TECHNICAL SESSIONS

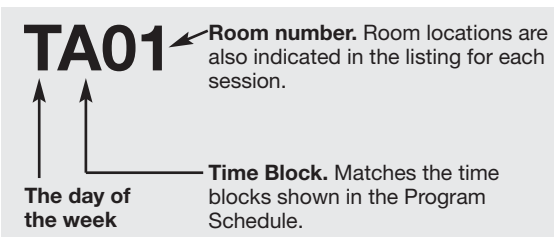## How to Navigate the Technical Sessions

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 501-542).

Quickest Way to Find Your Own Session

Use the Author Index (page 501) — 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

A — 8:00am - 9:30am
B — 11:00am - 12:30pm
C — 1:30pm - 3:00pm
D — 4:30pm - 6:00pm

Wednesday

A — 8:00am - 9:30am
B — 11:00am - 12:30pm
C — 12:45pm - 2:15pm
D — 2:45pm - 4:15pm
E — 4:30pm - 6:00pm

Room Locations /Tracks

All tracks and technical sessions will be held in the Hilton Hotel and Parc 55. Room numbers are shown on the Track Schedule and in the technical session listing.

Sunday, 8:00am - 9:30am

■ SA01

Hilton- Golden Gate 6

Analysis in Support of National Security

Sponsor: Military Applications Society
Sponsored Session

Chair: Richard Deckro, Professor of Operations Research, Air Force Institute of Technology, AFIT/ENS;Bldg 641, 2950 Hobson Way, Wright-Patterson AFB, OH, 45433, United States of America, richard.deckro@afit.edu

1 - A Markov Decision Process Model for the Optimal Dispatch of Military Medical Evacuation Assets
Matthew Robbins, Assistant Professor, Air Force Institute of Technology, 2950 Hobson Way, WPAFB, OH, 45433, United States of America, matthew.robbins@afit.edu, Sean Keneally, Brian Lunday

We develop a Markov decision process model to examine optimal military medical evacuation dispatch policies in a combat environment, considering complicating aspects to include the priority level of each casualty, multiple-casualty events, threat conditions at service locations, and the option for armed helicopter escort. We present the results of applying a relative-value iteration dynamic programming algorithm to instances representative of medical support to ground operations in Afghanistan.

2 - Reducing Cognitive Load on the UAS Controller
Jasmine Morgan, DSE/USMA, Bldg 752, 4th Floor, West Point, NY, 10996, United States of America, Jnikole08@yahoo.com, Michael J. Kwinn, Jr.

This is a final senior year capstone project for four US Military Academy Cadets. They were asked by the Product Manager for Unmanned Aerial Systems (PM-UAS, Army) to develop ideas to reduce the cognitive load on the currently required two operators for small UASs by redesigning the controller station. The team went a bit further by looking at a leap in technology from what the system currently employed.

3 - Utilizing Wargaming in Unrestricted Warfare: Benefits and Limits
David Smalenberger, Air Force Institute of Technology, Department of Operations Research, AFIT/ENS; Bldg 641, 2950 Hobson Way, Wright-Patterson AFB, OH, 45433, United States of America, David.Smalenberger@afit.edu, Richard Deckro

Wargaming (WG) enables doctrine and weapon systems evaluation in variable and replicable environments. This provides early warning detection of fallacies and capability limitations with scientific rigor. Capabilities testing through WG is therefore limited to interpolation of the current state. Unrestricted warfare (UW) provides a rebalancing of asymmetric advantages enjoyed by technologically advanced forces. This presentation discusses UW and the use of WG in the UW environment.

■ SA02

Hilton- Golden Gate 7

Harvesting Big Data for Technology Intelligence

Sponsor: Technology, Innovation Management and Entrepreneurship
Sponsored Session

Chair: Tugrul Daim, Associate Professor, Portland State University, Eng'g and Tech Mgmt Dept, Portland, United States of America, tugrul@etm.pdx.edu

1 - Trigger-based Location-Based Services: A Viral Geo-fencing Approach to Direct Digital Marketing
Robert Harmon, Professor of Marketing & Service Innovation, Portland State University, School of Business, P.O. Box 751, Portland, OR, 97207, United States of America, harmonr@pdx.edu, Robert Brown

The viral growth behavior of social media-based interactions has raised the potential for harnessing these epidemic-like communication dynamics as a digital marketing approach in the context of trigger-based geo-fencing LBS strategies. Recent developments in the integration of social networking dynamics, big data analytics, text mining, semantics, dynamic behavioral profiling, and real-time trigger-based geo-sensing capabilities are enabling the next generation of high performance LBS.

2 - Action Research of Bibliometrics in Public R&D Programs – Lessons Learned
Yuya Kajikawa, Tokyo Institute of Technology, 3-3-6 Shibaura, Minato-ku,, Tokyo, Japan, kajikawa@mot.titech.ac.jp

Science of science policy is becoming a new field of research. Decision making based on scientifically analyzed evidence is crucial and there are much rooms for bibliometrics analyzing papers and patents to contribute in policy making process of public R&D programs. In this contribution, results of action research utilizing bibliometrics for planning and management of public R&D projects are presented and lessons learned there are discussed.

3 - Technology Mining for Lighting Technologies
Nazrul Islam, School of Management and Business, Aberystwyth University, Rheidol Building, Aberystwyth, UK, mni@aber.ac.uk, Kevin van Blommestein, Tugrul Daim

An Energy Efficiency Technology Roadmap was develop to provide a direction for future R&D investments. This paper provides an analysis of a part of this roadmap with objective of identifying the right experts for providing input for the roadmap development. The research integrates the use of bibliometrics, patent analysis and social network analysis.

4 - Innovation Measurement Framework to Determine Innovativeness of a Company: Case of Semiconductor I
Kenny Phan, Assistant Professor, Portland State University, 1900 SW 4th Ave LL 50-02, ETM Dept - Portland State Univ, Portland, OR, 97201, United States of America, kenny4660@gmail.com, Dundar Kocaoglu

Innovation is one of the most important sources of competitive advantage. Because of its importance,companies need to manage it.This paper develops a framework to determine the innovativeness of a company in semiconductor industry by using output indicators. A hierarchical decision model (HDM) was constructed for the framework. The top three sub-factors are revenue from new products, market share of new products, and products that are new to the world.

■ SA03

Hilton- Golden Gate 7

Entrepreneurship and Innovation

Cluster: Business Model Innovation

Invited Session

Chair: Serguei Netessine, Professor, INSEAD, 1 Ayer Rajah Avenue, Singapore, 138676, Singapore, serguei.netessine@insead.edu

1 - Inclusive Innovation: Broader Market Coverage for Innovative Products with Deliberate Supply Chain
Oleksiy Mnyshenko, University of California - San Diego, 9500 Gilman Drive, La Jolla, United States of America, omnyshenko@ucsd.edu, Vish Krishnan, Hyoduk Shin

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.

2 - Optimal Time Allocation for Process Improvement and Growth for Entrepreneurs
Steve Yoo, UCL Department of Management Science and Innovation, Gower St, London, onesun.yoo@ucl.ac.uk, Charles Corbett, Guillaume Roels

Entrepreneurs are often reported to pay too little attention to process improvement before growing their business. In this paper, we characterize a dynamic model of time allocation for process improvement in small growth-oriented entrepreneurial firms. We find that entrepreneurs should first engage themselves in process improvement activities, which would save them future time, and then on revenue enhancement activities, which would make them earn future money, before harvesting profit.

3 - Business Model Innovation
Christophe Pennetier, Student, INSEAD, 1 Ayer Rajah Avenue, Singapore, 138676, Singapore, Christophe.Pennetier@insead.edu, Serguei Netessine, Karan Girotra

Using a novel dataset that combines information form 3 different sources (VentureSource, CrunchBase, AngelList), we study the success of start-ups through the lean start-up angle: how should entrepreneurs implement and use the key drivers of business model innovation that will mitigate the uncertainty risks putting any new venture at stake?

4 - The Role of Uncertainty and Bounded Rationality in Selecting Scientific Research Projects
Karim Lakhani, Harvard Business School, k@hbs.edu, Kevin Boudreau, Eva Guinan, Chris Riedl

We theorize & test how uncertainty surrounding innovative research projects shapes evaluations. We predict how uncertainty affects evaluations using data from a grant proposal process at a medical school with randomized assignment of evaluators and proposals. We find evaluators who judge proposals closer to their own specialized knowledge to give systematically more negative scores & highly novel research proposals to receive more critical evaluations.

■ SA04

Hilton- Continental 1

Managing Systems with Random Yields

Sponsor: Manufacturing & Service Operations Management

Sponsored Session

Chair: Saurabh Bansal, The Pennsylvania State University, Business Building, University Park, United States of America, sub32@psu.edu

1 - Optimal Policies for a Utility under the Renewable Portfolio Standard
Sha Liao, Ph.D. Candidate, University of British Columbia, 202-8640 Shaughnessy St, vancouver, Canada, sha.liao@sauder.ubc.ca, Tim Huh, Mahesh Nagarajan

A utility needs to supply a percentage of its energy from renewable resources, and will demonstrate its compliance by holding Renewable Energy Certificates (RECs). We formulate a single utility's problem as a dynamic stochastic program, and study its choice between renewable and regular energy, as well as its trading policy in the REC market. Explicit formulas are derived for the optimal purchasing quantities under different scenarios, along with monotonicity analysis.

2 - Sustainable Product Line Design under Co-production Technology
Yen-Ting Lin, Assistant Professor, University of San Diego, San Diego, 92110, United States of America, linyt@sandiego.edu, Haoying Sun, Shouqiang Wang

We consider a monopolist who produces a product using a scarce material such as wood. The quality of material varies by nature. The monopolist considers introducing only one product or multiple products using co-production technology. We examine how the monopolist's optimal product line design depends on consumers' valuation on resource sustainability. We also study the impact of consumers' sustainability awareness on material consumption and quantity of waste generated.

3 - Wine Analytics: Fine Wine Pricing and Selection under Weather and Market Uncertainty
Mert Hakan Hekimoglu, Syracuse University, 721 University Avenue, Syracuse, NY, United States of America, mhekimog@syr.edu, Burak Kazaz, Scott Webster

We investigate a distributor's portfolio selection problem of fine wine futures and bottles. Using Liv-ex.com data, we first empirically show how the evolution of futures prices for young wines can be predicted by changes in weather and market conditions. We then examine the distributor's investment decisions in futures, bottles, and cash position analytically using a Value-at-Risk measure.

4 - Sequential Capacity Management and Random Yield
Mahesh Nagarajan, Associate Professor and Division Chair, University of British Columbia, Henry Angus 478,, Sauder School of Business,2053 Main Mall, vancouver, BC, Canada, mahesh.nagarajan@sauder.ubc.ca, Saurabh Bansal

We discuss the problem of determining the optimal capacity allocation and lot sizes for two sequential production runs, where each production run is subject to random yield. We first provide an analytical solution to the problem and then discuss its structural properties. We use this to construct heuristics with a provable worst case performance that can be used in these setting effectively.

■ SA05

Hilton- Continental 2

Empirical Studies of Service Operations

Sponsor: Manufacturing & Service Operations Management

Sponsored Session

Chair: Robert Batt, Asst. Professor, UW-Madison, 975 University Ave., Madison, WI, 53706, United States of America, rbatt@bus.wisc.edu

1 - Retail in High Definition: using Video Analytics in Salesforce Management
Marcelo Olivares, Assoc. Professor, Columbia University, Broadway 3027, New York, United States of America, molivares@columbia.edu

In some product categories, assisting customer can be an important factor to generate a sale (for example, in apparel and electronics). Our research develops an empirical approach to estimate the impact of assisting customers on sales, combining sales transaction with video analytics tracking customer shopping paths in stores. These empirical results are used to support decisions related to store staffing and personnel training.

2 - The Persistence of Customer Misalignment: Evidence from a Retail Bank Acquisition
Ryan Buell, Assistant Professor, Harvard Business School, Morgan Hall 429, Boston, MA, 02163, United States of America, rbuell@hbs.edu, Dennis Campbell

In the event a firm acquires a customer whose needs and preferences are misaligned with the operating system, will the customer's preferences conform over time? Will the customer defect? Or, will the misalignment persist? To answer this question, we leverage a natural experiment created when one nationwide retail bank acquired another. Our results highlight the persistence of incompatible customers and their downward effect on operating performance.

3 - Third Party Ownership and the Adoption of Solar Energy Systems in the U.S. Residential Market
Jose Guajardo, University of California Berkeley, 545 Student Services Bldg #1900, Berkeley, CA, United States of America, jguajardo@haas.berkeley.edu, Ernesto Guerra

We analyze the role of business models in the adoption of solar PV systems in the U.S. residential market. We formulate an empirical model to characterize the drivers and effects of Third Party Ownership in the adoption of solar systems, in the context of government incentives and supply-side determinants.

4 - Who's Next?: An Empirical Study of Doctor-patient Selection in an Emergency Department
Robert Batt, Asst. Professor, UW-Madison, 975 University Ave., Madison, WI, 53706, United States of America, rbatt@bus.wisc.edu

We study an emergency department where physicians have the freedom to choose which patients to take on as their own and which to ignore. We empirically examine the operational and behavioral factors that influence these decisions. We also examine the impact of the patient selection decisions on patient flow.

■ SA06

Hilton- Continental 3

Stochastic Modeling In Healthcare Operations

Sponsor: Manufacturing & Service Operations Management

Sponsored Session

Chair: Masha Shunko, Purdue University, 403 W. State Street, West Lafayette, IN, 47906, United States of America, mshunko@purdue.edu

1 - Critical Care in Hospitals: When to Introduce a Step Down Unit?
Mor Armony, New York University, marmony@stern.nyu.edu, Carri Chan, Bo Zhu

Step Down Units (SDUs) provide an intermediate level of care between the Intensive Case Units (ICUs) and the general medical wards. There is an ongoing debate in the medical community as to whether and how SDUs should be used. An SDU alleviates ICU congestion by providing a safe environment for post-ICU patients, but it also takes capacity away from the ICU. We find that under some circumstances the optimal size of the SDU is zero, while in other cases, having a sizable SDU may be beneficial.

2 - Pareto Improving Policies in EMS Flow Control
Masha Shunko, Purdue University, 403 W. State Street, West Lafayette, IN, 47906, United States of America, mshunko@purdue.edu, Hung Do

In decentralized queueing systems, a performance improving coordination policy is sustainable only if it benefits all service agents. Using Emergency Medical Setting as

motivation, we find classes of coordination policies for ambulance traffic that improve performance of the system according to multiple objectives and guarantee that all agents are better off.

3 - Pareto Improving Flow Control Policies for Multi-Server Emergency Departments - New Perspectives
Hung Do, University of Vermont, Burlington, Burlington, United States of America, hdo@bsad.uvm.edu, Masha Shunko

Using Emergency Medical Services setting as motivation, we design and analyze flow control policies for service systems with N multiple-server queues. We focus on policies that improve performance of the system and that are also beneficial to all involved entities. We propose a new perspective on performance measures, conduct analysis and reveal managerial insights that help design such Pareto improving policies in practice.

4 - Human Resource Collaboration: An Empirical Study of Capacity Loss
Lu Wang, Kellogg School of Management, Northwestern University, 2001 Sheridan Road, Evanston, IL, 60201, United States of America, l-wang@kellogg.northwestern.edu, Jan Van Mieghem, Itai Gurvich

Collaboration and resource sharing in processing networks may introduce a capacity loss due to synchronization. To investigate this phenomenon, we conduct a model-based empirical study of collaboration and synchronization in a large hospital. In the presence of individual and collaborative tasks, doctors must decide which to process next. Combining a queueing network model and the hospital data, we study the impact of doctors' prioritization rules on the capacity loss induced by synchronization.

■ SA07

Hilton- Continental 4

Using Complementarity Modeling for Planning and Policy Analysis of Electricity & Energy Markets

Cluster: Tutorials

Invited Session

Chair: Ben Hobbs, Professor, Johns Hopkins University, 3400 N Charles St, Baltimore, MD, 21218, United States of America, bhobbs@jhu.edu

1 - using Complementarity Modeling for Planning and Policy Analysis of Electricity & Energy Markets
Ben Hobbs, Professor, Johns Hopkins University, 3400 N Charles ST, Baltimore, MD, 21218, United States of America, bhobbs@jhu.edu, Antonio J. Conejo, Steven A. Gabriel, Carlos Ruiz, J. David Fuller

Complementarity models can represent the simultaneous optimization problems of one or several interacting decision makers, and have become a powerful tool for formulating and solving bottom-up energy market models. An overview is provided of complementarity-based formulations (including MPECs and EPECs), followed by illustrative electricity market applications, including oligopolistic generation markets, transmission infrastructure planning, and environmental policy.

■ SA08

Hilton- Continental 5

2014 INFORMS Prize Winner: Mayo Clinic

Cluster: 2014 INFORMS Prize

Invited Session

Chair: Jeff Winters, UPS, Timonium, MD, 21093, United States of America, jwinters@ups.com

1 - 2014 INFORMS Prize Winner: Mayo Clinic
Amy Donahoe- Anshus, Mayo Clinic, Rochester, MN, United States of America, donahoeanshus.amerett@mayo.edu, Janine Kamath, Mark Hayward, Brian Klute, Dustin Kuchera, Tarun Mohan Lal

Mayo Clinic was awarded the 2014 INFORMS Prize for sustained excellence in clinical care, research and education through the effective integration of advanced analytics and operations research. This presentation will highlight the legacy, sophisticated infrastructure, novel application and dissemination of learning. Key success factors for leveraging analytics and engineering to address the formidable challenges in health care today and tomorrow will be discussed.

■ SA09

Hilton- Continental 6

Empirical Healthcare Operations

Sponsor: Manufacturing & Service Operations
Management/Healthcare Operations

Sponsored Session

Chair: Diwas KC, Emory University, 1300 Clifton Road, Atlanta, GA, 30322, United States of America, diwas.kc@emory.edu

1 - A Text Mining Analysis of Patient Portals
Hessam Bavafa, Assissant Professor, Wisconsin School of Business, 975 University Ave, Madison, WI, 53706, United States of America, bavafa@wharton.upenn.edu, Christian Terwiesch

We study the micro-structure of electronic communication between patients and providers through patient portals. We examine detailed information about the patients, providers, and communication details, e.g., message timing and text, to establish a better understanding of their role in primary care.

2 - Priority and Predictability
Jillian Berry Jaeker, Harvard Business School, Morgan Hall, Soldiers Field, Boston, MA, 02163, United States of America, jjaeker@hbs.edu

We explore how patient admission characteristics moderate the effects of high workload and demand, specifically, probability for admission for scheduled vs. emergent incoming patients. We find that while scheduled surgical patients, who are less emergent, are more likely to be postponed as the occupancy nears the hospital maximum, but are also more likely to cause the early discharge of currently convalescing patients as occupancy increases.

3 - Pacing Work under Goals and Deadlines: Econometric Analysis of an Outpatient Department
Sarang Deo, Assistant Professor, Indian School of Business, Hyderabad, 500032, India, sarang_deo@isb.edu, Aditya Jain, Pradeep Pendem

We draw upon psychology literature to build hypotheses regarding the impact of progress toward goals and deadlines on work pace and empirically test them in a high volume, tertiary care OPD. We find that teams regulate their effort in response to the discrepancy between intermediate subgoals and their performance toward them. Moreover, teams speed up closer to the deadline. Finally, teams are less likely to regulate their effort in response to a discrepancy closer to the deadline.

4 - Testing Patient Patience: Role of Time to Appointment on Patient Flow
Diwas KC, Emory University, 1300 Clifton Road, Atlanta, GA, 30322, United States of America, diwas.kc@emory.edu

Using data from over 900 providers, we examine the extent to which time to appointment impacts patient flow and overall clinic throughput.

■ SA10

Hilton- Continental 7

Consumer Behavior and Revenue Management

Sponsor: Manufacturing & Service Operations Management

Sponsored Session

Chair: Gustavo Vulcano, New York University, 44 West Fourth St, Suite 8-76, New York, NY, 10012, United States of America, gvulcano@stern.nyu.edu

1 - Inventory Management with Buy-Online-Pickup-in-Store
Fei Gao, The Wharton School, University of Pennsylvania, Philadelphia, United States of America, feigao@wharton.upenn.edu, Xuanming Su

Many retailers offer customers the option to buy online and pickup in store. We study the impact of this new initiative on inventory management in both online and offline channels. We identify situations when this initiative may hurt profits and offer recommendations to retailers.

2 - Loss Aversion and Reference Dependence: Evidence from Performing Arts Industry
Senthil Veeraraghavan, senthilv@wharton.upenn.edu, Necati Tereyagoglu

We hypothesize that not only the past price but also the observed sales for a seating area determines the utility of a customer from buying a ticket for a show in this industry. We test the reference effects for both prices and sales using customer level transaction data from an organization, and show that customer decisions are driven by the position of the seating alternatives relative to price and sales expectations. Finally, we find that the revenue effects of referencing are significant.

3 - Operating a Group-buy Mechanism in the Presence of Strategic Consumers
Gustavo Vulcano, New York University, 44 West Fourth St, Suite 8-76, New York, NY, 10012, United States of America, gvulcano@stern.nyu.edu, Navaporn Surasvadi, Chris Tang

We consider a group-buy mechanism under which a retailer offers multiple units at both a regular price and a lower price that will be activated when a pre-specified number of reservations has been made. Forward-looking consumers arrive over time, and if both prices are still offered, they must decide which one to pay. We analyze the subgame among consumers, and through an extensive numerical study, we show the convenience of this mechanism.

4 - Quantity Competition in the Presence of Strategic Consumers
Yuri Levin, Queen's School of Business, 143 Union Str., Kingston, Canada, ylevin@business.queensu.ca, Mikhail Nediak, Andrei Bazhanov

Retailers choose initial inventories of undifferentiated limited-lifetime product offered to strategic consumers. A manufacturer sets full price, while market clearing determines discount price. A complete characterization of symmetric pure-strategy rational expectations equilibria yields: increasing strategic behavior can benefit retailers and hurt consumers; increasing competition may harm local economy; and strategic behavior may protect against sales at salvage value.

■ SA11

Hilton- Continental 8

Information and Incentives in Supply Chains

Sponsor: Manufacturing & Service Operations
Management/Supply Chain

Sponsored Session

Chair: Fuqiang Zhang, Washington University, Olin Business School, St. Louis, United States of America, fzhang22@wustl.edu

1 - Public Forecast Information Sharing in a Market with Competing Supply Chains
Hyoduk Shin, University of California-San Diego, 9500 Gilman Drive, La Jolla, CA, United States of America, hshin@rady.ucsd.edu, Noam Shamir

Studying the motivation to publicly announce forecast information, we show that by making forecast information publicly available to both his manufacturer and the competitor, a retailer is able to credibly share his forecast information - an outcome that cannot be achieved by exchanging information within the supply chain.

2 - Offshoring Versus Reshoring: Supply Flexibility, Market Proximity, and Operational Levers
Bin Hu, Assistant Professor, University of North Carolina, Chapel Hill, NC, 27519, United States of America, bin_hu@kenan-flagler.unc.edu, Li Chen

The existing offshoring literature mostly focuses on cost advantages and market proximity. We instead note that a reshoring manufacturer may lose some supply flexibility that it once enjoyed when offshoring, and show that even without any cost differences, supply flexibility and market proximity can influence the manufacturer's preference between offshoring and reshoring. We further discuss operational levers that can tilt the preference either way.

3 - An Optimal Procurement Mechanism with Post-Bid Cost-Reduction
Patrick Nestor, University of Michigan, 1205 Beal Avenue, Room 2778, Ann Arbor, MI, 48105, United States of America, psnestor@umich.edu, Damian Beil, Izak Duenyas

We consider a procurement auction setting where the buyer may, after seeing the suppliers' price bids, exert effort to identify cost reduction opportunities with one or more suppliers, before selecting the contract winner. The buyer seeks to minimize her total procurement costs, namely the contract payment plus the cost of investigation effort. Using optimal mechanism analysis, we derive the optimal auction and cost investigation policy.

4 - Forecast Accuracy, Risk Aversion, and Information Sharing in Supply Chain
Fuqiang Zhang, Washington University, Olin Business School, St. Louis, United States of America, fzhang22@wustl.edu, Yifan Xu, Baojun Jiang, Lin Tian

In many distribution channels, the manufacturer may possess superior demand-forecast information than the downstream retailer. This paper studies the impacts of the manufacturer's accuracy and the retailer's risk aversion on information sharing between the channel members.

■ SA12

Hilton- Continental 9

Sustainability and Supply Chains

Sponsor: Manufacturing & Service Operations
Management/Sustainable Operations

Sponsored Session

Chair: Robert Swinney, Associate Professor, Duke University,
100 Fuqua Drive, Durham, NC, 27516, United States of America,
robert.swinney@duke.edu

**1 - Impact of Electricity Pricing Policy on Renewable Energy
Investments and Carbon Emissions**
Safak Yucel, PhD Student, Duke University, 100 Fuqua Drive,
Durham, NC, 27708, United States of America,
safak.yucel@duke.edu, Gurhan Kok, Kevin Shang

We investigate the impact of electricity pricing policies on renewable energy
investments and carbon emissions from the perspectives of different investors. We
show that the time-invariant (flat) pricing policy usually promotes renewable
energy investments and reduces carbon emissions. Moreover, our results indicate
that the pricing policy that leads to higher investments may not reduce carbon
emissions.

**2 - Inducing Environmental Disclosures: A Dynamic Mechanism
Design Approach**
Shouqiang Wang, Assistant Professor, Clemson University, 100
Sirrine Hall, Clemson, SC, 29634, United States of America,
shouqiw@clemson.edu, Peng Sun, Francis de Vericourt

When regulating a revenue-maximizing firm who is subject to a privately
observable stochastic environmental hazard, compliance benefits (e.g., subsidy)
and inspection are two commonly used instruments to induce voluntary
disclosure. We examine the regulator's problem of designing an efficient dynamic
regulation policy using these two instruments. The optimal policy, featured by a
cyclical structure, depends critically on the precision of the inspection technology.

3 - Managing Social Responsibility in Multi-tier Supply Chains
Lu Huang, PhD Student, Fuqua School of Business, Duke
University, 700 Bolinwood drive, Chapel Hill, NC, 27514,
United States of America, lu.huang2@duke.edu, Robert Swinney,
Jing-Sheng Song

We consider a multi-tier supply chain in which a Tier 2 supplier potentially violates
social and environmental standards, resulting in both capacity and demand loss for
a downstream (Tier 0) firm. We analyze the efficacy of both direct (Tier 0 to Tier 2)
and indirect (Tier 0 to Tier 1 to Tier 2) mechanisms to improve responsibility of the
Tier 2 supplier, and determine under what conditions the downstream firm should
delegate responsibility management to intermediate suppliers.

**4 - The Effect of Sourcing Policies on a Supplier's
Sustainable Practices**
Deishin Lee, Boston College, Carroll School of Management,
Chestnut Hill, United States of America, deishin.lee@bc.edu,
Vishal Agrawal

We investigate the sourcing decisions of firms who want to source sustainably-
produced parts, e.g., organic ingredients, in order to offer sustainable products. We
examine how the firm's sourcing policy and competition can influence an
upstream supplier's decision to convert to a new sustainable processing standard.

■ SA15

Hilton- Exec. Boardroom

Two-stage and Fuzzy DEA Topics

Cluster: Data Envelopment Analysis

Invited Session

Chair: Wade Cook, Wade D. Cook Schulich School of Business,
York University, Toronto, Ontario M3J 1P3, Canada,
wcook@schulich.yorku.ca

**1 - A Framework for a Sustainable Sourcing: A Flexible Cross
Efficiency Evaluation in Fuzzy DEA**
Pegah Khoshnevis, Master Student, Université Catholique de
Louvain, 34 Voie du Roman Pays, L1.03.01, Louvain-la-Neuve,
1348, Belgium, pegah.hajimirza@Student.uclouvain.be, Per Agrell,
Constantin Blome, Adel Hatami-Marbini

Nowadays, customer attitudes focus on sustainability of the products/services
regarding environmental, social and economic aspects. In this study, we propose a
product-based framework for sustainable supplier sourcing in SCM, which
considers sustainability, operational and organizational criteria in terms of the
outsourced product. We develop a flexible cross efficiency evaluation DEA for
effectively discriminating suppliers along with using fuzzy sets to tackle the
vagueness information.

2 - A Fully Fuzzified Two-stage DEA
Adel Hatami-Marbini, Université Catholique de Louvain,
34 Voie du Roman Pays, L1.03.01, Louvain-la-Neuve, 1348,
Belgium, adel.hatamimarbini@uclouvain.be, Joshua Ignatius,
Ali Ebrahimnejad

There is a growing literature in DEA where researchers are opening the black box
to evaluate the efficiency performance of internal processes. Within this context,
we study a relational two-stage DEA model where there is imprecision in the
representation of the input and output data. The imprecision is captured using
fuzzy sets and the models are evaluated with this representation. Insights are
provided and future research directions are outlined.

**3 - Two-Stage DEA: When Intermediate Measures Can Act as Outputs
from the Second Stage**
Wade Cook, wcook@schulich.yorku.ca, Sonia Aviles-Sacoto,
Raha Imanirad, Joe Zhu

This paper investigates efficiency measurement in a two-stage data envelopment
analysis (DEA) setting. While in the conventional closed serial system, the only
role played by the outputs from stage 1 is to behave as inputs to stage 2, the
current paper examines a variation of that system where the set of final outputs is
comprised not only of those that result from stage 2, but can include, in addition,
certain outputs from the previous (first) stage.

**4 - Two-Stage Financial Risk Tolerance Assessment using Data
Envelopment Analysis**
Joseph Paradi, Professor Emeritus, University of Toronto,
200 College Street, Toronto, On, M5S3E5, Canada,
paradi@mie.utoronto.ca, Angela Kingyens

In Canada Securities Acts in each Province include the "Know Your Client" rule.
This requires FSIs to consider an investor's personal and financial status and
comfort level for risk before recommending investments. They use questionnaires
to create a risk profile so an appropriate investment portfolio can be recommended.
The exact value of these risk profiles is unknown since questionnaires vary widely.
This work introduces DEA to this process with significant improvements to any
existing model.

■ SA16

Hilton- Franciscan A

Risk Management in Supply Chains

Sponsor: M&SOM/ iForm (Interface of Finance, Operations, and Risk
Management)

Sponsored Session

Chair: Xuan Zhao, Associate Professor, Wilfrid Laurier University,
75 University Ave. W., Waterloo, Canada, xzhao@wlu.ca

1 - The Value of Audit in Managing Supplier's Process Improvement
Mohammad Nikoofal, PhD Student, McGill University, 1001
Sherbrooke Street West, Bronfman Building, Montreal, QC, H3A
1G5, Canada, mohammad.nikoofal@mail.mcgill.ca,
Mehmet Gumus

Besides the benefits of outsourcing, firms are concerned about the lack of
information regarding their suppliers. Moreover, suppliers may take certain actions
that affect their supply risks without informing their buyers. We study the
effectiveness of incentive- and audit-based contracts in dealing with such suppliers.

**2 - Strategic Risk Management in Spot Market for Supply Chains
under Competition**
Xuan Zhao, Associate Professor, Wilfrid Laurier University, 75
University Ave. W., Waterloo, Canada, xzhao@wlu.ca, Wei Xing,
Shanshan Ma

This paper studies two risk management strategies related to spot market to
mitigate firms' exposure to demand uncertainty, namely, operational hedging and
financial hedging. We consider a supplier sells an intermediate good to two
manufacturers, who use it to produce a final product and compete with each other
in the final product market with uncertain demand.

3 - Price-matching Guarantees in Dual Channels
Arcan Nalca, arcan.nalca@business.queensu.ca

Price-matching guarantees (PMGs) are policies by which firms promise to match
any lower price offered by the competition. The impact of PMGs between a retailer
and a supplier is disregarded in the literature since previous studies concentrate
PMGs between competing retailers. We address this gap by shedding light on the
following research question: Why and when, i.e., under which market and
industry conditions, does the retailer and/or the supplier offer PMG in a dual
channel?

4 - Retailing in the Presence of Valuation Uncertainty and a Peer-to-Peer Marketplace
Benny Mantin, Assistant Professor, University of Waterloo, 200 University Ave. W., Waterloo, Canada, bmantin@uwaterloo.ca, Stanko Dimitrov, Lifei Jiang

Consumers oftentimes face uncertainty regarding their valuation for the goods they seek to purchase. A peer-to-peer marketplace can potentially mitigate the valuation uncertainty faced by consumers by allowing them to resell unwanted goods and at the same time it introduces competition to the retailer. We derive the equilibrium outcomes and characterize the conditions under which a marketplace can be bene?cial (or detrimental) to the retailer, the consumers, and the overall welfare.

■ SA17

Hilton- Franciscan B

Consumer Behavior in Services

Sponsor: Manufacturing & Service Operations Management/Service Operations

Sponsored Session

Chair: Pnina Feldman, UC Berkeley, Haas School of Business, 2220 Piedmont Ave, Berkeley, CA, 94720, United States of America, feldman@haas.berkeley.edu

1 - Lifting the Veil: How Cost Transparency Increases Purchase Intentions
Bhavya Mohan, Doctoral Candidate, Harvard Business School, 27 HBS Mail Center, 500 Soldiers Field Road, Boston, MA, 02163, United States of America, bmohan@hbs.edu, Leslie John, Ryan Buell

Firms typically do not reveal details of their cost structures to their consumers. However, a handful of online retailers are experimenting with cost transparency on their retail websites, by revealing the costs incurred during the production of a good. In a field experiment and series of lab studies, we examine when and how a firm's decision to disclose its costs influences a consumer's willingness to purchase.

2 - Inventory Announcements with Strategic Customers: A Structural Estimation Approach
Kate Ashley, UC Berkeley, Haas School of Business, 2220 Piedmont Ave, Berkeley, CA, 94720, United States of America, kate_ashley@haas.berkeley.edu, Jun Li, Pnina Feldman

Does inventory announcement affect the timing of consumer purchases? Using data from the airline industry, we estimate a structural model that accounts for the impact of a firm's inventory announcement policy on customer purchase decisions. We analyze the extent to which customers treat messages from the firm as cheap talk or as credible information, and characterize the market conditions under which various types of announcement policies are preferred by the firm.

3 - Managing Customer Expectations and Priorities with Delay Announcements
Gad Allon, Northwestern University - Kellogg, 2001 Sheridan Rd., Evanston, IL, United States of America, g-allon@kellogg.northwestern.edu, Qiuping Yu, Achal Bassamboo

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.

4 - Blind Queues: The Impact of Consumer Beliefs on Revenues and Congestion
Shiliang Cui, Georgetown University, McDOnough School of Business, Washingrton, DC, 20057, United States of America, shiliang.cui@georgetown.edu, Senthil Veeraraghavan

In many service settings, customers have to join the queue without being fully aware of the parameters of the service provider. We analyze a firm serving customers making decisions under arbitrary beliefs about the service parameters, and show while revealing the service information to customers improves revenues under certain customer beliefs, it may however destroy consumer welfare or social welfare.

■ SA18

Hilton- Franciscan C

Choice Models in Revenue Management and Pricing I

Sponsor: Revenue Management & Pricing

Sponsored Session

Chair: William Cooper, Professor, University of Minnesota, Industrial and Systems Engineering, Minneapolis, MN, 55455, United States of America, billcoop@umn.edu

1 - Assortment Optimization under Consider-then-choose Models
Ali Aouad, PhD Candidate, MIT, 99 1/2 Myrtle St Apt 2, Boston, MA, 02114, United States of America, aaouad@mit.edu, Retsef Levi, Vivek Farias

One classical approach to modeling choice in marketing explains that customers faced with a purchasing decision follow a two stage, consider-then-choose behavior. This work attempts to operationalize several models commonly used in marketing with assortment decisions. We investigate the combinatorial structure of the assortment optimization problem resulting from the incorporation of specific behavioral heuristics and devise exact polynomial time algorithms for such underlying choice structures.

2 - Near Optimal Algorithms for Constrained Assortment Optimization
Vineet Goyal, 304 S.W. Mudd Building, Columbia University, New York, NY, 10027, United Statesvg2277@columbia.edu, Antoine Desir

We consider the capacitated assortment optimization problem where each product has a given weight and there is a capacity constraint on the assortment. We present a fully polynomial time approximation scheme (FPTAS) for the capacitated assortment problem for a large family of choice models including the MNL model, Nested logit model, and the mixture of constant number of MNL models. We also show that the capacitated assortment optimization is NP-hard even for the special case of MNL model.

3 - Assortment Optimization under the d-Level Nested Logit Model
Paat Rusmevichientong, Associate Professor, University of Southern California, Marshall School of Business, Los Angeles, CA, United States of America, rusmevic@marshall.usc.edu, Huseyin Topaloglu, Guang Li

We provide a new formulation of the d-level nested logit model using a tree of depth d. We establish structural properties and develop an efficient algorithm for computing the optimal assortment. For a d-level nested logit model with n products, the running time of the algorithm is $O(d\ n \log n)$.

4 - Pricing for a Multinomial Logit Model with Network Effects
William Cooper, Professor, University of Minnesota, Industrial and Systems Engineering, Minneapolis, MN, 55455, United States of America, billcoop@umn.edu, Zizhuo Wang, Chenhao Du

We consider an extension of a classical MNL assortment pricing problem to network goods. For such network goods, the overall purchase quantities are not an explicit function of the prices. Rather, the quantities arise as an equilibrium outcome characterized by the consistency of the purchase quantities with the MNL choice probabilities. We describe the solution of the assortment pricing problem and discuss insights from the model.

■ SA19

Hilton- Franciscan D

New Frontiers in Pricing and Revenue Management

Sponsor: Revenue Management & Pricing

Sponsored Session

Chair: Robert Phillips, Columbia University, rp2051@columbia.edu

1 - Pay-per-unit vs. Subscription Pricing for Experiential Products under Competition
Varun Gupta, University of Texas at Dallas, Campbell road, Richardson, United States of America, varun.gupta@utdallas.edu, Ozalp Ozer, Alp Muharremoglu

In a market where distributors compete to sell experiential products (e.g.; movies and music), should they use pay-per-unit pricing or use subscription pricing? We study market dynamics when a content provider is selling to two distributors which are using different pricing modalities and characterize pricing conditions where both can co-exist profitably, where only one can make money and where price wars would be expected. We also investigate the role of the contractual powers of the players.

2 - "Big-Data" Revenue Management

Robert Phillips, Columbia University, rp2051@columbia.edu

In the spirit of Rudin and Vahn's "Big Data Newsvendor" (2013), we present a machine-learning approach to the single-resource revenue management problem that can accommodate a large number of features relative to the number of resource. The approach is non-parametric and can easily be made adaptive. We illustrate the effectiveness of the approach through numerical examples.

3 - The Effectiveness of Field Price Discretion: Empirical Evidence from Auto Lending

A. Serdar Simsek, Instructor/Researcher, Cornell ORIE, 282 Rhodes Hall, Ithaca, NY, United States of America, as2899@cornell.edu, Garrett van Ryzin, Robert Phillips

How much (if any) pricing discretion headquarters should grant local salespeople is a topic of debate. We used a unique data set from an auto lender and estimated the local sales force adjusted prices in a way that improved profits by 11%. A counterfactual analysis shows that using a centralized pricing optimization system could improve profits even further, up to 20% over current profits. Hence, centralized pricing –if appropriately optimized– can be more effective than field price discretion.

4 - Estimating Willingness-to-Pay in a Negotiated Selling Environment

Neil Biehn, Vice President, PROS Solutions, 3100 Main Street, ̦Suite 900, Houston, TX, 77002, United States of America, nbiehn@pros.com

In this talk, we'll explore the definition of Willingness-to-Pay (WTP) and what the literature has to say about estimating it. Recent tests and interviews with customers and sales people reveal that many B2B companies are purposefully under-pricing. Alternate approaches to estimating WTP are examined with a new WTP model presented along with numerical examples.

■ SA20

Hilton- Yosemite A

Economics of Information Systems

Sponsor: eBusiness
Sponsored Session

Chair: Byungwan Koh, Assistant Professor, University of Calgary, 2500 University Drive NW, Calgary AB T2N 1N4, Canada, bkoh@ucalgary.ca

Co-Chair: Yasin Ceran, Santa Clara University, 500 El Camino Real, Santa Clara CA, United States of America, yceran@scu.edu

1- Customer Churn Prediction in a Noncontractual Setting

Yasin Ceran, Santa Clara University, 500 El Camino Real, Santa Clara CA, United States of America, yceran@scu.edu, Debora Donato, Xiaojing Dong, Oytun Eskiyenturk

Under a noncontractual setting,customers conduct business with the firm as they wish and they donot need to declare when they become inactive.It is therefore challenging for the firm to reduce customer churn rate.In this study, we obtained a unique dataset from a social media website.Using a stochastic process model based on the Pareto/NBD framework, we developed a methodology that allows us to predict the churn probability, and identify efficient activities to prevent the customer from leaving.

2 - The Influence of Direct and Indirect Experience on Somatosensory Technology Adoption

Pei-Lee Teh,Senior Lecturer, Monash University, Jalan Lagoon Selatan, Bandar Sunway, Selangor 46150, Malaysia, teh.pei.lee@monash.edu, Pervaiz K. Ahmed, Emily Yim Lee Au, Soon-Nyean Cheong, Ravindra S. Goonetilleke, Wen-Jiun Yap

This study investigates the influence of direct and indirect experience on somatosensory technology adoption in two research settings (video demonstration versus product trial). Our findings provide an important implication for somatosensory technology marketers that product trial (direct experience) engenders more reliable inferences than does exposure to video demonstration (indirect experience).

3 - The Impact of IT on the Production Structure

Fengmei Gong, University of Calgary, MGIS Area, Haskayne School of Business, Calgary AB T2N 1N4, Canada, fgong@ucalgary.ca, Byungwan Koh, Barrie Nault

Information sharing and coordination as captured by supply chain members' IT investment has made product design and production methods possible that are not possible without information sharing. Consequently, industries are able to develop supply chains with different industries than they did before, and this can possibly change the production structure of the economy. We examine whether IT is responsible for the change in the production structure.

■ SA21

Hilton- Union Sq 1

Design of Transportation and Supply Chain Networks

Sponsor: Transportation Science & Logistics
Sponsored Session

Chair: Weijun Xie, Georgia Institute of Technology, Atlanta, GA, United States of America, xieweijun06@gmail.com

1 - Capacitated Relay Network Design with Generalized Imbalance Constraints

Halit Uster, Southern Methodist University, Lyle School of Eng., Dallas, TX, 75275, United States of America, uster@smu.edu, Panitan Kewcharoenwong

We introduce a relay network design problem under link capacity and flow imbalance considerations with applications in Less-than-Truckload (LTL) and and Truckload (TL) transportation. We present an efficient Lagrangean Decomposition algorithm for model solution and computational results to illustrate the performance of the approach and the impact of using relay networks in freight transportation.

2 - Freight Transportation Network Design in Urban Areas

Mehmet Pancaroglu, Research Assistant, Middle East Technical University, ODT Universiteler Mahallesi, Dumlupinar Bulvari No:1, Ankara, 06800, Turkey, mpancar@metu.edu.tr, Sinan Gürel, Haldun Süral

In this study, we investigate urban freight transportation under the perspective of City Logistics. From a strategic point of view, we aim to design low-cost and efficient urban freight transportation network. We try to decide on the number and location of distribution centers, fleet size and routes to make last mile delivery.

3 - Truck Line Network Optimization Based on Big Data Analytics

Hongbo Li, Manager, IBM Research - China, Diamond Building, ZGC Software Park #19,, Beijing, 100193, China, hboli@cn.ibm.com, Xin Shi, Hongwei Ding, Shuang Ren

Nationwide truck line network is the key infrastructure to supply high-level logistics service for large-scale 3PL company. It's very challenge to make a tradeoff between timeliness and cost for the transportation network designer. We present an improved method to optimize truck line network. Wherein, we integrate huge historical demand orders, waybills data, truck line information, transit ports data and so on to mine the frequent load patterns and find out the optimal transportation network.

4 - Optimal Spatial Layout of Transshipment Facilities on An Infinite Homogeneous Plane

Weijun Xie, Georgia Institute of Technology, Atlanta, GA, United States of America, xieweijun06@gmail.com, Yanfeng Ouyang

This paper studies optimal spatial layout of transshipment facilities and their corresponding service regions on an infinite homogeneous Euclidean plane that minimizes the total cost for facility set-up, outbound delivery and inbound replenishment transportation. This paper provides a tight bound for the Gersho's conjecture (1979) with the inbound transportation cost, which can be archived by elongated cyclic hexagons. Numerical study further verifies the analytical findings.

■ SA22

Hilton- Union Sq 2

Real-Time Information in Transportation

Sponsor: Transportation Science & Logistics
Sponsored Session

Chair: Dong Yoon Song, Purdue University, 610 Purdue Mall, West Lafayette, IN, United States of America, song50@purdue.edu

1 - Risk Equitable Routing and Prohibition Stratesis for Hazardous Materials Transportation

Ashrafur Rahman, Visiting Assistant Professor, Bunknell University, 116 Court Street, New Haven, CT, 06511, United States of America, arahman@engr.uconn.edu, Nicholas Lownes

A new risk measure for hazardous materials transportation is proposed. The new risk measure is used in mathematical modeling considering equity concept to suggest routing and prohibition strategies for hazmat transportation.

2 - Real-time Support System for Stranded Commuters Considering Traffic Conditions

Wenlong Yu, PhD Candidate, Graduate School for Creative Cities, Osaka City University, Room 408, 1-4-3 Sugimoto, Sumiyoshi-ku, Osaka, 558-0022, Japan, yule_tt@yahoo.co.jp, Hiroyuki Ebara, Raito Matsuzaki, Venkatesh Raghavan, Daisuke Yoshida

We propose a Real-time Support System based on GPS and wireless LAN function of mobile devices. In this system, we aim to support for stranded commuters in an earthquake disaster. We perform simulations with modeling systems considering traffic conditions.

3 - Psychological Benefits of Real-Time Travel Information under Heterogeneous Drivers

Dong Yoon Song, Purdue University, 610 Purdue Mall, West Lafayette, IN, United States of America, song50@purdue.edu, Srinivas Peeta

Psychological benefits of real-time travel information are affected by the heterogeneous characteristics of drivers. A modeling framework is proposed to accommodate the heterogeneity issue by introducing latent classes to represent different types of drivers. Driving simulator based experiments are used to analyze the behaviors and the effects of information provision.

■ SA23

Hilton- Union Sq 3

Less-than-Truckload Optimization Problems

Sponsor: TSL/Freight Transportation & Logistics

Sponsored Session

Chair: Ming Ni, University at Buffalo (SUNY), Buffalo, NY, United States of America, mingni@buffalo.edu

1 - Solving the Integrated Shipment Routing Problem of a Less-than-truckload Carrier

Okan Orsan Ozener, Özyegin University, Istanbul, Turkey orsan.ozener@ozyegin.edu.tr

We study a less-than-truckload (LTL) transportation network and investigate the potential benefits of implementing an integrated solution approach for shipment routing throughout this network. In LTL transportation, shipments are first delivered to local hubs to be consolidated, then transferred to another hub, and finally sent to their destinations. This routing planning process involves three routing decisions: (i) from origins to hubs, (ii) between hubs, and (iii) from hubs to destinations. These decisions are usually handled in a sequential manner due to the complexity of these individual problems, which may result in suboptimal solutions. In this study, we develop an integrated framework for solving all of these decision problems simultaneously. We propose an optimization-driven approach that can efficiently handle large instances with thousands of loads and provides solutions with significant cost savings over the sequential approach.

2 - Freight Put Option-Based Collaboration for Less-than-Truckload Carrier Logistics

Choungryeol Lee, lee1210@purdue.edu, Srinivas Peeta

We propose an option-based paradigm for carrier-to-carrier collaboration to manage the uncertainty in operational demand and supply. This leads to a mutually beneficial situation for collaborative LTL freight carriers. Numerical experiments illustrate that carrier-to-carrier collaboration with freight put options has the potential to improve the profitability, thereby enhancing the reliability and resilience of the LTL freight system.

3 - Operational Optimization at Con-way Freight

Olga Raskina, Con-way Freight, 2211 Old Earhart Rd, Ann Arbor, United States of America, Raskina.Olga@con-way.com

Con-way Freight is a premium LTL carrier operating the largest LTL network in North America. We manage an extensive network comprised of hundreds of service centers, thousands of tractors, trailers, and drivers, and hundreds of thousands of distinct origin-to-destination combinations. Every day as we pick up customers freight we need to decide the most cost-efficient way to move it while maintaining high customer service standards. In this talk we discuss the challenges of the decision support process and implementation lessons learned.

4 - Order Fulfillment from Collaborative Local Stores

Ming Ni, University at Buffalo (SUNY), Buffalo, NY, United States of America, mingni@buffalo.edu, Ruixia (Sandy) Shi, Qing He, Jun Ru

Instead of building new expensive distribution center, utilizing the brick and mortar stores to fulfill online order is good fulfillment option. We introduce algorithm and mechanism that combine the new inventory policy within store warehouse and collaboration between stores to achieve affordable and effective delivery.

■ SA24

Hilton- Union Sq 4

Advances in Traffic Flow Theory

Sponsor: TSL/Intelligent Transportation Systems (ITS)

Sponsored Session

Chair: Jorge Laval, Associate professor, Georgia Institute of Technology, 790 Atlantic Dr. NW., Atlanta, GA, 30332, United States of America, jlaval3@ce.gatech.edu

1 - Stochastic Approximations for the Macroscopic Fundamental Diagram on Inhomogeneous Corridors

Jorge Laval, associate professor, Georgia Institute of Technology, 790 Atlantic Dr. NW., Atlanta, GA, 30332, United States of America, jlaval3@ce.gatech.edu

This paper proposes analytical estimates of the Macroscopic Fundamental Diagram using probabilistic methods to tackle networks with different block length and signal timing. It is found that the distribution of the MFD depends mainly on two dimensionless parameters, the average block size and the average red to green ratio.

2 - Probabilistic Model for Estimating Vehicle Trajectories using Sparse Mobile Sensor Data

Peng Hao, haop@cert.ucr.edu, Kanok Boriboons, Guoyuan Wu

A stochastic model is proposed to estimate the second-by-second trajectories using sparse mobile sensor data that is under low penetration rate and low sampling frequency. We investigate all possible driving mode sequences between data points. The likelihood of each scenario are quantified with mode-specific priori distributions. Detailed trajectories are reconstructed based on the optimal driving mode sequences. They are expected to improve the accuracy of mobility and emission evaluation.

3 - Real-Time Traffic State Estimation using a Second-order Lagrangian Model and Online Filtering Method

Zhouyang Zhou, evergreen8710@gmail.com, Kerem Demirtas, Pitu Mirchandani

Traditional approaches for the real-time traffic state estimation use Eulerian measurements. Recently, as the Lagrangian measurements become available, researchers in this area began to look at Lagrangian estimators but limited by first-order Lagrangian traffic flow models. In this study we first propose a new second-order Lagrangian traffic flow model, and then integrate it into the filtering framework for real-time traffic state estimation. Experimental analysis results show the effectiveness of the second-order Lagrangian traffic flow model and the new estimator.

■ SA26

Hilton- Union Sq 6

Location Analysis

Sponsor: Location Analysis

Sponsored Session

Chair: Zvi Drezner, California State University, 800 N. State College, Fullerton, CA, 92834, United States of America, zdrezner@fullerton.edu

1 - A Case Study on the Location of Logistics Parks

Joy Bhadury, Professor, Univ of North Carolina at Greensboro, Dept of ISSCM, Bryan School, P.O. Box 26170, Greensboro, NC, 27402-6170, United States of America, j_bhadur@uncg.edu, Samuel Troy

This talk will focus on the results of a statewide project in North Carolina, USA. The objective was to locate high-capacity logistics parks in the southeastern region of the state. Project details including situational analysis, methodology and recommendations will be presented.

2 - An Efficient Approach for Solving Uncapacitated Facility Location Models with Concave Operating Cost

Robert Aboolian, Cal State San Marcos, 333 S. Twin Oaks Valley Road, San Marcos, United States of America, raboolia@csusm.edu, Emilio Carrizosa, Vanesa Guerrero

We consider the Uncapacitated Facility Location Problem with Concave Operating Cost (UFLPCOC), which is a nonlinear version of the UFLP. The total cost to be minimized is the sum of linear transportation costs and operating costs, which are non-decreasing concave functions of the demand at the facilities. An exact solution approach is presented. This approach is based on successive lower and upper bound improvements for UFLPCOC until convergence is obtained. Computational results are presented.

3 - A Location-Allocation Problem with Concentric Circles
Jack Brimberg, Royal Military College of Canada,
Kingston, Ontario, Canada, Jack.Brimberg@rmc.ca, Zvi Drezner

We consider the problem of locating p circles to serve a set of demand points. Each
demand point is serviced by the closest circle. The objective is to minimize the sum
of weighted distances between demand points and their closest circle. A rigorous
algorithm solved the largest tested problem with 1000 demand points in about 3.5
hours. The faster heuristic version solved it in about two minutes getting the same
solutions.

**4 - The Multidimensional Component Commonality Problem:
Re-visiting Facility Location Problems.**
Mozart Menezes, Associate Professor, University of Calgary, 2500
University Dr. NW, Calgary, AB, T2N1N4, Canada,
mozart.menezes@utoronto.ca, Diego Ruiz-Hernandez,
Renato Guimaraes

We investigate the component commonality problem. Different variations of a
particular part may allow it to be used in different SKUs. The more SKUs a part can
be used, the more unnecessary cost the part carries to each particular SKU. A SKU-
specific part can be made to reduce the part cost to a minimum but increases
complexity and fixed cost for certification. We model this problem as a facility
location problem and take advantage of well-known approaches for solving real
size problems.

■ SA27

Hilton- Union Sq 7

Railway Application Section Student Paper Award

Sponsor: Railway Applications
Sponsored Session

Chair: April Kuo, Manager Operations Research, BNSF,
2400 Western Center BLVD, Fort Worth, TX, 76034,
United States of America, April.Kuo@BNSF.com

1 - Double Ended Crew Modeling
April Kuo, Manager Operations Research, BNSF, 2400 Western
Center Blvd, Fort Worth, TX, 76034, United States of America,
April.Kuo@BNSF.com

A typical railroad hump yard contains multiple layers of complex operations.This
talk presents a time-expanded multi-layer network flow model to describe the
connection between different layers of yard operations. A mixed integer
programming is developed to schedule the humping and pullback engine activities
by jointly considering tightly interconnected components.

■ SA28

Hilton- Union Sq 8

Data Mining in Aviation

Sponsor: Aviation Applications
Sponsored Session

Chair: Yi Liu, University of California, Berkeley, 107 McLaughlin
Hall, Berkeley, CA, 94720, United States of America,
liuyi.feier@gmail.com

**1 - Categorization and Visualization of Safety Reporting Data using
Topic Models and Tableau**
Anil Yelundur, Technical Staff Member, MITRE Corporation, 7515
Colshire Drive, McLean, VA, 22102, United States of America,
ayelundur@mitre.org, Danijela Nardelli, Michelle Harper

Text-based safety reporting data are often inconsistently categorized due to
variations in the manual application of taxonomies. For automated categorization
of such data; the team developed a multi-algorithm modeling process including
NLP processing customized to aviation terminology, Principal Component Analysis
and Latent Dirichlet Allocation using stochastic variational Bayes optimization.
Tableau was used to visualize the topics and document categorizations.

2 - Predicting the Initiation of a Ground Delay Program
Yi Liu, University of California, Berkeley, 107 McLaughlin Hall,
Berkeley, CA, 94720, United States of America,
liuyi.feier@gmail.com, Michael Seelhorst, Mogeng Ying,
Alexey Pozdnukhov, Mark Hansen

In this work, we apply and compare three statistical techniques for predicting GDP
initiation. Two types of data are used: current conditions and forecasts of future
conditions. The methods are illustrated with a case study at EWR airport. Results
from this research reveal the importance of each variable (such as actual weather
variables) on GDP initiation and provide a means for flight operators to predict
GDP initiation.

**3 - Supporting Airline Revenue Management Decisions with
Data-Driven Market Analysis**
Catherine Cleophas, RWTH Aachen University, Kackertstr. 7, Raum
240, Aachen, 52072, Germany, catherine.cleophas@rwth-
aachen.de, Claus Gwiggner

Airline revenue management uses demand forecasts to optimize offers.
Performance measurement is difficult: Existing methods suffer from over-
determination and rely on unrealistic system assumptions. We propose an
approach comparing markets based on process data. It combines principal
component analysis and clustering techniques to map the heterogeneity of
markets. We validate our approach in simulation experiments and demonstrate its
applicability on a large empirical data set.

**4 - Ground Delay Program Analytics with Behavioral Cloning and
Inverse Reinforcement Learning**
Michael Bloem, Research Aerospace Engineer, NASA Ames
Research Center, P.O. Box 1, Mail Stop 210-15, Moffett Field, CA,
94035-0001, United States of America, michael.bloem@nasa.gov,
Nicholas Bambos

We used historical data to build behavioral cloning and inverse reinforcement
learning models that predict hourly implementation of Ground Delay Programs
(GDPs), a type of strategic air traffic management control. We will review the
quality of the predictions and discuss insights the models provide into how and
why GDPs are implemented. For example, the models suggest that GDP
implementation decisions are primarily based on conditions now or conditions
anticipated in the next couple of hours.

■ SA29

Hilton- Union Sq 9

JFIG Paper Competition I

Sponsor: Junior Faculty Interest Group
Sponsored Session

Chair: J. Cole Smith, Professor, University of Florida,
303 Weil Hall, Gainesville, FL, 32611, United States of America,
jcsmith@clemson.edu

Co-Chair: Shengfan Zhang, Assistant professor, University of
Arkansas, United States of America, shengfan@uark.edu

1 - Competition Introduction
J. Cole Smith, Professor, University of Florida,
303 Weil Hall, Gainesville, FL, 32611, United States of America,
jcsmith@clemson.edu

The 2014 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 - A Large-scale Multi-server Fork-Join Network with Non-
exchangeable Synchronization**
Guodong Pang, Penn State University, College of Engineering,
University Park PA, United States of America, gup3@engr.psu.edu,
Hongyuan Lu

We study a large-scale fork-join network of stations with multiple servers where
tasks are only synchronized when all the tasks associated with the same job are
completed, i.e., non-exchangeable synchronization. The main mathematical
challenge is the resequencing of arrival orders after service completion at each
service station. We present a new framework to analyze the queueing and
synchronization processes when all service stations are operating in the many-
server asymptotic regimes.

3 - Two-term Disjunctions on the Second-order Cone
Fatma Kilinc-Karzan, Assistant Professor, Carnegie Mellon
University, 5000 Forbes Ave, Pittsburgh PA 15213,
United States of America, fkilinc@andrew.cmu.edu, Sercan Yildiz

We study the convex hull of a two-term disjunction applied to second-order cone
(SOC). By identifying the structure of tight minimal valid linear inequalities for the
disjunction, and using conic duality, we introduce a technique on deriving closed-
form expressions for convex inequalities describing the convex hull. Our study
highlights that there are various cases when a single convex inequality is sufficient,
when this inequality can be expressed in conic form, and as well as much more
complicated cases where multiple convex inequalities are needed.

4 - Multistage Adaptive Robust Optimization for Electric Power Systems Operation
Andy Sun, Assistant Professor, Georgia Institute of Technology, 765 Ferst Drive NW, Atlanta, GA 30332, United States of America, andy.sun@isye.gatech.edu, Alvaro Lorca

The growing uncertainty associated with the increasing penetration of wind and solar power has presented new challenges to the operation of electric power systems. Motivated by this, we present a multistage adaptive robust optimization formulation for the critical daily operation of power systems under uncertain electricity load and renewable generation. We discuss the concept of simplified affine policy and develop an efficient solution method. Promising computational results will be shown.

■ SA30

Hilton- Union Sq 10

Project Scheduling: Stochastic And Game Theoretic Aspects

Cluster: Scheduling and Project Management
Invited Session

Chair: Erik Demeulemeester, Professor, KU Leuven, FEB, KBI, Naamsestraat 69, Leuven, Belgium, Erik.Demeulemeester@kuleuven.be

1 - A Public-private Partnership Pipeline: The Government's Way to Go for Proper Incentive Creation?
Dennis De Clerck, KU Leuven, FEB/KBI, Naamsestraat 69, Leuven, 3000, Belgium, Dennis.DeClerck@kuleuven.be, Erik Demeulemeester

The risky features of public-private partnerships and the high bidding costs inhibit contractors from entering the tender. Governments favor mechanisms that might increase the competition. This paper investigates whether a project pipeline positively affects the contractors' bidding behavior. The output of the Nash equilibrium approximation algorithms supports that an increase in the number of projects lowers the required mark-up percentages but the effect on investment incentives is limited.

2 - An Oracle-based B&B Algorithm for Chance-constrained Programming with Applications to the RCPSP
Patricio Lamas, KU Leuven, Research Centre for Operations Managemen, Leuven, Belgium, Patricio.LamasVilches@kuleuven.be, Erik Demeulemeester

The chance-constrained resource-constrained project scheduling problem (C-C RCPSP) is a generalization of the traditional deterministic RCPSP, where the activity durations are random variables with known probability and the schedule is feasible with a given probability. We present a b&b algorithm for solving this complex problem, which is based on an optimization oracle for the deterministic RCPSP. Our algorithm can be applied in any chance-constrained problem with random right hand side.

3 - A New Set of Valid Inequalities for Chance Constraint Programs: An Application to Proactive RCPSP
Morteza Davari, KU Leuven, Research Centre for Operations Managemen, Leuven, Belgium, Morteza.Davari@kuleuven.be, Erik Demeulemeester, Patricio Lamas

Chance constraint programming has become an attractive topic in the field of stochastic optimization. In this paper, we propose a new set of valid inequalities for chance constraint programs. We formulate the proactive RCPSP as a chance constraint program. A branch and cut algorithm exists in the literature to solve this problem. Initial results show that the proposed set of inequalities improves the speed of this algorithm.

■ SA31

Hilton- Union Sq 11

Modeling Co-creative Systems

Sponsor: Service Science
Sponsored Session

Chair: Ralph Badinelli, Professor, Virginia Tech, Dept. of Business Information Technology, Virginia Tech 0235, Blacksburg, VA, 24061, United States of America, ralphb@vt.edu

1 - Modeling Smart Service Systems with Analytics and Cognition
Haluk Demirkan, Associate Professor of Service Innovation & Business Analytics, Unviersity of Washington, 1900 Commerce Street, Box 358420, Tacoma, Wa, 98402-3100, United States of America, haluk@uw.edu, Jim Spohrer

Smart service systems can be characterized by the types of offerings to their consumers, the types of roles, and the types of returns they offer stakeholders, through improved use of technology, talent, or organizational and governance forms, which create (dis)incentives that (re)shape behaviors. This research presents Abstract Entity Interaction Outcome Universals (AEIOU) framework for innovation of smart service systems that enable value co-creation with analytics and cognitive systems.

2 - Integration Service Quality Gap in Service Network Systems
Stephen Kwan, Professor, San Jose State University, One Washington Square, San Jose, CA, 95192, United States of America, stephen.kwan@sjsu.edu, Peter Hottum

Service providers often have to construct networks of partners to fulfill service obligations to customers. We introduce an integration service quality gap that represents the difference between customer service quality expectation and perceived service quality in his service journey in a service system network. The integration service quality gap is incorporated with traditional service quality gaps to form a more complete treatment of service quality metrics in such an environment.

3 - Multi-agent Control in Service Systems
Ralph Badinelli, Professor, Virginia Tech, Dept. of Business Information Technology, Virginia Tech 0235, Blacksburg, VA, 24061, United States of America, ralphb@vt.edu

This paper builds on previous research on the trajectories of service recipients through service system hypernetworks. These trajectories are guided by the client's decisions in evaluating and accepting or rejecting service propositions. We extend this research by considering similar decisions by the agents of resource integrators and service providers. The viability of service systems is examined as an outcome of how these multi-agent decisions influence the trajectory of the service.

■ SA32

Hilton- Union Sq 12

Stochastic Models in Service Science

Sponsor: Service Science
Sponsored Session

Chair: Yan Xia, University at Buffalo, 342 Bell Hall, Buffalo, NY, 14260-2050, United States of America, yanxia@buffalo.edu

1 - Ambulance Dispatching, Redeployment and Reallocating
Seyed Amir Ali Nasrollah Zadeh, Clemson University, 206 Campus Drive, Apt. A, Central, SC, 29630, United States of America, snasrol@g.clemson.edu, Amin Khademi, Maria Mayorga

Larger cities, expensive medical cares and heavy traffics have led to an increasing number of medical emergency calls and associated costs. In this work we develop an optimization model to find near-optimal solutions to ambulance dispatching, redeployment and reallocation problem to minimize the total expected waiting time of patients. We calibrate our model using real data and compare our policies with current ones via a simulation model.

2 - Optimization of Imperfectly Timed Maintenance Actions
Kai He, Ph.d Student, University of Pittsburgh, 1048 Benedum Hall, 3700 O'Hara Street, Pittsburgh, PA, 15261, United States of America, kah167@pitt.edu, Lisa M. Maillart, Oleg Prokopyev

We consider a class of maintenance optimization problems in which preventive maintenance (PM)actions may not be performed "on time." We assume that the time when PM is performed follows some known distribution about the prescribed time and formulate cost rate-minimizing models that anticipate this "noncompliant" behavior. We establish analytical relationships between the resulting policies and policies with perfect compliance for both age replacement and block replacement with minimal repair.

3 - Pricing Option-based Restoration for Stochastically Degrading Systems
Yan Xia, University at Buffalo, 342 Bell Hall, Buffalo, NY, 14260-2050, United States of America, yanxia@buffalo.edu, Murat Kurt, Osman Ozaltin

This talk addresses the problem to optimize the wholesale price of a restoration service for stochastically degrading systems. We model the system operator's maintenance problem as a Markov decision process, based on which we derive models that determine the operator's purchase decisions. The service provider's pricing problem is then modeled as a bi-level optimization problem, for which we provide an exact algorithm. We illustrate the efficiency of the algorithm through numerical study.

4 - Stocking and Pricing Policies of the Newsvendor Problem under Mean-Variance Considerations

Javier Rubio-Herrero, Rutgers University, 100 Rockafeller Rd, Piscataway, NJ, 08854, United States of America, javier.rubioherrero@rutgers.edu, Melike Baykal-Gursoy

We consider the classical newsvendor problem under a mean-variance criterion with two decision variables, namely price and stock quantity. The demand is assumed to be additive with respect to the price. We present conditions under which the objective function is concave and has a unique optimal solution. Furthermore, we provide numerical examples that aim to endorse the theoretical results herein explained and compare our results to others previously published.

■ SA33

Hilton- Union Sq 13

Microfoundations of Innovation in Supplier Driven and Crowd Driven Contexts

Cluster: New Product Development

Invited Session

Chair: Anant Mishra, George Mason University, 5034 Dequincey Drive, Fairfax, Vi, 22032, United States of America, amishra6@gmu.edu

1 - Initiating and Sustaining Supplier Involvement in Development Projects: Behavioral Aspects

David Wuttke, EBS University, Konrad-Adenauer-Ring 15, EBS University, ISCM, Wiesbaden, De, 65187, Germany, david.wuttke@ebs.edu, Enno Siemsen, Karen Donohue

Using a combination of analytic 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.

2 - Do Incentives Help or Hurt Competition in Innovation Contests?

Anant Mishra, George Mason University, 5034 Dequincey Drive, Fairfax, Vi, 22032, United States of America, amishra6@gmu.edu, Cheryl Druehl, Jesse Bockstedt

Innovation contests allow firms to harness specialized skills and services from participants with diverse economic and cultural backgrounds to solve challenging business problems. In this study, we use data from a popular online logo-design contest setting and country-level archival data to examine the implications of incentives on the competitive environment in innovation contests.

3 - Staffing Decisions and Performance an Analysis of the Functional and Customer Domains of Experience

Juan Pablo Madiedo Montanez, IE Business School, Calle Maria de Molina, 12, 5∫, Madrid, Spain, jpmadiedo.phd2014@Student.ie.edu, Aravind Chandrasekaran, Fabrizio Salvador

This study examines the importance of accumulated levels of experience working on a specific functional domain and with a particular customer in a knowledge intensive work environment. We analyze the interplay among workers, managers and customers as sources of experience and its effect on task staffing decisions and performance. We use a dataset with information on over 4500 software maintenance tasks collected from a global IT and consulting corporation for testing our model.

■ SA34

Hilton- Union Sq 14

Homeland Security Applications I

Sponsor: Public Programs, Service and Needs

Sponsored Session

Chair: Paul Kantor, Professor, Rutgers/CCICADA, 4 Huntington St, New Brunswick, NJ, 08901, United States of America, paul.kantor@rutgers.edu

1 - Optimal Selection of Configurations to Test Radiation Detectors

Paul Kantor, Professor, Rutgers/CCICADA, 4 Huntington St, New Brunswick, NJ, 08901, United States of America, paul.kantor@rutgers.edu, Christie Nelson, Fred Roberts, Ashish Jain, Siddartha Dalal

The performance of radiation detectors (Portal and RIID) depends on scores of variables, and can be measured according to several criteria. This research presents an extension of Combinatorial Experimental Design (CED) to the efficient design of experiments. CED works well when outcomes are binary (PASS|FAIL) and inputs take only a few discrete values. This new approach combines CED with

expert elicitation to maximize the aggregate benefit of a design, while controlling the cost of experiments

2 - Optimal Boat Allocations with Sharing

Brian Nakamura, CCICADA/DIMACS, Rutgers University, 96 Frelinghuysen Road., 4th Floor, CoRE Bldg., Piscataway, NJ, 08854, United States of America, bnaka@dimacs.rutgers.edu, Jacob Baron, Endre Boros, Chad Conrad, Robert DeMarco, Kevin Hanson, Paul Kantor, Curtis McGinity, Christie Nelson, Matthew Oster, Brian Ricks, Fred Roberts, James Wojtowicz, Wang Yao, Patrick Ball, Thomas Rader

The US Coast Guard (USCG) allocates boats to stations annually. We present a model that allows boat allocations where stations share boats. A key innovation is to characterize the problem in terms of "sharing paths." The model uses Mixed Integer Programming to capture a subtle set of constraints and finds a boat sharing plan that minimizes either number of boats or total cost. The underlying problem is NP-complete, but current USCG operations permit adequate solution on a large laptop.

3 - ACCAM: Simulating Stochastic Effects of Maintenance and Missions on Aircraft Availability for USCG

Curtis McGinity, Rutgers University, 100 Rockafeller Road, Piscataway, NJ, 08854, United States of America, curtis.mcginity@gmail.com, Endre Boros, Paul Kantor, Fred Roberts, Christie Nelson, Brian Ricks, Kevin Hanson, Patrick Ball, Chad Conrad, Thomas Rader, Brian Nakamura

We present a model and discrete event simulation of USCG Air Stations, accounting for the mission demands and maintenance procedures of USCG aircraft. The simulation provides aircraft availability distributions and mission performance metrics for varying Air Station scenarios. The model is novel in its renewal-based treatment of maintenance procedures, mitigating the need for modeling of subprocesses. Simulations are consistent with historical data and offer insights into hypothetical scenarios.

4 - Relevance Feedback: A Better Boolean Approach

Justin Del Vecchio, Research Scientist, CUBRC, 4455 Genesee St., Buffalo, NY, 14225, United States of America, delvecchio@cubrc.org, Paul Kantor, Endre Boros

Experiments use the PLAD learning system to infer Boolean queries from judged items, and we estimate the statistical significance of the patterns.

■ SA35

Hilton- Union Sq 15

Challenges of Post-Disaster Humanitarian Logistics

Sponsor: Public Programs, Service and Needs

Sponsored Session

Chair: Felipe Aros-Vera, Rensselaer Polytechnic Institute, 110 8th st, Troy, NY, 12180, United States of America, arosvm@rpi.edu

1 - A New Method to Evaluate the Damage Degree and Forecast the Demand of the Disaster Areas

Buhao Li, Huazhong University of Science and Technology, 1037 Luoyu Road, Wuhan, China, lbh123@hust.edu.cn, Haijun Wang

Emergency logistics nowadays attracts great attention, but there are rarely papers concerning about the forecast of the disaster areas.We conduct a new method that clusters multiple sources of data about disaster areas,to evaluate damage of degree in disaster areas. Taking the degree of different disaster areas and the amount of total relief materials into consideration, we estimate the demand of the disaster areas.

2 - Real-time Optimization in Casualty Transportation Post-disaster

Armin Lüer-Villagra, PhD Candidate, Pontificia Universidad Catolica de Chile, Department of Electrical Engineering, Av. Vicuña Mackenna 4860, Santiago, 7820436, Chile, arminluer@gmail.com, Pamela P. Alvarez, Andres Bronfman

A problem in a post-disaster situation is health care in field and the movement of victims to medical facilities. This issue contains the complexities of disaster logistics. Based on real-time optimization models, this study applies a methodology to solve the problem of minimizing the response time and number of deaths from lack of medical care. The methodology considers prioritization of the affected people by the urgency in to be attended and different transport modes and medical centers.

3 - The Role of Access Restoration on Humanitarian Logistics
Felipe Aros-Vera, Rensselaer Polytechnic Institute, 110 8th St, Troy, NY, 12180, United States of America, arosvm@rpi.edu, Jose Holguin-Veras

This paper describes the problem of access restoration (AR) after disasters, develops a mathematical formulation capable of incorporating its main characteristics, and describes the role of AR in Humanitarian Logistics. The mathematical model uses deprivation cost functions to account for the impact on people by the decisions made in the process of AR. Numerical examples include a case study in Manhattan, NY.

■ SA36

Hilton- Union Sq 16

Panel Discussion: Teach Sports Analytics

Sponsor: SpORts
Sponsored Session

Chair: Edward Kaplan, Yale School of Management, New Haven, CT, United States of America, edward.kaplan@yale.edu

1 - Teaching Sports Analytics
Moderator:Edward Kaplan, Yale School of Management, New Haven, CT, United States of America, edward.kaplan@yale.edu, Panelists: Michael Magazine, James Cochran, Nils Rudi, Jeffrey W. Ohlmann

This session brings together five professors who teach sports analytics to different audiences at different levels of technical sophistication to accomplish different learning objectives. Each speaker will discuss his material, and show how a specific sports topic is covered in class. A lively discussion with audience participation will follow.

■ SA37

Hilton- Union Sq 17

Analyzing Social Networks and Social Media I

Sponsor: Artificial Intelligence
Sponsored Session

Chair: Kang Zhao, Assistant Professor, University of Iowa, S224 PBB, Iowa City, IA, 52242, United States of America, kang-zhao@uiowa.edu

1 - Predicting User Engagement in Online Health Communities Based on Social Support Activities
Xi Wang, The University of Iowa, United States of America, xi-wang-1@uiowa.edu, Kang Zhao, Nick Street

Online health communities (OHCs) have become a major source of social support for people with health problems. This research tries to build a predictive model of members' engagement in OHCs. We are especially interested in whether different types of social support (e.g., informational support, emotional support and companionship) activities a user was involved in can contribute to such prediction. The outcome of study will have implications for the management and design of an OHC.

2 - User Analysis and Recommendation in Online Health Communities
Mi Zhang, Drexel University, 3141 Chestnut Street, Philadelphia, PA, 19104, United States of America, mz349@drexel.edu, Christopher Yang

Many online communities are developed to support communication between health consumers. We focus on QuitStop, a smoking-cessation forum, to investigate how users interact with each other, and recommend discussion topics for them. First, we analyze user interaction patterns and behaviors with qualitative analysis and social network analysis. Second, we use classification and recommendation techniques to detect user interests and discussion topics in the community, and recommend threads to users.

3 - Sociotechnical Behavior Mining: Challenges, Opportunities, and Beyond
Nitin Agarwal, Professor, University of Arkansas at Little Rock, 2801 S University Ave., EIT 553, Little Rock, AR, 72204, United States of America, nxagarwal@ualr.edu

Social media platforms have profoundly impacted the behavior and the lifestyle of humans revealing novel sociotechnical behaviors, e.g. "hacktivism", crowdsourcing, flash mobs, citizen journalism, "tweetcasting" etc. Although these behaviors have been widely observed, they haven't been scientifically explained. We examine these behaviors afforded by the social cyber systems, leveraging a truly interdisciplinary research with deep roots in social science theories and computational underpinnings.

■ SA38

Hilton- Union Sq 18

Capacity Management in Operating Rooms and Clinics

Cluster: Healthcare Systems and Medical Informatics
Invited Session

Chair: Vikram Tiwari, Assistant Professor of Anesthesiology, Vanderbilt University, 1211 21st Ave. S, MAB 403G, Nashville, TN, 37212, United States of America, vikram.tiwari@vanderbilt.edu

Co-Chair: Linda LaGanga, Director of Quality Systems & Operational Excellence, Mental Health Center of Denver, 4141 East Dickenson Place, Denver, CO, 80222, United States of America, linda.laganga@mhcd.org

1 - Patients Inpatient Preoperatively Account for Most Total Cancelled Operating Room Time
Franklin Dexter, The University of Iowa, 200 Hawkins Drive, Iowa City, IA, 52242, United States of America, franklin-dexter@uiowa.edu, Johannes Ledolter, Richard Epstein

At 21 US private hospitals, patients inpatient preoperatively represented 16.2% ± 0.5% of total operating room (OR) minutes but 49% ± 2% of total cancelled minutes. Results were insensitive to % of outpatients [preoperatively] making physical visit to preoperative clinic vs. only preoperative phone call (P = 0.58). At academic hospitals, patients inpatient preoperatively accounted for 22.3% ± 0.4% of scheduled minutes but most (P < 0.0001) total cancelled minutes (70% ± 2%).

2 - Predicting Daily Surgical Service Volume using Provider-Away Information
Vikram Tiwari, Assistant Professor of Anesthesiology, Vanderbilt University, 1211 21st Ave. S, MAB 403G, Nashville, TN, 37212, United States of America, vikram.tiwari@vanderbilt.edu, Warren Sandberg

Identifying available block time in advance is the first step in dynamically reallocating it to services that can rearrange their schedules to use it. Using a simulation methodology, we predict 6 weeks in advance, daily case volume for each surgeon, and the entire service, using historical data of case volume distributions, probability of surgeons' OR days, and information about surgeon availability. Results from model's selective implementation highlight the challenges and next steps.

3 - Multi-objective Operating Room Scheduling
Srimathy Mohan, Associate Professor, Arizona State University, Tempe, United States of America, Srimathy@asu.edu, Qing Li, Mohan Gopalakrishnan, John Fowler

This research models the operating room (OR) planning and scheduling problem as a mixed integer program with multiple objectives. A multi-objective simulation-optimization approach is developed for the problem to address uncertainties in surgery and recovery durations and patient no-shows. This approach guides the search of "Pareto optimal" solutions.

4 - Practical Application of a Scheduling and Overbooking Model in a Clinical Setting
Linda LaGanga, Director of Quality Systems & Operational Excellence, Mental Health Center of Denver, 4141 East Dickenson Place, Denver, CO, 80222, United States of America, linda.laganga@mhcd.org, Steve Lawrence, Ken Bellian, Don Penning

Patient no-shows continue to trouble outpatient and hospital service delivery. We build on our earlier research by applying our overbooking scheduling model in a hospital's scheduling practice to test the model's performance in improving productivity and reducing costs. We incorporate medical practice experience to develop realistic estimates of costs and their effect on the selection of high-performing scheduling alternatives.

■ SA39

Hilton- Union Sq 19

Patient Monitoring at Hospital and at Home

Sponsor: Health Applications
Sponsored Session

Chair: Benjavan Upatising, PhD, Research Scientist, Regenstrief Center for Healthcare Engineering, Purdue University, 203 S. Martin Jischke Drive, West Lafayette, IN, 47906, United States of America, benjavan@purdue.edu

1 - Practical Considerations in Black-box Models for Patient Monitoring

Bruce W. Morlan, MS Statistician, Health Care and Policy Research, Mayo Clinic, 200 First Street SW, Rochester, MN, 55905, United States of America, brucewmorlan@gmail.com, Matthew Johnson, Joel Hickman, James Naessens, Jeanne Huddleston, Santiago Romero Brufau

Gradient Boosted Models have proven useful to create complex models. We use GBM to create a black box algorithm for use in an automated alerting system. The model is to be used to increase monitoring on patients predicted to have the highest absolute risk. We explored the variables using univariate models, then Poisson models are used to create the final GBM ensemble model. This model is then reduced by a series of simplifications, and we tracked concordance to demonstrate the loss in fidelity.

2 - Diurnal Cycle and Insulin Dosing in the Intensive Care Unit

Ying Zhang, Massachusetts Institute of Technology, 32 Vassar Street, Room 32-257, Cambridge, MA, 02139, United States of America, yingz@mit.edu

Critically-ill patients normally experience stress-induced hyperglycemia, which could be controlled by IV insulin; however, blood glucose concentration has to be closely monitored and insulin dosage promptly adjusted to prevent acute hypoglycemia. Data from the ICUs at a tertiary teaching hospital suggest diurnal cycles in patient response to IV insulin. This study develops tools to extract patterns in these cycles and to assist clinicians in timely dosing adjustment during night shifts.

3 - Cost Comparison between Home Telemonitoring and Usual Care of Older Adults

Benjavan Upatising, PhD, Research Scientist, Regenstrief Center for Healthcare Engineering, Purdue University, 203 S. Martin Jischke Drive, West Lafayette, IN, 47906, United States of America, benjavan@purdue.edu, Walter K. Kremers, PhD, Paul Y. Takahashi, MD, MPH, Sharon L. Christ, PhD, Douglas L. Wood, MD, Yuehwern Yih, PhD, Gregory J. Hanson, MD

Older adults incur more healthcare expenses than any other age group, could home telemonitoring be a potential solution to reduce these costs? The analysis of direct medical cost was conducted based a 12 months randomized clinical trial. We compared the total cost as well as the inpatient, outpatient and ED costs between the telemonitored group and the group that received usual care.

4 - A General Framework to Automatically Extract Medical Knowledge

Yuan Luo, yuanluo@mit.edu, Peter Szolovits, Yu Xin, Ephraim Hochberg, Rohit Joshi

We propose subgraph augmented non-negative tensor factorization (SANTF) to automatically extract knowledge from EMRs. SANTF composes a tensor using patients, higher-order features (e.g., relationships among the medical concepts) and atomic features (e.g., words in the clinical narrative text). SANTF identifies the groups for patients and different feature types and simultaneously models group interactions. SANTF demonstrates improved clustering performance and better interpretable models.

■ SA40

Hilton- Union Sq 20

Medical Decision Making and Public Policy

Sponsor: Health Applications
Sponsored Session

Chair: Mariel Lavieri, Assistant Professor, University of Michigan, 1205 Beal Avenue, 2783 IOE, Ann Arbor, MI, 48105, United States of America, lavieri@umich.edu

Co-Chair: Greggory Schell, University of Michigan, 1205 Beal Ave, Ann Arbor, MI, 48109, United States of America, schellg@umich.edu

1 - Preference-Sensitive Risk Cutoff Values for Prenatal Integrated Screening Test for Down Syndrome

Jia Yan, Student, Georgia Institute of Technology, 755 Ferst Drive, Atlanta, GA, 30332, United States of America, jyan40@gatech.edu, Pinar Keskinocak, Turgay Ayer, Aaron Caughey

Down syndrome (DS) is the most common chromosomal abnormality. Currently a risk of 1/270 is commonly used in DS screening to identify high-risk women and recommend an invasive confirmatory test, such as amniocentesis. However, evidence suggests that this one-size-fit-all cutoff value does not reflect different preferences among pregnant women with respect to pregnancy outcomes. In this study, we assess the impact of women's preferences on optimal DS risk-cutoff-values of integrated screening.

2 - Optimal Copayment Restructuring for Hypertension Pharmacotherapy

Greggory Schell, University of Michigan, 1205 Beal Ave, Ann Arbor, MI, 48109, United States of America, schellg@umich.edu, Mariel Lavieri, Jeremy Sussman, Rodney Hayward

With increasing healthcare expenditures in the United States, employers, government agencies and insurers are looking for new cost containment methods, such as copayment restructuring. Using the principles of value-based insurance design, we develop an optimization model for determining the ideal hypertension medication copayment levels for a heterogeneous patient population serviced by an insurance provider.

3 - An Outbreak Prediction Model to Inform Intervention Policy

Lauren Gardner, University of New South Wales, UNSW, Sydney, 2052, Australia, l.gardner@unsw.edu.au, David Rey

We seek to identify the most likely infection patterns in a contact network when only a subset of the infection case reports are available. The problem is represented using a maximum likelihood model and formulated as an integer program. The objective of the model is to identify a set of most likely directed trees that spans to the set of known infected nodes, which may or may not include additional nodes. Simulated contagion episodes are used to evaluate the performance of the solutions.

4 - Optimal Treatment Policies for Pelvic Organ Prolapse in Women

Yueran Zhuo, Ph.D. Candidate, University of Massachusetts Amherst, 121 Presidents Drive, 226, Amherst, MA, 01003, United States of America, yzhuo@som.umass.edu, Senay Solak, Oz Harmanli

Pelvic organ prolapse (POP) is a prevalent disease impairing women's health and quality of life. We develop a quantitative approach for long term POP treatment planning to maximize the patient's expected quality of life. A Markov Decision Process framework is adopted to capture the chronic features of POP development. Both numerical and analytical analyses have been performed to derive general guidelines and assess their effectiveness for the treatment of POP.

■ SA41

Hilton- Union Sq 21

Transplantation and Organ Allocation

Sponsor: Health Applications
Sponsored Session

Chair: Sommer Gentry, Associate Professor, United States Naval Academy, 572-C Holloway Road, Mailstop 9E, Annapolis, MD, 21402, United States of America, gentry@usna.edu

1 - Optimal Screening Strategies of Patients on the Kidney Transplant Waiting List

Alireza Sabouri, University of British Columbia, Vancouver, BC, V6T 1Z2, Canada, alireza.sabouri@sauder.ubc.ca, Tim Huh, Steven Shechter

The health condition of patients on the kidney transplant waiting list deteriorates while they are waiting for an organ arrival and hence they may no longer be suitable for transplant. Therefore, transplant centers screen waiting patients at various intervals to identify ineligible patients. We propose a model for finding screening strategies that minimizes the expected screening cost and the expected penalty cost associated with transplanting an organ to an ineligible patient.

2 - Exploring the Structure of the Kidney Paired Donation Pool

Wenhao Liu, PhD Candidate, Stanford University, 475 Via Ortega, Stanford, Ca, 94305, United States of America, owenliu@stanford.edu, Marc Melcher

We target to identify the truly hard-to-match pairs in a kidney paired donation pool. By applying a simple variation of PageRank algorithm, we manage to define a new measure of Paired Match Power that takes into considerations the global structure of the matching pool.

3 - Mitigating Information Asymmetry in the Liver Allocation System
Sepehr Nemati, Ivey School of Business, University of Western
Ontario, 1225 Western Rd., London, ON, Canada,
sproon@ivey.uwo.ca, Zeynep Icten, Lisa M. Maillart,
Andrew Schaefer

We address the information asymmetry in the liver allocation system in the U.S.
due to patients' gaming ability who may exploit the flexibility in the current health
reporting requirements. We propose a model to simultaneously minimize measures
of societal welfare associated with the information asymmetry, and data-processing
burdens. We determine the exact frontier of Pareto-optimal updating requirements
using clinical data.

4 - Redistricting to Reduce Geographic Disparity in Liver Allocation
Sommer Gentry, Associate Professor, United States Naval Academy,
572-C Holloway Road, Mailstop 9E, Annapolis, MD, 21402, United
States of America, gentry@usna.edu, Dorry Segev

Studies have documented persistent geographic disparity in the allocation of livers
by disease severity (MELD score). We partition the U.S. into optimal compact
districts with the explicit goal of reducing disparity in MELD at transplantation,
guided by years of interaction with the United Network for Organ Sharing. Our
approach eliminates repeated cycles of suggesting and testing new policies by
finding the policy most suited to the transplant community's values, determined a
priori.

■ SA42

Hilton- Union Sq 22

Dynamic Scheduling

Sponsor: Health Applications

Sponsored Session

Chair: Bjorn Berg, George Mason University, Fairfax, VA, United
States of America, bberg2@gmu.edu

Co-Chair: Van-Anh Truong, Assistant Professor, Columbia University,
500 West 120th St, New York, NY, 10027, United States of America,
vt2196@columbia.edu

**1 - A Simulation Based Approximate Dynamic Programming Approach
to Multi-class, Multi-resource Surgical**
Jonathan Patrick, Associate Professor, University of Ottawa,
55 Laurier Avenue, Ottawa, ON, K2G 3A6, Canada,
patrick@telfer.uottawa.ca, Davood Astaraky

We present a model for scheduling in a multi-class, multi-resource surgical system.
Given a master block schedule, we provide a surgical scheduling policy that seeks
to minimize a combination of the lead time between patient request and surgery
date, overtime in the operating room and congestion in the wards. We formulate it
as a MDP model and develop a version of the Least Squares Approximate Policy
Iteration algorithm and test our model on data from a local hospital.

**2 - The Impact of Hourly Discharge Rates and Prioritization on Timely
Access to Inpatient Beds**
Hari Balasubramanian, University of Massachusetts Amherst,
160 Governors Drive Amherst MA 01003, Amherst, MA, 01002,
United States of America, hbalasub@admin.umass.edu, Asli Ozen

We develop an empirically calibrated hospital-wide simulation model to represent
a time-varying, multi-server queuing network. We use this model to demonstrate
the impact on admission queues of (a) hourly discharge capacities, and (b) a
dynamic, threshold-based prioritization rule.

**3 - Fast Approximations for Online Scheduling of Outpatient
Procedure Centers**
Bjorn Berg, George Mason University, Fairfax, VA,
United States of America, bberg2@gmu.edu, Brian Denton

We present a new model for online decision making for problems motivated by
outpatient procedure centers. The dynamic extensible bin packing problem is
formulated as a multi-stage stochastic integer program. We present insights into
the optimal solutions as well as provide bounds for the problem. Results, including
the evaluation of approximation methods, are presented as part of a case study
based on a real outpatient procedure center.

■ SA43

Hilton- Union Sq 23

Joint Session ICS/OPT: Global Optimization and
Mixed-Integer Nonlinear Programming

Sponsor: Computing Society & Optimization

Sponsored Session

Chair: John Chinneck, Professor, Carleton University, Systems and
Computer Engineering, 1125 Colonel By Drive, Ottawa, On, K1S
5B6, Canada, chinneck@sce.carleton.ca

**1 - Extending the Scope of Algebraic MINLP Solvers to Black- and
Grey-box Optimization**
Nick Sahinidis, John E. Swearingen Professor, Carnegie Mellon
University, Department of Chemical Engineering, 5000 Forbes
Avenue, Pittsburgh, PA, 15213, United States of America,
sahinidis@cmu.edu, David Miller, Alison Cozad

We propose a methodology to optimize in the absence of algebraic models. The
methodology relies on the automatic learning of algebraic NLP and MINLP models
from data. We rely on linear and nonlinear integer programming techniques for
simultaneous determination of the parameters and structure of the unknown
models. We also develop techniques that account for partial theoretical
understanding of the system under study in an otherwise data-driven optimization
approach.

2 - Parallelizing the Master Problem in Benders Decomposition
Alexandra M. Newman, Colorado School of Mines,
1500 Illinois St., Golden, CO, 80401, United States of America,
anewman@mines.edu, Antony Tarvin, Wood Kevin

When (generalized) Benders decomposition (BD) is applied to solve a stochastic
program (SP) or a min-max model, each with binary first-stage variables, explicit
enumeration may solve the BD master problem. We parallelize that enumeration
and demonstrate order-of-magnitude computational speedups on a two-stage SP
and a (non-convex) network-interdiction problem; both single-cut and multi-cut
master problems are accommodated. For certain problem types, we have broken
the long pole in the BD tent.

3 - Tightening Concise Linear Reformulations of 0-1 Cubic Programs
Richard Forrester, Associate Professor of Mathematics,
Dickinson College, 5 North Orange Street, Carlisle, PA, 17013,
United States of America, forrestr@dickinson.edu

One of the most compact linear representations of 0-1 cubic programs is based on a
repeated application of the linearization method for quadratic programs introduced
by Glover. We develop a pre-processing step that strengthens the LP bound
provided by this model. The proposed scheme involves using optimal dual
multipliers of a partial level-2 RLT formulation to rewrite the objective function of
the cubic program before applying the linearization. Extensive computational
experience is provided.

4 - A Fast Heuristic for Global Optimization and MINLP
John Chinneck, Professor, Carleton University, Systems and
Computer Engineering, 1125 Colonel By Drive, Ottawa, On, K1S
5B6, Canada, chinneck@sce.carleton.ca, Mubashsharul Shafique

Steps in our heuristic: random initial points, rapid movement towards feasibility,
clustering to identify disjoint feasible regions, simple search to improve cluster
points, and local optimization. It is well-suited to large nonconvex models, and
runs quickly due to parallelism and very few local solver launches. The algorithm is
extended to MINLP by adding spatial and integer branching to return a solution
using very few local optimizer launches. Promising empirical results are given.

■ SA44

Hilton- Union Sq 24

Digital Channels and User Behavior

Sponsor: Information Systems

Sponsored Session

Chair: Beibei Li, Assistant Professor, Carnegie Mellon University,
5000 Forbes Ave, HbH 3026, Pittsburgh, PA, 15213, United States of
America, beibeili@andrew.cmu.edu

**1 - Network-biased Technical Change: Evidence from the Adoption of
Social Media in a Consulting Organization**
Lynn Wu, The Wharton School, 3730 Walnut St, JMHH 561,
Philadelphia, PA, 19104, United States of America,
wulynn@wharton.upenn.edu

Similar to skill-biased technical change (SBTC) in which information technology
complements skilled and educated workers, network-biased technical change
complements social capital. With the rapid adoption of enterprise social media
tools, individuals with high network diversity can have greater return for using
social media. At the same time, senior employees are worse off as social media

replace their deep organizational knowledge and eliminate their opportunity to arbitrage information.

2 - Zoom in iOS Clones: Examining the Antecedents and Consequences of Mobile App Copycats
Beibei Li, Assistant Professor, Carnegie Mellon University, 5000 Forbes Ave, HbH 3026, Pittsburgh, PA, 15213, United States of America, beibeili@andrew.cmu.edu, quan wang

We examine the drivers and impacts of mobile app copycats based on 10,100 action game apps from iOS app store over 5 years. We find significant heterogeneity in the interactions between copycats and original apps. Non-deceptive copycats are reluctant to enter the market when the original app is popular and free. High quality copycats have a negative effect on original app downloads. Interestingly, low quality deceptive copycats have a positive effect, suggesting a positive spillover effect.

3 - Hiring Biases in Online Labor Markets: The Case of Gender Stereotyping
Jason Chan, NYU Stern School of Business, New York, NY, United States of Americajcc534@stern.nyu.edu, Jing Wang

The exponential growth of online labor markets holds important social and economic implications, as the hiring decisions made on these online platforms implicate the incomes of millions of workers worldwide. Using a novel proprietary dataset from a leading online labor platform, we investigate the impact of gender-based stereotypes on hiring outcomes using a matched sample approach and quasi-experimental technique. Interestingly, we find a robust hiring bias working in favor of female workers.

■ SA45

Hilton- Union Sq 25

Remembrances of Susan Hong Xu

Cluster: Special Sessions

Invited Session

Chair: Yalcin Akcay, Assoc. Professor, Koc University, Sariyer, Rumelifeneri Yolu Sariyer, Istanbul, 34450, Turkey, yakcay@ku.edu.tr

1 - Dynamic Assignment of Flexible Service Resources
Anant Balakrishnan, McCombs School of Business, University of Texas at Austin, 2110 Speedway, Austin, TX, 78712, United States of America, anantb@utexas.edu, Yalcin Akcay, Susan Xu

In service contexts that require dynamically deciding whether to accept incoming jobs and what resource to assign to each accepted job, harnessing the benefits of resource flexibility requires using effective methods for making these operational decisions. In this paper, we address the dynamic job acceptance and resource assignment problem for systems with general resource flexibility structure, and propose three optimization-based approximate policies.

2 - Managing an Available-to-Promise Assembly System with Dynamic Short-Term Pseudo Order Forecast
Long Gao, University of California, School of Business Administration, Riverside, United States of America, long.gao@ucr.edu, Susan Xu, Michael Ball

We study an order promising problem in a multi-class ATP system with pseudo orders, whose properties change dynamically over time. We show that the optimal order acceptance policy is characterized by class prioritization, resource imbalance-based rationing and capacity-inventory-demand matching. The value of the short-term forecast is high when resource is moderate and customer heterogeneity is high.

3 - Accelerating Phase I Clinical Trial through Efficient Patient Recruitment Process and Trial Design
Hui Zhao, Penn State University, Smeal College of Business, University Park, United States of America, huz10@psu.edu, Leon Xu, Susan Xu

80% of clinical trials run overtime, causing drug companies millions of dollars daily in delay to market. In this paper, we look at mitigating clinical trial inefficiency in Phase I trial. We formulate it as a Markov Decision Process and propose different strategies to conduct the trials in order to reduce Phase I time.

■ SA46

Hilton- Lombard

Remembrances of Manfred Wilhelm Padberg

Cluster: Remembrances of Manfred Wilhelm Padberg

Invited Session

Chair: Karla Hoffman, khoffman@gmu.edu

1 - Remembrances of Manfred Wilhelm Padberg
Karla Hoffman,George Mason University, Fairfax VA, United States of America, khoffman@gmu.edu–
Remembrances of Manfred Wilhelm Padberg

This session will consist of many of Manfred Padberg's closest researchers and friends providing remembrances of him. This will be a celebration of his life. All are welcome to attend, provide stories, anecdotes and thoughts about how they interacted with Manfred.

■ SA47

Hilton- Mason A

Topics in Stochastic Optimization

Sponsor: Optimization/Optimization Under Uncertainty

Sponsored Session

Chair: Angelo Mancini, PhD Candidate, University of Chicago Booth School of Business, 5807 S. Woodlawn Avenue, Chicago, IL, 60637, United States of America, amancini@chicagobooth.edu

1 - Optimality of Quasi-Open-Loop Policies for Discounted Semi-Markov Decision Processes
Angelo Mancini, PhD Candidate, University of Chicago Booth School of Business, 5807 S. Woodlawn Avenue, Chicago, IL, 60637, United States of America, amancini@chicagobooth.edu, Dan Adelman

Quasi-open-loop (QOL) policies consist of Markovian decision rules that are insensitive to one component of the state space. We consider a semi-Markov decision process in which one state component is an exogenous multiplicative compound Poisson process, and provide an almost-everywhere condition on the reward function sufficient for the optimality of a QOL policy. In some cases, we can replace the almost-everywhere condition with a weaker one that holds only in expectation.

2 - Budget Allocation Strategies to Minimize Expected Operational Risk Losses in Financial Institutions
Yuqian Xu, NYU Stern School of Business, New York, United States of America, yxu@stern.nyu.edu, Jiawei Zhang, Michael Pinedo

This paper analyzes budget allocation strategies to minimize OpRisk losses in banks under deterministic and stochastic settings. We provide an alternative formulation of OpRisk that incorporates major investment variables. We show how decision scenarios influence the dominant power of investment parameters and provide some guidelines for banking regulation.

3 - Optimal A-B Testing
Nikhil Bhat, Columbia University, nbhat15@gsb.columbia.edu, Vivek Farias, Ciamac Moallemi

We consider the problem of A-B testing when the impact of the treatment is marred by a large number of covariates. Randomization can be highly inefficient in such settings, and thus we consider the problem of optimally allocating test subjects to either treatment with a view to maximizing the efficiency of our estimate of the treatment effect. Our main contribution is a tractable algorithm for this problem in the online setting.

4 - Exponential Approximations in Network Revenue Management
Christiane Barz, UCLA Anderson School of Management, 110 Westwood Plaza, None, Los Angeles, CA, 90095, United States of America, christiane.barz@anderson.ucla.edu, Dan Adelman, Canan Uckun

Although it is well-known that the value function in network revenue management is not linear, most of the literature on approximate dynamic programming is based on an affine approximation. We extend his work by allowing for exponential basis functions. In contrast to other work in approximate dynamic programming, we do not predetermine the basis functions but generate them dynamically for a given problem instance. Computational results show that our approach improves the bound significantly.

■ SA48

Hilton- Mason B

Applications of Distance Geometry: Nanostructures, Astrometry, and Big Data

Sponsor: Optimization/Global Optimization & MINLP

Sponsored Session

Chair: Carlile Lavor, Associate Professor, University of Campinas, IMECC - UNICAMP, Campinas, Brazil, clavor@ime.unicamp.br

1 - Practical Algorithms for Graph Embedding from Unassigned Distance Lists

Phil Duxbury, Chairperson and Professor, Physics and Ast. Dept., Michigan State Univ., East Lansing, MI, 48824, United States of America, Duxbury@pa.msu.edu, Saurabh Gujarathi

The matrix completion problem is NP-hard for imprecise assigned distance geometry problems, and the unassigned variant of this problem adds an additional layer of combinatorial complexity. A recent publication by our group describes practical algorithms for constructing graph embeddings in the plane, using only unassigned distance lists. In this paper we extend these algorithms, and bounds on their performance, to graph embedding in three dimensions.

2 - The Small-Field Astrometric Point-Pattern Matching Problem

Claudio Santiago, Postdoctoral Researcher, Lawrence Livermore National Laboratory, 7000 East Ave, Livermore, CA, 94551, United States of America, pratas@gmail.com, Alberto Krone-Martins, Carlile Lavor

The small-field astrometric point-pattern matching problem is a fundamental problem in astrometry that can be described as finding the common stars in two given lists arising from different observations performed at different times. We devised an algorithm based on the normalization of distance matrices that can be used to identify stars that are common to both lists. Our approach consists of finding a suitable normalization factor that allows us to identify pairs of stars with equal distances.

■ SA49

Hilton- Powell A

Network Optimization and Applications

Sponsor: Optimization/Network Optimization

Sponsored Session

Chair: Neng Fan, University of Arizona, Systems and Industrial Engineering, Tucson, AZ, United States of America, nfan@email.arizona.edu

1 - Assessing Complex Network Vulnerability under Cascading Failures

Yilin Shen, benoit.shen@gmail.com, My Thai

The assessment of network vulnerability is of great importance in the presence of unexpected disruptive events or adversarial attacks. We provide an in-depth probabilistic analysis for assessing the network vulnerability on the two well-known complex networks and show that, under random failures, power-law networks are no longer robust while small-world networks are more robust due to their homogeneous degree sequences. We also devise an effective approach to identify the most vulnerable nodes.

2 - Survivable Network Design with Vertex and Edge Connectivity Constraints

Elham Sadeghi, Graduate Research Assistant, University of Arizona, Systems and Industrial Engineering, Tucson, AZ, United States of America, sadeghi@email.arizona.edu, Neng Fan

In this talk, we present and prove several equivalent theorems to ensure a minimum-cost graph to be (k,l)-connected. A graph is (k,l)-connected if removal of certain numbers (related to k,l) of vertices and edges will not disconnect the graph. Based on these theorems, we present integer programming formulations and cutting plane algorithm to solve the minimum-cost network design problem.

3 - Analysis of Budget for Interdiction on Multicommodity Network Flows

Pengfei Zhang, Graduate Student, University of Arizona, Systems and Industrial Engineering, Tucson, AZ, 85721, United States of America, pfzhang@email.arizona.edu, Neng Fan

In this talk, we concentrate on computing several critical budgets for interdiction on the multicommodity network flows in the case of worst-case arc failures, and studying the interdiction effects of the changes of budget. Numerical experiments are performed to verify our conclusions.

4 - Simulating the Dynamics of Networks via Optimization

Tiago Schieber, University of Florida - Center for Applied Optimization, University of Florida, Gainesville, FL, 32611, United States of America, tischieber@gmail.com, Martìn Ravetti

The analysis of topological evolution of complex networks plays a crucial role in predicting their future. While an impressive amount of work has been done on the issue, very little attention has been so far devoted to the investigation of how information theory quantifiers can be applied to characterize networks evolution. With the objective of dynamically capture the topological changes of a network's evolution, we will present the Copycat model.

■ SA50

Hilton- Powell B

Optimization in Graphs and Digraphs

Sponsor: Optimization/Network Optimization

Sponsored Session

Chair: Baski Balasundaram, Associate Professor, Oklahoma State University, 322 Engineering North, Stillwater, OK, 74078, United States of America, baski@okstate.edu

1 - The Minimum Spanning k-core Problem with Bounded CVaR under Probabilistic Edge Failures

Juan Ma, Ph.D. Student, Oklahoma State University, 322 Engineering North, Stillwater, OK, 74078, United States of America, juan.ma@okstate.edu, Baski Balasundaram, Vladimir Boginski, Foad Mahdavi Pajouh

Given a non-negative integer k, a graph of minimum degree at least k is called a k-core. The concept of k-cores can be used to design resilient networks that preserve low diameter and high vertex-connectivity upon random graph component failures. This talk focuses on the minimum spanning k-core problem under probabilistic edge failures using the risk measure conditional-value-at-risk. Polyhedral reformulations and algorithms to solve the problem will be discussed.

2 - Network-Based Models for Optimization in Reliability

Kelly Sullivan, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, United States of America, ksulliv@uark.edu

Reliability of a system can be increased by adding redundant components. We seek to maximize the reliability of such systems subject to restrictions on the number and types of redundant components that can be installed. Representing the system as a binary decision diagram (a type of network) yields an exact mixed integer linear program for a general form of this problem. Computational results demonstrate that this approach is effective for structured (e.g., series-parallel) systems.

3 - Solving the Maximum Weighted Multiple Clique Problem: A Branch-Price-and-Cut Approach

Seyed Javad Sajjadi, University of South Florida, 4202 E Fowler Ave, Tampa, FL, 33620, United States of America, ssajjadi@mail.usf.edu, Bo Zeng, Xiaoning Qian

Deriving a collection of cliques with the maximum total weight in a general network where both nodes and arcs are weighted is considered and applied for biomarker identification in bioinformatics. An algorithm integrating column generation, branch-and-bound and cutting plane methods is developed for efficient computing. We also present numerical results on random and real-world networks.

4 - Maximum Degree-based Gamma-quasi-Clique Problem

Grigory Pastukhov, University of Florida, 303 Weil Hall, Gainesville, United States of America, gpastukhov@ufl.edu, Alexander Veremyev, Oleg Prokopyev, Vladimir Boginski

We consider the problem of finding the maximum-cardinality degree-based quasi-clique in a graph. A degree-based gamma-quasi-clique is a subgraph where the degree of each vertex is at least gamma times the highest possible degree. We prove the NP-completeness of the considered problem and propose an IP formulation and exact algorithms for solving this problem. Extensive computational experiments demonstrate that the proposed approaches perform very well on both random and real-world networks.

■ SA51

Hilton- Sutter A

Large-Scale Nonlinear Optimization Algorithms

Sponsor: Optimization/Nonlinear Optimization

Sponsored Session

Chair: Frank E. Curtis, Lehigh University, 200 W Packer Ave, Bethlehem, PA, 18015, United States of America, frank.e.curtis@gmail.com

1 - Orthant Based Method for L1 Regularized Optimization

Nitish Shirish Keskar, Northwestern University, 2145 Sheridan Road, Room C210, Evanston, IL, 60208, United States of America, nitishkeskar2012@u.northwestern.edu, Andreas Waechter, jJorge Nocedal, Figen Oztoprak

The problem of minimizing a composite function consisting of a smooth loss and a non-smooth penalty has been studied extensively in the last few years. In this talk, we propose a new Orthant-based method for solving the L1 regularized problem. The algorithm proposed consists of a new active-set identification strategy which has a predictive-corrective loop allowing for rapid changes while maintaining descent properties. Comparisons and numerical results on standard test cases are presented.

2 - New Inexact Versions of the ADMM

Wang Yao, Student, MSIS and RUTCOR, Rutgers University, 100 Rockafeller Rd, Piscataway, NJ, 08854, United States of America, yaowang74@gmail.com, Jonathan Eckstein

We present three new, more practically verifiable approximate versions of alternating direction method of multipliers (ADMM). One version is based on Douglas-Rachford operator splitting and an existing inexact version of the proximal point algorithm, and requires one of the ADMM's two minimization steps to be exact. The other two versions are based on a Lagrangian splitting analysis and use absolute summable and relative error criteria, respectively. We also present numerical experiments.

3 - A Primal-Dual Active-Set Framework for Large-Scale Convex Quadratic Optimization

Zheng Han, Lehigh University, 200 West Packer Avenue, Bethlehem, PA, 18015, United States of America, zhh210@lehigh.edu, Frank E. Curtis

We present a primal-dual active-set framework for large-scale convex quadratic optimization. The framework is flexible in that it allows multiple simultaneous changes in the active-set estimate during each iteration. By employing iterative methods and allowing inexactness to each reduced subproblem solve, our method is promising for large-scale optimization. Theoretical results for an important problem class and numerical results on a variety of problems illustrate the framework's efficacy.

4 - Handling Negative Curvature in Spectral Gradient Methods for Unconstrained Optimization

Wei Guo, Ph.D. Candidate, ISE department, Lehigh University, 200 West Packer Avenue, Bethlehem, PA, 18015, United States of America, weg411@lehigh.edu, Frank E. Curtis

A gradient-descent method is proposed for unconstrained nonlinear optimization. Emphasis is placed on techniques used to compute appropriate step sizes when negative curvature is present. The method extends the well-known "two-point step size" method of Barzilai and Borwein and some of its variants. Global convergence is guaranteed under mild assumptions. Numerical results are presented to illustrate the benefits of the method in the presence of negative curvature.

■ SA52

Hilton- Sutter B

Applications of Conic Optimization

Sponsor: Optimization/ Linear and Conic Optimization

Sponsored Session

Chair: Henry Wolkowicz, Professor, University of Waterloo, University of Waterloo, Waterloo, ON, N2L 3G1, Canada, hwolkowicz@uwaterloo.ca

1 - Geodesic Distance Maximization via Convex Optimization

De Meng, University of Washington, Electrical Engineering, Seattle, WA, United States of America, demeng@u.washington.edu, Maryam Fazel, Pablo Parrilo, Stephen Boyd

Given a graph with fixed edge weights, finding the shortest path, also known as the geodesic, between two nodes is a well-studied network flow problem. We introduce the Geodesic Distance Maximization Problem (GDMP), i.e., the problem of finding the edge weights that maximize the length of the geodesic, subject to

convex constraints on the weights. We show that GDMP is a convex optimization problem for a wide class of flow costs and develop an ADMM for its solution.

2 - Robust Convex Relaxation for the Sparse Planted Clique Problem

Brendan Ames, Assistant Professor, University of Alabama, Department of Mathematics, Tuscaloosa, AL, 35487, United States of America, bpames@ua.edu

The planted clique problem seeks to distinguish between graphs containing a single large clique and random graphs. We present a convex relaxation for the planted clique problem under additive and deletive noise. Our relaxation, which can be thought of as nuclear norm regularized linear programming, can detect planted cliques with sizes matching the current state of the art. Moreover, when the noise is sparse, we show that we can detect significantly smaller planted cliques.

3 - Quadratic Programming and Semidefinite Programming Bounds for Vertex Separators

Henry Wolkowicz, Professor, University of Waterloo, University of Waterloo, Waterloo, ON, N2L 3G1, Canada, hwolkowicz@uwaterloo.ca, Ting Kei Pong, Hao Sun, Ningchuan Wang

We consider the problem of partitioning the nodes of a graph into k sets of given sizes in order to minimize the cut obtained by removing the k-th set. This problem is closely related to the graph partitioning problem. In this talk, we look at lower and upper bounds obtained from two convex relaxation techniques: the quadratic programming bounds based on recent successful bounds for the quadratic assignment problems, and semidefinite programming bounds obtained via lifting.

■ SA53

Hilton- Taylor A

Optimal Control in Finance

Cluster: Optimization in Finance

Invited Session

Chair: Naveed Chehrazi, Assistant Professor, McCombs School of Business, 2110 Speedway Stop B6500, Austin, TX, 78705, United States of America, naveed.chehrazi@mccombs.utexas.edu

1 - Optimal Control of Multi-agent Consumption Patterns using Approximate Dynamic Programming

Greg Kaplan, Assistant Professor, Princeton University, Fisher Hall, Princeton, NJ, 08544, United States of America, gkaplan@princeton.edu, Jesus Fernandez-Villaverd, Erick Chen, Warren Powell, Daniel Jiang

We formulate and solve the multi-agent consumption problem using the modeling and algorithmic framework of approximate dynamic programming. The model captures accumulated assets, the state of the economy, wages, and current employment, along with the distribution of assets across the population. We use approximate dynamic programming to produce high quality policies without sacrificing the accuracy of the transition function.

2 - The Valuation of Storage

Long Zhao, McCombs School of Business, Austin TX 78705, United States of America, Long.Zhao@phd.mccombs.utexas.edu

We use moving boundary method to give the numerical optimal strategy of storage with transaction costs.

3 - Dynamic Credit-Collection Optimization

Naveed Chehrazi, Assistant Professor, McCombs School of Business, 2110 Speedway Stop B6500, Austin, TX, 78705, United States of America, naveed.chehrazi@mccombs.utexas.edu, Thomas Weber, Peter Glynn

We develop a dynamic model of consumer repayment behavior on delinquent credit-card loans using a marked point process. The intensity of this point process can be controlled by a sequence of impulses. A semi-analytic solution of the HJB equation is obtained.

■ SA54

Hilton- Taylor B

Quantitative Methods in Finance

Sponsor: Financial Services Section

Sponsored Session

Chair: Nan Chen, The Chinese University of Hong Kong, 609 William Mong Engineering Building, Hong Kong, Hong Kong - PRC, wyu@se.cuhk.edu.hk

1 - Fire Sale in Financial Networks
Haoshu Tian, Princeton University, PACM Fine Hall, Princeton, NJ, 08544, United States of America, htian@princeton.edu, Weinan E

Defaulting can be transmitted through two channels: inter-bank liability contagion and fire sale. When banks rush to sell the same asset, they may fall into a Nash equilibrium in which they sell the asset at an artificially low price to compete for liquidity. In this paper, a model that incorporates these two channels is developed and analyzed theoretically. An algorithm for finding the state in which both the market and the inter-bank liability network are in equilibrium is proposed and tested.

2 - Optimal Portfolio Selection under Counterparty Risk
Agostino Capponi, Johns Hopkins University, 3400 North Charles Street, Baltimore, MD, 21218, United States of America, acappon1@jhu.edu

We develop a portfolio allocation framework to assess the impact of counterparty risk on optimal investment decisions. When purchasing CDS upfronts, the investor receives collateral from her protection seller and uses it to mitigate losses arising when the counterparty defaults. We find that the investor may not take any credit exposure and simply invests all his wealth in the money market account, depending on credit risk and contagion effects between reference entity and counterparty.

3 - The Ross Recovery Theorem and Quasi-Stationary Distribution
Yiwei Wang, The Chinese University of Hong Kong, William M. W. Mong Engineering, Shatin, N.T., Hong Kong - PRC, ywwang@se.cuhk.edu.hk, Nan Chen

We analyze the Ross recovery theorem in the presence of absorption state when all assets in the market devalue completely. We find an interesting relation between the recovery theorem and quasi-stationary distribution.

■ SA55

Hilton- Van Ness

Sigmoidal and Geometric Programming: From Aircraft Design, to Virus Propagation, to Political Elections

Sponsor: Optimization/Global Optimization & MINLP

Sponsored Session

Chair: Amir Ali Ahmadi, Princeton University, 329 Sherrerd Hall, Dept. of Operations Research&Fin. Eng., Princeton, NJ, 08540, United States of America, a_a_a@princeton.edu

1 - Geometric Programming for Aircraft Configuration Design
Warren Hoburg, Assistant Professor, MIT Dept. of Aeronautics and Astronautics, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, whoburg@mit.edu

Modern aircraft represent some of the most complex, performance-driven engineering systems ever conceived and built. Surprisingly, many fundamental relationships and constraints on aircraft performance can be encoded via the feasible set of a geometric program. This observation gives us a reliable and efficient way to solve conceptual design problems, and may provide decision-makers with better understanding of tradeoffs, design spaces, and performance sensitivities.

2 - Optimal Resource Allocation for Network Protection against Spreading Processes
Victor Preciado, Assistant Professor, University of Pennsylvania, 3330 Walnut Street, Levine Hall 360, Philadelphia, PA, 19103, United States of America, preciado@seas.upenn.edu, Michael Zargham, Chinwendu Enyioha, Ali Jadbabaie, George Pappas

We study the problem of containing spreading processes in arbitrary directed networks by distributing protection resources throughout the nodes of the network. We consider two types of protection resources: (i) Preventive resources, and (ii) corrective resources. We study the problem of finding the cost-optimal distribution of resources throughout the nodes of the network. We show that the optimal resource allocation problems can be solved in polynomial time using Geometric Programming (GP).

3 - Maximizing a Sum of Sigmoids
Madeleine Udell, PhD Candidate, Stanford University, 350 Serra Mall, Stanford, CA, 94305, United States of America, udell@stanford.edu, Stephen Boyd

The problem of maximizing a sum of sigmoids over a convex constraint set arises in many application areas. We propose an approximation algorithm (using a branch and bound method) to find a globally optimal approximate solution to the problem. To illustrate the power of this approach, we compute the optimal positions which might have allowed the candidates in the 2008 United States presidential election to maximize their vote shares.

■ SA56

Hilton - Green Room

Software Demonstrations

Cluster: Software Demonstrations

Invited Session

1 - ProbabilityManagement.org - The SIPmath-Modeler Tools
Sam L. Savage, Executive Director, ProbabilityManagement.org, 3507 Ross Road, Palo Alto, CA, United States of America, sam@probabilitymanagement.org

The Open SIPmath Standard from non-profit ProbabilityManagement.org allows uncertainties to be communicated as big data for driving interactive simulation in native Excel and other environments without add-in software. We will demonstrate the SIPmath Modeler Tools, which facilitate the generation of such models in Excel, and also how to import and export results from @RISK, Crystal Ball, Risk Solver and MATLAB to leverage those packages. Visit the SIPmath page of SIPmath.org for videos and example files.

2 - IBM Decision Optimization - IBM Innovations that Simplify Application Development
John Chaves, IBM Decision Optimization Solutions Architect, IBM, 3031 N Rocky Point Drive West, Tampa, FL, 33607, United States of America, john.chaves@us.ibm.com

Web deployment of optimization applications requires integrating tasks such as data access and job control as well as optimization into an overall architecture. Learn how basic representational state transfer (ReST) APIs can be used to develop such an architecture.

■ SA64

Parc- Cyril Magnin I

Stationarity in Many-server Queues

Sponsor: Applied Probability Society

Sponsored Session

Chair: Itai Gurvich, Kellogg School of Management, Northwestern University, 2001 Sheridan Road, Evanston, IL, 60201, United States of America, i-gurvich@kellogg.northwestern.edu

1 - Heavy-traffic Limits for the Initial Content Process
Yunan Liu, NC State University, Raleigh, NC 27695, United States of America, A. Korhan Aras, Ward Whitt

In a queueing system with i.i.d having non-exponential service times, the state of the initial content can be described by specifying the elapsed service times of the remaining initial customers. We establish a heavy-traffic functional central limit theorem (FCLT) for the initial content process, assuming a FCLT for the initial age process, with the number of customers initially in service growing in the limit. For each time, including time 0, the conditional remaining service times, given the ages, are mutually independent but in general not identically distributed.

2 - Stochastic Comparison Approach to Multi-server Queues
David A. Goldberg, Assistant Professor, Georgia Institute of Technology, 765 Ferst Drive NW, Atlanta, GA, 30332, United States of America, dgoldberg9@isye.gatech.edu

We prove several results for multi-server queues using a stochastic comparison approach. First, we demonstrate that there are two limiting sub-regimes embedded within the Halfin-Whitt heavy-traffic regime. We describe a novel lower bound for the FCFS M/G/n queue, which we combine with other bounds to characterize the qualitative properties of these sub-regimes. We conclude by discussing several open questions, and (time permitting) recent progress on queues with heavy tails and abandonments.

3 - A Flexible-server System in the Halfin-Whitt Regime:
    Tightness of Stationary Distributions
        Alexander Stolyar, Bell Labs, Alcatel-Lucent, 600 Mountain Ave.,
        2C-322, Murray Hill, NJ, 07974, United States of America,
        Sasha.Stolyar@alcatel-lucent.com

We consider a so-called "N" flexible server system (as well as its generalization)
under a priority discipline, in the Halfin-Whitt asymptotic regime. Tightness of
diffusion-scaled stationary distributions is proved. The approach is based on
constructing a single common Lyapunov function and deriving bounds on its
derivatives.

4 - Diffusion Models and Steady-state Approximations for
    Exponentially Ergodic Markovian Queues
        Itai Gurvich, Kellogg School of Management, Northwestern
        University, 2001 Sheridan Road, Evanston, IL, 60201,
        United States of America, i-gurvich@kellogg.northwestern.edu

Motivated by queues with many-servers, we study Brownian steady-state
approximations for continuous time Markov chains (CTMCs). Our approximations
are based on diffusion models (rather than a diffusion limit). Within an asymptotic
framework, in which a scale parameter n is taken large, a uniform Lyapunov
condition is proved to guarantee that the gap between steady-state moments of the
diffusion and those of the properly centered and scaled CTMCs, shrinks at a rate of
the square root of n.

■ SA65

Parc- Cyril Magnin II
Control of Queues
Sponsor: Applied Probability Society
Sponsored Session

Chair: Hayriye Ayhan, Professor, Georgia Institute of Technology,
School of ISyE, Atlanta, GA, 30332, United States of America,
hayhan@isye.gatech.edu

1 - Dynamic Resource Management for Parallel Queues with Shared
    Pool of Flexible Servers
        Ravi Kumar, PhD Candidate, Cornell University, 292 Rhodes Hall,
        Cornell University, Ithaca, NY, 14853, United States of America,
        rk454@cornell.edu, Mark Lewis

We consider the problem of how servers can be dynamically allocated in a system
with parallel queues and multiple demand streams. The system incurs holding
costs, server usage cost and set-up cost for switching stations. A central controller
has access to a fixed number of flexible servers and needs to dynamically decide
how many servers to use and where to allocate their effort to minimize operating
costs. We characterize the optimal allocation policy and develop practical
heuristics.

2 - Combining Queueing and Scheduling Theories – A Flexible
    Server Study
        Douglas Down, McMaster University, Department of
        Computing and Software, Hamilton, Canada,
        downd@univmail.cis.mcmaster.ca, Daria Terekhov, Tony Tran,
        Christopher Beck

Using an example of a flexible server model (where service times are known upon
arrival), we discuss how one can use queueing-theoretic knowledge to help guide
online scheduling. The result is a hybrid scheduling model that demonstrates better
performance than standard online scheduling approaches. In addition to discussing
performance, we discuss stability properties of various scheduling approaches,
including our hybrid approach.

3 - Optimal Admission Control for Markovian Loss Systems of
    Two Stations
        Daniel Silva, Georgia Tech, 755 Ferst Dr, Atlanta, GA, United States
        of America, dfsi3@gatech.edu, Bo Zhang, Hayriye Ayhan

Consider a system of two Markovian queues in tandem with finite buffers. Losses
are incurred when a customer is rejected upon arrival to the first station or when
the second station is full upon service completion at the first station. We present
two special policies and give necessary conditions for these to be optimal. We also
provide some results on the structure of the optimal policy. Finally, we present
heuristic policies that yield near optimal cost performance.

4 - Processor Sharing in Non-Collaborative Queueing Networks
        Tugce Isik, Georgia Institute of Technology, 765 Ferst Drive NW,
        Atlanta, GA, 30332-0205, United States of America,
        tugceisik@gatech.edu, Sigrun Andradottir, Hayriye Ayhan

We study processor sharing (PS) in queueing networks where multiple servers
cannot work at the same station. For tandem lines with two stations, two servers,
and infinite buffers, we show that either a dedicated or a PS policy maximizes the
throughput, and the optimal PS policy can be achieved as a limit of round-robin
policies. For systems with general topology, we evaluate how the performance of
round-robin policies depends on the quantum of time spent at each station and the
buffer size.

■ SA66

Parc- Cyril Magnin III
Joint Session QSR/ENRE: Statistical Modeling and Analysis in Renewable Power Systems
Sponsor: Quality, Statistics and Reliability & Energy Natural
Resources and the Environment
Sponsored Session

Chair: Eunshin Byon, Assistant Professor, University of Michigan,
1205 Beal Ave., Ann Arbor, MI, 48109, United States of America,
ebyon@umich.edu

Co-Chair: Arash Pourhabib, Assistant Professor, Oklahoma State
University, 322 Engineering North, Stillwater, OK, 74078, United
States of America, arash.pourhabib@okstate.edu

1 - Wind Plant Design under Uncertainty
        Katherine Dykes, NREL, 15013 Denver W Pkwy, Golden, CO
        80401, United States of America, Katherine.Dykes@nrel.gov

Many sources of uncertainty affect wind plant performance and cost. This study
looks at bringing those uncertainties upfront into the plant development process at
the point of turbine selection and layout design. The result is the ability to optimize
the plant cost of energy not just by minimizing a deterministic cost but an expected
cost or even risk threshold. This work leverages new integrated wind plant
modeling capability to explore optimization of wind plant design under
uncertainty.

2 - A Bayesian Optimization Approach for Wind Farm Monitoring and
    Power Maximization
        Jinkyoo Park, Ph.D Student, Stanford University,
        473 Via Ortega, Stanford, CA, 94305, United States of America,
        jinkyoo.park@gmail.com, Kincho Law

The wakes formed by upstream wind turbines decrease the power outputs of
downstream wind turbines by reducing wind speed, which results in deterioration
of wind farm power. The total wind farm power can be improved by minimizing
wake interference by coordinated control actions of wind turbines. In this study,
we determine the optimal, coordinated yaw offset angles and induction factors for
wind turbines by applying Bayesian optimization (BO), a data-driven statistical
optimization algorithm.

3 - Data-driven Spatial-temporal Modeling of Local Wind Fields
        Arash Pourhabib, Assistant Professor, Oklahoma State University,
        322 Engineering North, Stillwater, OK, 74078, United States of
        America, arash.pourhabib@okstate.edu, Yu Ding, Jianhua Huang

Effective wind power system operation hinges on comprehending the near ground
behavior of wind in a wind farm and particularly the wind speed. We present a
data-driven spatial-temporal model for analyzing local wind fields. Our model,
which is an extension of the Vector Autoregression (VAR) by imposing structure to
the coefficient matrix, is constructed based on measurements coming from a large
number of turbines in a wind farm, as opposed to aggregating the data into a single
time-series.

4 - Spatial Modeling and Analysis for Wind Farms –
    Preliminary Investigation
        Eunshin Byon, Assistant Professor, University of Michigan, 1205
        Beal Ave., Ann Arbor, MI, 48109, United States of America,
        ebyon@umich.edu, Mingdi You, Giwhyun Lee, Judy Jin

This study focuses on developing analytical and statistical models for a wind farm
with multiple wind turbines. In a wind farm, turbines in downwind rows in large-
scale farms are impacted by wind speed deficit, thus capturing less energy (called
wake effects). We quantify such under-performance of wind turbines in a wind
farm.

■ SA67

Parc- Balboa

Nonlinear Dynamics and Chaos (Tutorials and Research)

Sponsor: Quality, Statistics and Reliability
Sponsored Session

Chair: Hui Yang, Assistant Professor, University of South Florida, 4202 East Fowler Avenue, ENB 118, Tampa, FL, 33620, United States of America, huiyang@usf.edu

1 - Nonlinear Dynamics and Chaos (Tutorials and Research)
Hui Yang, Assistant Professor, University of South Florida, 4202 East Fowler Avenue, ENB 118, Tampa, FL, 33620, United States of America, huiyang@usf.edu

This session will present the state-of-the-art methods and tools on Nonlinear Dynamics and Chaos, including both tutorials and research as follows: Part I – Nonlinear dynamical systems and chaos; Part II – Recurrence analysis of complex systems; Part III – Multiscale recurrence analysis; Part IV – Recurrence and complex networks;

2 - Recurrence Plot-based Control Chart for Nonlinear Profile Monitoring and Diagnosis
Cheng Zhou, PhD candidate, University of Science and Technology Beijing, 30 Xuyaun Road, Haidian District, Beijing, China, czhou88@gmail.com, Jianjun Shi, Kaibo Liu, Weidong Zhang

This paper proposes a novel nonlinear profile monitoring and fault diagnosis schemes by using the recurrence plot (RP) method. First, a multivariate CUSUM control chart is constructed to monitor the profile change based on RPs. Then, a simulation studies evaluate the performance of the control chart. Meanwhile, a process fault diagnosis scheme is proposed to localize the fault. A case study of progressive stamping processes is implemented to show the performance of the proposed schemes.

■ SA68

Parc- Davidson

Nanomanufacturing and Nanoinformatics

Sponsor: Quality, Statistics and Reliability
Sponsored Session

Chair: Qiang Huang, Associate Professor, University of Southern California, 3715 McClintock Avenue, Los Angeles, CA, 90089, United States of America, qiang.huang@usc.edu

1 - Interaction-based Modeling of Nanowire Growth Process Toward Improved Yield
Faranak Fathi, The University of Arizona, 3125 E Bellevue St, Unit 4, Tucson, AZ, 85716, United States of America, faranakfathi@gmail.com

In this research, we study a nanowire-interaction physical-statistical model that helps determine the minimum pitch (inter-wire distance) to ensure independent growth of nanowires and improve process yield and uniformity of nanowires.

2 - Process Design of Carbon Nanotube Synthesis Based on Fast Monte Carlo Simulation
Changqing Cheng, Texas A&M University, 3131 TAMU, College Station, TX, 77843, United States of America, ccheng@tamu.edu, Satish Bukkapatnam

Carbon nanotube (CNT) geometric features are determinant to its various properties, and process design and features control during the synthesis processes pose an immense challenge to improve the yield rate and quality for such nanostructures. We investigated process design for CNT synthesis based on fast Monte Carlo simulation to maximize the stiffness of CNTs.

3 - Analysis and Optimization of Edge Effects for Nanostructure Growth
Yanqing Duanmu, University of Southern California, 3715 McClintock Avenue, Los Angeles, 90089, United States of America, duanmu@usc.edu, Qiang Huang

In this talk we present a scheme to model the edge effect during nanostructure growth. The improved model captures well the nanowire length distribution across the substrate. Physical interpretation of skirt area effect is provided using the diffraction theory. With the established model, we provide a method to optimize the skirt area width to improve the structure uniformity.

■ SA69

Parc- Fillmore

Decision Analysis for Energy Systems

Sponsor: Energy Natural Resources and the Environment/ Sustainability and Environment
Sponsored Session

Chair: Todd Levin, Computational Engineer, Argonne National Laboratory, 9700 S. Cass Ave., Bldg. 221, Argonne, IL, United States of America, tlevin@anl.gov

1 - Optimal Hydroelectric Dispatching with Metaheuristic: A Genetic Algorithm and Ant Colony Comparison
Paulo Correia, Professor, University of Campinas, Energy Department, Fualculty of Mechanical Engineering, Campinas, SP, 13083-860, Brazil, pcorreia@fem.unicamp.br, Jessica Fernandes, Regiane Barros, Ieda Hidalgo

Usually, the units of a hydroelectric plants have the same design. However, circumstantial details, arising as them are manufactured and installed, result in actual different efficiency curves. Besides efficiency maximization, the dispatching could aim to minimize the units' start-up and shut-down. So the problem is formulated as a mixed integer non-linear multicriteria program. This paper discuss the results obtained with two approaches: genetic algorithm and ant colony.

2 - Optimization of Roof and Ground Greening Strategies to Mitigate the Urban Heat Island
Jean-Michel Guldmann, Professor Emeritus, The Ohio State University, 275 West Woodruff Avenue, COLUMBUS, OH, 43210, United States of America, guldmann.1@osu.edu, BumSeok Chun

The urban heat island (UHI), with temperatures in urban areas often much higher than in surrounding areas, induces heat stress, ozone formation, and increased power plant pollution and greenhouse gas emissions. A non-linear programming model, derived from a spatial statistical model estimated over a grid in downtown Columbus, Ohio, selects roof-top and ground areas for greening to maximize total temperature reduction in Columbus center, subject to a greening budget and other constraints.

3 - Risk-aware Load Shifting and Optimized Chiller Operation for Cooling Systems with Thermal Storage
Jeonghan Ko, Associate Professor, Ajou University, Korea and The University of Michigan-Ann Arbor, USA, Department of Industrial Engineering, Suwon-si, Gyeonggi-do, Korea, Republic of, jko@ajou.ac.kr, Yin Guo, Ehsan Nazarian, Kamlakar Rajurk

This research investigates the risk related to demand forecasting for production and inventory of chilled water in cooling systems. Thermal storage is used as chilled water inventory to reduce the peak loads of a cooling system, but increases the operation cost. We present new methods for robust demand prediction and optimal chilled water production and inventory. We also evaluate the trade-off between the peak demand reduction and operation cost increase.

4 - Utility-maximizing Financial Contracts for Distributed Rural Electrification
Todd Levin, Computational Engineer, Argonne National Laboratory, 9700 S. Cass Ave., Bldg. 221, Argonne, IL, United States of America, tlevin@anl.gov, Valerie Thomas

We develop a cost-benefit framework for extending rural electricity access. An economic model is developed to compare three financial mechanisms that make capital intensive electrification technologies more accessible in rural areas. These contracts are compared on their ability to increase consumer utility for a given cost to the provider. We show that a subsidy is preferred when the desired subsidization is high and that microloan and rental programs can profitably improve energy access.

■ SA70

Parc- Hearst

Copper Mining Applications

Sponsor: Energy Natural Resources and the Environment/ Natural Resources
Sponsored Session

Chair: Timothy Matis, Associate Professor, Texas Tech University, PO Box 43601, Lubbock, TX, 79409, United States of America, timothy.matis@ttu.edu

1 - Optimizing Capacity and Production in Copper Mining
Melanie Ruegg, Graduate Student, Texas Tech University, Box 43061, Lubbock, Tx, 79409, United States of America, melanie.ruegg@ttu.edu, Pablo A. Miranda, Milton Smith, Jose Ceroni, Timothy Matis

The copper mining industry may be characterized as having capital intensive fixed costs, long planning horizons, and variability in returns due to market fluctuations. In this presentation, we will discuss research related to optimizing capacity planning and production policies under variability in profit margins for refined and concentrate product.

2 - Sustainable Mining

Stefan Voss, University of Hamburg, IWI - Von-Melle-Park 5, Hamburg, 20146, Germany, stefan.voss@uni-hamburg.de

Operations related to and in mining are nowadays unthinkable without efficient use of information technology and appropriate optimization methods. As the sustainable use of natural resources has achieved undoubted importance, we describe and classify processes and operations in sustainable mining and provide methods for their optimization. This refers to constructing a mine, running it, and finally shutting it down, also including energy efficiency, supply chain optimization and risk management.

3 - A Simulation Based Integrated Model to Evaluate Supply Chain Maintenance Planning Policies

Jose Ceroni, Pontificia Universidad Catolica de Valparaiso, Av. Brasil 2241, Valparaiso, Chile, jceroni@ucv.cl, Monica Lopez-Campos, Pablo A. Miranda

We propose an integrated approach to evaluate maintenance policies considering the spare parts supply chain, based on simulation of the maintenance system for a copper concentrate shipping operation. The model considers spare parts inventory costs and decisions, for evaluating combined strategies for maintenance and spare parts inventory. Analysis consists of a bi-objective evaluation of system performance indicators: spare parts inventory and supply costs, and equipment availability.

■ SA71

Parc - Lombard

Auctions and Trading Agents

Cluster: Auctions

Invited Session

Chair: Wolf Ketter, Professor, Rotterdam School of Management, Burgemeester Oudlaan 50, Rotterdam, 3062 PA, Netherlands, wketter@rsm.nl

1 - Impact of Mari on Multi-unit Sequential Dutch Auctions

Yixin Lu, Rotterdam School of Management, Erasmus University Rotterdam, Burgemeester Oudlaan 50, T9-16, Rotterdam, 3062PA, Netherlands, ylu@rsm.nl, Alok Gupta, Wolf Ketter, Eric van Heck

We examine the performance of two auction formats which are widely used for selling perishable goods, the traditional multi-unit sequential Dutch auction mechanism and a variation of it which involves an additional stage called "Mari" where non-winning participants can purchase goods at the same price as the winner in the previous round. Using a lab experiment, we show that the inclusion of Mari can significantly speed up the auction process at a negligible cost of allocative efficiency.

2 - Intelligent Virtual Power Plant Control: Electric Vehicles for Flexible Load Balancing

Micha Kahlen, Rotterdam School of Management, Burgemeester Oudlaan 50, Rotterdam, 3062 PA, Netherlands, kahlen@rsm.nl, Jan Dalen van, Wolf Ketter

We study an intelligent agent based trading strategy for the electricity wholesale market. This trading strategy schedules the charging of Electric Vehicles, as well as when electricity from the Electric Vehicles storage should be provided to the grid to meet peak load. Several Electric Vehicles are aggregated to a Virtual Power Plant that reacts in real-time to changing load conditions. We make an optimal tradeoff between Electric Vehicle driver's mobility needs and the exploitation of storage.

3 - An Ascending Dynamic Auction for Team-based Assignments

De Liu, University of Kentucky, 550 S Limestone St,, Lexington, KY, 40506, United States of America, de.liu@uky.edu

Many assignment problems involve assigning an object to a team of individuals. Examples include sending teams of workers to multiple project sites and assigning dorm rooms to students. I propose a dynamic ascending auction for assigning objects to teams of individuals.

■ SA72

Parc- Stockton

Energy Management Analytics in the Demand Side

Sponsor: Energy, Natural Res & the Environment/Energy

Sponsored Session

Chair: Young Lee, Manager, IBM Research, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States of America, ymlee@us.ibm.com

1 - Harnessing the Electric Load Flexibility of Energy-conscious Intelligent Transportation Systems

Mahnoosh Alizadeh, Postdoctoral Research Fellow, Stanford University, Packard EE Building, Room 372, 350 Serra Mall, Stanford, CA, 94305, United States of America, malizade@stanford.edu, Tara Javidi, Yueyue Fan, Hoi To Wai, Andrea Goldsmith, Anna Scaglione

In this talk, we model the electric vehicle trip planning and charge problem under dynamic traffic conditions and locational and time-varying electricity pricing. We discuss how load management strategies used by the power system operator could affect path planning problems solved by individual users or a social planner, and discuss the necessity of a joint view of intelligent transportation systems and the smart grid.

2 - Optimizing Energy Storage in Microgrids with Renewables

Arnab Bhattacharya, University of Pittsburgh, 1077, Benedum Hall of Engineering, Pittsburgh, PA, 15261, United States of America, arb141@pitt.edu, Jeffrey Kharoufeh

We consider the problem of optimally and dynamically procuring and storing energy in residential microgrids in the presence of renewable sources and dynamic pricing. A multi-stage, stochastic optimization problem is formulated to minimize a consumer's finite horizon electricity costs while accounting for uncertainties in distributed energy demand and intermittent supply.

3 - A Network Modelling Approach to Energy Efficiency Optimization in Industrial Systems

Niloofar Salahi, PhD Candidate, Rutgers The State University of New Jersey, 308 Green Hill Manor Dr, Franklin Park, NJ, 08823, United States of America, niloofar.salahi@gmail.com, Mohsen Jafari

This work focuses on energy efficiency optimization for industrial systems.The problem is formulated as a network optimization where nodes are interlinked by energy and performance dependencies.A node can represent a process, a machine or equipment.Solution to this model is energy efficiency share of each node.For illustration,a manufacturing facility with a production line and a technical building is used.The model integrates building energy dynamics with labor productivity and thermal comfort.

4 - A Data Driven Approach to Optimal Control of Building Energy Use

Seyed Vaghefi, PhD Candidate, Rutgers University, 96 Frelinghuysen Road, CoRE Building, Room 201, Piscataway, NJ, 08854, United States of America, vaghefi@rutgers.edu, Jack Brouwer, Yan Lu, Jianmin Zhu, Mohsen Jafari

We propose an optimal framework for forecasting and optimization of building energy consumption. It consists of two main phases. First, a set of offline data is used to construct an energy forecast model. Then, in the next phase, the model is fed into an optimal control strategy to find the optimal set points for a finite horizon. The optimization model is a Multi-objective Dynamic Programming that minimizes total energy cost as well as total deviation from thermal comfort bounds.

5 - Optimal Control of HVAC Systems for Demand Response

Young Lee, Manager, IBM Research, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States of America, ymlee@us.ibm.com, Leo Liberti, Rui Zhang, Young Tae Chae, Raya Horesh

Building HVAC systems account for over 40% of the total energy consumption of buildings in the U.S. A method that dynamically computes the optimal control profile of HVAC Systems considering real-time electricity price, desired occupant comfort level, building operational schedule, weather forecast and thermal mass of buildings is presented. The control strategy can substantially reduce energy consumption and costs of HVAC systems in buildings.

◼ SA73

Parc- Mission I

Real Options in the Energy Sector

Sponsor: Energy, Natural Res & the Environment/Energy
Sponsored Session

Chair: Afzal Siddiqui, University College London, Gower Street,
London, United Kingdom, afzal.siddiqui@ucl.ac.uk

1 - Optimal Decision to Invest in an Engine-CHP Plant:
   A Real Options Approach in the Context of the German Regulatory
   Framework
   Reinhard Madlener, Full Professor of Energy Economics and
   Management, RWTH Aachen University, FCN, Mathieustrasse 10,
   Aachen, 52074, Germany, RMadlener@eonerc.rwth-aachen.de,
   Freia Harzendorf

We develop a 2-dimensional real options model for the irreversible investment in
an engine-CHP system. Fuel price and electricity price are subject to risk; heat
revenues are assumed to be certain. On this basis of German Renewable Energies
Act (EEG 2012) and Cogeneration Act (KWKG 2012) we determine and compare
the investment in a natural gas- and a biogas-fired CHP plant by means of RO
analysis. We also consider the biogas-fired engine-CHP plant as a 2-stage sequential
investment option.

2 - Persist or Perish: Optimal Management of
   Alternative-Energy Technologies
   Ryuta Takashima, Tokyo University of Science, 2641 Yamazaki,
   Noda, Chiba, 278-8510, Japan, takashima@rs.tus.ac.jp,
   Afzal Siddiqui

Policymakers have often backed alternative energy technologies, e.g., nuclear
power, due to their relatively low operating costs and emissions. However, they
have also been quick to respond to public perceptions about the safety of such
plants by suspending construction or even decommissioning existing facilities. We
address public concerns about physical plant risks along with stochastic market
prices for energy by modelling investment in and decommissioning of alternative
energy technologies.

3 - Investment and Capacity Sizing under Policy Uncertainty
   Michail Chronopoulos, Norwegian School of Economics, Helleveien
   30, Bergen, 5045, Norway, Michail.Chronopoulos@nhh.no, Verena
   Hagspiel, Stein-Erik Fleten

Frequent changes of support schemes and price uncertainty complicate investment
decisions particularly when a firm must determine both the optimal time of
investment and the size of a project. We analyse how investment timing and
capacity sizing decision are affected by policy and price uncertainty for a project
that can be completed in a single or multiple stages and find that policy uncertainty
has an ambiguous impact on the required investment threshold and the
corresponding optimal capacity.

4 - Anticipative Transmission Planning under Uncertainty
   Afzal Siddiqui, University College London, Gower Street, London,
   United Kingdom, afzal.siddiqui@ucl.ac.uk, Trine Krogh Boomsma,
   Verena Hagspiel

Transmission system operators (TSOs) build transmission lines to take generation
capacity into account. However, their decision is confounded by policies that
promote renewable energy technologies. Thus, what should be the size of the
transmission line to accommodate subsequent generation expansion? Taking the
perspective of a TSO, we use a real options approach not only to determine the
optimal timing and sizing of the transmission line but also to explore its effects on
generation expansion.

◼ SA74

Parc- Mission II

Market Issues for Hydro-Dominated
Electricity Systems

Sponsor: Energy, Natural Res & the Environment/Energy
Sponsored Session

Chair: Ramteen Sioshansi, Assistant Professor, The Ohio State
University, Integrated Systems Engineering, 1971 Neil Avenue,
Columbus, OH, 43210, United States of America,
sioshansi.1@osu.edu

1 - Risk and Contracting in Hydro-dominated Electricity Markets
   Andy Philpott, University of Auckland, Private Bag 92019,
   Auckland, New Zealand, a.philpott@auckland.ac.nz

Electricity markets with hydroelectricity are subject to energy shortages when
there are low reservoir inflows. In perfectly competitive markets some of the risk
of these shortages can be hedged by hydro generators trading contracts with agents
with thermal plant that can perform a hydro-firming role, or with agents on the

demand side. We examine the equilibrium outcomes of different types of contract
when agents are endowed with coherent time consistent risk measures.

2 - Hydrothermal Scheduling with a Detailed Representation of River
   Channel Constraints
   André Luiz Diniz, DSc, CEPEL - Brazilian Electric Energy Research
   Center, Av Horacio Macedo, 354, Cidade Universiteria,
   Rio de Janeiro, RJ, 21941911, Brazil, diniz@cepel.br

It is very important to have an accurate representation of reservoir cascades in
power system operation, specially in predominantly hydro systems. We present a
linear program to accurately model the river routing as well as several constraints -
such as maximum level variation - along the water channels that connect
reservoirs in cascade. Results for the short-term hydrothermal scheduling of the
real large-scale Brazilian system show the high accuracy of our approach, with
acceptable CPU times.

3 - Strategic Bidding for Price-Maker Hydro-Electric Producers
   Steffen Rebennack, Colorado School of Mines, Division of
   Economics and Business, Golden, CO, United States of America,
   srebenna@mines.edu, Gregory Steeger, Luiz Barroso

Deregulation has led to the use of auction-based markets while a growing desire
for efficient and renewable energy sources has rekindled modeling efforts in the
energy sector. In this talk, we review and discuss approaches to maximize revenue
in the production schedule for both single and multiple price-maker hydro-electric
producers in a deregulated, bid-based market. We model the problem for a single
price maker and for multiple price makers.

4 - Optimizing Offers for Cascaded Hydroelectric Generators in a
   Market with Centralized Dispatch
   Ramteen Sioshansi, Assistant Professor, The Ohio State University,
   Integrated Systems Engineering, 1971 Neil Avenue, Columbus, OH,
   43210, United States of America, sioshansi.1@osu.edu

We examine the problem of offering generation and ancillary services from a set of
cascaded hydroelectric units to a centrally dispatched market that does not account
for watershed constraints. We formulate the problem as a stochastic bilevel
optimization that maximizes generator profits under different demand and supply
realizations. We use two numerical case studies to demonstrate the benefits of the
proposed model.

◼ SA75

Parc- Mission III

Simulation Optimization and Ranking and Selection

Sponsor: Simulation
Sponsored Session

Chair: Shane Henderson, Professor, Cornell University, School of
ORIE, 230 Rhodes Hall, Ithaca, NY, 14850, United States of America,
sgh9@cornell.edu

1 - A Comparison of Two Parallel Ranking and Selection Procedures
   Eric Ni, Cornell University, 288 Rhodes Hall, Ithaca, NY, 14853,
   United States of America, cn254@cornell.edu, Shane Henderson,
   Susan Hunter

Traditional solutions to ranking and selection include two-stage procedures and
sequential screening procedures. We migrate two representative procedures to a
parallel computing platform to explore and compare their statistical validity,
efficiency, and implementation in various settings. Inspired by the comparison
results, we propose a framework for hybrid procedures that may further reduce
simulation cost or guarantee to select a good system when multiple systems are
clustered near the best.

2 - Feasibility Determination for Linearly Constrained Sets
   Roberto Szechtman, Naval Postgraduate School, 1411 Cunnigham
   Rd, Monterey, United States of America, rszechtm@nps.edu,
   Enver Yucesan

We consider the problem of feasibility determination in a stochastic setting, where
we wish to determine whether a system belongs to a given set based on a
performance measure estimated through Monte Carlo simulation. We consider
linearly constrained sets, and present a number of approaches that keep the
expected number of incorrect determinations within a bound with certain
probability. Our algorithms apply to random vectors with Gaussian, sub-Gaussian,
and bounded support distributions.

3 - Selection of the Best through Sequential Subset Selection
L. Jeff Hong, Professor, Hong Kong University of Science and Technology, IELM Dept, HKUST, Clear Water Bay, Hong Kong - PRC, hongl@ust.hk, Weiwei Fan

Frequentist's formulations of selection-of-the-best problem include the indifference-zone (IZ) formulation and the subset-selection (SS) formulation. However, the first needs an IZ parameter that is often difficult to specify, and the second may result a subset that include more than one alternatives. To resolve such problems, we propose a sequential SS procedure based on the law of iterative logarithm. It does not need an IZ parameter but guarantees to select the best with a pre-specified PCS.

4 - Bias Issues in Simulation-based Stochastic Optimization
Peter Glynn, Stanford University, Huang Engineering Center 357, Stanford, CA, 94305, United States of America, glynn@stanford.edu

We discuss optimization bias and accompanying bias in the optimizer, in the setting of simulation-based optimization, both in the presence of parameter uncertainty in the underlying distributions and in its absence. We also introduce a new unbiased estimator for the optimum and its optimizer. This work is joint with Jose Blanchet,Danielle Davidian,Gerd Infanger,and Zeyu Zheng.

■ SA76

Parc- Embarcadero

Planning and S&OP Processes

Sponsor: The Practice Track
Sponsored Session

Chair: Rob Hall, Managing Partner, End-to-End Analytics, 2595 E. Bayshore Rd., Suite 240, Palo Alto, CA, 94303, United States of America, rob@e2eanalytics.com

1 - How to Speed ERP Implementation and Reduce Time to ROI
Warren McCullough, Director, Sales & Operations Planning, NetApp, 495 East Java Drive, Sunnyvale, CA, 94089, United States of America, warrenm3@me.com

Executives have a compelling desire to limit project scope of an ERP implementation to core system of record functions, to avoid biting off too much too soon. But, unless key processes are included, it is much harder to get your ROI. By including these three key tangential processes: master data management, S&OP, and supply chain collaboration in your business requirements, you can help speed ERP system adoption and decrease time to achieve ROI from an ERP implementation.

2 - Delivering Effective and Robust Planning Tools using Excel
Rob Hall, Managing Partner, End-to-End Analytics, 2595 E. Bayshore Rd., Suite 240, Palo Alto, CA, 94303, United States of America, rob@e2eanalytics.com

Many businesses continue to rely on individualized Excel spreadsheets for their planning activities. Excel is ubiquitous, easy-to-use, flexible, and powerful business tool. But spreadsheets developed by individuals are notoriously error-prone, fragile, inefficient, and not scalable. However, it is possible to develop and deploy robust, standardized, and scalable Excel tools to the user community. I share a practical example of such an approach.

3 - Achieving Supply Chain Excellence at Sandisk Corporation
Shiva Esturi Sathyanarayan, Director II, Operations Management, Sandisk Corporation, 951 Sandisk Drive, Milpitas, CA, 95035, United States of America, Shiva.EsturiSathyanarayan@Sandisk.com, Bo Liao

We discuss how supply chain excellence towards improving inventory turns and customer service level at SanDisk Corporation is achieved through a postponement strategy coupled with business segmentation, prioritized replenishments for constrained supply, and improving supply chain visibility and response to exceptions.

■ SA77

Parc- Market Street

Analytics Applications on Decision Making

Sponsor: Analytics
Sponsored Session

Chair: Juan Li, Research Scientist, Xerox Corporation, 800 Phillips Road, Webster, NY, 14580, United States of America, Juan.Li@xerox.com

1 - Dynamic Framework for the Design and Evaluation of Kidney Exchange (KE) Programs
Tulia Plumettaz, Xerox Corporation, 800 Phillips Rd, Bldg 128-257F, Webster, 14580, United States of America, Tulia.Plumettaz@xerox.com, Jay Sethuraman

Mechanisms are typically evaluated by their overall performance on a large exchange pool, based on which recommendations are drawn. We consider a dynamic framework to evaluate extensively used KE mechanisms. Our results suggest that some of the features that are critical in a mechanism in the static setting have minor impact in its long-run performance. Also features that are generally underestimated in the static setting turn to be relevant when we look at a dynamically evolving exchange pool.

2 - Exploration vs. Exploitation in the Information Filtering Problem
Xiaoting Zhao, Cornell University, Rhodes Hall, Ithaca, NY, 14850, United States of America, xz337@cornell.edu, Peter Frazier

We consider information filtering, in which we face a stream of items to voluminous to process by hand, and must rely on a computer system to automatically filter out irrelevant items. Modeled as a Bayesian sequential decision-making problem, we show how it may be solved to optimality using dynamic programming and a decomposition that exploits special problem structure. We then present an application of this method to a historical dataset from the arxiv.org repository of scientific articles.

3 - Condition-Based Spare Parts Inventory Management for Aircraft Engines
Jennifer K. Ryan, Associate Professor, Rensselaer Polytechnic Institute, 110 8th Street, Industrial & Systems Engineering, Troy, NY, 12180, United States of America, ryanj6@rpi.edu, Michelle Park, Robert Gao, Robert Tomastik, Ana Muriel

Lack of coordination between maintenance decision-making and the inventory management of spare parts can lead to increased inventory costs and unnecessary equipment downtime. To address this gap, we have developed a framework for incorporating real-time condition information into inventory decisions for spare parts that are subject to deterioration. While equipment condition monitoring is of relevance to many manufacturers, the application context of this research is commercial jet engines.

■ SA78

Parc- Mason

Stochastic Analytics Models and Methods

Sponsor: Analytics
Sponsored Session

Chair: Michael N. Katehakis, Rutgers University, Newark, NJ, United States of America, mnk@rutgers.edu

1 - Switching Curve Optimal Policy in an Infinite Server Farm Model
Herman Blok, PhD, Leiden University, Niels Bohrweg 1, Leiden, Netherlands, blokh1@math.leidenuniv.nl, Flora Spieksma

We wish to minimise the expected cost due to energy consumption. After completing service, a server can be put on standby and consume extra energy. Or turned off, which saves energy, but yields extra costs when turned back on. We model this as an MDP, which is challenging due to unbounded rates and transient policies. The only existing result concerns bounded jumps and discounted cost. We show how to carry these results to the unbounded model. We further exploit the model to get average results.

2 - Markov Decision Processes and Inventory Control
Eugene Feinberg, Distinguished Professor, Stony Brook University, Dept. of Applied Math. & Statistics, Stony Brook, NY, 11790, United States of America, eugene.feinberg@stonybrook.edu, Yan Liang

Recent results on Markov Decision Processes (MDPs) with general state and action sets provide direct tools for optimization of periodic review inventory systems. In this talk we describe general results on MDPs and their applications to particular inventory control problems.

3 - DES and RES Processes and their Explicit Solutions
Laurens Smit, Leiden University, Niels Bohrweg 2, Leiden, Netherlands, lsmit@math.leidenuniv.nl, Michael N. Katehakis, Flora Spieksma

We define and study the down entrance state (DES) and the restart entrance state (RES) classes of quasi skip free processes. We derive explicit solutions and bounds for the steady state probabilities of both processes. To motivate the applicability we present solutions for queueing and inventory problems. In addition we present a procedure to decompose Markov processes into separate thinned processes. We discuss applications when the thinned processes satisfy the DES and RES property and the original process does not.

4 - Dynamic Models Valuation and Utilization of Tax Loss Carryforwards and Carrybacks
Nilofar Varzgani, PhD Student, Rutgers Business School, 101 Bleeker Street, Newark, NJ, 07102, United States of America, nvarzgani@gmail.com, Michael N. Katehakis, Suresh Govindaraj

We present new models for valuation and utilization of tax loss-carryforwards (TCLFs) and carrybacks (TLCBs) under deterministic and stochastic tax code conditions. We investigate similarities between TCLFs and the existing literature on perishable inventory models and we provide an algorithmic discrete time framework for valuing TLCFs (TLCBs).

■ SA79

Parc- Powell I

The Next 50 Years of Decision Analysis

Sponsor: Decision Analysis
Sponsored Session

Chair: Jim Matheson, Chairman, SmartOrg, Inc., 855 Oak Grove Ave Ste 202, Menlo Park, CA, 94025, United States of America, jmatheson@smartorg.com

1 - Decision Engineering – The Next 50 Years
Jim Matheson, Chairman, SmartOrg, Inc., 855 Oak Grove Ave Ste 202, Menlo Park, CA, 94025, United States of America, jmatheson@smartorg.com

The next 50 years of evolution: embedding sound decision processes throughout organizations, for big and little decisions, for exigent and routine, for strategic and operational, for situations dominated by value questions, by uncertainty or by complexity. In addition, all of these situations need to be supported by embedded software that does not often require power users, and that integrates the analytics on big data about the past with human judgments about the future. Create the future!

2 - Societal Decisions: The Next 50 Years?
Warner North, President and Principal Scientist, NorthWorks, Inc., 1715 Taylor Street, San Francisco, CA, 94133, United States of America, northworks@mindspring.com

Where will application of DA to societal decisions be in 50 years? I hope such application will have become part of standard decision support practice, along with accounting, cost-benefit analysis, and planning for acceptable safety. Improvements in education are needed, including probability theory and behavioral economics. Engineering of complex systems needs to be linked to DA. To some extent this has happened, but more linkage is needed.

3 - Healthcare Business Analytics and Decision Support: The Next 50 Years
Don Kleinmuntz, Professor of the Practice of Business Analytics, University of Notre Dame, 452 W Huron St, Chicago, Il, 60654, United States of America, don@kleinmuntzassociates.com

Healthcare businesses and organizations of all types are discovering opportunities presented by growing pools of detailed data, but are still at a relatively early stage of development and deployment. This talk will outline how more sophisticated decision tools and processes can transform healthcare service delivery, and also address the challenges these efforts are likely to encounter.

4 - Military Decision Making: The next 50 Years
Greg Parnell, Professor, Dept of Industrial Engineering, University of Arkansas, Fayetteville, AR, 72701, United States of America, gparnell@uark.edu, Terry Bresnick

Military planners must respond to opportunities and threats. New technologies and vast amounts of information will be available to military operators to perform their global missions. However, our adversaries will use asymmetric warfare including weapons of mass destruction/disruption using kinetic and cyber-warfare to achieve their objectives. Decision analysis will continue to provide insights about future military systems required to underwrite our national security in the next 50 years.

5 - Space and Security Decisions: The Next 50 Years
Ali Abbas, Professor, University of Southern California, Industrial and Systems Engineering, Price School of Public Policy, Los Angeles, CA, United States of America, aliabbas@illinois.edu

In the next 50 years, decision analysis will play an important role in space discovery and national security decisions. Space discovery decisions include asteroid recovery missions, long time horizons, uncertainty about asteroid composition, and real time decisions based on data that will be observed out in space. National security decisions will require cyber security considerations as well as ethical considerations and a wealth of data along with the decision process.

■ SA80

Parc- Powell II

Military Applications of Decision Analysis

Sponsor: Decision Analysis
Sponsored Session

Chair: Michael J. Kwinn, Jr., Professor of Systems Engineering, Dept of Systems Engineering, US Military Academy, West Point, NY, 10996, United States of America, michael.kwinn@usma.edu

1 - Big Data's Role on Tomorrow's Battlefield – Lessons Learned from Operation Enduring Freedom
Brian Harris, Operations Research Analyst, Center for Army Analysis, 6001 Goethals Road, Fort Belvoir, VA, 22310, United States of America, brian.j.harris18.mil@mail.mil

The digitalization of the battlefield, and the proliferation of machine-generated data will greatly increase the volume, velocity, and variety of data available for analysis. This massive increase in available data offers a tremendous opportunity to provide more timely and extensive advice to commanders. This brief will examine specific challenges faced in Operation Enduring Freedom as well as technologies that will change the way analysts support future military operations.

2 - A Constructive Assessment Process Supporting Army Acquisition
Patrick J. Driscoll, Professor, U.S. Military Academy, Dept of Systems Engineering, Bldg 752 Mahan Hall, West Point, NY, 10996, United States of America, patrick.driscoll@usma.edu, Timothy Elkins, Michael Jaye

An user-focused assessment process was developed in response to disappointing system acceptance and use in deployed settings. The process - Warfighter Technology Tradespace Methodology (WTTM) - integrates multiple perspectives on constructed scales to assess technological performance, human systems integration, and logistics supportability factors to expose potential system vulnerabilities. Select results from a subset of over 400 systems will be presented and discussed.

3 - using Peer Support Groups to Reduce Suicides
Ashok Deb, Assistant Professor, US Army, 1568 Cherry Tree Drive, Clarksville, TN, 37042, United States of America, ashok.k.deb.mil@mail.mil

This research seeks to empower members of the DoD to work together to mitigate suicides by designing a Peer Support Group that will increase resilience and self-esteem within Service Members. By leveraging the Systems Design Process eight necessary components of the proposed Peer Support Group was identified. Each component was explored using analysis, statistics, surveys and review of previous research to determine the best recommendations for each of these components.

4 - Evaluating Geospatial Data Collection Tools for the Army
Megan Wilton, megan.catherine.anne.wilton@gmail.com, Alexandra Sutherland, Breawna Davis

This report will consider the tradeoffs associated with a number of geospatial data collection tools in order to recommend the most valuable and cost effective solution to the Army. Through the Systems Decision Process, a collaborative process that focuses on the needs and values of a stakeholder when dissecting and creating alternatives for a given initial problem, the BuckEye system will prove most valuable in the context of the guidelines set by our stakeholders.

■ SA81

Parc- Divisadero

Networks and Information

Cluster: Data and Information

Invited Session

Chair: Shayan Ehsani, Stanford University, MS&E Department, Stanford, United States of America, shayane@stanford.edu

1 - On the Socially-Optimal Design of Online Reviewing Platforms
Yiangos Papanastasiou, London Business School, Regent's park, London, United Kingdom, yiangosp@london.edu, Kostas Bimpikis, Nicos Savva

In an online reviewing platform, information on the quality of alternative service providers is both generated and utilized by the consumer population. Social inefficiency arises from the fact that information is generated as a byproduct of self-interested consumer behavior, rather than with the benefit of future consumers in mind. Within a classic multi-armed bandit framework, we study how this inefficiency relates to alternative policies of information-disclosure to the platform's users.

2 - Multi-retailer Inventory Problem with Batch Production
Hyun-Soo Ahn, University of Michigan, 701 Tappan St., Ann Arbor, MI, 48104, United States of America, hsahn@umich.edu, Yang Wang, Stefanus Jasin, Phil Kaminsky

Motivated by a problem in biopharmaceutical manufacturing, we consider a discrete time finite horizon inventory problem where several retailers place orders to meet stochastic demand, and in each period, the sum of order quantities across retailers must be a multiple of a standard batch size. We characterize structure of optimal policy, and develop data-driven heuristics with analytic bounds.

3 - Disruption and Diversification in Supply Chains
Alex Teytelboym, Postdoctoral Fellow, MIT, 77 Massachusetts Ave., 32-D632, Cambridge, MA, 02139, United States of America, t8el@mit.edu, Asuman Ozdaglar, Daron Acemoglu, Marco Scarsini

We analyze how supply chains form in the presence of shocks that can cause cascades of production disruption. Firms' inputs are imperfectly substitutable and input diversification is costly. Firms face a tradeoff between the cost of signing more input contracts and the possibility of production disruption. We show how the structure of input-output network affects firms' incentives and the efficiency of equilibria. We discuss the benefits of coordination in supply chain formation.

4 - Auctions with Dynamic Costly Information Acquisition
Negin Golrezaei, Marshall School of Business, University of Southern California, Los Angeles, United States of America, golrezae@usc.edu, Hamid Nazerzadeh

We study the mechanism design problem for the seller of an indivisible good in a setting where buyers can purchase the additional information and refine their valuations for the good. This is motivated by information structures in online advertising where advertisers can target users using cookie-matching services. For this setting, we propose a rich class of dynamic mechanisms, called Sequential Weighted Second-Price, which encompasses the optimal and the efficient mechanisms as special cases.

■ SA82

Parc- Haight

Robust Multiobjective Optimization

Sponsor: Multiple Criteria Decision Making

Sponsored Session

Chair: Margaret Wiecek, Clemson University, Mathematical Sciences, Clemson, United States of America, wmalgor@clemson.edu

1 - Trade-Offs and Proper Optimality in Multiple-Criteria Optimization under Uncertainty
Anzhelika Lyubenko, Ph.D. Candidate, University of Colorado Denver, 1250 14th Street, Denver, CO, 80202, United States of America, anzhelika.lyubenko@ucdenver.edu, Alexander Engau

We present new results to characterize and compute objective trade-offs and a set of corresponding compromise solutions for multicriteria optimization problems that include elements of uncertainty. We compare our new solutions to those obtained from the alternative approaches of robust and stochastic programming on an example from financial portfolio optimization. We also summarize a few technical results that provide new theoretical insights into the closely related theory of proper optimality.

2 - Robust Biobjective Optimization with One Uncertain Objective
Andrea Raith, The University of Auckland, UniServices House, 70 Symonds St, CBD, Auckland, 1025, New Zealand, a.raith@auckland.ac.nz, Kenneth Kuhn, Anita Schöbel, Marie Schmidt

Standard robustness concepts are extended for biobjective optimization problems with one uncertain objective. The concepts are further refined to ensure robust efficient solutions are not dominated by another solution in all considered scenarios. We propose algorithms to identify robust efficient solutions for combinatorial problems and finitely many scenarios. Results of an application in modelling shipments of hazardous materials, a biobjective shortest path problem, are shown.

3 - Multiobjective Optimization under Uncertainty: Models and Robust Counterparts
Margaret Wiecek, Clemson University, Mathematical Sciences, Clemson, United States of America, wmalgor@clemson.edu, Erin Doolittle, Herve Kerivin

We study three models of uncertain multiobjective programs (MOPs): with uncertain coefficients in constraint functions, uncertain parameters converting MOPs into single-objective programs (SOPs), and uncertain objective functions. For each case, we propose a robust counterpart problem and reduce it into a computationally tractable deterministic MOP or SOP. We examine the relationships between the efficient sets.

■ SA83

Parc- Sutro

Doing Good with Good OR - Student Paper Competition

Cluster: Doing Good with Good OR - Student Paper Competition

Invited Session

Chair: Carri Chan, Columbia University Business School, 3022 Broadway, Uris 410, New York, NY, United States of America, cwchan@columbia.edu

1 - Doing Good with Good OR Student Competition
Ruben Proano, Assistant Professor, Rochester Institute of Technology, Rochester, NY, United States of America, rpmeie@rit.edu

Doing Good with Good OR - Student Paper Competition is held each year to identify and honor outstanding projects in the field of operations research and the management sciences conducted by a student or student group that have a significant societal impact.

2 - Volunteer Engagement in the Age of Analytics: A Case Study with American Red Cross, Greater Chicago Region
Andrew Fox, Northwestern University, Evanston, IL, 60208, United States of America, AndrewFox2014@u.northwestern.edu, Tessa Swanson

Many nonprofit agencies require volunteers as a resource for achieving operational objectives. Recognizing that volunteers can engage or disengage from an organization with relative ease, we study volunteer scheduling and dispatch at American Red Cross, Greater Chicago Region. We develop baseline metrics, predictive modeling, and scheduling policies to optimize the opportunities in which volunteers engage with the organization.

3 - Smarter Tools for (Citi) Bike Sharing
Eoin O'Mahony, Cornell University, Ithaca, NY, United States of America, eoin@cs.cornell.edu

Bicycle-sharing systems provide a low-cost, environment-friendly urban transportation option. Efficient management of these systems poses a bicycle rebalancing problem comprising three questions: where do bikes need to be, when must they be there, and how can they get there? I apply operations research techniques to yield practical answers to these questions; my solutions optimize current operations at NYC (Citi)Bike.

4 - Resource Allocation and Optimization for Advanced Voting in Gwinnett County
Mehran D'Souza, Georgia Institute of Technology, Atlanta, GA, United States of America, mehsd969@gatech.edu

We develop a decision support tool for the allocation of resources in a queueing network for advanced voting in Gwinnett County, Georgia. Resources include clerks, laptops, and voting machines. To illustrate this tool, we show that a reduction of 1.8 hours of average wait time for a presidential election can be achieved for about $6,000, which impacts roughly 40,000 voters.

Sunday, 11:00am - 12:30pm

■ SB01

Hilton- Golden Gate 6

DIME/PMESII 1

Sponsor: Military Applications Society

Sponsored Session

Chair: Dean Hartley, Principal, Hartley Consulting, 106 Windsong Ln, Oak Ridge, TN, 37830, United States of America, DSHartley3@comcast.net

1 - Understanding DIME/PMESII

Dean Hartley, Principal, Hartley Consulting, 106 Windsong Ln, Oak Ridge, TN, 37830, United States of America, DSHartley3@comcast.net

I introduce DIME/PMESII and tools to support understanding it. The US has been and will continue to be involved in DIME/PMESII situations. Understanding these situations is a prerequisite to dealing with them well – and they are difficult to understand. The Army has developed some tools that will be useful. We can convert these tools into enablers to allow fewer people to do more with fewer resources, support Institutional Memory retention, and leverage current information gathering tools.

2 - Best Practices for Irregular Warfare (IW) Data Quality Control

Jeff Appleget, Senior Lecturer, Naval Postgraduate School, 1411 Cunningham Road GL-239, Monterey, CA, 93943, United States of America, jaappleg@nps.edu

US DoDI 5000.61 mandates that "Models, simulations, and associated data used to support DoD processes, products, and decisions shall undergo verification and validation (V&V) throughout their lifecycles." This presentation identifies the challenges with finding, using, and the quality control of data for Irregular Warfare Methods, Models, and Tools (MMTs), and recommends best practices for DoD organizations to adopt to ensure that IW data is quality controlled.

3 - using Complex Adaptive Systems Research to Analyze Al Qaeda's Terror Network

Charlie Graham, American Military University, 111 W. Congress Street, Charles Town, WV, 25414, United States of America, charlie.c.graham@gmail.com, Philip Fellman

The US response to Al Qaeda, following the 9/11 attack on the World Trade Center, has to some extent diminished the centralized command of Al Qaeda. At the same time that Al Qaeda's central organization has been undermined, the Salafist jihad has expanded into a host of distributed cellular networks across allied organizations. We use social network theory and the computational tools of social network analysis to analyze the behavioral characteristics of these various organizations.

■ SB02

Hilton- Golden Gate 7

Strategies for Developing Inventions and Profiting from Them

Sponsor: Technology, Innovation Management and Entrepreneurship

Sponsored Session

Chair: Leonardo Santiago, Associate Professor, Federal University of Minas Gerais, Escola de Engenharia da UFMG, Av. Antonio Carlos 6627. Pampulha, Belo Horizonte, MG, 31270901, Brazil, lsantiago@ufmg.br

1 - Selling a New Product: The Role of Customer Learning Externality and Incumbent Reaction

Bilal Gokpinar, Assistant Professor, University College London, Gower Street, London, United Kingdom, b.gokpinar@ucl.ac.uk, Yufei Huang, Onesun Steve Yoo

We study an entrepreneur's optimal sales resource allocation strategy when selling a new product/service to rational customers who differ in their revenue potential and the level of influence on each other. We then consider the case of competition between a newcomer and an incumbent, and study the newcomer's customer acquisition and the incumbent's customer retention strategies in the presence of customer learning externality.

2 - Strategies for Technologies with Weak Patent Rights Revisited

Leonardo Santiago, Associate Professor, Federal University of Minas Gerais, Escola de Engenharia da UFMG, Av Antonio Carlos 6627. Pampulha, Belo Horizonte, MG, 31270901, Brazil, lsantiago@ufmg.br, Henrique Rocha, Jose Heleno Faro

In this paper we focus on strategies companies can adopt in order to prevent imitation of their technological innovations. We develop a game theoretical model to assess the key variables that can impact the firm's strategies for value appropriation or inhibit competitors from entering into the market. The results hinge on the competitor's absorptive capacity, and on it's choice between the alternatives for competing with a patented innovation.

3 - Is There a Doctor in the House?: The Impact of Users on Medical Device Innovation

Sruthi Thatchenkery, Stanford University, MS&E Department, Stanford, United States of America, sruthi@stanford.edu, Riitta Katila, Michael Christensen, Stefanos Zenios

We explore the innovation impact that users have in new firms. While users frequently advice firms as members of advisory boards or as external consultants, and commercialize their inventions by founding firms, we know little about how young firms can effectively leverage users in various other organizational roles. We draw on an extensive custom-collected dataset of 268 surgical instrument firms over a 31-year period.

■ SB03

Hilton- Golden Gate 7

Business Model Innovation: Operations and Information Management Perspectives

Cluster: Business Model Innovation

Invited Session

Chair: Jose Guajardo, University of California Berkeley, 545 Student Services Bldg #1900, Berkeley, CA, United States of America, jguajardo@haas.berkeley.edu

1 - The Risk-driven Business Model: Four Questions that will Define Your Company

Serguei Netessine, Professor, INSEAD, 1 Ayer Rajah Avenue, Singapore, 138676, Singapore, serguei.netessine@insead.edu, Karan Girotra

We discuss our take on business model innovation based on the book "The Risk-Driven Business Model: Four Questions that Will Define your Company" www.defineyourcompany.com. We make an argument that the field of Operations Management should be moving away from how to manage a company in a steady-state and towards innovation: taking company to a drastically new level.

2 - New Service Business Models - Problems and Opportunities

Kamalini Ramdas, London Business School, Regent's Park, London, United Kingdom, kramdas@london.edu

I will describe new business models in a variety of services in areas such as healthcare, education, tax, utilities and banking and identify common features within groups of business models, with a view to identifying research opportunities for operations management and innovation researchers in the area of business model innovation.

3 - From Problem Driven to Data Driven Research

David Simchi-Levi, Professor, MIT, 77 Massachusetts Ave, Room 1-171, Cambridge, MA, 02139, United States of America, dslevi@mit.edu

Increased computing power and the explosion of data are changing the way organizations capture data, analyze information and make decisions. These changes provide opportunities for our community to analyze extensive data so as to identify new models that drive decisions and actions. In this talk, I will presents my view on these opportunities and challenges.

4 - Randomized Field Experiments in Mobile Advertising and Mobile Coupons

Anindya Ghose, NYU, Stern School, New York, United States of America, aghose@stern.nyu.edu

We present results from randomized field experiments that measure the ROI of mobile marketing and promotions. In the first one, we explore cross channel synergies between web and mobile advertising. In another set of field experiments involving a location based app for smartphones, we measure user redemption behavior of geo-targeted mobile coupons.

■ SB04

Hilton- Continental 1

Topics in Operations with Marketing Incentives

Sponsor: Manufacturing & Service Operations Management
Sponsored Session

Chair: Guoming Lai, Assistant Professor, McCombs School of Business, University of Texas at Austin, 2110 Speedway, Austin, TX, 78712, United States of America, Guoming.Lai@mccombs.utexas.edu

1 - Search for Information on Multiple Products
   Tony Ke, UC Berkeley, IEOR, Etcheverry Hall, Berkeley, CA, 94720, United States of America, kete@berkeley.edu, Zuo-Jun Max Shen, Miguel Villas-Boas

When a consumer considers a purchase in a product category, she can gather information sequentially on several products. We develop a framework for continuous search for information on choice set of multiple alternatives, and apply it to consumer search in product market. We solve for the optimal search, switch, and purchase or exit behavior analytically. We show interesting implications of how product valuations, information correlation among products, and size of choice set influence sales.

2 - Customer Acquisition and Retention: A Customer Life Time Value Approach to Quality and Capacity
   Azin Farzan, Univesity of Southern California, Univesity of Southern California, Bridge 401, Los Angeles, CA, 90089, United States of America, afarzan@usc.edu, Yong-Pin Zhou

We analyze the optimal decision set for a service provider. The firm chooses both capacity and quality levels and also the marketing strategy and investment level to maximize profit. Because the nature of the consumer behavior is heavily dependent on the operations and marketing strategy, there is a natural tradeoff between these strategies. We model the effects of operations and marketing decisions on both the customer acquisition and retention processes and create an elaborate service model.

3 - Agility and Proximity Considerations in Supply Chain Design
   Ho-Yin Mak, Assistant Professor, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong - PRC, hymak@ust.hk, Michael Lim, Zuo-Jun Max Shen

In the increasingly competitive online retailing market, competitive edge is built on short response times and high product availability. In this work, we investigate the impact of agility, the ability to responsively and flexibly allocate demand among stocking locations in the distribution network, on the optimal network configuration. Our results offer insights into optimal designs of agile supply chains that contrast sharply with classical results on conventional supply chains.

4 - Sourcing with Deferred Payment and Inspection
   Guoming Lai, Assistant Professor, McCombs School of Business, University of Texas at Austin, 2110 Speedway, Austin, TX, 78712, United States of America, Guoming.Lai@mccombs.utexas.edu, Huaxia Rui

We study the deferred payment and inspection mechanisms for mitigating supplier product adulteration, with endogenous procurement decision and general defect discovery process. We derive the optimal deferred payment contract and the inspection equilibrium. We find that the deferred payment mechanism generally can outperform the inspection mechanism when either the market size is small or the profit margin is low.

■ SB05

Hilton- Continental 2

Retail Operations

Sponsor: Manufacturing & Service Operations Management
Sponsored Session

Chair: Zumbul Atan, Eindhoven University of Technology, School of Industrial Engineering, Eindhoven, Netherlands, Z.Atan@tue.nl

1 - Understanding the Risks and Benefits of Radio Frequency Identification (RFID) in Managing a Seasonal
   Ozgen Karaer, Assistant Professor, Middle East Technical University, Department of Industrial Engineering, Universiteler Mah. Dumlupinar Bulvari #1, Ankara, 06800, Turkey, okaraer@metu.edu.tr

Achieving inventory record accuracy through RFID (Radio Frequency Identification Technology) facilitates correct replenishment in a retail environment, which is expected to increase sales. We study the RFID impact on in-season management of a retailer of a seasonal product. We demonstrate how inventory discrepancy could hurt the retailer's revenue and quantify the value of RFID in this respect. We also study an imperfect RFID scenario to show it could adversely affect the benefits.

2 - An Efficient Algorithm for Capacitated and Stochastic Assortment Planning
   Alexander Huebner, Professor, Catholic University, Auf der Schanz 49, Ingolstadt, 85049, Germany, Alexander.Huebner@ku.de, Heinrich Kuhn, Sandro Kuehn

Increasing product variety in the retail trade is in conflict with the limited shelf space. We identify the underlying category planning problems and formulate a Newsboy-based capacitated assortment problem with stochastic demand and substitution. We develop an epsilon-exact procedure which is capable of solving problem instances of practical relevance. The numerical analyses show that out-of-assortment and out-of-stock substitution effects have a significant impact on profit and solution.

3 - Effect of Shelf Capacity on Backroom Operations
   Nesim K. Erkip, Bilkent University, Department of IE, Ankara, 06800, Turkey, nesim@bilkent.edu.tr, Zumbul Atan

Most retailers use backrooms as extra storage space. Backrooms are necessary when inventories do not fit to the available shelf space. Excess inventories are placed to the backrooms and used to satisfy customer orders when shelf inventory is depleted. We study a retailer with limited shelf capacity. Assuming a continuous review (r,q) policy with a given q, we investigate the optimal reorder level when unsatisfied customer demands are lost or backordered.

4 - Inventory Control with Shelf Space Consideration
   Zumbul Atan, Eindhoven University of Technology, School of Industrial Engineering, Eindhoven, Netherlands, Z.Atan@tue.nl, Nesim K. Erkip, Tom Van Woensel, Jan C. Fransoo

We consider a retailer with limited shelf space. Assuming continuous restocking from a backroom, we study retailer's optimal replenishment decisions and the optimal shelf capacity. The main determinants of the optimal solutions are investigated through sensitivity analysis.

■ SB06

Hilton- Continental 3

Behavioral Research in Information Sharing

Sponsor: Manufacturing & Service Operations Management
Sponsored Session

Chair: Saibal Ray, Professor, McGill University, Desautels Faculty of Management, Montreal, Canada, saibal.ray@mcgill.ca

Co-Chair: Jud Kenney, PhD Candidate, McGill University, Bronfman Building, 1001 rue Sherbrooke Ouest, Montreal, QC, H3A 1G5, Canada, jud.kenney@mail.mcgill.ca

1 - Information Sharing under Supply Uncertainty
   Jud Kenney, PhD Candidate, McGill University, Bronfman Building, 1001 rue Sherbrooke Ouest, Montreal, QC, H3A 1G5, Canada, jud.kenney@mail.mcgill.ca, Saibal Ray, Jim Engle-Warnick

This study investigates the behavior of manufacturers and suppliers sharing information when supply chain uncertainty is dominated by supply instead of demand. We elicit beliefs of both manufacturer and supplier roles and compare how subjects distort their information as manufacturers and compensate for the distortion as suppliers.

2 - On the Learning Process of a Newsvendor with Censored Demand Information
   Yingshuai Zhao, Ph.D. Candidate, Tsinghua University, Shunde Building, Tsinghua University, Beijing, China, zhao-ys08@mails.tsinghua.edu.cn, Xiaobo Zhao

We conducted an experimental study to explore the decision process in a fully censored-demand-information scenario. With censored information, participants had no demand distribution knowledge while they could only observe censored demand in every period. An efficient learning effect is verified and an exponential-type learning model based on the experimental data. We have found that the learning process could be influenced by both information and profit configurations

3 - Experimental Investigation of Salesforce Pricing Decisions
   Rashmi Sharma, PhD Student, The Pennsylvania State University, Business Building, University Park, United States of America, ros5253@smeal.psu.edu, Saurabh Bansal, Elena Katok, Peter Rimshnick

We model salesforce pricing decisions under the uncertainty of getting a contract, and various incentive schemes. We identify three classes of projects with specific risk profiles, and the incentive schemes best suited for each. Subsequently, we test pricing decisions in a lab to identify behavioral factors that influence pricing decisions.

SB07   *INFORMS San Francisco – 2014*

4 - How Team Personality, Dynamics and Material Work Flow Policies Affect Team Performance
David Cantor, Associate Professor, Iowa State University,
2340 Gerdin Business Building, Ames, IA, 50011,
United States of America, dcantor@iastate.edu, Paula Morrow

Supply chain and organizational behavior scholars are interested in understanding how individual differences such as personality traits and cognitive ability affect team performance. The focus of this study is on examining how individual differences affect team performance in material flow lines. This study seeks to answer the following research questions: How do team personality and dynamics affect team performance? Do material work flow policies moderate this relationship?

■ SB07

Hilton- Continental 4

Critical Infrastructure

Cluster: Tutorials

Invited Session

Chair: Dave Alderson, Associate Professor, Naval Postgraduate School, United States of America, dlalders@nps.edu

1 - Assessing and Improving Operational Resilience of Critical Infrastructures and Other Systems
Dave Alderson, Associate Professor, Naval Postgraduate School,
United States of America, dlalders@nps.edu,
Gerald Brown, Matt Carlyle

In this TutORial we quantify resilience for an infrastructure system to a set of disruptive events in terms of degradation of system function. We show how to build and solve a sequence of models to assess and improve the resilience of an infrastructure system to those disruptions. Through simple examples and real-world case studies, we provide motivation, details of the models, and solution algorithms.

■ SB09

Hilton- Continental 6

Incentive and Contracting in Healthcare Networks

Sponsor: Manufacturing & Service Operations
Management/Healthcare Operations

Sponsored Session

Chair: Retsef Levi, MIT Sloan School of Management, 100 Main Street, E62-562, Cambridge, MA, 02139, United States of America, retsef@mit.edu

1 - Online Algorithms for Dynamic Multi-priority Allocation Scheduling
Xinshang Wang, Columbia Business School, New York, NY,
United States of America, xw2230@columbia.edu, Van-Anh Truong

In a dynamic allocation scheduling problem, patients arriving in each period are either served in the current period, or placed in a queue. The trade-off for this problem is between overtime resource expenditure required for immediate service and patient waiting time. We introduce the first online scheduling algorithm which is 2-competitive, the best possible ratio for this class of problems. We use simulation results to test the performance of our algorithm and its variants.

2 - Efficiency of Revenue Sharing Joint Ventures with Capacity Investment Decisions
Cong Shi, Assistant Professor, University of Michigan, 2797 IOE
Building, 1205 Beal Avenue, Ann Arbor, MI, 48109,
United States of America, shicong@gmail.com, Wei Sun,
Retsef Levi, Georgia Perakis

We study capacity planning problems with resource pooling in joint ventures under uncertainties. When resources are heterogeneous, there exists a unique efficient revenue sharing contract under proportional fairness. This optimal contract rewards every player proportionally to her marginal cost. When resources are homogeneous, there does not exist an efficient revenue sharing contract. We propose a provably good contract that rewards each player inversely proportional to her marginal cost.

3 - Risk Sharing Pricing Contract between Healthcare Networks
Retsef Levi, MIT Sloan School of Management, 100 Main Street,
E62-562, Cambridge, MA, 02139, United States of America,
retsef@mit.edu, Fernanda Bravo, Georgia Perakis, Gonzalo Romero

Motivated by the pricing of referrals in healthcare, we present a new pricing contract for a service-based business interaction. Here, one firm provides a service to another firm, whereas the demand for that service is a priori uncertain. The model includes firm's risk valuation with respect to demand uncertainty, such that the new contract allows for better risk sharing. By modeling firms' interaction in a game theoretic framework, we fully specify the contract for general demand distributions.

■ SB10

Hilton- Continental 7

Product Assortment: Theoretical and Experimental Developments

Sponsor: Manufacturing & Service Operations Management

Sponsored Session

Chair: Aydin Alptekinoglu, Penn State, Smeal College, University Park, PA, 16802, United States of America, aydin@psu.edu

Co-Chair: Ali Parlakturk, Associate Professor, Kenan-Flagler Business School, University of North Carolina at CH, Campus Box 3490, Chapel Hill, NC, 27599, United States of America, Ali_Parlakturk@kenan-flagler.unc.edu

1 - Dynamic Assortment Competition and the Role of Supply Chain Responsiveness
Victor Martinez de Albeniz, IESE Business School, Av. Pearson 21,
Barcelona, 08034, Spain, valbeniz@iese.edu, Gurhan Kok

Fast fashion retailers can launch products inspired on popular trends and styles, while traditional retailers with longer lead times arrive late to the market for those items. We study dynamic assortment choices when retailers with different responsiveness capabilities compete. We find that shorter lead-times provide higher sales and higher margins. However, slow retailers may also benefit by entirely capturing the sales of products late in the product life cycle.

2 - The Effect of Contract Type on Retailer Product Choice
Anna Devlin, Assistant Professor, University of Alabama Huntsville,
College of Business, Huntsville, Al, United States of America,
anna.g.devlin@gmail.com, Wedad Elmaghraby,
Rebecca Hamilton

In this research we study experimentally if the type of contract offered influences the level of risk a retailer engages in when making product decisions. We first test if contract type influences the retailer's decision between two products and then extend this to subsequent order quantity decisions.

3 - The Exponomial Choice Model
Aydin Alptekinoglu, Penn State, Smeal College, University Park, PA,
16802, United States of America, aydin@psu.edu, John Semple

We propose a new discrete choice model and explore its implications for assortment planning and pricing.

4 - Is Servicization a Win-Win Strategy?
Ali Parlakturk, Associate Professor, Kenan-Flagler Business School,
University of North Carolina at CH, campus box 3490,
Chapel Hill, NC, 27599, United States of America,
Ali_Parlakturk@kenan-flagler.unc.edu, Vinayak Deshpande,
Adem Orsdemir

We study profit and environmental implications of servicization, the practice of selling the functionality of the product rather the product itself. We contrast segmentation benefit of servicization to that of offering a product line.

◼ SB11

Hilton- Continental 8

Operations Economics

Sponsor: Manufacturing & Service Operations
Management/Supply Chain

Sponsored Session

Chair: Gabriel Weintraub, Columbia Business School,
gyw2105@columbia.edu

Co-Chair: Gad Allon, Northwestern University - Kellogg, 2001
Sheridan Rd., Evanston, IL, United States of America, g-
allon@kellogg.northwestern.edu

1 - Network Effects in Conspicuous Consumption

Ruslan Momot, INSEAD, Boulevard de Constance, Fontainebleau,
77305, France, Ruslan.MOMOT@insead.edu, Elena Belavina, Karan
Girotra

We consider a firm selling goods to consumers who value the perception of the
good by other consumers in their social network. Customers most value goods that
their social connections are familiar with but are unable to acquire. Using recent
advances in network games, we identify product launch and distribution strategies.

2 - Procurement Auctions for Differentiated Products: Design and Applications

Daniela Saban, Columbia University, Uris Hall, 4I, New York, United
States of America, dhs2131@columbia.edu,
Gabriel Weintraub

We study the problem of a procurement agency using an auction to build an
assortment of differentiated products, offered by strategic suppliers and consumed
by heterogeneous customers. This setting arises in "framework agreements" (FAs),
commonly used in public and private procurement. Using mechanism design and
auction theory, we propose recommendations to improve the design of FAs. We
apply our results to the FAs run by the Chilean government to buy US$2 billion
worth of goods per year.

3 - Managing Service Systems in Presence of Social Networks

Gad Allon, Northwestern University - Kellogg,
2001 Sheridan Rd., Evanston, IL, United States of America,
g-allon@kellogg.northwestern.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.

4 - The Economics of Uber

Gerard Cachon, Wharton University, Philadelphia, PA,
United States of America, cachon@wharton.upenn.edu,
Kaitlin Daniels, Ruben Lobel

Uber provides a market that matches "black car" drivers with passengers in need of
transportation services. They are one of several recent companies contributing to a
new "sharing economy" in which people earn revenue from their existing assets
that otherwise would remain idle. This paper explores the impact of this new
business model on the market.

◼ SB12

Hilton- Continental 9

Sustainable and Socially Responsible Supply Chains

Sponsor: Manufacturing & Service Operations
Management/Sustainable Operations

Sponsored Session

Chair: Sang Kim, Yale School of Management, 165 Whitney Ave,
New Haven, CT, 06511, United States of America, sang.kim@yale.edu

1 - Measurement and Improvement of Environmental Performance under Voluntary versus Mandatory Disclosure

Basak Kalkanci, Associate Professor, Georgia Institute of
Technology, 800 West Peachtree Street NW, Atlanta, GA, 30308,
United States of America, Basak.Kalkanci@scheller.gatech.edu, Erjie
Ang, Erica Plambeck

When a firm exerts effort to evaluate its social & environmental impacts, it finds
opportunities to reduce them (and hence its risks associated with future
regulation). We investigate when a firm should learn and disclose its impact
(accounting for the response from consumers and investors) and whether policy
makers should mandate disclosure. Experimentally, we show that voluntary
disclosure can boost sales.

2 - Design Incentives, Coalitional Stability, or Cost Efficiency? A Network Perspective on EPR

Luyi Gui, luyig@uci.edu, Atalay Atasu, Ozlem Ergun, Beril Toktay

Extended Producer Responsibility (EPR) is an environmental policy tool that
mandates producers' financial responsibility for end-of-life treatment of their
products. EPR has been regarded at its heart a policy to provide incentives for more
environmentally-friendly design. We investigate the operational impact of
collective EPR implementation on its product design outcome.

3 - Allocating Emissions among Co-Products: Implications for Procurement, Offsetting & Border Adjustment

Nur Sunar, University of North Carolina at Chapel Hill,
Nur_Sunar@kenan-flagler.unc.edu, Erica Plambeck

A state with climate policy may impose a tax on imported products for greenhouse
gas emissions that occur in production and transportation to its border (a so-called
border adjustment) or a buyer may voluntarily commit to offset its upstream
supply chain emissions. When a process yields co-products in ?xed proportions,
how should emissions from the process be allocated among the co-products? We
address that question from the perspective of a border adjustment policy maker
and buyer, in turn.

4 - Managing a Responsible Supply Chain under Threat of Public Disclosure

Saed Alizamir, 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.

◼ SB15

Hilton- Exec. Boardroom

Environmental Efficiency

Cluster: Data Envelopment Analysis

Invited Session

Chair: Per-Olov Marklund, Umea University, Umea, 90187, Sweden,
pelle.marklund@econ.umu.se

1 - Measuring Environmentally Sensitive Efficiency and Productivity Growth in the Urban Water Sector

Jayanath Ananda, Senior Lecturer, La Trobe University, School of
Economics, Albury-Wodonga Campus, Wodonga, Vi, 3690,
Australia, j.ananda@latrobe.edu.au, Benjamin Hampf

Using the global Malmquist-Luenberger index approach, this paper analyses the
efficiency and productivity growth trends in the Australian urban water sector
whilst incorporating an undesirable output – greenhouse gas emissions. Results
indicate that the productivity growth of the sector has declined when greenhouse
gas emissions are included. The findings call for a greater understanding of energy
intensity of various water supply options and sewerage operations.

◼ SB16

Hilton- Franciscan A

Operational Issues in Agriculture

Sponsor: M&SOM/ iForm (Interface of Finance, Operations, and Risk
Management)

Sponsored Session

Chair: Onur Boyabatli, Singapore Management University,
50 Stamford Road 04-01, Singapore, Singapore,
oboyabatli@smu.edu.sg

1 - Mitigating the Impact of Product Return Regulations in the Hybrid Seed Industry

Sripad Devalkar, Indian School of Business, ISB Campus
Gachibowli, Hyderabad, India, sripad_devalkar@isb.edu,
Milind Sohoni, Saurabh Bansal

Existing laws dictate that a hybrid seed manufacturer will accept all unsold seeds
from the retailer. In the US market, manufacturers accept orders twice in the
season, with the first order guaranteed but not the second because of yield
uncertainty. This leads to inflated retailer orders and high return rates. We explore
supply chain contracts that address the problem of over ordering and high return
rates.

2 - Corn or Soybean: Optimal Farm Space Allocation under Yield and Price Uncertainties

Onur Boyabatli, Singapore Management University, 50 Stamford Road 04-01, Singapore, Singapore, oboyabatli@smu.edu.sg, Yangfang Zhou, Javad Nasiry

This paper analyzes the farm space allocation decision between corn and soybean in a multi-period framework. In each period, the farmer decides the allocation with respect to yield and spot price uncertainties. The crop yield is (stochastically) larger when the same product is not grown in the same farm space for two consecutive periods. We characterize the optimal allocation policy and investigate the impact of yield and price uncertainties on the farmer's profitability.

3 - Global Sourcing under Exchange-rate and Demand Uncertainty

Shahryar Gheibi, Syracuse University, 721 University Avenue, Syracuse, NY, United States of America, sgheibi@syr.edu, Burak Kazaz, Scott Webster

We consider a firm's capacity reservation decisions in the presence of demand and exchange-rate uncertainty. After observing the exchange rate, the firm determines what capacity to utilize for manufacturing under demand uncertainty. We characterize optimal solutions as onshore sourcing, offshore sourcing, and two dual sourcing strategies with rationing and excess capacity. We show that exchange-rate uncertainty can even make the firm reserve capacity only at the more expensive source.

■ SB17

Hilton- Franciscan B

Strategic Behavior in Service Systems

Sponsor: Manufacturing & Service Operations Management/Service Operations
Sponsored Session

Chair: Amy Ward, Professor, USC, Marshall School of Business, BRI401H, Los Angeles, CA, 90089-0809, United States of America, amyward@marshall.usc.edu

1 - Compensation and Staffing to Trade off Speed and Quality in Large Service Systems

Dongyuan Zhan, PhD Student, USC, 2667 Ellendale Place, Apt 308, Los Angeles, CA, 90007, United States of America, Dongyuan.Zhan.2015@marshall.usc.edu, Amy Ward

Human servers often must trade off speed and quality. The faster they work, the more the quality may be compromised. For large service systems, we explore how the servers respond to compensation incentives and propose compensation and staffing design to minimize the system costs. We find that different optimal staffing regimes appear with different system cost structures.

2 - Leadership Structure and Free Riding in Team Projects

Morvarid Rahmani, Assistant Professor, Georgia Tech, 800 West Peachtree Street, N.W., Atlanta, GA, 30308, United States of America, Morvarid.Rahmani@scheller.gatech.edu, Guillaume Roels, Uday Karmarkar

In this paper, we consider a multi-agent project with finite deadline, as may arise, for instance, in consulting services. We investigate whether appointing a team leader helps alleviate or exacerbate free riding, relative to having team members making their effort decisions in a decentralized fashion. We find that appointing a team leader is beneficial when the project has high stakes and a short deadline.

3 - Trading Time in a Congested Environment

Luyi Yang, Booth School of Business, University of Chicago, 5807 S. Woodlawn Avenue, Chicago, IL, United States of America, luyi.yang@chicagobooth.edu, Laurens Debo, Varun Gupta

We consider an M/M/1 queueing system in which heterogeneous time-sensitive customers with private information about their delay costs trade their waiting positions through a profit-maximizing broker. We find that the broker's optimal mechanism would restrict trading among a pool of customers with moderate delay costs. These customers wait on average just as much as they would in a first-come-first-served system and they are indifferent to participation in trading.

4 - Skill and Capacity Management in Large-scale Service Marketplaces

Eren Cil, University of Oregon, 1208 University of Oregon, Eugene, OR, United States of America, erencil@uoregon.edu, Gad Allon, Achal Bassamboo

We characterize the optimal skill screening mechanism of a firm moderating a large-scale service marketplace where the ability of a service provider to cater customers, who can be of two classes, varies. We show that when the values that a service provider generates for each customer class are independent, the firm may need to refuse some of the service providers via its screening mechanism whereas this is never optimal when these values are perfectly correlated.

■ SB18

Hilton- Franciscan C

Choice Models in Revenue Management and Pricing II

Sponsor: Revenue Management & Pricing
Sponsored Session

Chair: Hongmin Li, Assistant Professor, W.P. Carey School of Business, ASU, Tempe, 85287, United States of America, Hongmin.Li@asu.edu

Co-Chair: Tim Huh, Associate Professor, University of British Columbia, Sauder School of Business, Vancouver, BC, V6T 1Z2, Canada, tim.huh@sauder.ubc.ca

1 - Buy Now or Shop Around? Assortment Planning and Pricing with Search Cost

Ruxian Wang, Assistant Professor, Johns Hopkins Carey Business School, 100 International Dr, Baltimore, MD, 21202, United States of America, ruxian.wang@jhu.edu, Ozge Sahin

We consider assortment planning and pricing problems in the presence of consumer search cost. We show that the assortment problem with given prices is NP-hard and can be solved by dynamic programming. The multi-product pricing with search cost can be transformed to maximizing a set of unimodal single-variable functions of polynomial size. Finally, we investigate the effects of search cost in price competition.

2 - Quality Consistent Discrete Pricing and Assortment Optimization under the Nested Logit Model

James Davis, Ithaca, NY, United States of America, jamesmariodavis@gmail.com, David Williamson, Huseyin Topaloglu

We consider a joint assortment and pricing problem where relative product prices are constrained to match relative product quality. Each product price can be chosen from a discrete set of prices levels but higher quality products must have higher prices. We use the nested logit model to model purchase probabilities. Our objective is to choose an assortment of products, and quality consistent prices for those products, so that expected revenue is maximized.

3 - Quantity Pre-Commitment and Cournot Equivalence

Hongmin Li, Assistant Professor, W.P. Carey School of Business, ASU, Tempe, 85287, United States of America, Hongmin.Li@asu.edu, Amr Farahat, Tim Huh

Cournot equivalence established by Kreps and Scheinkman (1983) and Friedman (1988) indicates that the Cournot model applies when quantity and price decisions are sequential. However, the conditions they established preclude many commonly observed multi-product demand models. Our research expands the Cournot equivalency result to more general settings including the widely-adopted MNL demand model.

■ SB19

Hilton- Franciscan D

Topics in Pricing and Revenue Optimization

Sponsor: Revenue Management & Pricing
Sponsored Session

Chair: Victor Araman, AUB, Beirut, Lebanon, va03@aub.edu.lb

1 - Revenue Models for Off-grid Energy Access

Ioana Popescu, Professor, INSEAD, Singapore, ioana.POPESCU@insead.edu, Bhavani Shanker Uppari, Serguei Netessine

One quarter of the world's population does not have access to electricity. Poor households spend up to half of their income, for about $37 billion/year on kerosene and biomass. Alternative technologies, such as solar-based solutions are healthier and offer greater value, yet they require significant one-time investments which are not affordable to people living on $2/day. We explore innovative approaches and alternative revenue models for serving this market, including a case study in Rwanda.

2 - Dynamic Pricing with Risk Sensitive Consumers and Social Learning

Mikhail Nediak, Assistant Professor, Queen's School of Business, 143 Union Str., Kingston, ON, K7L3N6, Canada, mikhail.nediak@queensu.ca, Jue Wang, Tanya Levina, Yuri Levin

We present a dynamic pricing model for a monopolist offering a durable product to risk-sensitive consumers. Consumers use social learning to determine the true quality of the product to make purchase decisions. We study the structure of the optimal pricing policy and evaluate the relative gains of offering free samples to high-influence individuals prior to the selling season. The proposed model of social learning is tested on a sample of recent movie data.

3 - Dynamic Pricing with Buybacks
Rene Caldentey, Professor, New York University, 44 West Fourth Street, 8-77, New York, NY, 10012, United States of America, rcaldent@stern.nyu.edu, Ying Liu, Guillermo Gallego

We consider a dynamic pricing revenue management problem in which the seller is able to buy back units from previous customers. These customers are willing to return their units as their private valuations change over time. The seller's problem is to dynamically adjust both selling and buyback prices to maximize total expected revenue. We study the impact of the return policy and show that the policy benefits both the seller and customers.

4 - Pricing a Non Perishable Product when Facing Varying Valuations
Victor Araman, AUB, Beirut, Lebanon, va03@aub.edu.lb

In many contexts, a buyer's valuation of a particular product changes over time due to more information gathered about the product or to other external factors. In this talk, we consider a seller looking at pricing through time a non perishable product facing consumers with varying valuations. The optimal pricing policy happens to be non tractable, yet interestingly simple periodic policies are proven to perform very well.

■ SB20

Hilton- Yosemite A

Empirical Market Design

Cluster: Matching and Market Design (in honor of Al Roth)
Invited Session

Chair: Ramesh Johari, Stanford University, Huang 311, Stanford, CA, United States of America, ramesh.johari@stanford.edu

1 - Quality Externalities and the Limits of Reputation in Two-Sided Markets
Steve Tadelis, Professor, UC Berkeley, Haas School of Business, 2220 Piedmont Ave, Berkeley, CA, United States of America, stadelis@haas.berkeley.edu, Chris Nosko

Using data from eBay, we argue that platforms can mitigate externalities by actively screening sellers and promoting the prominence of better quality sellers. Exploiting the bias in feedback, we create a measure of seller quality and demonstrate the benefits of our approach through a controlled experiment that prioritizes better quality sellers to a random subset of buyers. .

2 - On the Near Impossibility of Measuring the Returns to Advertising
Randall Lewis, Economic Research Scientist, Google Inc., 1600 Amphitheatre Parkway, Mountain View, CA, 94043, United States of America, randall@econinformatics.com, Justin Rao

Firms have a hard time measuring the causal impact of advertising expenditures on profit. In twenty-five online field experiments, individual-level sales are volatile relative to the per capita cost of a campaign—a small impact on a noisy dependent variable can generate positive returns. Experiments can need more than ten million person-weeks. Further, small selection biases can severely bias observational estimates. Weak informational feedback and technological advances shape ad marketplaces.

3 - Corporate Prediction Markets: Evidence from Google, Ford, and Firm X
Bo Cowgill, UC Berkeley, 1931 Diamond St Apt 3, San Francisco, CA, 94131, United States of America, bo.cowgill@gmail.com, Eric Zitezwitz

We examine data from prediction markets run by Google, Ford and Firm X (a large private materials company). Despite theoretically adverse conditions, we find these markets are relatively efficient, and improve upon the forecasts of experts at all three firms by as much as a 25% reduction in MSE. The most notable inefficiency is an optimism bias in the markets at Google and Ford. The inefficiencies that do exist become smaller over time for reasons we document.

4 - At What Quality and What Price? Inducing Separating Equilibria as a Market Design Problem
John Horton, Professor, NYU Stern School of Business, Kaufman Management Center, 44 West Fourth St, 8-81, New York, NY, 10012, United States of America, john.joseph.horton@gmail.com, Ramesh Johari

A tool to promote revelation of buyers' price/quality preferences was experimentally introduced into an online labor market. In the treatment cells of the experiment, upon posting a job, buyers chose what price/quality level they were seeking from sellers. We find that buyers readily reveal their preferences and that this revelation—-which itself was experimentally manipulated—-strongly induced seller-side sorting.

■ SB21

Hilton- Union Sq 1

Routing Problems with Time Windows Constraints

Sponsor: Transportation Science & Logistics
Sponsored Session

Chair: Shu Zhang, University of Iowa, IA, United States of America, shu-zhang-1@uiowa.edu

1 - A Branch-cut-and-price Algorithm for a Production-delivery Routing Problem
Iman Dayarian, École Polytechnique de Montréal and GERAD, Montréal, Québec, Canada H3C 3A7, iman.dayarian@gerad.ca, Guy Desaulniers

We study a rich production-delivery routing problem with time windows arising at a catering services company. The production part consists of assembling the meals to deliver. It considers release dates to ensure freshness of the products to be delivered and is also restricted by due dates incurred by the constructed routes. Delivery and production costs are minimized under various constraints. A cutting-edge branch-cut-and-price is proposed to solve real-life instances to optimality.

2 - Robust Inventory Routing with Flexible Time Window Allocation
Chengliang Zhang, Georgia Institute of Technology, 765 Ferst Drive, NW, Atlanta, GA, United States of America, czhang85@gatech.edu, George Nemhauser, Joel Sokol, Myun-Seok Cheon, Dimitri Papageorgiou

We study an inventory routing problem with delivery time windows for uncertain disruptions, where the length and placement of time windows are also decision variables. The goal is to generate robust routes and time windows to withstand the disruptions. We generate routes using robustness strategies, and determine time windows by solving a stochastic program that considers a set of disruptions and their recovery solutions. Extensive simulation results illustrate the benefits of our approach.

3 - The Cooperative Orienteering Problem with Time Windows
Melih Ozlen, School of Mathematical and Geospatial Sciences, RMIT University, Melbourne, Australia, melih.ozlen@rmit.edu.au, James Minas, Martijn Van der Merwe, John Hearne

We define a new class of the team orienteering problem; the cooperative team orienteering problem with time windows (COPTW). It is a generalisation that requires visits by multiple vehicles at the same time to collect the reward from a location. We present an efficient two-index mixed integer programming formulation of this problem that eliminates symmetry related inefficiencies. This new formulation of COPTW is demonstrated on a wildfire scenario from South Hobart, Tasmania, Australia.

4 - Dynamic Orienteering on a Network of Queues with an Application to Textbook Sales
Shu Zhang, University of Iowa, IA, United States of America, shu-zhang-1@uiowa.edu, Jeffrey W. Ohlmann, Barrett Thomas

Motivated by the daily decision making faced by textbook sales representatives, we study a variant of the orienteering problem with time windows in which the decision maker may experience uncertain wait times due to the existence of queues at customers. We formulate the problem as a Markov decision process with an objective of maximizing the expected profit. We examine dynamic solutions using a rollout policy framework and present computational results.

■ SB22

Hilton- Union Sq 2

Logistics Planning under Disruptions

Sponsor: Transportation Science & Logistics
Sponsored Session

Chair: Hector Carlo, University of Puerto Rico - Mayaguez, Industrial Engineering Department, Call Box 9000, Mayaguez, PR, 00681-9000, Puerto Rico, hector.carlo@upr.edu

1 - Robust Hazmat Network Design Problems Considering Risk Uncertainty
Longsheng Sun, Ph.D. Student, University at Buffalo (SUNY), Industrial and Systems Engineering, Buffalo, NY, 14260, United States of America, lsun4@buffalo.edu, Mark Karwan, Changhyun Kwon

We study robust network design problems for hazardous materials transportation considering risk uncertainty. Risk uncertainty is considered in two ways: (1) uncertainty on each link across all shipments, and (2) uncertainty on each link for each shipment. We propose a Lagrangian relaxation heuristic to solve subproblems within a heuristic framework.

2 - Hybrid Optimization Model for the Humanitarian Aid Distribution Problem

Jaime Mora Vargas, jmora@itesm.mx

This work presents a model for humanitarian aid distribution in order to minimize delays, considering non-satisfied demand and reaching for balanced distribution aftermath. The model proposed solves the involved routing and distribution problems thorough a hybrid optimization metaheuristic that combines integer lineal programming and simulated annealing algorithm. The proposed model considers that the capacity of humanitarian aid storage at Distribution Points to satisfy the next period's demand, also considers that all vehicles are able to travel through several routes in each period, visiting the same Distribution Point within a single period.

3 - Road Network Restoration Optimization after Major Disruptions

Hector Carlo, University of Puerto Rico - Mayaguez, Industrial Engineering Department, Call Box 9000, Mayaguez, PR, 00681-9000, Puerto Rico, hector.carlo@upr.edu, Wilson Alvarez, Suzanna Long, Thomas Shoberg, Steven Corns

This study presents a mathematical model and heuristics to optimize road network restoration in the aftermath of major disruptions. The optimization problem consists of simultaneously assigning and scheduling repair crews to service damaged or destroyed road elements to minimize the expected delivery times in the network.

■ SB23

Hilton- Union Sq 3

Urban Logistics

Sponsor: TSL/Freight Transportation & Logistics

Sponsored Session

Chair: Tom Van Woensel, Professor, Eindhoven University of Technology, Den Dolech 2, Eindhoven, 5612AZ, Netherlands, t.v.woensel@tue.nl

1 - An Exact Method for the Fleet Composition Problem in Urban Areas

Anna Franceschetti, Eindhoven University of Technology, Den Dolech 2, Eindhoven, Netherlands, A.Franceschetti@tue.nl, Tom Van Woensel, Gilbert Laporte

We study the problem of managing a heterogeneous vehicle fleet for a logistics company which operates in an urban area subject to vehicle access restrictions. Using a continuous approximation approach we reduce the problem to an area partitioning problem. We propose an efficient procedure to find the optimal solution using dynamic programming. Our analytical results can be used to illustrate the tradeoffs between electric and diesel vehicles.

2 - Time-dependent Pollution Routing Problem with Path Flexibility in Mega-city Logistics

Yixiao Huang, Tsinghua University, Beijing, China, huangyx12@mails.tsinghua.edu.cn, Tom Van Woensel, Jean-Philippe Gross, Lei Zhao

Given the order of customers to visit, vehicles may choose different paths based on the traffic condition, in order to save fuel cost. The choice of paths, which is called path flexibility, is important in time-dependent vehicle routing. In this talk, we study the time-dependent pollution routing problem combined with a time-dependent shortest path problem, which is formulated as a two-stage stochastic mixed integer program. We construct the case study based on the network of Beijing urban area and historical traffic data.

3 - Heuristics for Same-day Delivery Routing

Jie Yang, Graduate Student, Northwestern university, 2145 Sheridan Road, Evanston, IL 60208, Evanston, Il, 60208, United States of America, jieyang2011@u.northwestern.edu, Diego Klabjan, Joe Schoenbeck

Same-day routing is a VRP problem including several extensions. We develop a VNS heuristic which has been tested on a real world dataset from a large big box retailer. We discuss the computational performance of the heuristic and conduct a business feasibility study.

4 - Ensuring Service Levels in Routing Problems with Time Windows and Stochastic Travel Times

Jan Fabian Ehmke, Assistant Professor, Freie Universitat Berlin, Garystr. 21, Berlin, 14195, Germany, JanFabian.Ehmke@fu-berlin.de, Ann M. Campbell, Timothy L. Urban

We explore how to route customers with a given service level in the environment of tight customer time windows and stochastic travel times. The service level defines the probability that each customer is visited within its time window. To be able to verify if the service level is satisfied, we investigate how arrival time distributions can be propagated throughout the tour given the presence of time windows. Computational experiments show how solutions change for different service levels.

5 - Branch-and-Price for a VRP with Time Windows Considering Driving and Working Hour Regulations

Tom Van Woensel, Professor, Eindhoven University of Technology, Den Dolech 2, Eindhoven, 5612AZ, Netherlands, t.v.woensel@tue.nl, Emrah Demir, Said Dabia

We consider restrictions on the amount of driving and working hours of truck drivers in the VRP model. A mathematical programming formulate is provided n and optimally solved using a specifically designed Branch-and-Price (B&P) algorithm. Results are presented.

■ SB24

Hilton- Union Sq 4

Mitigating Network Disruptions and Special Events

Sponsor: TSL/Intelligent Transportation Systems (ITS)

Sponsored Session

Chair: Rui Ma, University of California, Davis, CA, United States of America, drma@ucdavis.edu

1 - Active Demand Management Network Design for Optimizing VMS Location and Diversion routing Plans

Monirehalsadat Mahmoudi, Arizona State University, Tempe AZ, United States of America, mmahmou2@asu.edu, Xuesong Zhou

Variable Message Signs (VMS) have been recognized as important tools for information provision about traffic conditions ahead on the highway such as incidents, construction, and special events. Since the installation, operation, and maintenance of a VMS is costly, this research focuses on finding an optimal set of locations for installing a limited number of VMS in a traffic network through path based and column generation approaches to minimize the total travel costs of the system.

2 - Using Social Media to Assist Traffic Flow Prediction for Scheduled Sport Event

Ming Ni, Arizona State University, Tempe AZ, University at Buffalo (SUNY), Buffalo, NY, United States of America, mingni@buffalo.edu, Qing He, Jing Gao

User-generated contents from social networks can be mined to deduce useful information about present or future travelers' behavior. For planned sporting events, the rates at which social media are created about these will measure people's attention about different games. With help of topic modeling, sentiment analysis and rates of social media, methods are developed to incorporate social media features into traffic flow prediction at the event site.

3 - How Urban Traffic Pattern Evolves? A Case Study on Fix50 Project using Crowd-sourced Taffic Data

Rui Ma, University of California, Davis, CA, United States of America, drma@ucdavis.edu, H. Michael Zhang

We present methods for using crowd-sourced traffic data to measure urban traffic performances and study the changes in traffic patterns under major highway reconstructions. The recent Fix50 project in the Sacramento metropolitan area is used as a case study to demonstrate the proposed methods.

■ SB25

Hilton- Union Sq 5

Transportation Network Assignment and Optimization

Sponsor: TSL/Urban Transportation

Sponsored Session

Chair: Amit Kumar, Purdue University, West Lafayette, IN, United States of America, kumar44@purdue.edu

1 - Alternative Path Enumeration Algorithm for Public Transit Networks

Hector A. Vergara, Assistant Professor, Oregon State University, 204 Rogers Hall, Corvallis, OR, 97321, United States of America, hector.vergara@oregonstate.edu, SeJoon Park

Many people use transit networks of public transportation for commuting or travelling. Since public transportation networks are complex, it is difficult for a traveler to find optimal paths or alternative paths between origins and destinations when a limitation on travel time is considered. This research proposes a path enumeration algorithm that efficiently enumerates feasible alternative paths using a directed acyclic graph representation of the transit network. Results for randomly generated problem instances and a realistic test case are presented.

2 - Entropy Weighted Average Method for the Determination of Unique Path-flow Solution for Static Deterministic User Equilibrium Traffic Assignment Problem

Amit Kumar, Purdue University, West Lafayette, IN, United States of America, kumar44@purdue.edu, Srinivas Peeta

This study formulates entropy weighted user equilibrium (EWUE) to determine a unique path-flow solution to the static deterministic user equilibrium traffic assignment problem. The implementation simplicity of the EWUE represents an important benefit over the maximum entropy user equilibrium (MEUE) models proposed in the past. Computational experiments illustrate the characteristics of the EWUE solution.

3 - Estimating Link Travel Time Distribution Based on Network Entry/Exit Time Stamps of Trips

Kai Yin, Nomis Solutions, yinai1000@gmail.com, Wen Wang, Bruce X. Wang, Teresa Adams

We study the link travel time estimation problem on a road network, where each vehicle has a trip observation with entry and exit time stamp. Based on the observed trip travel times of individual travelers through the network, we aim to develop a framework to estimate the traffic conditions and learn the traffic patterns on roadway links. Therefore, a statistical framework is established under the likelihood principle. We examine the basic problem on how to extract travel time distributions from sufficient sample of trip observations, and then extend the model to the case with only partial information, where part of trip trajectories are unknown and we need to infer their traversed paths simultaneously. The latter shows a unified framework of statistical modeling and assignment optimization on a transportation network. Besides, we further investigate the Bayesian approach and its impact on the estimation results.

4 - Addressing the Observability Issue in Travel Demand Estimation

Yudi Yang, UC Davis, One Shields Avenue, Davis, CA, 95616, United States of America, ydyang@ucdavis.edu, Yueyue Fan

In this paper, we present a mathematical model for travel demand estimation that integrates multiple information sources. Through mathematical analyses, we identify critical information that is needed for ensuring the observability of the problem.

■ SB26

Hilton- Union Sq 6

Location Models

Sponsor: Location Analysis

Sponsored Session

Chair: Oded Berman, Professor, University of Toronto, 105 St. George Street, Toronto, ON, M5S3E6, Canada, berman@rotman.utoronto.ca

1 - Capacity and Location Decisions in the Presence of Congestion and Disruptions

Oded Berman, Professor, University of Toronto, 105 St. George Street, Toronto, ON, M5S3E6, Canada, berman@rotman.utoronto.ca, Opher Baron, Yael Deutch

We study the problem of choosing the optimal number, capacities and locations of facilities recognizing that customers may be blocked due to a finite waiting room and facilities may fail due to disruptions. The goal is to minimize the total cost that consists of the costs of travel, blocking, capacities, disruptions and opening. We obtain structural results for special cases and develop algorithms and heuristics for solving the problem on a network.

2 - Practical Benchmarks for Location-Routing Decisions via Approximation Algorithms

Mozart Menezes, Associate Professor, University of Calgary, 2500 University Dr. NW, Calgary, AB, T2N1N4, Canada, mozart.menezes@utoronto.ca, Vedat Verter

Practitioners frequently tackle large scale location-routing problems, where a pair of good feasible solution and a lower bound on the solution of the problem, rather than exact solutions, are sufficient for them in making strategic decisions. We present a simple methodology to derive such benchmarks for assessing the current distribution network. We show that the proposed analytical framework is amenable to develop managerial insights for fairly sizeable location-routing problems.

3 - Lagrangian Decomposition for Large Inventory-Location Problems

Samir Elhedhli, Professor, Universiy of Waterloo, Waterloo, ON, Canada, elhedhli@uwaterloo.ca, Ahmed Saif

We decompose the inventory-location problem to an uncapacitated facility location problem and a number of single-variable concave minimization problems. We give a closed form expression for the optimal Lagrangian multipliers; and obtain a feasible solution and the Lagrangian bound in a single step. The approach outperforms the current literature in terms of problem sizes and computational time. For the first time, the solution of very large instances with 500 and 1000 nodes is provided.

4 - A Network Design Problem For Hazardous Materials Routing And Emergency Response Units Locating

Masoumeh Taslimi, PhD Candidate, University at Buffalo (SUNY), Industrial and Systems Engineering, Buffalo, NY, 14260, United States of America, masoumeh@buffalo.edu, Rajan Batta, Changhyun Kwon

Hazardous materials (Hazmat) transports remains regulated due to its potential risk to health, safety and environment. A bi-level Hazmat network design model is proposed to determine the available road network to Hazmat carriers and to locate the Hazmat emergency response units, simultaneously. The goal is to investigate risk equity and carriers decisions to minimize the associated transport risk.

■ SB27

Hilton- Union Sq 7

RAS Problem Solving Competition

Sponsor: Railway Applications

Sponsored Session

Chair: Xiaopeng Li, Assistant Professor, Mississippi State University, PO Box 9546, 235L Walker Hall, 501 Hardy Road, Starkville, MS, 39762, United States of America, xli@cee.msstate.edu

1 - RAS Problem Solving Competition

Xiaopeng Li, Assistant Professor, Mississippi State University, PO Box 9546, 235L Walker Hall, 501 Hardy Road, Starkville, MS, 39762, United States of America, xli@cee.msstate.edu

This session is reserved for the finalists of the RAS problem solving competition. The presenters and their abstracts won't be determined until we finish the judging process, which is probably around mid-October. The selection committee will identify the top three teams who will present their results during the session.

■ SB28

Hilton- Union Sq 8

Modeling Airline Coordination and Competition for Improving National Airspace System Performance

Sponsor: Aviation Applications

Sponsored Session

Chair: Vikrant Vaze, Assistant Professor, Dartmouth, 14 Engineering Drive, Hanover, NH, 03755, United States of America, vikrant.s.vaze@dartmouth.edu

1 - Impact of Emission Trading System on US Aviation: A Future Story

Yi Liu, University of California, Berkeley, 107 McLaughlin Hall, Berkeley, CA, 94720, United States of America, liuyi.feier@gmail.com, Vikrant Vaze, Antony Evans

Emission from aviation accounts for approximately 2% of the global total and its share of the pie is expected to increase in the future. Emission trading system as used in the European Union is a strategy to reduce emissions while allowing for considerable flexibility. In this study, we explore the impact that the emission trading system, if adopted in the US, may have on US aviation. The interesting aspects include impact on frequency, air fare and aircraft size.

2 - Efficiency, Equity and Reliability of Schedule Coordination at Congested US Airports

Alexandre Jacquillat, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Building E40-246, Cambridge, MA, 02139, United States of America, alexjacq@mit.edu, Vikrant Vaze, Amedeo Odoni

Schedule coordination at US airports can mitigate congestion but also constrains airline competition. We design and assess a schedule coordination mechanism that is non-monetary, efficient (minimizes interference with airline competition), equitable (balances fairly scheduling constraints across airlines) and reliable (meets delay reduction objectives). The approach considers operating stochasticity, the diversity of stakeholder incentives and the interdependencies of scheduling and operations.

3 - Performance-Based Air Traffic Management: Game Theoretic Models and Multi-Criteria Evaluation

Vikrant Vaze, Assistant Professor, Dartmouth, 14 Engineering Drive, Hanover, NH, 03755, United States of America, vikrant.s.vaze@dartmouth.edu, Antony Evans, Cynthia Barnhart

For designing airline-driven traffic management initiatives (TMI), we propose several mechanisms for collecting and combining airline inputs into implementable TMIs, e.g. averaging, voting and ranking. We propose multiple criteria for evaluating effectiveness of each approach, including profitability, system optimality, and equity. We apply a game-theoretic approach to examine the gaming potential and offer a broad evaluation of each approach, through theoretical and simulation-based insights.

4 - Integrated Airline Scheduling: Competition Effects from the Entry of the High-speed Rail

Luis Cadarso, Rey Juan Carlos University, Camino del Molino, s/n, Fuenlabrada, 28943, Spain, luis.cadarso@urjc.es, Vikrant Vaze, Cynthia Barnhart, Angel Marin

Airlines and high-speed rail are increasingly competing for passengers, which affects the number of served passengers and revenues. We develop an approach that generates airline schedules capturing the impacts of airlines' decisions on passenger demand. We evaluate scenarios involving the entry of high-speed rail, and validate our results using past market entries of high-speed rail. The developed model predicts the optimal decisions to retain passengers and to maximize profits.

■ SB29

Hilton- Union Sq 9

JFIG Paper Competition II

Sponsor: Junior Faculty Interest Group
Sponsored Session

Chair: J. Cole Smith, Professor, University of Florida, 303 Weil Hall, Gainesville, FL, 32611, United States of America, jcsmith@clemson.edu

Co-Chair: Shengfan Zhang, Assistant professor, University of Arkansas, United States of America, shengfan@uark.edu

1 - Competition Introduction

J. Cole Smith, Professor, University of Florida, 303 Weil Hall, Gainesville, FL, 32611, United States of America, jcsmith@clemson.edu

The 2014 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 - Performance Guarantee of Modified (r, Q) Policies for Stochastic Multi-echelon Serial Inventory Systems

Ming Hu, Assistant Professor, Rotman School of Management, University of Toronto, 105 St George Street, Toronto ON, Canada, Ming.Hu@rotman.utoronto.ca, Yi Yang

We consider the classic continuous-review N-stage serial inventory system. Any shipment to each stage incurs a fixed cost and takes a nonzero lead time. Finding a good performance guarantee remains an open problem. We construct a simple, efficiently computable, heuristic policy within a class of modified echelon (r,Q) policies and provide good provably primitive-dependent performance bounds. The heuristic is even likely to numerically outperform the optimal integer-ratio echelon (r,Q) policies.

3 - Optimal Learning with Non-Gaussian Rewards

Zi DIng, University of Maryland, Department of Mathematics, College Park MD 20742, United States of America, zding@math.umd.edu, Ilya Ryzhov

We present a new theoretical characterization of the optimal "Gittins index" policy in multi-armed bandit problems with non-Gaussian, infinitely divisible reward distributions. Our approach probabilistically interpolates the sequence of discrete-time rewards by a continuous-time, conditional Levy process, and uses optimal stopping theory to relate the value function to a free-boundary partial integro-differential equation (PIDE). We state the PIDE for exponential and Poisson rewards, prove continuity and monotonicity of the solution, and discuss numerical issues.

4 - Unbalanced Random Matching Markets: The Stark Effect of Competition

Itai Ashlagi, MIT, 100 Main St., Cambridge MA, United States of America, iashlagi@mit.edu, Yash Kanoria, Jacob Leshno

We characterize the core in random matching markets with unequal numbers of men and women. We find that even the slightest imbalance leads to harsh competition on the long side. With high probability the core is small, in the sense that a vanishing fraction of agents have multiple stable partners. Further, under any stable matching, approximately, the short side ``chooses″ and the long side is "chosen″. Simulations show that these features are observed even in small markets.

■ SB30

Hilton- Union Sq 10

Planning and Scheduling Issues in Service and Manufacturing Systems

Cluster: Scheduling and Project Management
Invited Session

Chair: Chelliah Sriskandarajah, Professor, Mays Business School, Texas A&M University, 320Q, Wehner Building, College Station, TX, United States of America, chelliah@mays.tamu.edu

1 - Scheduling Unit-trains for Minimizing the Cost of Deadheading and Lite Train Movements

Manoj Vanajakumari, Associate professor, Texas A&M University, 3367 TAMU, College Station, TX, 77843, United States of America, manojuv@tamu.edu, William Oates, Chelliah Sriskandarajah

Unit trains operate between two stations that are not on regular routes. Railroad companies face challenges in scheduling unit trains which include ensuring the availability of locomotives at the origin stations for the train movement. We solve a unit-train scheduling problem for a major North American railroad company the solution methodologies, and results.

2 - Outpatient Appointment Scheduling under Patient No-Shows and Patient Heterogeneity

Seung Jun Lee, PhD Student, Texas A&M University, 320M Wehner Bldg. Tamu, College Station, TX, United States of America, sjlee@mays.tamu.edu, Gregory R. Heim, Yunxia Zhu, Chelliah Sriskandarajah

In this study, we study an outpatient appointment scheduling system under patient no-shows and patient heterogeneity with different policies (base model, overbooking, and open-access model). We evaluate and compare the performances of these proposed policies based on our block scheduling policy to provide optimal policies for outpatient clinics.

3 - U.S. Coin Supply Chain: Supply, Recycling and Inventory Management

Yiwei Huang, Mays Business School, Texas A&M University, 320R, Wehner Building, College Station, United States of America, yhuang@mays.tamu.edu, Neil Geismar, Chelliah Sriskandarajah

We investigate operational issues in the U.S. Coin Supply Chain and develop models to make the recirculation of coins more economical and efficient for the society. From the social perspective, we propose a coin exchange mechanism to coordinate the U.S. Coin Supply Chain and to minimize the societal cost of supplying coins nationwide.

4 - Increasing the Efficiency of Currency Supply within a Region in Banknote Supply Chain

Yunxia Zhu, Assistant Professor, Rider University, 2083 Lawrenceville Rd, Lawrenceville, NJ, 08648, United States of America, yuzhu@rider.edu, Chelliah Sriskandarajah, Subodha Kumar, Sara Rodriguez-Sanchez

We study the problem faced by regional banks in managing the currency supply in banknote supply chain with distinct features due to security concerns. After deriving a polynomial-time strategy to guarantee an optimal solution for the special bin-packing problem faced in this study, we provide an MIP formulation for this supply planning problem. We also propose four polynomial-time algorithms for deriving either optimal or near-optimal solutions for the problem under four different settings.

■ SB31

Hilton- Union Sq 11

Online Reviews of Services: An Examination of Their Content, Structure and Impact

Sponsor: Service Science

Sponsored Session

Chair: Rebecca Hamilton, Associate Professor, University of Maryland, R.H. Smith School of Business, 3456 Van Munching Hall, College Park, MD, 20742, United States of America, rhamilto@rhsmith.umd.edu

1 - Online Reviews of Credence Services: Content, Credibility, and Usefulness

Shannon Lantzy, Doctoral Candidate, University of Maryland, 3330M Van Munching Hall, College Park, MD, 20904, United States of America, slantzy@rhsmith.umd.edu, Rebecca Hamilton, Katherine Stewart

We study the content, structure, and consumer perceptions of online reviews for credence services. We find credence reviews systematically differ from reviews of experience services and are more likely to contain unsupported claims. We experimentally examine consumer perceptions of reviews: consumers discount the credibility of credence claims of short, simple reviews but we expect more complex argument structure and inclusion of experience attributes in the review to attenuate this effect.

2 - Word-of-Mouth vs. Word of Health Inspectors: Evidence from Restaurant Reviews

Chenhui Guo, University of Arizona, 1130 E. Helen, Tucson, AZ, 85721, United States of America, chguo@email.arizona.edu, Paulo Goes, Mingfeng Lin

We study the effect of disclosing health inspection results on the word-of-mouth generated by consumers. Using data from a popular website for restaurant reviews around the time of a policy change, we exploit temporal and spatial variations to identify the effect on several important metrics of word-of-mouth.

3 - Dynamics of Social Tagging Networks: Insights for Retail Demand Forecast

P. K. Kannan, University of Maryland, Smith School of Business, College Park, MD, United States of America, PKannan@rhsmith.umd.edu, William Rand, Hyoryung Nam

Products and service experiences are related to ideas, concepts and beliefs, and as interest in those ideas, concepts and beliefs change so does consumer interest in those products/services. This presentation investigates whether the position of products on social tagging networks can predict sales dynamics in a retail context.

4 - Controlling for Self-Selection Bias in Customer Reviews

Dina Mayzlin, University of Southern California, 3660 Trousdale Parkway, ACC 306E, Los Angeles, CA, 90089-0443, United States of America, mayzlin@marshall.usc.edu, David Godes, Leif Brandes

Customers frequently use user online reviews as a valuable information resource before making a purchase. One critique of reviews as a source of information is the self-selection in the review process: consumers self-select into choosing whether to review a product, which suggests that reviews may be prone to the extremity bias. We propose a method to control for this bias.

■ SB32

Hilton- Union Sq 12

Service Science in the Emerging Markets

Sponsor: Service Science

Sponsored Session

Chair: Qiang Qiang, Penn State Univ., 30 E. Swedesford Rd., Malvern, PA, 19355, United States of America, qzq10@psu.edu

1 - Quantifying the Bullwhip Effect in Service Supply Chain Networks of the Emerging Markets

Xiaowei Zhao, Tongji University, Dept of Management Science & Engineering, 1239 Siping Road, Shanghai, 200092, China, zhaoxiaowei119@126.com, Jiantong Zhang

In this paper, we quantify the bullwhip effect in service supply chain networks of the Emerging Markets. Our model includes two of the factors commonly assumed to cause the bullwhip effect in services: time delays and work backlogs. Then we propose a relative strategy with the fuzzy robust control method to reduce the bullwhip effect. Finally, an example is provided to illustrate the effectiveness of the proposed method.

2 - Competition of Online Shopping Malls with Logistics Investment

Yihong Hu, Assistant Professor, Tongji University, Economics and Management School,, No 1239, Siping Road, Shanghai, China, fox2002cn@gmail.com

We studies the competition between the online shopping malls based on price and logistics delivery service. The competition model between online shopping malls is constructed. The existence of Nash equilibrium is proved and the properties in the equilibrium is provided. The market structure analysis disclose that the total cost coefficient determines the winners in the competition.

3 - Rail Transit Passenger Behavior Model and Simulation in Emergencies Based on Multi-Agent System

Haifeng Zhao, Tongji University, Room 611,Block A, Tongji Building, No1. Zhangwu Road, Yangpu Distirct, Shanghai, 200092, China, hfzhao@tongji.edu.cn, Yi Dong

With the increasing population, rail transit is facing more frequent emergencies. The model, based on Multi-Agent System, is developed to establish passenger route choice algorithm and to describe the behavior of passengers. Through simulation, it finds that the conformity behavior of passengers will be disadvantageous to the evacuation, and the direction from external environment can reduce the influence of conformity. The result will provide theoretical basis of making the evacuation plan.

4 - International Financial Networks with Socially Responsible Investing

Ke Ke, Associate Professor, Central Washington University, 2400 S. 240th St, POBox 13490, Des Moines, WA, 98198, United States of America, kekegrace@yahoo.com

Although the research on SRI has increased significantly, the majority of them are focused on qualitative or empirical study. This research will extend my earlier paper (Qiang, Ke and Hu (2013)) regarding the modeling of financial networks with SRI to incorporate globalization and exchange rate risk. To be more specific, a framework for a multitiered international financial network with SRI will be developed where both the fund sources and the intermediaries are multicriteria decision-makers.

5 - Research on Dynamic SERVQUAL Model Based on QFD

Lixin Cui, Beijing Institute of Technology, Beijing, China cuilixin@bit.edu.cn, Renhe Shi

Both conventional SERVQUAL model and the QFD method have their own limitations. In this article,to constitute the dynamic SERVQUAL model based on QFD,we add the 22 dimensions of SERVQUAL model to the HOQ matrix,as well as the time dimension. This model combines customer requirements of service quality with technical methods of service enterprise. With the support of multi-period data, we can forecast dynamic customer requirements more effectively by using the GM(1,1) model with boundary value modified,which will provide support for the service enterprise to make efficient decisions.

■ SB33

Hilton- Union Sq 13

Technology Adoption and Innovation Management as a Search Process

Cluster: New Product Development

Invited Session

Chair: Raul Chao, University of Virginia, 100 Darden Blvd, Charlottesville, VA, 22902, United States of America, chaor@darden.virginia.edu

1 - Centrality and Misalignments in Complex New Product Development Projects

Javad Nasiry, Assistant Professor, HKUST, LSK Building, HKUST, Hong Kong, Hong Kong - PRC, nasiry@ust.hk, Michael Kirley, Mohsen Jafari Songhori

There are two forms of misalignments between product and organizational structures in complex new product development projects: interaction and interface misalignments. In a model of product design as a search on a rugged landscape, we model misalignments as design teams searching on a "perceived" rather than "real" landscape. We then study the effects of component centrality and misalignments on the project performance and convergence characteristics.

2 - Impact of Sequence and Timing of Information Technologies Adoption on Hospital Performance

Luv Sharma, The Ohio State University, 600 Fisher Hall, Columbus, OH, 43210, United States of America, sharma.154@buckeyemail.osu.edu, Aravind Chandrasekaran

This paper looks at the sequence of adoption of Health Information Technologies for 3600 US hospitals to identify ideal sequences of adoption. Deviations from the ideal sequences in terms of the order of adoption and the timing between adoption of technologies is conducted and performance implications studied.

3 - Knowledge Transfer in Product Development Projects
Wenli Xiao, Assistant Professor, University of San Diego, 5998
Alcala Park, San Diego, CA, 92110, United States of America,
wenlixiao@sandiego.edu, Cheryl Gaimon

We use a dynamic model to explore a manager's pursuit of a new product
development (NPD) project and an existing product improvement (EPI) project. A
key feature of our model is the characterization of the knowledge transfer process
from the NPD project to the EPI project. We identity the optimal knowledge
development strategies for both projects and the optimal strategy for knowledge
transfer. Lastly, we provide results in how different parameters impact the
manager's optimal decisions.

4 - On the Effectiveness of Patenting Strategies in Innovation Races
Fabian Sting, Rotterdam School of Management, Erasmus
University, Burgemeester Oudlaan 50, Rotterdam, Netherlands,
fsting@rsm.nl, Jurgen Mihm, Tan Wang

Which inventions should a company patent? We develop an integrative framework
of patenting strategies and contingencies for innovation races. Based on technology
landscape simulations we identify competitive dynamics as the most salient
determinant of the firm's patenting strategy. Thus our research contributes to
establishing a contingency theory of patenting strategies.

■ SB34

Hilton- Union Sq 14

Optimization and Modeling For Election Systems

Sponsor: Public Programs, Service and Needs
Sponsored Session

Chair: Theodore Allen, Associate Professor, The Ohio State
University, 1971 Neil Avenue, 210 Baker Systems, Columbus, OH,
43210, United States of America, allen.515@osu.edu

**1 - Convergent Algorithms for Satisfying Standards with
Election System**
Muer Yang, Assistant Professor, Opus College of Business,
University of St. Thomas, 1000 LaSalle Ave, Minneapolis, MN,
55403, United States of America, yangmuer@stthomas.edu,
Theodore Allen

We present methods for determining the minimum resources to meet service
objectives using simulation both for individual systems (Straddling a Standard) and
across multiple parallel systems (Service Constrained Minimax Optimization). We
describe proofs of rigor and implications for President Obama's guarantee of less
than 30 minutes of waiting time.

**2 - Feasible Allocation thru Iterative Relaxations with
Election Systems**
Theodore Allen, Associate Professor, The Ohio State University,
1971 Neil Avenue, 210 Baker Systems, Columbus, OH, 43210,
United States of America, allen.515@osu.edu, Muer Yang

We present an algorithm for minimizing the maximum waiting time across parallel
systems. We describe the proof of its properties and its real world applicability in
election systems. Also, results illustrate that dramatic reductions in computation
times compared with greedy methods making the methods more usable.

**3 - Methods for Estimating the Number of Deterred Voters
in Elections**
Shijie Huang, Performance Improvement Consultant, Carilion
Clinic, P.O. Box 13367, Roanoke, VA, 24014, United States of
America, skylovtata@gmail.com, Theodore Allen

This article proposes several methods for estimating the number of would be voters
who are deterred from voting because of current or past waiting lines. The
methods include linear regression, queuing-based imputation, and simulation-
based imputation. We use data from recent elections in Florida and Ohio to
illustrate and compare the alternative approaches.

**4 - Sequential Kriging Optimization to Determine the Cost Effective
Number of Early Voting Days**
Sayak Roychowdhury, Graduate Research Associate, The Ohio State
University, Integrated Systems Engineering, 1971 Neil Avenue,
Columbus, OH, 43210, United States of America,
roychowdhury.6@osu.edu, Theodore Allen

We propose a simulation model of waiting lines, cost, and turnout as a function of
the number of early voting days. Then, we describe results from optimizing this
model using Sequential Kriging Optimization with objectives ranging from
increasing turnout to reducing costs. We use data from real elections to illustrate.

■ SB35

Hilton- Union Sq 15

Routing for Public Needs

Sponsor: Public Programs, Service and Needs
Sponsored Session

Chair: Burcu Keskin, Associate Professor, University of Alabama, 300
Alston Hall, Tuscaloosa, Al, 35487, United States of America,
bkeskin@cba.ua.edu

**1 - Optimizing Itineraries in Public Transportation with Walks between
Rides**
Bram De Jonge, University of Groningen, P.O. Box 800, 9700 AV,
Groningen, Netherlands, b.de.jonge@rug.nl, Ruud Teunter

We optimize itineraries in public transportation, where we allow travelers to
alternate rides with walks. We derive theorems for identifying a small subset of all
possible walks that need to be considered, and test the results in a real-life setting
for bus transportation in a medium sized city. It turns out that (a) only one per
cent of all possible walks needs to be considered, and (b) that allowing walks
reduces the travel time in 6 per cent of all cases by more than 10 per cent on
average.

**2 - School Bus Routing with Stochastic Demand and
Duration Constraints**
Hernan Caceres, Ph.D. Student in IE, University at Buffalo, 342 Bell
Hall, University at Buffalo, Buffalo, NY, 14260-2050, United States
of America, hernanan@buffalo.edu, Qing He, Rajan Batta

We propose a model of the school bus routing problem responding to the
overbooking policies applied at a real-world school district, where the probability
of a student using the bus varies from 22% to 77%. Overbooking is modeled via
chance constrained programming, and it aims to improve their capacity utilization.
Additionally, the uncertainty of travel time is also considered. The district-problem
is partitioned into each school and solved sequentially, using column generation
for each one.

3 - OAR Lib: An Open Source Arc Routing Library
Oliver Lum, Graduate Student, University of Maryland, College
Park, 11604 Parkedge Drive, Rockville, MD, 20852,
United States of America, oliver@math.umd.edu, Bruce Golden,
Carmine Cerrone, Edward Wasil

We present computational results for a new Open Source Arc Routing Library
(OAR Lib). This Java library provides an extensible graph architecture and solvers
for problems in the field of arc routing. This library will allow researchers to begin
writing their own code quickly.

**4 - An Improved Formulation for the Maximum Coverage Patrol
Routing Problem**
Ibrahim Capar, Graduate Research Assistant, ISM Dept. 300 Alston
Hall, 361 Stadium Drive, Tuscaloosa, Al, 35487-0226, United States
of America, icapar@cba.ua.edu, Paul Rubin, Burcu Keskin

The main goal of the patrol routing problem is to maximize the coverage of critical
highway stretches while ensuring feasibility of routes. By using the structural
properties of the solution, we formulate an improved MIP that can solve large
instances to optimality within seconds, where methods in literature failed to find
provably optimal solutions. We show an average increase in coverage of 20% for
the randomly generated instances provided in literature, with a best case increase
over 46%.

■ SB36

Hilton- Union Sq 16

Decomposition Techniques for Network Design

Sponsor: Telecommunications
Sponsored Session

Chair: Bernard Fortz, Professor, Université Libre de Bruxelles, GOM
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bernard.fortz@ulb.ac.be

Co-Chair: Dimitri Papadimitriou, Pr. Eng. Research, Bell Labs,
Copernicuslaan 50, Antwerp, 2018, Belgium,
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**1 - Reliability-based Combined Network Design and
Routing Optimization**
Dimitri Papadimitriou, Pr.Eng.Research, Bell Labs, Copernicuslaan
50, Antwerp, 2018, Belgium, dimitri.papadimitriou@alcatel-
lucent.com, Bernard Fortz

The combined network design and routing problem with time-dependent demands
generalizes the fixed charge network design problem. This problem can be
formulated as a multi-period mixed integer optimization problem. As

decomposition techniques overcome the computational limit to solve such problem, we extend its formulation to account for failure patterns affecting installed arcs over time. We analyze the formulation with different reliability functions to derive the best arc replacement strategy.

2 - Lagrangian Decomposition for the Two-Level FTTx Network Design Problem
Andreas Bley, University of Kassel, Institute for Mathematics, Heinrich-Plett-Str. 40, Kassel, 34132, Germany, andreas.bley@mathematik.uni-kassel.de, Olaf Maurer, Ivana Ljubic

We address the design of a passive optical telecommunication network, where clients are connected via an intermediate level of distribution points to some central offices in a tree-like fashion. We discuss a Lagrangian algorithm that decomposes the problem based on the cost structure and solves the subproblems using advanced MIP techniques. Our computational results for realistic instances show that this approach yields high quality solutions and bounds requiring only little computing time.

3 - A Computational Comparison of Approaches to Lagrangian Duals: The Case Study of FC-MMCF
Enrico Gorgone, Université Libre de Bruxelles, Bld du Triomphe, 1040, Belgium, egorgone@ulb.ac.be, Bernard Gendron, Antonio Frangioni

The focus of this work is to compare a large set of approaches for solving Lagrangian duals of combinatorial problems. In particular we compare different nonsmooth optimization methods like (incremental, deflected, projected) subgradient-type algorithms and (disaggregated, generalized) bundle-type algorithms. We use as a test set the multicommodity capacitated network design problem (FC-MMCF), a problem arising in many different applications such as logistics and transportation.

4 - Spanning Trees with Variable Degree Bounds
Pedro Moura, Univ of Lisbon, Centro de InvestigaÁ„o Operacional, Bloco C6 - Piso 4- Campo Grande, Lisboa, 1749-016, Portugal, pmmoura@fc.ul.pt, Amaro de Sousa, Luis Gouveia, Mario Ruthmair

We study a generalization of the Degree Constrained Minimum Spanning Tree problem where we may install one of several transmission systems (TS) in each edge. We discuss a particular case in the design of wireless mesh networks where the degree of the endnodes of each edge depends on the TS installed on it and on the length of the edge. We propose 3 different models and compare them and the corresponding LP relaxations from a theoretical perspective as well as from a computational point of view.

■ SB37

Hilton- Union Sq 17

Analyzing Social Networks and Social Media II
Sponsor: Artificial Intelligence
Sponsored Session

Chair: Kang Zhao, Assistant Professor, University of Iowa, S224 PBB, Iowa City, IA, 52242, United States of America, kang-zhao@uiowa.edu

1 - Early Prediction of Movie Success – Social Network Perspective
Michael Lash, The University of Iowa, michael-lash@uiowa.edu, Kang Zhao

Recently, the movie industry has seen tremendous growth. . While many previous studies have focused on gross revenue, this research addresses profitability, an aspect that is more important to investors. Our prediction leverages characteristics of actors and their social networks, as such information is usually available in early stages of movie production, when investment decisions are made. Our model can determine movie success with decent accuracy early on in the production process.

2 - Efficient Respondents Selection for Biased Survey using Online Social Networks
Jiaofei Zhong, Assistant Professor, University of Central Missouri, 121 E Hunt Ave, #301, Warrensburg, MO, 64093, United States of America, fayzhong08@gmail.com, Minhyuk Lee, Deying Li, Yingshu Li, Alade Tokuta, Donghyun Kim

Online social networks provide rich sources of data for us to learn about our society, and online surveys are an essential tool for many applications. One important issue is to select a good respondent group so that the survey result is reliable. We investigate the use of online social network to form a biased survey respondent group that is useful for certain applications. We present a new optimization problem MIkCDSP, show its NP-hardness, and introduce a greedy approximation algorithm for it.

■ SB38

Hilton- Union Sq 18

Data-Driven Research in Healthcare
Cluster: Healthcare Systems and Medical Informatics
Invited Session

Chair: Masha Shunko, Purdue University, 403 W. State Street, West Lafayette, IN, 47906, United States of America, mshunko@purdue.edu

1 - Evaluation of Inventory Technologies for Operating Rooms
Vera Tilson, Simon School, University of Rochester, Rochester, NY, United States of America, vera.tilson@simon.rochester.edu, Greg Dobson, Abraham Seidmann

After labor, supply chain costs are the second-largest expense for hospitals, constituting up to 40% of the total operating budget. According to a recent PWC study perioperative services account for approximately 61% of these costs. We examine the issue of supply and inventory planning in operating rooms, and evaluate the benefits of standardization and of using technologies such as bar codes and RFIDs.

2 - Ranking Healthcare
Ping H. Huang, Research Scientist, Regenstrief Center for Healthcare Engineering, Purdue University, West Lafayette, IN, 47906, United States of America, huang74@purdue.edu

Many initiatives call for the dissemination of transparent data based on the assumption that it will lead to cost-effective healthcare. As healthcare providers face large volumes of data, they require decision-making assistance to become informed decision-makers. We develop a ranking method that accounts for multiple criteria but avoids the bias of assigning weight for each criterion. Our illustrated examples include hospital rankings for patients as well as patient stratification for providers.

3 - Impact of Ambulance Diversion Ban on Emergency Departments' Length of Stay
Ahmad Ashkanani, Purdue University, Krannert School of Management, 403 W. State Street, West Lafayette, IN, 47907, United States of America, aashkana@purdue.edu, Masha Shunko, Ping H. Huang

Emergency department (ED) crowding poses a serious threat to the access and quality of health care in the US. Many EDs use ambulance diversion (AD) practices in an effort to alleviate ED crowding. The state of Massachusetts (MA) issued a statewide ban in 2009 ending the AD practice. We study the impact of the AD ban on ED length of stay using 2008 and 2009 ED data from MA.

4 - Managing Hospital Inpatient Bed Capacity through Partitioning Care into Focused Wings
Thomas Best, Doctoral Candidate, The University of Chicago Booth School of Business, 5807 S Woodlawn Ave, Chicago, IL, 60637, United States of America, tbest@chicagobooth.edu, David Meltzer, Burhaneddin Sandikci, Donald Eisenstein

We provide an optimization framework to support a hospital administrator, who chooses between pooling inpatient demand and bed capacity, and forming specialized wings to focus on narrow ranges of care types. Specialized wings not only provide advantages from focused care, but also allow the protection of beds for high utility care types. Using data from an urban teaching hospital and a national database, we discuss our model's solutions and managerial insights.

■ SB39

Hilton- Union Sq 19

Decision-Making for Population Health Outcome Interventions
Sponsor: Health Applications
Sponsored Session

Chair: Monica Gentili, University of Salerno, Via Giovanni Paolo II n. 132 - 84084, Fisciano (SA), Italy, mgentili@unisa.it

1 - A Standard Acquisition Charge Model for a National Kidney Exchange Program
Andrew Schaefer, William Kepler Whiteford Professor, The University of Pittsburgh, 1048 Benedum Hall, 3700 O'Hara Street, Pittsburgh, PA, 15261, United States of America, schaefer@pitt.edu, Amin Dehghanian

Kidney exchange is a rapidly growing approach to solve the shortage of kidneys for transplantation. A major challenge to establish a national kidney exchange program is the establishment of the proper incentives for transplant centers to participate. We develop a mathematical program that explores payment strategies and maximizes a social welfare criterion subject to individual rationality and incentive compatibility constraints of transplant centers.

2 - Diffusion of Information in Diabetes Care

John Birge, Jerry W. and Carol Lee Levin Professor of Operations Management, University of Chicago Booth School of Business, 5807 S Woodlawn Ave, Chicago, IL, 60637, United States of America, john.birge@chicagobooth.edu, Vishal Ahuja

We evaluate the changes in prescription patterns of an anti-diabetic medication during the time period when health warnings were issued by FDA related to drug. Using data on diabetic patients from the Department of Veterans Affairs, we identify the regional variation in the prescription patterns to study the diffusion of information and examine operational factors that promote physician learning.

3 - The Impact of Geographic Access on Severe Health Outcomes for Pediatric Asthma

Erin Garcia, Georgia Institute of Technology, Atlanta, GA, 30332, United States of America, egarcia3@gatech.edu, Nicoleta Serban, Julie Swann

Access to medical care and severe pediatric asthma outcomes vary with geography. We measure geographic access to primary and asthma specialist care using mathematical optimization models and estimate the association between outcomes and access in the presence of other factors using logistic regression. The model is used to project the reduction in severe outcomes with improvement in access. To gain maximum benefit interventions should be targeted to areas with the greatest potential improvement.

4 - Chemotherapy Capacity Planning

Leah Weber, Operations Research Scientist, BC Cancer Agency, 600 W 10th Ave, Vancouver, BC, V5Z 4E6, Canada, leah.weber@bccancer.bc.ca, Claire Ma, Antoine Sauré, Emma Liu, Martin Puterman

Chemotherapy treatment within Canada is in high demand and there are currently insufficient resources to meet demand in a timely manner, leading to long wait times for new patient appointments and, consequently, the potential for the patient's disease to progress further. In order to ensure demand for treatment is met in a timely manner, we are developing a long-term resource planning strategy for the BC Cancer Agency that will aid in matching staffing requirements with demand levels.

■ SB40

Hilton- Union Sq 20

Appointment Scheduling

Sponsor: Health Applications
Sponsored Session

Chair: Van-Anh Truong, Assistant Professor, Columbia University, 500 West 120th St, New York, NY, 10027, United States of America, vt2196@columbia.edu

1 - Optimal Advance Scheduling

Van-Anh Truong, Assistant Professor, Columbia University, 500 West 120th St, New York, NY, 10027, United States of America, vt2196@columbia.edu

The dynamic assignment of advance appointments has been considered to be especially challenging due to its high-dimensionality. For a canonical model with two patient classes, we derive an elegant characterization of an optimal policy and an efficient algorithm to compute the policy exactly. We introduce the property of successive refinability, which allows advance schedules to be easily computable and under which there is no cost to the system to making advance commitments to patients.

2 - Managing Customer Arrivals in Service Systems with Multiple Servers

Christos Zacharias, New York University, Stern School of Business, New York, NY, 10012, United States of America, czachari@stern.nyu.edu

We analyze a discrete multi-server queueing model for scheduling customer arrivals in service systems with parallel servers. Theoretical and heuristic guidelines are provided for the effective practice of appointment overbooking to offset no-shows. The benefits of resource-pooling are demonstrated in decreasing operational costs and increasing customer throughput.

3 - Managing Patient Admissions in a Neurology Ward

Saied Samiedaluie, Post-Doctoral Fellow, University of British Columbia, E204 - 4500 Oak Street, Vancouver, BC, V6H 3N1, Canada, samiedal@mail.ubc.ca, Beste Kucukyazici, Vedat Verter, Dan Zhang

We study patient admission policies in a neurology ward where there are multiple types of patients with different medical characteristics. We formulate this problem as an infinite-horizon average cost dynamic program and propose an efficient approximation scheme. The computational results from applying our model to a neurology ward show that dynamic policies generated by our approach can reduce the overall deterioration in patients' health status compared to several static policies.

■ SB41

Hilton- Union Sq 21

Healthcare Modeling for Efficient Policy Decisions

Sponsor: Health Applications
Sponsored Session

Chair: Sze-chuan Suen, Stanford University, 117 Encina Commons, Stanford, United States of America, ssuen@stanford.edu

1 - Cost-effectiveness of Oral PrEP as HIV Prevention for Injection Drug Users in the United States

Cora Bernard, PhD Student, Stanford University, 9074 Great Dome Ct, Fair Oaks, CA, 95628, United States of America, clb210@stanford.edu, Chris Weyant, Margaret Brandeau, Jeremy Goldhaber-Fiebert, Douglas K. Owens

The US Centers for Disease Control and Prevention recently recommended oral pre-exposure prophylaxis (PrEP) for HIV prevention among at-risk individuals in the US. We use a dynamic compartmental model combined with an economic model to assess the cost-effectiveness of PrEP in the US IDU population. We evaluate cost-effectiveness as function of level of risk behavior and adherence to PrEP.

2 - Cost Effectiveness of Sofosbuvir-based Treatment for Hepatitis C in U.S. Incarcerated Populations

Shan Liu, Assistant Professor, Industrial and Systems Engineering, University of Washington, UW Box 352650, Seattle, Wa, 98195-2650, United States of America, liushan@uw.edu, Daena Watcha, Mark Holodniy, Jeremy Goldhaber-Fiebert

The prevalence of chronic hepatitis C virus (HCV) infection is estimated at 12-35% among U.S. incarcerated populations, where we assessed the cost-effectiveness of newer sofosbuvir-based therapy. We developed a decision-analytic Markov model that included the natural history of chronic HCV and combinations of treatment options both in and out of prisons; and the possibility of reinfection. We found sofosbuvir-based therapy is cost-effective for long and short-term incarcerated individuals.

3 - Cost-effectiveness of Rapid Diagnostics and Care Systems Improvements for Tuberculosis in India

Sze-chuan Suen, Stanford University, 117 Encina Commons, Stanford, United States of America, ssuen@stanford.edu, Kimberly Babiarz, Eran Bendavid, Jeremy Goldhaber-Fiebert

We evaluated the cost-effectiveness of novel drug susceptibility testing technologies, private patient referrals to more effective public clinics (PPM), and combinations of these policies in India. Using a dynamic transmission microsimulation model, we found that rapid TB and drug susceptibility testing provide benefits at costs below 3-times India's per-capita GDP. The combination of PPM with rapid drug susceptibility testing provides benefits at costs below 1-time per-capita GDP.

4 - Cost-effectiveness of Multiple Sclerosis Disease-modifying Therapy: Accounting for Patient Risk

Allie Leeper, Stanford University, 475 Via Ortega, Stanford, United States of America, allie105@stanford.edu, Alexandra Goodyear, Douglas K. Owens, Jeremy Goldhaber-Fiebert

Objective: We assess cost-effectiveness of glatiramer acetate (GA) and dimethyl fumarate (DMF) for patients with multiple sclerosis using a microsimulation model to account for variation in patient risk for long-term disability. Results: At full prices, both drugs yield health benefits at high costs relative to no drug. For clinical cases where drug therapy is indicated, DMF costs $99,000 per QALY gained compared to GA. Both drugs yield better value for money for high-risk patients.

■ SB42

Hilton- Union Sq 22

Stochastic Models on Medical Decision Making

Sponsor: Health Applications
Sponsored Session

Chair: F. Safa Erenay, University of Waterloo, 200 University Ave. CPH 4323, Waterloo, ON, N2L 3G1, Canada, ferenay@uwaterloo.ca

1 - Evaluate the Importance of Different Clostridium Difficile Sources in Hospital Setting by Agent Base

Biao Wang, PhD Candidate, University of Waterloo, 200 University Avenue, Waterloo, ON, Canada, b67wang@uwaterloo.ca, Kenneth McKay, William Ciccotelli

An agent based simulation of C. Difficile spread in a public hospital is developed using data from the hospital and literature. The simulation results suggest that the admission of asymptomatic patients in the ward could be the major source of hospital acquired C. difficile infection (CDIs). This observation is consistent with recent findings in the literature that diverse sources might exist for the hospital acquired CDI transmission.

2 - Optimal Design of the Annual Influenza Vaccine with Manufacturing Autonomy

Osman Ozaltin, Assistant Professor, North Carolina State University, Industrial and Systems Engineering, Raleigh, United States of America, oyozalti@ncsu.edu, Oleg Prokopyev, Andrew Schaefer

Seasonal influenza is a major public health concern, and the first line of defense is the flu shot. We propose a bilevel multi-stage stochastic mixed-integer program that maximizes societal benefit of the flu shot under autonomous profit maximizing manufacturers. Calibrated over publicly available data, our model returns the optimal flu shot composition and timing in a stochastic and dynamic environment. We derive analytical results, and perform extensive numerical experiments.

3 - Colonoscopy Surveillance for Metachronous Colorectal Cancer Prevention and Early Detection

F. Safa Erenay, University of Waterloo, 200 University Ave. CPH 4323, Waterloo, ON, N2L 3G1, Canada, ferenay@uwaterloo.ca, Oguzhan Alagoz, Adnan Said

Colorectal cancer (CRC) survivors have high risk of developing metachronous CRC (MCRC). We developed a discrete-event simulation model and compared the effectiveness of possible colonoscopy surveillance policies for MCRC prevention and early-diagnosis in a cost-utility analysis setting based on data from MAYO Clinic, Rochester. We derived the Pareto-efficient policies in the spectrums of MCRC risk, total cost, total quality adjusted life years, and expected number of required colonoscopies.

■ SB43

Hilton- Union Sq 23

Joint Session ICS/OPT: Global Optimization and Mixed-Integer Nonlinear Programming II

Sponsor: Computing Societ & Optimization

Sponsored Session

Chair: John Chinneck, Professor, Carleton University, Systems and Computer Engineering, 1125 Colonel By Drive, Ottawa, On, K1S 5B6, Canada, chinneck@sce.carleton.ca

Co-Chair: Leo Liberti, IBM TJ Watson Research Center, Yorktown Heights, Yorktown Heights, PA, United States of America

1 - Multidimensional Piecewise Linear Approximation Strategies for Nonlinear Programs

Leon Lasdon, University of Texas, Austin, TX, United States of America, lasdon@utexas.edu, Anant Balakrishnan, Vivek Vasudeva

Piecewise linear approximation (PLA) solves NLP's by approximating the non-linear functions by piecewise linear interpolations over a grid, imposing adjacency conditions on the grid point weights, and solving the resulting MILP. This has been extended to nonseparable functions of several variables. We discuss features and computational experience with our implementation of PLA, including grid shapes, speeding up the MILP, and problem reformulations. The approach has promise in finding near-optimal solutions of nonconvex NLP's and MINLP's.

2 - Piecewise-linear Approximations for MIQCP and Global Optimization of Electrical Power Flow Problems

James Foster, Postdoctoral Research Associate, University of Wisconsin/WID, Wisconsin Institute for Discovery, 330 North Orchard Street, Madison, WI, 53715, United States of America, jfoster@discovery.wisc.edu, Natashia Boland, Hamish Waterer

We present a novel global optimization approach to solving nonconvex power flow optimization problems. We describe a systematic approach to constructing minimal-error piecewise-linear approximations of the two-dimensional paraboloid function using the framework of the Delaunay triangulation and majorization theory. This analysis is applied to the problem of creating disjunctive outer approximations of indefinite quadratic constraints using MIP models with a limited number of integer variables.

3 - Generating Multi-row Simplex Cuts on Higher Dimensional Spaces

Emre Yamangil, Graduate Assistant, Rutgers University, 100 Rockafeller Road, Piscataway, NJ, 08854, United States of America, emreyamangil@gmail.com, Endre Boros

We consider the problem of generating a lattice-free convex set to find a valid inequality that minimizes the sum of its coefficients for multi-row simplex cuts. We formulate this problem as a fixed-dimensional semi-infinite disjunctive program on higher dimensional spaces. We investigate equivalent simplifications of this problem for efficiency and conclude with a numerical study on MIPLIB that shows improvement at the root gap.

■ SB44

Hilton- Union Sq 24

Digital and Social Media

Sponsor: Information Systems

Sponsored Session

Chair: Jui Ramaprasad, McGill University, 1001 Sherbrooke West, Montreal, QC, H3A 1G5, Canada, jui.ramaprasad@mcgill.ca

1 - Peer Influence in Academic Performance

Pedro Ferreira, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, United States of America, pedrof@cmu.edu, Ryan Turner, Rodrigo Belo

We track the usage of the wi-fi network on a college campus by engineering students to define networks of friends – those students that log to the same access point at the same time for most of the academic year. Using a panel with 3 years of data, we show that friends' grades influence one's grades. This result is obtained using randomization to separate the effect of peer influence from homophily and from other potentially unobserved covariates that might lead to correlation in grades.

2 - Reducing Medical Bankruptcy through Crowdfunding: Evidence from GiveForward.com

Jason Chan, Stern School of Business, New York, NY, United States of America, jcc534@stern.nyu.edu, Gordon Burtch

This paper examines the potential of medical crowdfunding in reducing bankruptcy. Medical crowdfunding is a relatively recent phenomenon where patients reach out to their social network for monetary support towards medical causes. We combine proprietary fundraising data with bankruptcy filing records in our analyses and find that medical crowdfunding reduce the financial burden faced by individuals on the brink of bankruptcy. This relationship is robust to alternative model specifications.

3 - Value of Following Network and User Interest in Social Advertising Targeting

Hyelim Oh, McGill University, Montreal, Canada, hyelim.oh@mail.mcgill.ca, Animesh Animesh, Alain Pinsonneault

This study investigates how firms can improve the effectiveness of social advertising by leveraging the viral features of social media platforms and social media analytics. Specifically, we focus on individual-level content retransmission decisions and examine how dyadic properties between a sender and receiver on Twitter networks affect the likelihood of a receiver's retweet decisions. Our preliminary findings show that latent homophily predicts the likelihood of a receiver's retweet decision.

4 - An Empirical Investigation of the Role of Basic and Social Features in the use of Online Music Sites

Genevieve Bassellier, Associate Professor, McGill University, Desautels Faculty of Management, 1001 Sherbrooke St. W., Montreal, Qu, H3A 1G5, Canada, genevieve.bassellier@mcgill.ca, Zachary Krastel, Jui Ramaprasad

This study examines users' perceptions of online music site features and their impact on use. We focus on two types of features: basic site features, e.g. the size of the song catalog, and social features that enable interaction amongst users and artists. We examine the impact of these features on different types of use for different types of sites. Preliminary results support the notion that not all features are created equally, which has significant implications for the design of such sites.

5 - A Brief History of Stenting: Antecedents of Organizational Technology Adoption and Abandonment

Brad Greenwood, University of Maryland, United States of America, brad.n.greenwood@gmail.com, Ritu Agarwal, Rajshree Agarwal, Anand Gopal

We investigate how factors which influence organizational adoption of technology also influence the decision to abandon technology after its efficacy is questioned. Using a census of 1.4 million patients admitted to Florida hospitals, results indicate that pecuniary incentives will retard the abandonment of technology, if it can still be leveraged for economic gain. However, incentives to adhere to scientific norms dominate these economic motives (resulting in an accelerated abandonment).

■ SB45

Hilton- Union Sq 25

Behavioral Modeling in Business

Sponsor: Behavioral Operations Management

Sponsored Session

Chair: Tony Cui, Associate Professor of Marketing, University of Minnesota, 321 19th Ave S, Ste 3-150, Minneapolis, MN, 55455, United States of America, tcui@umn.edu

1 - Cognitive Hierarchy in Capacity Allocation Games

Yinghao Zhang, Assistant Professor, Salisbury University, Perdue Hall 333, 1101 Camden Avenue, Salisbury, MD, 21804, United States of America, YXZHANG@salisbury.edu, Tony Cui

We experimentally study the capacity allocation game with the proportional allocation rule. The orders made by the subjects are significantly different from the Nash equilibrium. The data also suggests heterogeneities among the subjects. We propose a behavioral model to explain the phenomenon based on the Cognitive Hierarchy (CH) theory, in which decision makers are cognitively heterogeneous. The model coincides with the experimental observations and fits the data quite well.

2 - A Model of Bounded Cognition in Forecasting with Implications for Operations Management

Jordan Tong, Assistant Professor of Operations and Information Management, University of Wisconsin-Madison, Wisconsin School of Business, Madison, WI, United States of America, jtong@bus.wisc.edu, Daniel Feiler

We leverage psychological micro-foundations to analytically model bounded cognition in three forecasting tasks critical to operations management: the single forecast, the mth arrival time forecast, and the l-time demand forecast. For each task, we derive the distribution of behavior and the biases due to bounded cognition. Finally, we focus on the model's application to the well-studied newsvendor problem, including structural estimations and out-of-sample tests using existing empirical data.

3 - Information Sharing, Advice or Delegation: What Leads to Higher Trust in a Distribution Channel?

Upender Subramanian, Assistant Professor of Marketing, University of Texas at Dallas, 800 W Campbell Rd, Richardson, TX, 75080, United States of America, upender@utdallas.edu, Ozalp Ozer, Yu Wang

Many retailers solicit support from manufacturers in the form of information about market conditions, or advice about retail decisions, or even request manufacturers to make decisions on their behalf. Often such support is not explicitly governed by contracts, raising concerns about manufacturer opportunism. Using analytical and behavioral methods, we show how and why — contrary to predictions from standard theory — one form of support leads to more trust and cooperation than others.

4 - Is it Really Dumb to be a Dumber? Competitive Analysis of Hierarchically Strategic Firms

Tony Cui, Associate Professor of Marketing, University of Minnesota, 321 19th Ave S, Ste 3-150, Minneapolis, MN, 55455, United States of America, tcui@umn.edu, Zuhui Xiao

Research has suggested firms may have different levels of strategic reasoning capabilities. Incorporating hierarchical strategic capabilities into a duopoly model, we find that a less strategic firm may benefit from its limited strategic capability when competing with a more strategic firm, although the strategic firm can respond specifically towards the less strategic firm's decisions but not vice versa. A lab experiment provides empirical supports for theoretical predictions.

■ SB46

Hilton- Lombard

MINLP

Sponsor: Optimization/Integer and Discrete Optimization

Sponsored Session

Chair: Akshay Gupte, Assistant Professor, Clemson University, Martin O-321, Dept. of Math Sciences, Clemson, SC, United States of America, agupte@clemson.edu

1 - On the Equate-and-Relax Procedure for LPCCs

Jean-Philippe P Richard, University of Florida, 303 Weil Hall P.O. Box 116595, Gainesville, FL, 32611, United States of America, richard@ise.ufl.edu, Mohit Tawarmalani, Trang Nguyen

We study the problem of generating cuts for linear programs with linear complementarity constraints (LPCCs) from simplex tableaux of their LP relaxations. We show that the convex hull of a suitably defined single-complementarity corner relaxation can be derived through a constructive equate-and-relax procedure. This result also holds when side constraints are added and can be used to generate cuts for problems with multiple complementarity constraints using a generalization of split disjunctions

2 - Integer Quadratic Programming is in NP

Marco Molinaro, Georgia Tech, Ferst Drive, Atlanta, United States of America, marco.molinaro@isye.gatech.edu, Santanu Dey

We prove that Integer Quadratic Programming (IQP) is in NP. The decision version of IQP is the following problem: Given one quadratic inequality and a system of linear inequalities in n variables where all data is rational, decide whether there exists an integral vector that satisfies all these inequalities. We prove that if the system of inequalities is integer feasible, then there exists one integer feasible solution whose size is bounded by a polynomial function of the size of the instance.

3 - A Trust Region Method for Solving Grey-box MINLP

Claudia D'Ambrosio, CNRS & LIX, Ecole Polytechnique, Batiment A. Turing, Palaiseau CEDEX, 91128, France, dambrosio@lix.polytechnique.fr, Ky Vu, Andrew Conn, Claire Lizon, Leo Liberti

We aim at solving grey-box MINLP problems with binary variables, i.e., mixed integer nonlinear optimization problems where the objective function is the sum of smooth functions given in closed form and of a black-box. We propose a trust region method with adjoined local branching type constraints that define the trust region for the binary variables. Both theoretical aspects and computational results on applications like smart building design and oil reservoir engineering are discussed.

4 - New MIP and SDP Approaches to the Floor Layout Problem

Joseph Huchette, MIT Operations Research Center, 77 Massachusetts Avenue, Bldg. E40-149, Cambridge, MA, 02139, United States of America, huchette@mit.edu, Juan Pablo Vielma, Santanu Dey

The floor layout problem is central to VLSI: given a rectangular floor, find the best configuration of N rectangular boxes on the floor. The boxes must have a certain area, but their widths and heights can be varied. We present new MILP formulations for the problem, offering nontrivial LP relaxation bounds. We investigate incorporating existing SDP formulations into the MILP solution process as a cut generator, and we present extensive computational results for our formulations and techniques.

■ SB47

Hilton- Mason A

Stochastic Optimization in Networks

Sponsor: Optimization/Optimization Under Uncertainty

Sponsored Session

Chair: Yongjia Song, Virginia Commonwealth University, 1015 Floyd Ave, Richmond, VA, 23284, United States of America, yjsong.pku@gmail.com

1 - A Two-stage Ambiguous Stochastic Generalized Network Flow Model for Water Allocation

Güzin Bayraksan, Associate Professor, Ohio State University, 1971 Neil Ave., Columbus, OH, 43210, United States of America, bayraksan.1@osu.edu

We present a two-stage stochastic generalized network flow model for water allocation. The distributional ambiguity is modeled by considering all distributions that are sufficiently close to a nominal distribution with respect to a phi-divergence (e.g., Chi-sq. distance, Kullback-Leibler divergence, etc.). We integrate forecasts from different sources of uncertainty and examine the value of additional data.

2 - Sensor Deployment for Stochastic Traffic Congestion Observation

Siqian Shen, Assistant Professor, University of Michigan, 2793 IOE Building, 1205 Beal Avenue, Ann Arbor, MI, 48109, United States of America, siqian@umich.edu, Zhili Zhou

Under random traffic flows, we deploy sensors to cover all congested arcs. We minimize congested arcs subject to a chance constraint on flow losses. We generalize the cut-based flow inequalities and prove that they are facets of the MIP reformulation. Computational studies use data in Singapore, and show the effectiveness of integrating sensor deployment with traffic congestion minimization.

3 - Chance-constrained Multi-terminal Network Design Problem

Yongjia Song, Virginia Commonwealth University, 1015 Floyd Ave, Richmond, VA, 23284, United States of America, yjsong.pku@gmail.com, Minjiao Zhang

We study a chance-constrained multi-terminal network design problem, which is a stochastic variant of Steiner tree problems. We study formulations using valid inequalities that require different separation efforts. We conduct a computational test to show their performance.

**4 - Efficient Methods for Vulnerability Assessment in
Uncertain Networks**

Thang Dinh, Assistant Professor, Virginia Commonwealth
University, 401 West Main Street, Room 4244, P.O. Box 843019,
Richmond, VA, 23284, United States of America, tndinh@vcu.edu,
My Thai

We aim to identify the most critical elements whose removal maximizes the
disruptive effect in terms of connectivity. We show that computing expected
connectivity in uncertain networks is intractable and propose an FPRAS to
estimate the connectivity with an arbitrary accuracy. Further, we propose an
efficient two-stage stochastic programming and efficient solving methods to
identify critical elements.

■ SB48

Hilton- Mason B

Stochastic Programming - A Mix of Recent Results

Sponsor: Optimization/Optimization Under Uncertainty

Sponsored Session

Chair: Ruediger Schultz, University of Duisburg-Essen, Faculty of
Mathematics, Forsthausweg 2, Duisburg, D-47048, Germany,
ruediger.schultz@uni-due.de

**1 - Risk Averse Routing in Single-VRP with Simultaneous Delivery and
Stochastic Pickup**

Nadine Wollenberg, nadine.wollenberg@uni-due.de, Walter Rei,
Michel Gendreau, Ruediger Schultz

The talk addresses risk averse routing decisions. A stochastic extension of the
vehicle routing problem with simultaneous delivery and pickup is presented.
Delivery quantities are fixed and units to be picked up are a priori unknown. For
the single vehicle case, the stochastic model is formulated as a two-stage stochastic
program with recourse and solved by means of the integer L-shaped method.
Solutions of different stochastic mean-risk models are examined and compared to
the risk neutral case.

**2 - Sufficient Conditions for Metric Regularity and Stability of
Stochastic Dominance Constraints**

Matthias Claus, Universitat Duisburg-Essen, Forsthausweg 2,
Duisburg, 47057, Germany, matthias.claus@uni-due.de,
Ruediger Schultz

Minimizing a disutility function under first-order stochastic dominance constraints
for random variables arising as optimal values of stochastic programs with linear
recourse leads to an optimization problem with uncountably many chance
constraints. Metric regularity of the contraint function is the key to stability of the
solution set mapping subject to perturbations of the underlying probability
measure. The talk is on verifiable sufficient conditions based on a local linear
growth.

3 - Semidefinite Sochastic Programming in AC Power Flow

Tobias Wollenberg, University of Duisburg-Essen, Faculty of
Mathematics, Forsthausweg 2, Duisburg, D-47048, Germany,
tobias.wollenberg@googlemail.com

Considering the AC load flow problem under uncertainty of infeed from
renewables and customers' power demand leads us to specific semidefinite
stochastic programs. Basic structures of these models are studied and a
decomposition algorithm for their solution is proposed.

**4 - Stochastic Programming with PDE Constraints in Shape
Optimization with Random Load**

Ruediger Schultz, University of Duisburg-Essen, Faculty of
Mathematics, Forsthausweg 2, Duisburg, D-47048, Germany,
ruediger.schultz@uni-due.de

Shape optimization with linearized elasticity and random loading has attracted
research in stochastic programming only fairly recently. Typical paradigms from
stochastic programming, to be discussed in the talk, such as the recourse idea or
mean-risk objectives as well as dominance constrained constraints have their
counterparts in shape optimization under uncertainty.

■ SB49

Hilton- Powell A

Risk-averse Optimization in Networks

Sponsor: Optimization/Network Optimization

Sponsored Session

Chair: Pavlo Krokhmal, Associate Professor,
University of Iowa, 3131 Seamans Center, Iowa City, IA, 52242,
United States of America, krokhmal@engineering.uiowa.edu

1 - Risk Averse Strategic Planning of HVDC Grids

Bo Sun, University of Iowa, 3131 Seamans Center, Iowa City, IA,
52242, United States of America, bo-sun-1@uiowa.edu,
Yong Chen, Pavlo Krokhmal

We consider the problem of risk-averse strategic planning of high-voltage direct
current (HVDC) grids, which offer significant advantages over traditional AC
transmissions. We discuss the problem of long-term planning of HVDC grids that
incorporate sources of renewable energy. Risks of power shortages are controlled
using nonlinear higher-moment coherent risk (HMCR) measures. Solution
methods for the resulting mixed-integer programming problems and
computational case studies are presented.

2 - Two-stage Stochastic Maximum Clique Problem

Maciej Rysz, University of Iowa, 3131 Seamans Center, Iowa City,
IA, 52242, United States of America, maciej-rysz@uiowa.edu, Pavlo
Krokhmal, Eduardo Pasiliao

We consider the problem of determining the largest "robust" clique in a stochastic
graph, where links between nodes may randomly fail or "appear". The
"robustness" of a complete subgraph is defined as its repairability after observable
random changes to the graph's topology. A two-stage stochastic programming
model is formulated, and a graph-based branch-and-bound algorithm is proposed.
Numerical experiments illustrate computational effectiveness of the proposed
method.

3 - On Incremental Network Design under Uncertainty

Nathaniel Richmond, University of Iowa, 3131 Seamans Center,
Iowa City, IA, 52242, United States of America, nathaniel-
richmond@uiowa.edu, Pavlo Krokhmal, Dmytro Matsypura

We consider the incremental network design problem, where the goal is to
improve an existing network by building new arcs, given that only one arc can be
built at a time, the arc budget is limited, and at each time step the desired network
characteristic (e.g., a shortest path between two nodes) is minimized. Previous
studies have shown this problem to be NP-hard. A stochastic extension of the
problem is presented, and the theoretical and computational properties of its
solutions are discussed.

■ SB50

Hilton- Powell B

Network Design, Dynamics and Optimization

Sponsor: Optimization/Network Optimization

Sponsored Session

Chair: Mario Ventresca, Assistant Professor, School of Industrial
Engineering, Purdue University, 315 N. Grant St., West Lafayette, IN
47907, United States of America, mventresca@purdue.edu

**1 - Competitive Equilibrium in Electricity Markets with Price
Fluctuation Penalty**

Ermin Wei, MIT, Cambridge, MA, United States of America
erminwei@mit.edu, Azarakhsh Malekian, Asuman Ozdaglar

We develop a flexible model of competitive equilibrium in electricity markets
involving heterogeneous users with shiftable demand. The resulting equilibrium
prices and quantities may feature undesirably high price volatility over time. To
control this, we introduce an explicit penalty term on the price fluctuation and
provide a distributed market implementation thereof. We analyze the connection
between consumer utility properties and the price fluctuation at equilibrium.

**2 - Modeling Evolution of Social Networks with the
Node Prominence Profile**

Nitesh Chawla, Associate Professor, University of Notre Dame,
384 Nieuwland Science Hall, Notre Dame, IN, 46556,
United States of America, nchawla@nd.edu

Both preferential attachment and triadic closure properties are important in
defining the growth of a network. As the node's influence and relative position in
the neighborhood increases, it impacts the local network structure. We use the
concept of prominence, which captures trade-offs between preferential attachment
and triadic closure. We develop a method for predicting prominence and network
evolution, and demonstrate its effectiveness over multiple social networks.

3 - Distributional Robust Network Design Problems

Zhihao Chen, University of Michigan, 1205 Beal Avenue, Ann Arbor, MI, 48105, United States of America, czhihao@umich.edu, Siqian Shen

We investigate network design problems under uncertain demand; the true distribution is unknown but historical data is available. We use candidate distributions whose moments are close enough to the empirical moments and find the optimal solution under the worst-case distribution. We will compare the performance of the distributionally robust approach against a stochastic approach where the distribution is intelligently guessed, and also examine the effect of correlated demands on this approach.

4 - Detecting Cliques of Maximum and Minimum Centrality

Chrysafis Vogiatzis, University of Florida, chvogiat@ufl.edu

We consider the problem of finding the most and least "influential" or "influenceable" cliques in graphs based on three classical centrality measures: degree, closeness, and betweenness. In addition to standard betweenness,, we also consider its optimistic and pessimistic versions. We discuss their computational complexity and develop linear 0-1 programming formulations. Finally, we demonstrate the performance of the formulations, and provide some interesting insights based on the results.

■ SB51

Hilton- Sutter A

Optimization in Dynamics and Control

Sponsor: Optimization/Nonlinear Optimization
Sponsored Session

Chair: Amir Ali Ahmadi, Princeton University, 329 Sherrerd Hall, Dept. of Operations Research & Fin. Eng., Princeton, NJ, 08540, United States of America, a_a_a@princeton.edu

1 - An Input/Output Approach to Predicting and Engineering Emergent Network Behavior

Murat Arcak, Professor, UC Berkeley, Cory Hall, Berkeley, United States of America, arcak@berkeley.edu

Analytical and computational tools for certifying the stability and performance of feedback systems are applicable only to moderate size problems. We will present a compositional approach that exploits input-output properties of the subsystems and their interconnection structure to analyze large-scale systems. We will present a large-scale optimization technique to select important local properties to certify global objectives.

2 - Optimal Sampling-Based Motion Planning under Differential Constraints

Marco Pavone, Professor, Stanford University, 496 Lomita Mall, Room 261, Stanford, CA, 94305, United States of America, pavone@stanford.edu, Edward Schmerling

We present a thorough theoretical framework to assess optimality guarantees of sampling-based algorithms for robot motion planning under differential constraints. Our analysis yields convergence rate bounds - a first in the field. We exploit this framework to design and analyze two novel sampling-based algorithms that are guaranteed to converge, as the number of samples increases, to an optimal solution. Our focus is on driftless control-affine and on linear affine dynamical models.

3 - Robust to Dynamics Optimization (RDO)

Amir Ali Ahmadi, Princeton University, 329 Sherrerd Hall, Dept. of Operations Research&Fin. Eng., Princeton, NJ, 08540, United States of America, a_a_a@princeton.edu, Oktay Gunluk

We introduce a new type of robust optimization problems that we call "robust to dynamics optimization" RDO. The input to an RDO problem is twofold: (i) a mathematical program (e.g., an LP, SDP, IP), and (ii) a dynamical system (e.g., a linear, nonlinear, discrete, or continuous dynamics). The objective is to maximize over the set of initial conditions that forever remain feasible. We initiate an algorithmic study of RDO and demonstrate tractability of some important cases.

■ SB52

Hilton- Sutter B

First-Order Methods for Huge-Scale Optimization

Sponsor: Optimization/ Linear and Conic Optimization
Sponsored Session

Chair: Robert Freund, Professor, MIT, Sloan School of Management, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, rfreund@MIT.EDU

1 - Boosting in Regression: Computational Guarantees and Regularization via Subgradient Optimization

Paul Grigas, MIT Operations Research Center, E40-130, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, pgrigas@mit.edu, Rahul Mazumder, Robert Freund

We present a novel subgradient descent framework for interpreting boosting methods in linear regression that yields new convergence and computational guarantees. Our framework includes both the incremental forward stagewise regression algorithm and boosting methods for lasso. Our results draw on existing theory of first-order methods in convex optimization as well as new extensions of this theory in the setting of linear regression.

2 - An Optimal Stochastic Incremental Gradient Method for Convex Optimization

George Lan, Assistant Professor, University of Florida, 303 Weil Hall, Gainesville, FL, 32611, United States of America, glan@ise.ufl.edu

We present a novel stochastic primal-dual incremental gradient method and show that it can achieve the optimal $O(1/k^2)$ rate of convergence for deterministic smooth optimization. The cost per iteration for this algorithm is comparable to stochastic / incremental gradient methods. Our work thus provides a positive answer to the open question regarding whether there exists an optimal incremental gradient method for convex optimization.

3 - An Accelerated Randomized Coordinate Descent Method for Strongly Convex Composite Optimization

Qihang Lin, Assistant Professor, The University of Iowa, 21 East Market Street, PBB S380, Iowa City, IA, 52245, United States of America, qihang-lin@uiowa.edu, Lin Xiao, Zhaosong Lu

We propose an accelerated randomized block-coordinate descent method for minimizing the sum of a smooth convex function and a block-separable convex function. The algorithm is developed based on the technique of randomized estimate sequence. Compared to existing coordinate descent methods, our method guarantees a linear convergence rate when the problem is strongly convex and its complexity has a better dependence on the condition number of the problem.

4 - An Extended Frank-Wolfe Method, with Application to Low-Rank Matrix Completion

Robert Freund, Professor, MIT, Sloan School of Management, 77 Massachusetts Avenue, Cambridge, MA, 02139, United States of America, rfreund@MIT.EDU, Paul Grigas, Rahul Mazumder

We present an extension of the Frank-Wolfe method that is designed to induce near-optimal solutions on low-dimensional faces of the feasible region. In addition to computational guarantees for the method, we present computational results for large-scale low-rank matrix completion problems that demonstrate its usefulness in providing order-of-magnitude speed-up in computing low-rank near-optimal solutions.

■ SB53

Hilton- Taylor A

Systemic Risk

Cluster: Optimization in Finance
Invited Session

Chair: Ciamac Moallemi, Barbara and Meyer Feldberg Associate Professor of Business, Columbia Business School, 3022 Broadway, Uris 416, New York, NY, 10027, United States of America, ciamac@gsb.columbia.edu

Co-Chair: Garud Iyengar, Columbia University, S.W. Mudd 314, 500W 120th Street, New York, NY, 10027, United States of America, garud@ieor.columbia.edu

1 - Information Contagion in Financial Networks

Alireza Tahbaz-Salehi, Columbia Business School, 3022 Broadway, Uris 418, New York, NY, 10027, United States of America, alirezat@columbia.edu, Jennifer La'O

We analyze how incomplete information about the viability of bank assets may affect the fragility of the financial system. We show that fluctuations in expectations can be amplified and lead to systemic crises. Fragility depends both on the topology of the network as well as the structure of higher-order beliefs. Our results have implications for regulatory policies such as mandatory disclosure policies and stress tests.

2 - Measuring and Allocating Systemic Risk

Patrick Cheridito, Princeton University, 204 Sherrerd Hall, Princeton, NJ, United States of America, dito@princeton.edu

This paper develops a framework for measuring, allocating and managing systemic risk. SystRisk, our measure of total systemic risk captures the a priori cost to society for providing tail-risk insurance to the financial system. Our allocation principle distributes the total systemic risk among individual institutions according to their size-shifted marginal contributions.

3 - A Structural Model for Asset-based Contagion and Systemic Risk

Chen Chen, ShanghaiTech University, Shanghai, Shanghai, China, cc3136@columbia.edu, Garud Iyengar, Ciamac Moallemi

We develop a structural model for the analysis of systemic risk in financial markets based on asset-based contagion. Specifically, we describe a mechanism of contagion where exogenous random shocks to agents in an economy force portfolio rebalancing. This creates an endogenous chain reaction as agents trade in reaction to price changes. Our approach allows us to quantify the effect of attributes such as leverage and portfolio diversity on asset-based contagion.

4 - Optimal Capital Requirements in Interbank Networks

Jong Soo Hong, PhD Student, Duke Univ Fuqua School of Business, 4225 Larchmont Rd 527, Durham, No, 27707, United States of America, jongsoo.hong@duke.edu, David Brown

We consider a network of banks, with connections representing interbank liabilities, and study the problem of optimally trading off between capital reserves and systemic risk. In a model without default costs, the problem may be formulated as a stochastic linear program. Default costs and fire sales externality make the problem much more challenging, and we discuss approximation methods based on dual approach. We demonstrate the methods on an example using data from a central bank.

■ SB54

Hilton- Taylor B

Financial Engineering & Risk Management

Sponsor: Financial Services Section

Sponsored Session

Chair: Martin Haugh, Columbia University, 500 West 120th Street, Room 332, New York, NY, 10027, United States of America, mh2078@columbia.edu

1 - Systemic Risk and Preventive Policies

Agostino Capponi, Johns Hopkins University, 3400 North Charles Street, Baltimore, MD, 21218, United States of America, acappon1@jhu.edu

We provide a data driven network study to assess the effect of preventive policies for mitigating systemic risk in multi-tiers interbanking networks. Using balance sheet data from the Federal Reserve Call Report as well as interest rates from the Board of Governors H15 release, we calibrate the rules followed by the agents. Capital-to-asset and reserve-to-deposit ratio policies impact the structure of the system, with systemic risk switching from being generated by tier 2 to tier 3 institutions.

2 - Large Deviations for Affine Diffusion Processes on the Canonical State Space

Wanmo Kang, Professor, KAIST, 291 Daehak-ro, Yuseong-gu, Daejeon, Korea, Republic of, wanmo.kang@kaist.edu, Chulmin Kang

We approach this problem in two different ways. In the first approach, we first prove the large deviation principle for finite dimensional distributions, and then use it to establish the sample path large deviation principle. The second approach exploits the exponential martingale method of Donati-Martin et al. for the squares of Ornstein-Uhlenbeck processes. We provide an application to importance sampling of affine diffusion models.

3 - Datebase Monte Carlo Metamodeling

Imry Rosenbaum, Northwestern University, Evanston, United States of America, ImryRosenbaum2016@u.northwestern.edu, Jeremy Staum

Simulation metamodeling creates computational efficiency in applications such as financial risk management. However, metamodels based on function approximation need to be validated, which uses up analysts' time. Database Monte Carlo (DBMC) has been used for variance reduction in simulation. We explore the application of DBMC to construct metamodels that do not require validation.

4 - Information Relaxation Bounds for Infinite Horizon Stochastic Dynamic Programs

David Brown, Duke University, 100 Fuqua Drive, Durham, United States of America, dbbrown@duke.edu

We study infinite horizon MDPs with discounted costs and develop a general approach for calculating performance bounds using information relaxations. We discuss ways to make the approach computationally manageable on problems with large state spaces and study the quality of the resulting bounds. We demonstrate the method on an application involving dynamic scheduling for a multiclass queue.

■ SB55

Hilton- Van Ness

Integer Nonlinear Programming and Applications – I

Sponsor: Optimization/Global Optimization & MINLP

Sponsored Session

Chair: Monique Guignard, Professor, University of Pennsylvania, OPIM Dept., the Wharton School, 3730 Walnut Street, Philadelphia, PA, 19104-6340, United States of America, guignard_monique@yahoo.fr

1 - Multi-objective MINLP Optimization for the Aircraft Collision Avoidance Problem

F. Javier Martin-Campo, Universidad Complutense de Madrid, Department of Statistics and Operations, Office N227, Building 1, Pozuelo de Alarcon (Madrid), 28223, Spain, javier.martin.campo@ccee.ucm.es, Laureano Escudero, Antonio Alonso-Ayuso

The aircraft collision avoidance problem consists of providing a configuration for a set of aircraft flying in a certain air sector such that every conflict situation is avoided (being the violation of the safety distances to be kept in flight). To do so, three different maneuvers may be performed. Three different multi-objective methods have been applied to the proposed MINLP model. A broad computational experiment will be presented to compare the performance of the models and the methods.

2 - The Generalized Trace Ratio Optimization Problem

Said Hanafi, Professor, Universite de Valenceinnes, Valenciennes, France, Said.Hanafi@univ-valenciennes.fr, Yousef Saad, Raca Todosijevic, Mohammed Bellalij

Recently Ngo et al, 2012, show that the trace ratio optimization problem can be solved efficiently using the Lanczos procedure, a good initialization, and an approximation of an eigenvector computed by the Newton procedure. We propose a new Generalized Trace Ratio Optimization problem and a new formulation of the cell formation problem. We propose a hybrid approach using Singular Value Decomposition techniques to produce an initial feasible solution and heuristic to improve it.

3 - Evaluation and Analysis of CDAP Heuristics via Discrete Event Simulation

Frederick Abiprabowo, Graduate Student, University of Pennsylvania, frabi@wharton.upenn.edu

Although the bilinear 0-1 Crossdock Door Assignment Problem (CDAP) is proven to reduce operational costs, little is known regarding its effects on certain performance metrics, such as item cycle time. To evaluate CDAP's efficiency in a holistic crossdocking environment, we designed a discrete event simulation and used an adaptation of the CHH heuristic to solve CDAP. The performances of Static and Dynamic CDAP assignments compare favorably with the door assignments used by a commercial company.

4 - using Fractional Optimization to Accelerate Column Generation

Laurent Alfandari, ESSEC, 1 Avenue Bernard Hirsch, Cergy, France, alfandari@essec.fr

Column Generation (CG) is often efficient to solve the linear relaxation of large-size integer LPs. We diversify criteria to select the columns with a subproblem based on a ratio criterion. The subproblem is a non-linear 0-1 fractional optimization program, which is polynomial under some specified conditions. Mixing this criterion with the classic negative reduced cost criterion enabled to accelerate CG in the numerical experiments conducted.

■ SB56

Hilton - Green Room

Software Demonstrations

Cluster: Software Demonstrations

Invited Session

1 - GameLab: from Classroom to Playground

Bernardo Pagnoncelli, Assistant Professor, Universidad Adolfo Ibañez, Diagonal las Torres 2640, Oficina 533-C, Santiago, RM, 7910000, Chile, bernardo.pagnoncelli@uai.cl

Our company sells games to be used in the classroom as a learning tool in Undergraduate, Graduate and MBA courses. In the 45-minute slot we plan to do a demonstration in which the participants will be invited to play one of our games. Participants can play the games using their personal computers, and we encourage all participants to join us. Prizes will be given to the winners of the games.

SB64

INFORMS San Francisco – 2014

2 - JMP® Workshop: Interactive and Visual Data Analysis with JMP 11 Pro
Walter Teague, SAS Institute Inc., JMP Division, walter.teague@jmp.com

JMP Statistical Discovery Software is interactive and visual desktop software for Windows and Mac, with a complete array of integrated graphical and statistical procedures. We will demonstrate JMP tools for data analysis, visualization and exploration, including, Graph BuilderÆ, bubble plots, the data filter, and our popular mapping tools.. In addition to interactive techniques for Univariate and Bivariate analysis we will look at methods for Multivariate analysis including Clustering, Principal Components and Data Mining.

■ SB64

Parc- Cyril Magnin I

Applications of Approximate Queueing Analysis

Sponsor: Applied Probability Society
Sponsored Session

Chair: Ramandeep Randhawa, USC, Marshall School of Business, Los Angeles, United States of America, ramandeep.randhawa@marshall.usc.edu

Co-Chair: Achal Bassamboo, Northwestern University, 2001 Sheridan Rd., Evanston, IL, United States of America, a-bassamboo@kellogg.northwestern.edu

1 - Heavy-Traffic Limits for a Fork-Join Network in the Halfin-Whitt Regime
Guodong Pang, Penn State University, College of Engineering, University Park, PA, United States of America, gup3@engr.psu.edu, Hongyuan Lu

We study a fork-join network of stations with multiple servers and non-exchangeable synchronization under the FCFS discipline, where all service stations are in the Halfin-Whitt regime. Tasks are only synchronized if all the tasks associated with the same job are completed. We show FLLN and FCLT for the number of tasks in each waiting buffer for synchronization, jointly with the number of tasks in each parallel service station and the number of synchronized jobs.

2 - Virtual Allocation Policies for Many-Server Queues with Abandonment
Jiheng Zhang, HKUST, Clear Water Bay, Hong Kong, Hong Kong - PRC, jiheng@ust.hk, Zhenghua Long

We study a multiclass many-server system with generally distributed patience times. We establish fluid approximations and study the long-term behavior of the fluid model under a family of non-preemptive policies. The equilibrium state of the fluid model connects to a nonlinear program which helps to identify a lower bound of the long-run expected holding and abandonment cost, and design a policy to achieve such a lower bound when the patience time distributions have decreasing hazard rate.

3 - An Analysis of a Large-Scale Machine Repair Model
Petar Momcilovic, University of Florida, Weil Hall, Gainesville, FL, United States of America, momcilovic@ufl.edu, Amir Motaei

A machine repair model under general operating/repair distributions is considered in the Quality-and-Efficiency Driven asymptotic (QED) regime: both the number of machines and the number of repairmen are large, while the capacity and offered load relate via the square-root staffing rule. Process-level convergence of the number of broken machines is established — the limit is in terms of the corresponding tractable infinite-repairmen process, a stationary centered Gaussian process.

4 - Patience Time Based Scheduling in Multi-class Service Systems
Achal Bassamboo, Northwestern University, 2001 Sheridan Rd., Evanston, IL, United States of America, a-bassamboo@kellogg.northwestern.edu, Ramandeep Randhawa

We consider multiclass queueing systems in which customers have generally distributed patience times. We study optimal scheduling that utilizes the customers' patience distribution.

■ SB65

Parc- Cyril Magnin II

Systemic Financial Risk

Sponsor: Applied Probability Society
Sponsored Session

Chair: Kay Giesecke, Stanford University, Huang Engineering Center, Stanford, United States of America, giesecke@stanford.edu

1 - Interacting Particle Methods for Conditional Distributions
Tomoyuki Ichiba, University of California Santa Barbara, South Hall 5508, University of California, Santa Barbara, CA, 93106, United States of America, ichiba@pstat.ucsb.edu, Mike Ludkovski

We discuss importance sampling approaches to approximating conditional distribution of multidimensional Markov processes, given rare events, in order to compute conditional expectations of functionals of the processes under the worst-case scenarios of financial systems. Examples include Brownian motions with reflections, heavy tailed jump processes and diffusion processes of mean-field type. With the time-reversal of interacting particle system we improve the empirical importance sampling.

2 - Systemic Risk in the Repo Market
Alexander Shkolnik, UC Berkeley, Berkeley, CA, United States of America, ads2@stanford.edu

The repo (repurchase agreement) market is a crucial part of the US financial infrastructure. The complex inter-connectedness of financial institutions and the practice of rehypothecation, the re-use of repo collateral, amplify its inherent systemic risk. In contrast to static models in prior literature, we propose and analyze a dynamic model of a networked repo market. We illustrate the complex phenomena exhibited by the model and study its stability properties using the Lyapunov method.

3 - Modelling Financial Systemic Risk – Network Effect and Liquidity Effect
Nan Chen, The Chinese University of Hong Kong, 609 William Mong Engineering Building, Hong Kong, Hong Kong - PRC, wyu@se.cuhk.edu.hk, Xin Liu, David Yao

The goal of our study is to investigate how two channels of risk transmission, interbank liability network and market liquidity, interact to propagate individual defaults to a system-wide catastrophe. We formulate the model as an optimization problem with equilibrium constraints and derive the solution via a partition algorithm. The analysis and numerical experiments underscore the importance of the market liquidity in the formation of systemic risk.

■ SB66

Parc- Cyril Magnin III

QSR Student Introductions and Interactions

Sponsor: Quality, Statistics and Reliability
Sponsored Session

Chair: Tirthankar Dasgupta, Associate Professor, Harvard University, 1 Oxford Street, 7th Floor, Harvard Statistics Department, Cambridge, MA, 02138, United States of America, dasgupta@stat.harvard.edu

Co-Chair: Kaibo Wang, Associate Professor, Tsinghua University, Department of Industrial Engineering, Beijing, 100084, China, kbwang@tsinghua.edu.cn

1 - QSR Student Introductions and Interactions
Tirthankar Dasgupta, Associate Professor, Harvard University, 1 Oxford Street, 7th Floor, Harvard Statistics Department, Cambridge, MA, 02138, United States of America, dasgupta@stat.harvard.edu, Kaibo Wang

In this session, interested QSR student members will introduce themselves and their research interests through short presentations. Also, a few senior QSR members will be invited to discuss/share their experiences with students and to give them some words of advice about their careers.

■ SB67

Parc- Balboa

Condition Monitoring and Degradation Modeling

Sponsor: Quality, Statistics and Reliability

Sponsored Session

Chair: Liu Xiao, IBM Research, Singapore, Singapore, liuxiao@sg.ibm.com

Co-Chair: Nan Chen, Assistant Professor, National University of Singapore, 1 Engineering Drive 2, Singapore, Singapore, isecn@nus.edu.sg

1 - A Hierarchical Model for Lithium-Ion Battery Degradation Prediction

Xin Xu, ph.d Student, NUS, BLK E1-07-19,ISE,NUS, Singapore, Singapore, xuxin@nus.edu.sg, Nan Chen

This paper presents a new point of view to analyze the lithium-ion battery degradation by using the detailed discharging profiles to characterize the degradation process. A hierarchical model combining discharging process and degradation process is proposed based on this idea. With this model, the End-of-Discharging prediction and Remaining-Useful-Life prognostics can be realized in one framework.

2 - Imperfect Condition-based Maintenance under Performance-based Logistics

Yisha Xiang, Assistant Professor, Sun Yat-sen University, 135 W. Xingang Rd., Guangzhou, 57025, China, xiangysh@mail.sysu.edu.cn, David Coit

In this study, we consider a heterogeneous population, and allow for unit-to-unit heterogeneity in degradation paths within all subpopulations through the incorporation of random effects. We further propose a condition-based maintenance model under a profit-centric approach for the degradation process of our interest , and compare the optimal policies and costs/profits under the traditional cost-minimization and the new profit-centric approaches.

3 - Joint Mixed Effects Logistic Regression for Rescue Inhaler Usage Prediction in SAM Systems

Junbo Son, University of Wisconsin-Madison, 1513 University Avenue, Madison, WI, 53706, United States of America, json5@wisc.edu, Patricia Brennan, Shiyu Zhou

To effectively manage the asthma as a chronic disease, a statistical model based on the everyday patient monitoring is crucial. Also, a significant individualization is desirable to provide a patient-level prediction for key health indicators such as the rescue inhaler usage. Taking advantages from smart asthma management (SAM) systems, we propose an individualized prognostic model that has a form of extended logistic regression. Its promising features are shown in both simulation and case study.

4 - Predictive Maintenance for Data Centre Cooling System

Liu Xiao, IBM Research, Singapore, Singapore, liuxiao@sg.ibm.com

A condition-based maintenance approach is proposed for data centre cooling system. The statistical model is developed based on the first law of thermodynamics. The method has been tested and validated using real data. Our case study shows that the model successfully generates the early warning signal 2 to 3 weeks before the cooling system failure.

■ SB68

Parc- Davidson

Reliability Evaluation and Maintenance Optimization

Sponsor: Quality, Statistics and Reliability

Sponsored Session

Chair: Eunshin Byon, Assistant Professor, University of Michigan, 1205 Beal Ave., Ann Arbor, MI, 48109, United States of America, ebyon@umich.edu

1 - Reliability of Systems with Spatially Distributed Units

Elsayed Elsayed, Distinguished Professor, Rutgers University, Department of Industrial and Systems Eng, Rutgers University, Piscataway, NJ, 08854, United States of America, elsayed@rci.rutgers.edu, Dingguo Hua

The reliability of systems with spatially distributed units have emerged as an important topic in aerospace and military industries. In this paper, we investigate spatially distributed k-out-of-n pairs:G balanced systems with different requirements. Reliability and other metrics such as time to a specified failure are estimated.

2 - Performance Evaluation of Wind Turbines using Wind Power Curves

Hoon Hwangbo, Texas A&M University, 3131 TAMU, College Station, TX, 77845, United States of America, hhwangbo@tamu.edu, Andrew Johnson, Yu Ding

Performance of a wind turbine embodies a lot of internal and external variation. To control for external variation, we align different annual datasets with similar aerodynamic conditions. Then, we apply a method developed based on Convex Nonparametric Least Squares to provide two measures for evaluating internal change of a wind turbine. One measure is for efficiency and another is for variability; together they can account for the performance change of a wind turbine over time.

3 - Optimal Replacement in Partially-Observed Environments

Jeffrey Kharoufeh, Department of Industrial Engineering, University of Pittsburgh, Pittsburgh, PA, 15261, United States of America, jkharouf@pitt.edu

We address the problem of optimally replacing a component that resides in an uncertain environment. Two models are formulated using a partially-observed Markov decision process framework. The first model ignores downtime costs, while the second includes this cost explicitly. For both models, it is shown that a threshold replacement policy is optimal with respect to the cumulative level of degradation. These thresholds depend on the decision maker's assessment of the environmental conditions.

4 - Reliability Assessment of Wind Turbine using Stochastic Simulations

Youngjun Choe, Ph.D. Candidate, University of Michigan, 1205 Beal Avenue, Ann Arbor, MI, 48109, United States of America, yjchoe@umich.edu, Nan Chen, Eunshin Byon

As simulation models become more realistic, reliability evaluation remains challenging due to the high computational cost of each simulation replication. We provide computationally efficient methods for reliability evaluation using stochastic simulations that generate random outputs given a fixed input. A new sampling method has been devised and validated using aeroelastic simulators developed by the U.S. National Renewable Energy Laboratory.

■ SB69

Parc- Fillmore

Design and Optimization of Sustainable Supply Chains

Sponsor: Energy Natural Resources and the Environment/ Sustainability and Environment

Sponsored Session

Chair: Fengqi You, Assistant Professor, Northwestern University, 2145 Sheridan Road, Evanston, IL, 60201, United States of America, you.fengqi@gmail.com

1 - A Multistage Stochastic Optimization of the Supply Chains of Biofuels

Yongxi Huang, Assistant Professor, Clemson University, 314 Lowry Hall, Clemson University, Clemson, SC, United States of America, yxhuang@clemson.edu, Fei Xie

A multistage stochastic programming model is developed for a multi-year biofuel supply chain design and planning under time dynamics and uncertainty of feedstock supply. We then use block-separable property to transform the problem to an equivalent two-stage stochastic program. We decompose it into tractable subproblems using the nested decomposition method and generate maximal bender cuts in the iterative process to improve the rate of convergence. We present numerical implementations.

2 - Incorporating Sustainability Concepts into Hybrid Ethanol Supply Chain

Iddrisu Awudu, NDSU, 26 University Village, Fargo, ND, United States of America, Iddrisu.Awudu@my.ndsu.edu, Atif Osmani, Jun Zhang

We develop a framework for the modeling and analysis of a hybrid generation biofuel supply chain (HGBSC) with economic, social, and environmental sustainability concepts. A two-stage stochastic mixed integer linear programming (SMILP) approach is used with the Sample Average Approximation (SAA) algorithm. Analyses of the results conclude that incorporating sustainability concepts into the supply chain provide the HGBSC with visibility and managed expectations of profit realization.

SB70   *INFORMS San Francisco – 2014*

3 - Optimizing Biomass Co-Firing Decisions in Coal Fired Power Plants
> Hadi Karimi, Mississippi State University, PO Box 9542, Mississippi State, MS, 39762, United States of America, hadi.karimi.00@gmail.com

This paper provides an optimization model to aid with biomass co-firing decisions in coal fired power plants. Co-firing impacts plant's logistics-related costs, capital investments, plant efficiency, and tax credit collected. We develop a linear MIP model to capture the relationships that exists between biomass usage and the corresponding costs and savings due to production of renewable electricity. We test the impact of the model proposed on renewable electricity production using a case study.

4 - Life Cycle Optimization with Functional Unit for Sustainable Supply Chain Design and Operations
> Fengqi You, Assistant Professor, Northwestern University, 2145 Sheridan Road, Evanston, IL, 60201, United States of America, you.fengqi@gmail.com, Dajun Yue

We propose a life cycle optimization framework for the sustainable supply chain optimization considering the concept of "functional unit" under economic and environmental criteria. This modeling framework integrates LCA with multiobjective optimization and measures the system's performance based on a standard quantity of functional unit associated with final products. We also present tailored algorithms for efficiently solving the resulting mixed-integer linear fractional programming problems.

■ SB70

Parc- Hearst

Open Pit Mining and Logistics

Sponsor: Energy Natural Resources and the Environment/ Natural Resources
Sponsored Session

Chair: Alexandra M. Newman, Colorado School of Mines, 1500 Illinois St., Golden, CO, 80401, United States of America, anewman@mines.edu

1 - Open Pit Mine Production Scheduling with Stockpiling
> Mojtaba Rezakhah, PhD Student, Colorado School of Mines, 1500 Illinois Street, Golden, CO, 80401, United States of America, mrezakha@mymail.mines.edu, Alexandra M. Newman, Vitaliy Krasko

We present several ways of considering stockpiling in open pit mine production scheduling, including (i) individual stockpiles for each block, (ii) homogenously mixed stockpiles, and (iii) binned stockpiles with pessimistic grade estimates. These models are formulated for a currently operational mine and compared to results without stockpiling in order to assess the benefits of stockpiling and to analyze the relationship between milling capacity and stockpiling value.

2 - Production Scheduling for Open Pit Mine Planning: Comparing New and Traditional Approaches
> Marcos Goycoolea, Associate Professor, Universidad Adolfo Ibanez, School of Business, Santiago, Chile, marcos.goycoolea@uai.cl, Eduardo Moreno, Daniel Espinoza, Orlando Rivera

Mathematical programming (MP) methods were first proposed for the open pit production scheduling in the late 60s. Despite this, only in the last years has MP been a viable option for solving this problem due to the tremendous size of real planning instances. Instead, mine planners have relied on a heuristic known as the Nested Pit (NP) method. In this talk we describe a new MP approach, and compare it on real instances to Whittle, a market-leading mine-planning software using the NP method.

3 - Optimization of the Immediate Term Execution Schedule in Open Pit Mining
> Ryan Miles, Principal Advisor, AngloGold Ashanti, 6300 South Syracuse Way, Suite 500, Centennial, CO, 80111, United States of America, rmiles@anglogoldashanti.com

Operations research in the mining industry has historically sought to optimize an extraction schedule that maximizes net present value over the long run (years-decades). This formulation evaluates the optimal extraction sequence in the immediate term (0-30 day outlook) to support production and maintenance supervisorial decisions based on blasted rock inventory locations and the availability of critical heavy mining equipment (i.e. loaders, shovels, haul trucks, and mineral processing).

4 - Logistic System Analysis for the Mining Company LKAB
> Mikael Rönnqvist, Professor, Université Laval, Département de Génie Mécanique Pavillon, 1065, avenue de la Médecine, Québec, QU, G1V 0A6, Canada, mikael.ronnqvist@gmc.ulaval.ca, Patrik Flisberg, Dick Carlsson

LKAB is a large iron ore mining company and a world-leader in pellet manufacturing. It produces more than 20 million tons and this is increasing considerably over the next years. An important part of its logistic is to use trains to transport material and products. This system has a number of bottlenecks that may be critical. We present OR models of the transportation ranging from strategic down to operational planning. We present a number of case studies and analysis of these.

■ SB71

Parc - Lombard

Auctions and Markets for Information

Cluster: Auctions
Invited Session

Chair: Dirk Bergemann, Yale University, 30, Hillhouse Avenue, Cowles Foundation, New Haven, Co, 06511, United States of America, dirk.bergemann@yale.edu

1 - Robustness and Multidimensional Mechanism Design
> Gabriel Carroll, Stanford University, 579 Serra Mall, Stanford, CA, 94305, United States of America, gdc@stanford.edu

We consider a robust multidimensional screening problem. A monopolist sells several goods simultaneously to a buyer with additive valuation. The seller knows the marginal distribution of values for each good, but not their joint distribution. Any mechanism for selling the goods is evaluated by its worst-case expected revenue over all joint distributions consistent with the seller's knowledge. The main result is that it is optimal to simply post a price for each good separately.

2 - Selling Cookies
> Dirk Bergemann, Yale University, 30, Hillhouse Avenue, Cowles Foundation, New Haven, Co, 06511, United States of America, dirk.bergemann@yale.edu, Alessandro Bonatti

We analyze data pricing and targeted advertising. Advertisers seek to tailor their spending to the value of each consumer. A monopolistic data provider sells cookies about individual consumers' preferences. We characterize the set of consumers targeted by the advertisers and the optimal monopoly price of cookies. The price of data decreases with the reach of the database and increases with the fragmentation of data sales. We characterize the optimal policy for selling information.

3 - Surveying and Selling: Belief and Surplus Extraction in Auctions
> Benjamin Brooks, Princeton University, 001 Fisher Hall, Princeton, NJ, 08540, United States of America, babrooks@princeton.edu

I consider a seller who is highly uncertain about demand for the good he is selling. All the seller knows is that values are private and beliefs are derived from a common prior. The seller wants to guarantee himself as large a revenue-share of the efficient surplus as possible. This goal is achieved by running a modified second-price auction, in which the seller collects additional information in order to calibrate a reserve price.

4 - Reserve Prices in Internet Advertising Auctions: A Field Experiment
> Michael Schwarz, Yahoo! Labs, Sunnyvale, CA, United States of America, mschwarz@yahoo-inc.com, Michael Ostrovsky

We present the results of a large field experiment on setting reserve prices in auctions for online advertisements, guided by the theory of optimal auction design suitably adapted to the sponsored search setting. Consistent with the theory, following the introduction of new reserve prices revenues in these auctions have increased substantially.

■ SB72

Parc- Stockton

Demand Response in Electricity Markets

Sponsor: Energy, Natural Res & the Environment/Energy
Sponsored Session

Chair: Mahdi Kefayati, The University of Texas at Austin,
2501 Speedway ENS 506A, Austin, TX, 78712,
United States of America, kefayati@utexas.edu

Co-Chair: Ross Baldick, Professor, The University of Texas at Austin,
1 University Station TX, C0803, Department of Electrical & Computer
Engg, Austin, TX, 78712, United States of America,
baldick@ece.utexas.edu

**1 - A Graph-theoretic Computational Method for Emerging Power
Optimization Problems**
Ramtin Madani, Columbia University, 120th St, New York, NY,
10027, United States of America, rm3122@columbia.edu,
Javad Lavaei, Ghazal Fazelnia, Somayeh Sojoudi

We study a general power optimization using a convex relaxation named
semidefinite programming (SDP). The existence of a rank-1 matrix solution to the
SDP relaxation enables the recovery of a global solution of the original problem.
We show that the SDP relaxation has a solution whose rank is upper bounded by a
parameter, named the graph complexity of the network. This number will reduce
to 2 after sparsification. The results of this talk will be demonstrated on Polish and
New England systems.

**2 - Capturing User Behavior in the Smart Grid: Prospect Theory Meets
Energy Management**
Walid Saad, Virginia Tech, Perry St, Blacksburg, VA,
United States of America, saad.walid@gmail.com,
Narayan Mandayam, H. Vincent Poor

Active customer participation is seen as an integral part of the emerging smart grid.
However, despite the foreseen technological benefits of user-centric grid features
such as demand-side management, to date, their widespread adoption in practice
remains modest. To shed light on this challenge, we explore the potential of
prospect theory, a Nobel-prize winning theory, as a decision-making framework
that can help understand how risk and uncertainty can impact the decisions of
smart grid users.

3 - Pricing Mechanisms for Control
Desmond Cai, California Institute of Technology, Pasadena, CA,
United States of America, wccai@caltech.edu, John Ledyard,
Adam Wierman, Steven Low

We propose a mechanism for a principal to purchase the right to control the
amount of consumption by a group of agents. Such a mechanism could be
applicable when the principal is more efficient at managing the consumption of the
agents than the agents themselves. Our scheme has applications in demand-side
management, where a utility company could manage the power consumption of
its end-use customers in conjunction with wholesale prices, to reduce overall
energy costs of its end-use customers.

**4 - Optimal Simultaneous Energy Consumption and Regulation
Provision under Real-time Stochastic Prices**
Mahdi Kefayati, The University of Texas at Austin, 2501 Speedway
ENS 506A, Austin, TX, 78712, United States of America,
kefayati@utexas.edu, Ross Baldick

The power trajectory followed by flexible loads need not be bound to a specific
trajectory. Therefore, such loads can respond to prices or ancillary services
commands. We propose an optimal policy for simultaneous energy consumption
and regulation provision under the assumption that regulation provision requires
capacity reservation. We show that the optimal policy admits a piecewise linear
form which can be computed efficiently.

■ SB73

Parc- Mission I

New Paradigms in Transmission Expansion Planning

Sponsor: Energy, Natural Res & the Environment/Energy
Sponsored Session

Chair: Enzo Sauma, Associate Professor, Pontificia Universidad
Catolica de Chile, Santiago, Chile, esauma@ing.puc.cl

**1 - Scalable Decomposition Algorithms for Solving Stochastic
Transmission Investment Planning Problems**
Francisco Munoz, Analytics, Sandia National Laboratories, 1700
Indian Plaza Dr NE APT 5, Albuquerque, United States of America,
elpanchomunoz@gmail.com, Jean-Paul Watson

We describe a scalable decomposition algorithm to solve real-sized investment-
planning models taking into account the uncertainties that result from the
increasing penetration of renewable energy technologies, as well as from long-term
market and regulatory conditions. An application of our algorithm is illustrated
using a 240-bus network representation of the WECC. We discuss its performance
when implemented in both the Red Mesa supercomputer and a commodity multi-
core workstation.

2 - Robust Transmission and Generation Expansion Planning
David Pozo, Pontificia Universidad Catolica de Chile, Avendia
Vicuna Mackenna #4860, Raíl Deves Hall, 3rd floor, Macul,
Santiago, Chile, davidpozocamara@gmail.com, Enzo Sauma,
Javier Contreras

We present a robust model for a market-based transmission and generation
expansion. In a first stage, transmission expansion decisions are taken. Afterwards,
the optimal generation expansion among all generation companies is taken and
finally, the market equilibrium is at the third stage. The second and third stages
depict an EPEC. Manifold equilibria are possible with different costs for the system.
We solve a robust version considering the worst-case equilibria solution of the
EPEC problem.

3 - Transmission Planning for Reducing Emissions
Masood Jabarnejad, PhD Student, Auburn University, 333 East
Magnolia Ave. APT 44, Auburn, AL, 36830, United States of
America, masood@auburn.edu, Jorge Valenzuela

Dynamic thermal rating enhances the capability of in-service transmission lines
and transmission switching reduces the electricity generation cost by temporarily
removing inefficient transmission lines out of service. In this presentation, we
propose an optimization model to integrate both approaches to better utilize wind
energy and therefore reduce emissions.

**4 - Real Option Approach in Transmission Expansion Planning
under Uncertainty**
Alvin Henao-Perez, Universidad del Norte, Km 5 Via Antigua a
Puerto Colombia, Barranquilla, Colombia,
henaoa@uninorte.edu.co, Enzo Sauma

Transmission Expansion Planning (TEP) is full of uncertainties and often analyzed
from a probabilistic-choice or robustness point of view, under reliability and
economic criteria. Because of the transmission investment features, it is useful to
analyze the value of adding flexibility in the TEP. This study estimates this value
using a multinomial decision tree to handle uncertainties related with load growth
and electricity generation expansion, under a maximization of economic welfare
criterion.

■ SB74

Parc- Mission II

Mitigating Uncertainty in Power System Operations through Market Design and Computational Methods

Sponsor: Energy, Natural Res & the Environment/Energy
Sponsored Session

Chair: Anthony Papavasiliou, Assistant Professor, Catholic University
of Louvain, Voie du Roman Pays 34, Office b.114, CORE, Louvain la
Neuve, 1348, Belgium, anthony.papavasiliou@uclouvain.be

**1 - Efficiency Losses of Zonal Network Management under Large-
Scale Renewable Energy Integration**
Anthony Papavasiliou, Assistant Professor, Catholic University of
Louvain, Voie du Roman Pays 34, Office b.114, CORE, Louvain la
Neuve, 1348, Belgium, anthony.papavasiliou@uclouvain.be

We quantify the efficiency losses of zonal market clearing followed by counter-
trading due to unit commitment that ignores Kirchoff's laws and congestion within
zones. We focus on how these inefficiencies are exacerbated by uncertainty in the
presence of large-scale renewable energy integration. The market coupling model
is compared to an ideal stochastic unit commitment benchmark. We present results
for Central Western Europe (CWE).

2 - Look-Ahead Security Constrained Optimal Power Flow via Proximal Message Passing

Sambuddha Chakrabarti, Graduate Student, The University of Texas at Austin, 1 University Station C0803, Department of Electrical & Computer Engg, Austin, TX, 78712, United States of America, sambuddha.chakrabarti@gmail.com, Matt Kraning, Eric Chu, Ross Baldick, Stephen Boyd

We present here a fully decentralized algorithm, the Proximal Message Passing to solve the Look Ahead SCOPF where we represent the post contingency states and formulate a restoration scheme, limiting the post fault line temperature and line current rise to within safe values and ensuring system security with respect to the next set of contingencies through ramp rate constraints on generators. This method will enable us to implement a dynamic optimal transmission switching plan as well.

3 - Service Pricing and Multiplicity of Equilibria in Short Term Power Markets with Wind

Yves Smeers, Professor Emeritus, Université Catholique de Louvain, Ctr Operations Research & Econometrics, Voie du Roman Pays 34, L1.03.01, B-1348, Louvain-la-Neuve, B-1348, Belgium, yvessmeers@me.com, Sebastian Martin

We consider a two-settlement short-term power market of the European type (separation of the PX dealing with energy and TSO dealing with services). Wind is currently supported by different means, some of them being an improper pricing of the services that it implies. We show that this can lead to a multiplicity of equilibria, which can be interpreted as an unnecessary volatility introduced by the market design.

4 - A Mechanism Design Model for Firming Intermittened Renewable Generation with Curtailable Demand

Clay Campaigne, Dept of Industrial Engineering and Operations Research, University of California, Berkeley, Berkeley, CA, 94720, United States of America, clay.campaigne@gmail.com, Shmuel Oren

We characterize the one-period optimal policy, for an aggregator who owns a portfolio of stochastic renewable energy resources but must commit in day-ahead to a quantity of power with a linear penalty for shortfall from the commitment The aggregator can contract with retail customers for reductions from their baselines so as to hedge its supply. The counterfactual baselines are private information which are elicited in the contracting process.

■ SB75

Parc- Mission III

Simulation Modeling for Anaysis

Sponsor: Simulation

Sponsored Session

Chair: Lee Schruben, lees@berkeley.edu

1 - Capturing the Impact of Input Model Uncertainty in Stochastic Models and Analysis: Lessons Learned

Russell Barton, Pennsylvania State University, 210E Business Building, Pennsylvania, United States of America, rrb2@psu.edu, Wei Xie, Barry Nelson

Discrete event simulations are driven by input models fitted with finite data. This presentation will highlight the difficulties in characterizing the impact on output analysis for the general case, the progress that has been made in special cases, and the broader implications for many stochastic modeling and optimization settings.

2 - Optimal Selection of the Most Probable Multinomial Alternative

David Goldsman, Professor, Georgia Tech, Stewart School of Indust & Sys Engr, Atlanta, GA, 30332-0205, United States of America, Sman@isye.gatech.edu, Craig Tovey, Anton Kleywegt, Eric Tollefson

We present selection procedures based on linear and mixed-integer linear programs that find the multinomial cell having the highest probability. Our procedures are optimal in the sense that they minimize the number of observations taken to achieve a certain probability of correct selection.

3 - Vamp1re: A Single Criterion for Evaluating Confidence-Interval Procedures

Bruce Schmeiser, Emeritus Professor, Purdue University, School of Industrial Engineering, West Lafayette, United States of America, bruceschmeiser@gmail.com, Ying-chieh Yeh

Confidence-interval procedures are classically evaluated using actual coverage probability and expected half width. We argue for a single criterion, based on Schruben's coverage function when sample size is constant. We extend the criterion to procedures with stopping rules.

4 - Effective Simulation Warm-up for a Neonatal Intensive Care Unit

Emily Lada, SAS Institute, World Headquarters, SAS Campus Drive, Cary, NC, 27513, United States of America, Emily.Lada@sas.com, Anup Mokashi, James Wilson

In simulating a neonatal intensive care unit subject to constraints on the available computing budget for generating certain key responses, effective warm-up is required to compute accurate point and confidence-interval estimates of, for example, the expected number of admissions per year as well as the long-run average length of a patient's stay. Techniques for steady-state simulation analysis (N-Skart and SBatch) are adapted to this problem.

■ SB76

Parc- Embarcadero

Cloud Infrastructure Planning and Optimization

Sponsor: The Practice Track

Sponsored Session

Chair: Thomas Olavson, Google, 1300 Crittenden Lane, Mountain View, CA, 94306, United States of America, tolavson@google.com

1 - Machine Fleet Planning in an Internal Resource Economy

John Bossert, Sr Quantitative Analyst, Google, 1300 Crittenden Lane, Mountain View, CA, 94306, United States of America, bossert@google.com

Google recently began transforming its compute infrastructure allocation process from centralized planning to an internal resource economy under which each product area purchases capacity options. I describe several machine fleet planning problems arising within this environment, and then formulate as a dynamic bin-packing the problem of assigning capacity options sold against a datacenter campus to specific clusters within that campus.

2 - Improving the Efficiency of Resource Provisioning and Utilization in Cloud Computing

Chen Peng, Sr Quantitative Analyst, Google, 1300 Crittenden Lane, Mountain View, CA, 94306, United States of America, cpeng@google.com, Chao Ding

We provide an overview of various resource provisioning and efficiency problems encountered at Google in operating one of the largest cloud computing infrastructures in the world—-such as capacity provisioning ratios of different resource dimensions, impact of heterogeneous machine configurations, smart job scheduling by leveraging the statistical properties of workload, etc.

3 - Panel Discussion: Cloud Infrastructure Challenges and Opportunities

Moderator: Brian Eck, Quantitative Analyst, Google, Inc., 1300 Crittenden, Building CL3, Office 2S5, Mountain View, CA, 94043, brianeck@google.com, Panelists: Cathy Xia, Ilyas Iyoob, Thomas Olavson, Muntazir Mehdi

This panel will include representatives from industry and academia, to discuss topics in leveraging Operations Research techniques for managing Cloud Infrastructure.

■ SB77

Parc- Market Street

Stochastic Models in Health Care

Sponsor: Applied Probability Society

Sponsored Session

Chair: Nilay Argon, University of North Carolina, Department of Statistics and Operations, Chapel Hill, NC, 27599, United States of America, nilay@unc.edu

1 - Modeling the Effect of Nurse as a Transmitter on Hospital Acquired Infections

Lerzan Ormeci, Associate Professor, KoÁ University, Istanbul, Turkey, LORMECI@ku.edu.tr, Evrim Gunes, Onder Ergonul, Amin Khoshkenar

We analyze the role of nurse in hospital acquired infection dynamics in an intensive care unit. An analysis of a dataset reveals that the infection status of a patient is significantly influenced by her neighbors' infection status and length-of-stay. We develop a Markov chain model to represent the interactions between a nurse and patients, where factors such as nurse-to-patient ratio, nurse's hand-washing behavior, contact rate and probability of contamination during a contact are included.

2 - Optimal Allocation of Physician's Time when Patient Utility is Heterogeneous

Balaraman Rajan, Simon Business School, University of Rochester, CS 4-339 Carol Simon Hall, Rochester, NY, 14627, United States of America, balaraman.rajan@Simon.Rochester.edu, Tolga Tezcan, Abraham Seidmann

We analytically investigate the strategic decisions of a medical specialist who treats patients visiting from a significant distance. We find that a revenue maximizing specialist spends more time with the patients, partially to compensate for their travel ëcost', and thus sees fewer patients than a welfare maximizing one. We extend our model to investigate how telemedicine technology influences the specialist's decisions and his service level.

3 - Scheduling Series Patients in a Healthcare Facility

Siyun Yu, PhD Candidate, UNC Chapel Hill, BB26 Hanes Hall, UNC Chapel Hill, Chapel Hill, NC, 27599, United States of America, yusiyun@live.unc.edu, Vinayak Deshpande, Vidyadhar Kulkarni

Many healthcare patients, requiring services such as physical therapy, are considered as ëseries' patients, which means that they are scheduled for a series of appointments. They are classified according to the number, frequency and the duration of the sessions they need. We develop a multi-class queuing network model to determine the number of appointment slots for the new patients as well as the returning patients to either assure reasonable waiting times or minimize the total operating cost.

4 - Priority Assignment under Non-linear Cost Functions

Nilay Argon, University of North Carolina, Department of Statistics and Operations, Chapel Hill, NC, 27599, United States of America, nilay@unc.edu, Huiyin Ouyang, Serhan Ziya

Consider a queueing system with two types of customers, each incurring a non-linear cost depending on its type and waiting time in the queue. The controller has information only on the order of arrivals of customers and their types. For such a system, we identify sufficient conditions under which first-come-first-serve, last-come-first-serve, or priority policies are optimal. A numerical study compares these policies with more complex ones that use information on the waiting times.

■ SB79

Parc- Powell I

Decision Analysis and Behavioral Research

Sponsor: Decision Analysis
Sponsored Session

Chair: Detlof von Winterfeldt, Professor, University of Southern California, Dept of Industrial & Systems Engineering, Olin Hall of Engineering, Los Angeles, CA, 90089, United States of America, detlof@aol.com

1 - Improving the Practice of Decision Analysis with Prescriptive Behavioral Economics

Ralph Keeney, Professor Emeritus, Duke University, 401 Hilton-Lombard, #704, San Francisco, CA, 94111, United States of America, KeeneyR@aol.com

Behavioral economics focuses on the biases and errors of human decisions. Prescriptive behavioral economics involves experiments with decision-makers facing their own real decisions to improve the procedures and techniques for the process of decision-making and the use of decision analysis. The goal is higher quality decisions for individuals and groups.

2 - Behavioral Analytics: A Framework for Exploring Judgments and Choices in Large Data Sets

Gilberto Montibeller, London School of Economics, Houghton Street, London, United Kingdom, G.Montibeller@lse.ac.uk

The increasing availability of large data sets that store users' judgments and choices provides a fertile ground for Business Analytics. Behavioral Decision Research has much to offer to analytics, but its fragmented nature often prevents decision analysts to use its full power. In this paper we thus propose a framework to explore such data sets, Behavioral Analtyics, which can support behavioral data mining and behavioral data learning (joint work with I Durbach).

3 - Convergent Validation of a Methodology for Eliciting Trade-offs for Protected (sacred) Values

Richard John, Associate Professor, University of Southern California, RTH 310, University Park, Los Angeles, CA, 90089, United States of America, richardj@usc.edu, Heather Rosoff, Kenneth Nguyen

We describe a methodology for eliciting trade-offs in highly political contexts, involving potentially protected values. We apply this methodology to two different security contexts: Air Travel and Cyber Privacy. A decision problem is constructed, including an additive MAU model. The elicitation uses sequential binary choices to obtain weights based on indifference between pairs of alternatives. Convergent validation is reported comparing different sets of trade-offs and swing weights.

4 - Biases that Matter for Decision Analysis (and those that don't)

Detlof von Winterfeldt, Professor, University of Southern California, Dept of Industrial & Systems Engineering, Olin Hall of Engineering, Los Angeles, CA, 90089, United States of America, detlof@aol.com

A large number of biases in judgment and decision making have been discovered since the early 1970s. Some of these biases matter, because they affect the elicitation the inputs to a decision analysis. Others don't matter, either because they do not commonly occur in decision analysis or because they can easily be overcome.

■ SB80

Parc- Powell II

Decision Analysis in Integrated Care (Healthcare and Social Care)

Sponsor: Decision Analysis
Sponsored Session

Chair: Lea Deleris, IBM, Dublin Research Lab, Dublin, Ireland, lea.deleris@ie.ibm.com

1 - The Role of Decision-analytic Modeling in Early-stage Health-economic Assessments of Medical Devices

Jan Pietzsch, President & CEO, Wing Tech Inc., 228 Hamilton Ave., 3rd floor, Palo Alto, CA, 94025, United States of America, jpietzsch@wing-tech.com

Medical technology innovations can contribute to meaningful advances in patient care. At the same time, the financial burdens on healthcare systems continue to increase, requiring the demonstration of a clear clinical and economic value proposition. In this talk, we review the critical role of decision-analytic modeling can play in early-stage health-technology assessment, and illustrate opportunities and challenges based on the discussion of two recent medical device assessments.

2 - Clinical Trials for Pharmaceuticals: To Repeat, or Not to Repeat?

John Cavallaro, Technical Director, Portfolio & Asset Strategy, Bristol-Myers Squibb, P.O. Box 4000, Princeton, NJ, 08543, United States of America, john.cavallaro@bms.com, David Swank

Reports that early pharmaceutical clinical trial results are not very predictive of later success have led some to propose repeating successful early phase trials before proceeding. Using a decision analytic framework, we modeled the decision to repeat, continue, or abandon a clinical program as function of the trial costs, market value, and success probabilities. Our results show that only under very specific conditions is it optimal to repeat trials after early success.

3 - A Model for Vulnerability Indexes in Social Care

Lea Deleris, IBM, Dublin Research Lab, Dublin, Ireland lea.deleris@ie.ibm.com, Robert Shorten, Fabian Wirth, Shravan Sajja

We describe a model that we have developed to provide care workers with a multidimensional vulnerability dashboard to help them understand the current and upcoming problems of the citizens that they manage. Our model is built upon a Bayesian network representation of the factors affecting vulnerabilities and a Markov Chain model capturing the evolution over time. All vulnerabilities are measured with the same metric which means that it is possible to compare across categories and across persons.

4 - Improving Investment Decisions at Hospitals through System Dynamics and Decision Analysis

Christian Wernz, Virginia Tech, 205 Durham Hall, Blacksburg, 24061, United States of America, cwernz@vt.edu, Hazhir Rahmandad, Alba Rojas-Cordova, Arash Baghaei Lakeh, Hui Zhang, Anthony Slonim

Hospital executives have to make capital investment decisions that account for multiple stakeholders and organizational objectives, risk and limited budgets. Furthermore, the long-term, organization-wide effects of an investment are difficult to predict. In response, we have developed a decision support method that integrates system dynamics with the simple multi-attribute rating technique (SMART). We tested and validated our approach with hospital executives for the Da Vinci surgical robot.

■ SB81

Parc- Divisadero

The Role of Information in Dynamic Games

Cluster: Data and Information

Invited Session

Chair: Kostas Bimpikis, Assistant Professor, Stanford GSB, 655 Knight Way, Stanford, United States of America, kostasb@stanford.edu

1 - Learning Product Features from Consumer Reviews

Davide Crapis, Columbia Business School,
434 West 120th Street, New York, NY, United States of America,
dcrapis16@gsb.columbia.edu, Alireza Tahbaz-Salehi,
Costis Maglaras

In the context of learning from on-line reviews, we study a model in which a good is represented by an attribute vector and the respective quality vector is unknown. Consumers are heterogeneous with respect to their preferences for the various attributes. First, when consumers observe only one-dimensional reviews, they do not learn the product quality. Second, when reviews are multi-dimensional, we characterize how different assumptions on the population of consumers affect the learning outcome.

2 - Information Provision in Dynamic Innovation Tournaments

Kostas Bimpikis, Assistant Professor, Stanford GSB, 655 Knight Way, Stanford, United States of America, kostasb@stanford.edu, Mohamed Mostagir, Shayan Ehsani

Tournaments are suited for settings that feature a high degree of uncertainty. Participants learn about the underlying environment from their competitors' gradual progress. On the other hand, information about the status of competition may adversely affect effort provision from the laggards. Thus, the tournament's information provision mechanism is critical for its success. The paper suggests a number of design guidelines with the objective of maximizing the probability of reaching the end goal.

3 - Strategic Trading in Informationally Complex Environments

Nicolas Lambert, Assistant Professor of Economics, Stanford University, Graduate School of Business, 655 Knight Way, Stanford, CA, 94305, United States of America, nlambert@stanford.edu, Mikhail Panov, Michael Ostrovsky

We study trading behavior and properties of prices in informationally complex markets in the Kyle 85 model. We allow for arbitrary correlations among the random variables involved in the model: the value of the asset, the signals of strategic traders, the signals of the market maker, and the demand from noise traders. We characterize the unique linear equilibrium, illustrate its properties, and use this characterization to study the informational efficiency of prices as the market grows large.

4 - Network Resilience against Epidemic Spread

Kimon Drakopoulos, MIT, 77 Massachusetts Ave, Cambridge, MA, 02139, United States of America, kimondr@mit.edu, John Tsitsiklis, Asuman Ozdaglar

We study the problem faced by a network defender when an epidemic is evolving on a known network. We assume that the network defender has full information on the state of the epidemic and can allocate curing rates to nodes under a budget constraint. The goal is to minimize the expected extinction time of the epidemic. We find necessary and sufficient conditions on the graph structure under which curing policies that achieve sublinear extinction time exist.

■ SB82

Parc- Haight

Choice Behavior in MCDM

Sponsor: Multiple Criteria Decision Making

Sponsored Session

Chair: Hannele Wallenius, Professor, Aalto University, Otaniementie 17, Espoo, Finland, Hannele.Wallenius@Aalto.fi

1 - Pricing New Services using Utility Functions

Outi Somervuori, Aalto University, P.O. Box 11000, Aalto, 00076, Finland, outi.somervuori@aalto.fi, Merja Halme

Choice-based conjoint analysis is used to set prices of new services available for a trial period in an airport relaxation area. 300 passengers evaluated the services with different prices. The results allow to assess optimal prices for the different services and the value of different product profiles for the respondents. The study was ordered by the company managing Finnish airports. Its results will be compared with a study employing incentive-based conjoint analysis.

2 - Emotional-Motivational Responses Predicting Choices: A Neurophysiological Investigation

Jyrki Wallenius, Professor, Aalto University, P.O. Box 11000, Aalto, 00076, Finland, Jyrki.Wallenius@Aalto.fi, Outi Somervuori, Pekka Korhonen, Murat Köksalan, Niklas Ravaja

We examined how emotional attachment to a choice option predicts choices and mediates the endowment effect and the emotional-motivational responses to trade-off choices. The participants made win-win and trade-off choices between product packages in neurophysiological study. The results suggest that approach motivation and emotional attachment mediate the endowment effect. In addition, high trade-off difficulty was associated with increased withdrawal motivation and negatively valenced arousal.

3 - Linear Model Prediction for Cognitive Skill Subgroups in Multiple Criteria Decision Making

Tommi Pajala, Aalto University, Laaksolahdentie 49, Espoo, 02730, Finland, tommi.pajala@aalto.fi, Pekka Korhonen, Jyrki Wallenius

We predicted choices in a four-criteria pairwise MCDM problem with a linear value function model with the epsilon formulation (Korhonen et. al., 2012). We investigated whether the Cognitive Reflection Test score is related to the predictive power, but no effects were found. Most subjects were inconsistent with their importance of criteria, questioning the usefulness of eliciting judgments of importance. The model predicted 81,7 % of choices, outperforming comparison models.

4 - Difficulties in Making Rational and Consistent Choices

Pekka Korhonen, Professor, Aalto University, School of Business, Aalto, FI, 11000, Finland, Pekka.Korhonen@Aalto.fi, Niklas Ravaja, Outi Somervuori, Jyrki Wallenius

We present the results of an experiment with the aim to study, whether the choices of subjects are rational and consistent. If not, "why not"? The choice problems consists of 2-3 criteria and 3, 4, and 6 alternatives. Pilot study revealed that the subjects had difficulties in making rational and consistent choices. We will repeat the experiment with a larger group with an aim to look for explanations to findings. The study is based on the use of two sets of criteria: utilitarian and hedonistic.

■ SB83

Parc- Sutro

Doing Good with Good OR - Student Paper Competition

Cluster: Doing Good with Good OR – Student Paper Competition

Invited Session

Chair: Ruben Proano, Assistant Professor, Rochester Institute of Technology, Rochester, NY, United States of America, rpmeie@rit.edu

1 - Doing Good with Good OR - Student Paper Competition

Carri Chan, Columbia University Business School,
3022 Broadway, Uris 410, New York, NY, United States of America,
cwchan@columbia.edu

Doing Good with Good OR - Student Paper Competition is held each year to identify and honor outstanding projects in the field of operations research and the management sciences conducted by a student or student group that have a significant societal impact.

2 - Optimizing Vaccine Allocation for Pandemic Influenza

Hsin-Chan Huang, The University of Texas at Austin, 204 E. Dean Keeton Street, Stop C2200 ET, Austin, TX, 78712-0292, United States of America, neo.huang@utexas.edu, Bismark Singh

With the Texas Department of State Health Services, we develop a web-based decision-support tool to optimize vaccine allocations during an influenza pandemic. Our allocation is proportionally fair for user-specified target populations. Using 2009 H1N1 data, we show how reserving a small percentage of doses can achieve fair coverage, while most vaccines are allocated based on healthcare provider requests.

3 - Global Supply Chain Optimization – United Nations World Food Program

Yuvraj Singh, Georgia Institute of Technology, Atlanta, GA, United States of America, yuvrajasr7@gmail.com, Lakshmi Gadepalli, Maria Ayers, Ashfaque Kachwala, Tahsin Munir, Gabriel Rodriguez, Cane Punma

The MCNF model arrived at an optimal solution under 5 minutes for WFP's largest operation. Doubling operation size resulted in a processing time of 13 minutes ensuring the capacity of the model. The optimal solution indicates potential savings of $34 million. Essentially, this model quantifies the value of a centralized decision-making process with proper visibility of every decision's impact.

4 - Optimizing Mobile Blood Collection: Application in Turkey
Feyza Sahinyazan, McGill University, Montreal, QC, Canada,
feyza.sahinyazan@mail.mcgill.ca

Effective use of bloodmobiles is helpful in increasing the number of donors and
donation frequencies. Since bloodmobiles can reach potential donors with limited
time and means of transportation, they can attract more donors than fixed points.
In our project, we propose a new cost efficient and easy-to-implement mobile
blood collection system based on the practices of Turkish Red Crescent (TRC).

Sunday, 1:30pm - 3:00pm

■ SC01

Hilton- Golden Gate 6

MAS Tutorial Session. A Quick Peek at Predictive Analytics

Sponsor: Military Applications Society
Sponsored Session

Chair: Greg Parlier, Past President, MAS of INFORMS,
255 Avian Lane, Madison, AL, 35758, United States of America,
gparlier@knology.net

1 - A Quick Peek at Predictive Analytics
Thomas Willemain, Sr VP, Smart Software, Inc.,
4 Hill Road, Belmont, MA, 02478, United States of America,
tomw@smartcorp.com

This tutorial will introduce a few key methodologies in the field of predictive
analytics: extrapolative time series forecasting, regression and logistic regression,
and tree models including random forests. The emphasis will be on matching
methods to problems, understanding the inputs required by and outputs supplied
by the methods, and perspectives on the strengths and weaknesses of the methods.
Reprises presentation at MORS 82.

■ SC02

Hilton- Golden Gate 7

Organizational Issues in Technology Management

Sponsor: Technology, Innovation Management and Entrepreneurship
Sponsored Session

Chair: Zhijian Cui, Assistant Professor of Operations and Technology
Management, IE Business School, Calle de Maria de Molina, 12,
Madrid, 28006, Spain, zhijian.cui@ie.edu

1 - Buyer and Supplier Coordination for Knowledge Outsourcing under Information Asymmetry
Jaesoek Lee, Georgia Institute of Technology, 800 West Peachtree
NW, Atlanta, GA, 30308, United States of America,
Jaeseok.Lee@scheller.gatech.edu, Cheryl Gaimon

This paper examines coordination between a buyer and a supplier for knowledge
outsourcing under information asymmetry. Optimal decisions include the buyer's
levels of knowledge insourcing and outsourcing, and the supplier's price for
knowledge. This paper shows that the buyer's absorptive capacity, the scope of the
knowledge development project, and the information structure are key drivers of
the optimal solutions and payoffs in equilibrium.

2 - Optimal Search for the Best Alternative: An Experimental Approach
Gulru Ozkan, Clemson University, Department of Management,
120B Sirrrine Hall, Clemson, SC, 29634, United States of America,
gulruo@clemson.edu, Fred Switzer, David Hall,
Jeremy Hutchison-Krupat

Using a behavioral approach, we examine the strategy of decision makers who
search for the best alternative to develop into a new product. The impacts of facing
a set of radical or incremental set of alternatives and the level of time-sensitivity on
the evolution of decision makers' performances are analyzed.

3 - To Adapt or Disrupt? Performance Objectives as Drivers of Innovation Strategies
Fabian Sting, Rotterdam School of Management, Erasmus
University, Burgemeester Oudlaan 50, Rotterdam, Netherlands,
fsting@rsm.nl, Murat Tarakci

We use agent-based simulations to explain why and when firms opt for an
adaptive or a disruptive innovation strategy. We propose that a firm prefers
adapting to the landscape when its objectives are based on improving its
performance, whereas a firm follows a disruptive innovation strategy if it

prioritizes performance relative to competitors. We also find that a firm's
innovation strategy choice is contingent on its competitors' orientations and on the
market's receptivity to disruptions.

4 - Focused or Flexible Targets? How Organizational Design Influences the Definition of Success
Jeremy Kovach, Georgia Tech, 800 West Peachtree NW,
Atlanta, GA, United States of America,
Jeremy.Kovach@scheller.gatech.edu, Stelios Kavadias

We analyze how stakeholder metrics are used to define success and determine the
implementation of a strategic initiative, given the organizational design. We
recognize the dual role of performance metrics: they communicate the target
outcomes (i.e., which outcomes are considered "successful"), and they incentivize
the organizational impetus (i.e., stakeholder effort commitment). We find that the
same initiative might admit different definitions of success in different
organizational structures.

■ SC03

Hilton- Golden Gate 7

Business Model Innovation in Cleantech Markets

Cluster: Business Model Innovation
Invited Session

Chair: Jose Guajardo, University of California Berkeley, 545 Student
Services Bldg #1900, Berkeley, CA, United States of America,
jguajardo@haas.berkeley.edu

1 - Business Models and System Performance: Empirical Evidence from the U.S. Solar Energy Market
Jose Guajardo, University of California Berkeley, 545 Student
Services Bldg #1900, Berkeley, CA, United States of America,
jguajardo@haas.berkeley.edu

We empirically analyze the relationship between business models and system
performance in the U.S. solar energy market, characterizing the drivers and
mechanisms by which different business models affect system performance.

2 - Competition and Externalities in Green Technology Adoption
Charles Thraves, MIT, 70 Pacific Street APT 255B, Cambridge,
United States of America, cthraves@mit.edu, Maxime Cohen,
Georgia Perakis

We study competition among suppliers for green technologies with government
subsidies to the consumers. We quantify who benefits from competition and when,
as well as the impact of environmental externalities. The results differ depending
on demand uncertainty and supplier asymmetry but also can be affected by the
presence of externalities. We show that competition hurts suppliers and benefits
the government but not always the consumers.

3 - Effects of Buyer Safeguards on Prices for New, Used, and Remanufactured Products
Necati Tereyagoglu, Assistant Professor of Operations Management,
Georgia Institute of Technology, 800 West Peachtree NW, Atlanta,
GA, 30308, United States of America,
Necati.Tereyagoglu@scheller.gatech.edu, Ramanath Subramanyam,
Ravi Subramanian

Using detailed transaction-level data, we explore how seller- and product-specific
attributes influence the seller decision to allow returns and how the presence of
this safeguard influences prices paid for new, used, and remanufactured products.
We find evidence that the effect of this safeguard varies across these product types.
Our findings have implications for research on secondary markets and closed-loop
supply chains.

4 - The Potential of Servicing as a Green Business Model
Vishal Agrawal, Georgetown University, 37th and O streets,
Washington, D.C., United States of America,
va64@georgetown.edu, Ioannis Bellos

In recent years, manufacturers in various industries have begun to orient their
practices towards selling the use of the product as opposed to selling the product
itself. We investigate the economic and environmental implications of the
manufacturer's design and pricing decisions under different forms of servicizing
business models.

■ SC04

Hilton- Continental 1

Strategic Decision Making in Manufacturing & Service Operations

Sponsor: Manufacturing & Service Operations Management
Sponsored Session

Chair: Muge Yayla-Kullu, RPI Lally School of Management, 110 8th Street, Troy, NY, 12180, United States of America, YAYLAH@rpi.edu

1 - Optimal Design of Channel Effort
> Haresh Gurnani, University of Miami, United States of America, haresh@miami.edu, Mike Wang, Sammi Yu Tang

Customers buying certain products may lack functional knowledge and need additional help after purchase. This entails an inconvenience cost for them and handling costs to the provider. The retailer (or manufacturer) can invest in pre-sales effort; customers still needing help may receive after sales support. We study the service channel design problem with different structures and show that the retailer would even be worse off if the manufacturer chooses to share the cost of service effort.

2 - The Effect of Targeted Coupons on Quality Choices, Pricing Decisions and Market Segmentation
> Amit Eynan, Professor, University of Richmond, 1 Gateway Rd, Richmond, VA, 23173, United States of America, aeynan@richmond.edu, Benny Mantin

A manufacturer who faces customers with heterogeneous willingness to pay based on quality can segment the market by offering multiple products at different qualities and prices. Buyers will self-select the product that maximizes their utility. We investigate the effect of manufacturer's targeted marketing efforts in the form of coupons on his quality and price choices, the optimal product line and corresponding profit.

3 - Serving Heterogeneous Buyers through Price and Effort Differentiation
> Guangwen Kong, Assistant Professor, University of Minnesota, 111Church Street SE, MINNEAPOLIS, MN, 55455, United States of America, gkong@umn.edu, Hao Zhang, Sampath Rajagopalan

We consider optimal pricing of outsourced services such as web design to two types of consumers with different valuations for service quality. Two different scenarios are considered with public and private quality where the service provider's effort is hidden. We compare and contrast different pricing schemes in terms of profits and quality offered to both types of consumers and identify the benefits and costs of hidden effort. We provide managerial guidelines for pricing of services.

4 - A Pricing Survey for Utility Estimation on Household Electricity Consumption
> Osman Kazan, Assistant Professor, Tulane University, okazan@tulane.edu

Consumers' surveys are generated and carried out to estimate utility functions for electricity consumption in US households. The consumers are asked to schedule daily household activities in different pricing schemes: constant and dynamic. Utility of unit of electricity is estimated, and used in Time-of-Use electricity pricing models. Optimal pricing difference between peak and off-peak hours can be employed by the marketing departments of power utilities.

5 - National Culture and Service Quality
> Muge Yayla-Kullu, RPI Lally School of Management, 110 8th Street, Troy, NY, 12180, United States of America, YAYLAH@rpi.edu, Praowpan Tansipong, Adelina Gnanlet, Christopher M. McDermott, Jeffrey F. Durgee

This is a large-scale theory-building study of the impact of national culture on service quality outcomes. Because of the interactive role employees play in service operations, their behaviors often affect the customer's experience directly. Employee behaviors are often a function of the culture in which they are born and raised. This paper examines how a nation's culture impact service operations through employees' actions and how these relationships change in different segments of a market.

■ SC05

Hilton- Continental 2

Innovation in the Supply Chain

Sponsor: Manufacturing & Service Operations Management
Sponsored Session

Chair: Cheryl Druehl, George Mason University, 4400 University Drive, Fairfax, United States of America, cdruehl@gmu.edu

1 - Predicting High-tech Innovation Failures: Empirical Analysis of Big Data on Medical Device Recalls
> Ujjal Mukherjee, PhD Student, University of Minnesota, 1261 Gibbs Avenue, Saint Paul, MN, 55108, United States of America, mukh0067@umn.edu, Kingshuk Sinha

With increasing technological complexities of products, firms are becoming increasingly vulnerable to the risk of failure of technological innovations while in use in the marketplace. Hence, what is of significance is to be able to detect early signals of such failures, both internal and external to a firm. The central question that serves as the motivation for this paper is: Can user-level feedback related to episodic adverse events in the market predict product-level innovation failure?

2 - The Agency Model for Digital Goods
> Yinliang (Ricky) Tan, Doctoral Student, University of Florida, 355A Stuzin Hall, PO Box 117169, Gainesville, Fl, 32611, United States of America, yinliang.tan@warrington.ufl.edu, Janice Carrillo

Recently, the agency model exploited by publishers in the e-book industry has been highlighted in the press as a result of the U.S. Department of Justice's (DOJ) lawsuit against Apple, Inc. We investigate the strategic impact of the agency model in comparison with the prevalent wholesale and fixed price models by formulating a dual channel model of distribution accommodating sales of both traditional and digital goods.

3 - Modularity, Mass Customization, & Innovation Performance: The Role of Structural Sophistication
> Xenophon Koufteros, Jenna & Calvin R. Guest Professor in Business Administration, Texas A&M University, Mays Business School, INFO Department, College Station, TX, 77843-4217, United States of America, XKoufteros@mays.tamu.edu, Cornelia Droge, Shawnee Vickery, Roger Calantone

We investigate relationships among modularity, mass customization, and innovation performance and explore whether the structural sophistication of a product moderates these relationships.Product modularity is modeled as antecedent to process modularity; both are modeled as antecedent to mass customization, and all three are modeled as antecedent to innovation performance.The hypotheses are tested using structural equations modeling augmented by bootstrapping based on a sample of 109 companies.

4 - Innovation across the Supply Chain
> Cheryl Druehl, George Mason University, 4400 University Drive, Fairfax, VA, United States of America, cdruehl@gmu.edu, Janice Carrillo, Juliana Hsuan

Innovation is an integral part of every firm's ongoing operations. Beyond product innovation, supply chain innovations offer a unique source of competitive advantage. We synthesize recent research on innovation in the supply chain, specifically, innovative supply chain processes such as collaborations with customers and suppliers to create new product and process innovations, open innovation, and globally distributed innovation. We conclude with potential areas for future research.

■ SC06

Hilton- Continental 3

Topics in Sustainable Operations

Sponsor: Manufacturing & Service Operations Management
Sponsored Session

Chair: Chien-Ming Chen, Nanyang Business School, Nanyang Technological University, 50 Nanyang Ave., Singapore, 639798, Singapore, cmchen@ntu.edu.sg

1 - Supply Chain Strategies and Carbon Performance: The U.S. Manufacturing Sector
> Chien-Ming Chen, Nanyang Business School, Nanyang Technological University, 50 Nanyang Ave., Singapore, 639798, Singapore, cmchen@ntu.edu.sg, Maria Montes-Sancho

We empirically test how operational capabilities and strategies can jointly influence environmental and market performances, and whether broadening the scope of environmental assessment to include the supply chain will alter the aforementioned relationship. We find that manufacturers pursuing a broadly defined lean strategy with high operational leanness and a parsimonious process structure tend to attain better direct and supply-chain carbon performances.

2 - Greenhouse Gas Reduction: Why Do Firms Differ?
> Jason Nguyen, Carlson School of Managment, University of Minnesota, nguy1762@umn.edu, Karen Donohue, Rachna Shah

We use the CDP data set to empirically investigate the impact of firms' and industry characteristics on firms' choices of different strategies for reduction of greenhouse gas emissions.

3 - Investment in Environmental Process Improvement in Response to Regulation
    Cheryl Gaimon, Georgia Institute of Technology, 800 West Peachtree NW, Atlanta, GA, 30308, United States of America, Cheryl.Gaimon@scheller.gatech.edu, Markus Biehl, Ravi Subramanian

We analyze a firm's dynamic investment in environmental process improvement (EPI) to reduce waste and its toxicity in response to regulatory penalties and subsidies. The firm minimizes the costs incurred for investing in EPI (less subsidy), the production cost, and the penalty for waste and toxicity. We show that a firm's investment in EPI over time differs substantially in response to penalties versus subsidies and, thus, demonstrate the impact of regulatory choices on dynamic firm behavior.

4 - An Empirical Investigation of Firms' Waste Reduction Efforts under Changing Perceptions of Hazard
    Wayne Fu, Georgia Institute of Technology, 800 West Peachtree NW, Atlanta, GA, United States of America, Wayne.Fu@scheller.gatech.edu, Ravi Subramanian, Basak Kalkanci

Governments and NGOs provide public information on the potential hazards of industrial chemicals. However, there is limited research on the relationship between this information and firms' waste reduction efforts. We empirically investigate the relationship between changes in assessed hazards of chemicals and firms' waste reduction efforts for these chemicals. We also examine how differences in waste reduction efforts relate to chemical, firm, and market characteristics.

■ SC07

Hilton- Continental 4

From Data to Assessments and Decisions: Epi-Spline Technology

Cluster: Tutorials

Invited Session

Chair: Johannes Royset, Naval Post Graduate School, Monterey, CA 93943, United States of America, joroyset@nps.edu

Co-Chair: Ignacio Rios, Research Associate, Universidad de Chile, Department of Industrial Engeneering, Universidad de Chile, Santiago, Chile, ignacio.rios.u@gmail.com

1 - From Data to Assessments and Decisions: Epi-Spline Technology
    Johannes Royset, Naval Postgraduate School, Monterey, CA 93943 United States of America, joroyset@nps.edu

Analysts in every field face the challenge of how to best use available data to estimate performance, quantify uncertainty, and predict the future. The data is almost never "just right," but rather scarce, excessive, corrupted, uncertain, and incomplete. External information derived from experiences, established "laws," and physical restrictions offer opportunities to remedy the situation and should be utilized. Applications in sustainable energy, natural resources, image reconstruction, financial planning, uncertainty quantification, and reliability engineering are rich with problems where decisions rely on data analysis under such circumstances. We address these problems within a framework that identifies a function that according to some criterion best represents the given data set and satisfies constraints derived from the data as well as external information. Epi-splines provide the linchpin that allows us to handle shape restrictions, information growth, and approximations.

■ SC09

Hilton- Continental 6

The Impact of Workload and System Factors on Patient Outcomes

Sponsor: Manufacturing & Service Operations Management/Healthcare Operations

Sponsored Session

Chair: Anita Tucker, Harvard Business School, Morgan Hall, Soldiers Field, Boston, MA, 02163, United States of America, atucker@brandeis.edu

1 - Life is All about Timing: Differences in Treatment Quality for Trauma Patients
    David Anderson, Assistant Professor, Baruch College, Zicklin School of Business, 1 Bernard Baruch Way, New York, NY, 10010, United States of America, david.anderson@baruch.cuny.edu, Guodong Gao, Bruce Golden

Using data from the National Trauma Data Bank, we find that patients arriving at the hospital overnight (6 PM – 6 AM) receive significantly lower quality care than those who arrive during the daytime. We find that the inferior care overnight is likely due to limited availability of high-quality resources, and not unobserved heterogeneity, disruptions in circadian rhythms, or delays in receiving treatment. This leads to higher mortality, surgical complication rates, and longer length of ICU stay.

2 - Empirical Analysis of Ambulance Diversion: Policy Change in Los Angeles County
    Eric Park, Kellogg School of Management, Northwestern University, Evanston, IL, United States of America, eric-park@kellogg.northwestern.edu, Sarang Deo, Itai Gurvich

We study the effect of a policy change that was intended to reduce ambulance diversions in LA County, CA. We find that the new policy succeeded in its purpose of reducing the time emergency departments (EDs) spent on diversion but did not reduce the fraction of ambulances being diverted. A possible explanation for this outcome, identified by our empirical analysis, is a combination of operational process improvement EDs underwent in response to the policy change and neighboring ED effect.

3 - Decomposing the Effect of Workload on Patient Outcomes: An Empirical Analysis of a Maternity Unit
    Michael Freeman, Judge Business School, University of Cambridge, Cambridge, CB2 1AG, United Kingdom, mef35@cam.ac.uk, Nicos Savva, Stefan Scholtes

In this paper, we use a detailed dataset from the delivery unit of a major teaching hospital to better understand how workload impacts quality. We consider two mechanisms: direct impact through deterioration in the quality of task execution and indirect through the choice of care pathway. Our results provide a better understanding of how workload affects quality in service settings.

4 - Reducing Hospital Readmissions by Integrating Empirical Prediction with Resource Optimization
    Jon Stauffer, Indiana University, 1309 E. Tenth Street, Bloomington, United States of America, stauffer@indiana.edu, Jonathan Helm, Kurt Bretthauer, Adel Alaeddini, Ted Skolarus

17% of Medicare patients are readmitted within 30 days of discharge. Post-discharge monitoring is effective in reducing readmissions but is currently done ad-hoc. We develop a large scale optimization and decomposition approach for weakly-coupled network flow problems to design optimal post-discharge monitoring plans and allocate capacity for post-discharge patient visits.

■ SC10

Hilton- Continental 7

Supply Risk Management/Inventory Control

Sponsor: Manufacturing & Service Operations Management

Sponsored Session

Chair: Xin Chen, University of Illinois at Urbana-Champaign, 104 S. Mathews Ave., Urbana, IL, 61801, United States of America, xinchen@illinois.edu

1 - Supply and Demand Functions in Inventory Models
    Qi Feng, Professor, Purdue University, Krannert School of Management, West Lafayette, IN, 47907, United States of America, AnnabelleFeng@purdue.edu, George Shanthikumar

The existing inventory literature focuses on almost surely linear supply/ demand functions, which limits the applicability of the models. We provide a unified approach to analyze general supply / demand functions. By transforming the problem into one in a higher dimension, we show many of the seemingly highly (almost sure) nonlinear functions are linear in the stochastic sense. We derive properties of the profit function and optimal policy for a general class of random supply/ demand functions.

2 - Dual Sourcing under Supply Capacity Uncertainty
    Zhan Pang, Lancaster University, Management School, Lancaster, LA1 4YX, United Kingdom, z.pang@lancaster.ac.uk, Xin Chen

We study the optimal policies of a periodic-review dual-sourcing inventory system with demand and supply capacity uncertainty. The replenishment lead times can be arbitrary. To perform the structural analysis for this problem, we develop a transformation technique and some new preservation properties of L-natural-convexity. We show that these properties can be readily applied to characterize the optimal policy. We further show that dual-index policies are optimal under certain conditions.

3 - Dynamic Inventory Management with Total Minimum Commitments and Two Supply Options

Xiting Gong, Assistant Professor, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong, Hong Kong - PRC, xtgong@se.cuhk.edu.hk, Tong Wang, Sean Zhou

We study a dynamic inventory control problem for a firm who operates under a total minimum commitment (TMC) contract with two supply options. Under such a contract, the cumulative order quantity from either supply or from both supplies over a finite horizon must be at least as large as a given quantity. Using a decomposition technique and multimodularity, we characterize the firm's optimal inventory control policy under different TMC contracts.

4 - Managing Component Allocation for Assemble-to-Order (ATO) Manufacturing

Qiong Wang, Associate Professor, University of Illinois at Urbana-Champaign, 117 Transportation Builiding, 104 South Mathews Avenue, Urbana, IL, 61801, United States of America, qwang04@illinois.edu, Martin I Reiman, Haohua Wan

We study the allocation policy of Reiman and Wang, which is asymptotically optimal in minimizing the long-run average cost of ATO inventory systems with identical lead times. We show asymptotic optimality of their policy extends to other problems, e.g., maximizing the discounted profit of ATO production/inventory systems. By allowing continuous review, the policy never stops serving high-value demands, but may withhold components from low-value ones, which we prove is sometimes necessary.

■ SC11

Hilton- Continental 8

Competition and Coordination in Supply Chains

Sponsor: Manufacturing & Service Operations Management/Supply Chain

Sponsored Session

Chair: Robert Swinney, Associate Professor, Duke University, 100 Fuqua Drive, Durham, NC, 27516, United States of America, robert.swinney@duke.edu

1 - Dynamic Bargaining in a Supply Chain with Asymmetric Demand Information

Lauren Lu, Associate Professor, University of North Carolina - Chapel Hill, Kenan-Flagler Business School, Chapel Hill, NC, 27599, United States of America, lauren_lu@unc.edu, Qi Feng, Guoming Lai

We analyze a dynamic bargaining game in which a seller and a buyer negotiate over quantity and payment to trade for a product. Both firms are impatient, and they make alternating offers until an agreement is reached. The buyer is privately informed about his type, which can be high or low: the high-type's demand is stochastically larger than the low-type's. We characterize the equilibrium and generate insights into how demand forecasting accuracy affects firm profitability.

2 - Cournot Competition in Networked Markets

Kostas Bimpikis, Assistant Professor, Stanford GSB, 655 Knight Way, Stanford, United States of America, kostasb@stanford.edu, Shayan Ehsani, Rahmi Ilkilic

We consider competition among firms in a networked environment. A bipartite graph determines which subset of markets a firm can supply to. We show that the resulting game has a unique equilibrium for any network. We identify a close connection between equilibrium quantities and supply paths in the underlying network. We proceed to study the impact of new entry and mergers on firms' profits and consumer welfare.

3 - Coordination of a Two-Level Supply Chain with Multiple Shipments by Inventory Subsidizing Contracts

Shi Chen, Assistant Professor, University of Washington, Foster School of Business, Foster School of Business, ISOM Department, Box 353226, Seattle, WA, 98195, United States of America, shichen@uw.edu, Hau Lee, Kamran Moinzadeh

Consider a supply chain involving a supplier-retailer relationship and assume that the supplier can stock and deliver the product in multiple shipments for one season. We derive the retailer's optimal order quantities driven by the end-season and within-season critical ratios. The optimal contract requires adjusting both the wholesale price and the retailer's effective inventory holding cost. The contract can be implemented by either a direct subsidizing scheme or a delayed payment scheme.

4 - Supply Chain Models with Preferred Retailer Privy to Supplier's Inventory Information

Hamed Mamani, Assistant Professor, University of Washington, Foster School of Business, ISOM Department, Seattle, WA, 98195, United States of America, hmamani@uw.edu, Kamran Moinzadeh, Apurva Jain

In a supply chain consisting of a supplier and several retailers, some of the retailers have preferred status, providing them with information about the supplier's inventory level. Preferred retailers, thus, can be proactive and inflate their orders when supply gets short. We study the dynamics of such supply chains as a Stackelberg game where retailers react after the supplier has fixed his strategy. We evaluate outcome of the resulting game with solution of the centralized problem.

■ SC12

Hilton- Continental 9

Sustainable Operations Management with Public Interest

Sponsor: Manufacturing & Service Operations Management/Sustainable Operations

Sponsored Session

Chair: Nicholas C. Petruzzi, University of Illinois at Urbana-Champaign, 350 Wohlers Hall, 1206 S. 6th Street, Champaign, IL, 61820, United States of America, petruzzi@illinois.edu

Chair: Michael Lim, Assistant Professor, University of Illinois, Champaign, IL, 61822, United States of America, mlim@illinois.edu

1 - Productively using Waste as By-Product

Mustafa Tongarlak, Assistant Professor, Bogazici University, Department of Management, Bebek, Istanbul, Turkey, tongarlak@boun.edu.tr, Deishin Lee

Firms can often make productive use of their waste stream. In some cases, for example, profitable by-products may be created from the waste stream. We compare the profitability and social welfare of two scenarios: when the firm converts its excess product into by-product, and when it donates its excess product.

2 - The Economic Value of Market Information for Farmers in Developing Economies

Ying-Ju Chen, Berkeley- IEOR, 4121 Etcheverry Hall, Berkeley, United States of America, chen@ieor.berkeley.edu, Chris Tang

To alleviate poverty, various non-governmental organizations (NGOs) and for-profit companies have developed different ways to distribute information about market price, crop advisory and farming technique to farmers. Will information create economic value for farmers? We construct a stylized model in which farmers face an uncertain market price (demand) and must make production decisions before the market price is realized. We examine the interplay between private and public signals.

3 - Efficient Feed In Tariff Policies for Renewable Energy Technologies

Saed Alizamir, Yale School of Management, New Haven, CT, United States of Americasaed.alizamir@yale.edu, Peng Sun, Francis de Vericourt

Feed-in-tariff (FIT) policies aim at driving down the cost of renewable energies by fostering learning and accelerating the diffusion of green technologies. This paper provides insights and guidance into designing cost-efficient and socially-optimal FIT programs. We characterize the structure of the optimal policy for the social welfare objective as well as when the objective is achieving a capacity target at minimum cost. Our proposed policies are in contrast with the current practices of FIT.

4 - Municipal Groundwater Management: Optimal Allocation and Control of a Renewable Resource

Michael Lim, Assistant Professor, University of Illinois, Champaign, IL, 61822, United States of America, mlim@illinois.edu, Nicholas C. Petruzzi, Karthik Murali

Through a stylized dynamic optimization formulation, we study a municipality's problem of allocating renewable groundwater in the presence of water transfer opportunities through two prominent mechanisms. We establish and characterize dynamic threshold polices that govern the export/import decisions of a given municipality. We also address the increasing trend of privatization of water supply systems. Throughout, we assess the resulting allocation equilibria in the spirit of triple bottom line.

■ SC15

Hilton- Exec. Boardroom

Computational Issues and the Relationships Between Related Models

Cluster: Data Envelopment Analysis
Invited Session

Chair: Tim Anderson, tim.anderson@pdx.edu

1 - Parallel DEA in R
Tim Anderson, Portland State University, Portland, OR,
United States of America, tim.anderson@pdx.edu, Tom Shott

This work builds upon past research to provide an open source R package for doing DEA in R. Computational results are provided.

2 - Technology Forecasting using DEA in the Presence of Infeasibility
Dong-Joon Lim, PSU/ETM, 625 SW Jackson St. Apt.975, Portland, OR, 97201, United States of America, tgno3.com@gmail.com

As a predictive use of DEA, Technology Forecasting using DEA (TFDEA) measures the rate of frontier shift by which the arrival of future technologies can be estimated. This study develops an extended TFDEA model that can handle infeasibility based on the modified super-efficiency model proposed by Cook, et al. The application of LCD technology forecasting shows the proposed approach makes a reasonable forecast for formerly infeasible targets as well as a consistent forecast for feasible targets.

3 - A Parallel DEA Implementation for Massive Data Sets
Tom Shott, Graduate Student, Portland State University,
4110 SE Hawthorne Blvd., #113, Portland, OR, 97214,
United States of America, tshott@pdx.edu

Software enabling processing of massive data sets is presented. Running on a high-performance parallel cluster the software processes 10K's of DMU's with 20X speedup. The software uses preprocessing (early DMU classification including geometric techniques) and computational techniques (starting basis, preferred solution sets) for high performance analysis. The theoretical foundations, implementation tradeoffs and current performance of the software implementation in R are discussed.

4 - Dynamic Network Data Envelopment Analysis-DEA on Evacuation Performance
Kostas Triantis, Professor, ISE Department-Virginia Tech, 7054 Haycock Rd, Room 428, Falls Church, VA, 22043, United States of America, triantis@vt.edu, Oscar Herrera-Restrepo, Praveen Edara, Pamela Murray-Tuite, Joseph Trainor

This paper proposes a theoretical representation of a slacks-based dynamic network DEA approach for measuring evacuation performance when a ramp closure strategy is considered. It includes an integrated conceptual framework that incorporates stakeholder perspectives, evacuation-related systems and processes. The approach allows for the discovery of potential performance improvement actions that can inform the definition of future requirements of transportation evacuation strategy designs.

■ SC16

Hilton- Franciscan A

Operations and Finance Interface

Sponsor: M&SOM/ iForm (Interface of Finance, Operations, and Risk Management)
Sponsored Session

Chair: Saif Benjaafar, Distinguished McKnight University Professor Professor, University of Minnesota, 111 Church St SE, Minneapolis, MN, 55455, United States of America, saif@umn.edu

1 - Inventory Models with Tail Constraints
Rene Caldentey, Professor, New York University, 44 West Fourth Street, 8-77, New York, NY, 10012, United States of America, rcaldent@stern.nyu.edu

We propose a methodology for the optimal selection of inventory decisions for a company that faces tail risk constraints. We apply our methodology to some standard operations problems including the popular newsvendor model and a supply chain procurement/inventory problem.

2 - Inventory, Risk Shifting, and Trade Credit
Jiri Chod, Boston College, 140 Commonwealth Ave, Chestnut Hill, MA, 02459, United States of America, jiri.chod@bc.edu

We show that the use of trade credit prevents risk-seeking behavior often associated with debt financing. We consider a financially constrained retailer procuring inventory of two products under uncertain demand. With bank financing, the retailer overinvests in the riskier product where riskiness depends on salvage value, profit margin, mean demand, and demand volatility. A retailer relying on trade credit chooses the first-best inventory, for which he is rewarded by a lower cost of borrowing.

3 - On the Impact of Input Price Variability and Correlation in Stochastic Inventory Systems
David Chen, University of Minnesota, 111 Church Street, Minneapolis, MN, 55455, United States of America, chen2213@umn.edu, Saif Benjaafar, William Cooper

For inventory systems with stochastic demand and stochastic input prices, we show that higher input price variability in the sense of the convex order always leads to lower expected cost. We also find that expected cost is increasing in price correlation over time and decreasing in price correlation across components. We present numerical results that provide insights on how various parameters influence the effects of price variability and correlation.

■ SC17

Hilton- Franciscan B

Retail Operations

Sponsor: Manufacturing & Service Operations Management/Service Operations
Sponsored Session

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

1 - Detecting Stock-outs based on Transaction Data
Marcelo Olivares, Assoc. Professor, Columbia University, Broadway 3027, New York, NY, United States of America, molivares@columbia.edu

This work combines techniques from statistical process control and discrete choice models of demand to develop a real-time system to detect stock-outs in supermarket shelves. The method can be designed to attain a desirable level of false alarms, which is key to facilitate the adoption of the system by store employees. We tested our methodology by running a pilot study where actual shelf availability was monitored for several products with more than 4500 visual inspections.

2 - Intelligent Assortment Expansion for an Online Retailer
Youran Fu, Doctoral Candidate, The Wharton School, 532.4 Jon M. Huntsman Hall, 3730 Walnut St., Philadelphia, PA, 19104, United States of America, youranfu@wharton.upenn.edu, Marshall Fisher

We work with a Chinese e-retailer to develop optimal assortment expansion. The e-retailer believed they could just carry everything but many SKUs they added only became stale inventory. We view a SKU as a set of attributes, and apply both the multinomial logit model and the model developed by Fisher and Vaidyanathan (2012). With sales history data, the latter shows an overall better fit. It is implemented for the imported beer category, increasing the success rate of new SKUs from 24% to 83%.

3 - Size and Prepack Optimization to Minimize Lost Sales and Logistics Costs at an Apparel Retailer
Gurhan Kok, Duke University, 100 Fuqua Drive, Durham, NC, 27708, United States of America, gurhan.kok@duke.edu, Yunus Emre Koç, Ozgur Sivrikaya

Pre-pack optimization is a common problem in fashion retailing. Retailers pack multiple sizes of the same product (style) into the same package to minimize warehouse costs. We develop a stochastic inventory model based evaluation system for determining the optimal package configurations and the procurement amount of each package type. Live controlled experiments demonstrate a 10% increase in gross margin after taking into account a 5% increase in sales and slight increase in logistics costs.

**4 - Increasing Retail Sales via Improved Store Staffing:
An Empirical Study with Implemented Results**
Marshall Fisher, The Wharton School, University of Pennsylvania,
3730 Walnut Street, Room 542, Philadelphia, PA, 19104, United
States of America, fisher@wharton.upenn.edu, Serguei Netessine,
Santiago Gallino

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.

■ **SC18**

Hilton- Franciscan C

Choice Models in Revenue Management and Pricing III

Sponsor: Revenue Management & Pricing
Sponsored Session

Chair: Maarten Oosten, Senior Manager Advanced Analytics
Optimization Services, SAS Institute, SAS Campus Drive, Cary, NC,
27513, United States of America, maarten.oosten@sas.com

Co-Chair: Matt Maxwell, SAS Institute Inc., 500 SAS Campus Dr,
Cary, NC, 27513, United States of America, Matt.Maxwell@sas.com

1 - Estimation of Choice-Based Revenue Management Models
James Lemieux, Senior Research Statistician Developer,
SAS Institute, 100 Sas Campus Dr, Cary, NC, 27617,
United States of America, James.Lemieux@sas.com

Estimation of choice-based revenue management models is made difficult when
non-purchasers are missing. Talluri and van Ryzin (2004) overcome this limitation
by using an EM algorithm. Newman et al (2012) proposed an alternative based on
marginalizing the parameters under the assumption that choice is multinomial
logit. This paper discusses the technical difficulties in implementing these
techniques and proposes an extension that improves the arrival rate estimate in
certain circumstances.

2 - Assortment Planning under the Multinomial Logit Model with Totally Unimodular Constraint Structures
James Davis, jamesmariodavis@gmail.com, Guillermo Gallego,
Huseyin Topaloglu

We consider constrained assortment optimization problems where product
purchase probabilities are governed by the multinomial logit model and the
constraint structure can be captured by a totally unimodular matrix. This is a
general framework that captures a variety of capacity constraints and discrete
pricing problems. We develop a linear program for these problems and use it to
develop purely combinatorial algorithms and gain insight into the structure of
optimal solutions.

3 - Customer Choice Model Optimization with Overlapping Consideration Sets
Matt Maxwell, SAS Institute Inc., 500 SAS Campus Dr,, Cary, NC,
27513, United States of America, Matt.Maxwell@sas.com

Customer Choice Model (CCM) based revenue management has become
increasingly attractive due to recent market changes which weaken traditional
demand model assumptions; however, there are still significant optimization
challenges for revenue management given a CCM. In particular, optimization
algorithms frequently become intractable when multiple market segments have
overlapping consideration sets. We discuss heuristic methods used to overcome this
difficulty and compare their performance.

4 - Launch Price Optimization for Pharmaceutical Products
Bahadir Aral, Sr Operations Research Specialist, SAS Institute,
SAS Campus Drive, Cary, NC, 27513, United States of America,
bahadir.aral@sas.com

Pharmaceutical companies face unprecedented pressure to stay profitable in a
difficult global pricing environment that increasingly demands the ability to
respond swiftly (and smartly) to changing government requirements. A myriad of
price referencing rules complicate the already difficult business and mathematical
challenges of achieving optimal launch sequences and prices across all markets.
This presentation will describe challenges with the problem , a novel approach to
the launch optimization problem, including management of the scheduling and
pricing components simultaneously while allowing for extensive what-if analysis
to identify the most appropriate course of actions.

■ **SC19**

Hilton- Franciscan D

Topics in Revenue and Capacity Management

Sponsor: Revenue Management & Pricing
Sponsored Session

Chair: Dan Zhang, University of Colorado at Boulder, 419 UCB,
Boulder, CO, 80309, United States of America,
dan.zhang@colorado.edu

1 - Investing in a Shared Supplier in a Competitive Market: Stochastic Capacity Case
Anyan Qi, The University of Texas at Dallas, 800 W. Campbell Rd.,
Richardson, TX, 75080, United States of America,
axq140430@utdallas.edu, Amitabh Sinha, Hyun-Soo Ahn

We consider what happens when two competing firms invest in a shared supplier's
capacity under two common forms of restrictions: the investing firm has exclusive
use of the invested capacity, or first priority in having the firm's order fulfilled. We
model firms' investment and production decisions as a two-period game,
characterize the equilibrium capacity investment outcomes, and analyze the impact
of the spillover effect.

2 - Delivering Guaranteed Display Advertising under Reach and Frequency Requirements
Ali Hojjat, PhD Candidate, University of California Irvine,
Paul Merage School of Business, SB 332, Irvine, CA, 92697,
United States of America, hojjats@uci.edu, John Turner,
Suleyman Cetintas, Jian Yang

We propose a new modeling framework for scheduling guaranteed display
advertising in which advertisers demand a specific number of unique users (reach)
that each see the ad campaign at least a certain number of times (frequency). We
integrate a novel user-level approach into a common aggregate planning schema
which allows us to construct a solution and at the same time account for smooth
delivery of ads over time, diversity of ads seen by each user, and other desirable
factors.

3 - Preorder-contingent Pricing vs Preorder-contingent Production in Advance Selling
Fuqiang Zhang, Washington University, Olin Business School, St.
Louis, United States of America, fzhang22@wustl.edu, Mike Wei

Motivated by emerging industry practices, this paper studies the effectiveness of
two new advance selling strategies when facing strategic consumers. We show that
compared to the traditional advance selling strategy, preorder-contingent
production can significantly improve firm profit, while preorder-contingent pricing
does not yield much benefit.

4 - A Model of Consumer Loyalty Reward Programs
Dan Zhang, University of Colorado at Boulder, 419 UCB, Boulder,
CO, 80309, United States of America, dan.zhang@colorado.edu,
Yacheng Sun

Despite the prevalence of loyalty reward programs in the retail and service
industries, there is an ongoing debate on whether and when such programs are
profitable. We consider a monopolistic firm selling to forward-looking consumers
who are heterogeneous in product valuations and purchase frequencies. For each
purchase, a consumer earns a reward that expires after a fixed number of periods.
We discuss managerial implications of the model.

■ **SC20**

Hilton- Yosemite A

Matching and Market Design

Cluster: Matching and Market Design (in honor of Al Roth)
Invited Session

Chair: Jacob Leshno, Columbia University, 3022 Broadway,
Uris Hall, 406, New York, NY, 10027, United States of America,
jleshno@columbia.edu

1 - Matching in Networks
Michael Ostrovsky, Associate Professor of Economics, Stanford
Graduate School of Business, 655 Knight Way, Stanford, CA, 94305,
United States of America, ostrovsky@stanford.edu

In this talk, I will present results on the existence and properties of stable outcomes
in trading networks.

2 - Matching with Peers in School Choice
Atila Abdulkadiroglu, Professor, Duke University, 213 Social
Sciences Building, Durham, NC, 27708, United States of America,
atila.abdulkadiroglu@duke.edu

We develop a theory for matching of students to schools with peers and study
various matching mechanisms with field data.

3 - Endogenous Preferences and the Role of the Mechanism in School Choice
Estelle Cantillon, Senior Research Fellow, Université Libre de Bruxelles (ECARES), 50, av FD Roosevelt, CP 114, Brussels, 1050, Belgium, Estelle.Cantillon@ulb.ac.be

We consider a school choice model where preferences over schools are endogenous because students care about the quality of their peers. In such a setting, the mechanism affects the degree of preference polarization. We show how mechanisms can be designed to reduce polarization and improve the distribution of ranks of assigned schools in students' preferences. A policy change in the city of Ghent (Belgium) provides a test for the predictions of the theory.

4 - Evidence of Strategic Behavior in Hospital Claims Reporting
Hamsa Bastani, Stanford University, Stanford, Stanford, United States of America, hsridhar@stanford.edu, Mohsen Bayati, Stefanos Zenios, Joel Goh

We provide evidence from Medicare claims data that hospitals engage in upcoding behavior when reporting hospital-acquired infections that are no longer reimbursed by Medicare. In particular, we show that hospitals sometimes mark a hospital-acquired infection as present-on-admission, presumably in order to collect greater reimbursement.

■ SC21

Hilton- Union Sq 1

Traffic Flow Modeling and Management

Sponsor: Transportation Science & Logistics
Sponsored Session

Chair: Nikola Markovic, University of Maryland, Civil & Environmental Engineering, College Park, MD, United States of America, nikola@umd.edu

1 - Integrated Methodology for Online Calibration of Real Time Simulation Based Dynamic Traffic Assignment
Hossein Hashemi, Southern Methodist University, 3101 Dyer St, Room 203, Dallas, TX, 75205, United States of America, shashemi@smu.edu, Khaled Abdelghany, Ala Alnawaiseh

We present a methodology for online calibration of real-time traffic network simulation models. The methodology integrates time-dependent demand estimation and traffic flow propagation adjustment. The performance of the methodology is examined using a real-world application in which a real-time traffic network state estimation model is implemented for the US 75 Corridor in Dallas, Texas.

2 - Evasive Flow Capture: Optimal Location of Weigh-in-Motion Stations, Tollbooths, and Security Checkpoints
Nikola Markovic, University of Maryland, Civil & Environmental Engineering, College Park, MD, United States of America, nikola@umd.edu, Ilya Ryzhov, Paul Schonfeld

The flow-capturing location-allocation problem (FCLAP) consists of locating facilities in order to maximize the number of flow-based customers that encounter at least one of these facilities along their predetermined travel paths. The FCLAP literature assumes that, if a facility is located on a predetermined path of a flow of customers, that flow is considered captured. However, existing models for the FCLAP do not consider targeted users who behave non-cooperatively by changing their travel paths to avoid fixed facilities (such as weigh-in-motion stations used to detect and fine overweight trucks). We propose, for the first time, the evasive flow capture problem (EFCP), analyze its structural properties, present modeling techniques for reducing computational cost, and show a case study based on a real-world transportation network.

■ SC22

Hilton- Union Sq 2

Optimization and Disaster Management

Sponsor: Transportation Science & Logistics
Sponsored Session

Chair: Anuj Sharma, Assistant Professor, Iowa State University, Iowa, Ames, IA, 50011, United States of America, anujs@iastate.edu

1 - Characterization of Social Networks in Humanitarian Projects
Gloria Cecilia Urrea Castaño, PhD Student, University of Lugano, Via Giuseppe Buffi 13, Lugano, 6900, Switzerland, Sebastian Villa Betancur, Paulo Goncalves

When different organizations from distinct sectors are involved in humanitarian projects, complex relations arise creating unique structures. By analyzing 794 humanitarian projects and using exponential random graph models, we are able to (1) better understand the interactions among humanitarian actors and (2) identify the specific generative mechanisms and attributes that characterize the different structures emerging in humanitarian networks.

2 - Modeling the Dynamic Resource Allocation Problem for Large-Scale Transportation Network Evacuation
Xiaozheng He, NEXTRANS, 3000 Kent Ave, West Lafayette, IN, 47906, United States of America, seanhe@purdue.edu, Hong Zheng, Srinivas Peeta

This study addresses the dynamic resource allocation problem for large-scale transportation network evacuation in two aspects. First, we adapt the spatial-queue model to describe evacuation traffic flow dynamics such that the problem size can be reduced significantly. Second, a decomposition scheme is developed to improve the computational efficiency for the problem.

3 - Resilience of Networked Infrastructure with Evolving Component Conditions
Reza Faturechi, Senior Systems Engineer, Optym, 505 SW 2nd Ave, Gainesville, Fl, 32601, United States of America, reza.faturechi@gmail.com, Eyal Levenberg, Elise Miller-Hooks

The problem of evaluating and maximizing the resilience of a networked infrastructure given component performance deterioration, along with improvements due to maintenance under given maintenance policies, is modeled as a stochastic optimization problem. The effects of capturing deterioration and maintenance in resilience quantification are assessed for a specific case study.

4 - Designing Blackout Resilient Traffic Network using Hybrid Power Generation
Anuj Sharma, Assistant Professor, Iowa State University, Iowa, Ames, IA, 50011, United States of America, anujs@iastate.edu, Mo Zhao

During power outages, traffic control signals and ITS devices are unable to assist in traffic management. This paper develops a design optimization model to find the trade-off between traffic network reliability and investment on emergency power. The effectiveness of hybrid emergency power using wind and solar energy is investigated.

■ SC23

Hilton- Union Sq 3

Rich Vehicle Routing Problems I

Sponsor: TSL/Freight Transportation & Logistics
Sponsored Session

Chair: Baoxiang Li, TUE, Eindhoven, Netherlands, b.li@tue.nl

1 - using SA to Solve the VRP Problem with Capacity and Time Constraints in Non-Euclidean Networks
Alejandro Garcia del Valle, Professor, University of Coruña, Dept Economic Analysis and Management Sc, Ferrol, C, 15403, Spain, agvalle@udc.es, Javier Faulin, Diego Crespo Pereira, Rosa Rios Prado

In this paper we first analyze the behavior of the Simulated Annealing based on the quality of solutions used as a starting point, then we implement this method to solve the problem of designing the delivery routes with capacity constraints and time windows with a maximum time in each route, for non-Euclidean dispersed networks. Finally we analyze and discuss the results of our research.

2 - Designing Split Pickup Collection Routes with Operational Constraints
Zhijie Dong, Cornell University, Ithaca, NY, United States of America, zd57@cornell.edu, Mark Turnquist

We develop an extension of the Split Delivery Vehicle Routing Problem (SDVRP) that includes constraints on the number of routes visiting any customer and the total number of customers receiving split service. These constraints are important for development of collection routes for inbound materials being shipped to a manufacturing plant. An effective heuristic solution method is developed for the extended problem formulation and application to logistics operations in the automotive industry is demonstrated.

3 - Improving Profitability of Vehicle Routing Problems through Advanced Analytics
Dauwe Vercamer, Universiteit Gent, Belgium Dauwe.Vercamer@UGent.be, Dirk Van den Poel, Michel Gendreau, Philippe Baecke

Based on a real case in door-to-door sales, the study assesses whether revenue predictions coming from transactional data can effectively be used to improve fleet schedules. To do this, two different customer selection models are compared. In the static model, customers are first chosen based on the revenue predictions and then routed through a VNS. The dynamic model uses the predictions in an orienteering problem. Initial results show that the dynamic approach is the most profitable.

4 - Hierarchical Optimization Modeling of Vehicle Routing Problem in Urban Supply Chains
Yiou Wang, Penn State, State College, PA, United States of America
Terry Friesz, Tao Yao, Hongcheng Liu, Ke Han

This research proposes a novel bi-level extension of vehicle routing problem (VRP) by formulating it into a Stackelberg game that takes into account the congestion as a result of freight activities among the background passenger traffic in urban freight planning. The model incorporates the VRP with static user equilibrium traffic assignment as a lower level. Numerical experiment on variant problem sizes show that the routing decisions from the bi-level formulation outperform decisions from the classical VRP formulation.

5 - An Adaptive Large Neighborhood Search Heuristic for the Share-a-Ride Problem
Baoxiang Li, TUE, Eindhoven, Netherlands, b.li@tue.nl,
Dmitry Krushinsky, Tom Van Woensel

The Share-a-Ride Problem (SARP) aims at minimizing the cost of serving a set of passengers and parcels using a set of homogeneous vehicles. We propose an Adaptive Large Neighborhood Search (ALNS) heuristic for the SARP. Furthermore, we study the problem of determining the time slack of the SARP scheduling. The solution approach is tested on three sets of realistic instances. The performance of our heuristic is benchmarked against an MIP solver and DARP test instances.

■ SC24

Hilton- Union Sq 4

Traffic and Emissions Modeling

Sponsor: TSL/Intelligent Transportation Systems (ITS)
Sponsored Session

Chair: Xuesong Zhou, Associate Professor, Arizona State University, School of Sustainable Engineering and th, Tempe, AZ, United States of America, xzhou74@asu.edu

1 - Emission and Signal Optimization
Tao Yao, Penn State, State College, PA, United States of America
tyy1@engr.psu.edu, Y. Sun, Terry Friesz, K. Han

We propose a mathematical program wherein combining the dynamic user equilibrium, emission constraints and the decision variables that are the signal timing plans at all intersections.. The continuum signal model is an efficient and effective alternative of the so-called on-and-off signal models frequently employed in signal optimization problems.

2 - Traffic Signal Prediction for Engine Stop-start System
Jianfeng Zheng, University of Minnesota, Minneapolis, United States of America, zheng220@umn.edu, Henry X. Liu

Engine stop-start system, which shuts down and restarts an engine to reduce idling time when a vehicle stops, has become a common feature of vehicles nowadays. In this work, we propose a prediction model to predict vehicle stopping time at signalized intersections, aiming at better controlling engine stop-start system with traffic signal information. The feasibility and potential of the proposed method are demonstrated with a field example.

3 - System-optimal Traffic Routing Plans for Agents with Goals: Travel Time, Energy Cost and Emission Impacts
Jiangtao Liu, ASU, Tempe, AZ, United States of America
jliu215@asu.edu, Xuesong Zhou, Srinivas Peeta

Reducing energy consumption and pollutant emission from traffic systems is a practically important issue for urban network planners. Based on a set of queue and kinematic wave models, this talk will discuss a few analytical models for estimating the energy cost and emission impacts under different traffic states. Both non-linear and linear programming models are constructed to provide system-optimal routing plans for agents with various goals.

4 - Finding Green System Optimal Routing Policies through a Multi-Scale Dynamic Path Flow Assignment Model
Chung-Cheng Jas Lu, jasoncclu@gmail.com

This talk will discuss a problem of finding system optimal eco-routing or green routing flows that minimize total vehicular emission in a network. A mesoscopic dynamic network loading model that tightly links Newell's simplified kinematic wave and car-following models is proposed to facilitate an internally consistent dynamic traffic assignment for temporally cross-resolution and spatially multi-scale emission modeling.

■ SC25

Hilton- Union Sq 5

Flexible Transit and Ride-Share Systems

Sponsor: TSL/Urban Transportation
Sponsored Session

Chair: Shadi Djavadian, Ryerson University, 350 Victoria Street, Toronto, Canada, shadi.djavadian@ryerson.ca

1 - Benefits of Recourse in the Stochastic Dial-A-Ride Problem
Neza Vodopivec, Graduate Assistant, University of Maryland, 1173 Glenn Martin Hall, University of Maryland, College Park, MD, 20742, United States of America, nvodopivec1@gmail.com, Elise Miller-Hooks, Paul Schonfeld

DARP considers optimal schedules for door-to-door shared ride services. Few investigations incorporate the stochastic nature of real-world travel times, and none start from the premise that operators will wish to use means beyond their own fleets to minimize customer inconvenience. In this presentation, we investigate the handling of uncertain travel times by taxi and other recourse options.

2 - Agent Based Equilibrium Simulation Model to Evaluate Flexible Transit System Designs
Shadi Djavadian, Ryerson University, 350 Victoria Street, Toronto, Canada, shadi.djavadian@ryerson.ca, Jaeyoung Jung, Joseph Y.J. Chow

We design and develop an agent based transportation simulation tool which evaluates the equilibrium demand for flexible transit service designs that cannot be determined analytically. Alternatives evaluated include different service types (fixed route, flex-schedule versus pure demand-responsive service) and dispatch algorithms. This work bridges the gap between service simulation models that ignore schedule-based demand interactions and activity-based models like MATSim that do not exhibit robust transport service simulation components. The simulation model is applied to two different settings in Ontario: London and Oakville, to demonstrate effectiveness.

3 - Minimum Number of Cars a City Needs in a Fully Coordinated Vehicle Sharing System
Monirehalsadat Mahmoudi, ASU, Tempe, AZ, United States of America, mmahmou2@asu.edu, Xuesong Zhou

By introducing the concept of shared autonomous vehicles and ride sharing, we will address the following key questions: How many cars a city should use to support the overall transportation activity demand/desires, at different levels of coordination and pre-trip scheduling? How many parking lots and road infrastructure are required? We present a holistic optimization approach for synchronizing travel activity schedules, transportation services, and infrastructure on urban networks.

4 - Algorithms for Routing in Peer-to-peer Ride-share Systems
Neda Masoud, University of California, Irvine, CA, United States of America, R. Jayakrishnan

The current ride-matching techniques in peer-to-peer ridesharing systems are rather preliminary and don't allow taking advantage of the full potential of the ridesharing systems. This paper formulates the multi-hop peer-to-peer ride-matching problem and proposes algorithms to solve the problem efficiently.

■ SC26

Hilton- Union Sq 6

Location Optimization I

Sponsor: Location Analysis
Sponsored Session

Chair: Alan Murray, Professor, Drexel University, Center for Spatial Analytics and Geocomp, College of Computing and Informatics, Philadelphia, PA, 19104, United States of America, amurray@drexel.edu

1 - Mitigating Urban Heat Island Effects through Strategic Park Siting
Yujia Zhang, ASU, ASU, Tempe, United States of America, yzhan169@asu.edu, Kailai Wang, Alan Murray

The paper develops an approach for optimizing the cooling benefits of urban parks. A multi-objective spatial model is introduced accounting for area, shape and surrounding land cover of parks.

2 - Modeling Framework for Strategic Airline Network Design
Armin Lüer-Villagra, PhD Candidate, Pontificia Universidad Catolica de Chile, Department of Electrical Engineering, Av. Vicuña Mackenna 4860, Santiago, 7820436, Chile, arminluer@gmail.com, Guillermo Latorre-Níñez, Vladimir Marianov

We study the effect of different network policies in terms of strategic performance indicators on airlines. We formulate a location-network design problem, in which a company must locate their management and maintenance facilities in existing airports, together with deciding routes and the capacity allocation both on arcs (airplanes) and nodes (airports), minimizing costs, subject to an aggregated level of service constraint. The results suggest a strong impact of these policies.

3 - Spatial Strategy Development for Network Containment
Tony Grubesic, Professor, Drexel University, 3141 Chestnut St, Philadelphia, PA, 19104, United States of America, grubesic@drexel.edu, Alan Murray

This paper details location models to support containing, isolating and canalizing spatial flows to diminish the distribution of known and potential threats. Strategies for enhancing monitoring activities are discussed and public policy implications are discussed.

4 - Cournot-Stackelberg Games in Competitive Delocation
Diego Ruiz-Hernandez, Associate Professor, University College for Financial Studies, Serrano Anguita 9, Madrid, 28004, Spain, d.ruiz@cunef.edu, Javier Elizalde

During economic crises, the number of commercial facilities decreases. Many firms need to reduce their network minimizing the market share lost. We address the problem of facilities closing in a duopolistic market considering three ways of behaviour: myopic, Cournot and Stackelberg competition. We present a binary integer programming formulation, and provide an algorithm to find the non-cooperative solutions. The existence of Nash equilibrium is empirically tested.

■ SC27

Hilton- Union Sq 7

Roundtable Discussion on Bridging Data and Decisions I

Sponsor: Railway Applications
Sponsored Session

Chair: Marc Meketon, Vice President, Oliver Wyman, 1 University Square Drive, Suite 100, Princeton, NJ, 19002, United States of America, Marc.Meketon@oliverwyman.com

1 - Roundtable Discussion on Bridging Data and Decisions
Marc Meketon, Vice President, Oliver Wyman, 1 University Square Drive, Suite 100, Princeton, NJ, 19002, United States of America, Marc.Meketon@oliverwyman.com

The freight railway industry is awash in data in every corner of its business. From immediate operations that collect real-time information on locomotives, cars and even wheel bearings, the million+ commercial shipments per month, the tens of millions of duties performed in the yards, movement of almost a million containers and trailers, track analysis data, and so on. This roundtable will discuss how advanced techniques of data analysis and operations research are being used to make the best decisions from the data.

■ SC28

Hilton- Union Sq 8

Advanced Analytics: Applications to Solve Aviation System Level Problems

Sponsor: Aviation Applications
Sponsored Session

Chair: Philippe Bonnefoy, Lead Associate, Booz | Allen | Hamilton, 22 Batterymarch Street, Boston, MA, 02109,
United States of America, bonnefoy_philippe@bah.com

1 - Game Theoretic Based Decision Analytics:
Applications to the Aviation and Aerospace Markets
Philippe Bonnefoy, Lead Associate, Booz | Allen | Hamilton, 22 Batterymarch Street, Boston, MA, 02109, United States of America, bonnefoy_philippe@bah.com, Alice Fan, Gregory Raiffa

New game theoretic models that combine Bayesian Networks and Level-K solution concepts can help to better capture inherent uncertainties in the complex systems and (2) strategic interactions between decision makers. These models were applied to; (1) the aviation market by modeling and evaluating airlines' equipage of NextGen technology adoption under various policy scenarios and (2) the aerospace market to model the strategic interactions involving aircraft acquisitions.

2 - The Impact of Aircraft Design Reference Mission on Fuel Efficiency In The Air Transportation System
Brian Yutko, Post-Doctoral Associate, MIT, 9 Newbury Street, Somerville, MA, 02144, United States of America, byutko@mit.edu

There currently exists a large mismatch between commercial aircraft design capability (payload and range) and the way they are typically operated in the global system. This research proposes a new way of thinking holistically about the optimization of aircraft design capability, network structures, and operational techniques. Preliminary results indicate that there is a significant pool of potential fuel burn savings (~30-40%) that can be realized without new technology or fuels.

3 - Opportunities for Cruise Altitude and Speed Optimization in US Domestic Airline Operations
Luke Jensen, Research Assistant, MIT, 10 Landers St Apt 3, Somerville, MA, 02143, United States of America, ljensen@mit.edu

Operational strategies to reduce aircraft fuel consumption can mitigate costs and environmental impacts on a short time horizon. Most prior research has focused on lateral track optimization to achieve these benefits. This talk examines the system fuel burn reduction potential resulting from an alternative strategy, cruise speed and altitude optimization, in domestic US airline operations. Potential benefits, applications, and barriers to implementation are discussed.

4 - Encouraging Change in Air Traffic Control:
A Game Theoretic Application
Nicole Adler, Hebrew University of Jerusalem, Mount Scopus, Jerusalem, 91905, Israel, msnic@huji.ac.il, Eran Hanany

Drawing on lessons from the airline and airport sectors, it would appear necessary to change both the market structure and regulatory environment of the air traffic control sector in order to achieve the goals of SESAR and NextGen. Using a network flow quadratic program within a congestion game, we analyse potential regulatory and ownership typologies in order to determine how to encourage the air traffic control sector to adopt the new technologies that have been developed over the last decade.

■ SC29

Hilton- Union Sq 9

"Just the Facts" Papers in Strategy

Cluster: Strategy Science
Invited Session

Chair: Myles Shaver, U of MN, 321-19th Ave S, Suite 3-365, Minneapolis, MN, 55455, United States of America, mshaver@umn.edu

1 - Marked for Life?: Temporary Mobility Constraints and Entrepreneurship Decisions by Foreign Graduates
Martin Ganco, Assistant Professor, University of Minnesota, 321 - 19th Avenue South, #3-365, Minneapolis, MN, 55455, United States of America, mganco@umn.edu

I study the effects of individuals facing a constraint when making initial employment decision post-graduation. I design a quasi-experiment by examining the effect of timing of green card that was not received through employment sponsorship in the context of foreign graduates of U.S. universities in science and engineering. I find that individuals who are more constrained are more likely to start a growth-oriented business and are less likely to enter a field not related to their degree.

2 - Geographic Proportional Representation of Female-Owned Businesses: Survival and Performance Outcomes
Michele Williams, Assistant Professor, Cornell University, 393 Ives Hall Faculty Building, Ithaca, NY, 14853, United States of America, mwilliams@cornell.edu, Arturs Kalnins

Analyzing survival duration of one million proprietorships and revenues of six thousand lodging proprietorships, we find a robust positive relationship between the proportional representation of female-owned proprietorships and both the survival duration and revenue performance of female-owned proprietorships, relative to male-owned proprietorships. We address endogeneity via instrumental variables.

3 - The Impact of Collusive Non-poaching Agreements,
Mobility and Innovation
Ajay Bhaskarabhatla, Assistant Professor, Erasmus School of Economics, Burgemeester Oudlaan 50, PO Box 1738, Rotterdam, 3061XN, Netherlands, bhaskarabhatla@ese.eur.nl, Deepak Hegde

This study investigates the impact of secret bilateral agreements among select firms in Silicon Valley to not actively solicit each other's employees. Using US patent grant data during 1995-2009 and a differences-in-differences methodology, we find that inventor mobility declined among the colluding firms relative to others during the period of collusion. We also find that the individual inventor productivity and invention quality at the colluding firms declined during the period of collusion.

■ SC30

Hilton- Union Sq 10

Scheduling in Maritime Logistics

Cluster: Scheduling and Project Management

Invited Session

Chair: Xiangtong Qi, HKUST, Dept of IELM, HKUST, Hong Kong, Hong Kong - PRC, ieemqi@ust.hk

1 - Optimal Algorithm for the General Quay Crane Double-cycling Problem

Chung-Yee Lee, Professor, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, Hong Kong - PRC, cylee@ust.hk, Ming Liu, Chengbin Chu

This paper studies quay crane double-cycling problem. We show that it can be formulated as a flow shop scheduling problem with series-parallel precedence constraints, thus allowing it to be solved polynomially. This also answers the optimal question regarding the computaitonal complexity of the problem.

2 - New Solution Methods for the Continuous Berth Allocation Problem

Zhou Xu, Hong Kong Polytechnic University, Hong Kong, Hong Kong - PRC, lgtzx@polyu.edu.hk, Chung-Yee Lee

Port operators today are struggling to enhance efficiency through better utilization of berth spaces. In this paper, we have developed novel solution methods for a continuous berth allocation problem, based on a new lower bound of the optimal solution, a new heuristics, and a new exact algorithm. Computational results show that compared with existing methods, our methods can solve more instances to optimal, and generate better near-optimal solutions and lower bounds.

3 - The Impact of Slow Ocean Steaming on Delivery Reliability and Fuel Consumption

Jiheng Zhang, HKUST, Clear Water Bay, Hong Kong, Hong Kong - PRC, jiheng@ust.hk, Chung-Yee Lee, Hau Lee

Slow steaming has become a widely adopted practice as a way to reduce bunker costs and carbon footprints. In this paper, we propose a model to quantify the relationship among shipping time, bunker cost and delivery reliability. Moreover, we verify our model and results via numerical experiments by using actual data from a large ocean carrier in Hong Kong. Our findings lead to a simple and implementable policy with a controlled cost and guaranteed delivery reliability.

4 - Disruption Recovery for Berth Allocation

Xiangtong Qi, HKUST, Dept of IELM, HKUST, Hong Kong, Hong Kong - PRC, ieemqi@ust.hk, An Zhang

We consider berth allocation after the terminal is disrupted with multiple waiting vessels. While the terminal has the objective of reducing the queue quickly, the container transshipment among the vessels should also be respected as much as possible. We treat and solve the problem as scheduling with soft precedence constraints. The work is supported by a grant from the Research Grants Council of the HKSAR T32-620/11.

■ SC31

Hilton- Union Sq 11

Delivering Services Over the Digital Media

Sponsor: Service Science

Sponsored Session

Chair: Tuck Siong Chung, Nanyang Tech. U., Nanyang Bus. School, Singapore, 639798, Singapore, ATSChung@ntu.edu.sg

1 - An Integrated Model of Online Rating Decision: Role of Pre-Purchase Expectation and Post-Purchase Experience

Tuck Siong Chung, Nanyang Tech. U., Nanyang Bus. School, Singapore, 639798, Singapore, ATSChung@ntu.edu.sg

The authors developed a three stage sequential decision model that links expectation disconfirmation with post consumption rating decisions in the online context. They empirically examine the proposed model in a controlled laboratory setting and find that disconfirmation plays an important role in rating behaviors. They show via a simulation study that the proposed model can successfully recreate a range of distributional and evolutionary characteristics of online rating environment that are commonly found in real life.

2 - Digital Brand Delight - Structure, Causes and Consequences of Brand Delight in a Digital Environment

Markus Lenkar, University of Koblenz-Landau, Institute for Management, Germany, markus.lenker@audi.de

The Digitization greatly changed the behavior of customers. Purchase decisions for a car are strongest influenced by the websites of a brand. To differentiate from competitor, brands have to create emotional relationships to their customers. Two empirical Studies in cooperation with a German premium car manufacturer identify influencing factors of website quality and online brand experiences on brand delight. Overall, this research Shows how Brands can attain brand delight in an online environment and clarifies its effects on consumer behavior.

3 - Combining Quantitative and Text Mining Approaches for Win Prediction of IT Outsourcing Bids

Hamid R. Motahari-Nezhad, IBM Almaden Research Center, 650 Harry Road, San Jose, United States of America, motahari@us.ibm.com, Daniel Greenia, Taiga Nakamura, Aly Megahed

Information technology service providers, as IBM, design and propose bids to potential clients in an effort to win high-valued outsourcing information technology contracts. Several project factors contribute to whether the deal is won or lost. In this work, we develop and combine quantitative and text analytics approaches that predict and prioritize the winning deals among a given list of on-going deals. We present a real-world case study that shows the practical impact of using our model.

■ SC32

Hilton- Union Sq 12

Accelerate Service Innovations with Data Mining and Machine Learning

Sponsor: Service Science

Sponsored Session

Chair: Mu Qiao, Research Staff Member, IBM Almaden Research Center, 650 Harry Road, San Jose, CA, 95120, United States of America, mqiao@us.ibm.com

1 - Team Recommendation for IT Strategic Outsourcing Services

Mu Qiao, Research Staff Member, IBM Almaden Research Center, 650 Harry Road, San Jose, CA, 95120, United States of America, mqiao@us.ibm.com, Daniel Greenia, Rama Akkiraju, Taiga Nakamura, Haibin Liu, Hamid R. Motahari-Nezhad, Stephen Dill

In IT strategic outsourcing services, it is critical to have competent deal teams to design competitive service solutions and respond to clients' request for proposals swiftly. We present a team recommendation framework for finding the best deal team for a given set of job roles using a machine learning approach. It takes into account diverse individual and team level features, and can accommodate various cost or feature functions. We show the recommendation results in a real business scenario.

2 - End-to-end Real-time Proactive Cloud Management Analytics

Rong Liu, IBM Research, 1101 Kitchawan Rd, Ossining, NY, 10598, United States of America, rliu@us.ibm.com, Jeaha Yang, Juhnyoung Lee

As the complexity of cloud computing increases and software components are deeply interconnected, it is challenging for customers to manager their applications on cloud to achieve true self-service. Here we propose an end-to-end approach that allows customers to actively monitor their systems on cloud. This approach aggregates and analyzes data/events from software stacks on cloud, proactively alert customers potential failures, and recommend actions to remedy failures of their applications.

3 - using Social Network Analysis to Improve the Incident Handling in IT Services

Zhe (Jay) Shan, University of Cincinnati, Cincinnati, Ohio zhe.shan@uc.edu, Rong Liu

In a complex IT environment, the diagnosis of application-level incidents is very difficult. Therefore, matching incident cases with appropriate SMEs is one of the key challenges in IT service industry. In this work, we propose to use the social network information mined from historical communication information among SMEs to improve the case dispatch system. This analysis can not only identify the expertise similarity and complementarity among SMEs, but also their collaboration patterns.

■ SC33

Hilton- Union Sq 13

Managing the Innovation Process for New Product Development

Cluster: New Product Development

Invited Session

Chair: Joel Wooten, University of South Carolina,
Moore School of Business, Columbia, SC, United States of America,
joel.wooten@moore.sc.edu

1 - Sequential Innovation by Startups
Karthik Ramachandran, Associate Professor, Georgia Institute of
Technology, Scheller College of Business, 800 West Peachtree NW,
Atlanta, GA, 30308, United States of America,
Karthik.Ramachandran@scheller.gatech.edu,
Sreekumar Bhaskaran, Sinan Erzurumlu

Start-up firms often consider launching an immediately available product to
generate funds for developing a more advanced, but risky, product. However, this
release could have an adverse effect on the perception of the firm's future
products. We model this trade-off and derive managerial insights on this novel
problem

2 - Optimal Shapes of Innovation Pipelines
Joel Wooten, University of South Carolina, Moore School of
Business, Columbia, SC, United States of America,
joel.wooten@moore.sc.edu, Sriram Venkataraman

New product introductions often occur via R&D pipelines. We explore the optimal
number of innovation options to pursue in this complex managerial process. A
stylized game simulation of the pharma industry provides additional evidence for
our problem.

3 - Innovation Lessons from the Field II
Tom Arnold, CEO, Gridium, San Francisco, CA,
United States of America, tom@gridium.com

Serial entrepreneur (and current CEO of Gridium) Tom Arnold will discuss his
managerial insights from starting and running three different energy and
environmental start-ups.

4 - Innovation Lessons from the Field I
Erin Quist, COO, Wahwah Networks, San Francisco, CA,
United States of America, erin@wahwahnetworks.com

Erin Quist (COO of Wahwah Networks) will share her experience managing
innovation and product roll-outs at several different companies in the online
media and advertising industry.

■ SC34

Hilton- Union Sq 14

Humanitarian Logistics and Development

Sponsor: Public Programs, Service and Needs

Sponsored Session

Chair: Begona Vitoriano, Associate Professor, Complutense University
of Madrid, Faculty of Mathematical Sciences, Plaza de las Ciencias, 3,
Madrid, 28040, Spain, bvitoriano@mat.ucm.es

1 - SEDD: Disaster Diagnostic and Evaluation System
J.Tinguaro Rodriguez, Complutense University of Madrid,
Plaza de Ciencias 3, Madrid, 28040, Spain, jtrodrig@mat.ucm.es,
Begona Vitoriano, Javier Montero

A decision support system to assess consequences of disasters with the very first
available information is presented in this work. This DSS, refered as SEDD, is based
on a rule-based learning model focused on interpretability. Moreover, among its
main features, SEDD's methodology enables an expressive representation of
uncertainty and knowledge of predicted consequences of disasters, as well as to
include decision maker's attitude and requirements inside its learning and
inference procedures.

**2 - Integrating Real Time Data into Logistical Models:
A Case Study from Typhoon Haiyan**
Kezban Yagci Sokat, PhD Candidate, Nortwestern University,
2145 Sheridan Road, Room C210, Evanston, IL, 60208, United
States of America, kezban.yagcisokat@u.northwestern.edu,
Irina Dolinskaya, Karen Smilowitz, Jennifer Chan

We present a first-hand experience of collecting, analyzing and integrating real
time data into logistical models. Using the recent Philippines Typhoon Haiyan as a
case study, we analyze how dynamically emerging data can be collected, processed
and used in humanitarian logistical decisions.

**3 - Logistics for Rural Development: A Model for Photovoltaic Rural
Electrification in Morocco**
Begona Vitoriano, Associate Professor, Complutense University of
Madrid, Faculty of Mathematical Sciences, Plaza de las Ciencias, 3,
Madrid, 28040, Spain, bvitoriano@mat.ucm.es, Luis Miguel
Carrasco, Luis Navarte, M. Teresa Ortuño, F. Javier Martin-Campo

Photovoltaic electrification for rural development has experienced a scale change
in terms of size of the programmes developed, with thousands of solar home
systems, and long operation and maintenance service periods. Planning and cost
evaluation of maintenance operations is crucial for these decentralized systems. So
far it has not been done properly, leading to poor performance of these services. A
model for these purposes will be shown, applied to a real case on a province of
Morocco.

■ SC35

Hilton- Union Sq 15

Public Health I

Sponsor: Public Programs, Service and Needs

Sponsored Session

Chair: Chaitra Gopalappa, Assistant Professor,
University of Massachusetts, 160 Governors Drive, Amherst,
United States of America, chaitrag@umass.edu

1 - Global Health: Optimizing the Use of Scarce Resources
Eva Lee, Professor & Director, Georgia Institute of Technology, Ctr
for OR in Medicine & Healthcare, Atlanta, GA, 30332,
United States of America, eva.lee@gatech.edu

This work is joint with Tanzania public health ministry and CDC. Public health in
developing countries is often underfunded and has limited resources. The
healthcare systems have to explore strategies that allow them to serve the largest
population with regular needs such as pregnancy screening, childhood vaccination,
HIV and TB tests. We describe a decision support system that helps to improve
hospital throughput and maximize the population served.

**2 - Factors Influencing Healthcare Disparities in Breast Cancer
Patients: A Review**
Diana Prieto, Western Michigan University, 4601 Campus Drive,
Kalamazoo, MI, 49008, United States of America,
diana.prieto@wmich.edu

In the United States, there is a large body of research about factors influencing
healthcare disparities in breast cancer patients. We conducted a systematic review
to determine the factors that have been rarely investigated, and to identify the
relationships between factors and endpoints with respect to the different treatment
and post-treatment options for breast cancer. We will also discuss the modeling
frameworks that are currently used to investigate the factors.

3 - Modified Network Model to Estimate HIV Transmissions in the US
Stephanie Sansom, CDC, Atlanta, GA, United States of America
sos9@cdc.gov, Chaitra Gopalappa, Paul Farnham

Individual-based network models can simulate interactions among individuals and
are suitable for modeling infectious diseases such as HIV. However, fitting network
models can require long computational times, which may make them unsuitable
for simulating large populations. We present a modified network model designed to
overcome this limitation. We apply the model to the US population to estimate
annual HIV incidence and transmission rates.

**4 - Dynamic Network Disease Modeling of the Synergistic
Transmission of HIV and HSV2**
Yao-Hsuan Chen, CDC, 1600 Clifton Rd, Atlanta, United States of
America, xhj1@cdc.gov, Thomas Gift, Samuel Friedman, Joel Sokol

The purpose of the study was to test the hypothesis that contact dynamics and
contact network structures are important to closely predict the spread of sexually
transmitted diseases (STDs). Our work supported the hypothesis that considering
the underlying contact dynamics as well as network structures was important for
making optimal disease prevalence predictions. Our results also demonstrated the
need to model the data sampling process when validating against real-world data.

■ **SC36**

Hilton- Union Sq 16

Telecommunications Best Paper Award

Sponsor: Telecommunications

Sponsored Session

Chair: Michael Bartolacci, Pennsylvania State Univesity, Berks, Reading, PA, 19610, United States of America, mbartolacc@aol.com

1 - GUB Covers and Power-Indexed Formulations for Wireless Network Design

Fabio D'Andreagiovanni,f.dandreagiovanni@gmail.com, Carlo Mannino, Antonio Sassano

We propose a pure 0-1 formulation for the wireless network design problem, i.e., the problem of configuring a set of transmitters to provide service coverage to a set of receivers. In contrast with classical mixed integer formulations, where power emissions are represented by continuous variables, we consider only a finite set of power values. This has two major advantages: it better fits the usual practice and eliminates the sources of numerical problems that heavily affect continuous models.

2 - The Two-level Diameter Constrained Spanning Tree Problem

Luis Gouveia, Professor, University of Lisbon, Centro de Investigacao Operacional, Bloco C6 - Piso 4- Campo Grande, Lisbon 1749-016, Portugal, legouveia@fc.ul.pt, Markus Leitner, Ivana Ljubic

We introduce the Two-Level Diameter Constrained Spanning Tree Problem (2-DMSTP). We first observe that any feasible solution to the 2-DMSTP can be viewed as a DMST that contains a diameter constrained Steiner tree. This observation allows us to prove graph theoretical properties related to the centers of each tree which are then exploited to develop mixed integer programming formulations, valid inequalities, and symmetry breaking constraints.

3 - Multipath Wireless Network Coding: An Augmented Potential Game

Vinod Ramaswamy, Texas A&M University, College Station TX 77843, United States of America, vonod83@tamu.edu, Natarajan Gautam, Vinith Reddy, Srinivas Shakkottai, Alex Sprintson

We consider wireless networks in which multiple paths are available between each source and destination. We allow each source to split traffic among all of its available paths, and we ask the question: How do we attain the lowest possible number of transmissions per unit time to support a given traffic matrix? Traffic bound in opposite directions over two wireless hops can utilize the "reverse carpooling" advantage of network coding in order to decrease the number of transmissions used. We call such coded hops "hyper-links." With the reverse carpooling technique, longer paths might be cheaper than shorter ones.

4 - Branch-and-price Algorithm for the Resilient Multi-level Hop-constrained Network Design

Fernanda S.H Souza, Federal University of Minas Gerais, Belo Horizonte 31270-010, Brazil, fernandasumikahojo@gmail.com, Michel Gendreau, Geraldo R. Mateus

In this work, we investigate the Resilient Multi-level Hop-constrained Network Design (RMHND) problem, which consists of designing hierarchical telecommunication networks, assuring resilience against random failures and maximum delay guarantees in the communication. Three mathematical formulations are proposed and algorithms based on the proposed formulations are evaluated.

■ **SC37**

Hilton- Union Sq 17

Methods and Models for Large Social Networks

Sponsor: Artificial Intelligence

Sponsored Session

Chair: Bin Zhang, University of Arizona, McClelland Hall, Room 430, P.O. Box 210108, Tucson, AZ, 85721, United States of America, binzhang@arizona.edu

1 - Large-scale Social Identity Linkage via Heterogeneous Behavior Modeling

Siyuan Liu, Research Scientist, Carnegie Mellon University, Forbes Ave 5000, Pittsburgh, PA 15217-1011, United States of America, siyuan@cmu.edu, Shuhui Wang, Feida Zhu, Jinbo Zhang, Ramayya Krishnan

We study the problem of large-scale social identity linkage across different social media platforms. We propose HYDRA, a solution framework which consists of three key steps: (I) modeling heterogeneous behavior; (II) constructing structural consistency graph; and (III) learning the mapping function by multi-objective optimization. Extensive experiments demonstrate that HYDRA correctly identifies

real user linkage across different platforms.

2 - Price Discounts and Peer Effects in Information Goods: A Randomized Experiment

Rodrigo Belo, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA 15217-1011, United States of America, rbelo@cmu.edu, Pedro Ferreira, Miguel Matos

We analyze the role of word-of-mouth (WoM) and its relationship with price promotions on a video-on-demand (VoD) platform of a major telecom operator. We design, implement and analyze the outcomes of a randomized experiment aimed at studying the effect of price discounts on movie sales. We find that promoted movies increased short-term sales at the expense of non-discounted titles. We also find that WoM generated by purchases in our experiment accounted ~50% of all WoM generated by consumers.

3 - The Evolution of Generative Architecture of an Open Ecosystem: A Case of WordPress

SungYong Um, Temple University, 1810 North 13th Street, Philadelphia, PA19122, United States of America, sungyong.um@temple.edu, Bin Zhang, Youngjin Yoo, Sunil Wattal

We study the evolutionary pattern of an open digital ecosystem. We use text mining techniques on the source code of WordPress plug-ins created from 2004 to 2012, and extract all Application Programming Interface (API) data used in these plug-ins. We observe that the plug-in network eventually evolves into a hierarchical structure, which is induced by the generative feature of digital elements.

■ **SC38**

Hilton- Union Sq 18

Systems Engineering and Public Health

Cluster: Healthcare Systems and Medical Informatics

Invited Session

Chair: Saeideh Fallah-Fini, Assistant Professor, California State and Polytechnic University, Pomona, 3801 W. Temple Ave, Pomona, CA, 91768, United States of America, sfallahfini@csupomona.edu

1 - Dynamics of Obesity Interventions inside Organizations

Mohammad S. Jalali, Virginia Tech / MIT, 113 Harvard St, Apt 1, Cambridge, MA, 02139, United States of America, mj@vt.edu, Hazhir Rahmandad, Sally Bullock, Alice Ammerman

A large number of obesity interventions from upstream (policy) to downstream (individual) have been put forward to curb the obesity trend in the US but not all those interventions have been successful. In this study, we aim to understand how effectiveness of organizational level obesity interventions depends on dynamics of Adoption, Implementation, and Maintenance (AIM) of the interventions. Using a dynamic simulation model, we show how small changes in AIM can make a big difference in impact.

2 - An Agent-based Model to Assess the Role of the Food Environment on Body Mass Index in Children

Mehdi Jalalpour, Assistant Professor, Civil And Environmental Engineering, Cleveland State University, 1960 East 24th Street, Cleveland, OH, 44115, United States of America, M.Jalapour@csuohio.edu, Amii Kress, Thomas Glass

An agent-based model is proposed to assess the role of the food environment on body mass index (BMI). Children, ages 10-15 from 2 boroughs in Pennsylvania were used for validation. Spatial information was imported from GIS, and children data are from electronic health records. The model simulates food foraging outside the home, accounting for peer influences. The model is calibrated to BMI after 3 years.

3 - A Dynamic Model for Health Screening: Understanding Long Term Trends in Screening Mammography

Ozge Karanfil, PhD Candidate, Alfred P. Sloan School of Management, MIT, Sidney-Pacific NW 86-815, Cambridge, MA, United States of America, karanfil@mit.edu, John Sterman

In this study we develop the first explicit and integrated, broad boundary feedback theory around the dynamics of medical screening. The theory includes a decision theoretic core around costs and benefits including the fundamental tradeoff between sensitivity and specificity; and feedbacks that condition guidelines and the actual practice. To provide context we use the mammography case as a motivating example, but our model is generic and applicable to other contexts such as the PSA screening.

4 - Modeling the Potential Community-Wide Benefits of a Jail Based Screen-Treat Program for Chlamydia
> Ozgur Araz, Assistant Professor, Department of Health Promotion, Social, & Behavioral Health, University of Nebraska Medical Center, Omaha, NE, 68198-4365, United States of America, ozgur.araz@unmc.edu, Brock Hanisch, Ruth Margalit

Sexually Transmitted Infections (STIs) remain a major health burden within the United States. The US jail population is disproportionately impacted by STIs and thus serves as a key point of access for screening and treatment for this transient and high-risk population. To aid in implementing an opt-out screen-and-treat policy at the Douglas County Jail we developed a systems model that incorporates the mathematical epidemiology of Chlamydia.

■ SC39

Hilton- Union Sq 19

Medical Decision Making

Sponsor: Health Applications
Sponsored Session

Chair: Anahita Khojandi, University of Tennessee, Knoxville, TN, 37996, United States of America, khojandi@utk.edu

1 - Screening for Hepatocellular Carcinoma under Limited Resources: A POMDP Approach
> Elliot Lee, University of Michigan, 1205 Beal Ave, Ann Arbor, MI, 48105, United States of America, elliotdl@umich.edu, Mariel Lavieri, Michael Volk

We model the problem of allocating a limited screening capacity across a panel of patients at risk for developing hepatocellular carcinoma as a partially observable markov decision process. We seek to utilize biological information gathered sequentially over time to shift resources towards patients of higher risk. We present structural properties of this problem, and draw conclusions about more efficient screening behaviors.

2 - Valuing Paired Kidney Exchanges: A Stochastic Game Approach
> Murat Kurt, Assistant Professor, University at Buffalo (SUNY), 309 Bell Hall, University at Buffalo(SUNY), Buffalo, NY, 14260-2050, United States of America, muratkur@buffalo.edu, Andrew Schaefer, Utku Unver, Mark Roberts

Paired kidney exchanges (PKE) help alleviate the disparity between the supply and demand of kidneys for transplantation. We formulate patients' transplant timing decisions in a prearranged PKE as a non-zero sum stochastic game and compute a socially optimal equilibrium using a mixed integer linear programming formulation of the resulting equilibrium constraints. We use clinical data to present computational results that illustrate how the exchanges can be valued using their timings.

3 - MDP Model for Asymptotic Intracranial Aneurysm Treatment Selection under Risk Aversion
> Vera Tilson, Simon School, University of Rochester, Rochester, NY, United States of America, vera.tilson@simon.rochester.edu, David Tilson

We use a finite-horizon MDP model to find optimal treatment plans for patients diagnosed with asymptomatic intracranial aneurysm. We consider two distinct criteria: (a) maximizing the expected number of life years in good health, and (b) maximizing the expected utility for number of years in good health. Use of alternate patient-selected criteria leads to recommendations that vary from a previously published recommendations in several scenarios.

4 - Dynamic Abandon/Extract Decisions for Failed Cardiac Leads
> Anahita Khojandi, University of Tennessee, Knoxville, TN, 37996, United States of America, khojandi@utk.edu, Lisa M. Maillart, Oleg Prokopyev, Mark Roberts, Samir Saba

When a cardiac lead fails, physicians implant a new lead and may opt to extract the failed lead and/or any previously abandoned leads. Because the risk of extraction increases with lead age, physicians may extract leads to reduce the future risk of mandatory extraction, due to either infection or limited space in the vein. We use SMDP models for various cardiac devices to obtain patient-specific, lifetime-maximizing extraction policies and compare their performance to that of several heuristics.

■ SC40

Hilton- Union Sq 20

Scheduling Problems in Healthcare

Sponsor: Health Applications
Sponsored Session

Chair: Narges Hosseini, Postdoc, Mayo Clinic, 200 1st St. SW, Rochester, MN, 55901, United States of America, Hosseini.Narges@mayo.edu

1 - Elective Case Rescheduling on the Day of Surgery
> Robert Allen, Clemson University, Clemson, SC, United States of America, rallen3@g.clemson.edu, Kevin Taaffe

Operating room (OR) rescheduling is the process of adjusting the surgery schedule when the current schedule is subjected to disruptions on the day of surgery. Of particular importance is when, and which rescheduling method should be used to update the scheduling and tracking systems. Discrete event simulation was used to simulate surgical cases in the OR and to test different rescheduling policies and case updating policies for their effectiveness.

2 - Scheduling Coordinated Respirology Lab-clinics to Maximize the Service Level under Stochastic Time
> Farzad Zaerpour, University of Calgary, Haskayne School of Business, 118, 3420, 50th Street, NW, Calgary, AB, T3A 2E1, Canada, farzad.zaerpour@haskayne.ucalgary.ca, Diane Bischak, Mozart Menezes

In respirology outpatient clinics, a patient's lab tests must be completed just before the clinic appointment, but patients scheduled into a given clinic will require different amounts of testing time. We develop a MIP-based approach for assigning doctors to clinic slots so that the likelihood of a patient not completing testing in time for the clinic appointment is minimized. Using a pre-processing technique, we avoid the approach of simulation within optimization.

3 - An Algorithm for Advance Surgical Scheduling
> Narges Hosseini, Postdoc, Mayo Clinic, 200 1st St SW, Rochester, MN, 55901, United States of America, Hosseini.Narges@mayo.edu, Kal Pasupathy, Jeanne Huddleston

Spine surgeries are common and highly profitable. Based on Mayo Clinic, we developed a model to effectively schedule these surgeries. That includes a predictive model to accurately forecast surgical durations, and an algorithm that presents multiple solutions to the scheduling problem that minimizes the overall cost while meeting additional constraints. Offering multiple solutions gives the flexibility for scheduling convenient times and that is highly important in patient centered institutions.

■ SC41

Hilton- Union Sq 21

Medical Decision Making: Research by Bonder Scholars

Sponsor: Health Applications
Sponsored Session

Chair: Pooyan Kazemian, PhD Candidate, University of Michigan, 1205 Beal Ave., Ann Arbor, MI, 48109, United States of America, pooyan@umich.edu

1 - Optimal Policies for Arteriovenous Fistula Creation for Patients on Hemodialysis
> Reza Skandari, PhD Candidate, University of British Columbia, 2053 Main Mall, Vancouver, V6T-1Z2, Canada, reza.skandari@sauder.ubc.ca, Steven Shechter, Nadia Zalunardo

To deliver Hemodialysis (HD), patients need to have a vascular access. The gold standard for delivering HD is via Arteriovenous Fistula (AVF). Due to AVF creation failure, limited lifetime of a functional AVF, and limited places to create an AVF, patients may use an inferior access substitute called Central Venous Catheter (CVC). We characterize conditions under which the patient should or should not be referred for AVF creation, under total lifetime and quality adjusted lifetime metrics.

2 - Improving HIV Early Infant Diagnosis Supply Chains in Sub-Saharan Africa
> Jonas Jonasson, London Business School, Regent's Park, London, Regent's P, United Kingdom, jjonasson.phd2010@london.edu, Jérémie Gallien, Sarang Deo

Most countries in sub-Saharan Africa experience delays in HIV early infant diagnosis (EID). We develop a two-part modeling framework to generate operational improvements in EID networks and evaluate their impact on public health. For the case of Mozambique, we estimate that the interventions of optimally re-assigning clinics to labs and optimally re-allocating diagnostic capacity would result in 11% and 22% shorter turnaround times and 4% and 7% more infants starting treatment, respectively.

3 - Optimal Strategy for Hepatocellular Carcinoma Surveillance in Hepatitis C Patients

> Qiushi Chen, Georgia Institute of Technology, Atlanta, GA, United States of America, chenqiushi0812@gatech.edu, Jagpreet Chhatwal, Turgay Ayer

The practice guidelines recommend surveillance for HCC, the main type of liver cancer, in high-risk hepatitis C patients every 6-12 months. However, the optimal surveillance interval is controversial. We present a mixed-integer programming-based approach to evaluate the cost-effectiveness of routine and dynamic policies. We found that dynamic outperform routine policies.

4 - Dynamic Personalized Monitoring and Treatment Control of Chronic Diseases

> Pooyan Kazemian, PhD Candidate, University of Michigan, 1205 Beal Ave., Ann Arbor, MI, 48109, United States of America, pooyan@umich.edu, Jonathan Helm, Joshua Stein, Mark Van Oyen, Mariel Lavieri

We develop an innovative modeling framework for chronic disease patients to help guide clinicians to quickly detect disease progression and adjust the treatment plan over time to limit disease progression. The model is able to (1) optimize the time interval between sequential monitoring tests; (2) specify the best set of tests to take during each patient's office visit; and (3) provide target values for the controllable disease risk factors. Glaucoma is discussed as a case study.

■ SC42

Hilton- Union Sq 22

Network Epidemics: Theory Advancements and Applications

Sponsor: Health Applications
Sponsored Session

Chair: Benjamin Armbruster, Northwestern University, 2145 Sheridan Rd., IEMS, Evanston, Il, 60208, United States of America, armbruster@northwestern.edu

1 - Theoretical Results for Disease Spread on Networks

> Benjamin Armbruster, Northwestern University, 2145 Sheridan Rd., IEMS, Evanston, IL, 60208, United States of America, armbruster@northwestern.edu

There are few theorems in this area. I summarize existing results and present new theoretical results on (1) the role of heterogeneity; (2) the speed of spread on dynamic networks (a formula involving only the degree, infection rate, and relationship duration); (3) the optimal targeting of nodes and links to reduce spread; and (4) the convergence to mean-field models.

2 - A Model of Partnership Formation and Dissolution to Study HIV Transmission among Young MSM (YMSM)

> Ekkehard Beck, Northwestern University, 2145 Sheridan Road, Evanston, IL, United States of America, ekkehardbeck2015@u.northwestern.edu, Benjamin Armbruster

We introduce a discrete-time agent-based network simulation model of HIV/STI transmission and partnership formation and dissolution among YMSM using ego-centric network data of an ongoing longitudinal cohort study in Chicago. Results show that network position, age mixing, and race assortative mixing significantly impact HIV spread among YMSM. Additionally, sexually transmitted infections account for 13.7% of all HIV infections with rectal STIs accounting for more than 2/3 of these infections.

3 - Epidemics of Hepatitis C among Drug Injectors – The Role of Network Dynamics

> Alexander Gutfraind, Research Assistant Professor, University of Illinois at Chicago, 1603 W. Taylor Street, MC 923, Chicago, IL, 60612, United States of America, agutfraind.research@gmail.com, Basmattee Boodram

People who inject drugs (PWID) are the highest risk population for Hepatitis C virus (HCV) infections in the US. Using multiple datasets collected in Chicago we constructed and validated a detailed agent-based model for this epidemic. Using this model we found that network dynamics and disease dynamics contribute to the spread of HCV in different time scales.

■ SC43

Hilton- Union Sq 23

Software and Tools for Large-Scale Optimization

Sponsor: Computing Society
Sponsored Session

Chair: Jonathan Eckstein, Professor, Rutgers University, 100 Rockafeller Road, Piscataway, NJ, 08854, United States of America, jeckstei@rci.rutgers.edu

1 - Scenario Generation from Forecasts

> David Woodruff, UC Davis, One Shields Ave, Davis, CA, 95616, United States of America, dlwoodruff@ucdavis.edu

I will describe the work of a team of researchers that have created software to create scenarios based on point forecasts for input to large-scale stochastic programming problems. Experience with data for the stochastic unit commitment problem will be used to illustrate.

2 - Massively Parallel Branch-and-Bound with PEBBL

> Jonathan Eckstein, Professor, Rutgers University, 100 Rockafeller Road, Piscataway, NJ, 08854, United States of America, jeckstei@rci.rutgers.edu, Cynthia Phillips, William Hart

PEBBL is an object-oriented C++ library and software framework for implementing serial and parallel branch-and-bound algorithms. This talk describes PEBBL and its application to a machine learning problem, using a problem-specific combinatorial bound. On a large inifiband cluster, the application exhibits essentially linear speedup through 6,144 processor cores on our most difficult problem instance.

3 - Mixed-Integer Lower Bounds for Progressive Hedging

> Jean-Paul Watson, Distinguished Member of Technical Staff, Sandia National Laboratories, P.O. Box 5800, MS 1326, Albuquerque, NM, 87185-1326, United States of America, jwatson@sandia.gov, Jonathan Eckstein, David Woodruff

Nonconvexities and time limits may cause the progressive hedging (PH) algorithm to terminate in the mixed-integer case with a feasible solution, but no corresponding lower bound. We describe new methods to obtain lower bounds using both the information prices generated by PH and bundling methods. We additionally discuss experimental results and supporting open-source software implemenations.

4 - New Parallel Programming Languages for Optimization Research

> John Chinneck, Professor, Carleton University, Systems and Computer Engineering, 1125 Colonel By Drive, Ottawa, On, K1S 5B6, Canada, chinneck@sce.carleton.ca, Stephane Ernst

New optimization algorithms that do not take into account parallel execution are handicapped since multi-core machines are now everywhere, including on desktop PCs. For a recent project we searched for a programming language that has three characteristics: (i) easy to program, (ii) simple facilities for dealing with parallelism, and (iii) fast compilation and execution. Two free languages satisfied these criteria: Google's Go, and Julia. We assess these languages for optimization research.

■ SC44

Hilton- Union Sq 24

Service Operations and Information Systems

Sponsor: Information Systems
Sponsored Session

Chair: Subodha Kumar, Carol and G. David Van Houten, Jr. '71 Professor, Mays Business School, Texas A&M University, Wehner 301F - 4217 TAMU, College Station, TX, 77843, United States of America, skumar@mays.tamu.edu

1 - Network Effects in Healthcare Information Exchanges

> Emre Demirezen, Assistant Professor, Binghamton University Suny, Binghamton University Suny, 4400 Vestal Parkway East, Binghamton, NY, 13902, United States of America, edemirezen@binghamton.edu, Subodha Kumar, Arun Sen

Based on our interactions with three different healthcare information exchange (HIE) providers based in US, we study two models with network effects. The first one deals with the start-up HIEs; whereas in the second model, we analyze established HIE providers that also offer value-added services. We present several results and insights for HIE providers, healthcare practitioners, and policy-makers.

2 - Opportunistic Data Sharing: Co-opetition between Personalizing and Non-personalizing Firms

Abhijeet Ghoshal, University of Illinois, 1206 S. Sixth St, 446, Champaign, Il, 64820, United States of America, abhi@illinois.edu, Subodha Kumar, Vijay Mookerjee

We present a co-opetition model where a personalizing firm and a non-personalizing firm compete for the same set of customers while sharing data when it is mutually beneficial to them. The customer balances her purchases from the two firms in order to maximize her surplus. We provide conditions when the non-personalizing firm shares its data with the personalizing firm and the latter uses the data. Several interesting managerial insights are also provided regarding the data sharing equilibrium.

3 - ConSequence: Managing Fading Ads during a User Visit

Zhen Sun, University of Texas at Dallas, 800 W. Campbell Rd., Richardson, TX, 75080, United States of America, zhen.sun@utdallas.edu, Milind Dawande, Vijay Mookerjee, Ganesh Janakiraman

A fad is an ad that disappears if the visitor does not click on it after a given length of time. The withdrawn ad could be replaced by another ad. The goal of this paper is to choose a sequence of ads to display, such that the expected revenue is maximized.

4 - Coordination under Competition

Cheng Nie, Ph.D. Student, University of Texas at Dallas, 800 West Campbell Road, MC 1.406E, Richardson, TX, 75080, United States of America, cheng.nie@utdallas.edu, Vijay Mookerjee, Milind Dawande

Information sharing between various locations of a multi-location firm always seems beneficial for the firm. However, the duopolistic competition between firms might render this intra-firm information sharing harmful. We build a model to show that ignorance is bliss when firms compete with each other. The main lesson we learn is that a local-level competition between firms will change to a fiercer global-level competition when intra-firm information sharing is allowed.

■ SC45

Hilton- Union Sq 25

Service Operations Management

Sponsor: Behavioral Operations Management

Sponsored Session

Chair: Mirko Kremer, Professor, Penn State University, 460 Business Building, University Park, PA, United States of America, muk22@smeal.psu.edu

Co-Chair: Masha Shunko, Purdue University, 403 W. State Street, West Lafayette, IN, 47906, United States of America, mshunko@purdue.edu

1 - Impact of Observational Learning in a Congested Multi-Server Environment

Chen Jin, Northwestern University, Apt. 29 No. 2544 Prairie Ave., Evanston, IL, 60201, United States of America, chenjin2011@u.northwestern.edu, Laurens Debo, Mirko Kremer, Seyed Iravani

We study customers'queue selection behavior and its impact in a congested multi-server system with quality variation among servers and information asymmetry among customers who make decision based on the queue allocation across all servers observed upon arrival and their own private information (possessed by informed customers only). We show due to the presence of informed customer, the average welfare of uninformed can be worse off in some cases and we also found evidence in the experiment.

2 - Strategic Capacity Management When Customers Have Boundedly Rational Expectations

Tingliang Huang, Assistant Professor, UCL, Department of MS&I, Gower Street, London, WC1E 6BT, United Kingdom, t.huang@ucl.ac.uk, Qian Liu

The existing capacity rationing literature typically assumes that customers are able to form rational expectations about a firm's fill rate. In contrast, in this paper we ask: would strategic capacity rationing be optimal when customers have boundedly rational expectations?

3 - How do Delay Announcements Impact Customer Behavior: Experimental Study

Gad Allon, Northwestern University - Kellogg, 2001 Sheridan Rd., Evanston, IL, United States of America, g-allon@kellogg.northwestern.edu, Achal Bassamboo, Mirko Kremer

Delay announcements are prevalent in service systems. This paper is among the first experimental work studying how customers react to explicit and realtime waiting time information on anticipated delays. In particular, we are interested in studying how such announcements impact customers' beliefs about the anticipated waiting times.

4 - Experimental Study on State-dependent Productivity of Non-discretionary Tasks

Hao Zhang, Tsinghua University, Shunde Building 519A, Beijing, 100084, China, statistics.zhang@gmail.com, Xiaobo Zhao, Qi-Ming He

We conduct a 2 x 2 crossover laboratory experiment to investigate the impact of queue-length on performance at individual level. It shows that under the setting of non-discretionary task, different treatments of queue-length lead to the same average service time. However, queue-length influences participants' dynamic service times: a jump effect occurs when queue-length changes from zero to a positive value.

■ SC46

Hilton- Lombard

Joint Session OPT/ENRE: Mixed-integer Robust Optimization Models and Applications in Electric Power Systems

Sponsor: Optimization/Integer and Discrete Optimization & Energy Natural Resources and the Environment

Sponsored Session

Chair: Andy Sun, Assistant Professor, Georgia Institute of Technology, 765 Ferst Drive NW, Atlanta, GA, 30332, United States of America, andy.sun@isye.gatech.edu

1 - Multistage Adaptive Mixed-Integer Optimization

Angelos Georghiou, Research Associate, ETH Zurich, Physikstrasse 3, ETL K 12, Zurich, CH-8092, Switzerland, angelosg@control.ee.ethz.ch, Dimitris Bertsimas, John Lygeros

In recent years, decision rules have been established as the preferred solution method for addressing the computationally demanding, multistage adaptive optimization problems. Despite their success, existing decision rules (a) are typically constrained by their a priori design and (b) do not incorporate in their modelling adaptive binary decisions. In this talk, we present a methodology for the near optimal design of continuous and binary decision rules using mixed-integer optimization.

2 - Dynamic Uncertainty Sets for Robust Unit Commitment and Economic Dispatch

Alvaro Lorca, Georgia Institute of Technology, 765 Ferst Drive NW, Atlanta, GA, 30332, United States of America, alvarolorca@gatech.edu, Andy Sun

Power systems with a large penetration of renewable energy sources require innovative methods for dealing with the high uncertainty in their supply of electricity. In this talk we present adaptive robust optimization models for robust unit commitment and economic dispatch, using the concept of dynamic uncertainty sets for capturing the temporal and spatial correlations of uncertain parameters. We also discuss solution methods and present computational experiments.

3 - Adaptive Robust Optimization for Generation Maintenance via Sensor Based Condition Monitoring

Murat Yildirim, Geogia Tech, Atlanta, GA, United States of America murat@gatech.edu, Nagi Gabraeel, Andy Sun

We provide an adaptive robust optimization model to determine the optimal generation maintenance scheduling by leveraging sensor health monitoring data and considering network constrained unit commitment decisions. We develop solution algorithms and conduct computational experiments that demonstrate the advantages of our proposal over traditional approaches that use periodic and reliability based maintenance models.

4 - A Cutting Plane Method for Robust Mixed Integer Programming

Anna Danandeh, University of South Florida, 4202 E Fowler Ave, Tampa, Fl, United States of America, annadanandeh@mail.usf.edu, Bo Zeng

Robust optimization is one of the reliable methods to hedge against the uncertainty. However, solving this problem is computationally challenging. In this work, we intend to describe a polynomially solvable algorithm that strengthens cover inequalities via a robust lifting function and derives strong cuts valid for the convex hull of the robust knapsack set.

■ SC47

Hilton- Mason A

Computational Stochastic Dynamic Optimization

Sponsor: Optimization/Optimization Under Uncertainty

Sponsored Session

Chair: Xi Chen, New York University, New York University, New York, United States of America, xichen1987@gmail.com

**1 - Linear Coupling of Gradient and Mirror Descent:
A Novel, Simple Interpretation of Nesterov's Accelerated
Methodand Mirror Descent**

Zeyuan Allen-Zhu, Massachusetts Institute of Technology, CSAIL, Cambridge, MA, United States of America, zeyuan@csail.mit.edu, Lorenzo Orecchia

Almost all first-order methods rely on two standard algorithmic steps: gradient-descent and mirror-descent steps. We observe that the convergence of the two steps are complimentary, and obtain a simple reinterpretation of Nesterov's accelerated gradient method by expressing it as a linear coupling of the two. This complementary view lets us design new first-order (deterministic and stochastic) methods in a conceptually easier way, and facilitates two recent breakthroughs in approximately solving packing and covering LPs in nearly-linear time. These breakthroughs heavily relies on the linear couplings of (full or stochastic) gradient and mirror descent steps.

**2 - Stochastic Mixed Integer Programming with Log-exponential
Convex Risk Measures**

Pavlo Krokhmal, Associate Professor, University of Iowa, 3131 Seamans Center, Iowa City, IA, 52242, United States of America, krokhmal@engineering.uiowa.edu, Alexander Vinel

We consider stochastic nonlinear mixed integer programming problems that involve log-exponential convex risk measures. Two solution approaches are discussed, which include a branch-and-bound method that relies on polyhedral approximations of nonlinear log-exponential constraints, and a branch-and-cut that employs nonlinear lifted cuts. Numerical experiments on portfolio optimization problems are presented.

**3 - Tradeoff between Storage and Transport in Merchant Energy
Trading on a Network**

Selvaprabu Nadarajah, Assistant Professor, University of Illinois at Chicago, Liautaud Graduate School of Business, selvan@uic.edu, Nicola Secomandi

Merchant energy trading across wholesale markets and time can be represented as a network where storage and transport assets compete for capacity. We model this competition as a Markov decision problem and leverage structural analysis to develop an ADP policy. We find that the tradeoff between storage and transport is difficult to manage, as sequential storage and transport trading is considerably suboptimal. Our ADP policy is instead near optimal and more efficient than a practice-based method.

**4 - The Knowledge Gradient Policy using a Sparse Additive
Belief Model**

Yan Li, Princeton University, Sherrerd Hall, Charlton St., Princeton, NJ, 08544, United States of America, yanli@princeton.edu, Han Liu, Warren Powell

We propose a sequential learning policy for ranking and selection problems with high dimensional sparse belief functions. We derive a knowledge gradient policy for sparse linear model with group Lasso penalty and generalize it to the nonparametric additive model and functional ANOVA model. Theoretically, we provide the estimation error bounds. Empirical experiments show that the algorithm efficiently learns the correct sparsity structure and outperforms the knowledge gradient for a linear model.

■ SC48

Hilton- Mason B

Stochastic Integer Programming

Sponsor: Optimization/Optimization Under Uncertainty

Sponsored Session

Chair: Kibaek Kim, Argonne National Laboratory, 9700 S. Cass Avenue, Argonne, IL, 60439, United States of America, kibaekkim@mcs.anl.gov

**1 - Cut Generation in Optimization Problems with Multivariate
Risk Constraints**

Simge Kucukyavuz, Associate Professor, The Ohio State University, 210 Baker Systems Building 1971 Neil Ave, Columbus, OH, 43210, United States of America, kucukyavuz.2@osu.edu, Nilay Noyan, Xiao Liu

We give alternative mixed-integer programming formulations and algorithms for cut generation problems arising in optimization under multivariate risk constraints. We give the complete linear description of a non-convex substructure common in these cut generation problems. We present computational results that show the effectiveness of our proposed models and methods.

**2 - Polyhedral Study of Chance Constrained Program – Implications of
Bilinear Representation**

Bo Zeng, Assistant Professor, University of South Florida, 4202 E Fowler Ave, Tampa, FL, 33620, United States of America, Bzeng@usf.edu, Kai Huang, Ming Zhao

Based on the non-popular bilinear formulation, we derive strong formulations and polyhedral results for chance constrained program. Our work includes a convex hull description of a subset, a set of cutting planes and separation algorithms. Our results lead to a great computational improvement.

**3 - A Computational Comparison of Algorithms for Solving Two-stage
Stochastic Mixed-integer Programs**

Yunwei Qi, Ohio State University, 766 Saratoga Ave, San Jose, CA, 95129, United States of America, qi.47@osu.edu

This presentation focuses on solving two-stage stochastic programs with general mixed integer decision variables in both stages. We compare different decomposition algorithms in which the first stage approximation is solved using a branch-and-bound tree with ancestral Benders' cuts and the second stage convexification uses branch and bound tree with multi-term disjunctive cuts or Gomory cuts to obtain approximations of the second stage mixed-integer programs.

**4 - Two-stage Stochastic Programs with Mixed Binary
Recourse Function**

Kuo-Ling Huang, Northwestern University, 2145 Sheridan Rd, Evanston, IL, United States of America, jupiters1117@northwestern.edu, Kibaek Kim, Sanjay Mehrotra

We study two-stage stochastic programs with mixed binary recourse function. We present a Benders decomposition method with lift-and-project cuts in the second stage. A practical algorithm based on this method is implemented in a software package named iOptimize. Computational results are also given in this talk.

■ SC49

Hilton- Powell A

Connectivity and Cluster Detection in Networks

Sponsor: Optimization/Network Optimization

Sponsored Session

Chair: Austin Buchanan, Texas A&M University, 3131 TAMU, College Station, TX, 77843, United States of America, buchanan@tamu.edu

**1 - Detecting Sybil Nodes in Social Networks:
A Fractional Programming Approach**

Chrysafis Vogiatzis, University of Florida, chvogiat@ufl.edu

As online social networks become bigger and more widespread, they also become more prone to Sybil attacks. In its most basic form, a perpetrator creates multiple identities and tries to form bonds with honest users in order to disperse information, affect elections, and intercept messages. We formulate the problem as a ratio problem, and derive its complexity. We conclude by proposing different approaches to tackling the problem, and showing some preliminary computational results.

2 - Uncovering the Effect of Dominant Attributes on Community Topology in Facebook Networks
Soundar Kumara, Allen E. Pearce/Allen M. Pearce Professor, The Pennsylvania State University, 222 Leonhard Building, Industrial Engineering, University Park, PA, 16802, United States of America, skumara@psu.edu, YI-SHAN SUNG

Community structure does not only point to structural patterns but also reflects functional associations. Since one node may contain multiple attributes, it is difficult to identify the dominant attributes, having definitive effects on community formation. We obtain communities using a clustering game and elaborate the process to identify the dominant attributes. We test our method on 100 Facebook networks to enable an integrating observation on how the offline lives infer online consequences.

3 - Finding a Maximum k-club using the k-clique Formulation and Lazy Cuts
Esmaeel Moradi, Oklahoma State University, 322 Engineering North, Stillwater, OK, 74078-5018, esmaeel@ostatemail.okstate.edu, Baski Balasundaram

A subgraph of diameter at most k is called a k-club, which includes clique as a special case when k equals 1 and is a relaxation when k is larger than 1. It can be used to model low-diameter clusters in graph based data mining applications and social network analysis. In this talk, we present a branch-and-cut algorithm for the maximum k-club problem using the k-clique formulation as a linear programming relaxation. In this algorithm, the constraints are applied in a lazy fashion.

4 - On Imposing Connectivity Constraints
Austin Buchanan, Texas A&M University, 3131 TAMU, College Station, TX, 77843, United States of America, buchanan@tamu.edu, Yiming Wang, Sergiy Butenko

In many clustering and network design applications, one wants to impose connectivity constraints. To this end, we study the connected subgraph polytope—the convex hull of subsets of vertices that induce a connected subgraph. Extra emphasis is placed on special cases where the maximum weight connected subgraph problem is polytime solvable and admits a compact extended formulation.

■ SC50

Hilton- Powell B

Network Analysis

Sponsor: Optimization/Network Optimization
Sponsored Session

Chair: Bahar Cavdar, PhD Candidate, Georgia Institute of Technology, 755 Ferst Drive, NW, Atlanta, GA, 30332, United States of America, baharca@gatech.edu

1 - A CIP Approach for the Computation Time-Limited Vehicle Loading and Routing Problem
Bahar Cavdar, PhD Candidate, Georgia Institute of Technology, 755 Ferst Drive, NW, Atlanta, GA, 30332, United States of America, baharca@gatech.edu, Joel Sokol

In large instances of vehicle loading and routing problems where cutoff times limit the time available for computing solutions, good heuristic methods are unable to run until completion. We demonstrate a computation-implementation parallelization (CIP) approach that generates improved solutions and allows companies to trade off the benefit across three dimensions: shorter routes, later cutoff times, and earlier dispatch times.

2 - Arc Routing to Restore Post-Disaster Road Network Connectivity
Sibel Salman, Associate Professor, Koc University, Rumelifeneri Yolu, Sariyer, Istanbul, Turkey, ssalman@ku.edu.tr, Vahid Akbari

We find coordinated routes for road clearing teams to repair damaged roads and restore the network connectivity in shortest time after a disaster. The multi-vehicle problem combines arc routing, network design and scheduling aspects. We propose an effective constructive heuristic algorithm that processes a relaxed mixed integer programming solution.

3 - Supply Chain Network and Firm Returns
Jing Wu, PhD Student, University of Chicago Booth School of Business, 5050 S Lake Shore Dr 3417S, Chicago, IL, 60615, United States of America, wujing@chicagobooth.edu, John Birge

This paper investigates the effects of supply chain connections on firm performance, as reflected in stock returns, at two interaction levels, first-order from directions and second-order from systemic exposures through the network.

4 - Supply Chain Network and Systematic Risk
Jing Wu, PhD Student, University of Chicago Booth School of Business, 5050 S Lake Shore Dr 3417S, Chicago, IL, 60615, United States of America, wujing@chicagobooth.edu, John Birge

We study the systematic risk at different positions of the supply chain network, and find that under the goal of profit maximization, both manufacturing firms and

logistics firms have incentive to increase the number of connections to the upstream firms which results in lower risk for the manufacturing firms but higher risk for the logistics firms.

■ SC51

Hilton- Sutter A

Methods in Nonlinear Optimization

Sponsor: Optimization/Nonlinear Optimization
Sponsored Session

Chair: Katya Scheinberg, Lehigh University, 200 West Packer Ave,, Bethelehem, PA, 18015, United States of America, katyas@lehigh.edu

1 - Alternating Linearization Methods for Quadratic Least-Square Problem
Xi Bai, Lehigh University, 200 West Packer Avenue, Bethlehem, PA, 18015, United States of America, xib210@lehigh.edu, Katya Scheinberg

Second-order least square problems have arisen widely in binary optimization, portfolio optimization, etc.. In this talk, we propose an alternating linearization framework to solve this set of problems which are potentially nonconvex. We show the effectiveness of our technique in terms of both theory and numerical experiments in the application of risk parity optimization in portfolio management.

2 - using Probabilistic Regression Models in Stochastic Derivative Free Optimization
Ruobing Chen, Ph.D. Candidate, Lehigh University, 200 West Packer Ave., Bethlehem, PA, 18015, United States of America, ruc310@lehigh.edu, Katya Scheinberg

We consider the use of probabilistic regression models in a classical trust region framework for optimization of a deterministic function, only having access to noise-corrupted function values. Contrasting to traditional requirements on the poisedness of sample sets, our models are constructed using random samples while providing sufficient quality of approximation with high probability. We discuss convergence proofs of proposed algorithm based on error bounds from machine learning literature.

3 - Convergence Rates of Line-Search and Trust Region Methods Based on Probabilistic Models
Katya Scheinberg, Lehigh University, 200 West Packer Ave,, Bethelehem, PA, 18015, United States of America, katyas@lehigh.edu, Coralia Cartis

We examine traditional unconstrained optimization methods such as line search and adaptive regularization methods with cubics and extend them to the case where the first or second order models are random and have random "quality". Under assumptions that the "quality" is sufficiently good with probability >1/2 we derive expected convergence rates for these methods for nonconvex, convex and strongly convex cases. We give a general unified framework and its analysis based on random processes.

■ SC52

Hilton- Sutter B

Optimization, Variational Inequality Problems, and Games: Uncertainty, Imperfect Information, and Distributed Computation

Sponsor: Optimization/ Linear and Conic Optimization
Sponsored Session

Chair: Uday Shanbhag, Pennsylvania State University, 310 Leonhard Building, University Park, PA, 16803, United States of America, udaybag@engr.psu.edu

1 - Empirical Centroid Fictitious Play: Strong Convergence in a Distributed-Information Setting
Brian Swenson, Carnegie Mellon University, 5000 Forbes Ave., Pittsburgh, PA, United States of America, brianswe@andrew.cmu.edu, Soummya Kar, Jo„o Xavier

Empirical Centroid Fictitious Play (ECFP) is an adaptation of the well-known Fictitious Play (FP) algorithm that is well-suited to implementation in large games. However, a shortcoming of ECFP (and FP) is that learning occurs only in the weak sense of convergence in empirical beliefs —- players' period-by-period strategies do not necessarily converge to equilibrium. The paper presents a distributed-information implementation of ECFP that converges in the latter stronger sense.

SC53   *INFORMS San Francisco – 2014*

**2 - Variational Inequality Problems: Addressing Uncertainty and
Imperfections in Information**
Uma Ravat, University of Illinois at Urbana-Champaign,
1832 Orchard Place #c, Urbana, United States of America,
ravat1@illinois.edu, Uday Shanbhag

We consider the solution of variational inequality problems complicated by
uncertainty and imperfect information. We examine the role of learning and how
it may be combined with solution techniques. Preliminary algorithmic and
numerical results will be provided.

3 - On the Resolution of Misspecified Convex Optimization Problems
Hesamoddin Ahmadi, Student, Penn State University,
107 Holderman Hall, University Park, PA, 16802,
United States of America, hza108@psu.edu

We consider a misspecified optimization problem that requires minimizing of a
convex function f (x;q*) in x over set X where q* is an unknown vector but can be
learnt by a distinct learning problem. We develop joint first-order schemes for
computation and learning and provide rate statements.

■ SC53

Hilton- Taylor A

Data Driven Computational Finance

Cluster: Optimization in Finance
Invited Session

Chair: Gerry Tsoukalas, Wharton, Walnut Street, Philadelphia, PA,
United States of America, gtsouk@wharton.upenn.edu

1 - Data Driven Portfolio Optimization
Victor DeMiguel, London Business School, London, England,
United Kingdom, avmiguel@london.edu

To compute efficient mean-variance portfolios, an investor needs to estimate the
mean and the covariance matrix of asset returns, but due to estimation error the
resulting portfolios typically perform poorly out of sample. In this talk, we discuss
several approaches proposed in the recent literature to overcome these difficulties,
including robust optimization and estimation, shrinkage estimation, Bayesian
estimation, and norm constraints.

2 - Money Management with Performance Fees
Daniel Mitchell, Assistant Professor, Singapore University of
Technology and Design, 20 Dover Drive, Singapore, Singapore,
dan.mitchell@utexas.edu, Kumar Muthuraman, Sheridan Titman

Hedge fund contracts are generally characterized by a flat fee, a performance fee
and what are know as high-water-mark provisions. This paper describes and
characterizes these contract features and analyzes how they influence the hedge
fund's risk choices. We model the hedge fund's portfolio choice as a stochastic
control problem with hybrid discrete and continuous controls. We develop a
computational method to solve this class of problems and prove its convergence.

3 - A Multiclass Queueing Model of Limit Order Book Dynamics
Hua Zheng, Columbia Business School, 3022 Broadway,
Uris 4S, New York, NY, 10027, United States of America,
hzheng14@gsb.columbia.edu, Costis Maglaras, Ciamac Moallemi

We formulate and solve a problem of limit and market order placement in a limit
order book to optimally buy a block of shares over a short, predetermined time
horizon. We use the structure of the optimal execution policy to propose a
microstructure model of market impact, which we estimate using trade data and
highlight its increased accuracy over "macro" market impact models.

■ SC54

Hilton- Taylor B

Financial Risks

Sponsor: Financial Services Section
Sponsored Session

Chair: Justin Sirignano, Stanford University, 3 Gibbs Court, Irvine,
CA, 92617, United States of America, jasirign@stanford.edu

1 - Efficient Risk Analysis for Mortgage Pools and MBS
Justin Sirignano, Stanford University, 3 Gibbs Court, Irvine, CA,
92617, United States of America, jasirign@stanford.edu,
Kay Giesecke

Typical mortgage pools of interest are very large and computationally expensive to
simulate. We develop a dynamic law of large numbers and dynamic central limit
theorem in order to tractably calculate pool loss and prepayment distributions for a
broad class of models. Computational cost is often several orders of magnitude less
than simulation of the actual pool with a similar level of accuracy.

2 - Robust Rare Event Analysis and Computations
Jose Blanchet, Associate Professor, Columbia University, Rm. 323,
School of Engineering, 500 West 120th Street, New York, NY,
10027, United States of America, jose.blanchet@columbia.edu

We discuss a systematic approach which allows to broaden the applicability of
optimal rare-event simulation algorithms which are often designed under
somewhat restrictive assumptions. We discuss several examples, one of them is the
problem of performing risk analysis of Gumbel copula models, exploiting strongly
efficient algorithms for t-copula models.

3 - Dynamic Credit Swap Selection under Funding Costs
Agostino Capponi, Johns Hopkins University, 3400 North Charles
Street, Baltimore, MD, 21218, United States of America,
acappon1@jhu.edu

We develop a dynamic optimization framework to assess the impact of funding
costs on credit swap investments. A default risky investor can purchase CDS
upfronts, borrow at a rate depending on her credit quality, and invest in risk-free
money market account. Contagion effects make the optimal strategy coupled with
the value function. We show that the latter can be recovered as the solution of a
nonlinear HJB equation whose coefficients admit singular growth.

■ SC55

Hilton- Van Ness

Global Optimization: Algorithms and Applications

Sponsor: Optimization/Global Optimization & MINLP
Sponsored Session

Chair: Veronica Piccialli, University of Rome Tor Vergata,
via del Politecnico 1, Rome, Italy, piccialli@disp.uniroma2.it

**1 - Embedding SpeeDP Algorithm within a Branch & Cut Method for
Solving the Large Max Cut Instances**
Laura Palagi, Associate Professor, Sapienza University of Rome,
Via Ariosto 25, Roma, 00185, Italy, palagi@dis.uniroma1.it, Maryam
Salami, Veronica Piccialli, Giovanni Rinaldi

We design an algorithm that provides solutions to Max-Cut along with a
guaranteed optimality error. We consider embedding algorithm SpeeDP, a fast
method for the solution of low-rank semidefinite programming relaxations of
unconstrained {-1,1} quadratic problems, into a Brach&Cut method which uses a
Lagrangian relaxation of the additional cut constraints. We run it on very large
graphs to verify the effectiveness of SpeeDP with respect to standard SDP solver.

2 - A Feature Ranking Method for Nonlinear Regression
Veronica Piccialli, University of Rome Tor Vergata, via del
Politecnico 1, Rome, Italy, piccialli@disp.uniroma2.it, Luca Bravi,
Marco Sciandrone

Feature selection (FS) allows to identificate relevant features on big amount of
data. By exploiting the concept of inversion of a neural network, we reformulate
the FS problem as a global optimization problem involving smooth concave
approximations of the zero-norm. The effectiveness of the proposed strategy is
proved by an extensive experimentation on synthetic data and real world
problems.

3 - Exploiting Nonlinear Structure in Global Optimization
Sven Leyffer, Dr., Argonne National Laboratory, 9700 South Cass
Ave, Argonne, United States of America, leyffer@mcs.anl.gov

We present a new approach to generate tight and tractable convex relaxations of
nonconvex functions based on exploiting group-partial separability. We
demonstrate this approach in the context of two classes of powerful relaxation
techniques: semi-definite relaxations and the reformulation-linearization
technique. In both cases, we derive tight relaxations that can be solved orders of
magnitude faster than traditional techniques that do not exploit the nonlinear
structure.

■ SC56

Hilton - Green Room

Software Demonstrations

Cluster: Software Demonstrations

Invited Session

1 - Building AMPL Models into Your Applications
Robert Fourer, President, AMPL Optimization Inc, 2521 Asbury Ave, Evanston, IL, 60201, United States of America, 4er@ampl.com, Victor Zverovich

AMPL is well known for making optimization models easy to develop and to debug, but you don't have to give up these advantages when embedding your model into a larger system and deploying it to users. We present and contrast two facilities for building models into your applications: AMPL scripting, which provides powerful programming constructs within the modeling language; and the new AMPL API, which permits access to AMPL objects and methods from popular general-purpose programming languages.

■ SC64

Parc- Cyril Magnin I

Data-driven Decisions in Healthcare

Sponsor: Applied Probability Society

Sponsored Session

Chair: Mohsen Bayati, Stanford Graduate School of Business, Stanford, CA, 94305, United States of America, bayati@gsb.stanford.edu

1 - using Uncertain Markov Chains to Assess Cost-effectiveness of Medical Innovations
Joel Goh, joelgoh@stanford.edu, Sundeep Singh, David Moore, Stefanos Zenios, Mohsen Bayati

A common problem with using Markov chains in medical cost-effectiveness studies is that estimates of the transition matrix of the chain may be imprecise. We present an optimization-based approach for assessing the effect of this imprecision and apply it to studying the cost-effectiveness of fecal immunochemical testing (FIT) as a screening modality for colorectal cancer. We show that despite the larger uncertainty, FIT is highly cost-effective relative to colonoscopy.

2 - The Big Data Newsvendor
Cynthia Rudin, MIT Sloan School of Management, 100 Main Street, Cambridge, MA, 02139, United States of America, rudin@mit.edu, Gah-Yi Vahn

We investigate the newsvendor problem when one has n observations of p features related to the demand as well as past demands. Both small (sparse) data ($p/n = o(1)$) and big data ($p/n = O(1)$) are considered. We solve the problem as a high dimensional nonparametric quantile regression problem and provide theoretical guarantees on predictive performance.

3 - Improving the Prediction of Emergency Department Waiting Times
Erjie Ang, Stanford Graduate School of Business, 655 Knight Way, Stanford, CA, 94305, United States of America, erjieang@stanford.edu, Michael Aratow, Sarah Kwasnick, Mohsen Bayati, Erica Plambeck

Using data from San Mateo Medical Center, we develop an easy method to predict waiting time at the ED accurately. We further explore how to present wait time information to potential patients. Combining behavioral experiments, econometric and machine-learning methods, we develop a new objective function to determine the best wait time message to present to patients. We compare the performance of our objective to those generated by traditional accuracy based objective functions.

4 - Improving Hospital Queueing with Future Information
Kuang Xu, MIT, 77 Massachusetts Ave., Cambridge, United States of America, kuangxu@mit.edu, Carri Chan

With an increase in availability of patient data, new predictive models are being developed. This begs the questions: How can forecasts and predictions of the future be used to improve the efficiency and effectiveness of healthcare delivery? We examine a class of queueing models and admissions control problems in emergency departments. We show, both analytically and via simulations, that system efficiency can be substantially improved by the access to (limited) future information.

■ SC65

Parc- Cyril Magnin II

Case Competitions I

Sponsor: INFORM-ED

Sponsored Session

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

1 - Case Competition
Palaniappa Krishnan, University of Delaware, Newark, DE, United States of America, baba@udel.edu

INFORMed's Annual Cased Competition is an opportunity fir INFORMS Members to showcase their efforts in the classroom. Cases are often later published.

2 - Idiopathic Pulmonary Fibrosis Case
David Kopcso, Professor of Mathematics and Information Technology, Babson College, 1 College Drive, Wellesley, MA, United States of America, kopcso@babson.edu, Howard Simon, Annie Gao

InterMune Inc. is a developer of pharmaceutical products for the treatment of idiopathic pulmonary fibrosis (IPF), a lung disease. Pirfenidone, a non-steroid hormone, was a product at which InterMune had been looking closely as a promising new drug for IPF treatment. Marnac, Inc. held the rights to pirfenidone in the US while KDL GmbH held the European rights. InterMune needs to decide if it should license pirfenidone. The decisions can be viewed from Marnac's perspective which supplies an introduction to a simple two-alternative decision analysis. An expanded view of the decision process that needs to be followed for FDA approval offers potential hedging insights, such as offering a license to InterMune. Lastly, InterMune may or may not be interested in adopting the FDA approval risk by accepting the license offer from Marnac and KDL GmbH.

3 - Developing a Business Model to Improve Energy Sustainability of Existing Buildings
Baris Tan, Professor of Operations Management, Koç University, Rumelifeneri Yolu Sariyer, Istanbul, 34450, Turkey, btan@ku.edu.tr, Yahya Yavuz, Emre N. Otay, Emre Camlibel

The case study introduces the business model of Energy Saving Companies (ESCO) by using the setting of improving energy efficiency of existing buildings at a university campus. Identifying and investing in the right energy saving technologies within a given budget help the adoption of energy efficiency measures in existing buildings. A mathematical programming approach can be used to select the right energy efficiency measures among all the available ones to optimize financial or environmental benefits subject to budgetary and other logical constraints in single- and multi-period settings. In order to implement this approach, one should determine all the relevant energy efficiency measures for the campus and their expected cost, energy, and environmental benefits together with their investment costs. The case reports how these measures are identified by using engineering measurements and modeling, how a mathematical model is developed and used to select the energy efficiency measures within a budget to optimize environmental and financial objectives, and how the solution is used to develop a business model to offer investments in energy.

4 - Storage Assignment in a Unit-load Warehouse
Yun Fong Lim, Associate Professor, Singapore Management University, Lee Kong Chian School of Business, 50 Stamford Road, Singapore, 178899, Singapore, yflim@smu.edu.sg, Marcus Ang

This case describes a challenge faced by YCH Group, a leading third-party logistics provider in Singapore. In 2012, the company had started an ambitious plan to construct a US$159 million logistics hub. With 1.5 million square feet of warehouse space and a million square feet of office space, it would house YCH Group's headquarter, as well as research, training, and warehousing facilities. To keep pace with their fast expansion, it was crucial for YCH to increase their profitability. A key area to boost their profit was to improve the efficiency of the storage and retrieval operations of their unit-load warehouse. To achieve this, one approach was to use mathematical modeling (linear programming). The case requires students to make valid assumptions before they can formulate a linear programming model to find an efficient storage assignment policy for the warehouse. The case then directs the students to compare the performance of this policy with other heuristic policies using historical data. This case reinforces the students' skills in data processing, mathematical modeling, and numerical computation. After completing the case, the students will be able to: (1) Forecast mean demands with the data. (2) Build an appropriate linear programming model for the storage assignment problem, and evaluate the model's solutions using the data. (3) Perform sensitivity analysis on the parameters. This case can be used in undergraduate and graduate classes to illustrate the effectiveness of different policies for storage assignment in a unit-load warehouse.

SC66   *INFORMS San Francisco – 2014*

5 - VASTA Wireless – Push vs. Pull Distribution Strategies
Yao Zhao, Associate Professor, Rutgers University, 1 Washington Street, Newark, NJ, 07102, United States of America, yaozhao@andromeda.rutgers.edu

VASTA is one of the largest wireless services (voice and data) carriers in the United States, and is well known for its reliable national network and superior customer service. In the fiscal year of 2009-2010, VASTA suffered a significant inventory write-off due to the obsolescence of handsets. VASTA was carrying a huge amount of inventory (~$2 Billion) in its national distribution system with a majority held at 2000+ stores to satisfy consumer demand at stores. To address this challenge, the company is thinking to change the current "push" inventory strategy which pushes inventory to stores towards a "pull" strategy that pulls the inventory of handsets from stores to three distribution centers (DCs), and uses the stores only as showrooms. Customers visiting stores will have their favorite phones delivered to their homes overnight from the DCs free of charge. Although the pull strategy has been used in the furniture industry and consumer electronics (for instance, by Apple), it was never attempted by VASTA and other US wireless carriers by 2010.

6 - Advertising Analytics
U.K. Bhattacharya, Indian Institute of Management Indore, Rau, Pigdamber, Indore 453556, India, utpalb@iimidr.ac.in

The case "Advertising Analytics" introduces various key issues to connect large set of data in order to take appropriate advertising decisions. The motivation of the case is to decide the number of advertisements in various newspapers and optimal allocation of budget to the different media in order to maximize the reach to the target customers . Here the advertising media has been considered as various newspapers. Based on the popularity and number of circulation five important newspapers have been chosen for advertising purpose. The case setting is typical for dealing with both single criterion and multi-criteria decision making situations. Main focus of this case is to carry advertiser's messages to the target market in order to improve the quality and conversion ratio of the intake.

■ SC66

Parc- Cyril Magnin III

Data Fusion in Manufacturing and Biomedical Systems

Sponsor: Quality, Statistics and Reliability
Sponsored Session

Chair: Ran Jin, Virginia Tech, Virginia Polytechnic Institute and State, University, 111 Durham Hall,, Blacksburg, VA, 24061, United States of America, jran5@vt.edu

Co-Chair: Kamran Paynabar, Georgia Institute of Technology, 765 Ferst Drive, Atlanta, GA, 30327, United States of America, kamran.paynabar@isye.gatech.edu

1 - Statistical Metamodeling and Computer Experiments of Large-scale Cardiac Models
Dongping Du, University of South Florida, 4202 E Fowler Ave, ENG302, Tampa, FL. United States of America, dongpingdu@mail.usf.edu, Hui Yang

Cardiac voltage-gated sodium (Nav) channel plays significant roles in cardiac electrical signaling. Model of Nav channels involves greater levels of complexity. Traditional optimization methods have encountered many difficulties, even infeasible, for model calibration. We developed a new statistical metamodeling approach for computer experiments and optimization of Nav channels. The approach achieves superior performance for modeling the glycosylated and controlled kinetics of Nav channels.

2 - Classification of Additive Manufacturing (AM) Part Quality using Graph Laplacian Topology Modeling
Zhenyu Kong, Associate Professor, Virginia Tech, 1145 Perry Street, Blacksburg, VA, 24061, United States of America, zkong@vt.edu, Prahalad Rao

We present a graph Laplacian connectivity-based approach that can classify AM part quality in terms of dimensional integrity and surface roughness. Using empirical data we show that graph Laplacian topological invariants can unambiguously detect part quality deviations. Because the presented approach uses point cloud and image information obtained from non-contact scanners, it can significantly enhance the status quo of metrology in AM.

3 - Bayesian D-Optimal Design of Experiments with Quantitative and Qualitative Responses
Lulu Kang, Assistant Professor, Illinois Institute of Technology, 10 W 32nd Street, E1-208, Chicago, IL, 60616, United States of America, lkang2@iit.edu, Ran Jin, Xinwei Deng

Systems with quantitative and qualitative (QQ) responses are widely encountered in many applications. Experiments are conducted to study such systems. Classic experimental design methods are not suitable for such experiments. A Bayesian D-

optimal design method is developed for quantitative and binary qualitative responses. Both noninformative and informative conjugate prior distributions are considered. Iterative point-exchange search algorithm is developed.

4 - An Efficient Emulator for Multivariate Gaussian Processes using a Pairwise Fitting Approach
Qiang Zhou, Assistant Professor, City University of Hong Kong, Kowloon, Hong Kong - PRC, q.zhou@cityu.edu.hk, Yongxiang Li

Multivariate Gaussian process may be used for modeling multiple response systems for information sharing, yet the computation can be prohibitive when there is a large number of response levels. In this work, we propose a computationally efficient multivariate GP model which permits a pairwise fitting scheme with great scalability.

■ SC67

Parc- Balboa

System Informatics and Control: Learning from Complex Data

Sponsor: Quality, Statistics and Reliability
Sponsored Session

Chair: Arash Pourhabib, Assistant Professor, Oklahoma State University, 322 Engineering North, Stillwater, OK, 74078, United States of America, arash.pourhabib@okstate.edu

1 - Weak Hierarchical Lasso: Efficient Algorithms and Applications
Jieping Ye, Associate Professor, Arizona State University, Tempe, AZ, 85287, United States of America, jieping.ye@asu.edu

We consider weak hierarchical Lasso, a sparse interaction regression model, which produces sparse and hierarchical structured estimator by exploiting the Lasso penalty and a set of hierarchical constraints. We show how to efficiently solve the challenging non-convex weak hierarchical Lasso formulation based on a key observation that the associated proximal operator admits a closed form solution. Finally, we present numerical experiments to demonstrate the efficacy of the proposed algorithm.

2 - Learning for Wireless Systems with Orientation-Aware Devices and Structured Antenna Patterns
Jean-Francois Chamberland, Associate Professor, Texas A&M University, 3128 TAMU, ECE Department, College Station, TX, 77843, United States of America, chmbrlnd@tamu.edu, Gregory Huff

Wireless communication systems employ link adaptation and scheduling to exploit the diversity afforded by fading channels in multi-user environments. The emergence of reconfigurable antenna systems, together with the wide availability of orientation information in smartphones, offers new ways to improve performance. The power of these new modalities can be harnessed through a machine-learning framework, which seeks to exploit past observations in predicting suitable modes of operation.

3 - Extracting Sparse Patterns from High-dimensional Data using Gaussian Mixture Models
Yang Zhao, Ph.D. Student, City University of Hong Kong, 83 Tat Chee Ave, Kowloon, Hong Kong - PRC, yangzhao9-c@my.cityu.edu.hk, Kwok Leung Tsui, Abhishek Shrivastava

Gaussian mixture model (GMM) is widely used for learning the latent structure in data. Though effective in many applications, GMMs show poor performance in high-dimensional setting. We propose regularized parameter estimation for learning the GMM. The regularization ensures a positive definite inverse covariance matrix and captures important correlation information between features. We demonstrate the performance of the estimate through various datasets.

4 - Embedded Synthetic Data Generation for Imbalanced Two-class Classification
Arash Pourhabib, Assistant Professor, Oklahoma State University, 322 Engineering North, Stillwater, OK, 74078, United States of America, arash.pourhabib@okstate.edu, Yu Ding

We propose an algorithm for two-class classification problems when the number of training instances in one of the classes is so low that the conventional classification algorithms become ineffective in detecting the minority class. We present a modification of the kernel Fisher discriminant analysis in which synthetic data points are generated iteratively. The novelty of the proposed method is that synthetic data generation is embedded in the algorithm.

■ SC68

Parc- Davidson

Simulation Optimization and Sequential Sampling Rules

Sponsor: Simulation

Sponsored Session

Chair: Peter Frazier, Assistant Professor, Cornell University, 232 Rhodes Hall, Ithaca, NY, 14853, United States of America, pf98@cornell.edu

1 - New Methods for Choosing Parameters for Sampling Rules
Dashi Singham, Naval Postgraduate School, Mail Code: OR, Operations Research Dept, Monterey, United States of America, dsingham@nps.edu, Michael Atkinson

Sampling rules for simulation experiments depend on a number of parameters: desired precision and confidence in the output, underlying variance of data, and constraints on the number of samples. We analyze the relationships between these parameters by using a new measure of reliability for cumulative mean behavior that extends the traditional notions of coverage.

2 - Parallelized Bisection Method: Effectively using Asynchronous Information
Stephen Pallone, Cornell University, 290 Rhodes Hall, Cornell University, Ithaca, NY, 14853, United States of America, snp32@cornell.edu, Peter Frazier, Shane Henderson

We consider a one-dimensional bisection method for finding the zero of a monotonic function, where the function can be evaluated asynchronously in a parallel computing environment. Using dynamic programming, we characterize the Bayes-optimal policy for sequentially choosing points at which to query the function. Our results provide insight on how evaluation times, risk preferences, and computational budget affect the trade-off between search space reduction and a desirable query distribution.

3 - Optimal Sampling Laws for Multi-objective Simulation Optimization on Finite Sets
Susan Hunter, Assistant Professor, Purdue University, School of Industrial Engineering, West Lafayette, IN, 47907, United States of America, 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, including a solution for two objectives.

■ SC69

Parc- Fillmore

Land Use, Conservation and Sustainability

Sponsor: Energy Natural Resources and the Environment/ Sustainability and Environment

Sponsored Session

Chair: Hayri Onal, Professor, University of Illinois, United States of America, h-onal@illinois.edu

1 - Designing a Dynamic Reserve Problem under Stochastic Uncertainties
Nahid Jafari, University of Georgia, Athens, GA, United States of America, nahid.jafari@uga.edu, Clinton Moore

Conservation agencies tasked with reserve design need a dynamic decision system that provides guidance for short-term decision opportunities while focusing on a long-term objective of assembling the best set of protected areas possible. We outline an approach that provides optimal actions that account for stochastic behaviors in future funding levels, land prices, and lands lost to conservation use, given land protection status, constraints, and objectives related to ecological value and cost.

2 - Landscape Sustainability and Optimum Management of Military Training Areas
Hayri Onal, Professor, University of Illinois, United States of America, h-onal@illinois.edu, Scott tweddale, Philip Woodford, James Westervelt

Training-induced land degradation, especially formation of gullies, reduces the ability of training lands to support the scheduled training activity in military installations and poses serious risk for the personnel and training equipment. We present a dynamic optimization/simulation model which determines the optimal

timing, location and amount of land repairs for a given annual training schedule and budget constraints. Empirical results suggest that a preemptive repair schedule would be best.

3 - Optimal Harvest Schedules with Endogenous Road Maintenance Costs
Kai Ross, PhD. Student, University of Washington, Loew Hall 304, Seattle, WA, 98195, United States of America, mailkaiross@gmail.com, Weikko Jaross, Sandor Toth

Forest roads constitute the greatest financial and environmental cost to forestry. They degrade over time incurring extra costs and must be rebuilt to standard prior to timber haul. We propose an integer program that integrates road maintenance with harvest scheduling. The model captures both the road reconstruction costs that increase the longer a road is in disuse and the fixed cost savings that arise with the spatiotemporal coordination of harvests and road maintenance.

4 - An Optimisation Approach to Bushfire Fuel Management
Dmytro Matsypura, The University of Sydney, Sydney, Australia, dmytro.matsypura@sydney.edu.au, Oleg Prokopyev

Bushfires represent a real and continuing problem that has a major impact on people, wildlife and the environment. One way to reduce the severity of their effect is through fuel management. We propose a methodology to address the problem of optimal resource allocation for bushfire fuel management subject to landscape connectivity and stochastic fuel regeneration. In this work we draw inspiration from the literature on robust optimisation, network interdiction and critical element detection.

■ SC70

Parc- Hearst

Topics in Underground Mine Planning

Sponsor: Energy Natural Resources and the Environment/ Natural Resources

Sponsored Session

Chair: Alexandra M. Newman, Colorado School of Mines, 1500 Illinois St., Golden, CO, 80401, United States of America, anewman@mines.edu

1 - Moving Toward Holistic Mine Scheduling
Barry King, PhD Student, Colorado School of Mines, 1500 Illinois Street, Golden, CO, 80401, United States of America, barking@mymail.mines.edu

Currently, open pit and underground mine production schedules are generated separately and then melded together a posteriori in a suboptimal fashion. We present a unified open pit and underground schedule that provides a holistic view of the entire deposit. Our primary focus is creating a generic underground mine formulation that pairs well with the standard open pit formulation.

2 - using an Open Pit Production Scheduling Algorithm on an Underground Mine Scheduling Model
Andrea Brickey, PhD Candidate, Colorado School of Mines, 1500 Illinois Street, Golden, CO, 80401, United States of America, abrickey@mymail.mines.edu, Alexandra M. Newman

Open pit mine production scheduling has advanced since the 1960's, while its underground counterpart is still relegated primarily to manual scheduling methods. We present the application of an algorithm (Bienstock-Zuckerberg) that can be applied to precedence-constrained knapsack problems with the structure exhibited by open pit mine planning problems, to determine an underground production schedule with ventilation considerations, and compare the results with more traditional solution methods.

3 - Open Pit to Underground Transition Depth Determination through Production Scheduling Optimization
Kadri Dagdelen, Professor, Colorado School of Mines, Mining Engineering Department, 1600 Illinois Street, Golden, CO, 80401, United States of America, kdagdele@mines.edu, Ismail Traore

The transition depth from open pit to underground in a mining complex is a critical engineering problem with significant economic implications. This paper will present an iterative method based on mixed integer programing optimization of production scheduling of open pit and underground operations where net present value of production from combine operations are maximized at each iteration. The optimum depth is determined from a set of solutions corresponding the highest NPV.

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**4 - Underground Mine Access Design to Maximise the
        Net Present Value**
   Kashyapa Sirinanda, Graduate Student, University of Melbourne,
   Melbourne, Australia, kash.s@Student.unimelb.edu.au

We consider a modified Steiner tree problem in which the tree has construction
costs associated with edges and values associated with nodes. The objective is to
maximise the total discounted cash flows, or Net Present Value (NPV). An
application of this problem occurs in underground mining. We propose an efficient
iterative algorithm to optimally locate a single degree-3 Steiner point to maximise
the NPV. This algorithm converges and the Steiner point is unique for realistic
design parameters.

■ **SC71**

Parc - Lombard

Incentive Auctions

Cluster: Auctions
Invited Session

Chair: Robert Day, University of Connecticut, 2100 Hillside Road,
U-1041, Storrs, CT, United States of America,
Bob.Day@business.uconn.edu

1 - The Use of Optimization in the Spectrum Incentive Auctions
   Karla Hoffman, George Mason University, Fairfax, VA,
   United States of America, khoffman@gmu.edu, Rudy Sultana,
   Tony Coudert, Brian Smith

Optimization will be employed in a variety of ways in the upcoming FCC ncentive
auction. It will used to determine the clearing target (i.e. the amount of spectrum
to be acquired), to check whether a set of TV stations could be packed within a
specific band of spectrum, to determine the final channel assignment for those TV
broadcasters that remain on the air, and, possibly, to help set prices during the
auction. A brief overview of the optimization problems will be presented.

2 - Feasibility Checking for Spectrum Reallocation
   Kevin Leyton-Brown, Professor, University of British Columbia,
   2366 Main Mall, Vancouver, BC, V6T1Z4, Canada,
   kevinlb@cs.ubc.ca, Alexandre Frechette

The FCC's upcoming incentive auction gives rise to a computational problem
which is dubbed "feasibility checking": determining whether there exists a way of
reassigning a given subset of television stations to different frequencies so that they
can all broadcast in a reduced spectrum band without harmfully interfering with
each other. This talk will describe recent efforts towards addressing this problem,
and will emphasize both the methods used and the empirical performance
achieved.

3 - Deferred-Acceptance Auctions and Radio Spectrum Reallocation
   Paul Milgrom, Stanford University, 903 Cottrell Way, Stanford, CA,
   94305, United States of America, pmilgrom@gmail.com, Ilya Segal

Deferred-acceptance auctions choose allocations by an iterative process of rejecting
the least attractive bid. Any deferred acceptance auction with threshold pricing is
weakly group strategy-proof, can be implemented using a clock auction, and leads
to the same outcome as the complete-information Nash equilibrium of the
corresponding paid-as-bid auction. A paid-as-bid auction with a non-bossy bid-
selection rule is dominance solvable if and only if it is a deferred acceptance
auction.

■ **SC72**

Parc- Stockton

**Energy Storage for Grid Integration of
Renewable Energy**

Sponsor: Energy, Natural Resources & the
Environment/ Energy
Sponsored Session

Chair: Audun Botterud, Energy Systems Engineer, Argonne National
Laboratory, 9700 S. Cass Ave., Argonne, IL, United States of America,
abotterud@anl.gov

1 - Siting and Sizing of Distributed Battery Energy Storage
   Hrvoje Pandzic, University of Zagreb Faculty of Electrical
   Engineering and Computing, Unska 3, Zagreb, Croatia,
   hrvoje.pandzic@ieee.org, Daniel Kirschen

A three-stage method to identify the optimal locations and capacities of distributed
storage is proposed. In the first stage, the optimal storage locations are determined.
In the second stage, storage units are installed at these locations and their optimal
energy and power ratings are determined. In the final stage, the optimal operation
of the storage is simulated to quantify the benefits that it would provide by
reducing congestion.

2 - Grid Level Energy Storage for Integration of Renewable Energy
   Audun Botterud, Energy Systems Engineer, Argonne National
   Laboratory, 9700 S. Cass Ave., Argonne, IL, United States of
   America, abotterud@anl.gov, Prakash Thimmapuram,
   Emil Constantinescu, John Birge, Canan Uckun, Kevin Gallagher

We present initial results from a project where we are developing an analytical
framework to evaluate the potential benefits of energy storage for grid integration
of renewable energy. Numerical weather predictions are used to characterize the
spatio-temporal characteristics of wind and solar resources. We formulate and solve
operational decision problems for the grid system operator as well as for an energy
storage owner, considering different storage technology solutions.

**3 - Strategies for Mitigating the Reduction in Economic Value of
        Variable Generation at High Penetration**
   Andrew Mills, Staff Research Associate, Lawrence Berkeley
   National Laboratory, 1 Cyclotron Rd, MS90-R4000, Berkeley, CA,
   94720, United States of America, admills@lbl.gov, Ryan Wiser

Previously, we quantified a decline in the marginal economic value of wind and PV
with increasing penetration levels. We use the same model and data to evaluate
options to stem the decline in value of these technologies. The largest increase in
the value of wind comes from increased geographic diversity. The largest increase
in the value of PV comes from assuming that low-cost bulk power storage is an
investment option. Other attractive options include real-time pricing and
technology diversity.

**4 - Modeling Energy Storage as an Enabler of Ultra-low Carbon Power
        Systems**
   Jesse Jenkins, PhD Student, Engineering Systems Division /
   Research Assistant, MIT Energy Initiative, Massachusetts Institute of
   Technology, 77 Massachusetts Avenue, Room E40-369, Cambridge,
   MA, 02139-4307, United States of America, jessedj@mit.edu,
   Fernando de Sisternes

Reaching an ultra-low carbon electricity system will rely on an emissions free
source of flexibility for power systems operations. Absent such a source,
operational and economic constraints will limit the penetration of renewable
electricity, nuclear power, or a combination thereof. We use a capacity expansion
model with unit commitment constraints to explore the impact of storage on the
optimal mix of low-carbon electricity sources in renewable, nuclear, or hybrid
renewable-nuclear systems.

■ **SC73**

Parc- Mission I

Policy Analysis and Planning in Energy Sector

Sponsor: Energy, Natural Res & the Environment/Energy
Sponsored Session

Chair: Yihsu Chen, UC Merced, 5200 North Lake Road, Merced, CA,
United States of America, ychen26@ucmerced.edu

**1 - Cooperation in Regional Electricity Market Based on Tradable
        Green Certificate Offering**
   Yingjue Zhou, Oklahoma State University, Stillwater, OK,
   United States of America, yingjue.zhou@okstate.edu, Tieming Liu

We study the cooperation between green/black suppliers in regional electricity
markets. The green supplier has random power shortage. To attract the black
supplier to build response capacity and cover the shortage, the green supplier offers
tradable green certificate to the black supplier. We find the cooperation model
reaches the global optimum capacity. In a decentralized model without
cooperation, the capacity investment is less than the global optimum.

**2 - Selection of Climate Policies under Current Knowledge
        of Uncertainties**
   Massimo Tavoni, Fondazione Eni Enrico Mattei (FEEM), Corso
   Magenta 63, Milan, Lo, 20123, Italy, massimo.tavoni@feem.it,
   Valentina Bosetti, Laurent Drouet

In the present paper we use the best available knowledge to model the key risks
and uncertainties affecting the cost of mitigating greenhouse gases emissions, the
future change of climate and its economic impact on societies. We derive robust
climate policies, in terms of carbon budgets, consistent with different preferences
for dealing with these risks and uncertainties. Results indicate that different
preferences can lead to significantly different carbon budgets.

**3 - Multi-sector Model of Inter-temporal Permit Banking under
        Imperfect Competition**
   Makoto Tanaka, GRIPS, 7 Chome-22-1 Roppongi, Tokyo, Japan,
   mtanaka@grips.ac.jp, Yihsu Chen

This paper develops a multi-sector model of inter-temporal permit banking under
imperfect competition. The permit price rises at a higher rate than the discount
rate. Under a declining emissions cap system, the dominant firm has an incentive
to suppress the permit prices when buying the permits in early periods, and then
inflate the permit prices when selling them in later periods. Numerical results of
the California case are broadly consistent with the analytical conclusion.

4 - Pollution Regulation and Market Structure

Francois Giraud-Carrier, Assistant Professor, University of Illinois Springfield, College of Business and Management, One University Plaza, UHB MS 4021, Springfield, IL, 62703, United States of America, fgira2@uis.edu, Krishnan Anand

We develop an integrated pollution-production model to study the interactions between strategic firms operating under pollution regulations and the regulator when markets are imperfect. Our model incorporates the firms' emissions, abatement technologies, the damage from pollution, and three popular regulatory mechanisms—Cap, Cap-and-Trade, and Tax. We analyze the effect of these mechanisms on firms, consumers and society, and derive important implications for the regulator.

■ SC74

Parc- Mission II

Strategic and Complementarity Models in Energy Markets

Sponsor: Energy, Natural Res & the Environment/Energy

Sponsored Session

Chair: Jalal Kazempour, Postdoctoral fellow, Johns Hopkins University, 3400 N Charles St. Mechanical Eng. Dep., Latrobe 223, Baltimore, MD, 21218, United States of America, skazemp1@jhu.edu

1 - Strategic Forward Trading and Technology

Heikki Peura, London Business School, Regent's Park, London, United Kingdom, hpeura@london.edu, Derek Bunn

Forward trading in electricity markets is usually driven by hedging motives, but may also result from strategic considerations. In increasingly technologically diverse markets, the flexibility and reliability of production technologies may influence not only spot prices but also the nature of forward trading. We develop a theoretical model to study the impact of these factors and their interactions on spot and forward market equilibria, with implications on both firm strategy and market design.

2 - The Value of Demand Response in Day-ahead and Real-time Markets: A Stochastic Equilibrium Model

Venkat Prava, PhD Student, Johns Hopkins University, 108 W 39TH ST APT 10, BALTIMORE, MD, 21210, United States of America, vprava1@jhu.edu, Ben Hobbs, Jalal Kazempour

We analyze the value of demand-side operational flexibility in a two-settlement wind-integrated electricity market (including day-ahead and real-time). To this end, a stochastic equilibrium model is characterized through a simultaneous clearing of day-ahead and real-time markets. Wind power uncertainty in each market is represented by a separate set of scenarios. The upward and downward demand responses are considered in both markets.

3 - Imperfect Demand-side Response to Wind Power Integration: A Complementarity Model

Ali Daraeepour, Duke University, A327 LSRC, Box 90328, Durham, NC, 27708, United States of America, a.daraeepour@duke.edu, Jalal Kazempour, Antonio J. Conejo, Dalia Patino-Echeverri

Demand-side behavior (strategic or competitive) affects clearing of wind-integrated electricity markets. We investigate this impact using a bilevel optimization model (as a complementarity approach) whose upper-level represents the expected utility maximization problem of a strategic consumer under wind-power production uncertainty and whose lower-level represents the clearing of day-ahead and real-time markets. We also explore the effects of wind power penetration and volatility levels.

4 - Modelling Strategic Interaction between Russia and Ukraine in Natural Gas Trade: Application of MPEC

Chi Kong Chyong, University of Cambridge, k.chyong@jbs.cam.ac.uk, Ben Hobbs

We formulate a mathematical problem with equilibrium constraints where Russia acts as a leader in both strategically investing in transportation capacity to ensure security of supply as well as supplying gas to Ukraine. Ukraine in turn is a follower and decides on investment in its transit capacity to serve Russian gas transit to Europe as well as investing in alternative routes to diversify away from Russian gas imports. We test the model with N-1 scenarios for Ukraine's major transit routes.

■ SC75

Parc- Mission III

Efficient Learning in Stochastic Optimization

Sponsor: Simulation

Sponsored Session

Chair: Ilya Ryzhov, Assistant Professor, University of Maryland, Robert H. Smith School of Business, College Park, MD, 20742, United States of America, iryzhov@rhsmith.umd.edu

1 - Forgetful Bayes and Myopic Planning: Human Learning and Decision Making in a Bandit Setting

Shunan Zhang, University of California San Diego, s6zhang@mail.ucsd.edu, Angela Yu

We study how humans negotiate the tension between exploration and exploitation in a multi-armed bandit task. By comparing human behavior to a variety of models that vary in their representational and computational complexity, we found that subjects' choices are best captured by a "forgetful" Bayesian iterative learning model in combination with a partially myopic decision policy known as Knowledge Gradient, outperforming the optimal Bayesian learning and risk minimization and other heuristics.

2 - An Inverse Reinforcement Learning Model of Human Behavior in Social Media

Sanmay Das, Associate Professor, Washington University in St. Louis, sanmay@seas.wustl.edu, Allen Lavoie

How do humans change their behavior in response to feedback in social media? We introduce a model for how humans learn in response to different types of feedback, and validate our model on data from the social news website Reddit. Our model combines the behavioral reinforcement learning model of Erev and Roth with a Hierarchical Dirichlet Process model of preferences, and significantly outperforms all known baselines in predicting users' future behavior.

3 - Hierarchical Bandits with Infinitely Many Arms: Properties and Heuristics

Alessandro Arlotto, Duke University, 100 Fuqua Drive, Durham, NC, 27708, United States of America, alessandro.arlotto@duke.edu, Noah Gans, Stephen E. Chick

We study hierarchical bandit models with a finite number of subpopulations and infinitely many arms in each subpopulation. The statistics of each subpopulation are unknown, and they are modeled as independent draws from some known hyperprior distribution. The statistics of each arm are also unknown, and modeled as independent draws from the subpopulation distribution to which the arm belongs. In this talk, we discuss properties of this model and propose sampling schemes that perform well.

4 - The Local Time Method for Targeting and Selection

Ilya Ryzhov, Assistant Professor, University of Maryland, Robert H. Smith School of Business, College Park, MD, 20742, United States of America, iryzhov@rhsmith.umd.edu

We present the new targeting and selection (T&S) model, in which the goal is to find a simulation design that is maximally similar to a pre-specified target, a problem with applications in simulation validation and the design of competitive events. We also present a novel method for this problem based on the expected local time of a Brownian approximation. The method exhibits interesting parallels to value of information procedures for ranking and selection, but performs better in T&S.

■ SC76

Parc- Embarcadero

Community Service OR: Learn By Doing

Sponsor: The Practice Track

Sponsored Session

Chair: Tali Freed, Professor, Cal Poly State University, Industrial and Manufacturing Engineering, 1 Grand Avenue, San Luis Obispo, Ca, 93407, United States of America, tfreed@calpoly.edu

1 - Community Waste Management Optimization

Colyn Dickson, Student, Cal Poly State University, Industrial and Manufacturing Engineering, 1 Grand Avenue, San Luis Obispo, Ca, 93407, United States of America, cmdickso@calpoly.edu, Tali Freed

A cost minimization model for residential and commercial waste removal is presented. The model considers dumpster capacity constraints as well as pooling capacity of adjacent sub-communities. A case study of a university's waste management is discussed in detail.

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2 - E-Waste Recycling Optimization
    Roopak Mitra, United States of America, Mitra rmitra@calpoly.edu,
    Liang Li, Andrea Schmidt, Tali Freed

We propose a model for regional optimization of e-waste recycling. The existing drop off system utilized in many communities is modified to include optimization of pickup locations and vehicle scheduling. The goals include higher recycling rates of various types of e-waste, and minimal costs to the region and its residents.

3 - Integer Programming Formulation for Course Timetabling using Partially Aggregated Student Data
    Jesse Bukenberger, jbukenbe@gmail.com, Tali Freed

We propose an integer programming formulation for the course timetabling problem that maximizes student enrollment in their desired courses. The formulation takes partially aggregated student data and quickly generates an optimal timetable; specific student enrollments are then generated from the timetable. The method is tested with local schools.

4 - Small-scale Dynamic Job Shop Scheduling
    Heidi Richardson, California Polytechnic State University,
    San Luis Obispo, CA, United States of America,
    herichar@calpoly.edu, Lauryl Nakagawa,
    Tali Freed

This paper presents a heuristic scheduling algorithm created for dynamic work environments with multiple types of inputs and resources to address scheduling conflicts and tardiness. Better resource utilization is shown to increase throughput and customer satisfaction.

5 - Optimal Search Pattern for Difficult to Find Targets
    Blake Currie, California Polytechnic State University,
    San Luis Obispo, CA, United States of Americabcurrie@calpoly.edu,
    Jessica Burke, Tali Freed

This paper focuses on optimization of search patterns based on the orienteering problem with resource dependent rewards. Target location probabilities are based on environmental conditions and last known location. Variable search times are allowed with upper limit on total time. Node probabilities decay exponentially as the area is searched.

■ SC77

Parc- Market Street

Joint Session Analytics/HAS: Topics of Healthcare Analytics I

Sponsor: Analytics & Healthcare
Sponsored Session

Chair: Issac Shams, University of Michigan-Ann Arbor,
1205 Beal Ave, Ann Arbor, MI, 48109, United States of America,
issacsh@umich.edu

1 - Phenotyping from Electronic Health Records using Tensor Factorization
    Jimeng Sun, Associate Professor, School of Computational Science
    and Engineering, Georgia Tech, 266 Ferst Drive, Atlanta, GE,
    30363, United States of America, jsun@cc.gatech.edu,
    Joydeep Ghosh, Joyce C. Ho

Limestone, a nonnegative tensor factorization method to derive phenotype candidates with no human supervision. We demonstrate the capability of Limestone on a cohort of 31k patient records. Our results show that using only 40 phenotypes, we can outperform the original 640 features to achieve AUC of 0.720. Moreover, in consultation with a medical expert, we confirmed 82% of the top 50 candidates are clinically meaningful.

2 - Does Healthcare Insurance Matter? Establishing Insurance Status as a Risk Factor for Trauma Mortality
    Bruce Golden, Professor, University of Maryland - Robert H. Smith
    School of Business, University of Maryland - Robert H. Smith,
    College Park, MD, 20742, United States of America,
    BGolden@rhsmith.umd.edu, Hector Corrada Bravo,
    Shawn Mankad, Hisham Talukder

The identification of risk factors that affect the outcome of trauma patients has critical healthcare policy implications. We investigate the National Trauma Database, a collection of outcome records from over 100 trauma centers in the United States, to find that insurance status has a significant impact on survival outcomes when controlling for confounding variables. We utilize logistic regression and visualization techniques to identify potential explanations for these findings.

3 - Cost-effectiveness of HIT-facilitated Adoption of Collaborative Depression Care for Diabetes Patient
    Shinyi Wu, Associate Professor, University of Southern California,
    1150 S. Olive Avenue, Suite 1400, Los Angeles, CA, 90015,
    United States of America, shinyiwu@usc.edu, Haomiao Jin

Collaborative depression care is an evidence-based care model but providers find it difficult to implement among low-income minority diabetic patients. To support its adoption, an automated telephone assessment tethered with an enhanced disease management registry to task provider team was developed and tested in a three-group quasi-experimental trial with 1406 patients for 18 months. This study presents the propensity score adjusted regression results for cost-effectiveness of the intervention.

■ SC78

Parc- Mason

Panel Discussion: Promoting INFORMS International Activities

Sponsor: Analytics
Sponsored Session

Chair: Grace Lin, VP & Director General, Advanced Research Institute, Institute for Information Industry, Taipei, Taiwan, gracelin.ny@gmail.com

1 - Promoting INFORMS International Activities
    Moderator: Grace Lin, VP & Director General, Advanced Research
    Institute, Institute for Information Industry, Taipei, Taiwan,
    gracelin.ny@gmail.com

Panel Members INFORMS International Activities Committee (IAC)Panelists: Professor Tamar Abdelmaguid from Egypt, Professor Fugee Tsung from Hong Kong, Professor Michel Gendreau, Represtative, IFORS, Professor Leonardo Santiago from Brazil, Professor Roman Slowinski from Poland, and Professor Jian Chen from China. In this session, Members of INFORMS International Activities are invited to share their views about ORMS including emerging trends and opportunities in their respective regions. Q&A will then be conducted to discuss potential INFORMS International activities such as meetings, certification, continuing education, and promoting emerging areas such as Big Data Analytics and Global ORMS.

■ SC79

Parc- Powell I

Joint Session DAS/SPPSN: Societal Applications of Decision Analysis

Sponsor: Decision Analysis & Public Programs, Service and Needs
Sponsored Session

Chair: Warner North, President and Principal Scientist,
NorthWorks, Inc., 1715 Taylor Street, San Francisco, CA, 94133,
United States of America, northworks@mindspring.com

1 - Informing Decisions in a Democratic Society
    Warner North, President and Principal Scientist, NorthWorks, Inc.,
    1715 Taylor Street, San Francisco, CA, 94133, United States of
    America, northworks@mindspring.com

My nearly 50 years of career experience, including many projects for U.S. and other government agencies plus participation in numerous reports of the National Research Council, endorse normative decision analysis fused with deliberative dialogue as a process that provides insight on critical information and value assessments in support of decision making. While decision analysis methodology fits the need, leadership and dialogue process improvements may enable more success in application.

2 - Improving Public Policy Decisions in California
    Stephen Barrager, Publisher, Baker Street Publishing,
    San Francisco, CA, 94123, United States of America,
    steve@bakerstreetpublishing.com

California policy makers and implementors face three challenges: (1) moving large groups of people toward mutual learning; (2) Integrating the inputs of stakeholders, scientists, and experts; and (3) Overcoming the shortcomings of bureaucracies. This presentations reviews some of the key reasons for the success of the California Marine Life Protection Act Initiative. The charge of this initiative was to design a network of marine protected areas the length of California.

3 - EPA's Uses of Risk Assessment in Setting Ambient Air Quality Standards

Anne Smith, Senior Vice President, NERA Economic Consulting, 1255 23rd St NW, Ste 600, Washington, DC, 20008, United States of America, Anne.Smith@NERA.com

US air quality standards must be set at levels USEPA determines are protective of public health with a margin of safety. USEPA must make this judgment in face of uncertainties about critical relevant considerations such as levels for effects thresholds, often even lacking knowledge of physiological mechanisms that might cause health effects of concern. USEPA's risk analysis methods are described, and areas where principles of decision analysis could be more effectively applied are identified.

4 - DA and Analytics-Based Policy Program Design Enabling Balanced Growth and Job Creation for Nationals

Mazen Skaf, Managing Director, Strategic Decisions Group, 745 Emerson St, Palo Alto, CA, 94301, United States of America, mskaf@sdg.com

We present a DA-based approach to designing an active labor market policy program. Since its launch in May 2011, the program has spurred a significant increase in the rate of job creation for nationals in an economy that had a historical over-reliance on foreign labor. As of January 2014, within 32 months following the launch, more than 700,000 net new jobs for nationals have been created.

■ SC80

Parc- Powell II

Ensembles and Big Data

Sponsor: Decision Analysis
Sponsored Session

Chair: Yael Grushka-Cockayne, Darden School of Business, 100 Darden Blvd, Charlottesville, United States of America, GrushkaY@darden.virginia.edu

1 - Induced Dependence Coefficient for Heavy-tailed Distributions in DM

Jose Luis Guerrero-Cusumano, Associate Professor, Georgetown University, 435 Hariri Builing, Business School, 37 and O street, NW, Washington, DC, 20016, United States of America, guerrerj@georgetown.edu

The detection of changes in the dependence structure of a multivariate process is essential in Data Mining given the large number of variables and its interactions. The multivariate mutual information T(X) and induced dependence coefficient are used as tools for supervised and unsupervised learning in Data Mining to summarize changes in the dependence of the multivariate process under the multivariate t family (Cauchy) distribution. Detection mechanisms in the dependence structure are developed

2 - An Ensemble of Ensembles

Alan Briggs, Elder Research Inc., VA, United States of America alan.briggs@datamininglab.com

Data scientists are always looking for new problems to solve, going directly to the data in pursuit of knowledge and insight that hasn't always been available. Experience suggests that just as ensemble methods have increased performance of certain machine learning applications by blending multiple advanced analytic methodologies into a single approach, ensembling popular data science techniques with conventional metrics and heuristics can provide practical solutions to many difficult problems.

3 - Ensembling Overfit and Overconfident Forecasts

Yael Grushka-Cockayne, Darden School of Business, 100 Darden Blvd, Charlottesville, United States of America, GrushkaY@darden.virginia.edu, Casey Lichtendahl, Victor Richmond Jose

We study the effect of combining forecasts that are overfit to sample data. We introduce a model that relates base-rate neglect and overconfidence. We present theory that suggests a trimmed opinion pool will be effective in combining forecasts that are both overfit and overconfident. Using a popular machine learning algorithm that ensembles a large number of overfit regression models, we test this hypothesis empirically on several public data sets.

4 - Ensemble Methods in DoD Decision Analyses: Improving Accuracy through Combining Utility Models

Aaron Burciaga, Senior Manager, North America Inventory Analytics Lead, Accenture, 4305 Majestic Lane, Fairfax, VA, 22033, United States of America, adburciaga@gmail.com

No single method for developing Decision is perfect, however each can be useful, and even powerful when considered in aggregate. Ensemble methods in Decision Analysis provide aggregate strength, detail, and confidence in prescribed actions. We present how ensemble methods have been used to support strategic DoD initiatives, through a combination of State Trees, Decision Trees, Influence Diagrams, Dynamic Bayesian Networks, and the Analytic Hierarchy Process.

■ SC82

Parc- Haight

Business Location Analysis with MCDM

Sponsor: Multiple Criteria Decision Making
Sponsored Session

Chair: Luiz Flavio Autran M. Gomes, Professor, Ibmec, Rua Professor Manuel Ferreira, 115,, Apt. 201, Gavea, Rio de Janeiro, RJ, 22451030, Brazil, autran@ibmecrj.br

1 - Retail Location Analysis: A Comparison between TODIM-FSE and the Choquet Integral

Luiz Flavio Autran M. Gomes, Professor, Ibmec, Rua Professor Manuel Ferreira, 115,, Apt. 201, Gavea, Rio de Janeiro, RJ, 22451030, Brazil, autran@ibmecrj.br, Maria Augusta S Machado, Renato Monte Araujo

This paper approaches the problem of locating a new store for a major retailer in the City of Rio de Janeiro, Brazil. A number of factors are considered by the company's decision makers and some of them are clearly interrelated. Therefore the problem has a multicriteria nature. It is solved by the TODIM-FSE method as well as by using the unipolar Choquet Integral. The two results are next compared and suggestions are provided for future studies.

2 - An Approximation Algorithm for the Bi-criteria p-median/p-dispersion Problem

Golbarg K. Tutunchi, PhD stdudent, North Carolina State University, 400 Daniels Hall College of Engineering, Industrial and Systems Engineering, Raleigh, NC, 27695-7906, United States of America, gkazemi@ncsu.edu, Yahya Fathi

We consider the p-median and the p-dispersion problems in the context of a bi-criteria location analysis. We discuss a mathematical programming approach to obtain a non-dominated solution with respect to these two objectives, and an e-approximation algorithm to obtain the corresponding efficient front. Through a computational experiment we demonstrate the effectiveness of this approach for relatively large instances of the problem.

■ SC83

Parc- Sutro

INFORMS Data Mining Best Student Paper Award

Sponsor: Data Mining
Sponsored Session

Chair: Onur Seref, Assistant Professor, Virginia Tech, Pamplin 1007, Blacksburg, VA, 24061, United States of America, seref@vt.edu

1 - Saddle Points and Accelerated Perceptron Algorithms

Adams Wei Yu, Graduate Student, Carnegie Mellon University, GHC 5508, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States of America, weiyu@cs.cmu.edu

We consider the problem of finding a linear classifier or providing a near-infeasibility certificate if there is none. We bring a new perspective to addressing these two problems simultaneously in a single efficient process, by investigating a related Bilinear Saddle Point Problem(BSPP). We show that such a approach provides either a linear classifier or an ϵ-infeasibility certificate and that Mirror Prox can be used to achieve the best known convergence rate.

2 - Career Development Paths in Online Labor Markets

Marios Kokkodis, PhD Student, New York University, Room 8-180,, 44 W 4th New York, New York, NY, 10012, United States of America, mkokkodi@stern.nyu.edu

The workers' value in an online labor market resides in a combination of both observable (e.g., list of skills) and latent characteristics (e.g., true expertise on these skills). In this work, I propose a framework that (1) estimates the level of expertise of a given worker for a given skill (2) quantifies the value of each skill given the worker's level of expertise and (3) recommends additional skills based on the current skill set of the worker.

3 - Image Defect Detection with Smooth-Sparse Decomposition

Hao Yan, PhD Student, Georgia Institute of Technology, 755 Ferst Dr, NW, Atlanta, GA, 30332, United States of America, yanhao@gatech.edu, Jianjun Shi, Kamran Paynabar

Defect detection in noisy images is important in modern manufacturing system. Most of the existing approaches perform denosing and detection separately, which affects detection accuracy. In this paper, we develop a novel one-step methodology through a regularized least square optimization model together with a fast algorithm implementation for defect detection in noisy images under a smooth background. The accuracy and computational speed is evaluated using simulation study and case study.

4 - Finding Short Peptide Substrates using Bayesian Active Learning
Jialei Wang, PhD Student, Cornell University, Frank HT Rhodes
Hall, 292, Ithaca, NY, 14853, United States of America,
jw865@cornell.edu, Pu Yang, Peter Frazier, Nathan Gianneschi,
Michael Burkart, Michael Gilson, Lorillee Tallorin, Nicholas Kosa

We consider a Bayesian active learning problem arising in biochemistry, in which
we wish to find peptides with properties that support a number of innovations in
medicine, biochemistry, and materials science. Such peptides are difficult to find,
and expensive to experimentally verify. We present a machine learning method for
choosing which peptides to test to find such peptides as quickly as possible. We
prove theoretical bounds on its solution quality and demonstrate performance in
simulation.

Sunday, 4:30pm - 6:00pm

■ SD01

Hilton- Golden Gate 6

Mathematical Modeling and Operations Research in Military Decision Making I

Sponsor: Military Applications Society
Sponsored Session

Chair: William Fox, Professor, Naval Postgraduate School,
Department of Defense Analysis, Monterey, CA, 93943,
United States of America, wpfox@nps.edu

1 - Mathematical Modeling of Terrorists for Decision Making
William Fox, Professor, Naval Postgraduate School, Department of
Defense Analysis, Monterey, CA, 93943, United States of America,
wpfox@nps.edu, Tiffany Crosby

We present two models of terrorists. Model 1 is an OML human targeting model
than ranks terrorists based upon criteria. We provide some insights and sensitivity
analysis. Model 2 describes an attempt to use a software package, CrimeStat, to
predict terrorist event activity.

2 - Using Operational Patterns to Influence Attacker Decisions on a Transportation Network
Daniel Stimpson, Operations Research / Systems Analyst, Joint
Improvised Explosive Device Defeat Organization, 115 Hunton
Drive, Fredericksburg, VA, 22405, United States of America,
stimpsonde@yahoo.com, Rajesh Ganesan

We introduce a Reinforcement Learning (RL) model for determining convoy and
route clearance schedules to minimize attack costs on a network subject to IED
ambushes. We assume dependence between attack probabilities and observed
traffic patterns. RL algorithms offer opportunities for meaningful improvements by
optimizing individual movements across the planning horizon, accounting for
downstream interaction. Our approach is grounded in Boyd's observe, orient,
decide, and act (OODA) loop.

3 - Using a Simulation Model to Test Policies for Managing a Fleet of Naval Combat Helicopters
David Marlow, Defence Science and Technology Organisation, Joint
and Operations Analysis Division, Australia, domarlow@nps.edu

We present a discrete-event simulation model of a fleet of naval combat
helicopters. The model represents helicopters moving between being embarked on
ships to ashore and between various types of scheduled and unscheduled
maintenance over their life. The fleet must always provide eight embarked aircraft
and meet annual embarked and ashore flying hour requirements. Here we test the
impact of various policies for managing multiple squadrons on the ability to meet
these requirements.

■ SD02

Hilton- Golden Gate 7

Entrepreneurial Innovation Process (Discussant Session)

Sponsor: Technology, Innovation Management and Entrepreneurship
Sponsored Session

Chair: Sinan Erzurumlu, Associate Professor, Babson College,
231 Forest St, Babson Park, MA, 02457, United States of America,
serzurumlu@babson.edu

1 - Returns to Bargaining Power in the Market Process
Moren Levesque, Professor, York University, 4700 Keele Street,
Toronto, ON, M3J1P3, Canada, MLevesque@schulich.yorku.ca,
Mohammad Keyhani

This study investigates the role of bargaining power in the market process as
described by the Kirznerian school of Austrian market process theory. We study
market dynamics using computer simulations of coalition formation in a
cooperative game in which players form new coalitions by discovering the
opportunities afforded by the characteristic function. Counter-intuitively, we find
that when all players have entrepreneurial discovery capability, the returns to
bargaining power are not monotonic.

2 - Sequential Innovation by Start-ups: Balancing Survival and Profitability
Sinan Erzurumlu, Associate Professor, Babson College,
231 Forest St, Babson Park, MA, 02457, United States of America,
serzurumlu@babson.edu, Karthik Ramachandran,
Sreekumar Bhaskaran

Start-up firms typically consider launching an immediately available first version of
a product to generate funds for developing more advanced products. However, this
release could have an adverse effect on the perception of the firm's future
products. We characterize an optimal policy with cash thresholds to determine
when the firm should launch the first version and whether it should continue
development.

3 - What is Your Return on Time Invested?
Onesun Steve Yoo, Assistant Professor, University College London,
Gower Street, London, United Kingdom, o.yoo@ucl.ac.uk,
Charles Corbett, Guillaume Roels

For entrepreneurs, how they invest their time and money has immediate
consequences as they are often the key resource of their business. We discuss
frameworks for (i) discounting time and money and (ii) exchanging time and
money, and introduce a two-by-two NPV-type framework linking current and
future money and time. We use it to show that high-growth entrepreneurs should
discount time less than money.

■ SD03

Hilton- Golden Gate 7

Innovating in the Mobile World using Analytics

Cluster: Business Model Innovation
Invited Session

Chair: Marcel Goic, Assistant Professor of Marketing, University of
Chile, Republica 701, Santiago, Chile, magoic@gmail.com

1 - Analyzing Mobile Application Usage and Ad Response for Optimal Targeting
Liye Ma, Assistant Professor, University of Maryland, 3323 Van
Munching Hall, University of Maryland, College Park, MD, 20742,
United States of America, liyema@rhsmith.umd.edu, Baohong Sun

Research shows that 64% of mobile phone time is spent on applications, and
mobile advertising is expected to quadruple in five years. We study three questions
regarding these two activities: 1) how does mobile application usage vary across
people and time? 2) how are mobile ad responses driven by time and context? 3)
how should firms target mobile ads? We develop an integrated model of mobile
application usage and ad response, and develop optimal targeting strategy by
solving a DP problem.

2 - Firm Value of Product Innovation in the Service Ecosystem
Hyunwoo Park, Georgia Institute of Technology,
85 5th St NW, Atlanta, GA, 30308, United States of America,
hwpark@gatech.edu, Rahul Basole

We examine the asymmetric impact of product innovation on the market value of
manufacturers (e.g. device manufacturers) and service providers (e.g. mobile
network operators) in the mobile service ecosystem. Our analysis is based on a
comprehensive dataset comprising over 1,500 smartphones and considers the
influence of product characteristics, the frequency and timing of product
innovation, and the network structure of the service ecosystem. Theoretical and
managerial implications are discussed.

3 - Real-time Decisions to Serve the Unbanked Poor in the Developing World: Examples from Mexico & India
Devendra Potnis, Assistant Professor, University of Tennessee at
Knoxville, School of Information Sciences, Communications Bldg.,
Suite 451, Knoxville, TN, 37996, United States of America,
dpotnis@utk.edu, Lakshmi Mohan

Formal financial service providers like banks and microfinance institutions deploy
field agents with mobile devices for serving the 2.5 billion "unbanked" poor at
their door step. We present the applications of Banco Azteca in Mexico and Equitas
Microfinance in India for making real-time decisions using data sent by field agents
on their mobile devices. The business value of these applications is lower financial
risk and improved operational efficiency.

4 - Empirical Analysis of the Effectiveness of Mobile Channels
Marcel Goic, Assistant Professor of Marketing, University of Chile, Republica 701, Santiago, Chile, magoic@gmail.com, Jose Guajardo

The continuously growing use of mobile devices provides the opportunity to use this new channel to complement the value proposition that companies offer to their customer. However, the nature of costumer responses to these initiatives remains largely unexplored. We empirically investigate the drivers of effectiveness in managing a mobile transactional channel and how to use location-based information to interact with consumers.

■ SD04

Hilton- Continental 1

Empirical Research in Operations Management

Sponsor: Manufacturing & Service Operations Management
Sponsored Session

Chair: Suresh Muthulingam, Assistant Professor, Cornell University, 401P Sage Hall, Ithaca, NY, 14853, United States of America, sm875@cornell.edu

1 - The Effects of National Culture on the Leakage of Proprietary Digital Assets
Brett Massimino, Cornell University, School of Hotel Administration, Ithaca, NY, 14850, United States of America, massimino.3@fisher.osu.edu, John Gray

In this study, we relate the cultural characteristics of parties in a product development chain to the propensity that the product under development will be leaked to unauthorized distribution channels. In our empirical analysis, we utilize longitudinal data covering the development of video game products from the years 2000 through 2010, as well as data detailing the illegal distribution activities of a major black-market distribution channel.

2 - Spillover of Quality Knowledge at Suppliers: an Empirical Investigation
Suresh Muthulingam, Assistant Professor, Cornell University, 401P Sage Hall, Ithaca, NY, 14853, United States of America, sm875@cornell.edu, Anupam Agrawal

We investigate whether quality knowledge developed by a buyer at its suppliers spills over and benefits other firms. We find that quality knowledge spills over: (i) At suppliers with low levels of operational complexity, (ii) When it is not embedded in technology, and (iii) When it is related to the output activities of a supplier. Further, the spilled-over quality knowledge depreciates faster than knowledge developed by undertaking quality improvement initiatives directly with suppliers.

3 - Critical and Complex Technological Capability Development: Longitudinal Study of a Surgical Robot
Kingshuk Sinha, Professor, Mosaic Company Professor of Corporate Responsibility, Carlson School of Management, University of Minnesota, Minneapolis, MN, United States of America, ksinha@umn.edu, Shoubhik Sinha, Scott Bosch, Ujjal Mukherjee

We report the results of a longitudinal field study on the adoption and usage of a surgical robot. Specifically, we investigate doctors' learning, surgical team's learning and the impact of doctors' specialization and experience (general and specific) on capability development. The impact of doctor and team learning on the usage of the surgical robot is also analyzed. The empirical setting of the study is a large multi-specialty hospital.

■ SD05

Hilton- Continental 2

Supplier Responsibility Management

Sponsor: Manufacturing & Service Operations Management
Sponsored Session

Chair: Li Chen, Associate Professor, Duke University, 100 Fuqua Drive, Durham, NC, 27708, United States of America, li.chen@duke.edu

1 - Designing Supply Networks for Relational Sourcing
Elena Belavina, Assistant Professor, University of Chicago Booth School of Business, 5807 S Woodlawn Ave, Chicago, United States of America, belavina@uchicago.edu, Karan Girotra

Socially responsible sourcing has become a necessity for many global firms and a competitive advantage for others. Sourcing strategies based on social responsibility now increasingly employ long-term commitments (relational sourcing). This study examines the role that supply network configuration plays in the efficacy of relational sourcing in ensuring socially responsible behavior across the supply network (compliance).

2 - Time to Come Clean? Disclosure and Inspection Policies under Random Environmental Violations
Sang Kim, Yale School of Management, 165 Whitney Ave, New Haven, CT, 06511, United States of America, sang.kim@yale.edu

We examine the interplay between a regulator's inspections and a firm's noncompliance disclosure in the setting where environmental violations occur randomly, by developing a model that combines reliability theory and law enforcement economics. Our analysis shows that a threat of increased penalty does not always lessen the need for costly inspections. We also find that there are situations where pre-announced periodic inspections are preferred to unannounced random inspections.

3 - Supplier Evasion of a Buyer's Audit: Implications for Motivating Compliance with Labor and Environment
Terry Taylor, Associate Professor, U.C. Berkeley, Haas School of Business, 2220 Piedmont Ave., Berkeley, CA, 94720, United States of America, taylor@haas.berkeley.edu, Erica Plambeck

Many brands have recently been tarnished by publicity of suppliers' labor and environmental violations, and have responded by increasing their auditing efforts. Suppliers seek to pass audits not only through efforts to comply with standards, but also through efforts to deceive auditors. We characterize when auditing backfires by increasing deception effort and reducing a supplier's effort to comply with labor and environmental standards.

4 - Mitigate Supplier Responsibility Risk in Emerging Economies: An Ethical Sourcing Framework
Li Chen, Associate Professor, Duke University, 100 Fuqua Drive, Durham, NC, 27708, United States of America, li.chen@duke.edu, Hau Lee

Sourcing from emerging economies may yield direct cost savings, but this practice often entails greater supplier responsibility risk. In this paper, we discuss the effectiveness of various contracting and certification mechanisms that aim to mitigate such risk.

■ SD06

Hilton- Continental 3

Strategic Supply Risk Management

Sponsor: Manufacturing & Service Operations Management
Sponsored Session

Chair: Yimin Wang, Arizona State University, Department of Supply Chain Management, Tempe, 85287, United States of America, Yimin_Wang@asu.edu

1 - To Remarket Now or Save for Warranty Claims
Cerag Pince, Kuehne Logistics University, Grosser Grasbrook 17, Hamburg, 20457, Germany, Cerag.Pince@the-klu.org, Beril Toktay, Mark Ferguson

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.

2 - Worker Poaching in a Supply Chain: Enemy from Within?
Gad Allon, Northwestern University - Kellogg, 2001 Sheridan Rd., Evanston, IL, United States of America, g-allon@kellogg.northwestern.edu, Achal Bassamboo, Evan Barlow

Luring workers away from other firms (or poaching) has become a universal practice. Poaching between firms usually hurts firm profits through higher wages and higher worker turnover. We explore worker poaching between firms linked in a supply chain. We show that the supply chain relationship reverses some common conclusions from the labor economics literature. Furthermore, we show how and under what conditions worker poaching can, in fact, improve supply chain performance.

3 - Unsold versus Unbought Commitment: Minimum Total Commitment Contracts with Nonzero Setup Costs
Geoffrey Chua, Nanyang Technological University, Singapore, 639798, Singapore, geoffchua@pmail.ntu.edu.sg, Frank Youhua Chen, Xing Liu, Quan Yuan

We study a minimum total commitment where the buyer commits to purchase a minimum quantity of a single product from the supplier over the contract horizon. We consider non-stationary demand and per-unit cost, discount factor, and nonzero setup cost. Since existing method cannot solve this problem, we develop a new method based on a state transformation technique using unsold commitment instead of unbought commitment as state variable. We prove for the first time the optimality of a modified (s,S) policy. We also discuss some extensions to show the generality of our method's effectiveness.

4 - United We Stand, Divided We Fall: Strategic Supplier Alliances under Default Risk
Xiao Huang, Assistant Professor, Concordia University, 1455 de Maisonneuve Blvd W, Montreal, QC, H3G1M8, Canada, xiaoh@jmsb.concordia.ca, Tamer Boyaci, Mehmet Gumus, Saibal Ray, Dan Zhang

We study coalition formation among suppliers in a one downstream firm-n upstream suppliers framework. Each supplier faces an exogenous default risk and is endowed with certain risk-mitigating resources that can be shared within an alliance. We characterize the Coalition-proof stable alliance structure and stakeholders' equilibrium investment strategy and establish under what conditions will suppliers form large coalitions and when will they opt for only a few partners.

■ SD07

Hilton- Continental 4
Global Healthcare Operations
Cluster: Tutorials
Invited Session

Chair: Pinar Keskinocak, Georgia Institute of Technology, 755 Ferst Dr. NW, Atlanta, United States of America, pinar.keskinocak@isye.gatech.edu

Co-Chair: Julie Swann, Harold R. and Mary Anne Nash Associate Professor, Georgia Institute of Technology, 755 Ferst Drive, NW, Atlanta, GA, 30332, United States of America, jswann@isye.gatech.edu

1 - Research in Public Health for Efficient, Effective, and Equitable Outcomes
Pinar Keskinocak, Georgia Institute of Technology, 755 Ferst Dr. NW, Atlanta, United States of America, pinar.keskinocak@isye.gatech.edu, Julie Swann, Turgay Ayer

Public health focuses on preventing disease, prolonging life, and promoting health in a population. In this tutorial, we discuss examples of work in several areas of public health including Access and Equity, Disease Screening, Chronic Diseases and Infectious Diseases. In each of these areas, we give a brief overview of challenging issues and related literature, give a specific example of a research topic, and point to potential future directions for research. We describe several trends that could impact future public health research including aging populations and an increase in electronic records. The tutorial is intended to introduce OR/MS researchers to the many opportunities for having a positive impact on specific populations and the society overall, through OR/MS research related to public health.

■ SD09

Hilton- Continental 6
Tackling Readmissions: From Policy to Practice
Sponsor: Manufacturing & Service Operations Management/Healthcare Operations
Sponsored Session

Chair: Jonathan Helm, Indiana University, 1309 E. 10th St, Bloomington, IN, United States of America, helmj@indiana.edu

1 - Missed Opportunities in Preventing Readmissions: Redesigning Post-discharge Checkup Policies
Michael Hu, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Bldg. E40-149, Cambridge, MA, 02139, United States of America, hum@mit.edu, Mariel Lavieri, Jonathan Helm, Kedi Wu, Ted Skolarus, Xiang Liu

Readmissions affect hundreds of thousands of patients annually, negatively impacting patients and tremendously burdening the healthcare system. Post-discharge checkups can reduce readmissions, but the methods behind designing effective checkup policies are poorly understood. Up to 67% of readmitted patients are readmitted before their first scheduled checkup. We examine the structure of optimal policies and develop policies that mitigate at least 32% more readmissions than current practice.

2 - Should Hospitals Keep Their Patients Longer? The Role of Inpatient Care in Reducing Readmissions
Song-Hee Kim, Yale School of Management, sk3116@columbia.edu, Carri Chan, Ann Bartel

Under the Affordable Care Act, hospitals with higher than expected 30-day readmission are being financially penalized. Using retrospective data on the over 6.6 million Medicare patients treated between 2008 and 2011, we develop an understanding of the potential impact of an inpatient intervention (keeping patients in the hospital for an extra day) versus providing outpatient interventions.

3 - Hospital Readmission Reduction Program: An Economic and Operational Analysis
Itai Gurvich, Kellogg School of Management, Northwestern University, 2001 Sheridan Road, Evanston, IL, 60201, United States of America, i-gurvich@kellogg.northwestern.edu, Dennis Zhang, Jan Van Mieghem, Eric Park, Robert Young, Mark Williams

The Hospital Readmission Reduction Program is a new government policy that penalizes hospitals with excess readmissions. The policy benchmarks hospitals against similar peers and inherently introduces a game theoretic element to hospital decisions. We take an economic and operational (patient flow) view to map hospitals' characteristics to their readmission reduction decisions and quantify the effectiveness of the policy. We apply our model to data from hospitals in California.

4 - Reducing Readmissions through Scheduling and Staffing a Follow-up Organization
Jonathan Helm, Indiana University, 1309 E. 10th St, Bloomington, IN, United States of America, helmj@indiana.edu, Shanshan Hu, Sean Yu

Readmissions are an increasingly major problem for US healthcare organizations because of new reimbursement structures, government penalties and more. The medical literature has shown that following up with patients can have a major impact. We investigate scheduling and staffing rules for follow-ups to improve the effectiveness of follow-ups in a systematic way based on reallocating current medical staff time or contracting with an independent follow-up organization.

■ SD10

Hilton- Continental 7
Crowdsourcing
Sponsor: Manufacturing & Service Operations Management
Sponsored Session

Chair: Michael Wagner, University of Washington, Seattle, United States of America, mrwagner@uw.edu

1 - Managing Innovation in a Crowd
Mohamed Mostagir, University of Michigan, Ross School of Business, Ann Arbor, United States of America, mosta@umich.edu, Daron Acemoglu, Asuman Ozdaglar

A central problem in crowdsourcing innovation is that the difficulties of innovation tasks as well as the skills of crowdsourced labor are not known in advance. How can we then best match tasks to workers when we know neither the difficulties of the tasks nor the skills of the workers? We give a pricing mechanism for tasks that provides an incentive for workers to reveal their skills and that implements the optimal matching.

2 - Crowdsourcing Critical Fractiles from Overconfident Forecasters
Casey Lichtendahl, University of Virginia, 100 Darden Blvd, Charlottesville, United States of America, LichtendahlC@darden.virginia.edu, Yael Grushka-Cockayne

We present a model of overconfident forecasters and show how to optimally aggregate their critical fractiles into a consensus critical fractile for the newsvendor problem. We also introduce an incentive-compatible mechanism for eliciting critical fractiles that are well-calibrated. This mechanism provides a reward as a function of the consensus critical fractile.

3 - Mechanisms Design for Crowdsourcing: The Optimal Budget-Feasible Mechanism for Large Markets
Afshin Nikzad, Stanford University, 37 Angell Court, Stanford, Ca, 94305, United States of America, afshin.nikzad@gmail.com, Gagan Goel, Nima Anari

We consider a mechanism design problem in the context of large-scale crowdsourcing markets such as Amazon's Mechanical Turk: There is a requester who wants to hire workers to accomplish some tasks. Each worker gives some utility to the requester; each worker also has a minimum cost (only known to himself) that he needs to be paid for getting hired. We design a (provably optimal) direct revelation mechanism that picks the right set of workers to hire in order to maximize the requester's utility.

■ SD11

Hilton- Continental 8

Joint Session M&SOM Supply Chain/BOM: Pricing from the Practitioner's Perspective

Sponsor: Manufacturing & Service Operations & Behavioral Operations Management

Sponsored Session

Chair: Wedad Elmaghraby, Associate Professor, University of Maryland, wedad_elmaghraby@rhsmith.umd.edu

1 - Revenue-Maximizing Dynamic Tolling

Robert Phillips, Columbia University, rp2051@columbia.edu

Increasingly, new highway capacity is being built by private companies who have the authority to set tolls to maximize revenue. We present a dynamic toll-setting algorithm that seeks to maximize revenue based on current and anticipated traffic. We discuss the real-world challenges in implementing the approach considering technical limitations, issues of public acceptance, and regulatory consideration.

2 - Pricing Mediated by Humans: The Role of Sales Rep Discretion

Loren Williams, Chief Data Scientist, EY, 55 Ivan Allen Jr. Blvd, Suite 1000, Atlanta, GA, 30308, United States of America, loren.williams@ey.com

Many observers hold the belief that permitting front line B2B sales reps to have pricing discretion leads to over discounting, while at the same time many firms execute their pricing with such a policy. In this talk we examine reasons that we might expect sales reps to over discount, some survey results on the prevalence of the practice of granting pricing discretion and some reasons that might explain the patterns observed.

3 - The Emperor has no Clothes! Issues and Opportunities to Enhance the Human Agent Role in PRM

Vedat Akgun, Director, Operations Research, Revenue Analytics, 3100 Cumberland Blvd, Suite 1000, Atlanta, GA, 30339, United States of America, vakgun@revenueanalytics.com, Jon Higbie

At Revenue Analytics we have had a unique opportunity to observe many companies' current and future Pricing and Revenue Management processes. Based on our experience and research, we will share insights that challenge perceptions that persist in public domain research. We will also share some success stories on how companies have achieved extraordinary benefits by dealing directly with the role of the human agent in the process.

■ SD12

Hilton- Continental 9

Sustainability Impacts of Operational Choices in Energy Generation and Storage

Sponsor: Manufacturing & Service Operations Management/Sustainable Operations

Sponsored Session

Chair: Gil Souza, Associate Professor, Indiana University, Kelley School of Business, Bloomington, IN, 47405, United States of America, gsouza@indiana.edu

1 - Combining Operations Management and Engineering Models to Manage and Value Electricity Storage

Yangfang Zhou, Assistant Professor, Singapore Management University, 50 Stamford Road, Singapore, 178899, Singapore, helenzhou@smu.edu.sg, Nicola Secomandi, Stephen Smith, Alan Scheller-Wolf, Jay Apt

The extant literature on the management and valuation of grid-level electricity storage facilities often ignores their physical characteristics and operating dynamics (such as energy-capacity degradation). We develop a stochastic optimization model and apply it to realistic data to study the importance of modeling these features when determining the storage operating policy and resulting valuation, focusing on three state-of-the-art grid-level electricity storage technologies.

2 - Operations and Investment of Energy Storage in the Presence of Transmission Losses

Owen Wu, Indiana University, owenwu@indiana.edu, Roman Kapuscinski, Santhosh Suresh

Due to transmission losses, the value of energy storage depends on the location of its investment. We consider the problem of sizing and siting storage facilities on a grid, to minimize investment and production costs. We model this problem as a trade-off between centralizing storage capacity, that increases aggregation, or localizing storage capacity, that brings it closer to the end consumer. We provide intuition on how changes in system parameters will affect this choice.

3 - Building and Replacing Battery Capacity for Energy Shifting

Shanshan Guo, Doctoral Student, Indiana University, Kelley School of Business, Bloomington, IN, 47405, United States of America, guoshan@indiana.edu, Gil Souza, Shanshan Hu

Batteries may be used for energy shifting in the power system: storing electricity when the power supply is abundant and cheap, and releasing electricity when the supply is tight and more expensive. The batteries' effective (storage) capacity decays over time, and its deterioration speed is determined by the depth of discharge, which decreases in the battery capacity. This paper determines the optimal battery size and replacement time, as a function of energy shifting demands.

4 - Capacity Investment in Renewable Technology with Uncertain Yield

Shanshan Hu, Assistant Professor, Indiana University, Kelley School of Business, 1309 E. 10th St,, Bloomington, IN, 47405, United States of America, hush@indiana.edu, Wenbin Wang, Mark Ferguson, Gil Souza

Motivated by the penetration of renewable technologies, particularly in the energy sector, we study a firm's one-time strategic capacity investment in a portfolio of technologies that are used to meet stochastic demand. The renewable intermittency is modeled through stochastic capacity yield. We derive closed-form solutions for the optimal investment. Actual case studies demonstrate the effects of yield uncertainty and its correlation with demand.

■ SD15

Hilton- Exec. Boardroom

Stochastic Alternatives: SFA and StoNED

Cluster: Data Envelopment Analysis

Invited Session

Chair: Timo Kuosmanen, Aalto University, Finland, timo.kuosmanen@aalto.fi

1 - Modeling Joint Production under Noise: Axiomatic Nonparametric Approach

Timo Kuosmanen, Aalto University, Finland timo.kuosmanen@aalto.fi, Andrew Johnson, Chris Parmeter

Stochastic data generating process of joint production is introduced where all inputs and outputs correlate with inefficiency and noise. We show that directional distance functions (DDF) are identified by an appropriate specification of the direction vector. A consistent nonparametric estimator of DDF is developed, which satisfies the axioms of the production theory. DDF of Finnish electricity distribution firms is estimated.

2 - Intra-Firm Wage Bargaining, Hold-Up, and Over-Employment: A Test of the Stole-Zwiebel Model

Ronald Warren, Professor of Economics, University of Georgia, Department of Economics, Terry College of Business, Athens, GA, 30602, United States of America, warren@uga.edu, Yongseung Han, Arthur Snow

We test the Stole-Zwiebel model of intra-firm wage bargaining in the presence of the threat of employee hold-up, using panel data on savings banks in Korea. We find evidence of allocative inefficiency, in the form of over-employment of labor, and equality of the bargain-determined wage and the competitive wage, consistent with the key predictions of the model.

3 - A Multivariate Seminonparametric Bayesian Concave Regression Method to Estimate Stochastic Frontiers

Andrew Johnson, Texas A&M, 3131 TAMU, College Station, TX, United States of America, ajohnson@tamu.edu, Jose Luis Preciado Arreola

We estimate a production frontier using Multivariate Bayesian Convex Regression and several distributional assumptions for inefficiency combining Bayesian semi-parametric regression and parametric Bayesian inefficiency modeling. Only axiomatic restrictions are imposed on the production function. The concavity constraints are automatically satisfied by our regression method, while monotonicity is imposed through a rejection method. The method can be used in data sets with up to 3000 observations.

4 - Orthogonality Conditions for Identification of Joint Production Technologies Axiomatic

Chris Parmeter, University of Miami, 5250 University Drive, Miami, United States of America, cparmeter@bus.miami.edu

This paper sheds some new light on this issue from the perspective of the production theory. We introduce a stochastic data generating process of joint production where all inputs and outputs correlate with inefficiency and noise. We show that an appropriately specified direction vector can provide the orthogonality conditions required for identification of the directional distance functions.

■ SD16

Hilton- Franciscan A

Information, Risk Management, and Production Strategies

Sponsor: M&SOM/ iForm (Interface of Finance, Operations, and Risk Management)

Sponsored Session

Chair: Ying-Ju Chen, Berkeley- IEOR, 4121 Etcheverry Hall, Berkeley, United States of America, chen@ieor.berkeley.edu

1 - On the Supply Chain Finance Role of 3PL's Procurement Service
Gangshu Cai, Santa Clara University, OMIS Department, Santa Clara, CA, 95053, United States of America, gcai@scu.edu, Xiangfeng Chen, Jing-Sheng Song

Some third-party logistics (3PL) firms have taken the role of procurement for the retailers in addition to the traditional shipping service. Our analysis indicates that there exists a Pareto zone where all firms benefit from the procurement service compared with the traditional pure logistics service.

2 - Supply Diagnostic Incentives in New Product Launch
Mehmet Gumus, Associate Professor of Operations Management, McGill University, 1001 Sherbrooke Street West, Bronfman Building, Montreal, QC, H3A 1G5, Canada, mehmet.gumus@mcgill.ca, Mohammad Nikoofal

In launching new products, the newness of the production leads to unexpected reliability issues on supply side. The adverse effect of supply risk can be mitigated via test production. We explore how such a diagnostic technology investment may affect both incentive and information asymmetries across channel partners.

3 - A Bayesian Nonparametric Mixture Model for Logistics Disruption Risk Assessment
Yan Shang, PhD Candidate, Duke University, 845 Ivy Meadow Ln, Apt 3D, Durham, NC, 27707, United States of America, ys79@duke.edu, David Dunson, Jing-Sheng Song

We develop a Bayesian nonparametric (BNP) mixture model to estimate multi-stage logistics service delay distributions. These estimates allow us to separate recurrent and disruption risks, which helps to devise suitable hedging strategies. They can also be used to rank service supplier reliability, aiding supplier selection decisions. We apply this method to a one-year international air cargo dataset and use the results to make suggestions on airport cargo warehouse capacity planning.

4 - Nonlinear Pricing with Consumer Satiation
Hui Xiong, Huazhong University of Science and Technology, 1037 Luoyu Road, Wuhan, 430074, China, zsjxh@163.com, Ying-Ju Chen

In various scenarios, consumers may get satiated with the products, and the degree of satiation is directly associated with their prior experiences. We find that the ex ante quantity is first decreasing and then increasing in the satiation rate. Further, the two-stage information asymmetries may give rise to a rationale for the quantity upward distortion when the consumers' preferences are highly sensitive to the first-stage consumptions.

■ SD17

Hilton- Franciscan B

Customer Behavior and Call Center Management

Sponsor: Manufacturing & Service Operations Management/Service Operations

Sponsored Session

Chair: Philipp AfËche, Rotman School of Management; University of Toronto, 105 St.George Street, Toronto, Canada, Philipp.Afeche@Rotman.Utoronto.Ca

1 - Service Time Sensitivity to Load: Who is to ìBlameî?
Pnina Feldman, UC Berkeley, Haas School of Business, 2220 Piedmont Ave, Berkeley, CA, 94720, United States of America, feldman@haas.berkeley.edu, Galit Yom-Tov, Jun Li

The service operations literature typically assumes that firms control service times and that those are independent of the time customers spend waiting. Empirical evidence suggests otherwise. In fact, the time customers spend in line affects their expected service length. The reasons for that are many and involve agents and customers mechanisms for adaptations to load. Using call center data, we examine such correlations, and distinguish between customer and agent effects.

2 - Customer Learning in Call Centers
Seyed Emadi, Assistant Pofessor, Kenan-Flagler Business School, 300 Kenan Drive, Chapel Hill, NC, 27599, United States of America, Seyed_Emadi@kenan-flagler.unc.edu, Baris Ata, Jay Swaminathan

We investigate the impact of customers' repeat contacts on their abandonment behavior. We use a Bayesian learning framework to model customers' behavior and estimate their parameters from a call center data.

3 - Optimal Staffing under Endogenous Arrivals with Heterogeneous Customer Time-of-Service Preferences
Yang Li, Doctoral Student, Rotman School of Management, University of Toronto, 105 St. George Street, Toronto, ON, M5S3E6, Canada, Yang.Li10@rotman.utoronto.ca, Philipp AfËche

The service operations literature usually treats arrivals as exogenous processes. However, arrival processes may be endogenous in many settings. That is, customers may account for system congestion in choosing their time of service. We propose an equilibrium model that captures how rational customers with heterogeneous preferences decide their time-of-service. We also study the optimal staffing policies, taking into account customers' time-of-service choices.

4 - using Estimated Patience Levels to Optimally Schedule Customers
Ramandeep Randhawa, USC, Marshall School of Business, Los Angeles, CA, United States of America, ramandeep.randhawa@marshall.usc.edu, Achal Bassamboo

In M/M/N+G queueing systems, even though arriving customers appear identical, as they wait in the queue, an update can be formed on their willingness to wait. In this manner, as time progresses, customers become differentiated. We exploit this dimension of customer heterogeneity to construct scheduling policies that dynamically prioritize customers based on their time in the system in order to optimize any given system performance metric.

■ SD18

Hilton- Franciscan C

Choice Models in Revenue Management and Pricing IV

Sponsor: Revenue Management & Pricing

Sponsored Session

Chair: Jeffrey McGill, Professor, Queen's University, Queen's School of Business, 143 Union Street, Kingston, ON, K7L3N6, Canada, jmcgill@business.queensu.ca

Co-Chair: Mikhail Nediak, Queen's University, Kingston, Ontario, Canada

1 - Pricing under the Nested Attraction Model
Tim Huh, Associate Professor, University of British Columbia, Sauder School of Business, Vancouver, BC, V6T 1Z2, Canada, tim.huh@sauder.ubc.ca, Hongmin Li

We develop a solution approach to the centralized pricing problem of a nested attraction model with a multi-stage tree structure. We identify conditions under which the optimal solution can be uniquely determined and characterize the optimal solution as a fixed-point of a single variable.

2 - Sequential Price Competition with Unknown Demand Functions
Yonatan Gur, Assistant Professor, Stanford University, 655 Knight Way, Stanford, CA, United States of America, ygur@stanford.edu, Omar Besbes

In most dynamic pricing problems demand depends on prices selected by competitors. This, in conjunction with the uncertainty about the underlying demand leads to dynamic interactions among competitors. We study such interactions and appropriate equilibrium notions.

3 - Probabilistic Choice Models for Aggregate Pricing in RM markets
Srini Krishnamoorthy, Visiting Assistant Professor - Management Science, A.B. Freeman School of Business, Tulane University, New Orleans, LA, 70118, United States of America, Srinivas.Krishnamoorthy@tulane.edu

Standard game theoretic methods fail to explain aggregate pricing decisions of travel capacity providers that often appear to be economically irrational. We use probabilistic choice models to obtain more realistic predictions of provider behavior in competitive revenue management markets.

4 - Revenue Management under a Markov Chain Based Choice Model
Jacob Feldman, Cornell University, Ithaca, NY, United States of America, jbf232@cornell.edu, Huseyin Topaloglu

We study both static and dynamic assortment problems under a Markov chain based choice model. We provide a novel LP formulation for the static assortment optimization problem whose geometry allows us to develop efficient solution approaches for the network revenue management problem.

■ SD19

Hilton- Franciscan D

Integrating Pricing and Supply Chain Planning

Sponsor: Revenue Management & Pricing
Sponsored Session

Chair: Mike Freimer, VP Science & Research, PROS,
101 Montgomery Street, Suite 400, San Francisco, CA, 94104, United
States of America, mfreimer@pros.com

1 - Coordinating Pricing and Production Decisions for Commodity-Based Manufacturers
Mike Freimer, VP Science & Research, PROS,
101 Montgomery Street, Suite 400, San Francisco, CA, 94104,
United States of America, mfreimer@pros.com

Price volatility has become increasingly dramatic in agricultural and other
commodity industries, causing significant pain for manufacturers who suffer the
effects of volatility on both upstream procurement and downstream sales. We
present an optimization framework that allows manufacturers to react more
quickly to changes in the marketplace, and to make coordinated pricing,
production, inventory and procurement decisions.

2 - Demand-Driven Production Optimization for Commodity-Based Manufacturers
Evan Davidson, Senior Scientist, PROS, 101 Montgomery Street,
Suite 400, San Francisco, CA, 94104, United States of America,
edavidson@pros.com

In this talk, we round out the description of an optimization framework for
commodity-based process manufacturers. We focus on the supply side of the
problem, describing how procurement, production, and inventory planning can be
coordinated with allocation and pricing to maximize overall profitability. We
discuss how the procurement optimization problem can be viewed as the mirror
image of the pricing problem.

3 - Supply Chain Analysis of Contract Farming
A. Serdar Simsek, Instructor/Researcher, Cornell ORIE, 282 Rhodes
Hall, Ithaca, NY, United States of America, as2899@cornell.edu, Awi
Federgruen

Contract farming sustains the operations of vulnerable farmers while better
positioning the manufacturers to manage their supply risks. In this setting, a
manufacturer who owns several production plants – each with a random demand
for the crop – selects the set of farmers that minimizes her expected procurement
and distribution costs before the growing season. We present two solution methods
to this problem. We applied our model to a company contracting with hundreds of
small farmers in India.

4 - Structural Results for a Capacity Sharing Problem
David McCaffrey, Senior Scientist, PROS, 3100 Main Street,
Houston, TX, 77002, United States of America,
dmccaffrey@pros.com, Darius Walczak

We consider a capacity sharing problem for a single leg airline reservation process
with two compartments, business and economy, in which business reservations are
accepted only into business, but economy reservations are accepted into either
economy or business. We define the dynamic programming equation for this
problem and show that the 2-dimensional value function is discretely sub-modular
and concave in both variables. We present examples and consider generalizations
to more compartments.

■ SD20

Hilton- Yosemite A

Matching Markets

Cluster: Matching and Market Design (in honor of Al Roth)
Invited Session

Chair: Yash Kanoria, Columbia Business School, 404 Uris Hall, New
York, NY, 10027, United States of America, ykanoria@columbia.edu

1 - Stable Matching in Large Economies
Fuhito Kojima, Stanford University, 579 Serra Mall, Stanford, CA,
943055007, United States of America, fkojima@stanford.edu

Complementarities of preferences have been known to jeopardize stability of two-
sided matching markets, yet they are a pervasive feature in many matching
markets. In large markets, we demonstrate that if each firm's choice changes
continuously as the set of available workers changes, then there exists a stable
matching even if firm preferences exhibit complementarity. Building on this result,
we show that there exists an approximately stable matching in any large finite
economy.

2 - The Prior-Independence Approach
Inbal Talgam-Cohen, PhD Candidate, Stanford University, 86 Hulme
Ct, Apt 108, Stanford, CA, 94305, United States of America,
italgam@stanford.edu, Tim Roughgarden

The matching literature has recently begun to consider priors on agents' utilities.
One of the barriers to adopting this potentially very fruitful approach is that priors
add significant informational assumptions to the model. We survey a successful
alternative approach from mechanism design called prior independence, which
alleviates such assumptions while still reaping most benefits. We discuss both
sampling-based methods and methods based on ensuring sufficient competition in
the market.

3 - The Structure of the Core in Assignment Markets
Yash Kanoria, Columbia Business School, 404 Uris Hall, New York,
NY, 10027, United States of America, ykanoria@columbia.edu,
Daniela Saban, Jay Sethuraman

Assignment markets (Shapley & Shubik 1971) involve matching with transfers, as
in labor markets and housing markets. We consider a two-sided assignment market
with agent types and stochastic structure similar to models used in empirical
studies. Each agent has a randomly drawn "productivity" associated with each type
on the other side. We characterize how the structure of the core, i.e., the set of
stable outcomes, is determined by market characteristics.

■ SD21

Hilton- Union Sq 1

Transportation and Routing under Uncertainty I

Sponsor: Transportation Science & Logistics
Sponsored Session

Chair: Arthur Flajolet, MIT, Cambridge, MA,
United States of America, flajolet@mit.edu

1 - Reliable Vehicle Routing Problems (RVRP) with Correlated Parameters
Carlos Felipe Ruiz, Universidad de los Andes, Cra 1 Este No 19A -
40, Bogota, DC, 0000, Colombia, cf.ruiz1135@uniandes.edu.co,
Andres Sarmiento, Raha Akhavan Tabatab, Andrés L. Medaglia,
Jorge Mendoza

Reliable vehicle routing problems consist of designing time-dependable
transportation routes of minimal expected cost over a network where travel and
service times are represented by random variables. In this work we consider the
case in which the random variables describing travel times may be correlated. We
propose a flexible methodology that comprises a state-of-the-art routing engine
and is able to effectively handle any travel and service time distribution and
pairwise correlations.

2 - Handling Travel Time Uncertainty in City Logistics
Utku Can Kunter, Research Assistant, Middle East Technical
University, ‹niversiteler mah. ODTU Kampüsü, Endüstri
Mühendisligi Bölümü Oda No:325, Ankara, 06800, Turkey,
kunter@metu.edu.tr, Cem Iyigün, Haldun Süral

City logistics aims to design freight distribution networks on a large scale. In this
study, we consider the travel time uncertainty in 1-tier city logistics systems. We
propose approaches to analyze the effect of travel time stochasticity on the location
decisions of city distribution centers. We provide computational results to compare
the performances of the proposed approaches with those of deterministic methods.

3 - Dynamic Technician Routing with Experience-based Service Times
Xi Chen, University of Iowa, IA, United States of America,
xi-chen-3@uiowa.edu, Barrett Thomas, Michael Hewitt

We study a dynamic technician routing problem with experience-based service
times. We use well-established models from the psychology community to model
how gains in experience impact service times. We assume that the volume and
location of customer requests are uncertain. We model the problem as a Markov
decision process with the objective of minimizing the expected total makespan
over a finite horizon. We also propose a number of approximate dynamic
programming schemes and present results.

4 - Robust Adaptive Routing under Uncertainty
Arthur Flajolet, United States of America, flajolet@mit.edu,
Patrick Jaillet, Sebastien Blandin

We consider an adaptive stochastic shortest path problem with independent
random arc costs. Our contributions are two-fold. First, we extend a pre-existing
dynamic programming formulation to a large class of objective functions. Second,
in an attempt to mitigate the impact of scarce information on the arc costs, we
develop a robust counterpart that relies on lower-order statistics as opposed to
entire arc cost probability distributions for the nominal problem.

■ SD22

Hilton- Union Sq 2

Preparing for and Responding to Disaster with Tools of OR

Sponsor: Transportation Science & Logistics
Sponsored Session

Chair: Martijn Mes, University of Twente, P.O. Box 217, Enschede, 7500 AE, Netherlands, m.r.k.mes@utwente.nl

1 - Empirical Study on People's Route Choice Behavior in Response to the Reopening of the I-35W Bridge

Sharon(Xuan) Di, University of Minnesota, 500 Pillsbury Dr. SE, Minneapolis, MN, 55455, United States of America, dixuan@umn.edu, Henry X. Liu, Shanjiang Zhu, David M. Levinson

Fewer people used the new I-35W Bridge after its reopening in 2008 in Minneapolis though it provided substantial time saving to commuters. The classical route choice model assumption that people always take the shortest path fails to capture the above anomalous phenomenon. This study proposes a boundedly rational route choice model to explain the observation and the parameter related to bounded rationality is estimated from a GPS study conducted before and after the reopening of the bridge.

2 - Objective Decision-Making Tools for Infrastructure Investments to Combat Impacts of Sea Level Rise

Ali Asadabadi, Graduate Research Assistant, University of Maryland, College Park, College Park, College Park, MD, 20742, United States of America, ali.asadabadi@gmail.com, Elise Miller-Hooks

Probabilistic projections of sea level rise and related intensified storm surges can affect coastal transportation infrastructure through temporary or permanent inundation. Mitigative and adaptive actions can be taken to combat these impacts. We will present optimization-based, decision-making techniques to aid in choosing among these options.

3 - Goal Programming Model for Integrated Relief Supply and Network Restoration-Hazus based Application

Kasin Ransikarbum, Clemson University, 103 Freeman Hall, Clemson, SC, 29634, United States of America, kransik@g.clemson.edu, Scott Mason

We present a goal programming model for integrated relief supply and network restoration operations. Our model provides fairness-based solutions for constrained capacity, budget, and resource problems. We analyze efficient frontiers between objectives and discuss compromise solutions when targets or goals are desired. Our results are illustrated with loss data in South Carolina generated from Hazus software to provide decision makers with candidate supply distribution and restoration plans.

4 - Integrated Tactical and Operational Planning of Police Helicopters

Martijn Mes, University of Twente, P.O. Box 217, Enschede, 7500 AE, Netherlands, m.r.k.mes@utwente.nl

We propose a tactical planning model to support various decisions regarding the use police helicopters, which include shift planning, standby time and the positioning of helicopters, while taking into operational decisions such as the starting times and optimal routes of surveillance flights. Decisions are based on historic data of high impact crimes. We also present a trade-off between maximizing the response time and an equitable distribution of helicopter capacity over the Netherlands.

■ SD23

Hilton- Union Sq 3

Rich Vehicle Routing Problems II

Sponsor: TSL/Freight Transportation & Logistics
Sponsored Session

Chair: Han Zou, University of Southern California, Los Angeles, CA, 90089, United States of America, hanzou@usc.edu

1 - A Multi-start Biased Method for the Vehicle Routing Problem with Backhauls and Environmental Impact

Javier Faulin, Professor, Public University of Navarre, Dept Statistics and OR, Campus Arrosadia, Pamplona, NA, 31006, Spain, javier.faulin@unavarra.es, Adrian Serrano, Javier Belloso, Angel Juan, Alejandro Garcia del Valle

We solve the Vehicle Routing Problem with Backhauls (VRPB) using a multi-start approach based on an adaptation of the SR-GWCS-CS method introduced by Juan et. al (2011). Later, the environmental impact associated with CO2 emissions was calculated using the Ubeda et al. (2012) methodology. Some classical benchmark instances for the VRPB were selected in order to compare the efficiency of our approach. Promising solutions have been obtained from our method implementation.

2 - An Adaptive Large Neighborhood Search Heuristic for the PDP with Fixed Scheduled Lines Services

Veaceslav Ghilas, Eindhoven University of Technology, Den Dolech 2, Eindhoven, 5612 AZ, Netherlands, v.ghilas@tue.nl, Emrah Demir, Tom Van Woensel

The investigated problem concerns scheduling a set of vehicles to serve the freight requests such that a part of the journey can be carried out on fixed scheduled lines transportation service. We propose an Adaptive Large Neighborhood Search heuristic algorithm to solve the problem. Extensive computational results provide a clear understanding of the benefits of using fixed scheduled services as part of the freight's journeys.

3 - A Large Neighborhood Search Approach for the Truck and Trailer Routing Problem

Wentao Zhang, University of Southern California, Los Angeles, CA, United States of America, wentao@usc.edu

In the truck and trailer routing problem (TTRP), a fleet of trucks and trailers is used to serve a set of customers, some of which are only accessible by trucks, while the others are also accessible by a truck coupled with a trailer. A large neighborhood search heuristic is developed to solve the problem. Operators are designed to take care of the special constraint of TTRP. Our competitive numerical results indicate the effectiveness of this relatively simple approach.

4 - An Intelligent Look-ahead Framework for the Dynamic Vehicle Routing Problem

Han Zou, University of Southern California, Los Angeles, CA, 90089, United States of America, hanzou@usc.edu, Maged Dessouky

The problem concerns routing a fleet of capacitated vehicles in real time to fulfill both advanced and dynamic orders from a set of known customers. We develop an intelligent look-ahead framework that makes predictions based on historical information, instantly accepts or rejects dynamic orders, and constructs partial vehicle routes. Our approach has the potential to outperform both a priori routing and total dynamic dispatching schemes when the uncertainty level is moderate.

■ SD24

Hilton- Union Sq 4

Modeling of Emerging Sensor Technologies

Sponsor: TSL/Intelligent Transportation Systems (ITS)
Sponsored Session

Chair: Pablo Durango-Cohen, Northwestern University, 2145 Asbury Avenue, Evanston, United States of America, pdc@northwestern.edu

1 - Analytics Approach to Support Health-monitoring and Management of Transportation Infrastructure

Pablo Durango-Cohen, Northwestern University, 2145 Asbury Avenue, Evanston, United States of America, pdc@northwestern.edu, Yikai Chen

Motivated by recent technological advances, we describe the development and validation of a statistical framework to support health-monitoring and management of transportation infrastructure. The framework consists of formulation of structural time-series models to explain, predict, and control for common-cause variation, and use of multivariate control charts to detect special-cause variation. We present several examples from an in-service bridge to validate the framework.

2 - Utilizing Mutiple Wireless Roadside Sensors At Intersections

David Kim, david.kim@orst.edu, Nadia Bathaee, SeJoon Park, Alireza Mohseni, David Porter

This research examines the estimation of vehicle time-distance trajectory through an intersection utilizing the data collection capabilities of multiple wireless roadside sensors that have been deployed along an intersection. Prior research with Bluetooth wireless roadside sensors show that signal strength data collected when data is obtained from a wireless device present in a vehicle can be used to estimate when the vehicle is close to passing a sensor. This capability is exploited through the development of portable Bluetooth wireless data collection units that communicate and synchronize time utilizing a Zigbee mesh network.

3 - Penetration Requirement of Mobile Sensing Data for Arterial Performance Measurement

Peng Hao, UC Riverside, Riverside, CA 92507, United States of America, haop@cert.ucr.edu, Xuegang (Jeff) Ban

This paper investigates the penetration requirement of mobile data to generate satisfactory performance measures for urban arterials. The results will help decision makers to assess the necessity and feasibility of mobile sensing at a given urban location or area.

4 - Real Time Freeway Traffic State Estimation and Prediction with a p-detector Based Approach in a Lagrangian Framework
Kerem Demirtas, Research Assistant, Arizona State University, Tempe, AZ, 85281, United States of America, kerem.demirtas@asu.edu, Zhuoyang Zhou, Pitu Mirchandani, Xuesong Zhou

Along with the recent technological developments, the availability of Lagrangian measurements become more widely used in real time traffic management applications. In this talk, we present a fast and novel approach to the freeway state estimation and prediction problem, that is based on a p-detector method in a Lagrangian sensing framework. Preliminary results show the accuracy of our proposed method.

■ SD25

Hilton- Union Sq 5

Advances in Routing and Scheduling Problems

Sponsor: TSL/Urban Transportation
Sponsored Session

Chair: Hai Wang, PhD Candidate, Massachusetts Institute of Technology, 77 Massachusetts Ave, Cambridge, MA, 02139, United States of America, wanghaimit@gmail.com

1 - Dynamic Hierarchical Modeling of Vehicle Routing Problem in Urban Supply Chains
Tao Yao, tyy1@engr.psu.edu, Terry Friesz, Yiou Wang, Ke Han, Hongcheng Liu

This research proposes a substantial extension of dynamic vehicle routing problem (VRP) formulation to a dynamic Stackelberg game model that takes into account the congestion as a result of freight activities among the background passenger traffic in urban freight planning. The model incorporates the dynamic VRP with dynamic traffic assignment problems by explicitly capturing their interplay on a network. We find that the routing decisions that explicitly consider congestions yields a significantly lower cost than the dynamic VRP solutions.

2 - Dynamic Vehicle Routing and Pricing with Look Ahead for Taxi Fleet
Hamid R. Sabarshad, Ryerson University, Toronto, ON, hsabarsh@ryerson.ca, Joseph Y.J. Chow

We propose a dynamic dial a ride and pricing problem with non-myopic policies for last mile transit, one with time-dependent non-homogeneous Poisson process for customer demands. Two policies are considered: customer-vehicle allocation, and dynamic fare pricing. The policy proposes a new fare structure which accounts for extra travel distance by anticipating the value of having the vehicle at the new location. The proposed model is compared against an "allocation only" queueing approach from Hyytia et al. (2012).

3 - Scheduling and Routing Operation of a Last Mile Transportation System
Hai Wang, PhD Candidate, Massachusetts Institute of Technology, 77 Massachusetts Ave, Cambridge, MA, 02139, United States of America, wanghaimit@gmail.com

We describe a model that considers a last mile transportation system as a batch arrival, batch service, and multi-server queueing system. We present several methodologies to operate the system through near-optimal scheduling and routing decisions. Technically the model focus on "multi-server queue operation with flexible service combinations."

4 - Vehicle Routing with Flexible Delivery Locations
Daniel Gartner, Carnegie Mellon University, The H. John Heinz III College, Pittsburgh, PA, 15213, United States of America, dgartner@andrew.cmu.edu, Alexander Düge, Markus Frey, Rainer Kolisch

We present a new extension of the vehicle routing problem (VRP): The VRP with flexible delivery locations (VRPFDL). In the VRPFDL, a job not only corresponds to exactly one location but has to be performed at one out of a set of possible locations. In order to solve the VRPFDL we present a Dantzig-Wolfe formulation which is solved by means of branch-and-price. The column generation's subproblem is treated as an elementary shortest path problem with resource constraints (ESSPRC).

■ SD26

Hilton- Union Sq 6

Location Optimization II

Sponsor: Location Analysis
Sponsored Session

Chair: Alan Murray, Professor, Drexel University, Center for Spatial Analytics and Geocomp, College of Computing and Informatics, Philadelphia, PA, 19104, United States of America, amurray@drexel.edu

1 - Exploiting Spatial Properties in Location Optimization
Alan Murray, Professor, Drexel University, Center for Spatial Analytics and Geocomp, College of Computing and Informatics, Philadelphia, PA, 19104, United States of America, amurray@drexel.edu

This paper details properties of space and spatial arrangement that can be relied upon to establish and solve a number of location models. Models are presented for which this is true, and application results are demonstrated.

2 - High Performance Computing to Optimize Spatial Coverage
Ran Wei, Oregon State University, 104 CEOAS Admin BLDG, Corvallis, OR, 97331, United States of America, rwei@coas.oregonstate.edu, Alan Murray

This paper addresses a continuous space problem focused on complete spatial coverage of continuously distributed demand. A new solution approach is developed through an iterative bounding scheme based on high performance computing techniques.

3 - Easy and Not so Easy Continuous Multifacility Location Problems
Justo Puerto, Universidad de Sevilla, Universidad de Sevilla, Sevilla, Spain, puerto@us.es, Victor Blanco

This talk presents a methodology for solving a class of continuous, multifacility location problems, in any dimension and l_p-norms: 1) by a new mixed integer second order cone programming formulation and 2) by a sequence of semidefinite programs that converges to the solution of the problem; each of these relaxed problems solvable in polynomial time. We apply dimensionality reductions of the problems by sparsity and symmetry to be able to solve larger problems.

4 - A Bi-objective Model for Designing Safe Walking Routes for School Children and its Applications
Ken-ichi Tanaka, Keio University, 3-14-1 Hiyoshi, Kohoku-ku, Yokohama, Japan, ken1tnk@ae.keio.ac.jp, Yuichiro Miyamoto, Ryuhei Miyashiro

We consider the problem of designing safe walking routes from school to homes for school children. Children are thought to be safer when walking together in groups rather than alone. We propose a bi-objective model in which both the total distance walked alone and the total distance traveled by children are minimized. We apply the problem to road networks and analyze Pareto optimal solutions. We also apply heuristic methods to solve real-size instances.

■ SD27

Hilton- Union Sq 7

Roundtable Discussion on Bridging Data and Decisions II

Sponsor: Railway Applications
Sponsored Session

Chair: Marc Meketon, Vice President, Oliver Wyman, 1 University Square Drive, Suite 100, Princeton, NJ, 19002, United States of America, Marc.Meketon@oliverwyman.com

1 - Roundtable Discussion on Bridging Data and Decisions
Marc Meketon, Vice President, Oliver Wyman, 1 University Square Drive, Suite 100, Princeton, NJ, 19002, United States of America, Marc.Meketon@oliverwyman.com

The freight railway industry is awash in data in every corner of its business. From immediate operations that collect real-time information on locomotives, cars and even wheel bearings, the million+ commercial shipments per month, the tens of millions of duties performed in the yards, movement of almost a million containers and trailers, track analysis data, and so on. This roundtable will discuss how advanced techniques of data analysis and operations research are being used to make the best decisions from the data.

■ SD28

Hilton- Union Sq 8

AAS Dissertation Prize Finalists

Sponsor: Aviation Applications
Sponsored Session

Chair: Thomas Vossen, University of Colorado Boulder,
Leeds School of Business, UCB0419, Boulder, CO, 80309,
United States of America, Vossen@Colorado.edu

1 - AAS Dissertation Prize Finalists
Thomas Vossen, University of Colorado Boulder, Leeds School of
Business, UCB0419, Boulder, CO, 80309, United States of America,
Vossen@Colorado.edu

This session will feature finalists for the Aviation Applications dissertation prize.
The Aviation Applications dissertation prize winner will be announced in the
business meeting at INFORMS.

2 - The Airline Container Loading Problem with Pickup and Delivery
Virginie Lurkin, PhD Student, Université de Liège, Rue Louvrex 14,
Liège, 4000, Belgium, vlurkin@ulg.ac.be, Michael Schyns

We look into the problem of optimizing the loading of a set of containers into cargo
aircraft serving multiple airports. Due to the pickup and delivery operations, this
problem is simultaneously a weight and balance problem and a sequencing
problem. Our objective is to minimize fuel and handling operations costs. We
resort to a mixed integer linear program. We show that our approach yields better
solutions than traditional manual planning, which results in substantial cost
savings.

3 - Wind Models and Stochastic Programming Algorithms for En Route Trajectory Prediction and Control
Clayton Tino, Resource Management Architect, Virtustream, Inc., 6
Concourse Pkwy NE #1930, Atlanta, GA, 30328,
United States of America, clayton.tino@gmail.com

There is a need for a fuel-optimal required time of arrival (RTA) mode for aircraft
flight management systems capable of enabling controlled time of arrival
functionality in the presence of wind speed forecast uncertainty. A computationally
tractable, two-stage stochastic algorithm utilizing a data-driven, location-specific
wind forecast uncertainty model to generate forecast uncertainty scenarios is
examined.

■ SD29

Hilton- Union Sq 9

New Directions in Understanding Buyer-Supplier Relations

Cluster: Strategy Science
Invited Session

Chair: Todd Zenger, Washington University, St. Louis, Missouri,
United States of America, zenger@wustl.edu

1 - Discovering Value in Buyer-supplier Relationships
Olivier Chatain, HEC Paris, France, chatain@wharton.upenn.edu,
Peter Zemsky

Relevant information about how much value can be created in a buyer-supplier
relationship is often difficult to evaluate before exchange takes place. For instance,
in professional services, the fit between buyers and suppliers can be hard to assess
ex ante. We use a formal model to explore the implications of the lack of ex ante
observability of bilateral value creation on the process of value discovery. We
explore how the cost of resolving the uncertainty about value creation potential is
magnified or minimized due to conflicts about the distribution of value.

2 - Contracts and Trust: Foundations and Emerging Directions
Laura Poppo, University of Kansas, lpoppo@ku.edu

Cooperative strategy has emerged as a paradigm for examining interfirm
exchanges, with trust and contracts as focal concepts. After reviewing the
significant work which has explored these facets, I will explore three under-
researched and emerging areas: 1) different bases of trust; 2) asymmetric trust; and
3) the emergence of cooperation.

3 - The Fragility of Trust in Interorganizational Relationships
Bart S. Vanneste, University College London, United Kingdom,
b.vanneste@ucl.ac.uk, Onesun Steve Yoo

We investigate under which conditions interorganizational trust is fragile (i.e.,
easily lost). We propose a generalized trust game, which has the well-known trust
game as a special case. Using a formal model, we show that whether
interorganizational trust is fragile depends on situation characteristics: value
(creation vs. capture), risk (scope for failure vs. opportunism), task (difficulty vs.
temptation), and fragility of trustworthiness (competence vs. benevolence).

4 - Creating and Capturing Value in Repeated Exchange Relations: Managing a Second Paradox of Embeddedness
Daniel Elfenbein, Washington University, elfenbein@wustl.edu,
Todd Zenger

Prior studies reveal a strong relationship between repeated exchange and value in
exchange relations, suggesting buyers may focus exchange to maximize
relationship value. However, by distributing exchange, buyers may position
themselves to capture more of the value created. We label this dilemma the second
paradox of embeddedness, distinguishing it from Uzzi's (1997) paradox driven by
technological uncertainty. Using data on the procurement activities of a large,
diversified manufacturing company, we then test for supplier and buyer behavior
consistent with this paradox.

5 - Buyer-supplier Relations: Exploring the Contractual Micro-foundations
Tomasz Obloj, HEC Paris, tobloj@gmail.com

The design and ensuing effectiveness of the buyer-supplier relationships interact in
an important way with internal contractual structures and individual
characteristics of organizational members. Yet, much remains to be understood
about the micro-foundations of productive relationships. Unpacking these
interactions, I study two sources of behavioral heterogeneity across and within
firms: social comparison costs and transactional integrity of economic actors. I then
discuss the broader implications of the behavioral micro-foundations for productive
relationships.

■ SD30

Hilton- Union Sq 10

Supply Chain and Scheduling

Cluster: Scheduling and Project Management
Invited Session

Chair: Zhi-Long Chen, Professor, University of Maryland,
R.H. Smith School of Business, College Park, MD, 20742,
United States of America, ZChen@rhsmith.umd.edu

1 - Supply Chain Scheduling in Steel-making and Hot Rolling Operations
Lixin Tang, Chair Professor, Northeastern University,
3-11 Wenhua Road, Heping District, Shenyang, 110004, China,
lixintang@mail.neu.edu.cn, Hongzhi Luo

We study a supply chain scheduling problem in steel-making and hot rolling
operations. In steel making, orders with similar steel grades are grouped into
charges, which are produced as a batch in oxygen converters. In hot rolling, slabs
are chosen and produced in a serial of capacitated turns. We propose a column-
generation-based algorithm for this problem with additional cuts. We test our
algorithm on randomly generated data, and show the effectiveness of the proposed
algorithm.

2 - Managing Engineering Design for Competitive Sourcing in Closed-Loop Supply Chains
Nagesh Murthy, Associate Professor, University of Oregon,
Lundquist College of Business, Eugene, OR, 97403, United States of
America, nmurthy@uoregon.edu, Tolga Aydinliyim

Using a game theoretical framework, we study the joint design and procurement
decisions of a manufacturer who chooses between integral or modular design
alternatives, and the pricing decisions made by its suppliers. The integral design
requires more raw materials per pound of final product and prevents yield loss due
to final joining. However, the modular design is simpler, resulting in a more
competitive supplier base and allows the suppliers to rely less on reverse material
flows.

3 - Integrated Production and Two-stage Delivery Scheduling
Feng Li, Northeastern University, Shenyang, China,
fengli055@gmail.com, Zhi-Long Chen, Lixin Tang

We study several integrated production and two-stage delivery scheduling
problems that arise in practical make-to-order settings in several industries. In
these problems, make-to-order products are first processed in a plant, then
delivered from the plant to a pool point, and finally delivered from the pool point
to customer sites. We propose algorithms and analyze their performance
theoretically and computationally.

■ SD31

Hilton- Union Sq 11

Theory Development, Measurement and Testing in Service Science

Sponsor: Service Science
Sponsored Session

Chair: Aleda Roth, Professor, Clemson University, 100 Sirrine Hall, Clemson, SC, United States of America, aroth@clemson.edu

**1 - Innovative Experimental Approaches for Behavioral
    Service Research**
    Liana Victorino, Assistant Professor, University of Victoria, Peter B.
    Gustavson School of Business, PO Box 1700 STN CSC, Victoria, BC,
    V8W 2Y2, Canada, lianav@uvic.ca, Mike Dixon, Rohit Verma

From observation to participation to co-production to co-creation, service operations require customer engagement. Therefore to investigate behavioral issues for service design, researchers must leverage innovative methodologies such as video experiments or illustrated written scenarios. We review examples and offer suggestions for newer applications of experimental approaches for service research.

**2 - Success and Failure of Technology-based Innovations in Service
    Encounters**
    Min Kyung Lee, Student, Clemson University, 100 Sirrine Hall,
    Clemson, SC, 29634-1305, United States of America,
    minl@g.clemson.edu, Mike Dixon, Rohit Verma, Aleda Roth

Technology-based innovations are introduced to increase efficiency and enhance service delivery. However, not every technology is successful for service industry. We present customer usage and preference of technology-based innovations in the US restaurant industry to demonstrate the success or failure of technology-based innovations.

**3 - Managerial and Employees' Perceptions of Improvisation in
    Service Settings: A Multigroup Analysis**
    Enrico Secchi, Assistant Professor, University of Victoria, Gustavson
    School of Business, PO Box 1700 STNCSC, Victoria, BC, V8W2Y2,
    Canada, esecchi@uvic.ca, Aleda Roth, Rohit Verma

This paper tests a model of antecedents and consequences of Service Improvisation Competence-the ability of service delivery employees to promptly deviate from established processes when needed-across samples of hotel managers and employees. We find a mismatch between service design choices and their realization in the service encounter.

**4 - Efficiency Analysis of U.S. and Indian Banks:
    Theory and Evidence**
    Sriram Venkataraman, Assistant Professor, University of South
    Carolina, Department of Management Science, Moore School of
    Business, Columbia, SC, 29208, United States of America,
    sriram.venkataraman@moore.sc.edu, Aleda Roth, Paul Wilson

By integrating diffusion theory from marketing literature and path dependency theory from economics into service operations, we compare and contrast the efficiency of U.S. and Indian banks. We find that Indian banks have caught up to U.S. banks in terms of efficiency after the entry of foreign banks into India.

■ SD32

Hilton- Union Sq 12

Data Science in Online Retailing

Sponsor: Service Science
Sponsored Session

Chair: Zhiwei (Tony) Qin, Data Scientist, Walmart Labs,
850 Cherry Ave, San Bruno, CA, 94066, United States of America,
tqin@walmartlabs.com

**1 - Mixtures of Multivariate Dynamic Linear Models for Demand
    Forecasting in the Long-Tail Environments**
    Shubankar Ray, Walmart Labs, 850 Cherry Ave, San Bruno, CA,
    94066, United States of America, SRay@walmartlabs.com,
    Abhay Jha

We model multivariate time series via dynamic regressions of cross-sectionally correlated sales (from similar products) on structural multivariate Gaussian processes. Bayesian machinery is used to continuously ensemble/learn infinitely many dynamic regressions with new incoming sales; and effectively predict future sales for a variety of retail product categories in long-tail environments.

**2 - Product Clustering through Low-rank Matrix Factorization with
    Side Information**
    Arnau Puig, Walmart Labs, 850 Cherry Ave, San Bruno, CA, 94066,
    United States of America, APuig@walmartlabs.com

We present new matrix factorization techniques that find a representation of products on a lower dimensional space which enhances their clustering into frequently purchased groups. The novelty of our approach resides in the combination of various sources of data to estimate the low dimensional latent factors: an incomplete matrix of customer orders data for each product, and a complete matrix of semantic features that contains item attributes obtained from our catalog.

**3 - Real-Time and Scalable Anomaly Detection using
    Parallel Regression**
    Derek Farren, Walmart Labs, 850 Cherry Ave, San Bruno, CA,
    94066, United States of America, derek@walmartlabs.com

In this paper we propose Sherlock, a scalable real-time Anomaly Detector that has been tested in large production systems. This Anomaly Detector was developed in order to accurately detect anomalies in massive data streams that can not be monitored with traditional Anomaly Detection solutions because of to the big processing needs required by such streams. We show Sherlock's efficacy and speed by comparing it against other popular Anomaly Detection solutions.

**4 - Trend Spotting through Word Clouds: The Effects of Online
    Product Reviews on Product Sales**
    Hsuanwei Chen, Assistant Professor, San Jose State University, One
    Washington Square, San Jose, CA, 95192,
    United States of America, hsuanwei.chen@sjsu.edu

I will investigate the effects of online product reviews on product sales, particularly from an information visualization perspective. I will conduct a trend spotting analysis on product reviews through word cloud visualizations. The word clouds are used to identify the opinions and sentiments expressed by consumers. I will then examine the relationship between the evolutions of word clouds and product popularity trends (e.g., product sales).

■ SD33

Hilton- Union Sq 13

Incentives and Organizational Issues In
New Product Development

Cluster: New Product Development
Invited Session

Chair: Nicos Savva, London Business School, Regentís Park, London, NW1 4SA, United Kingdom, nsavva@london.edu

Co-Chair: Niyazi Taneri, SUTD, 20 Dover Drive, Singapore, Singapore, niyazitaneri@sutd.edu.sg

**1 - Resource Allocation Decisions under Imperfect Evaluation and
    Organizational Dynamics**
    Nektarios Oraiopoulos, University of Cambridge, Judge Business
    School, Trumpington Street, Cambridge, CB2 1AG, United
    Kingdom, n.oraiopoulos@jbs.cam.ac.uk, Jochen Schlapp,
    Vincent Mak

Every product portfolio manager is challenged by the limited information that she has available when allocating resources across multiple products. Her task is further complicated when this information is obtained from self-interested managers who might have an incentive to be overly optimistic about their own products. Our work studies how balancing individual and shared incentives can mitigate such inefficiencies and improve the product selection process.

**2 - How Communication and Incentives Transform a Strategic Plan
    into Action**
    Jeremy Hutchison-Krupat, University of Virginia, Darden School of
    Business, Charlottesville, VA, United States of America,
    KrupatJ@darden.virginia.edu

We study the incentive and communication decisions that senior leadership makes to transform a strategic plan into actions. We embed a game of strategic information transmission in a principal agent framework to study senior leadership's incentive and communication decisions. We provide a characterization of senior leadership's communication and we contrast the results that are driven by an initiative's characteristics as opposed to those that are driven by the structure of the organization.

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3 - Too Successful to Innovate? Dynamic Entrepreneurial Reputation and Venture Capital
Noam Shamir, Tel Aviv University, Tel Aviv, Israel, nshamir@post.tau.ac.il, David Zvilichovsky

This research integrates entrepreneurial experience, success, reputation and venture financing into a dynamic model which explores the execution of innovative projects under asymmetric information. We are interested in exploring the tension between the desire of the entrepreneur to exploit the current project opportunity and her understanding that the success or failure in this current project also impacts her future reputation.

4 - Licensing Contracts: Control Rights and Options
Niyazi Taneri, SUTD, 20 Dover Drive, Singapore, Singapore, niyazitaneri@sutd.edu.sg, Bert De Reyck, Pascale Crama

We investigate the impact of control rights, options, payment terms and timing decisions on R&D collaborations. Our study reveals a counterintuitive result; the innovator may, under certain conditions, prefer to grant launch control rights or buy-out options to the marketer despite the fact that both terms restrict its downstream actions. Studying renegotiation and postponed contracting we demonstrate that contract timing can also have a significant influence on the outcome of collaborative R&D.

■ SD34

Hilton- Union Sq 14

Humanitarian Operations Management Applications
Sponsor: Public Programs, Service and Needs
Sponsored Session

Chair: Alfonso Pedraza-Martinez, Assistant Professor, Kelley School of Business, Indiana University, 1309 E 10th Street, Kelley School of Business, IU, Bloomington, In, 47405, United States of America, alpedraz@indiana.edu

1 - Post-Disaster Information Dissemination in Online Social Networks
Eunae Yoo, Arizona State University, PO Box 874706, Tempe, AZ, 85287, United States of America, eunae.yoo@asu.edu, Mahyar Eftekhar, Elliot Rabinovich

Humanitarian organizations utilize social media platforms to collect local and instantaneous data. While this helps resolve post-disaster informational needs, data may be inaccurate. We integrate Network Theory and Information Cascades Theory to explore how information disseminates in online social networks and what network structures affect correction time. Our study contributes by analyzing misinformation propagation and by shedding light on the reliability of social media data.

2 - Service Agreements in Vehicle Leasing Programs: Turning Perception Gaps into Opportunities
Nathan Kunz, Research Fellow, INSEAD, Bd de Constance, Fontainebleau, 77305, France, nathan.kunz@insead.edu, Luk Van Wassenhove

Fleet leasing models in the humanitarian sector have led to significant savings for relief organizations. However, the adoption of this model is inhibited by biased perception from field offices. Through a case study we demonstrate how service agreements and performance measurement can facilitate the acceptance of fleet leasing models and lead to higher efficiency. Our findings are also relevant to other areas in humanitarian logistics similarly affected by perception gaps.

3 - Funding-Strategy Competition in Humanitarian Operations
Arian Aflaki, Duke University, Durham, NC, United States of America, arian.aflaki@duke.edu, Alfonso Pedraza-Martinez

Humanitarian organizations (HOs) follow the general practice of earmarking their funds to specific programs. Extant literature has shown that this practice negatively affects operational performance. To understand HOs' behavior, we use an analytical model that captures the effect of earmarking on operational performance, fundraising effort, and donor preferences. We find that no-earmarking could be a dominant strategy under monopoly; however, competition forces HOs to ask for earmarked funds.

4 - Measuring Humanitarian Response Capacity
Jason Acimovic, The Pennsylvania State University, 462 Business Building, University Park, PA, 16802, United States of America, jaa26@smeal.psu.edu, Jarrod Goentzel

Humanitarian aid organizations may manage several supply depots around the world used to help respond to disasters. They must decide how much to store and how to distribute inventory. We develop a metric based on a stochastic linear program that measures the capacity to respond to a disaster, and the quality of the inventory distribution.

■ SD35

Hilton- Union Sq 15

Decisions in a Nonprofit Supply Chain I
Sponsor: Public Programs, Service and Needs
Sponsored Session

Chair: Gemma Berenguer, Purdue University, 403 W. State St., West Lafayette, IN, 47906, United States of America, gemmabf@purdue.edu

1 - The Nonprofit Newsvendor's Procurement Problem
Gemma Berenguer, Purdue University, 403 W. State St., West Lafayette, IN, 47906, United States of America, gemmabf@purdue.edu, George Shanthikumar

The standard decision-making policies developed to efficiently run operations by for-profit organizations are not always efficient when run by nonprofit organizations. This talk focuses on the analysis of the newsvendor problem in a nonprofit context. Several scenarios are analyzed including the newsvendor problem that incorporates the external influence of the government through the use of subsidies.

2 - Dynamic Programming to Reduce Food Waste at Campus Dining Services
Esma Birisci, PhD Student, University Of Missouri, 217 W Broadway Apt C31, Columbia, United States of America, esmabirisci@mail.missouri.edu, Ronald McGarvey

In this study we propose a dynamic programming equation for minimizing food wastage in a stochastic inventory model at the University of Missouri. The aim is to reduce food wastage over multi-period horizon by taking into account uncertain demand. Mainly, focusing on how food production and ordering decision can reduce storage losses and over preparation loses. Because of uncertainty of demand, we use robust optimization to make decision on quantity of order for Campus Dining Services.

3 - Dynamic Facility Location and the Value of Inventory Mobility in Disaster Relief
Amber Richter, PhD Candidate, University of California, Berkeley, 4141 Etcheverry Hall, Berkeley, CA, 94720, United States of America, amberr@berkeley.edu, Zuo-Jun Max Shen

This research examines dynamic inventory relocation for responding to disasters over time. We model the problem using dynamic programming (DP) and find analytical and numerical results regarding optimal movement policies and the value of inventory mobility over traditional warehouse pre-positioning. We develop a heuristic which, on average, solves large instances of the problem within 0.5 percent of optimality in less than 1 percent of the time taken by an exact backward DP algorithm.

4 - Foreclosure Operations and Strategy Design for Community-based Organizations
Michael Johnson, Associate Professor, University of Massachusetts Boston, 100 Morrissey Blvd., McCormack Hall Room 3-428A, Boston, MA, 02125-3393, United States of America, Michael.Johnson@umb.edu, Senay Solak, David Turcotte, Jeffrey Keisler

The foreclosure crisis in the U.S. has resulted in immense economic and social losses for individuals and neighborhoods. The scale of the problem and the financial and technical limitations of not-for-profit responding organizations require novel methods for community stabilization and revitalization. We discuss neighborhood-based decision modeling responses that support housing acquisition and redevelopment as well as alternative land uses, depending on the likelihood of continued local decline.

■ SD36

Hilton- Union Sq 16

Wireless Mobility Modeling
Sponsor: Telecommunications
Sponsored Session

Chair: David Shallcross, Applied Communication Sciences, 150 Mount AIry Road, Basking Ridge, NJ, 07920, United States of America, dshallcross@appcomsci.com

1 - Hadal Zone Networks Modeling
Michael Bartolacci, Pennsylvania State Univesity, Berks, Reading, PA, 19610, United States of America, mbartolacc@aol.com

There has been recent interest in the exploration of the hadal zones of the world's oceans, the parts of the oceans that are below 6,000 meters deep. Recent interest in such explorations have brought to light the need for networks that can support the use of undersea technologies. Model such hybrid networks represents a challenge from several points of view: propagation of signals through the deep ocean, power conservation, heterogeneous hybrid nature of network devices, and other factors.

2 - Distributed Location of Wireless Mobile Relay Nodes

David Shallcross, Applied Communication Sciences, 150 Mount AIry Road, Basking Ridge, NJ, 07920, United States of America, dshallcross@appcomsci.com, Eric Van Den Berg

Client nodes distributed over an area may require relay nodes to enable communication. We consider mobile relay nodes, such as unmanned aerial vehicles, that may travel to position. We investigated variations of a simple distributed algorithm to minimize link lengths, and improve capacity. This is related to the Euclidean Steiner tree problem. We have both theoretical results and experimental results.

3 - Optimal Sensor Deployment to Increase the Security of the Maximal Breach Path

Necati Aras, Bogazici University, Bebek, Istanbul, Turkey, arasn@boun.edu.tr, Kuban Altinel, Ezgi Karabulut

We focus on an application of wireless sensor networks for border surveillance. It is a bilevel optimization problem involving two players. The defender is the leader of the Stackelberg game and wants to determine the best sensor locations in order to maximize the security in the area. The intruder, who is the follower, is capable of destroying some of the sensors to identify the maximal breach path. For the solution of the model we propose three heuristics based on Tabu search.

■ SD37

Hilton- Union Sq 17

Social Intelligence: Learning, Aggregation and Applications

Sponsor: Artificial Intelligence
Sponsored Session

Chair: Ankur Mani, Massachusetts Institute of Tech, 20 Ames Street #385, Cambridge, MA, 02139, United States of America, amani@MIT.EDU

1 - Homophily in Voter Networks

Peter Krafft, Massachusetts Institute of Tech, 20 Ames Street #385, Cambridge, MA, 02139, United States of America, pkrafft@mit.edu, Ankur Mani, Alex Pentland, Joshua Tenenbaum

In this work we study the effect of network homophily on voting outcomes in multicandidate elections. We observe that homophily among rational voters affects this type of election by shifting the distribution of votes away from center candidates, which may lead to non-central candidates winning more often.

2 - Point of View and Manipulation on Wikipedia

Sanmay Das, Associate Professor, Washington University in St. Louis, sanmay@seas.wustl.edu, Allen Lavoie, Malik Magdon-Ismail

We describe new machine learning techniques for automatic classification of points of view and detection of possible manipulation on Wikipedia, and show how these techniques can be used to study social processes. In particular, we discuss applications to understanding administrator promotion elections as well as the evolution of Wikipedia pages in terms of which points of view are represented.

3 - Airplanes Aloft as a Sensor Network for Wind Forecasting

Debadeepta Dey, United States of America, debadeep@cs.cmu.edu, Ashish Kapoor

We explore the feasibility of using commercial aircraft as sensors for observing weather phenomena at a continental scale. We focus on the problem of wind forecasting and explore the use of machine learning and inference methods to harness air and ground speeds reported by aircraft at different locations and altitudes. We validate the learned predictive model with a field study where we release an instrumented high-altitude balloon and compare the predicted trajectory with the sensed winds.

■ SD38

Hilton- Union Sq 18

Healthcare Analytics

Cluster: Healthcare Systems and Medical Informatics
Invited Session

Chair: Sinjini Mitra, Assistant Professor, California State University, Fullerton, ISDS Dept. SGMH-4113, 800 N State College Blvd, Fullerton, CA, 92831, United States of America, smitra@fullerton.edu

1 - Studying Consumer Behavior for Adopting Social and Mobile Media for Health Management via Analytics

Sinjini Mitra, Assistant Professor, California State University, Fullerton, ISDS Dept. SGMH-4113, 800 N State College Blvd, Fullerton, CA, 92831, United States of America, smitra@fullerton.edu, Rema Padman

Advances in technology and increased availability of large amounts of data in the recent decade has made it possible to use extensive analytical methods for effective decision-making, particularly in the healthcare industry. Based on a member survey of a large health plan, we identify factors (demographic, clinical and technological) that are significantly associated with member interest in adopting social and mobile media for obtaining health information from the health plan via analytics.

2 - On Learning and Visualizing Practice-based Clinical Pathways for Chronic Kidney Disease

Yiye Zhang, Carnegie Mellon University, 532 Tyrella Ave, Apt 56, Mountain View, CA, 94043, United States of America, yiyez@andrew.cmu.edu, Larry Wasserman, Rema Padman

This study analyzes the treatment data of chronic kidney disease (CKD) patients. We use hierarchical clustering based on longest common subsequence distance to discover patient subgroups, and represent each subgroup's clinical pathway as 2nd-order Markov chains to learn practice-based clinical pathways. Further, we model treatments as hidden states, and laboratory data as observations in the context of hidden Markov model, to decode the most likely sequence of treatments given laboratory data.

3 - Impact of Individual and Organizational Usage Experience on eVisit Service Efficiency

Changmi Jung, changmi@andrew.cmu.edu, Ateev Mehrotra, Rema Padman, Linda Argote

In this study, we aim to understand how the service efficiency is linked to individual and organizational usage experience. We address our questions by using physicians' evaluation time associated with eVisits in primary care practices affiliated with a major academic medical center. Results demonstrate that there is evidence of individual learning with moderating effect from physicians' system expertise, and complementing effect from organizational experiences on physician service efficiency.

4 - Evaluating m-Health Services for User Engagement and Health Promotion: A Randomized Field Experiment

Yi-chin Lin, Carnegie Mellon University, 4800 Forbes Ave HBH 3011, Pittsburgh, PA, 15213, United States of America, yichinl@andrew.cmu.edu, Vibhanshu Abhishek, Julie Downs, Rema Padman

Mobile technologies have the potential to engage patients and change their healthy behaviors, yet little evidence has been documented. Drawing on theoretical frameworks, this study proposes novel mobile-enabled interventions to improve healthy eating behaviors. The effects of interventions are examined via a randomized field experiment. Analysis of objective usage and subjective survey data provide strategic insights that can be generalized to other healthy behaviors.

■ SD39

Hilton- Union Sq 19

Joint Session HAS/Analytics/CPMS: Practicing OR/OM in Healthcare Providers - A Panel

Sponsor: Health Applications, Analytics & CPMS, The Practice Section
Sponsored Session

Chair: Alexander Gutfraind, Research Assistant Professor, University of Illinois at Chicago, 1603 W. Taylor Street, MC 923, Chicago, IL, 60612, United States of America, agutfraind.research@gmail.com

1 - Panel on Implementation of Operations Research/Operations Management in Healthcare

Alexander Gutfraind, Research Assistant Professor, University of Illinois at Chicago, 1603 W. Taylor Street, MC 923, Chicago, IL, 60612, United States of America, agutfraind.research@gmail.com, Tarun Mohan Lal

Leading healthcare organizations like the Mayo Clinic, Geisinger Health System, and Cincinnati Children's Hospital have benefited from utilizing OR/OM and present approaches from idea generation to implementation. The panel will share examples that have benefited their organization, highlight tools and applied technologies, as well as present challenges and successes that can be translated for both academics and practitioners.

2 - Bridging the Gap between Theory & Application at Geisinger Health System

Christopher Strömblad, Senior Modeler - Operations Research, Geisinger Health System, 100 N. Academy Ave, Danville, PA, 17822, United States of America, chris.stromblad@gmail.com

This will be an integrated part of the above panel discussion with OR/OM practitioners in leading healthcare organizations.

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3 - using Analytics to Improve Quality at Cincinnati Children's Hospital
Denise White, PhD, Director, QI Analytics, Cincinnati Children's Hospital, 3333 Burnet Avenue, Cincinnati, OH, United States of America, DeniseL.White@cchmc.org

This will be an integrated part of the above panel discussion with OR/OM practitioners in leading healthcare organizations.

■ SD40

Hilton- Union Sq 20

Public Health Applications

Sponsor: Health Applications
Sponsored Session

Chair: Margaret Brandeau, Professor, Stanford University, MS&E Department, Stanford, CA, 94305, United States of America, brandeau@stanford.edu

1 - Cost-effectiveness of Cardiac Resynchronization Therapy Defibrillator in Mild Heart Failure
Allison Pitt, Stanford University, 475 Via Ortega, Stanford, CA, 94305, United States of America, alpitt@stanford.edu, Christopher Woo, Erika Strandberg, Jeremy Goldhaber-Fiebert, Mark Hlatky, Michelle Schmiegelow, Douglas K. Owens

Objective: We develop a decision analytic Markov model to estimate the cost-effectiveness of cardiac resynchronization therapy (CRT) in addition to an implantable cardioverter-defibrillator (ICD), compared with ICD alone, in patients with left ventricular systolic dysfunction, prolonged intraventricular conduction, and mild heart failure. Results: CRT plus ICD increased life expectancy and QALYs compared with ICD at a cost of $70,000 per QALY gained.

2 - Optimal Screening Strategies for Cervical Cancer
Esma Gel, Associate Professor, Arizona State University, 699 S Mill Ave, BYENG 318, Tempe, AZ, 85281, United States of America, Esma.Gel@asu.edu, Raha Akhavan Tabatab, Isabel Namen Leon

The recent use of the human papillomavirus DNA (HPV) test has motivated questions on how the test should be used in conjunction with traditional cervical cancer screening methods such as pap smear. We propose a POMDP model to suggest optimal policies for cervical cancer screening and prevention. For a case study, we use data from a practice in Colombia as well as specificity/sensitivity results from the medical literature to provide guidelines on optimal screening strategies for cervical cancer.

3 - Planning for HIV Screening, Testing and Care at the Veterans Health Administration
Sandeep Rath, PhD Student, UCLA Anderson, B513 Gold Hall, 110 Westwood Plaza, Los Angeles, CA, 90024, United States of America, sandeep.rath.2015@anderson.ucla.edu, Sarang Deo, Kumar Rajaram

CDC has recommended a routine screening policy for HIV. We modeled a QALY maximizing nonlinear mixed integer program incorporating system dynamics and disease progression and found that routine screening may not be always feasible. We applied this model to the Greater Los Angeles station of the Veterans Health Administration and used it to develop and evaluate managerially relevant policies within existent capacity and budgetary constraints to improve upon the current screening policy.

4 - Expansion of the National Salt Reduction Initiative: Requirements for Reducing Cardiovascular Disease
Sung Eun Choi, Stanford University, 475 Via Ortega, Stanford, CA, 94305, United States of America, sungeunc@stanford.edu, Sanjay Basu, Margaret Brandeau

A number of public health programs, including National Salt Reduction Initiative, are increasingly seeking to mitigate upstream causes of high cardiovascular disease mortality in the United States by reducing dietary sodium intake. Individuals have different degrees of benefit from sodium reduction, given their demographic characteristics, such as age, race, and income. A microsimulation model was developed to investigate these complexities affecting national efforts to reduce dietary sodium.

■ SD41

Hilton- Union Sq 21

Decision Modeling for Disease Prevention Considering Imperfect Screening

Sponsor: Health Applications
Sponsored Session

Chair: Mahboubeh Madadi, PhD Candidate, University of Arkansas, 4117 Bell Engineering Center 1 Universit, Fayetteville, AR, 72701, United States of America, mmadadi@email.uark.edu

1 - A Simulation-based Cost-effectiveness Study on Age and Gender-specific CRC Screening Strategies
Nan Kong, Assistant Professor, Weldon School of Biomedical Engineering, Purdue University, West Lafayette, IN, 47907, United States of America, nkong@purdue.edu, Carolina Vivas Valencia, Robert Klein, Thomas Imperiale

Current colorectal cancer (CRC) screening guidelines do not tailor recommendations to patients of different risks. However, there is new evidence that polyps form earlier and progress faster in men. We extend the Vanderbilt-NC State CRC simulation model and update model parameters based on recent evidence. Model-based cost-effectiveness analyses are conducted for distinct age- and gender-specific subpopulations. Our results quantify the benefits of starting screening earlier in men than women.

2 - Considering Heterogeneity of Provider Implementation of Screening Policies in Simulation models
Irene Vidyanti, Los Angeles Department of Public Health, 3530 Wilshire Boulevard, Los Angeles, CA, 90010, United States of America, irenevidyanti@gmail.com, Shinyi Wu

Imperfect screening requires a targeted approach and cooperation from providers to implement evidence-based policies. Implementation at the provider level and provider's heterogeneity of implementation then becomes an important issue in accurately assessing cost-benefit of screening. We use the case of Diabetic Retinopathy screening to compare a simulation model that takes into account heterogeneity of provider implementation with one that does not to show differences in precision of estimates.

3 - Analyzing the Effects of Different Models of Screening Choice in Colorectal Cancer Outcomes
Maria Mayorga, Associate Professor, North Carolina State University, 111 Lampe Dr., Raleigh, NC, 27695, United States of America, memayorg@ncsu.edu, Rachel Townsley, David Cornejo, Kristen Hassmiller Lich

Modality and compliance choice decisions substantially affect the health outcomes in colorectal cancer screening programs. We have created a dynamic simulation model that evaluates the effects of individual choice of screening modality and compliance on health outcomes. We experiment with different frameworks for defining these choice decisions. We find that the embedded assumptions of these choice frameworks lead to different results.

4 - A Nonlinear Programming Model to Optimize Screening Policies Considering Patients' Adherence
Mahboubeh Madadi, PhD Candidate, University of Arkansas, 4117 Bell Engineering Center 1 Universit, Fayetteville, Ar, 72701, United States of America, mmadadi@email.uark.edu, Shengfan Zhang, Edward Pohl

Patients' imperfect adherence is one of the issues that physicians encounter when recommending their patients undergo screening tests such as mammography. In this study, a nonlinear optimization model is developed to extract a screening guideline that minimizes the risk of a disease getting clinical while taking into account uncertainty in patient adherence behavior. Some numerical examples with application to screening mammography tests are solved using a heuristic method.

■ SD42

Hilton- Union Sq 22

Healthcare Operations

Sponsor: Health Applications
Sponsored Session

Chair: Mehmet Erkan Ceyhan, Operations Research Manager, Lahey Hospital & Medical Center, 41 Mall Road, Burlington, United States of America

1 - Anesthesiologist and Nurse Anesthetist Assignment
　　Ayten Turkcan, Northeastern University, Mechanical and Industrial Engineering, Boston, MA, 02115, United States of America, a.turkcan@neu.edu, Mehmet Erkan Ceyhan, Sina Aghsaei

We worked with the Surgery Department at Lahey Hospital and Medical Center to develop an optimization based decision support tool to solve anesthesiologist and nurse anesthetist (CRNA) assignment problem. We proposed integer programming models that consider working hours, skill levels, surgery durations, and difficulty of surgeries to assign anesthesiologists and CRNAs to operating rooms on the day of the surgery with the objective of balancing workload.

2 - Simulation of Chemotherapy Patient Flow in an Oncology Clinic
　　Bohui Liang, Northeastern University, Mechanical and Industrial Engineering, Boston, MA, 02115, United States of America, liang.boh@husky.neu.edu, Ayten Turkcan, Mehmet Erkan Ceyhan

We worked with the Hematology and Oncology Clinic at Lahey Hospital and Medical Center to improve patient flow and appointment scheduling for chemotherapy patients. We developed a discrete event simulation model to evaluate the operational performance in the clinic and to identify initiatives for improvement in process flow, scheduling and staffing. We proposed a mathematical programming model to generate balanced appointment schedules for oncologist visit and chemotherapy treatment.

3 - Stochastic Appointment Sequencing and Scheduling with Heterogeneous Service Times and No-show Rates
　　Onur Arslan, Teaching Assistant, Northeastern University, 360 Huntington Avenue, Boston, MA, 02115, United States of America, arslan.o@husky.neu.edu, Ayten Turkcan

We solve appointment sequencing and scheduling problem in a primary care setting where multiple patients with heterogeneous service time distributions and no-show probabilities are considered. We propose a two-stage stochastic programming model that minimizes waiting time, idle time, and overtime cost. We present the properties of an optimal solution for special cases, and provide comparative results for different service time distributions, uncertainty levels, and cost coefficients.

■ SD43

Hilton- Union Sq 23

Sparse Optimization: Theory and Applications

Sponsor: Computing Society
Sponsored Session

Chair: Dongdong Ge, Shanghai University of Finance and Economics, 777 Guoding Road, Shanghai, China, dongdong@gmail.com

1 - A Linear Time Algorithm for Bridge Regression Problem
　　Dongdong Ge, Shanghai University of Finance and Economics, 777 Guoding Road, Shanghai, China, dongdong@gmail.com

In this paper we consider a class of non-Lipschitz and non-convex minimization problems which generalize the L2-Lp minimization problem. We propose an iterative algorithm that decides the next iteration based on the local convexity/concavity/sparsity of its current position. We show that our algorithm finds a nearly KKT point within linear time iterations.

2 - New Analysis on Sparse Solutions to Random Standard Quadratic Optimization Problems and Extensions
　　Xin Chen, University of Illinois at Urbana-Champaign, 104 S. Mathews Ave., Urbana, IL, 61801, United States of America, xinchen@illinois.edu, Jiming Peng

The standard quadratic optimization problem (StQP) refers to the problem of minimizing a quadratic form over the standard simplex. Such a problem arises from numerous applications and is known to be NP-hard. In this talk, we present an analysis for random StQPs combining probability inequalities derived from both the first-order and second-order optimality conditions to quantify the sparsity of optimal solutions, significantly improving our previous results.

3 - A Fast First Order Algorithm for Linear Constrained L2-Lp Problem
　　Rongchuan He, City University of Hong Kong, AC1-G7722, Tat Chee Ave 83, Kowloon, 852, Hong Kong - PRC, rongchuhe2@gmail.com

We propose a fast first order algorithm for solving linear constrained L2-Lp problem, which is shown to have the worst complexity O(\epsilon^-2) to reach an ϵ-KKT point. Further more, we use several techniques, such as lower bound cut, noise de-blurring and so on, to improve the speed of the algorithm and the quality of the solution. Numerical results on several applications demonstrate the efficiency of our algorithm.

4 - SOCP Formulation for Singly Constrained QCQP
　　Rujun Jiang, Student, CUHK, Department of Seem,CUHK,HK, Hong Kong, Hong Kong - PRC, rjjiang@se.cuhk.edu.hk, Duan Li

We investigate a general class of singly constrained QCQP. Applying simultaneous block diagonalization, we obtain a congruent canonical form for both symmetric matrices in the objective function and in the constraint. We derive necessary conditions for the solvability of QCQP. For all solvable QCQP problems, we can transform them into their corresponding SOCP formulation. Compared to the state-of-the-art in formulating QCQP as SDP, our SOCP formulation delivers a much faster solution algorithm.

■ SD44

Hilton- Union Sq 24

Social Media and Virtual Worlds

Sponsor: Information Systems
Sponsored Session

Chair: Sunil Wattal, Temple Univ, 1810 N 13 Street, Philadelphia, PA, 19122, United States of America, swattal@temple.edu

1 - Anonymity and Information Revelation in Online Crowdfunding
　　Sunil Wattal, Temple Univ, 1810 N 13 Street, Philadelphia, PA, 19122, United States of America, swattal@temple.edu, Gordon Burtch, Anindya Ghose

Most online crowdfunding platforms maintain a public record of transactions while providing users with transaction-level information controls, which enable them to conceal their identity or contribution amount. In this study, we explore the impact of these information control mechanisms on crowdfunder behavior, acknowledging possible positive (e.g., comfort) and negative (e.g., privacy priming) impacts. We also discuss the implications of our findings for the design of online platforms.

2 - Through the Looking Glass: The Relationship between Real World and Virtual World Behavior
　　Michael Frutiger, PhD Candidate, GT Scheller College of Business, 800 West Peachtree Street, Atlanta, GA, 30308, United States of America, mike.frutiger@scheller.gatech.edu, Eric Overby, D. J. Wu

Online services increasingly support complex individual expression by providing rich environments that are substantially abstracted from real-world experiences. While real-world meaning is often inferred from user online behavior (and vice versa), there is a limited understanding of how these are related. Using a combination of survey and archival data, this study contributes to a foundational understanding of the relationship between an individual's real world and virtual world behavior.

3 - Impact of Platform Integration on Consumer Demand in Complementary Markets
　　Zhuoxin Allen Li, PhD Student, University of Texas at Austin, 2110 Speedway Stop B6500, Austin, TX, 78703, United States of America, zhuoxin.li@phd.mccombs.utexas.edu, Ashish Agarwal

Platform owners often seek for complementary innovations from third-party providers (third-party contents), while at the same time providing their own applications to consumers (first-party contents). Using the Facebook platform as an example, we study the impact of Facebook's acquisition and tighter integration of Instagram on consumer demand for Instagram and other photo-sharing applications provided by third-party developers.

■ SD45

Hilton- Union Sq 25

INFORMS BOM Best Working Paper Award Finalist Presentations

Sponsor: Behavioral Operations Management

Sponsored Session

Chair: Brent Moritz, Assistant Professor, Penn State University, 469 Business Building, University Park, PA, 16802, United States of America, bmoritz@psu.edu

1 - INFORMS BOM Section Best Working Paper Award

Brent Moritz, Assistant Professor, Penn State University, 469 Business Building, University Park, PA, 16802, United States of America, bmoritz@psu.edu

The three finalists from the 2014 best working paper competition will be presenting their papers.

■ SD46

Hilton- Lombard

New Developments on MINLP and MIQCP

Sponsor: Optimization/Integer and Discrete Optimization

Sponsored Session

Chair: Daniel Bienstock, Columbia University, 500 W. 120th Street, New York, NY, United States of America, dano@columbia.edu

1 - A Two-Variable Analysis of the Two-Trust-Region Subproblem

Boshi Yang, University of Iowa, Department of Mathematics, 14 MacLean Hall, Iowa City, IA, 52242, United States of America, boshi-yang@uiowa.edu, Samuel Burer

The two trust-region subproblem (TTRS) minimizes a general quadratic function over the intersection of two ellipsoids. For this problem, a general semidefinite-programming (SDP) relaxation admits a gap. In this paper, for the special case of TTRS with two variables, we fully characterize the remaining valid inequalities to close the gap. We also discuss computational issues and generalizations to the case of an arbitrary number of variables.

2 - Branch-and-Cut for Integer Programs with Complementarity Constraints

Ismael de Farias, Texas Tech, Department of Industrial Engineering, Lubbock, TX, United States of America, ismael.de-farias@ttu.edu

We give new inequalities valid for the complementarity-constrained optimization problem (CCOP), and in particular for CCOPs that are mixed-integer. We then present an extensive computational study where we discuss the effectiveness of different formulations for CCOP and the dramatic reduction in computational time, over some professional optimization solvers, that results from using the inequalities, particularly when the variables are constrained to be integers.

3 - Extended Formulations for Conic Quadratic Mixed Integer Programming

Juan Pablo Vielma, Assistant Professor, Massachusetts Institute of Technology, E62-561, 77 Massachusetts Ave, Cambridge, MA, 02142, United States of America, jvielma@mit.edu

An extended formulation for Mixed Integer Programming (MIP) is a formulation that uses a number of auxiliary variables in addition to the original or natural variables of a MIP. Extended formulations for linear MIP have been extensively used to construct small, but strong formulations for a wide range of problems. In this talk we consider the use of extended formulations in quadratic MIP and show how they can be used to improve the performance of branch-and-cut algorithms.

4 - Progress on Solving Quadratically Constrained Optimization Problems

Daniel Bienstock, Columbia University, 500 W. 120th Street, New York, NY, United States of America, dano@columbia.edu

We present results and survey older results on solving optimization problems subject to multiple quadratic constraints, starting with the classical CDT (Celis Dennis Tapia) problem (minimizing a general quadratic subject to two ellipsoidal constraints).

■ SD47

Hilton- Mason A

Computations and Applications of Stochastic/Robust Optimization

Sponsor: Optimization/Optimization Under Uncertainty

Sponsored Session

Chair: Siqian Shen, Assistant Professor, University of Michigan, 2793 IOE Building, 1205 Beal Avenue, Ann Arbor, MI, 48109, United States of America, siqian@umich.edu

1 - Stochastic Inventory Systems with Service Level Constraints: Structures and Approximations

Yuchen Jiang, University of Michigan, G815 IOE Building, 1205 Beal Avenue, Ann Arbor, MI, 48109, United States of America, ycjiang@umich.edu, Cong Shi, Siqian Shen

We study multiperiod stochastic inventory systems with probabilistic service level guarantees for restricting stockout probabilities. We prove that base-stock policies are optimal in the backlogging model and partially characterize optimal policies in the lost-sales model with positive lead time. We also propose an efficient approximation algorithm that admits a worst-case performance guarantee of 2 for the backlogging model and give an effective heuristic policy for the lost-sales model.

2 - A New Method for Solving Large-scale Multi-stage Stochastic Integer Programs

Osman Ozaltin, Assistant Professor, North Carolina State University, Industrial and Systems Engineering, Raleigh, United States of America, oyozalti@ncsu.edu, Burhaneddin Sandikci

Many large-scale multi-stage stochastic integer programs are among the most computationally challenging optimization problems. We propose a new solution method based on scenario decomposition, which is inherently parallelizable. Computational experiments demonstrate that the proposed method scales nicely with problem size and produces high quality solutions to practical instances within a reasonable time.

3 - Appointment Scheduling in Two-stage Stochastic Service Systems

Qingxia Kong, Assistant Professor, Universidad Adolfo Ibañez, Av. Diagonal Las Torres 2700, 531C, Penalolen, Santiago, Chile, q.kong@uai.cl, Chung-Piaw Teo, Zhichao Zheng

We study the design of healthcare appointment system when the patients need to go through two stages of service with stochastic duration. The problem is motivated by a case from en eye clinic where the patients have to take some tests (e.g., visual acuity test, dilation, etc.) before the consultation with the doctor. We use a network flow model to capture the dynamics of the system and develop a co-positive program to solve the appointment scheduling problem.

4 - Solution of Moment Robust Optimization using a New Cutting Surface Algorithm

Sanjay Mehrotra, Professor, Northwestern University, 2145 Sheridan Rd, Industrial Engineering & Mgmt. Sciences, Evanston, IL, 60208, United States of America, mehrotra@northwestern.edu

A central cutting surface method for semiinfinite convex problem, and its use to develop an algorithm for distributional robust optimization is presented. The uncertainty set consists of distributions with bounds on generalized moments of any arbitrary order. Results showing improvements over cutting plane approaches are presented. Computational experience and theoretical results on this moment robust optimization framework will also be presented.

■ SD48

Hilton- Mason B

Applications of Stochastic Programming

Sponsor: Optimization/Optimization Under Uncertainty

Sponsored Session

Chair: Kai Huang, Dr., McMaster University, 1280 Main St. W, Hamilton, On, L8S 4L8, Canada, khuang@mcmaster.ca

1 - Total Power Optimization of Multiple Wind Turbines
Shengyuan Chen, Assistant Professor, York University, 4700 keele street, Toronto, Canada, chensy@mathstat.yorku.ca, Yousef Akhavan, Dong Liang

Though the optimal operating point of a single wind turbine is known, the optimal operation of multiple wind turbines of a wind farm is a less explored area. We model the problem as a PDE-constrained optimization.

2 - Inventory Management Based on Target-Oriented Robust Optimization
Yun Fong Lim, Associate Professor, Singapore Management University, Lee Kong Chian School of Business, 50 Stamford Road, Singapore, 178899, Singapore, yflim@smu.edu.sg, Chen Wang

We propose a target-oriented robust optimization approach to solve a multi-product, multi-period inventory management problem subject to ordering capacity constraints. By tuning a cost target, we can achieve a balance between expected cost and the associated cost variance. Our approach significantly outperforms traditional methods based on dynamic or stochastic programming if inaccurate demand distributions are used. We apply our approach to two case studies from different industries.

3 - Resource Planning under Uncertainty
Haitao Li, Associate Professor, College of Business Administration, 229 ESH, One University Blvd, St. Louis, MO, 63121-4400, United States of America, lihait@umsl.edu, Carlos Valencia, Cipriano Santos, Sergio Perez, Ivan Perez, Marcos Vargas

Service enterprises face various uncertainties of project win probability and attrition in their daily operations. We have extended our existing deterministic resource planning (RP) model, developed at HP, to a stochastic one for explicitly handling uncertainties. Various efficient algorithms are developed to solve large-size problems with up to thousands of resources and jobs. Comprehensive computational study has shown significant benefit of our methodology for real world applications.

■ SD49

Hilton- Powell A

Optimal Allocation of Scarce Infrastructure Capacity: Lessons from Different Network Industries

Sponsor: Optimization/Network Optimization

Sponsored Session

Chair: Mort Webster, Associate Professor, Penn State, 123 Hosler Bldg, State College, PA, 16802, United States of America, mort@MIT.EDU

1 - Design of Capacity Pricing and Capacity Allocation Mechanisms in Shared Railway Systems
Maria Teresa Pena Alcaraz, Massachusetts Institute of Technology, 77 Massachusetts Avenue, E40-246, Cambridge, Ma, 02139, United States of America, maitepa@MIT.EDU, Joseph Sussman, Mort Webster, Andres Ramos Galan, Jose A. Gomez-Ibanez

The use of shared railway systems enables high utilization of rail infrastructure. High utilization translates into efficiency gains for railways where infrastructure is often expensive and scarce. However, shared use requires the design of capacity pricing and allocation mechanisms to coordinate the infrastructure manager and the train operators (which trains access the system, when and at what price). This research analyzes how the design of these mechanisms impacts the system performance

2 - Design of a Capacity Allocation Mechanism for Airport Congestion Mitigation
Alexandre Jacquillat, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Building E40-246, Cambridge, MA, 02139, United States of America, alexjacq@mit.edu, Amedeo Odoni, Mort Webster

We design a mechanism for allocating airport capacity to competing airlines to mitigate congestion. We consider airlines' preferred flight schedules and airport capacity estimates. We develop a flight rescheduling approach to meet efficiency (minimizing scheduling changes), equity (balancing fairly changes across airlines) and reliability (reducing delays) objectives. It integrates an Integer Programming

scheduling model, a Dynamic Programming operational model and a queuing model of congestion.

3 - Allocating and Planning Transmission in Competitive Power Markets
Jonathan Ho, Johns Hopkins University, 313 Ames Hall, Baltimore, MD, United States of America, jho19@jhu.edu, Ben Hobbs, Pearl Donohoo-Vallett, Francisco Munoz, Ozge Ozdemir

Electric transmission planning and allocation is radically changing due to restructuring, which has separated generation and transmission ownership, and the increasing importance of small-scale (distributed) generation and remote large-scale renewable power sources. Transmission planning must consider long-run uncertainties and the response of generation siting and operating decisions, implying a important role for stochastic, multi-level optimization. We provide computational examples.

4 - A Case for Virtualizing the Electric Utility in Cloud Data Centers
Bhuvan Urgaonkar, Associate Professor, Pennsylvania State University, 338D IST Building, State College, PA, 16802, United States of America, bhuvan@cse.psu.edu

Several shortcomings arise from the big gap that exists between the pricing interfaces exposed by electric utilities to clouds and by clouds to their tenants. To overcome these, we propose the idea of a virtual electric utility that cloud providers should expose to individual tenants. We discuss initial ideas for pricing design and cost-effective control in such environments.

■ SD50

Hilton- Powell B

Network Design with Hubs I

Cluster: Network Design

Invited Session

Chair: Hans-Jurgen Sebastian, Professor, RWTH Aachen University, Kackertstrafle 7B, Aachen, NR, D-52062, Germany, sebastian@or.rwth-aachen.de

1 - Modeling Hub Location and Network Design with Fixed and Variable Costs
James Campbell, campbell@umsl.edu, Ricardo Saraiva de Camargo, Gilberto de Miranda Jr., Morton O'Kelly

Many hub location models adopt restrictive assumptions on the topology, path lengths or cost structure. We present a new hub location and network design model with fixed and variable costs for all arcs that allows direct O-D arcs and incomplete hub networks. Results document a wide range of different types of optimal hub networks that emerge based on the relative cost pressures.

2 - Consolidation of Residual Volumes in a Parcel Service Provider's Long-haul Transportation Network
Martin Baumung, RWTH Aachen University, Kackertstr. 7, Aachen, 52072, Germany, baumung@or.rwth-aachen.de, Halil Ibrahim Guenduez

We consider the direct long-haul transportation network of a parcel service provider where transports are carried out using swap bodies. Our focus is on residual volumes, which are not enough to fill a swap body, and investigate how consolidation using hubs can lead to cost reduction through better capacity utilization. We developed a corresponding model minimizing total costs consisting of transportation costs for the swap bodies and costs for the additional sorting required in the hubs.

3 - Planning Tank Wash Activities for Dispatch Optimization in Bulk Transport Operations
Ted Gifford, Distinguished Member of Technical Staff, Schneider National Inc., 3101 Packerland Dr., Green Bay, WI, 54313, United States of America, giffordt@schneider.com

Over-the-road transportation of liquid bulk chemicals are significantly complicated by requirements to wash and prep tanker trailers between shipments. These washes occur at a limited number of facilities distributed across the service region. We consider these facilities as de facto hubs in a network and describe methods to provide minimum cost solutions for assigning tankers to wash facilities and optimal matching of drivers and tanker trailers to shipments.

■ SD51

Hilton- Sutter A

Recent Advances in Numerical Aspects for Nonlinear Programming

Sponsor: Optimization/Nonlinear Optimization

Sponsored Session

Chair: Andreas Waechter, Associate Professor, Northwestern University, 2145 Sheridan Road, Evanston, IL, 60208, United States of America, andreas.waechter@northwestern.edu

1 - JuMP: Nonlinear Modeling with Exact Hessians in Julia
Miles Lubin, MIT Operations Research Center, 77 Massachusetts Avenue, Bldg. E40-149, Cambridge, MA, 02139, United States of America, mlubin@MIT.EDU, Iain Dunning, Joseph Huchette

We describe the recent advances for nonlinear programming in JuMP, a solver-independent easy-to-use open-source algebraic modeling language built on top of the Julia programming language. This includes a reimagined implementation of Automatic Differentiation (AD) techniques for computing exact sparse Hessian matrices which takes advantage of Julia's advanced technical features like just-in-time compilation and metaprogramming. We present performance comparisons with AMPL.

2 - A Derivative-free Method for Solving Nonlinear Problems with Deterministic Noise
Andreas Waechter, Associate Professor, Northwestern University, 2145 Sheridan Road, Evanston, IL, 60208, United States of America, andreas.waechter@northwestern.edu, Irina Dolinskaya, Alvaro Maggiar

We present a derivative-free algorithm for problems with deterministic noise. In contrast to previously proposed methods, we do not assume a stochastic objective function whose value is determined as the expected value of a random variable. Instead, the algorithm optimized a modified objective function that is smoothed using a Gaussian kernel. The method is based on an approximation of the modified objective function that is based on random sampling.

3 - Experiments with Linear and Nonlinear Optimization using Quad Precision
Ding Ma, Stanford University, Dept of MS&E, Huang Engineering Center, Stanford, CA, 94305, United States of America, dingma@stanford.edu, Michael Saunders

For challenging numerical problems, Kahan has said that "default evaluation in Quad is the humane option". We describe experiments on multiscale linear and nonlinear optimization problems using a Quad implementation of MINOS.

■ SD52

Hilton- Sutter B

Advances in Binary Quadratic Programming

Sponsor: Optimization/ Linear and Conic Optimization

Sponsored Session

Chair: Nathan Krislock, Northern Illinois University, Department of Mathematical Sciences, DeKalb, IL, 60115-2888, United States of America, krislock@math.niu.edu

1 - Quadratization of Pseudo-Boolean Functions
Endre Boros, Distinguished Professor, Rutgers University, 100 Rockafeller Road, Piscataway, NJ, 08854, United States of America, endre.boros@rutgers.edu, Martin Anthony, Yves Crama, Aritanan Gruber

Representing high degree binary optimization problems as equivalent quadratic optimization is an idea introduced originally by Rosenberg in 1975. Such a transformation allows the derivation of persistencies, leading to simplifications in the problem. The price we pay is the higher number of variables. In this research we provide new quadratization algorithms, and tight lower and upper bounds for the number of additional variables.

2 - Separating Hierarchical Cuts to Strengthen Semidefinite Relaxations of Max-Cut Problems
Elspeth Adams, Polytechnique Montreal, Montreal, Canada, elspeth.adams@polymtl.ca, Miguel Anjos, Franz Rendl, Angelika Wiegele

The max-cut problem can be closely approximated using the basic semidefinite relaxation. This relaxation can be further improved by adding valid inequalities. We propose projection polytopes as a new way to improve the relaxation. We further discuss the problem of identifying promising projection polytopes to add to the relaxation. Theoretical and computational results will be presented.

3 - Some Experiences with Solving Semidefinite Programming Relaxations in Computational Biology
Alexander Engau, Assistant Professor, University of Colorado Denver, 1250 14th Street, Denver, CO, 80202, United States of America, aengau@alumni.clemson.edu

We present two recent integer programming models in molecular biology and study practical reformulations to compute solutions to some of these problems. In extension of previously tested linearization techniques, we formulate a class of corresponding semidefinite relaxations and discuss practical rounding strategies to find good feasible approximate solutions. Our computational results highlight the possible advantages and remaining challenges of this approach especially on large-scale problems.

4 - BiqCrunch: A Semidefinite-based Solver for Binary Quadratic Problems
Nathan Krislock, Northern Illinois University, Department of Mathematical Sciences, DeKalb, IL, 60115-2888, United States of America, krislock@math.niu.edu, Jérome Malick, Frédéric Roupin

BiqCrunch is a branch-and-bound solver for finding exact solutions of any 0-1 quadratic problem, such as Max-Cut, Max-k-cluster, and Max-independent set. The bounds are based on a regularized semidefinite relaxation and are efficiently computable using eigenvalue decomposition and a quasi-Newton optimization method. The resulting semidefinite bounding procedure gives us a competitive branch-and-bound algorithm for solving many binary quadratic problems to optimality.

■ SD53

Hilton- Taylor A

Robust and Data-Driven Portfolio Optimization

Cluster: Optimization in Finance

Invited Session

Chair: Daniel Kuhn, EPFL, EPFL CDM MTEI RAO, Station 5, Lausanne, 1015, Switzerland, daniel.kuhn@epfl.ch

1 - Tracking-Error Models for Multiple Benchmarks: Theory and Empirical Performance
Zhichao Zheng, Assistant Professor, Singapore Management University, Lee Kong Chian School of Business, 50 Stamford Road, Singapore, 178899, Singapore, danielzheng@smu.edu.sg, Yunchao Xu, Karthik Natarajan, Chung-Piaw Teo

We propose a new multiple-benchmark tracking-error model for portfolio selection. We construct a strategy to track the highest return from a set of benchmarks, by minimizing a quadratic loss function. This portfolio strategy retains features of the linear combination rule, with weights determined by the probability that each benchmark portfolio attains the highest return among all the benchmark portfolios. We develop the theory and describe several applications of this new approach.

2 - Portfolio Optimization with Ambiguous Correlation and Stochastic Volatilities
Chi Seng Pun, The Chinese University of Hong Kong, Rm2202, PGH2, CUHK, Shatin, N.T., Hong Kong, Hong Kong - PRC, cspun@cuhk.edu.hk, Hoi Ying Wong, Jean-Pierre Fouque

In a continuous-time economy, we investigate the asset location problem among a risk-free asset and two risky assets with an ambiguous correlation between the two risky assets. We formulate the robust portfolio selection as the utility maximization problem over the worst-case scenario with respect the possible choice of correlation. We solve the problem under the Black-Scholes model using theory of G-Brownian motions. We then extend the problem to stochastic volatility models.

3 - Robustifying Convex Risk Measures for Linear Portfolios: A Non-Parametric Approach
David Wozabal, Technische Universitat München, Arcisstrafle 21, Munich, 80333, Germany, david.wozabal@tum.de

We introduce a framework for robustifying convex risk measures. The robustified risk measures are defined as the worst case portfolio risk over neighborhoods of a reference probability measure. It is shown that the optimization problem of finding the worst-case risk can be solved in closed form. The resulting robust risk measures are computationally tractable and a numerical study shows that in most cases they perform significantly better out-of-sample than their non-robust variants.

4 - Robust Growth-Optimal Portfolios
Daniel Kuhn, EPFL, EPFL CDM MTEI RAO, Station 5, Lausanne, 1015, Switzerland, daniel.kuhn@epfl.ch

The log-optimal portfolio is known to outperform any other portfolio in the long run if stock returns are i.i.d. and follow a known distribution. In this talk, we establish similar guarantees for finite investment horizons where the distribution of stock returns is ambiguous. By focusing on fixed-mix portfolios, we exploit temporal symmetries to formulate the emerging distributionally robust optimization problems as tractable conic programs whose sizes are independent of the investment horizon.

■ SD54

Hilton- Taylor B

Financial Services Section Student Paper Competition

Sponsor: Financial Services Section

Sponsored Session

Chair: Jim Bander, National Manager, Decision Science, Toyota Financial Services, Chandler, AZ, 85226, United States of America, jim.bander@gmail.com

1 - Risk Analysis and Hedging of Parisian Options
Dong-Young Lim, Ph.D. Student, KAIST, 291 Daehak-ro, Yuseong-gu, Industrial and Systems Engineering,KAIST, Daejeon, Ch, 305-701, Korea, Republic of, ldy1848@kaist.ac.kr, Kyoung-Kuk Kim

A Parisian option is a variant of barrier options. We study its greeks via Laplace transform and conduct risk analysis, showing that theta is important to understand the behavior of a Parisian option and how it can make dynamic hedging fail. As an alternative, we propose a quasi-static hedging strategy by decomposing a Parisian option into other contingent claims which are statically hedged. Numerical comparisons of dynamic and static hedging are reported.

2 - Employee Stock Option Valuation with Job Termination Risk and Jumps in Stock Price
Haohua Wan, PhD Student, UIUC, Room 14 Transportation Bldg, 104 S. Mathews Ave, Urbana, IL, 61801, United States of America, hwan3@illinois.edu, Tim Leung

This paper studies an Employee stock options (ESOs) valuation framework that accounts for job termination risk and jumps in stock price under general Levy dynamics, which shows that the optimal exercise boundary and ESO cost can be determined by solving an inhomogeneous partial integro-dierential variational inequality (PIDVI).

3 - Equilibrium Asset Pricing with Rational and Irrational Investors
Jing Guo, Columbia University, 500 W 122nd Street, Apt. 1E, New York, NY, 10027, United States of America, jg3222@columbia.edu, Xuedong He

We study a multi-period asset pricing problem with rational investors having recursive utility preferences and irrational investors having additional CPT utility of gains and losses. In the logarithmic utility case, we derive the unique equilibrium analytically, propose a stock performance measure that determines the irrational investors' stock holding and show the market dominance of the rational investors in the long run. In the general case, we develop an algorithm to compute the equilibrium.

4 - Optimal Mean Reversion Trading with Transaction Cost and Stop-Loss Exit
Xin Li, Columbia University, 500 West 120th Street, New York, United States of America, xl2206@columbia.edu, Tim Leung

Motivated by the industry practice of pairs trading, we study an optimal double stopping problem to analyze the timing to start and subsequently liquidate the position subject to transaction costs and stop-loss constraint. We apply a probabilistic methodology and derive the optimal price intervals for entry and exit.

5 - Robust Investment Management with Uncertainty in Fund Manager Asset Allocation
Yang Dong, Senior Analyst, J.P. Morgan, 330 E. 46th street, Apt 2A, New York, NY, 10017, United States of America, woshidongyang@gmail.com, Aurelie Thiele

In this paper, we propose a robust framework that takes into account the uncertainty stemming from the fund managers' allocation in the context of portfolio management. We assume that only bounds on the fund managers' holdings are available. Numerical experiments suggest that our robust model provides better protection against risk than the nominal model when the fund managers' allocations are not known precisely.

■ SD55

Hilton- Van Ness

Meta-control Techniques for Non-convex Optimization

Sponsor: Optimization/Global Optimization & MINLP

Sponsored Session

Chair: Zelda Zabinsky, Professor, University of Washington, Industrial & Systems Engineering, University of Washington, Box 352650, Seattle, WA, 98195-2650, United States of America, zelda@u.washington.edu

1 - Solving Global Optimization Problems Via Stochastic Inclusion Sets
Wolf Kohn, Professor and Chief Scientist, University of Washington,

Industrial and Systems Engineering, University of Washington, Box 352650, Seattle, WA, 98195-2650, United States of America, wolfk@u.washington.edu, Zelda Zabinsky, Yanfang Shen

We present a feedback controller based on mean field theory that operates on domains defined by rules that represent physical principles, requirements and sensory data. The controller learns and adapts to changing environmental conditions by building a model that is dynamically tuned using data. Our approach captures multiple objectives and uncertainties by propagating sets of points towards a set of non-dominated (Pareto) solutions using a dynamic set inclusion approach and turnpike theory.

2 - A Stochastic Meta-control Bang-bang Solver for a Large Binary Integer Program
Pengbo Zhang, Ph.D. Student, University of Washington, Industrial and Systems Engineering, University of Washington, Box 352650, Seattle, WA, 98195-2650, United States of America, pbzhang@u.washington.edu, Wolf Kohn, Zelda Zabinsky

We develop a discrete stochastic meta-control algorithm that provides a good approximation to large-scale binary integer programs with low polynomial time complexity. The key idea is to balance the feasibility problem and optimizing the objective function. We define two coupled linear quadratic tracking problems, and iteratively solve them in sequence to improve the feasibility and optimality measures with respect to the original binary integer problem.

3 - A Fast Marching Algorithm with I-frames for Parameter Estimation in the Cloud for Demand Forecasting
Philip Placek, Ph.D. Student, University of Washington, Industrial and Systems Engineering, University of Washington, Box 352650, Seattle, WA, 98195-2650, United States of America, pcplacek@gmail.com, Wolf Kohn, Zelda Zabinsky

We develop a methodology for solving parameter estimation problems in a cloud environment for demand forecasting. The classic approach is to solve a nonlinear least squares optimization problem. Our method divides the optimization into a two-step process, the I-frame optimization and the incremental optimization. The incremental optimization connects the I-frame solutions at discrete points in the state space to approximate the solution of the original problem.

■ SD56

Hilton - Green Room

Software Demonstrations

Cluster: Software Demonstrations

Invited Session

1 - Online Games to Teach Operations and Supply Chain Management
Sam Wood, Responsive Learning Technologies, wood@responsive.net

Learn about online competitive exercises that are used in Operations Management courses and Supply Chain Management courses to teach topics like capacity management, lead time management, inventory control, supply chain design and logistics. These games are typically used as graded assignments.

2 - Provalis Research - How to Analyze Big Text Data with Text Analytics Tools
Normand Peladeau, President & CEO, Provalis Research, 2997 Ave Cedar, Montreal, QC, H3Y 1Y8, Canada, npeladeau@provalisresearch.com

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.

■ SD64

Parc- Cyril Magnin I

Scaling Limits of Stochastic Networks

Sponsor: Applied Probability Society
Sponsored Session

Chair: Kavita Ramanan, Professor, Brown University,
182 George St, Providence, RI, 02912, United States of America,
kavita_ramanan@brown.edu

1 - A Decentralized Variant of a Limited Flexibility System

John Tsitsiklis, Massachusetts Institute of Technology, Cambridge,
Ma, 02139, United States of America, jnt@mit.edu, Kuang Xu

We consider a multiserver system with a limited degree of flexibility, whereby a
fraction p of the total available service rate resides at a flexible server that serves
jobs from a longest queue. For large systems, The resulting delay is known to be
very favorable. We show the same for a "push" policy that diverts jobs to the
flexible server whenever a corresponding local queue exceeds a suitable threshold,
and for a broad class of interarrival and service time distributions.

2 - Ticket Queue with Impatient Customers: Optimal Ticket-based Staffing Policies

Li Xiao, National University of Singapore, BIZ 2 Building,Basement
B2-03, 1 Business Link, NUS Business School, singapore, Singapore,
lixiao@nus.edu.sg, Hanqin Zhang, Susan Xu, David Yao

For ticket queues with impatient customers, we use Markov chain analysis and
fractional programming to optimize the ticket-based staffing policy so as to
minimize the combined delay, abandonment and operating costs. We also develop
a random-walk/Brownian motion based approximation approach, and show its
asymptotic optimality.

3 - Diffusion Limits for Shortest Remaining Processing Time Queues under Nonstandard Spatial Scaling

Amber Puha, Professor, California State University San Marcos,
Department of Mathematics, 333 S. Twin Oaks Valley Road, San
Marcos, CA, 92058, United States of America, apuha@csusm.edu

We develop a heavy traffic diffusion limit theorem under nonstandard spatial
scaling for the queue length process in a GI/GI/1 shortest remaining processing
time queue. For processing time distributions with unbounded support, standard
diffusion scaling yields an identically zero limit. For a natural class of rapidly
varying processing time distributions that includes Weibull distributions, we specify
an alternative spatial scaling that produces a nonzero limit.

4 - Fluid Limits of a Randomized Load Balancing Model

Mohammadreza Aghajani, Brown University,
Mohammadreza_Aghajani@brown.edu, Kavita Ramanan

We introduce a general framework for studying a class of randomized load
balancing models in a system with a large number of servers that have generally
distributed service times and use a first-come-first serve policy within each queue.
Under fairly general conditions, we use an interacting measure-valued process
representation to establish fluid limits in these models, and discuss the insights that
the fluid limit provides into the performance of the system.

■ SD65

Parc- Cyril Magnin II

Case Competitions II

Sponsor: INFORM-ED
Sponsored Session

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

1 - Case Competition

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

INFORMed's Annual Cased Competition is an opportunity fir INFORMS Members
to showcase their efforts in the classroom. Cases are often later published.

2 - Case Study: using Regression to Improve Parole Board Decisions

Wendy Swenson-Roth, Associate Professor, Georgia State
University, 6230 Forest Park Dr, Signal Mountain, TN, 37377,
United States of America, wroth@gsu.edu

In this case, students are guided in the process of developing a regression model for
a parole board to predict recidivism of inmates coming up for parole. The case is
based off of an article from the Wall Street Journal, increasing the credibility of the
assignment and with the additional goal of exposure to outside sources of business
information. (A copy of the article is included at the end of the document for

reference.) Students are exposed to steps of the entire decision making process
instead of just focusing on tool usage. This allows for a broader discussion of the
implementation of regression. Students may be intimidated when asked to collect
their own data. Enhanced discussion of the process as part of this case helps better
prepare students to address data collection issues in future assignments.

3 - Growing Pains Case

Mina Hadianniasar, PhD Student, University of Arkansas,
Fayetteville, AR, United States of America, mhadiann@uark.edu,
Ashlea Milburn

This is a case study of transportation and distribution services in undergraduate
and graduate level transportation logistics or optimization courses. More
specifically, this case is appropriate for use in any course that emphasizes on
modeling, solving and interpreting the outputs of mixed integer programs by using
various heuristics related to vehicle routing problem (VRP). This problem is faced
by a real transportation company, where the company names and details have
been changed to protect privacy. The major problem considered in this case study is
estimating the annual freight transportation miles of Northeastern Home Goods
(NHG) which is a retail chain offering contemporary home furnishings for bargain
prices; if a single DC in Wilmington is used under the current service schedule.
Designing a set of feasible and minimum-distance routes to serve all customers of
NHG and determining the minimum number of drivers and vehicles required for
this feasible set are some other aims of this case. This case study is designed to
improve students' skills on modeling, finding set of feasible solutions using various
heuristics and interpreting the outputs of mixed-integer programs. During this case
study which is based on a real problem, students will learn how to model and
analyze real data set and interpret the outputs and solutions, in order to make
appropriate decisions leading to increasing their confidence and preparation for
confronting and managing real-life problems. Moreover, this case study helps the
students improve their skills to interpret results on a complex problem and
understand that large unsolvable problems can be divided into smaller more
manageable problems.

4 - Contracting for LTL Services at Hankey Industries

Matthew J. Drake, Duquesne University, Pittsburgh, PA,
United States of America, drake987@duq.edu

Michael Barth, logistics manager at Hankey Industries, has received contract
quotes from four less-than-truckload (LTL) carriers to supply its outbound
transportation services for the next 18 months. Michael must analyze the quotes
and determine which quote or combination of quotes to select to minimize the
total monthly transportation costs. This case fills a void in the existing library of
educational materials by focusing on the LTL industry, especially the intricacies of
pricing for LTL services. Very few, if any, published cases give students the
opportunity to perform contract analysis in the LTL industry. This is an important
part of many transportation analyst positions in third-party logistics (3PL)
providers, an industry that has recently lamented the lack of available talent
graduating from university programs. The case is appropriate for any
undergraduate or graduate course that includes coverage of transportation services.
The first part of the case requires that students determine the cost to ship to each
customer location using various contract options; students at any level should be
able to complete this task. Once all of the costs are determined, the students must
then develop and solve a binary integer program that determines the best
combination of contracts to select; this part may only be appropriate for graduate
and advanced undergraduate students.

5 - Material Handling Improvement in Warehouses by Parts Clustering

Mohammad Moshref-Javadi, Purdue University, 315 N. Grant St.,
Purdue University, West Lafayette, In, 47907,
United States of America, moshref@purdue.edu, Mark Lehto

In this study, several methods and algorithms were used to form part families and
determine the locations of parts in the layout. The applied clustering methods are
based on statistical tools. These methods help researchers and practitioners to
become familiar with new applications of statistical methods. In addition, this
approach is a new method in order picking problem and hopefully can trigger
more extensions and improvements of the techniques in facilities design problems.
This case study also teaches students four different layout design algorithms and
the best method among them to be applied. The results, algorithms, and
techniques utilized in this case study can be helpful to both students and
researchers to become familiar with new methods, as well as practitioners to
optimize facilities for performance improvement.

■ SD66

Parc- Cyril Magnin III

Recent Advances in Experimental Designs

Sponsor: Quality, Statistics and Reliability

Sponsored Session

Chair: Moein Saleh, Research Associate, Arizona State University, 699 S. Mill Ave., Tempe, AZ, 85281, United States of America, Moein.Saleh@asu.edu

1 - A Clustering-based Coordinate Exchange Algorithm for Finding G-optimal Experimental Designs

Moein Saleh, Research Associate, Arizona State University, 699 S. Mill Ave., Tempe, AZ, 85281, United States of America, Moein.Saleh@asu.edu

In experimental designs, the G optimality criterion minimizes the maximum prediction variance over the entire experimental design region. In this presentation, a hybrid of a clustering-based point exchange algorithm and a coordinate exchange algorithm is developed for obtaining G-optimal experimental designs for line

2 - Adding Realism to Choosing and Constructing Optimal Designed Experiments

Christine Anderson-Cook, Research Scientist, Los Alamos National Laboratory, PO Box 1663 MS F600, Los Alamos, NM, 87545, United States of America, c-and-cook@lanl.gov, Lu Lu

As computational power improves, statisticians can choose designs increasingly tailored to study experimental goals. Recent optimal designs allow more flexibility, but usually consider only one criterion. The Pareto Front approach adapts to different # of criteria, eliminates non-contenders based on user-specified criteria, and provides tools to select a design which best matches user needs. Examples illustrate choosing from a catalog of designs and constructing designs using a search algorithm.

3 - Projection Properties of Three-Level Fractional Factorial Designs under the Linear-Quadratic System

Arman Sabbaghi, Assistant Professor of Statistics, Purdue University, Department of Statistics, 150 N. University Street, West Lafayette, IN, 47907, United States of America, sabbaghi@purdue.edu

The linear-quadratic (LQ) system is important in applications because it yields partially aliased and interpretable interaction contrasts for quantitative factors. Projection properties of fractional factorial designs are evident from their indicator functions. By means of a new algebraic operation for calculation of indicator function coefficients, new insights and connections are obtained for different projection properties of three-level designs under the LQ system.

4 - Iterative Sparsity Search for Modeling Brand Correlation and Computer Experiments with Mixed Factors

Qiong Zhang, UW-Madison, 9406 West Brightway Circle, Madison, WI, 53705, United States of America, zhangqiong1985@gmail.com

We propose a statistical approach to estimating covariance structures of multiple brands with similar products in grocery stores. This approach models the sales performances of multiple brands in multiple markets using a multivariate spatial processes and develops an iterative sparsity search algorithm to estimate the model parameters. The effectiveness of the method is illustrated by examples from a consumer packaged goods database. Interestingly, the method is also applicable to computer experiments with quantitative factors and a large number of qualitative levels.

■ SD67

Parc- Balboa

Data Mining in Medical Decision Making and Bioinformatics Applications

Sponsor: Data Mining

Sponsored Session

Chair: Kamran Paynabar, Georgia Institute of Technology, 765 Ferst Drive, Atlanta, GA, 30327, United States of America, kamran.paynabar@isye.gatech.edu

1 - Modeling Outcomes of Cancer Screening

Alex Tsodikov, Professor of Biostatistics, University of Michigan, 1415 Washington Heights, Ann Arbor, MI, 48109, United States of America, tsodikov@umich.edu

Analysis of cancer data in the presence of screening is challenging because the phenotype observed at diagnosis and survival thereafter vary with cancer screening even in the absence of treatment benefit. In order to develop a foundation for decision making in the dynamic situation, we provide a statistical modeling approach and synthesize prostate cancer data from a variety of sources.

2 - Integrating Biological and Statistical Models for Predicting Complications in Radiation Therapy

Jing Li, Associate Professor, Arizona State University, jing.li.8@asu.edu, Xiaonan Liu

Intensity-modulated radiation therapy is a modern technique for treatment of aggressive cancers. Biological models exist for linking complications with radiation dose. While these models offer great biological insight, they do not consider individual patient difference. We propose an integrated approach that combines biological mechanisms and patient-specific data, to achieve better prediction and potentially individualized treatment.

3 - Aggregation of Statistical Findings, Case Study: BMR Estimation Models, White Males 8-18 Years Old

Mohammad S. Jalali, Virginia Tech / MIT, 113 Harvard St, Apt 1, Cambridge, MA, 02139, United States of America, mj@vt.edu, Hazhir Rahmandad, Kamran Paynabar

In this study, we present a general method to aggregate empirical statistical findings from prior studies. We present our method with a case study in obesity research where the literature provides over 100 equations to estimate Basal Metabolic Rate (BMR) as a function of different attributes (age, height, etc). There is currently no method that combines these equations into a more reliable one. Using our method, we aggregate BMR estimation models for a subpopulation (white males 8-18 years old).

4 - Measurement Error Isolation in Longitudinal MRI Data Analysis

Chitta Ranjan, Georgia Institute of Technology, 755 Ferst Drive NW, Atlanta, GA, United States of America, nk.chitta.ranjan@gatech.edu

MRI is common in hospitals for diagnosis, disease staging etc. Typically a patient undergoes MRI scanning in long intervals due to its harmful effects on health. This results into un-replicated longitudinal data and, owing to complexity of the procedure, with inherent measurement error. If this error is high then any inference is difficult to make. In this work we aim to measure and isolate the measurement error from the modeling error for better inferences using Bayesian mixed effect modeling.

■ SD68

Parc- Davidson

Interfaces Between Simulation and Optimization

Sponsor: Simulation

Sponsored Session

Chair: Tito Homem-de-Mello, Professor, Universidad Adolfo Ibañez, School of Business, Diagonal las Torres 2640, Santiago, Chile, tito.hmello@uai.cl

1 - Random Search vs Sample-average Approximation

Peter Glynn, Stanford University, Huang Engineering Center 357, Stanford, CA, 94305, United States of America, glynn@stanford.edu

We discuss and contrast random search algorithms with sample-average approximations (SAA). We show that the complexity of random search depends upon the problem instance in a fundamentally different way than does SAA, and note that random search can be implemented in such a way that its complexity is close to that obtained in the setting of deterministic function evaluations.

2 - Chance-constrained Problems and Rare Events: An Importance Sampling Approach

Tito Homem-de-Mello, Professor, Universidad Adolfo Ibañez, School of Business, Diagonal las Torres 2640, Santiago, Chile, tito.hmello@uai.cl, Javiera Barrera, Eduardo Moreno, Bernardo Pagnoncelli, Gianpiero Canessa

We study chance-constrained problems where the constraints involve the probability of a rare event. In this context, existing sampling-based algorithms require an impractical number of samples. Using a Sample Average Approximation approach combined with importance sampling techniques, we show how variance can be uniformly reduced so the problem can be solved with much fewer samples. We apply our methodology to a telecommunications problem and present numerical results to illustrate the ideas.

3 - Derivative-Free Optimization of Noisy Functions using a Trust Region Framework

Stephen Billups, Associate Professor, University of Colorado Denver, Dept of Math. and Stat. Sciences, CB 170, PO Box 173364, Denver, CO, 80217-3364, United States of America, Stephen.Billups@ucdenver.edu

Modern derivative-free trust region algorithms efficiently find local optima of functions where only function values (not derivatives) can be calculated. This makes them attractive for optimizing functions evaluated by computer simulations. However, noise or uncertainty, which is typically present in such function evaluations can pose significant problems for such algorithms. This talk describes a derivative-free trust region algorithm designed to robustly and efficiently handle such noise.

4 - Sequential Detection of Convexity from Noisy Function Evaluations

Nanjing Jian, PhD Student, Cornell University, School of ORIE, Rhodes Hall, Ithaca, NY, 14850, United States of America, nj227@cornell.edu, Susan Hunter, Shane Henderson

Given simulation estimates of function values at a finite set of points, we want to detect convexity or non-convexity of the true function on those points. We review a frequentist hypothesis test and introduce a sequential Bayesian test. The Bayesian test works for both independent sampling and CRN, and allows unknown variance, iteratively updating a posterior on the true function values. We approximate the probability that the function is convex based on the posterior using Monte Carlo.

■ SD69

Parc- Fillmore

Sustainable and Responsible Supply Chain Management

Sponsor: Energy Natural Resources and the Environment/ Sustainability and Environment

Sponsored Session

Chair: Jose Cruz, Associate Professor, School of Business, University of Connecticut, Storrs, CT, United States of America, Jose.Cruz@business.uconn.edu

1 - Corporate Social Responsibility and Performance in the Supply Chain Network

Trisha Anderson, Texas Wesleyan University, Fort Worth, TX, United States of America, trdanderson@txwes.edu, Zugang Liu

We study the level of corporate social responsibility (CSR) and performance over a period of seven years (2003-2009) to compare the relationship between activities, across time, and with different size firms for various industries identified by the Standard Industrial Classification codes. We explain and validate a dynamic panel regression model that is used in the supply chain network model.

2 - The Impact of Customer Satisfaction Function on Sustainable Remanufacturing of Commercial Returns

Farhad Azadivar, Professor, University of Massachusetts Dartmouth, 285 Old Westport Road, North Dartmouth, MA, 02747, United States of America, fazadivar@umassd.edu, Ardavan Ardeshirilajimi

Commercial returns are products returned by customers within a relatively short period after purchase due to perceived deficiencies. The environmental costs of disposal and wasted material have made remanufacturing almost a necessity. Common assumption has so far been that all customers have the same perception of deficiency. In this report an alternative is presented by considering the role of a customer satisfaction function in targeting the product quality and remanufacturing policies.

3 - How Coopetition Have Effect on Green Product Development?

Maryam Hafezi, Wilfrid Laurier University, 1207-125 Lincoln Road, Waterloo, ON, N2J 2N9, Canada, hafe1390@mylaurier.ca, Xuan Zhao

In this research, we use game-theoretic approach to see how competition affects the price, quantity and quality of green products. By considering three innovation strategies – independent innovation, investment sharing, and innovation sharing strategy – we try to help manufacturers know how much to cooperate and how much to compete.

4 - Economic Sustainability of Closed Loop Supply Chains: A Holistic Decision and Policy Analysis

Jose Cruz, Associate Professor, School of Business, University of Connecticut, Storrs, CT, United States of America, Jose.Cruz@business.uconn.edu, Sudip Bhattacharjee

This paper develops an end-to-end model of a closed-loop supply chain (CLSC), and analyzes the economic viability of participants in this chain. We model the lifecycle of consumer electronics good and implement a system dynamic (SD)

model to examine the complex interactions among different components. Our results highlight the product and marketing strategies that create profitable streams for all stakeholders in the chain for the closed-loop to be economically and environmentally sustainable.

■ SD70

Parc- Hearst

Analytics in the Petrochemical/Petroleum Industry

Sponsor: Energy Natural Resources and the Environment/ Natural Resources

Sponsored Session

Chair: Margery Connor, Chevron, 6001 Bollinger Canyon Road, San Ramon, United States of America, mhco@chevron.com

1 - O&G Value of Information of Appraisal Well with Continuous Distributions

Brian Putt, OC Manager, Chevron, 6001 Bollinger Canyon, San Ramon, CA, 94588, United States of America, brianputt@chevron.com

Traditional Value of Information requires Bayesian conditional probability assessments that are used in a decision tree with discrete outcomes. New modeling techniques enable the VOI analysis to consider continuous distribution. This presentation will contrast various VOI analyses techniques using an oil and gas upstream example and will introduce SIPmath to facilitate the probabilistic arithmetic of the VOI distributions using Excel only.

2 - R&D Roadmap for Aviation Biofuels: New Use for Decision Analysis Methods

Elizabeth Connelly, Graduate Research Assistant, University of Virginia, 151 Engineers Way, Charlottesville, VA, 22904, United States of America, ec5vc@virginia.edu, Lisa Colosi, James Lambert, Andres Clarens

Replacing petroleum-based jet fuel with renewable jet fuel addresses concerns related to environmental sustainability, price volatility, long-term supply, and national security. Multi-criteria decision analysis integrated with scenario analysis can be used to develop an R&D roadmap for promoting an aviation biofuel industry. Stakeholder preferences and uncertainties from emergent conditions are considered to produce a robust prioritization of R&D initiatives applicable to diverse groups.

3 - Rational Decision Making Model for Risk Assessment of Offshore Drilling

Maryam Tabibzadeh, University of Southern California, 1157 W., 30th St., Los Angeles, CA, United States of America, m.tabibzadeh@gmail.com

This paper introduces a rational decision making model, using the signal detection theory as a foundation, for risk assessment of misinterpreting a negative pressure test (NPT), as the primary means to ascertain well integrity during offshore drilling. This model proposes a structured framework to the practitioners of oil and gas industry for the interpretation of conducted NPTs and the analysis of involved decision making biases. This framework can be used in analyzing all high-risk operations.

■ SD71

Parc - Lombard

Panel Discussion: Government Auctions of Spectrum Licenses

Cluster: Auctions

Invited Session

Chair: Karla Hoffman, George Mason University, Fairfax, VA, United States of America, khoffman@gmu.edu

1 - Panel Discussion: Government Auctions of Spectrum Licenses

Moderator: Karla Hoffman, George Mason University, Fairfax, VA, United States of America, khoffman@gmu.edu, Panelists: Melissa Dunford, Brett Tarnutzer, Evan Kwerel

In 2015, the FCC will hold the first-ever "incentive auction" whereby the government buys back spectrum from TV broadcasters and then sells that spectrum for flexible wireless use. This panel will provide a historical view of all aspects of the auction from conceptualization, to auction design and finally testing and implementation. The panel will discuss how the agency interacted with Congress, OMB, the industry and the public. OR aspects of the problem will be presented.

■ SD72

Parc- Stockton

KINFORMS

Sponsor: KINFORMS (Korea Chapter)

Sponsored Session

Chair: Chang Won Lee, Professor, Hanyang University Business School, 222 Wangshimni-ro, Seoul, KR, 133-791, Korea, Republic of, leecw@hanyang.ac.kr

1 - Identifying the Impacts on the Social Enterprises Development in Cambodian Tourism Industry

Sungyong Choi, Assistant Professor, Yonsei University, 1 Yonseidae-gil, Wonju, 220-710, Korea, Republic of, sungyongchoi@gmail.com, Sonita Eng

This research focuses on the work of identifying the impacts on the Social Enterprises (SEs) development in Cambodian tourism industry. In this exploratory work, we verify the four key factors, which are legal framework, financing, ownership, and social capital. The study wishes to find out both positive and negative impacts that are influencing current state of these SEs by analyzing its strengths, weaknesses, opportunities and threats (SWOT).

2 - Supply Chain Success Factors and Performance: Trust, Involvement and Partnership Perspectives

Chang Won Lee, Professor, Hanyang University Business School, 222 Wangshimni-ro, Seoul, KR, 133-791, Korea, Republic of, leecw@hanyang.ac.kr, Sang Hyung Ahn

The study is to present the relationship between supply chain success factors and supply chain performance in terms of trust, involvement and partnership perspectives. The research model is developed and empirically tested by Korean manufacturers. The results shows significant implications of trust, involvement and partnership in exploring supply chain success factors affecting supply chain performances in Korea business settings.

3 - Price Competition or Uncertainty Reduction? An Investigation of Green Car Technology

Byung Cho Kim, Associate Professor, Korea University Business School, Hyundai Motor Hall, KUBS, Anam-dong, Seongbuk-gu, Seoul, 136-701, Korea, Republic of, bkim@korea.ac.kr, Hosun Rhim, Hongsuk Yang

This paper examines the strategic choice of the green vehicle manufacturers under competition, between price competition and uncertainty reduction. Grounded on a stylized model for platform and two-sided market, we find profit- and welfare-maximizing levels of prices and uncertainty reduction effort, and investigate how the scope of network externality and cost differential influence the manufacturer's and the social planner's strategic choices.

4 - A Study on Emergency Logistics Problem after Massive Natural Disaster

Sumin Han, Ph.D candidate, Seoul National University, 39-317, Dept. of Industrial Engineering,, Seoul National University, Shillim-don, seoul, 151-744, Korea, Republic of, hans8501@mailab.snu.ac.kr, Youngwoo Kim, Gyusun Hwang, Sangyun Choe, Jinwoo Park

The occurrences of massive disasters increase in the 2000s. To minimize the damages due to disasters, studies on emergency logistics have received a wide attention. It is a logistics problem with uncertain information. So in these studies, it is important to include measures from advanced ICT and optimization tools. We suggest a solution that evolves with the information content of the situation beginning from uncertainty. Finally a simulation study supports the validity of our approach.

5 - Use of Noncental Composite Designs for Sequential Assembly

JH Byun, Professor, Gteongsang National University, 501 Jinju-daero, Jijju, Gyeongnam, Jinju, 660-701, Korea, Republic of, jbyun@gnu.ac.kr

In this paper we propose a non-overlapping noncentral composite design (NNCD) that can be used effectively when the data analysis result of the first factorial design shows synergistic interaction effects. We present design matrices and experimental points for NNCDs with two and three factors, in which the first factorial design is assembled with the second factorial design sharing one design point. A simple method for estimating linear, interaction, and quadratic coefficients is also given.

6 - Sequential Capacity Allocation under Order Manipulation

Kun Soo Park, Assistant Professor, KAIST College of Business, 85 Hoegi-ro, Donegaemun,, Seoul, Korea, Republic of, kunsoo@business.kaist.ac.kr, Bosung Kim, Seyed Iravani

We consider an allocation of a supplier's capacity that is made sequentially. In particular, we analyze how the ordering strategy of manufacturers change if they are allowed to manipulate their orders from their actual needs.

7 - A Rectified LAD for Numerical Data

Cui Guo, Shantou University Business School, No.243, Daxue Road, Shantou, China, cguo@stu.edu.cn, Hong Seo Ryoo

LAD presents some limitations when analyzing numerical data, owing to a difference in structural properties of originally 0-1 data and binarized 0-1 data. This paper illustrates these limitations and develops a way to rectify the general LAD framework to more accurately analyze numerical data.

■ SD73

Parc- Mission I

ENRE Awards Session

Sponsor: Energy, Natural Res & the Environment/Energy

Sponsored Session

Chair: Miguel Anjos, Professor and Canada Research Chair, Polytechnique Montreal, C.P. 6079, Succ. Centre-ville, Montreal, QC, Canada, miguel-f.anjos@polymtl.ca

1 - ENRE Young Researcher Prize 2014

To Be Announced

This award is given annually to one or more young researcher(s) for an outstanding paper on the application of OR/MS to an important problem in energy, natural resources and/or the environment. The Prize serves as an esteemed recognition of promising colleagues who are at the beginning of their academic or industrial career.

2 - ENRE Best Student Paper Award 2014

To Be Announced

This award is given annually to the best paper dealing with Energy, Environmental, or Natural Resource issues by a student author who is presenting at the INFORMS Annual Meeting.

3 - ENRE Best Publication Award 2014 in Natural Resources

To Be Announced

This award is given annually to the best refereed journal article in the area of Natural Resources published within the two calendar years prior to the year in which the award is given.

4 - ENRE Best Publication Award 2014 in Energy

To Be Announced

This award is given annually to the best refereed journal article in the area of Energy published within the two calendar years prior to the year in which the award is given.

5 - ENRE Best Publication Award 2014 in Environment and Sustainability

To Be Announced

This award is given annually to the best refereed journal article in the area of Environment and Sustainability published within the two calendar years prior to the year in which the award is given.

■ SD74

Parc- Mission II

Analytics Case Studies

Sponsor: The Practice Track

Sponsored Session

Chair: Chris Fry, Managing Director, Strategic Management Solutions, PO Box 5721, Redwood City, CA, 94065, United States of America, chris@strategicmgmtsolutions.com

1 - Inventory Allocation in an eCommerce Fulfillment Network

Jagtej Bewli, Group Product Manager, WalmartLabs, 850 Cherry Avenue, San Bruno, CA, 94066, United States of America, jbewli@walmartlabs.com, Mohan Akella

eCommerce Inventory allocation poses new and interesting challenges in the areas of OR and Machine learning. Unlike physical retail, demand in an ecommerce network can be fulfilled from any node, which changes the concept of "In Stock" and the "Demand' at a node. In this talk, we will discuss the challenges of this structure as well as enhancements to demand forecast and network flow models that are needed to optimize ecommerce fulfillment operations.

2 - Spare Parts Inventory Management for Google's Data Centers

John Khawam, Operations Strategy Lead, Google Inc., 1600 Amphitheatre Parkway, Mountain View, CA, 94043, United States of America, johnkhawam@google.com

Our goal is to forecast and set inventory levels for spare parts that serve Google's Data Centers throughout the world. Server uptime is critical to Google, and spare parts are often the last defense in preventing down machines.

3 - NASA's SACE Analytic Software Demonstrates Hybrid Artificial Intelligence – Operations Research Serving Critical Space Station Operations
John Chachere, Sargeant, NASA Ames Research Center, Mountain View, CA, United States of America, john.chachere@gmail.com

NASA's Solar Array Constraints Engine (SACE) demonstrates hybrid artificial intelligence – operations research analytics serving critical operations. The SACE software has helped the International Space Station (ISS) flight controllers safely and effectively operate ISS solar arrays. Flight controllers must position the arrays to collect adequate power for life and experiments on the station, yet avoid numerous hazards, including thruster firings, environmental contamination, communications interference, and extra-vehicular activities. Within minutes, violating these constraints could result in catastrophic failure of ISS (loss of $100B station, a global partnership, and astronaut heroes). Analytically, SACE linear programming prioritizes the diverse constraints while knowledge-engineered constraint propagation optimizes across time. SACE has provided the Mission Control Center with awareness of operational constraints that are in danger of being violated either at the current time or in the immediate future, and given them the ability to plan solar array activities for periods of weeks into the future.

■ SD75

Parc- Mission III

Simulation Methods for Risk Analysis and Finance

Sponsor: Simulation
Sponsored Session

Chair: Marvin Nakayama, Professor, New Jersey Institute of Technology, Computer Science Department, 218 Central Avenue, Newark, NJ, 07102, United States of America, marvin@njit.edu

1 - Simulation of Tempered Stable Levy Bridges and its Applications
Kyoung-Kuk Kim, Associate Professor, Korean Advanced Institute of Science and Technology, 291 Daehak-ro, Yuseong-gu, Industrial and Systems Engineering,KAIST, Daejeon, Ch, 305-701, Korea, Republic of, catenoid@kaist.ac.kr

We consider tempered stable Levy subordinators and develop a bridge sampling method, i.e. sample paths conditioned on the end points. An approximate conditional PDF is derived using the double saddle-point approximation. The acceptance-rejection algorithm is then proposed using the known gamma and inverse Gaussian bridges as its proposals depending on a stable index. The method is applied to financial options under subordinated Brownian motion models and finite variation CGMY processes.

2 - A Sequential Procedure for Estimating Steady-State Quantiles
James Wilson, North Carolina State University, Dept.of Industrial & Systems Engineering, 111 Lampe Drive, Daniels Hall, Raleigh, NC, 27695, United States of America, jwilson@ncsu.edu, Anup Mokashi, Christos Alexopoulos, Kai-Wen Tien, David Goldsman

We formulate a fully sequential procedure yielding improved point and confidence-interval (CI) estimators for a steady-state quantile that incorporate effective methods to eliminate initialization bias in the point estimator and to adjust the CI half-length for the effects of skewness and correlation in the underlying simulation-generated process. We summarize the results of an experimental performance evaluation of the procedure.

3 - Stratified Estimators for Quantiles
Raghu Pasupathy, Associate Professor, Purdue University, Dept. of Statistics, West Lafayette, United States of America, pasupath@vt.edu, Soumyadip Ghosh

We consider quantile estimation in the context of streaming data.We present a new estimator obtained by adaptively stratifying incoming data, with the strata becoming progressively finer around the desired quantile. We find that the resulting reduction in storage is often dramatic, with negligible deterioration in estimator convergence rate. The method, while demonstrated for quantile estimation, seems to be applicable more widely.

4 - Confidence Intervals for a Quantile When Applying Latin Hypercube Sampling
Marvin Nakayama, Professor, New Jersey Institute of Technology, Computer Science Department, 218 Central Avenue, Newark, NJ, 07102, United States of America, marvin@njit.edu, Hui Dong

We develop confidence intervals (CIs) for a quantile when applying replicated Latin hypercube sampling (LHS). LHS reduces variance by stratifying inputs on all dimensions simultaneously. We use batching and sectioning to build asymptotically valid CIs. Similar to batching, sectioning CIs replace the batching estimator with the overall estimator. We establish the validity of the sectioning CI by first proving that a LHS quantile estimator satisfies a Bahadur representation.

■ SD76

Parc- Embarcadero

Innovations in Supply-Chain Operations

Sponsor: The Practice Track
Sponsored Session

Chair: Sam Eldersveld, Principle Research Scientist, Amazon, 333 Boren Ave. N., Seattle, WA, 98109, United States of America, sam.eldersveld@comcast.net

1 - Multimodel Inference as the Basis for Improved Supply-chain Planning
Sam Eldersveld, Principle Research Scientist, Amazon, 333 Boren Ave. N., Seattle, WA, 98109, United States of America, sam.eldersveld@comcast.net

Optimizing suppl-chain performance depends on good supply-chain planning; Future predictions of exogenous operational factors are crucial to meet this end. Multiple predictive models are available to help explain historical data and often no one model may be "perfect" over any time horizon. We present strategies for making better predictions from an a priori set of models based on information-theoretic and Bayesian criteria. The theory and application in supply chain settings will be presented.

2 - Large Scale Multi-item Order Optimization
Andrea Qualizza, Sr. Research Scientist, Amazon, Seattle, United States of America, qualizza@amazon.com

Near real-time multi-item order planning problems are computationally challenging since they entangle a number of nested NP-hard problems. In this talk we present an approach based on Generalized Networks that trades off some of the complexity of the nested problems and is able to get solutions in useful time for tens of millions of multi-orders simultaneously. Several business constraints, like for example load balancing across warehouses, are readily embedded in the model.

3 - Network Solutions and Shipment Optimization at Starbucks
Stephen Stoyan, Manager, Advanced Analytics, Starbucks Coffee Company, 2401 Utah Ave. S., Seattle, WA, 98134, United States of America, stoyan@mie.utoronto.ca

The supply chain network at Starbucks Coffee Company is facing new complexities on how products are shipped, stored, and distributed in the network. The advanced analytics team at Starbucks has developed a set of tools that optimizes the network, consolidates shipments, and tackles new challenges faced in the supply chain. We present the set algorithms that has already lead to millions of dollars in savings and growing.

4 - Hybrid Metaheuristics and Large Neighborhoods for the Clustered Vehicle Routing Problem
Thibaut Vidal, LIDS — Massachusetts Institute of Technology, 77 Massachusetts Avenue, Room 32-D566, Cambridge, MA, 02139, United States of America, vidalt@mit.edu, Anand Subramanian, Maria Battarra, Günes Erdogan

A vehicle routing problem with cluster constraints is studied, in which deliveries within a cluster must be serviced consecutively by the same vehicle. Postal services can include such features when considering zip code restrictions. Our newly-proposed hybrid metaheuristics generate very high quality solutions in about five minutes on a single CPU, for instances with up to 1200 service locations.

■ SD77

Parc- Market Street

Joint Session Analytics/CPMS: Panel Discussion: Making the Connection Between Analytics and OR

Sponsor: Analytics & CPMS, The Practice Section
Sponsored Session

Chair: Don Kleinmuntz, Professor of the Practice of Business Analytics, University of Notre Dame, 452 W Huron St, Chicago, Il, 60654, United States of America, don@kleinmuntzassociates.com

1 - Making the Connection between Analytics and OR
Don Kleinmuntz, Professor of the Practice of Business Analytics, University of Notre Dame, 452 W Huron St, Chicago, Il, 60654, United States of America, don@kleinmuntzassociates.com, Glenn Wegryn, Jack Levis, Anne Robinson

Analytics and related topics like Big Data continue to attract tremendous attention in the business community. This panel, consisting of accomplished industry executives at the intersection of OR and Analytics, will address the implications for the OR profession and how INFORMS is responding to this opportunity. Questions, comments, and discussion from the audience are actively encouraged.

■ SD78

Parc- Mason

Predictive Analytics Models and Methods

Sponsor: Analytics
Sponsored Session

Chair: Michael N. Katehakis, mnk@rutgers.edu

1 - Adaptive Task Assignment Policies for Multi-channel Call Centers
Ger Koole, VU, De Boelelaan 1105, Amsterdam, Netherlands,
ger.koole@vu.nl, Benjamin Legros, Oualid Jouini

In many situations scheduling policies depend on the parameters of the system.
However, often we have at best unreliable estimates of these parameters. In this
paper we propose a policy for task assignment in call centers that automatically
adapts itself to changes in the parameters without estimating these parameters but
by changing the policy on the basis of changes in the objective value.

2 - On Single Payout Multi-armed Bandits and the Secretary Problem
Wesley Cowan, Rutgers University, Dept. of Mathematics,
Piscataway, NJ, United States of America,
cwcowan@math.rutgers.edu, Michael N. Katehakis

In this talk we present several extensions to the theory of the multi -armed bandit
problem that are made possible by a new model of single payout bandits. We
discuss applications to biding in auctions and extensions of the secretary problem.

**3 - Multi-agent Coordination in Team Search Problems under a
Bayesian Framework**
Peter Beling, Associate Professor, University of Virginia, 151
Engineer's Way, Charlottesville, VA, 22904, United States of
America, pb3a@virginia.edu, Yijia Zhao, Stephan D. Patek

We consider a decentralized path-planning problem for team Bayesian search.
Each agent must formulate and solve a decentralized planning problem to compute
its future actions. This planning problem is formulated as a partially observed
Markov decision problem whose objective function is evaluated based on the
assumption that all agents will use the same mixed strategy policy. We propose
three dynamic programming heuristics for this planning problem.

4 - Predicting Inventory Status from Sales Transactions Data
Garrett van Ryzin, Columbia University, 412 Uris Hall,
Columbia University, New York, NY, 10027, gjv1@columbia.edu,
Juan Chaneton, Margaret Pierson

We use Monte Carlo Markov Chain (MCMC) methods to develop predictions of
inventory status using only sales transactions data. Our predictions are shown to be
effective at identifying out-of-stock status on both simulated and field tests and
perform well relative to more naïve predictors. Such predictions are useful in a
variety of supply chain applications and for detecting phantom stock-outs.

■ SD79

Parc- Powell I

Applications of Decision Analysis

Sponsor: Decision Analysis
Sponsored Session

Chair: Mazen Skaf, Managing Director, Strategic Decisions Group,
745 Emerson St, Palo Alto, CA, 94301, United States of America,
mskaf@sdg.com

1 - Decision Quality: A Cultural Change Effort
James Driscoll, Director of Decision Quality, Intel Corporation, 2200
Mission College Blvd, Santa Clara, CA, United States of America,
james.r.driscoll@intel.com

Discussion of the adoption of Decision Quality at a large, multi-national technology
leader. History and evolution of the effort and what we've learned along the way.
Emphasis will be on the cultural changes that are required to embed and derive
value from DQ/applied decision theory. Note: this presentation will NOT cover
details regarding applications of DQ to internal and/or non-public business
strategies.

**2 - Decision Analysis in Life and Business:
Differences and Similarities**
Larry Neal, Manager, Decision Analysis Consulting, Chevron,
6001 Bollinger Cyn. Rd., San Ramon, CA, 94583-2324,
United States of America, larryneal@chevron.com

On the occasion of using decision analysis for a personal medical situation, the
author compares and contrasts the experience with applying decision analysis
professionally in the workplace. The author draws conclusions from the experience
and offers suggestions for better serving the layperson in a difficult or ambiguous
decision making situation.

**3 - Process and System for Optimizing the Allocation of Energy
Resources in an Energy-Rich State**
Mazen Skaf, Managing Director, Strategic Decisions Group,
745 Emerson St, Palo Alto, CA, 94301, United States of America,
mskaf@sdg.com

We present a DA-based process and system for optimizing the allocation of
hydrocarbon resources and other energy resources across proposed uses taking into
account: i) uncertainty in future supply and demand, ii) various economic, social,
and environmental value measures, and iii) existing commitments. The
methodology has been successfully applied over the past four years to support
decision-making on resource allocation as well as to guide investments on the
supply side.

**4 - Reducing Risk and Improving Incentives to Entrepreneurs
and Backers**
Sam Bodily, John Tyler Professor, Darden School, UVA,
100 Darden Boulevard, Charlottesville, VA, 22903,
United States of America, BodilyS@Darden.virginia.edu

Incentive-compatible mechanisms are identified, risk analysis models are
developed, and insights are obtained about how backers' funding (e.g. equity
capital, incentive gifts, insurance, revenue contracts, and derivative swaps) can
provide proper incentives and reduce risk to the entrepreneur, at least cost to the
backers. Attention is given to avoiding problems of moral hazard. Certainty
equivalents for financing alternatives are derived.

■ SD80

Parc- Powell II

Real Option Applications

Sponsor: Decision Analysis
Sponsored Session

Chair: Luiz Brandão, Associate Professor, PUC Rio, Rua Marques de
Sao Vicente 225, Rio de Janeiro, RJ, 22450-900, Brazil,
brandao@iag.puc-rio.br

**1 - A Symmetrical Binomial Lattice Approach for Modeling Generic
One Factor Markov Continuous Processes**
Carlos Bastian-Pinto, Assistant Professor, IBMEC RJ,
Rio de Janeiro, RJ, Brazil, carbastian@gmail.com

The mathematical complexity associated with real options derives from the need
for a probabilistic solution for the optimal decision. Binomial lattices such as that of
Cox et al are robust, precise and intuitively appealing for option valuation. We
propose a Symmetrical Binomial Lattice equivalent to the Cox et al when modeling
GBM, but which can be utilized for a wide variety of other stochastic processes that
have the Markov property. We demonstrate its applicability with several examples.

2 - Switching Options in Nitrogen Fertilizer Plants
Luiz Ozorio, Assistant Professor, IBMEC RJ, Rio de Janeiro, RJ,
Brazil, lmozorio@ibmecrj.br, Carlos Bastian-Pinto,
Luiz Brandão, Rafael Branco

Fertilizers are extremely important to agricultural production due to the
productivity improvements in cropping that it allows. This article uses the Real
Options Theory to evaluate the switch-output option, ammonia or urea, in a
nitrogen fertilizer plant. The Monte Carlo simulation was used to define the value
of the option and it was assumed that the prices of natural gas (input), ammonia
and urea follow MRM as stochastic process. The results show that the option of the
investor is valuable.

**3 - Stochastic Price Process Calibration Methods and Their Impact on
Real Option Values and Strategies**
Reidar Bratvold, Professor, University of Stavanger, Kjell
Arholmsgate 41, Stavanger, 4036, Norway, reidar.bratvold@uis.no,
Philip Thomas

Stochastic commodity price models play a central role when evaluating energy
investment opportunities. Despite this, there has been little systematic evaluation
of the effects of choosing different calibration methods and time horizons to
determine state variables and parameters of such models. We present sensitivity
analysis results of the impact the choice of calibration method and time horizon on
real option values and strategies.

**4 - Is the Rio – Sao Paulo High Speed Rail Project Feasible?
A Real Options Analysis**
Luiz Brandão, Associate Professor, PUC Rio, Rua Marques de São
Vicente 225, Rio de Janeiro, RJ, 22450-900, Brazil,
brandao@iag.puc-rio.br, Leandro Monteiro, Leonardo Lima

We analyze the 18 billion dollar Rio–Sao Paulo High Speed Railway project under
the Real Options approach considering a PPP risk sharing scheme where the
government offers demand insurance in the form of a minimum traffic guarantee
(MTG). As MTGs can generate significant long term liabilities for the government,
we propose liability caps and the use of CVaR to determine the optimal
combination of MTG and cap level which maximizes the returns and minimizes the
risk for the government.

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■ SD81

Parc- Divisadero

Optimization and Modeling in Radiation Therapy Treatment Planning

Sponsor: Data Mining
Sponsored Session

Chair: Shouyi Wang, Assistant Professor, University of Texas at Arlington, 500 West First Street, 420H Woolf Hall, UT Arlington, Arlington, TX, 76019, United States of America, shouyiw@uta.edu

1 - A New Optimization Approach for Multi-objective Radiotherapy Treatment Planning
Wenhua Cao, Research Assistant Professor, University of Houston, E206 Engineering Building 2, Houston, TX, 77204, United States of America, wcao@central.uh.edu, Laleh Kardar, Gino Lim

Designing treatment plans for radiotherapy often involves combining multiple objectives into a single objective function by taking a linear combination of multiple objectives. However, it is challenging to set the proper weights for those objectives. Here we introduce a sub-gradient optimization algorithm to find objective weights which can capture clinically relevant trade-offs. We test the algorithm on real patient data to show that the optimized weights outperform the ones used in the clinic.

2 - A Novel Approach for Real-Time Prediction of Semi-periodic and Nonstationary Time Series
Kin Ming Kam, The University of Texas at Arlington, Arlington, TX, 76019, United States of America, kinming.kam@mavs.uta.edu, Shouyi Wang

To suppress side effects of radiotherapy, system latency of device is needed to be compensated in order to accurately trace the respiratory motion. A novel method is developed by using adaptive orthogonal polynomials to precisely model the respiratory motion. Effective pattern recognition is then done by using the coefficients of OPs. The method can also be applied on other kinds of semi-periodic time series. Comparison with the latest methods will be presented to show the advancement.

3 - A Critical Evaluation of Worst Case Optimization Methods for Robust Proton Therapy Planning
Rasmus Bokrantz, RaySearch Laboratories, Sveavagen 25, Stockholm, 111 34, Sweden, rasmus.bokrantz@raysearchlabs.com, Albin Fredriksson

We analyze three optimization formulations for robust proton therapy treatment planning. The formulations range from protecting against the worst case error to protecting against the worst case error for each patient geometry volume element considered independently. We discuss the formulations' advantages and disadvantages based on their performance on clinical cases.

4 - A Scenario-based Generalization of Margins in Radiation Therapy Treatment Plan Optimization
Albin Fredriksson, RaySearch Laboratories, Sveavagen 25, Stockholm, Sweden, albin.fredriksson@raysearchlabs.com, Rasmus Bokrantz

We propose an optimization formulation using multiple scenarios to handle the effects of errors in radiation therapy treatment planning. This formulation coincides with margin-based planning if the implicit assumptions made when the margins are delineated are valid, but also generalizes to more difficult situations where these assumptions do not hold.

■ SD82

Parc- Haight

Bilevel Optimization: Algorithms and Applications

Sponsor: Multiple Criteria Decision Making
Sponsored Session

Chair: Pekka Malo, Assistant Professor, Aalto University School of Business, P.O. Box 11000, Helsinki, Finland, pekka.malo@aalto.fi

1 - A Bilevel Optimization Approach to Automated Parameter Tuning
Peng Xu, Aalto University School of Business, Runeberginkatu 22-24, Helsinki, 00100, Finland, peng.xu@aalto.fi

In this paper, we propose that the parameter tuning problem is inherently a bilevel programming problem. Based on this insight, we introduce an evolutionary bilevel algorithm for parameter tuning. A few commonly used optimization algorithms (Differential Evolution and Nelder-Mead) have been chosen as test cases, whose parameters are tuned on a number of standard test problems. The bilevel approach is found to quickly converge towards the region of efficient parameters.

2 - Multiobjective Bilevel Optimization under Decision Uncertainty
Pekka Malo, Assistant Professor, Aalto University School of Business, P.O. Box 11000, Helsinki, Finland, pekka.malo@aalto.fi, Kalyanmoy Deb, Pekka Korhonen, Jyrki Wallenius, Ankur Sinha

Bilevel optimization problems are characterized by a hierarchical leader-follower structure, where the leader desires to optimize her own strategy taking the response of the follower into account. Such problems are often encountered in strategic product design, homeland security applications, and economics. In this paper, we focus our attention on the development of a flexible evolutionary algorithm for solving multi-criterion bilevel problems with lower level (follower) decision uncertainty.

3 - Multi-objective Stackelberg Game between a Regulating Authority and a Mining Company
Oskar Ahlgren, Aalto University, Runebergingkatu 22-24, Helsinki, 00100, Finland, oskar.ahlgren@aalto.fi

I present a bilevel programming problem in the form of a Stackelberg game with multiple objectives at the upper level and a single objective at the lower level. The leader is the regulating authority, which tries to maximize the total tax revenue over multiple periods while trying to minimize the environmental damages. The follower is a mining company that is trying to maximize its total profit.

■ SD83

Parc- Sutro

Machine Learning, Data Mining, and Statistics I

Sponsor: Data Mining
Sponsored Session

Chair: Cynthia Rudin, MIT Sloan School of Management, 100 Main Street, Cambridge, MA, 02139, United States of America, rudin@mit.edu

1 - Predicting Power Failures in Electrical Grids
Seyda Ertekin, MIT, 100 Main Street E62 Building, Cambridge, MA, 02139, United States of America, seyda@mit.edu, Cynthia Rudin, Tyler McCormick

We present a new statistical model for predicting discrete events continuously in time, called Reactive Point Processes (RPP's). RPP's are a natural fit for many domains where time-series data are available, and their development was motivated by the important problem of predicting serious events (fires, explosions, power failures) in the underground electrical grid of New York City (NYC). The RPP model can also provide a cost/benefit analysis of different proactive maintenance programs.

2 - Statistical Methods for Ambulance Fleet Management
Dawn Woodard, Assistant Professor, School of ORIE, Cornell University, 206 Rhodes Hall, Ithaca, NY, 14850, United States of America, woodard@cornell.edu, Shane Henderson, David Matteson, Bradford Westgate

We address a problem arising in the management of ambulance fleets: predicting the distribution of ambulance driving time on an arbitrary route in a road network. We use a computationally efficient procedure to train a statistical model using GPS data from ambulance trips; challenges include the large size of the network and the lack of trips in the data that follow the route of interest. We demonstrate the accuracy of our methods using data from Toronto Emergency Medical Services.

3 - A Simple Frequency based Rule Classification Algorithm
Chun-An Chou, SUNY Binghamton, 4400 Vestal Pkwy, Binghamton, NY, United States of America, cachou@binghamton.edu, Anas Hourani

Associative classification has been increasingly applied to personalized medicine. Conventional approaches generate a large number of rules for classification of diagnostic outcomes. However, a simple rule, instead of various rules, is more desirable while accurate classification remains. In this work, we propose a new simple rule classification algorithm. A simple rule for individual patients is generated based on the class frequency.