, Hong Kong, sxiaoab@connect.ust.hk, Ying-Ju Chen, Christopher S Tang

NGOs and governments are advocating knowledge sharing and learning platforms to improve smallholders' productivity. Putting altruism aside, we examine the economic implications for heterogeneous farmers to share their private farming knowledge voluntarily with other farmers under competition. By analyzing a multi-person sequential game, we provide a plausible reason for farmers' sharing motivation. We find that the voluntary knowledge shared level is always lower than or equal to the "first best" knowledge shared level. Upon examining different mechanisms, we establish a quota-based reward mechanism that can entice farmers to share their knowledge up to the first-best level voluntarily.

3 - Altruistic Rationality: The Value Of Strategic Farmers And Social Entrepreneurs In Crop Planting Decisions In Developing Economies

Wenbin Wang, Shanghai University of Finance and Economics, Shanghai, China, wang.wenbin@shufe.edu.cn, Ming Hu, Yan Liu

We study how farmers make crop-planting decisions over time. We consider both strategic farmers who rationally anticipate the near-future crop prices as a basis for making planting decisions, and naïve farmers who shortsightedly react to recent prices. The latter behavior may cause recurring over- or under-production which leads to price fluctuations. We examine the roles of the strategic farmers and social entrepreneurs in influencing the farmers' crop-planting decisions and stabilizing the market price. Surprisingly, we find the self-serving behaviors from a tiny amount of strategic farmers may be enough to reduce price volatility and benefit all the farmers.

■ WE37

205C-MCC

Health Care, Other II

Contributed Session

Chair: Mostafa Hasan, Research Assistant, Wichita State University, 1629 N Fairmount St, Wichita, KS, 67208, United States, mhasann16@yahoo.com

1 - A System Dynamic Approach For Risk Assessment Of Lyme Disease – A Case Study At Binghamton University Campus In Broome County, New York State

Nasser Sharareh, PhD, Binghamton University, 4400 Vestal Parkway East, Binghamton, NY, 13902, United States, nsharar1@binghamton.edu, Nasim Sabounchi, Amanda Roome, Ralph Garruto

Our objective in this paper is to develop a risk assessment framework of Lyme disease that includes the pathogen, reservoir, vector and environmental factors as well as social, behavioral and demographic risk factors. System Dynamics modeling has been used to develop a simulation tool to evaluate significance of different risk factors on the Binghamton University campus in replicating the historical trend of Lyme disease cases. The data for human behavioral risk, pathway risk, and tick density and infectivity have been gathered by direct observation and laboratory analysis. The model provides recommendations for preventive strategies and control of tick population growth.

2 - Modeling Medical Overpayments Using Truncated Distributions

Babak Zafari, Babson College, Babson, MA, United States, zafari.babak@gmail.com

In this work, we explore some new methods used in overpayment extrapolations and compare their performance to existing models.

3 - Procurement Models For Clinical Supplies: Indian Context

Bhavin J Shah, Associate Professor, Indian Institute of Management, Indore, Faculty Office # C-206, First Floor,, Prabandh Shikhar, Rau-Pithampur Road,, Indore - Madhya Pradesh, 453556, India, bhavinj@iimidr.ac.in, Hasmukh Gajjar

This paper seeks to understand and explore applications of procurement models followed in sourcing clinical supplies to reduce cost of healthcare in Indian hospitals. It aims at improving efficiency of healthcare delivery without sacrificing service levels and explore various alternatives such as forming cross-functional collaborative teams comprising clinicians and sourcing experts for operational improvements.

4 - A Multiple Criteria Decision Tree Algorithm For Selecting Breast Cancer Treatment

Mostafa Hasan, Research Assistant, Wichita State University, 1629 N Fairmount St, Wichita, KS, 67208, United States, mhasann16@yahoo.com, Esra Buyuktahtakin, Elshami Elamin

According to the American Cancer Society, 246,660 new cases will be diagnosed with invasive breast cancer and approximately 40,450 women will die in the United States in 2016. To deal with the complexity, a decision support system is proposed combining MCDM techniques and decision trees. We then propose a detailed algorithm which will evaluate each factor and condition of the breast cancer patients in order to determine the best treatment alternatives.

■ WE38

206A-MCC

General Session III

Contributed Session

Chair: Seyedali Mirzapour, PhD Student, Wichita State University, 1845 Fairmount St., Wichita, KS, 67260, United States, mirzapour.ie@gmail.com

1 - Modeling And Performance Evaluation Of Bernoulli Transfer Lines With Batch Processors

Feiyi Yan, Northwestern Polytechnical University, 127 West Youyi Road, Xi’an, China, pacpos.fyyan@gmail.com, Jun-Qiang Wang

This paper focuses on analytical methods for performance evaluation of transfer lines with Bernoulli unreliable batch processors and finite buffers. Each machine has a limited capacity to process a batch of parts simultaneously. Three different analytical models of production lines with two batch processors are established. The modulo n congruence class theory is introduced to depict the system state of the Markov chain and to prove the ergodicity condition. An aggregation method is proposed to analyze a general Bernoulli transfer lines. Numerical experiments are conducted to verify the accuracy of the proposed methods. The impact of machine capacity on system performance is analyzed.

2 - A New Relaxation Method For Mathematical Program With Complementarity Constraint

Tangi Migot, IRMAR-INSA, Rennes, France, tangi.migot@gmail.com, Jean-Pierre Dussault, Mounir Haddou

p { margin-bottom: 0.25cm; line-height: 120%; } Recent progress on optimality conditions for MPCC allows to build efficient relaxation methods starting from Kadrani et al. in 2009. We will present an overview on these methods and discuss both the properties of the sequence of non-linear program (NLP) generated by these algorithms and the weakest conditions needed to ensure convergence of the methods. We will also present a new method with improved properties on the sequence of NLP, which provides a certificate when the method converges to undesirable points. We run a numerical comparison of these methods on a large number of test problems.

3 - Leaf Trajectory Optimization For Dynamic Delivery Of Intensity-modulated Radiotherapy Plans

Seyedali Mirzapour, PhD Student, Wichita State University, 1845 Fairmount St., Wichita, KS, 67260, United States, mirzapour.ie@gmail.com, Ehsan Salari

In intensity-modulated radiotherapy, a multi-leaf collimator (MLC) consisting of rows of paired leaves, is used to dynamically modulate the shape and intensity of radiation beams. Traditionally, unidirectional leaf sweeping schemes have been considered for dynamic beam modulation. In this research, we investigate the potential gain in plan quality and efficiency obtained from allowing for a free movement of MLC leaves.

■ WE39

207A-MCC

Applied Probability and Economics II

Sponsored: Applied Probability

Sponsored Session

Chair: Krishnamurthy Iyer, Cornell University, 225 Rhodes Hall, Ithaca, NY, 14853, United States, kriyer@cornell.edu

1 - The Magician’s Shuffle: Re-using Lottery Numbers For School Seat Redistribution

Irene Yuan Lo, Columbia University, New York, NY, United States, iyl2104@columbia.edu, Itai Feigenbaum, Yashodhan Kanoria, Jay Sethuraman

We consider a dynamic model of the school choice problem, where students are given an initial allocation, learn the value of their outside option, and are then given a final allocation based on their updated preferences. The goal is to obtain an efficient final allocation that is individually rational with respect to the initial allocation and minimizes student movement. We propose a family of mechanisms that are fair, efficient, two-round strategy-proof and individually rational. We show that when a natural ‘order’ condition is satisfied, all these mechanisms produce equivalent final allocations, and that the mechanism that reverses student lotteries between rounds minimizes student movement.

2 - Promotional Campaigns Under Social Learning

Ehsan Valavi, Columbia University, New York, NY, 30332-0205, United States, valavi19@gsb.columbia.edu, Costis Maglaras

We study some promotional pricing heuristics in settings where consumers get informed about a product through a product reviews via a social learning mechanism.

3 - The Strange Case Of Privacy In Equilibrium Models

Rachel Cummings, California Institute of Technology, 1200 E California Blvd, MC 305-16, Pasadena, CA, 91125, United States, rachelc@caltech.edu

We study how privacy technologies affect user and advertiser behavior in a simple economic model of targeted advertising. In our model, a consumer first decides whether or not to buy a good, and then an advertiser chooses an ad to show her. The advertiser would like to use information about the consumer’s purchase decision to target the ad that he shows, but he is given only a differentially private signal about the consumer’s behavior. We study equilibrium behavior as a function of the privacy level and show that this behavior can be highly counter-intuitive. The effect of adding privacy in equilibrium can be completely different from what we would expect if we ignored equilibrium incentives.

4 - Delay-predictability Tradeoffs In Reaching A Secret Goal

Kuang Xu, Stanford University, Stanford, CA, United States, kuangxu@stanford.edu, John N. Tsitsiklis

We formulate a model of dynamic decision-making to study an agent’s predictability as she attempts to reach a final goal through a sequence of intermediate actions, while watched by an adversary who tries to predict the goal before it is reached. We are motivated by the increasing ubiquity of large-scale data collection infrastructures capable of predicting an agent’s intentions and future actions, in juxtaposition with an agent’s desire for privacy. We show the predictability of the agent’s goal can be made inversely proportional to the time she spends reaching it, and that this is the best possible. This characterization does not depend on the structure of the agent’s state space beyond the diameter.

■ WE40

207B-MCC

Queues with Correlations

Sponsored: Applied Probability

Sponsored Session

Chair: Ohad Perry, Northwestern University - Evanston, Evanston, IL, United States, ohad.perry@northwestern.edu

1 - The Impact Of Delays On Service Times In The Intensive Care Unit

Carri Chan, Columbia Business School, cwchan@columbia.edu

Most queueing models used to model healthcare delivery ignore the effects of delay experienced by patients awaiting care. We empirically verify that delays in time-to-treatment can increase a patient’s service requirement. We then propose a queueing model which incorporates these measured delay effects and approximation the expected work in the system when the service time of a job is adversely impacted by the delay experienced by that job. Our approximation demonstrates that work grows much faster than the traditional $1/(1 - \ )$ relationship seen in most queueing systems. As such, ignoring this effect of delay could have dire operational consequences.

2 - The Impact Of Dependence On Unobservable Queues

Jamol Pender, Cornell University, jamol.pender@gmail.com

In unobservable queueing systems, customers may choose to leave by balking, which is based on the queue length or they may leave by reneging from the queue, which is based on the virtual waiting time. The current literature assumes that the sequences of balking and reneging random variables are independent and a customer's decision to join the line is independent of the their willingness to wait. Thus, we relax the independence assumption and assess the impact of dependence. We show that the joint density near the origin and not the correlation of the balking and reneging random variables describes the impact of the dependence for the queue length and workload processes.

3 - Service Systems With Correlated Service And Patience Times

Chenguang Wu, Northwestern University, ChenguangWu2013@u.northwestern.edu

In most of the literature on service systems, a customer's patience time is typically assumed to be independent of her service time. However, in many settings one expects a customer's service and patience times to be related, as is empirically reported in call centers and intensive care units. In our work we capture the correlation in a many-server queuing model and explore the implications of the correlation on capacity decisions to maximize profit. The profit in our case is the difference between revenue generated by serving customers and personnel cost associated with capacity. We demonstrate a nontrivial relation between capacity and profit in a system with correlations.

4 - Service Systems With Slowdowns

Jing Dong, Northwestern University, jing.dong@northwestern.edu, Pnina Feldman, Galit Yom-Tov

Many service systems exhibit service slowdowns when the system is congested. In this project we investigate this phenomenon and its effect on system performance. We modify the Erlang-A model to account for service slowdowns and carry out the performance analysis in the heavy-traffic asymptotic regime. We find that when the load sensitivity is high, the system can alternate randomly between two performance regimes, a phenomenon which we refer to as bi-stability. We analyze how the system parameters affect the bi-stability phenomenon and propose an admission control policy to avoid the bad performance regime.

■ WE41

207C-MCC

Topics in Portfolio Optimization

Sponsored: Financial Services

Sponsored Session

Chair: Brian Clark, Rensselaer Polytechnic Institute, Lally School of Management, Troy, NY, 12180, United States, clarkb2@rpi.edu

1 - The Implicit Value Of Tracking The Market

Majeed Simaan, Rensselaer Polytechnic Institute, Troy, NY, 12180, United States, simaam@rpi.edu, Chanaka Edirisinghe, Brian Clark

We find that the bias of the tracking error portfolio is mainly due to the mean-variance portfolio rather than the tracking error component. We find that shifting the weights of the portfolio toward the tracking error direction mitigates the higher estimation error that originates in the mean vector. Using bootstrap approach, we find that the committed estimation risk in the tracking error portfolio is significantly lower than that committed in the mean-variance portfolio. Additionally, this difference is amplified for cases that are associated with greater estimation risk.

2 - Optimal Portfolio Rebalancing Under Mean-risk Tradeoff, Market Impact, And Leverage

Jaehwan Jeong, Radford University, Department of Management, P.O. Box 6954, Radford, VA, 24142, United States, jjeong5@radford.edu, Chanaka Edirisinghe

A portfolio optimization problem is considered with frequent rebalancing, market impact costs, and random returns, to determine the efficient frontier between the Sharpe ratio and leverage ratio. Using an upper bound for portfolio variance, a nonconvex separable quadratic optimization model with two quadratic constraints is formulated. We develop an algorithm to solve this NP-hard problem and provide a strategy analysis.

3 - Disentangle Signals And Noises In Portfolio Optimization

Long Zhao, University of Texas at Austin, Austin, TX, United States, zhaolong.soul@gmail.com, Deepayan Chakrabarti, Kumar Muthuraman

Mean-variance portfolios constructed using the sample mean and covariance have a poor out-of-sample performance. There are two groups are better. The first group shrinks the covariance. The second imposes norm-constraints. However, the shrinkage targets and the norm-constraints are not validated. Our method disentangles signals and noises in sample covariance matrix. By using signals and bounding noises, this new method is parameter-free but can achieve significant lower out-of-sample variance than the naive portfolios across ten datasets. Finally, we show that the higher out-of-sample Sharpe ratio can be obtained by cautiously using the information in sample mean.

■ WE42

207D-MCC

Strategic Behavior and Dynamic Choice in Revenue Management

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Jue Wang, Queen's School of Business, 143 Union St. West, Kingston, ON, K7L 3N6, Canada, jw171@queensu.ca

1 - To Ration Or Not To Ration? Selling To Strategic Customers Under Shortage Effect.

Stephen Shum, City University of Hong Kong, swhshum@cityu.edu.hk, Peng Hu, Hanqing Liu

We consider the dynamic pricing and rationing policy of a firm facing strategic customers under the influence of shortage effect. We provide conditions under which it is optimal for the firm to ration. We also identify the necessary and sufficient conditions for the existence of steady state. We also characterize the firm's pricing and rationing policy under this steady state.

2 - Dynamic Pricing Of Vertically Differentiated Products For Consumers With Sequential Search

Chi-Guhn Lee, University of Toronto, cglee@mie.utoronto.ca, Sajjad Najafi, Sami Najafi-Asadolahi, Steven Nahmias

We consider a firm that wishes to maximize the expected revenue from a line of vertically differentiated products with fixed inventory over a finite horizon. Consumers are utility maximizers and sequentially check the products for one maximizing the utility. We analytically derive the optimal prices of products as well as the optimal order of products' presentation. We show that if the reservation utility is stationary or increasing, it is optimal for the seller to present the products in the descending order of quality and to increase price over time under a certain condition.

3 - Competing With Responsive Follower: Imitator And Strategic Consumers

Mike Mingcheng Wei, University at Buffalo, mcwei@buffalo.edu

In this work, we study the production and pricing decisions of a market leader facing an imitator under strategic consumer behavior with possible network externalities.

4 - Dynamic Pricing Of The Fixed-term Subscription Contract Offered To The Strategic Customers

Roozbeh Yousefi, Smith School of Business, 143 Union St., Kingston, ON, K7L 3N6, Canada, r.yousefi@queensu.ca, Yuri Levin, Mikhail Nediak, Jue Wang

Subscriptions are contracts that a company makes with its customers for regular service delivery or for providing access to the service. Service access limits can be stipulated in the subscription contract. We present a continuous time dynamic pricing model for a monopolist offering a fixed term subscription contract without per-use charges to strategic customers. We formulate the monopolist's problem in terms of optimal control, derive its optimality conditions, and study the structure of the optimal solution. We also examine the stationary optimal pricing regime and evaluate it in numerical experiments.

■ WE43

208A-MCC

Decision Analysis Arcade II

Sponsored: Decision Analysis

Sponsored Session

Chair: Alba Rojas, Virginia Tech, Progress Street, Blacksburg, VA, 24060, United States, albarc@vt.edu

1 - Adaptive Clinical Trials And The Hot Stove Effect

Alba Rojas-Cordova, Virginia Tech, Blacksburg, VA, United States, albarc@vt.edu, Niyousha Hosseinichimeh

Adaptive clinical trials promise cost savings to the pharmaceutical industry and have triggered significant regulatory changes. We model the dynamics of the drug development decision within the context of adaptive clinical trials. We consider the randomness surrounding the drug's probability of technical success and the bias inherent to its estimation. We show a bias against candidates that appear to be worse than they actually are.

2 - Sequential Exploration With Geological Dependencies And Uncertainty In Oil Prices

Babak Jafarizadeh, Statoil, Sandsliveien 90, SE-SV ND2, Bergen, 5020, Norway, bajaf@statoil.com

Economic valuation and analysis of drilling decisions for a cluster of exploration opportunities can be analytically challenging. If oil is found in one location, the probability of finding oil in the nearby prospects may increase. Furthermore, the time required to interpret data and update the geological understanding exposes these investments to hydrocarbon price dynamics. In this work, we develop a framework for valuation of clusters of exploration opportunities where prospects are geologically dependent and uncertainty in oil prices is described as a mean-reverting stochastic process.

3 - Sequential Sample Allocation For Multiple Attribute Selection Decisions

Dennis D Leber, NIST, 100 Bureau Drive, MS 8980, Gaithersburg, MD, 20899-8980, United States, dennis.leber@nist.gov, Jeffrey W Herrmann

When faced with a limited budget to collect data in support of a multiple attribute selection decision, the decision-maker must decide how many samples to observe from each alternative and attribute. This allocation decision is of particular importance when the observed attribute values contain uncertainty, such as with physical measurements. We present a sequential allocation scheme that relies upon Bayesian updating in an attempt to maximize the probability of correct selection when the attribute values contain Gaussian measurement error.

■ WE44

208B-MCC

Perceptions, Behavior, and Decisions

Sponsored: Decision Analysis

Sponsored Session

Chair: Franklyn Koch, Koch Decision Consulting, Eugene, OR, United States, kochfg@gmail.com

Co-Chair: Gregory L Hamm, Stratelytics, LLC, Alameda, CA, United States, ghamm@strts.com

1 - Perceived Catastrophic Risks In Sequential Social Networks

Shu Huang, Master Candidate, Tsinghua University, Tsinghua University, Haidian District, Beijing, 100084, China, huang-s15@mails.tsinghua.edu.cn, Chen Wang

Slovic (1987) proposes to use degrees of dread, unknown and personal exposure to describe individual risk perception. These factors depend on whether an individual has undergone disasters or near misses in the past, and are also affected by experiences and perspectives of his or her neighbors in the social network. We model each individual’s risk perception of uncertain consequences and likelihood of personal exposure as a Bayesian learning process to achieve equilibrium of estimation within each neighborhood. We can then construct a utility map over the social network to depict the dynamics of risk perception in response to multiple disasters.

2 - Bipolar Cardinal Ranking For Group Disagreement Evaluations

Aron Larsson, Associate Professor, Stockholm University, Postbox 7003, Kista, SE-16407, Sweden, aron@dsv.su.se, Tobias Fasth

Public decision making involve decisions that affect many stakeholders who have conflicting opinions. This may cause implementation issues for an authority, and to avoid this and to identify which stakeholder groups that are credited or discredited, it is of interest for the authority to understand how their preferences differ. One way of approaching this is to provide effective means for stakeholders to state preferences and affect towards proposed alternatives. For this we developed a web questionnaire using bipolar cardinal ranking where stakeholders state negative, neutral, or positive affect towards alternatives. The approach is demonstrated in a real-life case in Upplands Väsby, Sweden.

3 - Effects Of Total Cost Of Ownership on Automobile Purchasing Decisions

Muhammed Sutcu, Assistant Professor, Abdullah Gul University, Sumer Campus, Erkilet Bulvari, Kayseri, 38060, Turkey, muhammed.sutcu@agu.edu.tr

We reveal a complete picture of ownership-related expenses and construct a decision model which helps decision maker to make the optimal choice when purchasing an automobile. The decision model helps the costumers to understand what a car will cost beyond its purchase price when customers consider out-of-pocket expenses like fuel, repair, and insurance. For that purpose, representative joint probability distributions of a decision maker are approximated using maximum cumulative residual entropy (CRE) and CRE based first order dependence tree approaches to elicit decision maker’s preferences to calculate the total cost of ownership of an automobile.

■ WE45

209A-MCC

Simulation and Optimization

Contributed Session

Chair: B Vermeulen, Eindhoven University of Technology, Eindhoven, Netherlands, b.vermeulen@tue.nl

1 - Bi-level Stochastic Approximation For Decomposable Stochastic Optimization Formulations

Soumyadip Ghosh, IBM TJ Watson Research Center, 1101 Kitchawan Road, Route 134, Yorktown Heights, NY, 10598, United States, ghoshs@us.ibm.com, Ebisa Wollega, Mark S Squillante

We propose a bi-level algorithm to solve stochastic optimization formulations with a certain decomposable structure. Consider, for example, the problem of maximizing total revenue by jointly maximizing unit sales, subject to non-linear market conditions, and minimizing costs, which for fixed sales is a two-stage linear program (2SLP). An outer loop runs stochastic approximation (SA) accounting for the non-linear part. An inner loop solves the 2SLP. The gradient of the objective function of the 2SLP is used in the outer SA, and is obtained using parametric programming. We analyze the convergence of this bi-level SA, and provide experimental evidence of its efficacy on an energy-domain problem.

2 - A Decentralized Solution To The Car Pooling Problem

Pawel J. Kalczynski, Professor of IS and Decision Sciences, California State University-Fullerton, 800 N State College Blvd., Fullerton, CA, 92834-6848, United States, PKalczynski@fullerton.edu, Malgorzata Miklas-Kalczynska

Existing carpool optimization techniques based on the centralized approach serve policy-makers’ goals, but neglect the realities of participants. Moreover, absent strict enforcement, participants often ignore centralized solutions and maximize their own utility. We present a new model (formulated and tested on real-world and simulated problem instances) that mimics a decentralized carpool self-organization process. Our findings reveal savings similar to centralized models, and a potential strategy for improving carpool utilization.

3 - Avoiding Singularities In Parallel Robotic System Design

Cameron Turner, Associate Professor, Clemson University, 206 Fluor Daniel EIB, Clemson, SC, 29634-0921, United States, cturne9@clemson.edu, Sean Fry

Singular configurations in robotic systems present significant design and control problems. In parallel robotic systems, the complex nature of singularities makes their consideration during the design process even more significant when high precision motions are desired. Using surrogate-based optimization techniques, this paper achieves a solution for the design of a parallel robotic system for engineered material characterization.

4 - MO-COMPASS For Constrained Simulation Optimization

Haobin Li, Institute of High Performance Computing, A*STAR, 1 Fusionopolis Way, #16-16 Connexis North, Singapore, 138632, Singapore, lihb@ihpc.a-star.edu.sg, Xiaofeng Yin, Wanbing Zhang, Loo Hay Lee

MO-COMPASS is recently developed for multi-objective simulation optimization, which has limitation that only linear constraints on the decisions space can be explicitly handled. Whereas, for non-linear or stochastic constraints as simulation outputs, the default approach that penalizes the constraint violation on the objective values can be inefficient with the “most-promising-area” (MPA) structure. In this study, we propose a novel approach for constraint handling in the multi-objective environment, by considering Pareto optimality in different feasibility layers with generalized MPAs. So we extend MO-COMPASS to solve constrained optimization problems in an efficient manner.

5 - Approximate, Adaptive Maintenance Scheduling Of Maritime Assets Under Different Operating Modes

B Vermeulen, Eindhoven University of Technology, Eindhoven, Netherlands, b.vermeulen@tue.nl, Sena Eruguz, Tarkan Tan, Geert-Jan Van Houtum

In the maritime sector, vessels are used under different operating modes with different degradation rates, different maintenance setup and downtime costs, and particular maintenance/ replacement options. Given uncertainty on actual degradation rates for components, asset owners follow the OEMs’ hyper-conservative and hence costly maintenance and replacement policies. We provide an approximate dynamic programming model (and proprietary software tool) with online adjustment of degradation rates and adaptive planning of maintenance activities given the schedule of operating modes.

■ WE46

209B-MCC

Revenue Management and Pricing with Consumer Choice Models

Sponsored: Revenue Management & Pricing

Sponsored Session

Chair: Ruxian Wang, The Johns Hopkins Carey Business School, 100 International Dr, Baltimore, MD, 21202, United States, ruxian.wang@jhu.edu

1 - Product Line Design And Pricing Under Logit Model

Anran Li, Columbia University, al2942@columbia.edu

We study a manufacture who wants to design and price products which are feature-level combinations. This allows us to design products of different quality at different prices. We assume that demand for products follows a Logit model (MNL or NL) that measures utility as the aggregate value of the feature-levels and the unit production cost is equal to the sum of the component's wholesale prices. We show that optimal product configurations give priority to feature levels with high net value. The K best configurations can be obtained through a greedy algorithm derived from the K-shortest path problem. This allows us to find an optimal profit configuration in polynomial time.

2 - Demand Estimation Under The Multinomial Logit Model From Sales Transaction Data

Tarek Abdallah, New York University, New York, NY, United States, tabdalla@stern.nyu.edu, Gustavo Jose Vulcano

We study an MNL model of demand when customers arrive over time in accordance to a non-homogeneous Poisson process. We characterize conditions under which the model is identifiable and our maximum likelihood estimates are consistent. Then, we propose a maximize-minorize (MM) method for estimating the model parameters. Through an exhaustive set of numerical comparisons we conclude that the MM-based estimates are of similar quality to the ones obtained by state-of-the-art benchmarks, but its computation is orders of magnitude faster.

3 - Pricing And Assortment Management Under New Choice Models

Ruxian Wang, Johns Hopkins Carey Business School, Baltimore, MD, 21202, United States, ruxian.wang@jhu.edu

When facing multiple products, a consumer chooses the one with the highest utility, which depends on the product attributes, its own price, and perhaps the prices of other products. We characterize the structure of the optimal strategies and provide efficient exact and approximation algorithms.

■ WE48

210-MCC

Social Media Collective

Invited: Social Media Analytics

Invited Session

Chair: Lauren Rhue, Wake Forest University, 212 Farrell Hall, Winston-Salem, NC, 27106, United States, rhuela@wfu.edu

1 - Communication Of Collective Action Over Time: The Arousal, Interpretation, And Realization Model

Sung Won Kim, University of Illinois at Urbana Champaign, swk@illinois.edu, Shaila Miranda

Social media have recently been used by participants in social movements. Twitter was a key tool in the 2011-2012 protest against the Stop the Online Piracy Act (SOPA). This research develops a theory of the role of affective and cognitive mechanisms in online social movements. Tweets from the protest against SOPA were analyzed using vector autoregression and Granger causality analysis. The results of the Granger causality were used as empirical data points to build a theory of communication of collective action over time. Affect was found not only to spread through the community, but also to influence cognitive mechanisms. Cognitive mechanisms were used to identify problems and their solutions.

2 - Who Gets Started On Kickstarter? Demographic Variation In Crowdfunding Success Rates

Jessica Clark, Stern, jclark@stern.nyu.edu, Lauren Rhue

This study examines the variance in success rates across racial groups in the crowdfunding platform Kickstarter using two novel data sets: the race of subjects in photos associated with projects (determined using facial recognition software), and linguistic elements of the project descriptions found to be predictive of the race of the project photos' subjects. Even controlling for observable differences in both project and text characteristics, we find that there are significant racial differences in success rates. The results have managerial implications for individual fundraisers and platform designers.

3 - Watch Where You Eat!

Jorge Mejia, University of Maryland, jmejia@rhsmith.umd.edu

We focus on how social media analytics can be incorporated into the efforts to reduce foodborne illness, a major public health concern. We demonstrate how machine learning techniques can be used to monitor the hygiene quality of restaurants through social media. Using these techniques, we show evidence of moral hazard in how restaurants achieve high grades in the New York City program.

■ WE49

211-MCC

Teaching OR at Service Academies

Sponsored: Education (INFORMED)

Sponsored Session

Chair: Richard McGrath, United States Naval Academy, 121 Blake Road, Annapolis, MD, 21402, United States, rmcgrath@usna.edu

1 - Teaching Operations Research At The United States Naval Academy

Richard G McGrath, United States Naval Academy, mcgrathrg@alum.mit.edu

The United States Naval Academy (USNA), founded in 1845, is the undergraduate college of the U.S. naval service. Midshipmen attend the academy for four years, graduating with Bachelor of Science degrees and commissions as ensigns in the U.S. Navy or second lieutenants in the U.S. Marine Corps. Since 2012, the Mathematics Department has offered an undergraduate major in Operations Research, which has become one of the most popular majors at the academy. In this talk, we will discuss the OR program at USNA. We will describe a typical course of study, as well as how military and security applications are incorporated into the curriculum through coursework, project-based learning, and capstone projects.

2 - Teaching Operations Research At The United States Air Force Academy

Gerry Gonzalez, United States Air Force Academy, Colorado Springs, CO, United States, gonzalezgo@aol.com, Jesse Pietz

The United States Air Force Academy (USAFA) is an undergraduate college and one of three commissioning sources for the United States Air Force. Cadets attend the Academy for four years, graduating with Bachelor of Science degrees and commissions as second lieutenants in the United States Air Force. USAFA has offered an undergraduate major in Operations Research since 1966. In this talk, we will discuss the OR program at USAFA. We will describe a typical course of study, as well as how operational military applications are incorporated into the curriculum through coursework, project-based learning, and capstone projects.

3 - Teaching Operations Research At The United States Coast Guard Academy

Melinda D. McGurer, Head, Department of Mathematics, United States Coast Guard Academy, 15 Mohegan Avenue, New London, CT, 06320, United States, melinda.d.mcgurer@uscg.mil, Eric C. Johnson

The United States Coast Guard Academy (USCGA), founded in 1876 as the Revenue Cutter School of Instruction, is the undergraduate college of the U.S. Coast Guard in the Department of Homeland Security. Cadets attend the academy for four years, graduating with Bachelor of Science degrees and commissions as ensigns in the U.S. Coast Guard. Since 1997, the Mathematics Department has offered a degree in operations research. This talk discusses the OR program at the USCGA including a typical course of study and the incorporation of USCG applications. The talk emphasizes the senior capstone course in which the cadets serve as OR consultants for the USCG and broader military and homeland security communities.

WE50

212-MCC

Opt, Nonlinear Programming II

Contributed Session

Chair: Carlos Deck, PhD Student, UC Berkeley, 4141 Etcheverry Hall, University of California Berkeley, Berkeley, CA, 94720, United States, cgdeck@berkeley.edu

1 - An Eigenvalue Decomposition Based Branch And Bound Algorithm For Nonconvex Qcqp With Convex Quadratic Constraints

Qingwei Jin, Zhejiang University, School of Management, 866 Yuhangtang Road, Hangzhou, 310058, China, qingweijin@gmail.com, Cheng Lu, Zhibin Deng

In this paper, we propose a branch-and-bound algorithm for finding a global optimal solution for a nonconvex quadratic program with convex quadratic constraints (NQPCQC). We reformulate NQPCQC by adding some nonconvex quadratic constraints induced by eigenvectors of negative eigenvalues associated with the nonconvex quadratic objective function to Shor's semidefinite relaxation. Under the assumption of having a bounded feasible domain, these nonconvex quadratic constraints can be further relaxed into linear ones to form a special semidefinite programming relaxation. Then an efficient branch-and-bound algorithm branching along the eigendirections of negative eigenvalues is designed.

2 - Deployment Of Patrolling And Stationary Service Vehicles For Freeway Incident Management

Mohsen Parsafard, University of South Florida, 14440 Hellenic Drive, Apt 206, Tampa, FL, 33613, United States, parsafard@mail.usf.edu, Xiaopeng Li, Zhenyu Wang, Pei-Sung Lin

Freeway Service Patrols (FSP) are effective incident management systems to alleviate the incident related congestion in urban areas. A FSP system divides a network of freeways into a set of non-overlapping patrol beats and a number of tow trucks are then assigned to these beats. This study investigates a FSP system design problem. A mixed-integer nonlinear programming model is formulated for designing the optimal beat configuration and service vehicle allocation to maximally reduce delay, avoid secondary accident risks and mitigating fuel consumptions and emissions. Also, this study considers not only traditional patrolling vehicles or but also newly proposed stationary vehicles.

3 - Solutions Of Complementarity Problems Monotone With Respect To Parameters

Vyacheslav V. Kalashnikov, Professor and Researcher, Tecnologico de Monterrey, ITESM, Campus Monterrey, Ave. Eugenio Garza Sada 2501 Su, Monterrey, 64849, Mexico, kalash@itesm.mx Nataliya I. Kalashnykova, Mariel A. Leal-Coronado

In many applied problems (such as the elastohydrodynamic lubrication problem, some economic equilibrium problems, etc.), one of the important questions is if certain complementarity problem's solution is monotone with respect to parameters. Our paper investigates this question and provides several types of sufficient conditions that guarantee such a monotonicity of the solutions to linear and nonlinear complementarity problems with parameters. In the majority of cases, it is required that the principal mapping of the complementarity problem be monotone with respect to the decision variables and, vice versa, antitone with respect to the parameters.

4 - Solving Lps Using Parametric Quadratic Programming

Carlos Deck, PhD Student, UC Berkeley, 4141 Etcheverry Hall, University of California - Berkeley, Berkeley, CA, 94720, United States, cgdeck@berkeley.edu

Our approach for solving a standard LP with m constraints and n variables is based on a parametric QP where we relax the inequality constraints of the polyhedron of optimal solutions in primal-dual space. Using this approach, we can solve the bad instances of the simplex method given by the deformed products of Amenta and Ziegler (1999) in a polynomial number of pivots.

WE53

Music Row 1- Omni

DMA Text Mining

Contributed Session

Chair: Bill DeGray, IT Program Manager, Deloitte Services, LP, Hermitage, TN, 37076, United States, william.degray@gmail.com

1 - Cognitive Analytics For Financial Compliance

Aditya Vempaty, IBM Research, Yorktown Heights, NY, United States, avempat@us.ibm.com, Elham Khabiri, Swapna Buccapatnam, Matthew Riemer, Ta-Hsin Li, Ashish Jagmohan

Financial services firms require compliance with a complex set of regulatory requirements, laws, and regulators. In the face of increased regulatory enforcement, firms have significantly increased compliance spend. A major contributor to soaring compliance spend is the intensive expert manual component of current compliance processes. We propose approaches for automating key compliance processes using statistical machine learning and natural language processing techniques. We present preliminary results comparing performance against expert outcomes.

2 - On Determining The Viability Of Parametric Cost Forecasting Of Agile Software Development Projects To Improve Project Cost Forecasts

Bill DeGray, IT Program Manager, Deloitte Services, LP, Hermitage, TN, 37076, United States, william.degray@gmail.com

This presentation describes methods being used in a four phased investigation to determine whether parametric forecasting is a viable alternative to bottom-up forecasting for software development projects. Phase 1 (completed) - design. Phase 2 (completed) - determine if there is a relationship between the percentage of the historical project costs incurred (the response variable) and the percentage of the project schedule completed (the predictor variable). Phase 3 (in-progress) - identifying the model(s) that best describe(s) the relationship. Phase 4 will focus on development, testing, and piloting a parametric forecasting tool model based on the best regression model(s).

WE54

Music Row 2- Omni

Value Co-creation

Sponsored: Service Science

Sponsored Session

Chair: Ralph D Badinelli, Professor, Virginia Tech, Blacksburg, VA, 24061, United States, RALPHB@vt.edu

1 - Empirical Analysis Of Hospital Behaviors Resulting From Value Based Purchasing

Gregory Heim, Mays Business School, Texas A & M University, College Station, TX, 77845, United States, GHeim@mays.tamu.edu

We examine impacts of the federal Value Based Purchasing financial incentive policy to determine whether this federal program has changed practices and processes of healthcare providers in a manner that enhances process quality and improves healthcare outcomes, thereby enhancing value for patients.

2 - Value Derivation In The Service Journey

Ralph Badinelli, Virginia Tech, ralphb@vt.edu

Value co-creation is accomplished in service systems through an adaptive journey by service participants in a hypernetwork of service contexts. The viability of the service ecosystem depends on the engagement decisions made by participants at each context of the journey. Predicting and controlling this path is made complex by the stigmergy enabled by social networking and other information sources. We use fuzzy models of engagement decisions and examine the role of swarm intelligence in determining the viability of service ecosystems. We justify a value derivation principle in the place of value propositions and we derive patterns of service journeys under different touchpoint strategies.

■ WE55

Music Row 3- Omni

E Business/Commerce II

Contributed Session

Chair: Avijit Sarkar, Associate Professor, University of Redlands, 1200 E Colton Avenue, Redlands, CA, 92373, United States, avijit_sarkar@redlands.edu

1 - Why Some Markets Refuse Innovation And Entrepreneurship, When They Say They Love It: Evidence From Uber's Transportation Network Service

Robert Seamans, New York University-Stern, 1 Washington Square Village, # 7J, New York, NY, 10012, United States, rseamans@stern.nyu.edu, Sukhun Kang, Yongwook Paik

We study how established firms use non-market strategy to slow entry by sharing economy firms. We study this issue using a unique dataset that includes data on Uber's expansion into various U.S. cities during 2011-2015, together with data on political contributions and election outcomes. We find that the more politically entrenched a market is, the more resistance the entrant faces when working to commercialize its innovation. This study has theoretical, managerial, and policy implications for the ever-growing sharing economy, and highlights that, despite the benefits of innovation, there often times exists strenuous resistance to it, particularly from established firms in a market.

2 - The Effect Of Individual Characteristics On Online Purchase Decision Processes And Outcomes

K. Nadia Papamichail, Senior Lecturer (Associate Professor), University of Manchester, Manchester Business School, Booth Street East, Manchester, M15 6PB, United Kingdom, nadia.papamichail@manchester.ac.uk, Sahar Karimi, Christopher P. Holland

This paper presents a typology of online purchase archetypes based on consumers' individual characteristics such as decision-making style and knowledge of product. Video material has been collected and analysed to capture how online purchase decision making processes unfold for different archetypes. This is followed by an empirical study that explores the effect of decision-making style and knowledge of product on decision-related outcomes such as satisfaction with process and satisfaction with choice. Practical implications for online retailers are discussed.

3 - Subscribe Or Sell: Itunes Versus Google Play Music All Access

Hooman Hidaji, Alberta School of Business, 2-24 Alberta School of Business, Edmonton, AB, T6G 2R6, Canada, hooman.hidaji@ualberta.ca

Recently, subscription has become a popular method of user monetization in online media business along with selling model. It is expected that firms utilize both approaches to cover as much demand as possible. However, pricing strategy of the firms is crucial in determining the demand for the two. In this study, using an economic model with endogenous demand, we set to model how the firm decides on the business model. Different user types and business model-dependent demand are considered. We also look into advertising and group plans (such as family plans) for such services in the online entertainment industry.

4 - Socioeconomic Determinants And Geographic Patterns Of Internet Use For E-commerce And E-entertainment In Counties Of The United States

Avijit Sarkar, Associate Professor, University of Redlands, 1200 E Colton Avenue, Redlands, CA, 92373, United States, avijit_sarkar@redlands.edu, James B Pick

This research analyzes social-economic, innovation, and social capital influences on the use of the internet to access e-commerce and e-entertainment services for a large sample of U.S. counties. Nationwide geographic patterns and clustering of e-commerce and e-entertainment use of the internet are identified and explained. A Spatially Aware Technology Utilization Model explicitly considers underlying geographic relationships between model variables and diagnoses spatial bias in standard multivariate analysis. Implications for the digital divide in the United States are discussed and policies to expand use of the internet for e-commerce and e-entertainment use are recommended.

■ WE56

Music Row 4- Omni

Decision Support Systems III

Contributed Session

Chair: Munirpallam A Venkataramanan, Professor, Indiana University, Bryan Hall, 100, 107 S. Indiana Avenue, Bloomington, IN, 47405, United States, venkatar@indiana.edu

1 - An Operational Control Design Methodology For Warehouse Order Fulfillment

Timothy Sprock, Post Doctoral Fellow, Georgia Institute of Technology, 755 Ferst Dr, NW, Georgia Institute of Technology, Atlanta, GA, 30332, United States, tsprock3@gatech.edu

Smart operational control mechanisms for material handling systems must not only integrate real-time data from system operations, but also formulate and solve a wide variety of optimal-control analyses and then translate the results into executable commands. Automated and cost-effective access to multiple analyses from a single conceptual model of the target system would broaden the usage and implementation of analysis-based decision support and system optimization. The fundamental contribution of this research is concerned with interoperability and bridging the gap between operations research analysis models and practical applications of the results.

2 - Analytic Approaches In Higher Education Administration

Munirpallam A Venkataramanan, Professor, Indiana University, Bryan Hall, 100, 107 S. Indiana Avenue, Bloomington, IN, 47405, United States, venkatar@indiana.edu, Kathryn Ernstberger

Analytic grounded decision making offers new ways for universities to make operational decisions as well as address student teaching and learning issues. An overview of platforms available for such an approach is provided along with a discussion of some best practices. Recent successes at Indiana University are highlighted.

■ WE58

Music Row 6- Omni

Finance IV

Contributed Session

1 - Re-Evaluating The Performance Of Markowitz's Portfolio Selection Model In Terms Of The Distance Measure Approach

Hunbae Jeon, Master Student, Yonsei University, 109-1902, Lotte Apt., 31, Saemal-ro, Guro-gu, School of Business (Bld.#212) Rm.#301, Seoul, 08291, Korea, Republic of, hborjh1021@naver.com, Hongseon Kim, Seongmoon Kim

We have used Sharpe Ratio to evaluate the performance. However, it couldn't evaluate portfolios itself, because it is no more than checking the risk and return. Therefore we suggest distance measure approach as a new method to evaluate the portfolio performance. In this paper, we construct the optimal portfolio by using Markowitz's model, and generate random portfolios, and then calculate some distances between optimal and random portfolios. Then we show Euclidean distance is the best for analyzing the performance of Markowitz's model by comparing differences in terms of these distances.

2 - Official Visits And Firms' Employee: Evidences From China

Qiu Muqing, Tongji University, Siping Road, Shanghai, China, qsolemn@126.com

Different from the articles which discuss how to seek the protection of government by political connections from the angle of the firms, this paper studies how to achieve the social goals by official visits from the angle of Chinese government. We find that political connections are common in countries around the world, but official visits have "Chinese Characteristics". The paper finds that the officials are inclined to visit the firms which can absorb more employees. Official visits can increase the number of employees, especially for employees with college degree or below. This relation is much stronger in state-owned firms.

3 - A Real Option Analysis On Performance-sensitive Debt

Bo Liu, University of Electronic Science and Technology of China, No.2006, Xiyuan Ave, West Hi-Tech Zone, Chengdu, 611731, China, b.liu07@fulbrightmail.org

This paper adopts a real option approach to examine how the use of Performance-Sensitive Debt (PSD) contract affects the inefficiencies arising from financing constraints. The results show that if financing constraints are sufficiently weak, the use of PSD encourages the constrained firm to use a higher investment threshold and thus leads to a significant decrease in ex ante firm value compared to fixed-coupon debt. These results further imply that although PSD makes more financially constrained firms better off, less financially constrained firms face a trade-off between lower efficiency in ex ante firm value and higher efficiency in investment and financing decisions.

WE59

Cumberland 1- Omni

Supply Chain Networks Design under Uncertainty

Sponsored: TSL, Facility Logistics

Sponsored Session

Chair: Nima Sadghiani, University of Michigan, Ann Arbor, MI, 12121, United States, nsalehi@umich.edu

1 - Rolling Stock Maintenance Location Routing: Stochastic And Robust Programming Formulations

Denise Désirée Tönissen, Eindhoven University of Technology, Eindhoven, Netherlands, D.D.Tonissen@tue.nl, Zuo-Jun Max Shen, Joachim Jacob Arts

The maintenance location routing problem for train units is a NP-hard problem, where we locate maintenance facilities, while also taking the maintenance routing into account. Facility location is a long term strategic decision, but the optimal facility locations depend on line planning and rolling stock schedules. Since these change on a regular basis, our objective is to minimize the costs under different discrete line planning and rolling stock schedule scenarios. We give robust and stochastic formulations, provide algorithms to solve the problems and perform numerical tests.

2 - Global Sourcing Under Correlated Uncertainties: A Scenario-based Stochastic Programming Approach

Nima Salehi Sadghiani, University of Michigan, 3545 GreenBrier Blvd,, Apt. 39A, Ann Arbor, MI, 48105, United States, nsalehi@umich.edu, Mark Stephen Daskin, Don Zhang, Mark Everson, Michael Sanders

Managing uncertainty is one of the challenging issues in supply chains. Using only the expected value of the uncertain parameters for sourcing decisions in a deterministic model can be risky due to the uncertainties that threaten both the optimality and feasibility of the decision variables. Most previous studies on supply chain network design assume that uncertainties are independent. In this study, we address the need for an effective tool to incorporate potential uncertainties associated with the model parameters and their correlation into sourcing decisions.

WE60

Cumberland 2- Omni

Collaborative Logistics

Sponsored: TSL, Freight Transportation & Logistics

Sponsored Session

Chair: Brett Shields, UTSI, 411 B.H. Goethert Parkway, Tullahoma, TN, 1, United States, bshields@utsi.edu

1 - A Classification For Collaborative Logistics State Of The Art Analysis

Andrea Rusich, Univeristy of Trieste, Andrea.Rusich@phd.units.it

Scientific literature on collaborative logistics still misses a harmonized approach to analyse its management implications. This paper aims to fill this gap by introducing a classification canvas based on four perspectives: decision-makers, form of collaboration, ICT and decision technology enablers, operations management. The proposed analysis enhances the understanding of existing collaborative logistics approaches and identifies further research steps. In addition, an application example to the Physical Internet shows how the classification could support the study of emerging collaborative logistics frameworks.

2 - Vehicle Routing Problem In Collaborative Environments: Introducing An Exchange Mechanism For Orders.

Vincent Karels, TUE, v.c.g.karels@tue.nl

Considering the distribution of orders, we introduce a system that exchanges orders in such a way that cooperating distribution companies maintain their competitiveness and autonomy while also decreasing their costs. First an instrument is formulated which determines the marginal costs of any order within the vehicle routing problem, while retaining that the calculations remain computationally tractable. Subsequently an auctioning mechanism utilizing this instrument is introduced, and the measure to which this mechanism evolves to the best allocation of orders (the social optimum) is evaluated.

3 - Fair Sharing Approach For Network-wide Adoption Of Collaborative Container Logistics

Rob A Zuidwijk, Professor of Ports in Global Networks, Erasmus University Rotterdam, P.O. Box 1738, Rotterdam, 3000 DR, Netherlands, rzuidwijk@rsm.nl, Irina Romochkina, Peter van Baalen

This paper draws from cooperative game theory while studying fair sharing schemes and is inspired by actual issues in the adoption of Inter-Organizational Systems (IOS) in container logistics in a sea port environment. We demonstrate (1) the influence that network effect, as experienced in business network communication structure and propensity for coordination between players, has on the chances of an IOS to be fully adopted by a business network under fair sharing conditions, and (2) that a fair sharing scheme has the potential to eliminate two types of conflicts related to uneven benefits distribution and through this enhance IOS adoption under certain conditions."

4 - A Stochastic Make Or Buy Model Considering Additive Manufacturing In Supply Chain

Brett Shields, University of Tennessee Knoxville, 411 B.H. Goethert Parkway, Tullahoma, TN, United States, bshields@utsi.edu, Javad Seif, Andrew Yu

In this project a two-stage stochastic program is presented in a make or buy setting, considering the supply of parts produced by additive manufacturing. This model generalizes a number of works in the literature and provides a framework for implementing additive manufacturing in supply chain during times of uncertainty.

WE61

Cumberland 3- Omni

Facility Location

Contributed Session

Chair: Zhaomiao Guo, Universtiy of California, Davis, 609 Anderson Road,, Apt. 264, Davis, CA, 95616, United States, zmguo@ucdavis.edu

1 - Service Network Design With Equilibrium Constraints Based On General M/g/1 Waiting Time

Mahdi Hamzeei, Post Doctoral Fellow, University of Maryland, Baltimore, 685 West Baltimore Street, MSTF 7-00D, Baltimore, MD, 21201, United States, hamzeei.m@gmail.com, Amir Ahmadi Javid

We consider the service network design in which an operator determines some facilities and their size to open. The customers then choose facilities to send their demand such that their time is minimized. Customers' time consists of a travel and a waiting time. Assuming M/G/1 waiting time in each facility, using conjugate duality and decomposition approaches, we propose and efficient method to solve this problem. This structure was motivated by several applications such as preventive healthcare and disaster management. We conclude by presenting preliminary numerical results.

2 - Service Level Restrictions In Location Problems With Disproportionate Assignment Costs

Jeremy W North, Murray State University, 9400 Wickliffe Rd., Wickliffe, KY, 42087, United States, jnorth@murraystate.edu, Robert M Nauss

A common assumption in facility location modeling is that customer assignment cost is proportional to distance. In this work, we drop this assumption and analyze the subsequent effect on service level when weighted average distance is minimized. Computational experiments contrast the p-median with an augmented version enforcing higher overall service levels. We show that our modeling approach is more economical than implementing a closest assignment restriction. Additionally, a Greedy Random Adaptive Search Procedures (GRASP) algorithm is applied to solve larger problem instances.

3 - A Continuum Approximation Method For Reliable Facility Location Design With Imperfect Information

Hongqiang Fan, University of South Florida, Tampa, FL, United States, hongqiangfan@mail.usf.edu, Xiaopeng Li, Lifen Yun

In this paper, we propose a continuum approximation method to solve the reliable facility location design problem with imperfect information. Then a discrete algorithm is proposed to obtain discrete facility locations. The results of case studies indicate that this model also can get the near-optimal solution compared with the discrete model and has a robust performance.

4 - Facility Location In A Competitive Market: Incorporating Network Congestion Effects

Zhaomiao Guo, Universtiy of California, Davis, 609 Anderson Road,, Apt. 264, Davis, CA, 95616, United States, zmguo@ucdavis.edu, Yueyue Fan

We assess facility networks in a competitive market, where the infrastructure system is shaped by collective actions of multiple decision entities from both supply and demand sides. A network-based multi-agent optimization modeling framework is developed to reflect "selfish" behaviors of individual service investors and users and to simultaneously capture the interactions among all over a network structure. To overcome computational difficulty imposed by non-convexity of the problem, we rely on recent theoretical development on variational convergence of bivariate functions to design a solution algorithm with analysis on its convergence properties.

WE62

Cumberland 4- Omni

Passengers and Parts: Analytics and Machine Learning in Aviation

Sponsored: Aviation Applications

Sponsored Session

Chair: Catherine Cleophas, RWTH Aachen University, Kackertstr. 7, Aachen, 52072, Germany, catherine.cleophas@rwth-aachen.de

Co-Chair: Phillip Mah, Boeing, Commerce, Richmond, BC, V6V 2L1, Canada, phillip.mah@aeroinfo.com

1 - Predictive Maintenance from Analysis Of Airplane Sensor Data

Phillip Mah, Boning, Commerce, Richmond, BC, V6V 2L1, Canada, phillip.mah@aeroinfo.com, Ruiwei Jiang, Dawen Nozdryn-Plotnicki

Unscheduled maintenance drives 10% of the annual operational cost to airlines worldwide. Predictive Maintenance could reduce those costs, particularly when synchronized with airline's operations. By using engineering expertise, statistics and machine learning on aircraft sensor and fault data, as well as analysis of an airline's flight and maintenance schedule, we detect impending issues on the aircraft and suggest maintenance tasks in accordance with the prediction and an airline's working rhythm. These predictive maintenance tasks will increase reliability and reduce unscheduled maintenance.

2 - Applications Of Text Mining Techniques To Fleet Health And Maintenance Data

Bingjing Yu, Boeing Vancouver, 1146 Homer Street, Vancouver, BC, V6B 2X6, Canada, bingjing.yu@aeroinfo.com, Gaku Tobinobu, Candice Chan, Ehsan Nobakht

Textual data is one of the richest data sources for fleet health and maintenance analytics. Taking advantage of these information is the key for optimizing airline's and Boeing's business. Due to its large volume and highly unstructured nature, however, its full potential is rarely leveraged. Advanced Analytics group works on text analytics projects with airlines in the areas such as reliability, maintenance program and Boeing customer support. Case studies on how we help businesses by applying natural language processing, machine learning and visualization techniques will be presented.

3 - On The Flight Choice Behaviour Of Business Purpose Passengers In The Australian Domestic Market

Cheng-Lung Wu, Associate Professor, UNSW Australia, School of Aviation, UNSW Australia, Kensington, NSW 2052, Australia, c.l.wu@unsw.edu.au, Hanson So

This paper examined the flight choice behaviour difference of business-purpose passengers who work in small and medium enterprises (SMEs,) and those in non-SMEs. Statistics show that SME business passengers tend to fly less, are more price-sensitive, and derive less satisfaction in flying with full-service carriers if they have previously flown with low-cost carriers. Discrete choice models show that fewer flight service attributes are significant on shorter flights. Flight comfort attributes have a larger significance on inbound flights. Attribute non-attendance (ANA) is above 55% for all tested attributes except fare; not all attributes are perceived equally by business passengers.

WE63

Cumberland 5- Omni

Urban Operations Research

Sponsored: Location Analysis

Sponsored Session

Chair: Daisuke Watanabe, Tokyo University of Marine Science and Technology, 2-1-6 Etchujima, Koto-ku, Tokyo, 135-8533, Japan, daisuke@kaiyodai.ac.jp

1 - Coverage Modeling In Public Street Lighting

Alan T. Murray, University of California at Santa Barbara, Santa Barbara, CA, 93106, United States, amurray@ucsb.edu, Xin Feng

The spatial distribution of public area lighting in an urban region greatly influences human activities and safety, yet is costly to provide. This paper details a coverage optimization model for nighttime light provision, enabling benefits and impacts to be taken into account. Application results for an urban area are presented and discussed.

2 - A Robust Optimization Approach For Ambulance Location Problem

Hozumi Morohosi, National Graduate Institute for Policy Studies, morohosi@grips.ac.jp, Takehiro Furuta

This work studies an application of robust optimization to a cooperative covering model with focusing on ambulance location problem. We propose a procedure for defining the uncertain set of parameters in the problem based on actual data in a Bayesian way. Then we bring out a robust version of cooperative covering problem and give a solution analysis with some numerical examples.

3 - Generalized Weighted Benefit And Maximal Expected Covering Location Problem

Daisuke Watanabe, Tokyo University of Marine Science and Technology, daisuke@kaiyodai.ac.jp, Richard Church

The purpose of this study is to analyze the optimal location model for Counter-Piracy Surveillance System in Somalia using Weighted Benefit and Expected Coverage Model based on Maximal Covering Location Problem.

WE64

Cumberland 6- Omni

Vector Optimization: Algorithms and Applications

Sponsored: Multiple Criteria Decision Making

Sponsored Session

Chair: Firdevs Ulus, Bilkent University, Ankara, Turkey, firdevs@bilkent.edu.tr

1 - Multiobjective Risk-averse Two-stage Stochastic Programming

Cagin Ararat, Assistant Professor, Bilkent University, Ankara, 06800, Turkey, cararat@bilkent.edu.tr, Ozlem Cavus

Risk-averse two-stage stochastic programming is concerned with the minimization of a risk measure of a random cost function over the feasible choices of a deterministic and a random decision variable. We study the multiobjective version of this problem in which case the cost function is vector-valued and its risk is quantified via a set-valued risk measure. Although the resulting problem has a set-valued objective function, we reformulate it as a convex vector optimization problem and propose a customized version of Benson's algorithm to solve it. In particular, we develop duality-based cutting-plane type methods to solve the scalar subproblems appearing in Benson's algorithm.

3 - Convex Vector Optimization Problems: Unboundedness

Firdevs Ulus, Bilkent University, firdevs@bilkent.edu.tr

In order to solve convex vector optimization problems (CVOPs), Benson type algorithms have been proposed recently. These algorithms work well if the feasible region is compact which implies that the problem is bounded and a 'finite weak epsilon-solution' to the problem exists. However, in many applications, the feasible region of the problem does not necessarily compact and the problem may be unbounded. In this talk, the aim is to discuss the following: 1- Is there a finite solution concept for unbounded convex optimization problems? 2- If this is the case, are there conditions which guarantee the existence of such a solution? 3- Can we extend the existing algorithms to unbounded CVOPs?

2 - Quantification Of The Robustness Gap For Uncertain Multiobjective Optimization Problems

Corinna Krüger, Georg August University Göttingen, Göttingen, Germany, ckrueger@math.uni-goettingen.de, Anita Schöbel, Margaret M Wiecek

We investigate linear multiobjective optimization problems with uncertain right hand sides of the constraints which are modeled as the elements of a polyhedral uncertainty set. Generalizing Ben-Tal and Nemirowski's definition of the robustness gap (RG) for the single objective case to the multiobjective case, we quantify the gap in two ways. We develop a quadratic program whose objective value corresponds to the RG. We also relate the RG to the distance beween appropriate Pareto sets.

■ WE65

Mockingbird 1- Omni

Advanced Monitoring Techniques for Complex Data

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Mohammed Saeed Shafae, Virginia Polytechnic Institute and State University, TBD, Blacksburg, VA, 00000, United States, shafae1@vt.edu

Co-Chair: Lee Wells, Western Michigan University, 1903 W Michigan Ave, Kalamazoo, MI, 49008, United States, lee.wells@wmich.edu

1 - Statistical Process Monitoring Of Multimode Shape Profiles

Kai Wang, Hong Kong University of Science and Technology, kwangai@connect.ust.hk

Traditional shape profile monitoring focuses on one mode of shapes. Little attention has been paid to multimode shape profiles, where different types of shapes appear in a sample of objects. In this work, we exploit the process monitoring of multimode shape profiles. First, we develop a two-step feature extraction approach, where different shape modes can be separated into several clusters. This enables us to build a finite Gaussian mixture model for the extracted features. In Phase II, a control chart is built for detecting shifts in the proportions and shape features of multimode shape profiles. Numerical simulations and a real example demonstrate the effectiveness of our proposed framework.

2 - A Bayesian Self-starting Control Chart For Count Data

Baosheng He, University of Iowa, Iowa City, IA, United States, baosheng-he@uiowa.edu, Yong Chen

In this work we propose a Bayesian framework to detect a random but sustained shift in count data, including Poisson and Binomial data. The in-control and out-of-control states are both unknown and modeled by corresponding priors, and so as the shift probability, if necessary. The decision is based on the posterior probability that the shift occurs at each time. The monitoring performance is evaluated by the average run lengths. The effectiveness of the method is demonstrated via simulation and real data.

3 - Functional Regression Based Monitoring Of Service Systems

Devashish Das, Mayo Clinic, 2015, 41st Street NW, F47, Rochester, MN, 55901, United States, das.devashish@mayo.edu, Kalyan Pasupathy, Curtis B. Storlie, Mustafa Y Sir

In this research, we focus on building a statistical monitoring method for service systems that experience time varying arrival rates. The goal of the proposed method is to build a functional regression model based on customer arrival and departure time data collected from an in-control system. It is then used to find discrepancy between expected departure rates and observed departure rates. Deviations from expected departures greater than a threshold are used to signal a deterioration ins quality of service.

■ WE66

Mockingbird 2- Omni

Service Robotization: Building a Collaborative research Agenda for Interactive Service Robots

Sponsored: Service Science

Sponsored Session

Chair: Thorsten Gruber, Loughborough University, Centre for Service Management, Sir Richard Morris Building, Loughborough, LE11 3TU, United Kingdom, T.Gruber@lboro.ac.uk

Co-Chair: Willy Barnett, The University of Manchester, Manchester Business School, Manchester, M13 9QS, United Kingdom, willy.barnett@postgrad.mbs.ac.uk

1 - Human-robot Interaction For Real-world Situations

Julie Adams, Professor/Computer Science & Computer Engineering, Vanderbilt University, Nashville, TN, 37212, United States, julie.a.adams@vanderbilt.edu

Robots (generally any semi-autonomous vehicle) are increasingly being used by individuals in their daily activities, be such activities personal or professional. However, robots have traditionally been used by highly trained personnel in highly controlled environments and settings. Real-world environments tend to be highly dynamic with large amounts of uncertainty. Further, the human may not have extensive training and cannot be a dedicated robot controller or supervisor, but must also be responsible for other activities and actions in said environment. Thus, traditional interaction mechanisms are difficult to use and place too many demands on the humans. The question is how can the human-robot interaction become more natural for the human in order to support the collective goals? The answer is multi-dimensional. From one perspective, the human needs to easily interact with the robot and be able to develop a reliable understanding of the robot's expected actions. Further, the robots need to easily perceive the human's state, predict what the human will do, and develop a plan to maximize the likelihood of achieving the goal, while minimizing the demands placed on the human. These and related questions are still open research questions within human-robot interaction.

2 - Developing an Innovative Research Methods Toolkit To Explore User Perceptions Of HRI: Part 1- The Laddering +ZMET Method

Thorsten Gruber, Loughborough University, Sir Richard Morris Building, Loughborough, United Kingdom, T.Gruber@lboro.ac.uk, Kathy Keeling

User acceptance is a critical issue in the domain of Human-Robot Interaction (HRI). Many studies address user acceptance through methods such as needs analysis, which allow users to interact with robots and identify the pros/cons of use. Such methods are effective in uncovering superficial needs but fail to obtain deeper meanings of use. We argue that HRI could benefit from innovative research designs that help researchers obtain a deeper understanding of what users value in HRI. We present a toolkit consisting of three well-established methods adapted to HRI and present research examples.

3 - Developing an Innovative Research Methods Toolkit To Explore User Perceptions Of HRI: Part 2 – The Netnography Method

Kathy Keeling, University of Manchester, Booth Street West, Manchester, United Kingdom, kathy.keeling@manchester.ac.uk

User acceptance is a critical issue in the domain of Human-Robot Interaction (HRI). Many studies address user acceptance through methods such as needs analysis, which allow users to interact with robots and identify the pros/cons of use. Such methods are effective in uncovering superficial needs but fail to obtain deeper meanings of use. We argue that HRI could benefit from innovative research designs that help researchers obtain a deeper understanding of what users value in HRI. As a follow-up to the first section on Innovative Research Methods, this section will introduce the method known as Netnography. The presentation concludes with some examples previous studies.

4 - Older Consumers Value Perceptions Of Service Robots: Exploring The Intersection Of Marketing, Robotics, And Design

Willy Barnett, The University of Manchester, Manchester Business School, Manchester, M13 9QS, United Kingdom, willy.barnett@postgrad.mbs.ac.uk

This study explores the relationship between two major phenomena facing developed worlds today: robotics and global aging. It attempts to examine human-robot interaction through a marketing lens by exploring the nature of robot value perceptions, their relationship to robot design and user acceptance. To address this goal, a multi-method, qualitative study of a service-dominant network consisting of older adults and their care providers is conducted. Results show that robot acceptance can be better understood and communicated in terms of high level user values associated with robot use.

■ WE67

Mockingbird 3- Omni

High Dimensional Statistical Process Monitoring and Diagnosis

Sponsored: Quality, Statistics and Reliability

Sponsored Session

Chair: Yan Jin, University of Washington, Seattle, WA, United States, yanjin@uw.edu

Co-Chair: Shuai Huang, University of Washington, shuaih@uw.edu

1 - Parametric Uncertainty Propagation In Potassium Channel Model Of Mouse Ventricular Myocytes

Dongping Du, Texas Tech University, dongping.du@ttu.edu

Cardiac potassium (K+) channel plays an important role in cardiac electrical signaling. Mathematical models have been widely used for investigating the effects of K+ channels on cardiac functions. However, K+ channel models involve parametric uncertainties. It is critical to assess the parameter uncertainties to provide more reliable predictions. In this study, a generalized polynomial chaos expansion is used to propagate the uncertainties onto the modeled predictions of steady state activation and steady state inactivation of the K+ channel. As compared with the Monte Carlo simulations, the proposed method shows superior performance in terms of computational efficiency and accuracy.

2 - Correlation Based Adaptive Sampling Strategy For Online Monitoring Of Correlated High Dimensional Data Streams

Mohammad Nabhan, Georgia Institute of Technology, m.nabhan33@gmail.com, Jianjun Shi

Effective process control of High dimensional data with embedded spatial structure has been an arising challenge, due to the inability of classical techniques to detect changes in such processes. This article proposes an adaptive sampling technique that achieves better change detection power by identifying and exploiting the hidden spatial structure. The adaptive nature of the proposed method allows for effective monitoring with partial observations. Simulation studies are performed to validate the efficacy of the proposed monitoring scheme. This is followed by real data case studies to evaluate the performance under practical scenarios.

3 - An Effective Online Data Monitoring And Saving Strategy For Large-scale Climate Simulations

Xiaochen Xian, University of Wisconsin - Madison, Madison, WI, xxian@wisc.edu, Kaibo Liu

Large-scale climate simulation models have been developed and widely used to generate historical data and study future climate. This long-duration simulation process creates huge amount of data; however, how to effectively monitor and record the climate changes still remains to be resolved. To address this issue, we propose an effective online data monitoring and saving strategy over the temporal and spatial domains with the consideration of practical storage and memory capacity constraints. Specifically, our proposed method is able to intelligently select and record the most informative extreme values in the raw data in the context of better monitoring climate changes.

4 - A Wavelet-based Penalized Mixed-effects Model For Multichannel Profile Detection Of In-line Raman Spectroscopy

Xiaowei Yue, Georgia Institute of Technology, xwy@gatech.edu, Hao Yan, Jin Gyu Park, Richard Liang, Jianjun Shi

Modeling of high-dimension nonlinear profiles is an important and challenging topic in statistical process control. Conventional mixed effect model has limitations in solving the multichannel profile detection in nanomanufacturing. A wavelet-based penalized mixed-effects model (WPMM) is proposed to exploits a regularized high-dimensional regression with linear constraints to decompose profiles into four parts: fixed effect, normal random effect, defective random effect, and noise. An accelerated proximal gradient algorithm is developed to efficiently estimate parameters. Case study shows that the WPMM can realize a better detection power and shorter computation time.

■ WE69

Old Hickory- Omni

Dynamic Programming /Control

Contributed Session

Chair: Jefferson Huang, Postdoctoral Associate, Cornell University, Ithaca, NY, United States, jh2543@cornell.edu

1 - Segmentation Of Anatomical Structures Using Dynamic Identification And Classification Of Edges (dice) Model In Medical Images

Maduka M. Balasooriya, Teaching Assistant, Southern Illinois University, Edwardsville, Edwardsville, IL, 62026, United States, mbalaso@siue.edu, Sinan Onal, Xin W Chen

Segmentation of anatomical structures using medical images such as MRI, CT scan, and digital fundus image is still ongoing research subject. We developed the dynamic identification and classification of edges (DICE) model that aims to automatically identify edges of a contour of an anatomical structure without any intervention from domain experts. The DICE model includes three sequential but intertwined steps: (a) identifying potential edge points of a contour using moving range control charts; (b) extrapolating additional edge points of a contour through noise reduction; and (c) classifying points into different edges using neighborhood gradient search.

2 - Military Applications Of Approximate Dynamic Programming: Optimizing Helicopter Lift Operations

James Grymes, Instructor, United States Military Academy, 646 Swift Rd, West Point, NY, 10996, United States, james.grymes@usma.edu

Military commanders rely on helicopter lift assets to serve as force multipliers by moving military personnel and equipment around the battlefield. Inefficiency is a byproduct of uncertainty inherent in military operations which can lead to mission delays and possible failures. This research is designed to explore approximate dynamic programming as a tool for assisting air movement planners. We model Army helicopter lift operations as a Markov Decision Process and learn the value of decisions through machine learning. The algorithm returns an approximating value function for scheduling air lift routes in order to enhance combat power.

3 - Value Function Discovery In Markov Decision Processes

Sandjai Bhulai, Vrije Universiteit Amsterdam, Faculty of Sciences, De Boelelaan 1081a, Amsterdam, 1081 HV, Netherlands, s.bhulai@vu.nl, Martijn Onderwater, Robert van der Mei

We introduce a novel method for discovery of value functions for Markov Decision Processes (MDPs). This method is based on ideas from the evolutionary algorithm field. Its key feature is that it discovers descriptions of value functions that are algebraic in nature. This feature is unique, because the descriptions include the model parameters of the MDP. The algebraic expression can be used in several scenarios, e.g., conversion to a policy, control of systems with time-varying parameters. We illustrate its application on an example MDP.

4 - Making College Admission Offers: A Dynamic Programming Approach

Subhamoy Ganguly, Indian Institute of Management Udaipur, IIM Udaipur, MLSU Campus, Udaipur, 313001, India, subhamoy.ganguly@iimu.ac.in, Michele Samorani, Ranojoy Basu, Viswanathan Nagarajan

College admissions problem refers to the problem where each college seeks to admit the best possible class from a pool of applicants and most applicants apply to multiple colleges, hoping to enroll in one of their most preferred colleges. Most of the extant literature models this problem in the context of a two-sided matching market. However, admissions offices often cannot use these approaches due to practical limitations. We develop a dynamic programming model that could help colleges make optimal decisions of offering admission to secure the best possible class while filling all seats.

5 - Reductions Of Undiscounted Markov Decision Processes And Stochastic Games To Discounted Ones

Jefferson Huang, Postdoctoral Associate, Cornell University, Ithaca, NY, United States, jh2543@cornell.edu, Eugene A Feinberg

We provide conditions under which certain total and average cost Markov decision processes (MDPs), with possibly uncountable state and action spaces, can be reduced to discounted ones. These reductions are used to obtain complexity estimates for computing an optimal policy for finite MDPs and for computing a nearly optimal policy for infinite MDPs. We also provide analogous reductions for zero-sum stochastic games with possibly uncountable state and action spaces, and show how they can be used to obtain results on the existence of the value and optimal strategies, as well as results on robust MDPs.

■ WE71

Electric- Omni

Game Theory V

Contributed Session

Chair: Edward Cook, Senior Vice President, Capital One, 4 Bisley Court, Henrico, VA, 23238, United States, Ed.cook2000@gmail.com

1 - Bayesian Opponent Exploitation In Imperfect-information Games

Sam Ganzfried, Ganzfried Research, 55 West 26th Street #36E, New York, NY, 10010, United States, sam.ganzfried@gmail.com

For all game classes one can potentially do better than following a static Nash equilibrium strategy by learning to exploit perceived weaknesses of opponents. An exact efficient algorithm is known for best-responding to the opponent's posterior distribution assuming a Dirichlet prior with multinomial sampling in normal-form games; however, for imperfect-information games the best known algorithm is a sampling algorithm approximating an infinite integral without theoretical guarantees. The main result is the first exact algorithm for accomplishing this in certain imperfect-information games. We also present an algorithm for the natural setting where the prior is uniform over a polyhedron.

2 - Strategic Decentralization: Implications For Equity And Equality

Omkar D Palsule-Desai, Faculty, Indian Institute of Management Indore, Rau Pithampur Road, Wing C, Ground Floor, Indore, 453331, India, omkardpd@iimidr.ac.in

We develop a noncooperative game theoretic model to examine network performance and stability related implications of allocation mechanisms that endogenously balance equity vis-à-vis equality, and hence, the degree of collusion among the network firms in a decentralized setting. We show that inefficiencies and instability of decentralization can be eliminated by incorporating an additional degree of freedom in the network formation game. Our model and the structural results are applicable to networks such as producers' cooperatives, industrial clusters, joint production and research facilities, etc., wherein the conflicts of equity-equality and degree of collusion are predominant.

3 - A Nonlinear Programming Approach For Determining A General Equilibrium For N-person Games

Ahmad Nahhas, Gradiate Researcj Associate I, University of Texas at Arlington, 706 W Mitchell Cir Apt 621, Arlington, TX, 76013, United States, ahmad.nahhas@mavs.uta.edu, H. W. Corley

A general equilibrium for n-person normal form games is a set of mixed strategies with the following property. No player in some subset B of all players can achieve a better payoff if players in an associated proper subset G of all players change strategies unilaterally. A nonlinear programming approach is presented to prove the existence of such an equilibrium and then compute one.

4 - Stability Analysis Of Horizontal Mergers In A Market With Asymmetric Substitutability

Kohei Takeda, Keio University, Hiyoshi 3-14-1 Kohoku-ku, Yokohama, 2238522, Japan, tkdkt.k@gmail.com, Nobuo Matsubayashi

We consider the stability of horizontal mergers between firms in a Cournot oligopoly in which the substitutability of goods is asymmetric. We specifically focus on the core allocation under the grand coalition in a general N-firm oligopoly. The main result of our analysis shows that the grand coalition is stable in a highly asymmetric market in terms of substitutability.

5 - Applying Game Theory To Multiobjective Multistakeholder Decisions

Edward Cook, Senior Vice President, Capital One, 4 Bisley Court, Henrico, VA, 23238, United States, Ed.cook2000@gmail.com

For Multi-Objective Decision Analysis (MODA) when the decision-makers grow past one, there is difficulty. Often one decision-maker's process impacts another. To solve this, the application of Game Theory to model the objectives can be used. Game Theory models the interaction between multiple players enabling discovery of the Pareto Equilibrium and not just a Nash Equilibrium which may be suboptimal.

■ WE72

Bass- Omni

Supply Chain, Decision II

Contributed Session

Chair: Emre Berk, Bilkent University, Faculty of Business Administration, Ankara, 6533, Turkey, eberk@bilkent.edu.tr

1 - Network Characteristics And Supply Chain Disruption Resilience

Yuhong Li, Virginia Tech, Blacksburg, VA, United States, yuhongli@vt.edu, Christopher Zobel, Onur Seref

Previous studies on supply chain network resilience focus on network types, which cannot describe a real supply chain network well. Hence, we focus on characteristic level in this study. This work aims to show what combinations of characteristics will make the supply network more resilient, and we expect to provide executable prescriptions to practitioners to improve supply chain resilience. Classification methods and simulations are employed to carry out this study.

2 - Supply Chain Cooperation In Enterprise Platform Transformation Strategies

Lyu Gaoyan, PhD, Guanghua School of Peking University, Beijing, China, swallowlvgaoyan@sina.com

With rapid development, the Internet has changed the traditional supply chain structure and is creating new business models and the way of enterprise management. Based on the background of Chinese market, we study the transformation of supply chain platform strategy considering the attitudes of decision makers in different supply chain stages. Using the revenue sharing contract, we obtain the pareto improvement interval. By solving the equilibrium of the platform innovation cooperation strategies, we find the innovation cooperation strategy between the supplier and the platform retailer and provide the profit allocation method of the full-cooperation strategy.

3 - Optimal Product Design And End-of-Life Options For an OEM Under Different Pricing Strategies

Jie Zhang, PhD Student, Virginia Tech, 852 Claytor Square, Blacksburg, VA, 24060, United States, jiezhang@vt.edu

The design of a product impacts its production cost, salvage value, and demand. In this paper, a novel two-stage model pertaining to the reverse supply chain of an original equipment manufacturer (OEM) and containing the impact of product design, is formulated. We first and foremost give demand function under different pricing strategies of new and remanufactured products. Then, optimal prices and optimal end-of-life options are derived. All the possible cases are analyzed and graphed under different market and cost parameters. By considering different pricing strategies and proportion of green market demand at the second stage, we generate insights pertaining to optimal product design strategies. Finally, we determine optimal product design strategies for the OEM.

4 - Quantifying The Benefits Of Continuous Replenishment Program For Partner Selection

Payam Parsa, PhD Candidate, University of Arkansas, 1818 W Bedford Loop, Apt 3, Fayetteville, AR, 72701, United States, pparsa@uark.edu, Manuel D Rossetti, Shengfan Zhang, Edward A Pohl

This research develops a data-driven model that quantifies the benefits of a continuous replenishment program (CRP). CRP is a well-established supply chain collaboration program that has been used widely in various business sectors. The proposed model is able to compute the cost savings of CRP for both partners and at three levels of inventory holding, transportation and ordering cost components. The model is adopted by a major healthcare manufacturer who seeks to estimate the cost savings of a business relationship with a major distributor. The results indicate that CRP reduces the total cost of supply chain by 19.1% where the distributor gains disproportionately more savings.

5 - The Newsvendor Problem Re-visited With Novel Funding Schemes

Emre Berk, Bilkent University, Faculty of Business Administration, Ankara, 06533, Turkey, eberk@bilkent.edu.tr

Recently novel funding mechanisms have emerged for new or small businesses which have limited access to traditional financing and credit mechanisms. These provide unique opportunities and challenges for operational decision making. In this talk, we revisit the newsvendor problem under such novel financing schemes and discuss some operational implications and issues.

■ WE73

Legends A- Omni

Operations Management IX

Contributed Session

Chair: Feng Xu, Georgia Southwestern State University, School of Business Administration, 800 GSW State University Drive, Americus, GA, 31709, United States, fenghsu@hotmail.com

1 - Two-stage Supply Chain With Product Substitution From Different Carbon Emissions And Government Intervention

Wang Chuanxu, Dean, Shanghai Maritime University, 1550 Haigang Ave, Shanghai, 201306, China, cxwang18@aliyun.com

The two stage supply chain consisting of one retailer and one manufacturer is considered, in which manufacturer produce two substitutable items with different carbon emissions. Government levies carbon emissions tax on the production of high carbon item and offer subsidies on the production of low carbon item.The profits of manufacturer and retailer as well as the social benefit of government are compared under the three situations.A numerical example is given to demonstrate the effectiveness of propose models and analyze the impact of market share for high carbon item, manufacturing cost coefficient for low carbon product and green cost coefficient for high carbon item on the decision results.

2 - A Study On The Effect Of Life-skills Improvement With Team-based Learning In Operations Management

Sungyong Choi, Assistant Professor, Yonsei University, College of Government and Business, 1 Yoneseidae-gil, Wonju, 26493, Korea, Republic of, sungyongchoi@gmail.com

The purpose of this study is to show that my Operations Management class help students improve their life skills in a semester. I designed my class more interactively by introducing a well-known approach of team-based learning, but the detailed ideas of class management were developed by my own careful considerations. Then, I defined the students' life skills as problem solving and self-directed learning. Finally, at the end of the semester, the levels of the life skills in each student had been improved significantly compared with the levels at the beginning of the semester.

3 - Log-linear Analysis Of Moral Duties Of Transformative Leadership

Feng Xu, Georgia Southwestern State University, School of Business Administration, 800 GSW State University Drive, Americus, GA, 31709, United States, fenghsu@hotmail.com

Recent development in transformative leadership theories focuses on studying the duties of leaders. Applying log-linear model towards the survey data, this paper presents that there exists positive relationship between moral development stages and the ethical focus of the perspectives of transformative leadership. The findings can help both scholars and practitioners to understand more completely the relationship between effective leadership and leaders' moral duties, and help leaders retain trust and increase commitment within an organization.

WE74

Legends B- Omni

Ops/Economics Inter

Contributed Session

Chair: Huaqing Wang, Assistant Professor, Emporia State University, 1 Kellogg Circle, Emporia, KS, 66801, United States, hwang4@emporia.edu

1 - Optimal Bundling Of Information Goods In A Duopoly

Araz Khodabakhshian, UCLA Anderson School of Management, 501 Gayley Avenue, Apt 11, Los Angeles, CA, 90024, United States, araz.khodabakhshian.1@anderson.ucla.edu, Uday S Karmarkar, Guillaume Roels

Bundling is a common practice in several business sectors, but there are also many examples of firms that choose not to bundle. We study bundling in the presence of competition to examine its implications for bundling strategy. We model the bundling strategy of two firms offering two products to two customers as a two-stage non-cooperative game. In the first stage, firms choose their product offering combinations. In the second, they simultaneously choose prices for their offerings. We consider two extreme cases of perfectly positively and perfectly negatively correlated customer valuations. We show that in equilibrium, only one of two competing firms chooses to bundle.

2 - Launching Next Generation Products In A Competitive Market

Xishu Li, Erasmus University, Mandeville (T) Building, Room 9-56, Erasmus University, Rotterdam, 3062PA, Netherlands, x.li@rsm.nl, Rob A Zuidwijk, M.B.M. (Rene) de Koster

We consider a next-generation product launch problem in a competitive market under uncertain product quality and consumer taste. We focus on two levels of competition: 1) next-generation product competes with the existing product for capacity and demand; 2) firm competes with its competitor for product quality, market share and price.

3 - Retailer Strategic Pricing Under Sticky Demand

Zheng Li, Student, Texas A&M University, 263 Navarro Dr, College Station, TX, 77845, United States, lzrain@tamu.edu, Haoying Sun, Xirong Chen, Haipeng Chen

The literature on dynamic pricing assumes that consumer demand responds to any changes in price. Recent advances in economics, however, have suggested that consumers may be rationally inattentive and not respond to small price changes, resulting in demand stickiness. We explicitly model the implications of this sticky demand on firm's pricing behaviors. Using a large dataset consisting of eight years of weekly grocery retail data, we estimate the magnitude of demand stickiness and demonstrate how the estimates vary with consumer demographics. Furthermore, we conduct a counterfactual analysis showing the profit improvement a retailer could enjoy by taking into account this demand stickiness.

4 - Association Between Relatedness In Diversification And Performance Of Us Public Firms

Muhammad Zubair, Nanyang Business School, 50 Nanyang Avenue, Blk S3-01B-73, Singapore, 639798, Singapore, c130016@e.ntu.edu.sg, Chen Chien-Ming

This study empirically examines the link between relatedness in the diversification of a firm and its inventory performance. The study is based on firms' annual financial and segment sales data in addition to US industry input-output data.

5 - Product Quality Differentiation Through Information Provision

Huaqing Wang, Assistant Professor, Emporia State University, 1 Kellogg Circle, Emporia, KS, 66801, United States, hwang4@emporia.edu, Haresh B Gurnani, Raphael Boleslavsky

We examine the joint interaction of information provision and pricing decisions by two competitive firms when a buyer is uncertain about product valuations. Firms generate product differentiation by allowing consumers to learn about valuations or prevent them from doing so. We characterize equilibrium prices and its interaction with information policies.

WE75

Legends C- Omni

Ops/Finance & Economics

Contributed Session

Chair: Panayotis Markou, IE Business School, Calle Maria de Molina 12, Bajo, Madrid, 28006, Spain, pmarkou.phd2016@student.ie.edu

1 - How To Handle Extreme Supply Chain Situation

Wenqing Zhang, University of Minnesota Duluth, 1318 Kirby Drive, Labovitz School of Business and Economics, Duluth, MN, 55812, United States, zhangwenqing@gmail.com, Prasad Padmanabhan, Chia-Hsing Huang

We investigate the impact of industry market concentration on the ability of firms with adventurous and rational managers to deal with extreme cash flows. We provide simulation results on how market concentration (from a monopoly to a perfectly competitive structure), influence the NPV decisions of firms with different manager/cash flow types. While prices to consumers are higher under a monopoly, they may provide additional benefits to society in the form of having extended ability to survive extreme cash flows.

2 - Organizational Design: Scale, Scope, Focus And Decentralization

Phillip J Lederer, Professor, University of Rochester, Box 270100, Rochester, NY, 14627, United States, Lederer@simon.rochester.edu

Scale, scope, focus and decentralization affect the design of management hierarchy that monitors and controls production. Modeled as a network of information processors, an optimal design minimizes capacity and time delay costs. Among the results are: sufficient conditions that induce "product" and "process focus are derived. Large changes in cost don't much change the hierarchy's departmental structure but greatly affect capacity allocation. Local decision making has a much larger effect on hierarchy's height than large delay cost. Staff utilization falls with level.

3 - Volatility Spillover Dynamics In Chinese Steel Markets

Wen Fang, Xidian University, Xi'An, China, az-moju@163.com

The development of steel market plays an important role in the development of China's bulk stock commodity market. China has emerged a typical steel market —— steel electronic market, which is in the process of vigorous development. Three types of steel market coexisting is a realistic background and trend in Chinese steel industry. Our research focuses on volatility spillover in Chinese steel markets. The objective of our research is to reveal which steel market is a strong barometer for the steel price fluctuations. A dynamic multi-dimensional volatility spillover method based on GARCH model and Kalman filter is proposed aiming at the volatility dynamics research in Chinese steel markets.

4 - Optimal Design Of Discrete Dutch Auction With Time Limitation

Jinfeng Yue, Middle Tennessee State University, Department of Managment and Marketing, Murfreesboro, TN, 37132, United States, jinfeng.yue@mtsu.edu, Jinfeng Yue, Shanghai University of Finance and Economics, Shanghai, China, jinfeng.yue@mtsu.edu, Zhen Li

This research concerns the optimal design of discrete Dutch auction. It explains why Dutch auction is a fast auction; a secret reserve price alone cannot improve the auction outcome, but its influence can be achieved through the existence of strategic shoppers and the magnitude of their salvage values; the knowledge about bidding population size yields a higher expected revenue per unit of time.

5 - The Effects Of Financial And Operational Hedging On Operational Variables: Evidence From The Gold Mining Industry

Panayotis Markou, IE Business School, Calle Maria de Molina 12, Bajo, Madrid, 28006, Spain, pmarkou.phd2016@Student.ie.edu, Daniel S Corsten

Prior analytical models of hedging are sometimes contradictory, and the exact mechanism by which hedging affects operations is not well understood. We use a detailed data set comprising the financial and operational hedging decisions of 82 gold miners from 2003 to 2011 to analyze the effects of risk management on inventory and profit variance. Gold miners can utilize operational hedging, yet this strategy increases inventory and profit variance. Financial hedging is also used to mitigate price risk, and this reduces inventory and profit variance. When used simultaneously, the financial hedge controls the operational hedge, resulting in significant reductions in inventory and profit variance.

WE76

Legends D- Omni

Decision Analysis

Contributed Session

Chair: Tao Du, Beijing Insititute and Technology, Beijing, China, dutao0608@163.com

1 - The Impact Of Capability Portfolio on Competitive Position Between Industry Duopoly

Yanyun Zhang, Guanghua School of Management, Peking University, Beijing, China, yanyunzhang2010@163.com

We attempt to study the impact of a firm's capability portfolio on performance between industry duopoly with Stackelberg model. The weaker position firm owns its specific advantages, regarding as its capability as well as for the stronger one. Meanwhile, the capability's contribution weight differs. A firm faces a risk of failure when the performance is lower than a certain threshold. Respectively from static and dynamic perspectives, we know how to balance capabilities to overcome the competitors, or to remain competitive and whether to strengthen or weaken the capability to improve the competitive position where firm's performance varies with the boundary changes of the firm's capability.

2 - Resource Optimization Based On Data Envelopment Analysis - Dynamic Programming Method

Tao Du, Beijing Insititute and Technology, Beijing, China, dutao0608@163.com

As the resource optimization is one of main approach to improve organization's efficiency, we propose a DEA-Dynamic Programming (DEA-DP) method which is a resource optimization method combining with the DEA model for measuring efficiency and the Dynamic Programming method for multistage decision. The basic ideas of the method is to determine the optimal resource planning strategy for improving the inter DMUs' relative efficiency of organization through Dynamic Programming method. Through a case study, we proves investment can be saved by 11.23% using the method.

■ WE77

Legends E- Omni

Opt, Large Scale III

Contributed Session

Chair: Tao Jiang, Purdue University, 403 W. State Street, Krannert School of Management, West Lafayette, IN, 47906, United States, taujiang@purdue.edu

1 - Robust Principal Component Analysis In Multiclass Problem Structures

Sam Davanloo, Ohio State University, Columbus, OH, United States, sdt144@vt.edu, Xinwei Deng

Robust Principal Component Analysis (RPCA) is mainly used to decompose a data matrix to a low rank and a sparse component, and has applications in face recognition, video surveillance, latent semantic indexing, and etc. In this study, we consider a multiclass structure in which classes share a common low rank component, a class-specified low rank component, and a class-specific sparse component. RPCA is then utilized to estimate these components. A first-order optimization method is proposed to solve the problem in high-dimensional settings. Numerical simulation results support the proposed methodology.

2 - Stability Of The Stochastic Gradient Method For Approximated Large Scale Kernel Machine Using Random Fourier Features

Aven Samareh, PhD Student, University of Washington, 4324 8th ave NE, D7, Seattle, WA, 98105, United States, asamareh@uw.edu, Mahshid Salemi Parizi

We measured the stability of stochastic gradient method (SGM) for learning an approximated Fourier support vector machine. The stability of an algorithm is considered by measuring the generalization error in terms of the absolute difference between the test and the training error. Our problem is to learn an approximated kernel function using random Fourier features for binary classification data sets via online convex optimization settings. We showed that with a high probability SGM generalize well for an approximated kernel under a convex, Lipschitz continuous and smooth loss function given reasonable number of iterations. We empirically verified the theoretical findings as well.

3 - Modeling Improvements And Refinements To The Fleet Modernization Capability Portfolio Analysis Tool

Frank Muldoon, Sandia National Labs, 1525 Summit Hills Drive NE, Albuquerque, NM, 87112, United States, fmmuldo@sandia.gov, Matthew Hoffman, Stephen Henry, Lucas Waddell, Peter Backlund

The Capability Portfolio Analysis Tool (2015 Edelman Finalist) is currently being used to model both the fleet of ground combat systems under the U.S. Army PEO Ground Combat Systems and the fleet of logistics and support systems under PEO Combat Support & Combat Service Support to provide analytical capability in support of modernization and investment decisions. This large-scale multi-phase MILP has evolved over the last year to meet the challenges posed by both PEOs including the incorporation of budgetary earmarks, system age, and modeling techniques developed to mitigate its large size.

4 - An Iterative Rounding Algorithm And Almost Feasibility For Nonconvex Optimization

Tao Jiang, Purdue University, 403 W. State Street, Krannert School of Management, West Lafayette, IN, 47906, United States, taujiang@purdue.edu, Thanh Nguyen, Mohit Tawarmalani

We consider a class of high-dimensional non-convex minimization problems for which the objective is separable and constraints are linear. We solve a convex relaxation to obtain a lower bound and to restrict the original problem to an integer program. Then, we study the trade-off in approximation gap between admitting solutions that violate some constraints slightly versus not allowing such solutions. In particular, we show that if we admit solutions that "almost" satisfy the constraints with small coefficients, the iterative rounding procedure can find a solution much closer to the relaxation bound than if we disallow such solutions. We discuss applications of this result in various settings.

■ WE78

Legends F- Omni

Opt, Linear Programing

Contributed Session

Chair: Joseph L Trask, North Carolina State University, 3500 Mill Tree Rd, Apt B2, Raleigh, NC, 27612, United States, jltrask@ncsu.edu

1 - Optimal Assignment Of Inspection Stations In A Flowline

Md Shahriar Jahan Hossain, Louisiana State University, 2508 Patrick F. Taylor Hall, Baton Rouge, LA, 70803, United States, msjhossain1@gmail.com, Bhaba R Sarker

The research deals with multiple in-line inspection stations that partition a production flowline into multiple flexible lines. A unit cost function is developed for determining the number and locations of in-line inspection stations along with the alternative decisions on each type of defects: scrapping or reworking (on/off-line). The problem is formulated as fractional mixed-integer nonlinear programming problem to minimize the unit cost of production, and solved with branch and bound method. A construction heuristic is also developed to determine a sub-optimal solution for large instances.

2 - The Double Pivot Simplex Method

Fabio T Vitor, Graduate Teaching Assistant, Kansas State University, 2061 Rathbone Hall, 1701B Platt St., Manhattan, KS, 66506, United States, fabioftv@k-state.edu, Todd W Easton

The Simplex Method (SM) is considered one of the top 10 algorithms of the 20th century. Each iteration of SM pivots between basic feasible solutions by exchanging one nonbasic variable with a basic variable. This talk presents the Double Pivot Simplex Method (DPSM), which can pivot on two variables. The Slope Algorithm is a new method that replaces the ratio test of SM, and guarantees the optimal basis at every iteration of DPSM. Furthermore, each iteration of DPSM not only has the same theoretical running time as SM, but also improves the objective value by at least as much as an iteration of SM. Computational experiments demonstrate that DPSM is approximately 15% to 40% faster than SM.

3 - Inverse Optimization For Utility Measurement

Yu-Ching Lee, National Tsing Hua University, Hsinchu, Taiwan, ylee77@illinois.edu, Yi-Hao Huang, Ciou Si-Jheng

Utility function has been prevalent to express one consumer's preference representing consumer's demand. We formulate a mathematical program with quadratic objective function and complementarity constraints as the inverse problem that minimizes the error of the measured utility function. Our research indicates that the program with complementary constraints will help us find a set of more accurate parameters.

4 - Determining The Aggregate Plan: A Cross-functional Perspective

Kathleen Iacocca, Villanova University, Villanova, PA, United States, kathleen.iacocca@villanova.edu, Kingsley Gnanendran

The traditional aggregate plan is extended to include marketing and financial aspects. On the marketing side, we determine the optimal price and demand for each period, while on the financial side we include month-by-month collections, taxes, interest on loans and/or return on surplus funds, depreciation, and minimum cash balances in determining optimal production levels. The problem is modeled as a linear program and implemented on a spreadsheet to demonstrate ease of managerial applicability.

■ WE80

Broadway E- Omni

Retail Mgt II

Contributed Session

Chair: H. Sebastian Heese, EBS University, ISCM, Burgstr. 5, Oestrich-Winkel, 65375, Germany, sebastian.heese@ebs.edu

1 - Consumer Perceptions Of Return Policies

Yue Cheng, Pennslyvania State University, 460A Business Building, University Park, PA, 16802, United States, yuc190@psu.edu, Daniel Guide, Margaret Meloy

This study investigates consumer perceptions of three types of return policies by using survey data. The consumers responded to the amount of discounts and premiums associated with different return policies and brand equity. We provide managerial insights for firms to take advantages of using different return policies strategically.

2 - Immediate And Long-term Benefits Of In-store Return Experience

Necati Ertekin, Assistant Professor, Santa Clara University, 500 El Camino Real, Santa Clara, CA, 95053, United States, nertekin@scu.edu

We study the association between in-store customer experiences during returns and immediate exchange/subsequent repurchase behaviors. Using transactional data and satisfaction survey responses from 7,921 customers at a jewelry retailer, we identify perceived product quality, customer-oriented selling, and time to return as the factors that may influence customer exchange and repurchase behaviors.

3 - Effects Of Assortment Size Announcements On Manufacturer Competition

H. Sebastian Heese, EBS University, ISCM, Burgstr. 5, Oestrich-Winkel, 65375, Germany, sebastian.heese@ebs.edu, Victor Martinez de Albeniz

We study the impact of retailer assortment strategies on manufacturer wholesale pricing. The size of an assortment affects both competition between manufacturers for inclusion in the assortment and competition between participating manufacturers for market share. We optimize retailer assortment strategies taking into account these two effects.

■ WE82

Broadway G- Omni

Multicriteria Decision II

Contributed Session

Chair: Tommi Juhani Pajala, Aalto University School of Business, Runeberginkatu 22-24, Helsinki, 100, Finland, tommi.pajala@aalto.fi

1 - An Integrated Black Topsis And Grey Linear Programming Approach To Deal With Uncertainty And Confidence Level Of Decision Makers

Hanif Malekpoor, PhD Student, University of East Anglia, Norwich Research Park, Norwich, NR4 7TJ, United Kingdom, H.Malekpoor@uea.ac.uk

In order to deal with uncertainty of Decision Makers (DMs) opinions in supplier selection, applying interval valued data is a popular method. However the level of confidence, DMs have about their judgments, is also significant. In addition the supplier's information related to constraints of order allocation problem is not precise. In this research to overcome the two aforementioned problems we have developed an integrated approach for order allocation, using Black-TOPSIS (TOPSIS with interval numbers which their upper and lower bounds are also grey numbers) and multi objective grey linear programing to determine the best supplier and order quantity from each suppliers.

2 - A Multi-criteria Decision Making Model For Evaluating Alternatives Under Large And Distinct Decision Makers

Anthony Afful-Dadzie, University of Ghana, P.O. Box LG 78, Legon, Accra, Ghana, atosarsah@gmail.com

This study proposes a method for analyzing the evaluation and ranking problem of alternatives in the case where there are large number of distinct decision makers for each alternative. Relying on the underlying distribution to the evaluation data, this peculiar problem is transformed into the format of a typical MCDM problem for easier analysis and interpretation. A numerical example is presented to illustrate the richness and applicability of the problem.

3 - P-center And P-dispersion Problems: A Bi-criteria Analysis

Golbarg Kazemi Tutunchi, Operations Research Specialist, SAS Institute, 100 SAS Campus Dr,, Cary, NC, 27513, United States, golbarg.tutunchi@sas.com, Yahya Fathi

We consider the p-center and the p-dispersion problems in the context of a bi-criteria location analysis. We propose a mathematical programming model and a binary search procedure to obtain the corresponding non-dominated frontier. We further study the structure of the proposed IP model and propose a new family of valid inequalities to help solve this IP model more effectively. Through a limited computational experiment we demonstrate the effectiveness of the proposed procedure and the valid inequalities.

4 - Judgments Of Importance Revisited: What Do They Mean?

Tommi Juhani Pajala, Aalto University School of Business, Runeberginkatu 22-24, Helsinki, 00100, Finland, tommi.pajala@aalto.fi, Pekka J Korhonen, Jyrki Wallenius

In a MCDM problem, decision makers can often say that one criterion is more important than another. What has remained unclear is whether value function weights are somehow connected to these judgments of importance. A surprisingly common assumption is that a more important criterion will have a larger weight, as if weights and importance were closely related. We present experimental evidence that Goldstein's (1990) idea of judgments of importance as impact is a better interpretation. Further, we show that if we wanted to interpret importances as weights, we would need to know the scale the decision maker has in her mind. Without that knowledge, considering importance in terms of weights is not feasible.

■ WE83

Broadway H- Omni

Supply Chain, General

Contributed Session

Chair: Arda Yenipazarli, Assistant Professor of Operations Management, Georgia Southern University, 2224 College Of Business Administration, Department of Logistics & Supply Chain Management, Statesboro, GA, 30460, United States, ayenipazarli@georgiasouthern.edu

1 - Mechanism Design In Pet Bottle Recycling Auction

Kazuaki Okubo, Assistant Professor, Saitama University, 255 Shimo-okubo, Sakura-ku, Saitama, 338-8570, Japan, okubo@dp.civil.saitama-u.ac.jp

This study examines an efficient auction mechanism where firms bid for set-period contracts to recycle polyethylene terephthalate (PET) bottles in Japan. For the auctions, the Japanese municipalities estimate their PET bottle recycling amounts in contract period, and the recycling firms prepare bids to win the recycling contracts. I focus on a negative impact of the estimation error of the amounts on the firms' bids and analyze an efficient mechanism with consideration of such uncertainty. I also examine the effect of asymmetric bidder size and the distance between the recycler's location and the municipality on the performance of the auction.

2 - Sales Agents Incentive Contracts In Competing Supply Chains

Samar K Mukhopadhyay, Professor, GSB SKK University, 53 Myeongnyung-dong 3-ga, Jongno-gu, Seoul, 110-745, Korea, Republic of, samar@skku.edu

We investigate contracting and sales agent incentives in two competing supply chains, each consisting of one manufacturer and one sales agent. The two supply chains are identical, but may have different contract types. We use a non-cooperative game where, in the first stage, the manufacturers decide the contract types. In the next stage, the manufacturers offer contracts to their sales agents who engage in competition. We analyze the game for two different contract types - a single linear contract and a menu of linear contracts. We find conditions under which a given contract type is preferred. We also find how risk aversions and uncertainties affect the profits.

3 - Managing Speed And Price In Customer-intensive Services

Chengzhang Li, Harbin Institute of Technology, No. 92 West b, Harbin, China, lcz_grown@163.com

This paper investigates the optimal price and service rate in a customer-intensive service, where customers' perceived service quality decreases in the service speed. Customers are assumed to be heterogeneous in terms of their reservation utility which is captured by a random variable and they will join the queue if their expected utility is greater than their reservation utility. The optimal service rate and price are derived under two classes of customers with different customer intensities. The results suggest that the optimal service rate and price depend on the customer intensity, customers' reservation utility distribution and the potential market size.

■ WE84

Broadway J- Omni

Logistics

Contributed Session

Chair: Andrew Junfang Yu, Associate Professor, The University of Tennessee Knoxville, UT Space Institute, 411 B. H. Goethert Pkwy., MS 19, Tullahoma, TN, 37388-9700, United States, ajyu@utk.edu

1 - A Fix & Optimize Heuristic For Capacitated Foodgrain Inventory Multi-Modal Transportation Problem In Indian Public Distribution System

Ajinkya Tanksale, Doctoral Student, Indian Institute of Technology Kharagpur, IIT Kharagpur, West Bengal, Kharagpur, 721302, India, ajinkya.tank@gmail.com, Jitendra Kumar Jha

In this work, we study an integrated inventory and multi-modal transportation problem in a region-bound multi-facility supply chain, which is motivated from the case of foodgrain distribution in the Indian public distribution system. The problem is formulated as mixed integer programming problem and solved using fix-and-optimize heuristic with several new decomposition schemes and a greedy heuristic for initial solution. The effectiveness and efficiency of the proposed solution approach is supported by comprehensive computational experiments.

2 - Pricing Model Of Feeder And Trunk Routes Combined Transport Based on Revenue Sharing Mechanism

Hualong Yang, Professor, Dalian Maritime University, Room 510, Management Building, 1 Linghai Road, Dalian, 116026, China, hlyang@dlmu.edu.cn

There are strong complementarities between feeder and trunk routes. This paper considered the competition among parallel substitute itineraries and studied the pricing problem of feeder and trunk routes combined path. Based on the vertical integration and diversification in transport chain, a Bertrand game model was established. A reasonable revenue sharing mechanism was further designed, making the transport chain coordinate under decentralized decision making. Numerical Example verifies the effectiveness of the model. The results show that centralized decision making and reasonable revenue sharing mechanism contribute more to boost profits and reduce the transport cost of the shipper.

3 - A Multi Objective Hub Location Model For A Distribution Network Under Uncertainty In Demand And Time

Andrew Junfang Yu, Associate Professor, The University of Tennessee Knoxville, UT Space Institute, 411 B.H. Goethert Pkwy., MS 19, Tullahoma, TN, 37388-9700, United States, ajyu@utk.edu, Fahimeh Rahmanniyay

In this paper, we develop a multi-objective mixed integer stochastic model (MMS) for hub location problem under uncertainty. The transportation time between each pair of nodes and demand of each node are uncertain parameters. Our multi-objective model includes (1) Minimization of establishment cost as well as transportation cost and (2) minimization of delay between each pair of nodes.

■ WE85

Broadway K- Omni

Sustainability V

Contributed Session

Chair: Hua Cai, Assistant Professor, Purdue University, 315 N. Grant St., West Lafayette, IN, 47907, United States, huacai@purdue.edu

1 - Sustainable Supply Chain Habits: Translating Ethical Practices Into Socially Responsible Supplier Selection And Development Practices

Karen Eboch, Senior Lecturer, Bowling Green State University, Department of Management, BAA 3020, Bowling Green, OH, 43403, United States, eboch@bgsu.edu

This qualitative study examines the influence of individuals involved in sourcing decisions to determine how corporate social responsibility practices in the selection and development of suppliers are transformed. Based on the relationship between the neuroscience of routine decisions (habits) and the established views of moral development, triggers of critical reflection regarding current policies are investigated to identify the drivers which alter existing supplier relationships. As individual morality is judged along cultural norms, the establishment and change of corporate patterns is seen as an extension of an individual's development and alteration of existing habits.

2 - On Sustainability Reporting: Increasing Role Of Global Reporting Initiative?

Andriy Shapoval, Georgia Institute of Technology, Atlanta, GA, United States, ashapoval3@gatech.edu, Henry Osadolor Aigbedo, Marina Mattera, Ivan Oliver Hilliard

This is the continuation of the work of the same authors about standards and initiatives in sustainability and corporate social responsibility reporting. Many businesses around the world follow the Global Reporting Initiative, but at different levels and not necessarily incorporate what the stakeholders desire to see. This study evaluates the case of aerospace and defense companies.

3 - Climate Change Initiatives In Supply Chains

Alireza Tajbakhsh, McMaster University, DeGroote School of Business, 1280 Main Street West, Hamilton, ON, L8S 4M4, Canada, alirezt@mcmaster.ca

There is ample literature about regional, nationwide, and international efforts in establishing mechanisms to curb pollution and emissions. In this study, we first review a variety of these policy instruments, with a focus on emissions trading systems, and then propose a model in the presence of uncertain demand. To do so, through a static game we investigate a multi-pollutant framework in which a number of entities compete in their product markets.

4 - Environmental Benefits Of Individually Optimized Electric Vehicle Battery Range

Hua Cai, Assistant Professor, Purdue University, 315 N. Grant St., West Lafayette, IN, 47907, United States, huacai@purdue.edu, Xiao Shi, Jian Pan

Previous studies evaluating the environmental impacts of electric vehicles (EV) often assume that all the adopters will choose the same EV, neglecting the heterogeneity of individual decisions considering individual travel needs and access to charging infrastructure.This study develops optimization models to identify the optimal EV battery range at the individual level using real world vehicle travel data and charging station location information. This study includes both a static analysis, which optimizes with current and historical data, and a dynamic analysis, which considers the uncertainties in individual travel pattern change and the further development of charging infrastructure.

■ WE88

Broadway B-Omni

Strategy/Strategic

Contributed Session

Chair: Hye Ryeong Lim, Seoul National University, Gangnamgu Dogok2dong Academysweet A -1704, Seoul, Korea, Republic of, limhr@snu.ac.kr

1 - Stakeholders' Influence On Mergers And Acquisitions: The Analysis Of The Impact On Acquisition Premium And Deal Completion Probability

JaSeung Koo, Assistant Professor, Kobe International University, 9-1-6 Koyocho-naka, Higashinada-ku, Kobe, 658-0032, Japan, koo.academic@gmail.com

There is extensive management literature on stakeholders' influence on corporate business operations, yet there is little known about whether and how stakeholders influence M&A progress. This study focuses on three types of primary stakeholders: employees, shareholders, and lenders, and examined their influence on the likelihood of completing an announced M&A and acquisition premiums. I explored stakeholders' reactions, which reflect their anticipation of benefits and losses from the proposed M&A with an empirical analysis of longitudinal data for listed Japanese non-financial firms' M&As between 1986 and 2012. The results showed general support for the proposed hypotheses.

2 - The Relationship Between Deep Level Diversity And Team Benefits: A Mixed Method from China

Yanqiu Song, Central University of Finance and Economics, Haidian, 39th South College Road, Beijing, China, sunny_syq@163.com, Aijing Ran

By using a mix-method, this paper aims to explore the dynamics of deep-level diversity in heterogeneous teams. First, we use an exploratory multi-case study to identify the influential factors of team diversity and team outcomes. Through interviews of 12 innovation teams in 6 international corporations, this study explores the impact mechanism of personality diversity and culture diversity on team process and team outcomes. Secondly, based on a dataset of 209 questionnaires, we testify the mediating role of team conflict and the moderating role of personality diversity and culture diversity in teams.

3 - New Perspectives on Contingent Workers

Hye Ryeong Lim, Seoul National University, Gangnamgu Dogok2dong Academysweet A -1704, Seoul, Korea, Republic of, limhr@snu.ac.kr, Kyung Suk Lee

In a fast changing business environment, firms rely on contingent workers to achieve flexibility. We found that contingent workers with high trust and various backgrounds engage with more voice behaviors than regular workers, bringing new perspectives to the organization as strength of weak tie theory suggests. With panel-data collected biennially from 41,740 contingent workers in 355 different organizations from 2005 to 2013, we conducted cluster analysis, dividing them into four categories: high trust, different backgrounds, high fatigue and perception of competitive organizational culture. We suggest firms first need to build trust with them to make the most of their knowledge.

■ WE90

Broadway D-Omni

Health Care, Modeling XVI

Contributed Session

Chair: Babak Hoseini, PhD Candidate, NJIT, 10 Hill Street, Apartment 2N, Newark, NJ, 7102, United States, bh77@njit.edu

1 - Bi-criteria Appointment Scheduling Of Patients With Heterogeneous Service Sequences

Payman Jula, Associate Professor, Simon Fraser University, Beedie School of Business, WMC 5358, Vancouver, BC, V5A 1S6, Canada, pjula@sfu.ca

We address the appointment scheduling of patients with heterogeneous service sequences and stochastic service times in multi-stage facilities, while considering the availability and compatibility of resources with presence of a variety of patient types. Mathematical programming, simulation, and multi-objective Tabu Search methods are used to achieve our bi-objectives of minimizing the waiting time of patients, and the completion time of the facility. Results of a case study and insights for practitioners are provided.

2 - Wait Time Announcements At Hospital Emergency Departments

Marco Bijvank, University of Calgary, 2500 University Dr. NW, Calgary, AB, T2N 1N4, Canada, marco.bijvank@haskayne.ucalgary.ca, Zhankun Sun

A number of Canadian hospitals have started publishing live emergency department (ED) wait times online in an effort to provide patients with expectations on how long they will have to wait to be seen for non-urgent care after initial assessment by a triage nurse. We accurately predict the state-dependent wait times at emergency departments based on a busy-period analysis for a multi-class, multi-server priority queue with delayed feedback. We illustrate the robustness and impact of the predictor on patient flow and patient care with a case study at four major hospitals in the Calgary area.

3 - Modeling The Impact Of Mandated Quality Outcome Thresholds On Transplant Center Wait Times, Patient Mortality, And Unused Organs

Mohammad Delasay, Post-Doctoral Fellow of Operation Managemet, Tepper School of Business, Carnegie Mellon University, 6315 Forbes Avenue, #1105, Pittsburgh, PA, 15217, United States, delasays@cmu.edu, Sridhar R Tayur

We develop a queueing model of a transplant center's waiting list where patients arrive in two health states (with health deterioration over time) leading to differing post-transplant outcomes if transplanted. Offered organs, if accepted, are allocated to each health state based on a randomized policy. We derive performance metrics including wait list mortality. We extend the model to multiple health states using fluid approximations. We investigate the impact of the mandated survival outcome benchmarks on the transplant center's self-optimized allocation policy and their unintended negative consequences, including increase in the wait list mortality and the fraction of unused organs.

4 - Primary Care Scheduling With Urgent Patients In Carve Out Appointment System

Babak Hoseini, PhD Candidate, NJIT, 10 Hill Street, Apartment 2N, Newark, NJ, 07102, United States, bh77@njit.edu, Wenbo (Selina) Cai

In this work, we consider a carve-out scheduling where certain slots are allocated for the urgent patients while the rest are reserved for appointments requested in advance and some slots may be double booked if the demand arise. We develop a stochastic model under this policy to optimize the social welfare. Our model takes into account the stochastic demands of routine and urgent patients as well as no-shows and derives the optimal numbers of open slots and the maximum number of patients allowed being double-booked. We also develop heuristic schedules and compare their performances with the optimal schedules obtained from the complete enumeration algorithm.

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Sunday, 8:00am – 9:00am

Sunday, 10:00am – 10:50am

Sunday, 11:00am – 12:30am

SB45 Model Uncertainty, Risk, & Compliance
SB46 Sharing Economy, Mechanism Design and Networks I
SB47 New Topics in Revenue Management and Pricing
SB48 Social Media Analytics for Businesses
SB49 Case Competition II
SB50 Decision Making in Healthcare
SB51 Emergency Response, Recovery, and Resilience
SB52 Proactive Planning Against Weather Events
SB53 Emerging Trends in Business Innovation
SB54 Panel: Meet the Editors of Service Science
SB55 Modeling and Optimization for Renewable Energy Integration
SB56 Analytical Models in E-business
SB57 Behavioral Research on Inventory and Pricing
SB58 Energy II
SB59 TSL Keynote Address
SB60 Advances in Traffic Equilibrium and Network Loading Models
SB61 Advances in Railway Research
SB62 Aviation Applications Section: Best Student Presentation Competition II
SB63 Alternative Fuel Vehicles and Sustainable Transportation
SB64 Applications and Methodological Issues on MCDM
SB65 Learning Analytics of Massive Open Online Courses (MOOCs)
SB66 Panel: QSR Student Introduction and Interaction and Best Student Poster Competition
SB67 Dynamic Data Driven Application Systems
SB68 Advanced Maintenance Modeling
SB69 Panel Discussion: Internet of Things Data Analytics
SB70 Trans, Freight II
SB71 Trans, Public II
SB72 Supply Chain Mgt II
SB79 JFIG Paper Competition II
SB86 Manufacturing II
SB94 Technology Tutorial – Bayesia/Palisade Corp.

Sunday, 1:30pm – 3:00pm

SC01 Supervised and Unsupervised Methods
SC02 Quality and Statistical Decision Making in Health Care Applications
SC03 Doing Good with Good OR I
SC04 Gas-Power Market Integration
SC05 Power transmission planning under uncertainty
SC06 INFORMS 2016 Data Mining Best Student Paper Awards
SC07 Joint Session DM/AI: Data Mining for Decision Making
SC08 Undergraduate OR Prize – II
SC09 Energy and Environmental Policy
SC10 Advances in Energy Systems Modeling
SC11 Dense Clusters in Network Optimization
SC12 Convex Relaxations for Nonconvex Polynomial Optimization
SC13 Advances in Mixed Integer Polynomial Optimization
SC14 Syngenta Crop Challenge in Analytics
SC15 Big Data Modeling
SC16 Algorithms for Large-Scale Stochastic Programs
SC17 Optimizing Chance-Constrained Programming Variants
SC18 HPC in Optimization 2
SC19 Computation and Theory in Network Optimization and Analysis
SC20 Novel Dimension Reduction Techniques for High Dimensional Data Using Information Complexity
SC21 Monitoring and Prevention of Healthcare Associated Infections
SC22 Joint Panel Session: ORHP/HAS/MSOM-Hlth: Challenges and Lessons Learned from Influencing National Policy Change in Organ Transplant
SC23 Risk Management in Global Food Supply Chains
SC24 Dynamics of Competition
SC25 Latest Developments in Scheduling Research
SC26 Auction Design Topics
SC27 Panel: Emerging Themes in Innovative Operations
SC28 Empirical Research in Operations Management
SC29 MSOM Energy and Sustainability
SC30 Empirical Studies in Operations Management
SC31 Managing Finances and Risk in Supply Chains
SC32 Scheduling III
SC33 Simulation and Optimization III
SC34 Joint Session HAS/MSOM-HC: Analytics in Drug Development
SC35 Frontiers of Supply Chain Research
SC36 Information and Risk in Supply Chain Networks
SC37 Revenue Management, Assortments and Choice Models
SC38 Collaborative New Product Development
SC39 Market Microstructure and Optimal Trading
SC40 Computational Issues in Productivity and Efficiency Measurement
SC41 Finance Section Student Paper Competition
SC42 Stochastic Systems in Finance
SC43 Spatial Risk and Decision Analysis
SC44 Modeling of Uncertainty and Preference in Decision Analysis
SC45 Panel: Systemic Risk Issues in Counterparty Risk and Central Clearing
SC46 Dynamic Pricing with Substitution, Learning and Reference Price Effects
SC47 New Topics in Revenue Management
SC48 Social Media in Marketing and Talent Management
SC49 Social, Political, and Economic Applications of Social Media Analysis
SC50 Achieving Professional Success by Managing the Work/Life Balance
SC51 Analytical Research in Humanitarian Service Delivery
SC52 Public Policy for Energy and the Environment
SC53 Advances in Research Exploring the Link between Learning and Innovation
SC54 Mathematical Modeling and Data Analytics in the Service Industry
SC55 Emerging Topics in Service Operations
SC56 Crowdsourcing and sharing economy
SC57 Consumer Behavior and Pricing Optimization
SC58 Energy III
SC59 Spatial Analysis in Transportation & Logistics
SC60 Facility Layout
SC61 Fleet Sizing Models
SC62 Aviation Applications Section: Best Student Presentation Competition III
SC63 Network Design and Maintenance in Transportation
SC64 DAAD Special Session on Multiobjective Optimization for Improved Modeling of Complex Systems
SC65 Machine Learning, Big Data and Economics
SC66 Additive Manufacturing
SC67 Decision Analysis Approaches and Predictive Modeling to Managing Uncertainty in Manufacturing and Service Systems Design & Operations
SC68 Panel Discussion: Funding Opportunities
SC69 Pierskalla I
SC70 Trans, Freight III
SC71 Trans, Public III
SC72 Supply Chain Mgt III
SC79 Health Care, Modeling III
SC86 Manufacturing III
SC94 Technology Tutorial – Wiley/Provalis Research

Sunday, 3:10pm – 4:00pm

Sunday, 4:30pm – 6:00pm

Monday, 8:00am -9:30am

MA34 Networks in Healthcare
MA35 Breakthroughs in Teaching Operations
MA36 Emerging Issues in Supply Chain
MA37 Securing Sustainable Future
MA38 Panel: Meet the Editors – NPD, Innovation, and Technology
MA39 Applied Probability and Machine Learning II
MA40 Supply Chain/ Inventory in Applied Probability I
MA41 FSS Tutorial
MA42 Systemic Risk and Financial Networks
MA43 Decision Analysis, Game Theory, and Disaster Management I
MA44 Environmental Decision Analysis
MA45 Agent-based Modeling and Simulation – Overview
MA46 Pricing, Revenue Management and Operations in Retailing
MA47 Optimizing Pricing for Multiple Substitutable Products
MA48 Social Media Analytics for Business Applications
MA49 Tutorials and Examples of Software and Methods for Social Media Analytics
MA50 Panel: Life after the PhD: Early Career Development
MA51 New Models in Criminology
MA52 Recent Developments in Humanitarian Logistics
MA53 Decision Analytics for Technology Management
MA54 Analytics and Operations Research for the IT Services Industry
MA55 Modeling, Optimization, and Data Analytic in the Service Industry
MA56 Economics of IS in the Age of Big Data
MA57 The George B. Dantzig Dissertation Prize
MA58 Energy V
MA59 Network Design and Operations
MA60 Fleet and Marketplace Optimization for Mobility-on-Demand (MOD) Systems
MA61 Intermodal Transportation
MA62 Determinants of Aviation Strategies and Market Outcomes
MA63 Continuous Space Location Modeling
MA64 MCDA Methods and Applications
MA65 Gamification and User Engagement
MA66 Model Calibration
MA67 Maintenance and Reliability Planning
MA68 Panel: IOT-enabled Data Analytics: Opportunities, Challenges and Applications
MA69 Game Theory and Competitive Applications
MA70 Trans, Maritime I
MA71 Supply Chain, Shipping I
MA72 Supply Chain Mgt V
MA79 Health Care, Modeling V
MA86 Marketing I
MA94 Technology Tutorial-Mathworks/Artelys

Monday, 10:00am -10:50am

Plenary Philip McCord Morse Lecture: Margaret L. Brandeau

Monday, 11:00am -12:30pm

MB01 Data Mining Under Uncertainty
MB02 Data Mining in Healthcare
MB03 Daniel H. Wagner Prize Competition II
MB04 Topics in Power Generation Scheduling
MB05 2016 INFORMS BOM Section Best Working Paper Awards
MB06 Data Mining in Text Analytics
MB07 New Product Development
MB08 Empirical Research in Operations and Service Innovation
MB09 Development of Electricity Systems
MB10 Energy Models: Diversity and Complementarity
MB11 Network Optimization Models and Applications II
MB12 Joint Session APS/Optimization: Advances in Causal Inference Using Optimization
MB13 Uncertain Linear Optimization
MB14 Data Analytics
MB15 Stochastic and First-order Methods for Data Analysis
MB16 Data-driven and Robust Optimization
MB17 Risk Measures on Stochastic Programs
MB18 Recent Advances in Theory and Applications of IPCO
MB19 Models and Methods for Large-Scale Mixed-Integer Optimization
MB20 Research and Teaching Opportunities in Project Management
MB21 Applications of Stochastic Models in Medical Decision-making Problems
MB22 Policy Evaluation from Operations to Public Health
MB23 Healthcare Analytics: Collaborations with Practitioners
MB24 Strategy and Uncertainty
MB25 Project Management Methodologies
MB26 Assignment and Matching Markets
MB27 Empirical Research in Operations
MB28 New Models for Pricing
MB29 Incentive Mechanisms and Sustainability
MB30 Sustainable Supply Chains
MB31 Operations and Finance Interface
MB32 Structural Estimation in Operations
MB33 Simulation II
MB34 Simulation and Stochastic Optimization
MB35 Empirical Research in Healthcare Operations
MB36 Empirical and Theoretical Models in Supply Chains
MB37 Socially and Environmentally Responsible Operations Management
MB38 Behavioral Modeling with Social Data
MB39 Panel: Future of Applied Probability
MB41 Advances in Quantitative Finance
MB42 Crowd-Commerce Applications in Operations and Revenue Management
MB43 Applied Decision Analysis
MB44 Panel: Advice from Award Winning Researchers
MB45 Advances in Simulation Optimization
MB46 Revenue Management and Assortment Optimization
MB47 Multi-product Revenue Management
MB48 Marketing Insights from Social Media
MB49 Predicting Business Outcomes Using Social Media
MB50 MIF Rising Young Scholars Award
MB51 Community-Based Operations Research I
MB52 Resilience Management Concepts for Infrastructure and Service Systems
MB53 Emerging Scholars in Technology Management
MB54 Optimal Services and Coordination Strategies of O2O Channel in Fast Fashion Supply Chain
MB55 Inventory Management I
MB56 Firm Competitive Strategies
MB57 Queues and Customer Behavior
MB58 Energy VI
MB59 Connected and Automated Vehicles
MB60 Latest Advances in Last Mile Distribution
MB61 Practical Steps Towards Shipment & Network Capacity Management
MB62 Data Mining in Air Transportation
MB63 HUB Location
MB64 MCDM for System Design: No Camels Allowed
MB65 Field Experiment Research on Mobile and Social Applications
MB66 Data Visualization
MB67 Advances in Degradation Modeling and Operations Management
MB68 Joint Session QSR/DM: Data Analytics for System Improvement I
MB69 Military Operations Research II

Monday, 12:30pm – 2:30pm

Monday, 1:30pm – 3:00pm

Monday, 3:10pm – 4:00pm

Monday, 4:30pm – 6:00pm

Recycling, and Servicization
MD30 Retail Operations II
MD31 Operations and Financing Interface
MD32 Scheduling
MD33 Simulation II
MD34 Joint Session HAS/MSOM: Healthcare Operations
MD35 Empirical Service Operations
MD36 Control, Learning, and Strategic Behavior in Queueing Models
MD37 Sustainability in Supply Chains
MD38 Reliability
MD39 Markov Lecture
MD40 Theoretical Development in Estimation
MD41 Quantitative Methods for Finance and Energy
MD42 Pricing and Information Provision of Services
MD43 Simulation for Supply Chain
MD44 DAS Awards Session
MD45 Simulation-based Optimization
MD46 Customer Choice Estimation and Assortment Optimization
MD47 Pricing, Promotion Planning, and Revenue Management
MD48 Peeling Back the Onion in Social Media Analysis
MD49 Social Media User Behavior
MD51 Humanitarian & Disaster Relief Logistics
MD52 Routing Models for Public Safety
MD53 TIMES Distinguished Speaker
MD54 Service Optimization, Design and Measure in Emerging Market
MD55 CPMS Isolated Practioner
MD56 IOT: Technology Innovation and Business Impact
MD57 Influencing Behavior in Aircraft Operations
MD58 Energy VIII
MD59 TSL Prize Winners
MD60 Modeling and Analysis of Innovative Mobility Services I
MD61 Advances in Blocking & Trip Planning
MD62 Aviation Applications Section: Keynote Presentation
MD63 UAS Traffic Management and Low-altitude Airspace Operations
MD64 Multicriteria Applications in the Public Section
MD65 Data Analytics and Machine learning
MD66 Computer Experiments and Uncertainty Quantification
MD67 IEEE T-ASE Invited Session II
MD68 Quality Engineering Invited Session
MD69 Routing and Allocation in Military Operations
MD70 Trans, Rail I
MD71 Vehicle Routing I
MD72 Supply Chain Mgt VIII
MD79 Health Care, Modeling VIII
MD94 Technology Tutorial- Gurobi/AMPL

Tuesday, 8:00am – 9:30am

TA01 Machine Learning II
TA02 Predictive Modeling for Wind Power
TA03 Entertainment Analytics
TA04 Advances in Using Market Models for Power Transmission Planning
TA05 Short-term Operation, Maintenance, and Long-term Planning for Power Systems
TA06 Optimization Models in Data Mining
TA07 Retail Analytics
TA08 Collaborative Innovation and Project Supply Chain Management Interfaces
TA09 Panel Discussion: Open Challenges in Internet of Things & Agriculture Analytics
TA10 Renewable Energy Systems and Grid Integration
TA11 Novel Applications of Network Optimization
TA12 Mixed-Integer Programming with Applications
TA13 Computational Linear Optimization
TA14 Data Mining in Genetics and Genomics
TA15 Academic Job Search Panel
TA16 Energy Systems
TA17 Stochastic Programming for Long Term Planning
TA18 Finance, Portfolio I
TA19 Optimization Modeling and Beyond with a Focus on Practice
TA20 Mathematical Finance, Models, Simulation and Today’s Pressing Problem
TA21 Beyond Predictive Analytics
TA22 Joint Session MSOM-HC/HAS: Modeling and Optimization for Chronic and End-Stage Renal Disease Patients
TA23 Modelling Care and Treatment of Chronic Diseases
TA24 Practice-Based Research in Healthcare OM
TA25 Project Related SCM III
TA26 Auctions and Econometrics
TA27 New Developments in Sourcing and Selling Strategies
TA28 hold Sequential Sampling and Optimization
TA29 Managing Capacity in Energy Markets Through Demand and Supply-side Interventions
TA30 Studies in Service Operations
TA31 Supply Chain Finance and Risk Management
TA32 Revenue Mgt, Pricing I
TA33 Queueing Models
TA34 Provider Staffing and its Impact on Patient Flow
TA35 Online Services: Learning and Pricing
TA36 Operations and Supply Chains for Innovative Goods
TA37 Sustainability Issues in Supply Chains I
TA38 Reliability II
TA39 Artificial Intelligence in Big Data
TA40 Markov Decision Processes: Applications
TA41 Quantitative Methods in Finance VI
TA42 Choice Models and Assortment Optimization
TA43 Data-Driven Decision Making
TA44 Investment Analysis and Financial Applications
TA45 Efficient Learning in Stochastic Optimization
TA46 Dynamic Games and Applications to Revenue Management
TA47 Personalized E-commerce
TA48 Social Media Analysis II
TA49 Classroom Activities
TA50 SpORts: Sports Analytics Education
TA51 Lifting up Populations
TA52 Transportation Issues in Smart Cities
TA53 Organizational learning, innovation and knowledge creation
TA54 Service Science in Electricity Supply
TA55 Inventory Management III
TA56 Economics of Information technology and social media
TA57 Insights from Relaxing Traditional Modeling Assumptions about Human Behavior in OM Settings
TA58 Energy VX
TA59 Modeling Interdependent Infrastructure Networks
TA60 Modeling and Analysis of Innovative Mobility Services II
TA62 Distributed Control of Multi-Agent Networks
TA63 Alternative Fuel Refueling Location Problems
TA64 Multi-Criteria Decision Making in Agriculture
TA65 Analytical and Empirical Analyses of Digital Markets
TA66 Data Analytics and Reliability in Energy/Smart Grids
TA67 IEEE T-ASE Invited Session III
TA68 Graph Analytics for Complex Systems
TA69 Economics IV
TA70 Trans, Rail II
TA71 Vehicle Routing I
TA72 Supply Chain Mgt IX
TA73 Operations Management I
TA74 Optimization Methodology I
TA75 Behavioral Operations I
TA76 Decision Analysis
TA77 Opt, Integer Programing I
TA78 Opt, Network I
TA79 Health Care, Modeling VX
TA86 Marketing V
TA87 Panel: Guide to the Analytics Body of Knowledge (ABOK)
TA88 Service Science Best Student Paper Competition I

TA89 Advances in Traffic Flow Modeling
TA90 Opt, Stochastic II
TA94 Technology Tutorial- Frontline/ SAS-GAP/EDU

Tuesday, 10:00am – 10:50am

Plenary Big Data and Big Decisions

Tuesday, 11:00am – 12:30pm

TB01 Clustering Methods in Data Mining
TB02 Methods for Analysis of Next-Generation Sequencing Data
TB03 Marketing Strategies of Entertainment Products
TB04 Developing Country Electricity Systems
TB05 Optimal Power Flow
TB06 Solving Hard Optimization Problems in Machine Learning
TB07 Networks and Data Analytics in Finance
TB08 Business Model Innovation
TB09 Information and Market Structure
TB10 Natural Gas Markets
TB11 Optimization in Network Reliability, Security, and Interdiction
TB12 New Models and Approximation Results in Stochastic and Combinatorial Optimization
TB13 Recent Advances in Stochastic Integer Programs
TB14 Revenue Mgt, Pricing
TB15 Industry Job Search Panel
TB16 Information in Optimization
TB17 Stochastic Sequential Assignment and Planning
TB18 Finance, Portfolio II
TB19 Computational Methods for Healthcare Applications
TB20 Robust Multiobjective Optimization for Decision Making under Uncertainty and Conflict
TB21 Coordinated Care Delivery
TB22 Data-Driven Healthcare Operations
TB23 Models in Medical Decision Making
TB24 Analytics in Evidence-Based Practice (EBP)
TB25 Scheduling and Contracts
TB26 Combinatorial Auction Pricing
TB27 Social Networks and Learning
TB29 Incentives Issues in Sustainable Operations
TB30 Predictive Modeling in Healthcare
TB31 Topics in Operations and Finance Interface
TB32 Revenue Mgt, Pricing III
TB33 Queueing Models I
TB34 Scheduling and Workload Assignment in Healthcare
TB35 Managing Service Systems with Strategic Servers
TB36 Pricing and Supply Chain Management in Healthcare Industry
TB37 Sustainability Issues in Supply Chains II
TB38 Reliability I
TB39 Applied Probability and Simulation I
TB40 Markov Decision Processes: Theory
TB41 Quantitative Methods in Finance XII
TB42 Learning, Estimation, and Experimentation in RM and Pricing
TB43 Panel: New Frontiers in Decision Analysis Practice and Theory
TB44 Graphical Methods
TB45 Parallel Simulation Optimization
TB46 Choice Modeling and Assortment Optimization
TB47 Pricing, Promotions and Bundling for Revenue Management
TB48 Optimization and Statistical Learning
TB49 Educational Research in OR/MS
TB50 Panel: Topics for PhD Students
TB51 Matchings and Assignments with Societal Impact
TB52 Urban Transportation and Logistics in Public Sector OR I
TB53 Innovations and Value Chain Management
TB54 Service Science in Emerging Economy
TB55 Inventory Management IV
TB56 Innovation through IT Management
TB57 Managing Decentralized Processes
TB58 Energy X
TB59 Innovations in Transporation Network Pricing
TB60 Moving People and Goods More Efficiently in Traffic Networks: Models and Algorithms
TB61 Online Delivery Routing
TB62 Data Mining and Optimization for Improved Airport Operations
TB63 Deterministic Network Design
TB64 Multi-objective Optimization: Algorithms and Applications
TB65 Digital Business Models and Strategies in the Era of Analytics
TB66 Data Analytics for Quality and Reliability Assurance
TB67 IIE Transactions Invited Session
TB68 Tutorial: Wind Energy Applications
TB69 Decision Support Systems I
TB70 Trans, Planning I
TB71 Vehicle Routing III
TB72 Supply Chain Mgt X
TB73 Operations Management II
TB74 Optimization Methodology II
TB75 Behavioral Operations II
TB76 Resource Allocation
TB77 Opt, Integer Programing II
TB78 Opt, Network II
TB79 Opt, Stochastic II
TB86 Monte Carlo Methods for Multi-stage Decision Making under Uncertainty
TB87 Community-Based Operations Research II
TB88 Service Science Best Student Paper Competition II
TB89 Evolution of Network-wide Traffic Dynamics
TB90 Health Care, Modeling X
TB94 Technology Tutorial- SAS/SAS-JMP

Tuesday, 12:30pm – 2:30pm

Poster Session Tuesday Poster Competitition

Tuesday, 1:30pm – 3:00pm

TC01 Ensemble Methods in Data Mining
TC02 Data Mining in Medical and Brain Informatics I
TC03 Panel: Publication Tips
TC04 Power System Operations Under Increasing Uncertainty
TC05 Reliable Power System Design and Operations
TC06 Data-Intensive Computational Methods for Large-scale Infrastructure Systems
TC07 Information and Influence Diffusion in Networks
TC08 Ethics and Sustainable Business Models
TC09 Environmental Logistics and Supply Chain Operations
TC10 Optimizing Distributed Energy Generation I
TC11 Paths, Cycles, and Transversals
TC12 New Results on Nonconvex Optimization
TC13 Recent Advances in Computational Optimization
TC14 Sustainable and Responsible Supply Chain Management I
TC15 Joint Session AI/SMA: Social Media Analytics and Big Network Data
TC16 Inverse Optimization: Applications
TC17 Stochastic Optimization for Large-Scale Learning
TC18 Finance, Portfolio
TC19 Population Health: Infectious and Chronic Diseases
TC20 Multiagent Systems Modeling
TC21 Payment Models, Pricing, and Incentives in Healthcare
TC22 Dealing with Uncertainty in Hospital Operations
TC23 New Models in Health Care
TC24 Public Health and Health System Modeling
TC25 Scheduling in Practice
TC26 Combinatorial Auctions

TC27 Empirical Studies in Supply Chain Management
TC28 Operations-Marketing Interface
TC29 Issues in Environmental Operations: Managing Risk, Customer Returns, and Regulations
TC30 Supply Chain Channel Management
TC31 Operations/Corporate Finance Interface
TC32 Revenue Mgt, Pricing II
TC33 Queueing Models II
TC34 Public Policy and Healthcare Operations
TC35 Public Sector Service Operations
TC36 Innovative Pricing
TC37 Sustainable Operations II
TC38 Service Science II
TC39 Dynamic Learning Applications
TC40 Applied Probability and Machine Learning I
TC41 Quantitative Risk Management
TC42 Revenue Management with Advertising Applications
TC43 Decision Making in Public Policy
TC44 Decisions, Sensitivity and Applications
TC45 Multi-Objective Optimization Via Simulation
TC46 Empirical and Data-Driven Studies in Revenue Management and Pricing
TC47 Choice-based Demand and Strategic Consumers
TC48 Social Media Analysis IV
TC49 Experiential Field Learning
TC50 SpORts: Sports Analytics I
TC51 Modeling Complex Systems in Education
TC52 Urban Transportation and Logistics in Public Sector OR II
TC53 Management of Product and Service Innovation
TC54 Service Science: Best Cluster Paper Presentation
TC55 Inventory Management V
TC56 Managing Sales in On-demand Economy
TC57 New Topics in Behavioral Operations
TC58 Energy XII
TC59 Robust and Reliable Optimization in Transportation and Logistics
TC60 Network Optimization for Efficiency, Sustainability and Resilience
TC61 Stochastic Network Design
TC62 Robust and Low Cost Airline Operations under Uncertainty and Disruptions
TC63 Location Analysis I
TC64 Multiple Criteria Decision Making Applications 1
TC65 Topics on Internet Economics
TC66 Networked System Reliability and Resilience
TC67 Industrial Big Data System
TC68 Reliability Evaluation and Optimization from Complex Systems II
TC69 Airports, Runways, and Descents
TC70 Trans, Planning II
TC71 Vehicle Routing IV
TC72 Supply Chain Mgt XI
TC73 Operations Management III
TC74 Optimization Methodology III
TC75 Behavioral Operations III
TC76 Decision Analysis I
TC77 Opt, Integer Programing III
TC78 Opt, Network III
TC79 Opt, Stochastic III
TC86 Marketing VII
TC87 Minority Issues Forum Paper Competition
TC88 Service Science Best Student Paper Competition III
TC89 Applications of Optimization and Control Theory in Traffic Management
TC90 Logistics, Humanitarian
TC94 Technology Tutorial- SIMIO/Neusrel

Tuesday, 3:10pm – 4:00pm

Keynote Optimizing the Future ? Supply Chain at Amazon
Keynote Wagner Prize Winner Reprise
Keynote Edelman Reprise-UPS

Tuesday, 4:30pm – 6:00pm

TD01 New Methods in Data Mining
TD02 Data Mining in Medical and Brain Informatics II
TD03 Recent Developments in Opaque and Probabilistic Selling
TD04 Joint Session QSR/ENRE: Data-driven Modeling and Analytics in Wind Power Systems
TD05 Forest Management
TD06 Optimization for Large-Scale Learning
TD07 Emerging Topics on Internet of Things (IoT) and Data Analytics
TD08 Outsourcing Innovation
TD09 Big Data II
TD10 Optimization in Renewable Energy
TD11 Quality-Guaranteed Network Design: Interdiction, Routing, and Resource Allocation
TD12 New Results on Polyhedral Relaxations
TD13 Software and Methodologies for (Nonlinear) Integer Programming
TD14 Predictive Analytics: Big Data with Purpose
TD15 Joint Session AI/Analytics: Machine Learning for Public Policy
TD16 Joint Session DM/Optimization Under Uncertainty: Optimization in Data Mining and Machine Learning
TD17 Statistical Learning with Convex Optimization
TD18 Resource Allocation Problems in Nonprofit Settings
TD19 Stable Sets, Zero-forcing Sets, and Target Sets in Graphs
TD20 Optimality Conditions for Inventory Control
TD21 Data Analytics for Healthcare
TD22 Decision Making in Healthcare Supply Chain
TD23 Operations Management Approaches Applied in Healthcare Settings: Achieving Patient Health and Operational Effectiveness.
TD24 Modeling Systems for Public Health
TD25 Scheduling with Applications
TD26 Spectrum Auction
TD27 Stochastic Modeling In Healthcare Operations
TD28 Topics in Sustainability
TD29 Issues in Sustainable Operations
TD30 Innovative Data-driven Analyses in Healthcare Research
TD31 Information Economics in Operations
TD32 Revenue Mgt, Pricing IV
TD33 Queueing Models III
TD34 Joint Session HAS/MSOM-HC: Care Transition Policy and Management
TD35 On Demand Services
TD36 MSOM/Supply and Procurement
TD37 Investment in Renewable Energy and Energy Efficiency
TD38 Service Science I
TD39 Applied Probability and Optimization III
TD40 Applications in Applied Probability
TD41 Quantitative Methods in Finance
TD42 RM in Online Markets
TD43 Portfolio Decision Analysis
TD44 Applications of Multiattribute Preferences
TD45 Simulation Optimization and Ranking and Selection
TD46 Empirical Research on Pricing and Revenue Management
TD47 Cloud Computing in RM
TD48 Social Media Analytics Award Session
TD49 Panel: First Course in Analytics or Only Course in Analytics – What Difference Does It Make?

Wednesday, 8:00am – 9:30am

Wednesday, 10:00am – 10:50am

Keynote The Goals of Analysis are Understanding, Decisions, and Influencing Policy
Keynote Can Prediction be Better than Cure? On Analytics in Health-Care
Keynote SportSource Analytics

Wednesday, 11:00am – 12:30pm

WB01 Pattern Recognition Applications in Data Mining
WB02 Data Mining in Healthcare 2
WB03 Advances in Emergency Department Operations Management/Research
WB04 Optimization Methods in Smart Grid
WB05 Forest Management: Transportation and/or Collaborative Logistics
WB07 Simulation and Data Mining
WB08 Supply Chain Mgt, Green
WB09 Empirical Research on Sustainable Operations
WB10 Underground Mine Planning
WB11 Transportation Network Analysis
WB12 Polyhedral Methods in Combinatorial Optimization
WB13 Advances in Integer Programming Software
WB15 Detection of Structure and Anomalous Patterns in Data
WB16 Optimal Learning and Optimization via Simulation
WB17 Distributed Consensus Optimization
WB18 DMA General
WB19 Future of Disease Modeling in Clinical and Public Health
WB20 Assets and Structured Hedges in Energy Markets Severe Incompleteness and Methods for Dealing with It
WB21 Emerging Methods for Healthcare Analytics and Visualization
WB22 Empirical Analysis of Resource Utilization
WB23 Optimal Treatment & Screening of Chronic Care Patients
WB24 Optimization in Radiation Therapy
WB25 Logistics II
WB26 Information Systems I
WB27 Information and Consumer Behavior in Supply Chain Management
WB28 Product Recalls
WB29 Managing Responsibility in Supply Chains
WB30 Management of Critical Care
WB31 Service Operations in a Modern Economy
WB32 Risk Analysis II
WB33 Production and Scheduling II
WB34 Operations Analysis in Healthcare
WB36 Supply Chain Analytics
WB37 Supply Chain Structure and Sustainability
WB38 Opt, Robust
WB39 Joint Session APS/MSOM: Service Systems in Applied Probability I
WB40 Queueing in Applied Probability I
WB41 Stochastic Control and Quantitative Finance
WB42 RM in Practice II
WB43 Decision Making with Incentives
WB44 Behavioral Decision Analysis
WB45 Simulation for Performance of Non-Stationary Queues
WB46 Networks and Games in Operations
WB47 Applications of RM and Pricing
WB48 Business Applications in Social Media Analytics
WB49 Panel: Publishing in INFORMS Transactions on Education
WB50 SpORts: Sports Analytics IV
WB51 Education I
WB52 New advances in Operating Room (OR) Scheduling
WB53 Opt, Stochastic VI
WB54 Service Science: Uncertainty in Business Processes
WB55 Inventory Management VIII
WB56 Predictive Analytics in eBusiness
WB57 Behavioral Aspects of Managing Innovation
WB58 Energy XIII
WB59 Drone-Based Logistics
WB60 Routing Optimization Problems
WB61 Railway Analytics
WB62 Aviation Economics Decision-making
WB63 Location Models in Humanitarian Logistics
WB64 Representations and Approximations in Multiobjective Optimization
WB65 Digital Innovation & Analytics
WB66 Graph Analytics for Complex Systems – II
WB67 Joint Session QSR/DM: Process Monitoring for Diverse Types of Data
WB68 Spatiotemporal Data based Quality Control Methods in Manufacturing
WB69 Network Design and Optimization
WB70 Trans, Ops II
WB71 Game Theory II
WB72 Supply Chain Mgt XIV
WB73 Operations Management VI
WB74 Ops Mgt/Marketing II
WB75 Economics II
WB76 Applied Probability II
WB77 Opt, Integer Programing VI
WB78 Opt, Metaheuristics II
WB79 Opt, Convex
WB80 Health Care, Public II
WB81 Health Care, Strategies II
WB82 Networks and Graphs II
WB83 Supply Chain Optimization II
WB84 Supply Chain, Risk II
WB85 Sustainability II
WB88 Military Applications II
WB89 Maritime Transportation
WB90 Health Care, Modeling XIII

Wednesday, 12:45pm – 12:15pm

WC01 Data Mining in Aviation
WC02 Data Mining Applications in Health Care
WC03 Big Data III
WC04 Power System Operation Models for Ramping Scarcity Mitigation
WC05 Spatial Optimization
WC06 Big Data 2
WC07 Process Modeling
WC08 Technology Mgt
WC10 Designing Energy and Water Supply Chains for Prosperity
WC11 Decision Making Under Multistage Uncertainty
WC12 Recent Advances in Decision Diagrams for Optimization
WC13 Computational Approaches to Large-scale/Exact Optimization
WC14 Transportation and Disaster Analytics
WC15 Exploiting Sparse and Low Rank Structures for Inference
WC16 Optimization and Learning in Supply Chain Systems
WC17 Nonlinear Optimization Algorithms I
WC18 DMA Healthcare
WC19 Open-Source Tools for Operations Research
WC20 Understanding the US Index Futures Stock Market using Research
WC21 Healthcare Operations and Capacity Planning
WC22 Appointment Scheduling Models and Analytics
WC23 Optimization in Radiation Therapy Treatment Planning
WC24 Scheduling Providers and Patients
WC25 Logistics III
WC26 Information Systems II
WC27 Innovations in Retail Operations
WC29 Mechanisms to Enhance the Value of Used and

Wednesday, 2:45pm – 4:15pm

Wednesday, 4:30pm – 6:00pm