

## How to Navigate the Technical Sessions

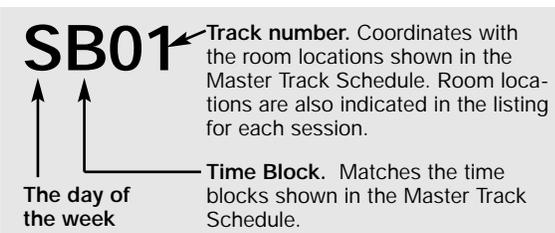
There are four primary resources to help you understand and navigate the Technical Sessions:

- 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 Session Chair, Author, and Session indices provide cross-reference assistance (pages 375-409).
- The map and floor plans on pages 42 and 43 show you where technical session tracks are located.
- The Master Track Schedule is on pages 44-47. This is an overview of the tracks (general topic areas) and when/where they are scheduled.

## Quickest Way to Find Your Own Session

Use the Author Index (pages 379-400) — the session code for your presentation(s) will be shown along with the track number. You can also refer to the full session listing for the room location of your session(s).

## The Session Codes



## Time Blocks

- A — 8:00am - 9:30am
- B — 10:00am - 11:30am
- C — 1:30pm - 3:00pm
- D — 4:30pm - 6:00pm

On Wednesday, D block is 3:30-5:00pm. Plenaries, keynotes and lunch breaks are interspersed among the technical session time blocks.

## Room Locations/Tracks

All tracks and technical sessions are held in the Convention Center and Sheraton. Room numbers are shown on the Master Track Schedule and in the technical session listing.

## Quick Reference

Don't miss the Quick Reference, a separate flier you received in your registration packet. It includes the Master Track Schedule and floor plans, providing a quick, portable summary of the meeting

Sunday, 8:00am - 9:30am.

## ■ SA01

### Supply Chain Management I

Contributed Session

Chair: Nagihan Comez, Assistant Professor, Bilkent University, Ankara, Ankara, Turkey, nagihan@utdallas.edu

#### 1 - Comparative Study of Consignment and Wholesale Contractual Arrangement

Dengfeng Zhang, University of Iowa, S210 Pappajohn Business Building, Iowa City, IA, 52242, United States, dengfeng-zhang@uiowa.edu, Renato deMatta, Timothy Lowe

The unprecedented growth of businesses in online marketplaces brings with it new challenges to manage the supply chain. In this paper, we investigate the decisions and channel performance issues surrounding consignment contractual arrangement (CCA) and how they differ from a wholesale contractual arrangement (WCA). Also, we provide some insights on contractual preferences of managers to learn why they prefer CCA over WCA with certain sellers.

#### 2 - Contract Design for Multiple Channels

Xiaowei Zhu, Assistant Professor, West Chester University, 312A Anderson Hall, West Chester, United States, xzhu@wcupa.edu, Samar Mukhopadhyay, Xiaohang Yue

A firm faces potential channel conflict when it opens online sale in addition to its existing retail channel. To reduce this, the firm can allow the retailer to add value to the product, the cost of which is private information, to differentiate it. We use a game theoretic approach to derive optimal contracts under full and asymmetric information.

#### 3 - Dynamic Pricing and Ordering Decisions for Perishable Products

Chulung Lee, Professor, Korea University, Anam-dong, Seongbuk-gu, Seoul, 136-713, Korea, Republic of, leecu@korea.ac.kr, Rujing Liu, Ek Peng Chew

We study the coordination of the dynamic pricing and ordering decisions of a perishable product. We compute the optimal order quantity of new product and the optimal discounted price for older products given the remaining inventory level in order to maximize the total profit.

#### 4 - Design of an Agent-based Supply Chain Simulation System

Liping Fang, Professor, Ryerson University, Dept. of Mechanical & Industrial Engin., 350 Victoria Street, Toronto, ON, M5B 2K3, Canada, lfang@ryerson.ca, Yucheng Wang

Design of an agent-based supply chain simulation system is presented, in which a supply chain entity is represented by an agent. The proposed system has six layers: raw material providers, component manufacturers, product assemblers, product holders, retailers, and final customers. Issues in supply chain management could be simulated and studied.

#### 5 - Buyer-supplier Relationship Dissolution: Insights From the Ford-Firestone Breakup

Yi-Su Chen, University of Minnesota, 3-150 Carlson School of Management, 321-19th Ave S., Minneapolis, MN, 55455, United States, chen1276@umn.edu, Johnny Rungtusanatham, Kevin Dooley

Developing a strategic relationship is arduous, dissolving one is equally strenuous. The relationship between Ford and Firestone was once long-standing and valued before it was terminated. By scrutinizing their breakup, we offer insights on the key forces that increase the probability of relationship dissolution during times of crisis. Theoretical contributions and managerial implications are also discussed.

## ■ SA02

### Issues in Product Life Cycle and Durability Management

Cluster: Supply Chain  
Invited Session

Chair: Steve Gilbert, Associate Professor, The University of Texas at Austin, McCombs School of Business, 1 University Station, B6500, Austin, TX, 78712, United States, Steve.Gilbert@mcombs.utexas.edu

## 1 - Product Design for Life Cycle Mismatch

James Bradley, Associate Professor, College of William and Mary, Mason School of Business, 118C Tyler Hall, Williamsburg, VA, 23187-8795, United States, james.bradley@mason.wm.edu, Hector Guerrero

Life-cycle mismatch occurs when component life cycles are shorter than the life cycles of products that contain them. Mitigating component obsolescence can be costly, but durable product designs can be more expensive to design and produce. Our model determines the appropriate durability for a particular product life cycle.

## 2 - Evaluating the Environmental Performance of Product Leasing

Mark Ferguson, Georgia Institute of Technology, 800 West Peachtree Street NW, Atlanta, GA, United States, Mark.Ferguson@mgt.gatech.edu, Vishal Agrawal

We evaluate the impact of the lease versus sell decision on environmental performance measures such as the quantity of products remanufactured versus recycled or disposed. We extend the results on durable goods from the economics literature and on closed-loop supply chains in the operations literature.

## 3 - Replenishment Decision with Extended Warranty

Xinxin Hu, Assistant Professor, Indiana University, Kelley School of Business, Room BU570C, Bloomington, IN, 47405, United States, hux@indiana.edu, Seb Heese

This is a retailer's multiperiod replenishment problem with extended warranty. Retailer has two demands - new customers and old customers who exercise the warranty. The warranty demand has the first priority to be satisfied, and retailer must guarantee a full satisfaction. Hence, it reduces retailer's capability to meet new demand and even incurs an additional cost. We consider three uncertainties: new demand, warranty exercise ratio, and fraction of customers who buy warranty.

## 4 - Implications of Product Lifecycle and Channel Structure Upon Optimal Investment in Durability

Sreekumar Bhaskaran, Assistant Professor, Southern Methodist University, COX Business School, 389 Crow, Dallas, TX, 75275, United States, sbhaskar@cox.smu.edu, Steve Gilbert

We investigate how the use of intermediaries in the channel of distribution affects a manufacturer's investment in the durability of a product. Depending upon the product and technology life-cycles, the nature production technology and manufacturing costs, we find that a manufacturer can have an incentive to invest more in durability when he sells through intermediaries than when he sells directly.

## ■ SA03

## Inventory in Supply Chains

Cluster: Supply Chain

Invited Session

Chair: Rodney Parker, Assistant Professor of Operations Management, Yale School of Management, 135 Prospect St, New Haven, CT, 06520-8200, United States, rodney.parker@yale.edu

## 1 - Duopoly Competition Between Price-setting Newsvendors

Harish Krishnan, University of British Columbia, 2053 Main Mall, Vancouver, BC, Canada, Harish.Krishnan@sauder.ubc.ca, Ralph Winter

In a duopoly with demand uncertainty, consumers who experience a stock-out at one store may spill over to the competitor. Demand spillovers can turn price competition on its head, making duopoly prices higher than the monopoly price. The impact of higher prices will be offset by higher inventory levels.

## 2 - Setting Inventory Targets for Multiple Products with Joint Service Levels and Correlated Demands

Sridhar Tayur, SmartOps, 12 Federal Street, Suite 400, Pittsburgh, PA, 15212, United States, stayur@smartops.com, Bahar Biller

We introduce a novel comprehensive simulation-based framework for setting good inventory targets to achieve a joint service level (such as purchase order fill rate, or dollar fill rate) in a discrete time, finite horizon model where the product demands are correlated in any period, and demands of any product are correlated across time. Our solutions are close to best possible within classes of policies that APS systems can recognize.

## 3 - Assortment Planning with Stockout-based Substitution

Dorothee Honhon, University of Texas, Dorothee.Honhon@mcombs.utexas.edu

We consider the problem of determining the optimal assortment and inventory levels for a discrete set of products with varying prices and costs in order to maximize expected profit in a single-period setting. We use a fluid-type model to represent customer demand and obtain the optimal solution under stockout-based substitution. We then analyze the tradeoffs involved in making assortment decisions.

## 4 - Dynamic Inventory Games with Substitution

Rodney Parker, Assistant Professor of Operations Management, Yale School of Management, 135 Prospect St, New Haven, CT, 06520-8200, United States, rodney.parker@yale.edu, Tava Olsen

We consider multi-period stochastic games involving substitutable inventory and study when the equilibrium behavior is consistent with that observed in the equivalent static game. For inventory substitution games, we show the sustained equilibrium inventory policy is base-stock and when compared to the integrated firm, there is greater overall inventory holding but individual firms may stock less.

## ■ SA04

## Tutorial: Community-based Operations Research

Cluster: Tutorials

Invited Session

## 1 - Community-based Operations Research

Michael Johnson, Associate Professor, Department of Public Policy and Public Affairs, John W. McCormack Graduate School of Policy Studies, University of Massachusetts Boston, 100 Morrissey Blvd, Boston, MA, 02125-3393, United States, michael.johnson@umb.edu, Karen Smilowitz

Community-based operations research is the application of decision models to social issues of a local nature. The goal of this field is to design policies and tactics that have the potential to improve individual life outcomes and neighborhood-level outcomes by addressing welfare, equity and administrative efficiency simultaneously. Community-based OR problems tend to be messy and dependent on political and social considerations. This tutorial defines community-based OR in the context of public-sector OR/MS, highlights current research in a variety of domains and identifies a number of new research opportunities. Two case studies in food security and affordable housing emphasize the commonality of problem attributes and the diversity of modeling and solution methods.

## ■ SA05

## 2007 Dantzig Dissertation Award Finalists

Cluster: Dantzig Dissertation Prize

Invited Session

Chair: Jeannette Song, Duke University, Fuqua School of Business, Durham, NC, 27708, United States, jssong@duke.edu

## 1 - The Management of Uncertainties in Radiation Treatments of Lung Tumors

Timothy Chan, MIT, 77 Massachusetts Ave., E40-130, Cambridge MA, United States, tcychan@MIT.EDU

In the context of patient care for life-threatening illnesses, the presence of uncertainty may compromise the quality of a treatment. In this talk, we present a robust framework to optimize radiation therapy treatments (subject to realistic uncertainties) for cancer patients. We illustrate our results on a clinical case where the uncertainty is due to organ motion during treatment.

## 2 - Game-theoretic Approaches for Complex Systems Optimization

Shih-Fen Cheng, Singapore Management University, 80 Stamford Road, Singapore 178902, Singapore, sfcheng@smu.edu.sg

In this talk, two optimal decision-making problems in the context of automotive industry are presented. The first problem deals with the complex operational problem of shutting down a serial production line so as to achieve a desirable state. The proposed method significantly outperforms prevalent ad hoc procedures. The second problem deals with the complexity of making joint decisions within a large manufacturing corporation. A game-theoretic decomposition scheme is proposed and it's shown to have a good balance between efficiency and effectiveness.

## 3 - Satellite Network Design, Optimization and Management

Ioannis Gamvros, Optimization Consultant, ILOG Inc., 1195 West Fremont Ave., Sunnyvale CA 94087-3832, igamvros@ilog.com

Abstract not available at this time.

## ■ SA06

### Product Variety, Markets, and Operational Tradeoffs

Sponsor: Manufacturing & Service Oper Mgmt  
Sponsored Session

Chair: Sergio Chayet, Assistant Professor, Olin School of Business, Washington University in St Louis, St Louis, MO, 63141, United States, chayet@wustl.edu

- 1 - Multi Market Competition and Global Sourcing:  
The Role of Intellectual Property Protection  
Laurens Debo, Tepper School of Business, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, laurdebo@andrew.cmu.edu, Jiong Sun, Sunder Kekre

We develop a model in which a US firm determines whether to sell products to the Chinese market in addition to the US market. If the firm decides to do so with a manufacturing facility in China, a local Chinese company may copy the US firm's product and compete in both Chinese and US markets. If the firm decides not to do so, the US firm incurs higher production costs for both markets. We characterize the optimal entry strategy of the US firm in these global markets.

- 2 - Leadtime-variety Tradeoff in Product Differentiation  
Aydin Alptekinoglu, Assistant Professor, University of Florida, 358 Stuzin Hall, Gainesville, FL, 32611-7169, United States, aalp@ufl.edu, Charles Corbett

Customers generally prefer products to be delivered sooner rather than later, and they prefer products that are closer to their ideal specifications. However, firms have to make a choice between offering a more limited product line that is available immediately from stock or a broader product line that is only available to order, hence at a delay. To some degree firms can use inventory or capacity to mitigate this tradeoff, but they cannot eliminate it as Squire et al. (2006) show empirically.

- 3 - A Product Line Problem in a Retail Environment with Stochastic Demand  
Gal Raz, Associate Professor, Darden Graduate School of Business, University of Virginia, Charlottesville, VA, 22906-6550, United States, raz@darden.virginia.edu, Oded Koenigsberg

This paper investigates a retailer's decision on the variety of products to offer while simultaneously deciding on their prices and quantities under a stochastic demand newsvendor environment that takes into account the customer heterogeneous valuation of the products in the product line. We derive the retailer's optimal strategy and examine the effect of the problem parameters on this strategy.

- 4 - Product Variety and Congested Production Systems:  
Capacity Investments and Vertical Differentiation  
Sergio Chayet, Assistant Professor, Olin School of Business, Washington University in St Louis, St Louis, MO, 63141, United States, chayet@wustl.edu, Panos Kouvelis, Dennis Yu

We investigate product line design and capacity investment decisions for vertically differentiated products on design quality levels. Customers are heterogeneous in quality valuations and arrive according to a Poisson process. We model product-focused and product-flexible production processes via queuing systems. We derive the optimal capacity, product variety, and quality levels, the resulting market coverage, segmentation, and effects on congestion levels, and provide managerial insights.

## ■ SA07

### Behavioral Operations

Sponsor: Manufacturing & Service Oper Mgmt  
Sponsored Session

Chair: Karen Donohue, Associate Professor, The Carlson School, University of Minnesota, 321 19th Ave S, Minneapolis, MN, 55455, United States, kdonohue@csom.umn.edu

- 1 - An Experimental Investigation of Risk-Pooling Effect  
Tony Haitao Cui, Assistant Professor, University of Minnesota, 321 19th Ave South, 3-150 CSOM, Minneapolis, MN, 55455, United States, tcui@umn.edu, Teck-Hua Ho, Noah Lim

This paper experimentally investigates the effect of centralization in inventory ordering decisions. The results suggest that subjects do not risk-pool in the manner predicted by the classical inventory theory. We generalize the classical theory to capture the empirical regularities by allowing subjects to form (possibly mistaken) belief about the demand and have reference-dependent preference.

- 2 - The Negotiation Power of Groups  
Feng Chen, USC, Bridge Hall, 400F, Los Angeles, CA, 98119, United States, fchen@marshall.usc.edu, Yehuda Bassok

Negotiation power of individual is defined in several ways. It is quite common that individual players form groups and negotiate as teams. But it is not clear what the negotiation power of a team is. Typically 3 types of assumptions are made: The negotiation power of a team is equal to the average, maximum or minimum power of its members. In this study we report the result of laboratory experiment to determine the negotiation power of teams.

- 3 - Supplier Competition When Service Matters  
Karen Donohue, Associate Professor, The Carlson School, University of Minnesota, 321 19th Ave S, Minneapolis, MN, 55455, United States, kdonohue@csom.umn.edu, Elena Katok, Saif Benjaafar

How should a buyer outsource demand across competing suppliers to optimize the level of service he receives? We analyze this problem from an analytical perspective and then test the resulting theory using a series of laboratory experiments. We find that human subjects are more aggressive in their service investments, and more sensitive to the type of competition offered, than theory would suggest.

## ■ SA08

### Managing Supply Chain Risks

Cluster: Managing Disruptions in Supply Chains  
Invited Session

Chair: Yusen Xia, Assistant Professor, Georgia State University, Robinson College of Business, Atlanta, GA, 30303, United States, mgtyxx@langate.gsu.edu

- 1 - Inventory Model with Setup Cost Under Uncertain Demand and Supply  
Yusen Xia, Assistant Professor, Georgia State University, Robinson College of Business, Atlanta, GA, 30303, United States, mgtyxx@langate.gsu.edu, Annabelle Feng

Although there is an extensive literature on inventory systems with random yields in various contexts, little is known about the ordering strategy with setup costs under demand and yield uncertainties. We formulate a periodic review inventory model and characterize the optimal policy in three segments of the on-hand inventory. Given the complexity of the optimal policy, we propose a simple piecewise linear policy which demonstrates good cost performance in our computational study.

- 2 - Conceptual Model of Performance for Contract Manufacturers  
Craig Hill, Assistant Professor, Georgia State University, P.O. Box 4014, Atlanta, GA, 30302-4014, United States, chill4@gsu.edu, Robert Burgess

This research presents a model for performance from a contract manufacturers' point of view. Included in this research are descriptions of types of contract manufacturer's relationships within the supply chain and insights into possible managerial opportunities for performance enhancement.

- 3 - Impact of Store Brand Introduction on Product Line Selection  
Liwen Chen, PhD Candidate, University of Texas at Austin, Department of IROM, McCombs School of Business, Austin, TX, 78712, United States, liwen.chen@mail.utexas.edu, Steve Gilbert, Yusen Xia

Store brands become important parts of retail stores. National brands suppliers may act strategically to the competition threat through offering horizontally differentiated product lines. We study the impact of the introduction of a store brand by a retailer on the optimal product line selection of the national brand supplier using a vertical differentiation model. We also study the effect on the supply chain profit and consumer surplus.

- 4 - Demand Uncertainty and Optimal Decision Making for the Newsvendor Problem  
Peter Kischka, Professor, University Jena, Carl Zeiss Strasse 3, Jena, 07743, Germany, p.kischka@wiwi.uni-jena.de, Werner Jammerneegg

We consider a set of possible demand distributions and a prior distribution for this set. Based on the predictive distribution of demand induced by the prior we introduce a mean deviation rule to incorporate the degree of uncertainty implied by an order quantity. We analyze the dependence of the optimal order quantity on the prior distribution as well as on the price and cost variables of the newsvendor model.

## ■ SA09

### Multicriteria Decision Making I

Contributed Session

Chair: Margaret M. Wiecek, Clemson University, Department of Mathematical Sciences, Clemson, SC, 29634, United States, wmalgor@clemson.edu

#### 1 - Multi-criteria Decision Case for Traffic Improvement Project Selection

Peter Kelle, Professor, Louisiana State University, ISDS CEBA, Baton Rouge, LA, 70803, United States, qmkell@lsu.edu, Helmut Schneider

Our decision support system has been prepared for a highway improvement case based on 4 years of accident data for over 65 thousand accidents per year at more than 23 thousand locations. The Multi-Criteria Decision Making is based on Data Envelopment Analysis and it is compared with other MCDM methods.

#### 2 - Exact Multi-attribute Group Balancing: Why Does it Work?

Anton Ovchinnikov, Darden School of Business, University of Virginia, 100 Darden Blvd, Charlottesville, VA, 22903, United States, aovchinnikov@darden.virginia.edu, Dmitry Krass

Consider a set of objects (e.g., students) possessing several properties that must be partitioned into a certain number of groups. The objective is to ensure that all groups are as balanced (equal) as possible with respect to the number of objects possessing each property. A direct approach, enforcing balance through hard constraints, may lead to infeasibility, but works well in practice. We present worst-case and average-case analysis of this phenomenon.

#### 3 - Polynomially Solvable Multiobjective Traveling Salesperson Problems

Ozgur Ozpeynirci, Tubitak, Ataturk Bulvari No 221 Kavaklidere, Ankara, Turkey, ozgur.ozpeynirci@tubitak.gov.tr, Murat Koksalan

TSP is NP-hard in general graphs. However, some special cases are solvable in polynomial time. We work on cases where the matrix structure guarantees that tours having special properties (pyramidal tours) yield optimal solutions. We study the multi-objective extensions of this problem. We investigate the properties of the efficient solutions and develop an exact algorithm to find efficient solutions. We develop a procedure to find all efficient solutions for the special case of bi-objective TSP.

#### 4 - Clustering Multi-objective Land Use Optimization Results

Christina Moulton, MASC Student, Systems Design Engineering, University of Waterloo, 200 University Ave W, Waterloo, ON, N2L 3G1, Canada, cmmacnei@engmail.uwaterloo.ca, Steven Roberts, Paul Calamai

Real world applications often have many competing objectives. The potentially many Pareto optimal solutions can make it be difficult for a decision maker to choose a final solution. We apply cluster analysis to organize the candidate solutions into a more tractable representation. This approach is applied to a land use change problem in an urban fringe area in Ontario, Canada. NSGA-II is used with eight landscape ecology metrics to generate non-dominated solutions as cluster analysis input.

#### 5 - A Priori Inclusion of Preferences in Multiobjective Programming

Margaret M. Wiecek, Clemson University, Department of Mathematical Sciences, Clemson, SC, 29634, United States, wmalgor@clemson.edu

MCDM has been relying on the concept of Pareto optimality and the resulting set as the set of candidates for a final preferred decision. We propose to elicit preferences from decision makers to modify the Pareto optimality, reduce the Pareto set, and support decision making. Using convex or nonconvex, polyhedral or nonpolyhedral cones, we model preferences such as relative importance of criteria, equitability of outcomes, approximate nondominance of outcomes, and motivate their use in MCDM.

## ■ SA10

### Cooperation in Inventory Management I

Cluster: Inventory

Invited Session

Chair: Jiawei Zhang, Assistant Professor, New York University, 44 West 4 St., Suite 8-66, New York, NY, 10012, United States, jzhang@stern.nyu.edu

#### 1 - A Decentralized Distribution System with the Manufacturer's Buyback and Resale

Greys Susic, Marshall School of Business, University of Southern California, Los Angeles, CA, United States, susic@marshall.usc.edu, Ulas Ozen

We analyze a distribution system in which  $n$  retailers facing uncertain demand order inventory from a manufacturer. Orders arrive to the warehouse after a lead time, during which the retailers update demand forecasts. The manufacturer can buy back items from the retailers facing low demand and sell them to those facing high demand. We study the impact of this resale opportunity and compare our results with other cases (no resale of returned items, retailers redistributing inventory on their own).

#### 2 - Dynamic Realization Games in Newsvendor Inventory Centralization

Moshe Dror, Professor, University of Arizona, MIS, Eller College of Management, Tucson, AZ 85721, Tucson, AZ, 85721, United States, mdror@eller.arizona.edu, Ana Meca, Luis Guardiola, Justo Puerto

Consider a newsvendor centralization game. When holding and penalty costs are identical for all subsets, the game has a non empty core. We examine a related game based on demand realizations. Based on Lehrer (2002) we propose a repeated cost allocation scheme. We prove that the cost allocation processes converge a.s. to either a least square value or the core of the expected game. We also extend the results to a more general class of dynamic cost games.

#### 3 - Partner Selection in Inventory Pooling

Eda Kemahlioglu-Ziya, UNC- Chapel Hill, CB# 3490, Chapel Hill, NC, 27514, United States, Eda\_KemahliogluZiya@unc.edu

We analyze a supply chain with a single supplier and two retailers. The retailers do not carry inventory, but enforce minimum-inventory-level constraints on the supplier and share a percentage of her inventory carrying cost. Our main research question is: With what type (high/low demand and/or bargaining power) of player does each player prefer to cooperate on inventory pooling if the objective is to maximize expected profit?

#### 4 - Cooperation in Service Systems

Shoshana Anily, Professor, Tel Aviv University, Faculty of Management, Tel Aviv, 69978, Israel, anily@post.tau.ac.il, Moshe Haviv

Consider M/M/1 service systems which can cooperate to generate a single pooled server. The cost of any coalition of servers is the mean number of customers in steady-state in that system. As the total cost is minimized by the grand coalition, we ask how to allocate it among the servers. We define a transferable utility cooperative game whose players are the servers, and show that its core is infinitely large; all of this albeit the fact that it is neither a monotone nor a concave game.

## ■ SA11

### Multi-echelon/Multi-product Inventory Optimization

Cluster: Manufacturing

Invited Session

Chair: Jiang Zhang, Assistant Professor, Adelphi University, School of Business, Garden City, NY, 11530, United States, zhang@adelphi.edu

#### 1 - Flexible Backup Supply and The Management of Leadtime Uncertainty

Jian Li, Northeastern Illinois University, 5500 N. St. Louis Ave, Chicago, IL, 60625, United States, jli@neiu.edu, Panos Kouvelis

Facing leadtime uncertainty, the retailer conventionally places an order at a chosen time ahead to meet future demand. In this paper we study the potential use of a flexible backup supplier in a sole role, as an emergency resource in response to the leadtime information, or in a dual role, as a regular supplier that is assigned to meet part of the original demand interval and as an emergency response to leadtime information.

#### 2 - Inventory Control When the Lead-time Changes

Sven Axsater, Lund University, P. O. Box 118, SE-22100 LUND, Sweden, Lund, Sweden, sven.axsater@iml.lth.se

A single-echelon inventory system with continuous review and Poisson demand is considered. There are linear holding and backorder costs. We study a change in the lead-time, which is typical in connection with a Just-In-Time philosophy. Our main focus is a lead-time decrease. Due to the lead-time change, the optimal steady state solution will, in general, change. We consider the transient problem of bringing the system from its original steady state to the new steady state in an optimal way.

#### 3 - Base-stock Control of Two-stage Inventory Systems with Periodic Batching Under Fill-rate Constraint

Jun Zhang, Assistant Professor, University of Texas at Dallas, School of Management, Richardson, TX, United States, jun.zhang@utdallas.edu, Jiang Zhang, Yuanjie He

We consider a two-stage inventory system with linear inventory holding cost and a fill-rate constraint. The inventory replenishment at both stages follows an echelon base-stock policy with periodic batching. We develop an exact expression for the system's fill rate. When demand is mixed Erlang, our exact expression only involves the PDF and CDF of the Erlang distribution. Under a

general assumption, we show that the inventory optimization problem is a convex programming problem.

#### 4 - Optimal Replenishment Policies for Multi-product Stochastic Inventory Systems

Vinayak Desphande, Purdue University,  
vinayak@exchange.purdue.edu,  
Kumar Muthuraman, Haolin Feng

We analyze optimal replenishment policies for multi-product inventory systems with joint-replenishment costs and correlated demand. Our focus is on computing and finding the structure of the optimal policies. An efficient method to compute the optimal policy that uses a moving boundary based policy improvement scheme is analyzed. A new heuristic, called an (s, c, d, S) policy is proposed, and is shown to significantly outperform the simple (s,c,S) policy analyzed in prior literature.

## ■ SA12

### Integration and Approximation Issues

Cluster: Scheduling

Invited Session

Chair: Nicholas G. Hall, Professor, Ohio State University, Fisher College of Business, 2100 Neil Avenue, Columbus, OH, 43210-1144, United States, hall\_33@cob.osu.edu

#### 1 - Allocation of Jobs and Resources to Pooling Centers

Hui-Chih Hung, Assistant Professor, National University of Singapore, Industrial & Systems Engineering, Singapore, 117576, Singapore, hhc43212@gmail.com, Marc Posner

We simultaneously partition servers and job types into parallel pooling centers. Each job type has a distinct Poisson arrival rate and WIP weight. The goal is to minimize the total WIP cost. For non-identical servers, important monotonic properties are established. Improved heuristics are evaluated both theoretically and experimentally.

#### 2 - Algorithms for Parallel Machine Problems with Capacity Restrictions

Hans Kellerer, Professor, Karl-Franzens-Universitaet, Institut fur Statistik und O.R., Universitaetsstrasse 15, Graz, A-8010, Austria, hans.kellerer@kfunigraz.ac.at

We present approximation algorithms for two variants of the classical multiprocessor scheduling with the objective of minimizing the makespan. In the first problem considered jobs have a restricted set of machines to which they may be assigned. In the second problem class considered a limit is imposed on the number of jobs which can be processed on each machine.

#### 3 - Noncooperative Scheduling Games with Auctions

Zhixin Liu, Assistant Professor, University of Michigan-Dearborn, United States, liu.573@osu.edu, Nicholas G. Hall

We consider models where a group of agents, each with a set of jobs, schedule their jobs on a common processing facility. Each agent wants to minimize an objective function which depends on her own jobs' completion times. Sequencing positions or time slots are allocated to alternative jobs based on the bids of participating agents. We investigate the efficiency and effectiveness of auction mechanisms, and the optimization, closure, effectiveness and equilibrium of agents' bidding policies.

#### 4 - Cell Formation with Machine Duplication and Cell Setup Costs

Wenhui Zhao, Dr., The Ohio State University, Integrated Systems Engineering, 1971 Neil Avenue, Columbus, OH, 43210, United States, zhao.108@osu.edu, Marc Posner

The process of cell formation assigns machines to cells. The objective is to minimize the inter-cell job flow. Two important factors that influence cell formation are machine duplication and cell setup cost. We develop and analyze a mathematical programming method to incorporate the effects of these two factors.

## ■ SA13

### Theory and Applications of Integer Programming

Sponsor: Optimization/ Integer Programming

Sponsored Session

Chair: Jean-Philippe Richard, Assistant Professor, Purdue University, 315 North Grant Street, West Lafayette, IN, 47907, United States, jprichar@ecn.purdue.edu

#### 1 - Mapping Onto a Flexible Low-power Electronic Fabric Architecture

Mustafa Baz, University of Pittsburgh, Pittsburgh, PA, mub3@pitt.edu, Brady Hunsaker, Gayatri Mehta, Justin Stander, Alex K. Jones

We consider a mixed-integer linear program for solving a combinatorial problem that arises from a novel electronic fabric architecture. The problem entails the mapping of a data flow graph represented as an acyclic directed graph onto a particular implementation of the architecture. For this problem, finding feasible solutions is a challenge. We present modeling and algorithmic enhancements that were necessary to make the problem tractable.

#### 2 - Computing Maximal Sets of Mixed Integer Programs

Bo Zeng, Purdue University, Industrial Engineering, West Lafayette, IN, 47906, United States, bzeng@purdue.edu, Jean-Philippe Richard

In this talk, we introduce a systematic method to derive strong bounds on sequential lifting coefficients. We also propose a scheme to derive the maximal set of an inequality, which is defined as the set of variable coefficients whose lifting coefficients are not influenced by the lifting sequence. We then apply this tool to derive the maximal sets of various inequalities for 0-1 MIPs. In particular, we show that our result strengthens known bounds for GUB knapsack polytopes.

#### 3 - The Value Function of a Mixed-integer Linear Program (MILP) with a Single Constraint

Menal Guzelsoy, Lehigh University, 200 West Packer Ave, Room 362, Bethlehem, PA, 18015, United States, megb@lehigh.edu, Ted Ralphs

The value function of a MILP is a function that returns the optimal solution value as a function of the right-hand-side. In this work, we analyze the structure of the value function of a MILP with a single constraint. Using subadditive duality, we show that all the information necessary to construct the value function can be obtained by examining the structure in a neighborhood of the origin. We propose a new method for extending the function from such a neighborhood to the entire real line.

#### 4 - An Efficient Optimization Algorithm for the Capacitated Plant Location Problem(CPLP)

Choonho Ryu, Professor, Hongik University Dept.of Business Administration, 72-1 Sangsoo-dong Mapo-gu, Seoul, 121-791, Korea, Republic of, ryuch@wow.hongik.ac.kr, Monique Guignard

This paper discusses an efficient optimization algorithm for the capacitated plant location problem(CPLP), which is based on the branch-and-bound scheme. It uses Lagrangean bounds rather than LP bounds and tries to fix as many integer variables as possible at the top node, by using the information of its feasible solution which comes from the Lagrangean heuristic. Computational results are reported in terms of bound gap percentage and CPU time.

## ■ SA15

### Conic Optimization and Complementarity Problems

Sponsor: Optimization/ Linear Programming and Complementarity Sponsored Session

Chair: Paul Tseng, Professor, University of Washington, Department of Mathematics, Box 354350, Seattle, WA, 98195-4350, United States, tseng@math.washington.edu

#### 1 - A Homogeneous Algorithm for Monotone Complementarity Problems Over Symmetric Cones

Akiko Yoshise, Associate Professor, Univ. Tsukuba, Graduate School of Systems & Information, Univ. Tsukuba, Tsukuba, 305, Japan, yoshise@sk.tsukuba.ac.jp

For monotone conic CPs, a homogeneous model has been proposed where a bounded path having a trivial starting point exists, any accumulation point of the path is a solution of the model, if the problem is solvable then it gives us a solution, if the problem is strongly infeasible, then it gives us a certificate proving infeasibility. We propose a class of algorithms for tracing the path above. For linear problems, polynomial iteration complexity bounds of the algorithms are derived.

#### 2 - Convex Optimization Methods for Dimension Reduction and Coefficient Estimation

Zhaosong Lu, Assistant Professor, Simon Fraser University, 8888 University Drive, Burnaby, BC, V5A 1S6, Canada, zhaosong@sfu.ca, Ming Yuan, Renato Monteiro

The penalized least squares estimate model (PLSEM) recently proposed by Yuan et al. conducts parameter estimation and factor selection simultaneously and has been shown to enjoy nice properties in both large and finite samples. We explore Nesterov's first-order methods and interior point methods (IPM) for computing the PLSEM. The performance of these methods is then compared. We show that the best of Nesterov's first-order methods substantially outperforms the IPM implemented in SDPT3.

### 3 - A Second-order Cone Cutting Surface Method: Complexity and Application

Mohammad Oskoorouchi, Assistant Professor, California State University San Marcos, College of Business Administration, San Marcos, CA, 92096, United States, moskooro@csusm.edu, John E. Mitchell

An analytic center cutting surface algorithm that uses multiple second-order cone cuts is presented. We discuss the complexity results and show that the overall algorithm is fully polynomial. Computational experiences with random problems of moderate to large size are presented. We compare the results with that of SDPT3, SDPLR and SeDuMi and show that our algorithm outperforms the above software packages on fully dense problems.

### 4 - Monotonicity of Lowner Operators and its Applications to Symmetric Cone Complementarity Problems

Lingchen Kong, University of Waterloo, Department of Combinatorics and Optimiza, Waterloo, Canada, konglchen@126.com, Levent Tunçel

We present necessary and sufficient conditions for locally Lipschitz Lowner operators to be monotone, strictly monotone and strongly monotone. As a by-product of our results, we extend the Mangasarian family of NCP functions to Symmetric Cone Complementarity Problems. This corollary also solves an open problem of Tseng from 1998.

## ■ SA16

### Combinatorial Optimization I

Contributed Session

Chair: Vineet Goyal, Graduate Student, Tepper School of Business, A19C, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, vgoyal@andrew.cmu.edu

#### 1 - Distributed Best First Search Strategy: An Illustrative Example with the 1|r|U Scheduling Problem

Edward Sewell, Professor, Southern Illinois University Edwardsville, SIUE, Edwardsville, IL, 62026, United States, esewell@siue.edu, Shane Hall, Sheldon H. Jacobson, Gio Kao

We introduce the Distributed Best First Search (DBFS) strategy for Branch and Bound algorithms. Its effectiveness is illustrated on the 1|r|U single machine scheduling problem (minimize the number of late jobs). A Branch, Bound, and Remember (BBR) algorithm is also presented that incorporates new memory-based dominance properties. The BBR algorithm with DBFS was able to solve all problems instances with up to 300 jobs, while previous algorithms encountered difficulties on problems with 120 jobs.

#### 2 - Linear Programming Formulation of the Set Partitioning Problem

Moustapha Diaby, Associate Professor, University of Connecticut, 2100 Hillside Road, Storrs, CT, 06269, United States, moustapha.diaby@business.uconn.edu

In this talk, we will present a polynomial-sized linear program formulation of the Set Partitioning Problem. The formulation will be illustrated with a numerical example. Computational testing and results will be discussed.

#### 3 - An Application of Ant Colony Optimization to Job Shop Scheduling

Minseok Seo, The Pennsylvania State University, 232 Leonhard Blvd, University Park, PA, 16802, United States, mxs713@psu.edu, Jose Ventura

An algorithm based on ant colony optimization is proposed for the job shop scheduling problem with the objective of minimizing the makespan. The algorithm iteratively executes two interconnected phases. In phase I, job processing times are updated with pheromone values and a heuristic procedure, which attempts to reduce job waiting times and machine idleness, is executed to construct a new schedule. Then, in phase II, this schedule is improved through a block local search procedure.

#### 4 - A Note on Approximation of 1-Regular 2-Color Paintshop Problem

Yuichi Asahiro, Kyushu Sangyo Univ., 2-3-1 Matsukadai, Higashi-ku, Fukuoka, 813-8503, Japan, asahiro@is.kyusan-u.ac.jp, Taku Nakamura, Eiji Miyano

Consider the following problem: The input is a word with every letter occurring exactly twice. The output is a coloring of the letter, say, red or blue under the condition that the two occurrences of the letter must be colored with different colors. Our goal is to minimize the number of color changes between adjacent letters. It is known that this problem is APX-hard. The aim of this presentation is to propose an approximation algorithm and to show several tractable special cases.

### 5 - Approximation Algorithms for Robust and Stochastic k-Median Problems

Vineet Goyal, Graduate Student, Tepper School of Business, A19C, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, vgoyal@andrew.cmu.edu, Anupam Gupta, Viswanath Nagarajan, Barbara Anthony

We consider a variant of the k-median problem in which the demand is uncertain and is modeled by a list of scenarios. Each scenario is a set of demand points. We need to locate k facilities such that the maximum (expected) median cost over all scenarios is minimized for the robust (stochastic) version. We give an  $O(\log n + \log m)$  approximation using a reverse greedy type algorithm. The algorithm is general and gives similar approximations for other robust/stochastic location problems as well.

## ■ SA17

### Joint Session ISS/ICS: Systems Evaluation

Sponsor: Information Systems Society, INFORMS

Computing Society

Sponsored Session

Chair: Subodha Kumar, Assistant Professor, University of Washington, Business School, Seattle, WA, United States, subodha@u.washington.edu

#### 1 - A Model to Analyze the Impact of P2P Networks on the Market for Content Provision and Distribution

Monica Johar, msjohar@email.uncc.edu, Nanda Kumar, Vijay Mookerjee

We develop an economic model to investigate the recent thinking that the development of P2P networks will pose a serious threat to firms in the business of providing content distribution services (e.g., Akamai). Our model considers the incentives of the producer (the content provider, e.g., CNN) together with the incentives of the consumer (who derives a positive utility from consuming the content) to derive the optimal extent of content distribution, with and without the existence of a P2P.

#### 2 - A Model for Integrated Decision in Information Security Investment

Tridib Bandyopadhyay, Assistant Professor, Kennesaw State University, 1000 Chastain Road, Kennesaw, GA, 30144, United States, tbandyop@kennesaw.edu, Dengpan Liu

Firms invest in perimeter hardening as well as intrusion detection systems, but often under stand-alone decision frameworks. This could mean suboptimal investments in general. In this paper we develop a model that helps answer 1) How to optimally split available IT security budget among prevention and detection regimes? and 2) When an IDS is in place, how to choose the operating point in the detection regime, and investment in the prevention regime to lower the overall system cost?

#### 3 - Our of Fear or Desire: Why Do Employees Follow Information Systems Security Policies?

Jai-Yeol Son, University of British Columbia, 2053 Main Mall, Vancouver, BC, Canada, Jai-Yeol.Son@sauder.ubc.ca, Hyeun-Suk Rhee

Two well-grounded motivational models, command-and-control and self-regulation, which are viewed as competing explanations of why individuals follow rules, are used to explain employees' adherence to information systems security policy (ISSP). We aim to identify specific factors drawn from each of the two competing approaches that determine the level of employees' adherence to ISSP, and to develop and empirically test a conceptual model based on the two groups of determinants to be identified.

#### 4 - Impact of Introducing a Direct Channel on Supply Chain Performance

Xuemei Su, College of Business Administration, California State University, Long Beach, Long Beach, CA, 90840, United States, xuemeisu@uwm.edu, Lifang Wu, Xiaohang Yue

We study the incentives for a manufacturer to introduce a direct channel in a stochastic demand environment. We find that the customer acceptance of direct channel, cross channel price sensitivity and the difference in distribution costs of the two channels play important roles in determining the existence of dual channel in equilibrium.

## ■ SA18

### Integrated Methods

Sponsor: INFORMS Computing Society  
Sponsored Session

Chair: John Hooker, Carnegie Mellon University,  
Tepper School of Business, Pittsburgh, PA, 15213, United States,  
john@hooker.tepper.cmu.edu

- 1 - The Accuracy of Search Heuristics: An Empirical Study on Knapsack Problems  
Meinolf Sellmann, Assistant Professor, Brown University,  
sello@cs.brown.edu, Daniel Leventhal

Theoretical models for the evaluation of search strategies are based on assumptions regarding the probability that a value selection heuristic makes a correct prediction. We provide an empirical evaluation of value selection heuristics for knapsack problems. We investigate how their accuracy varies as a function of depth in the search-tree, and how they are affected by the relative strength of inference methods like pruning and constraint propagation.

- 2 - Open Constraints in a Closed World  
Willem-Jan van Hoeve, Tepper School of Business,  
Carnegie Mellon University, Pittsburgh, PA, United States,  
vanhoeve@andrew.cmu.edu, Jean-Charles Régin

Open constraints are defined on a flexible set of variables and appear, e.g., in the context of task scheduling on alternative resources. We present efficient domain filtering algorithms for the open global cardinality constraint, and for conjunctions of them, by integrating network flow techniques. The algorithms filter the scope of the open constraint, as well as the domains of the variables on which it is eventually defined.

- 3 - A Multi-point Constructive Search / Metaheuristic Hybrid for Job Shop Scheduling  
Chris Beck, University of Toronto, 5 King's College Rd, Toronto,  
ON, M5S 3G8, Canada, jcb@mie.utoronto.ca, Jean-Paul Watson

Sophisticated multi-point metaheuristics represent the state-of-the-art in job shop scheduling. The multi-point approach has recently been incorporated in a constructive search algorithm, yielding near state-of-the-art performance. We examine a hybridization of these two approaches. Our hybrid algorithm enables fine control of the relative effort expended in intensification and diversification phases, allowing us to quantify their relative contribution to aggregate algorithm performance.

## ■ SA19

### Computational Advances in Approximate Dynamic Programming

Sponsor: INFORMS Computing Society  
Sponsored Session

Chair: Warren Powell, Professor, Princeton University,  
Engineering Quadrangle, Princeton, NJ, 08544, United States,  
powell@princeton.edu

- 1 - Approximate Dynamic Programming for Serial Multi-echelon Systems with Economies of Scale  
Diego Klabjan, University of Illinois at Urbana-Champaign,  
205 North Mathews Avenue, Urbana, IL, 61801, United States,  
klabjan@uiuc.edu

The value function of a serial systems with economies of scale is very complex and the underlying policies are not structured. We present a computational study based on algorithms that combine Monte-Carlo sampling and optimization. Various approximations to the value function are discussed.

- 2 - A Novel Method for Solving Continuous-state POMDPs  
Enlu Zhou, Electrical & Computer Engineering Department,  
University of Maryland, College Park, MD, 20742, United States,  
enluzhou@umd.edu, Steven Marcus, Michael Fu

Most research on Partially Observable Markov Decision Processes (POMDPs) has been focused on finite-state space problems, where the belief space is a finite-dimensional simplex. However, many practical problems have continuous state spaces, and hence the belief space is infinite dimensional. To address this difficulty, we integrate modified projection particle filtering into MDP solving techniques to greatly reduce the dimension of the belief space and make continuous-state POMDPs tractable.

- 3 - Value Function Approximations for Multistage Linear Programs  
Warren Powell, Professor, Princeton University, Engineering  
Quadrangle, Princeton, NJ, 08544, United States,  
powell@princeton.edu

We describe how high-quality, practical solutions can be obtained for multistage stochastic linear programs using approximate dynamic programming. The first step involves setting up Bellman's equation using the post-decision state variable. The next step involves finding value function approximations that can be used within an LP solver. We present a series of approximation strategies, and describe where they have proven successful, as well as possible limitations.

- 4 - An Optimal Dynamic Hedging Strategy for Jet Fuel Costs  
Juliana Nascimento, Princeton University, EQuad, ORFE  
Department, Princeton University, Princeton, NJ, 08544,  
United States, jnascime@princeton.edu, Warren Powell

We propose a dynamic strategy to hedge changes in the price of aircraft fuel using future contracts on commodities that are highly correlated with fuel. We model the commodity price using an unobservable two-factor model that allows mean-reversion in short-term prices and uncertainty in the equilibrium level to which prices revert. We combine dynamic programming and Kalman filter estimation to obtain an optimal policy that minimizes the expected costs while keeping the variance at low levels.

## ■ SA20

### Joint Session DAS/MAS: Military Decision Analysis

Sponsor: Decision Analysis, Military Applications  
Sponsored Session

Chair: Gregory Parnell, Professor of Systems Engineering, United States  
Military Academy, Mahan Hall 432, West Point, NY, 10996,  
United States, gregory.parnell@usma.edu

- 1 - Comparing Organic vs. Handoff UAV Support to the Maneuver Company  
Roger Chapman Burk, Associate Professor, US Military Academy,  
Department of Systems Engineering, West Point, NY, 10996,  
United States, roger.burk@usma.edu, Robin Burk

We consider two alternatives: (1) the Organic system, which consists of two VTOL vehicles of ~50 kg each assigned to each company and flying missions when needed; and (2) the Handoff system, a 100-200 kg air vehicle in the air constantly, operated at the battalion level, but handed off as needed to control by a company. We focus on performance measures that are strongly affected by the architecture and use high-level queuing and Markov chain models to estimate performance.

- 2 - Personality Modeling in High Threat Analytical Simulations  
Paul West, Assistant Professor, Department of Systems  
Engineering, United States Military Academy, West Point, NY,  
10996, United States, Paul.West@usma.edu

Computer simulations are key tools for course-of-action and materiel development analyses. Extensive work has been conducted in behavioral science to determine what physiological and psychological factors drive human action, but this information is often overlooked in simulations. This paper describes a methodology for enhancing synthetic humans with personality-based attributes for simulations where high-risk and high-threat environments make human performance assessment difficult.

- 3 - Probabilistic Modeling of Insurgency  
Paul Kucik, Department of Systems Engineering, United States  
Military Academy, Mahan Hall, West Point, NY, 10996,  
United States, pkucik@stanford.edu

I use the methods of probabilistic risk analysis and systems analysis to represent the dynamic interaction between an insurgent group and the government in order to propose strategies to defeat insurgency. The model focuses at the village level and includes probabilistic submodels for both the insurgent decisionmaker and the government policymaker, where the insurgent leader's decisions affect the uncertainties faced by the policymaker, and vice versa.

- 4 - Setting Priorities: Value-based Program Decision Making  
Patrick Driscoll, Professor, U.S. Military Academy, Dept. of  
Systems Engineering, Mahan Hall, Bldg 752, West Point, NY,  
10996, United States, Patrick.Driscoll@usma.edu

Setting resource priorities for complex programs is recognizably difficult, a challenge compounded by the range of possible futures and the uncertainty contained in current performance estimates. We introduce a value-based approach for assisting decision makers in this context that uses DOE, simulation, and efficient portfolio principles to minimize total value return variability to stakeholders while simultaneously maximizing average value return against a set of future scenarios.

## ■ SA21

### Joint Session DAS/ENRE: Expert Elicitations For Energy Technology

Sponsor: Decision Analysis, Energy, Natural Res & the Environment Sponsored Session

Chair: Erin Baker, University of Massachusetts, 220 ELab, Amherst, MA, United States, edbaker@ecs.umass.edu

#### 1 - Prospective Evaluation of Applied Energy R&D at the Department of Energy

James Smith, Professor, Duke University, Fuqua School of Business, Durham, NC, 27708-0120, United States, jes9@duke.edu, Karen Jenni

In 2003, Congress asked the National Research Council (NRC) to develop an approach for estimating the benefits of DOE's fossil energy and energy efficiency R&D programs. The NRC's approach is based on a decision tree framework with expert panels assessing the likelihood of success and estimating the benefits given success. In this talk, we describe the approach and discuss the results of some applications.

#### 2 - Photovoltaic Technology Options for Addressing Climate Change: an Expert Elicitation

Aimee Curtright, Carnegie Mellon University, Engineering and Public Policy, Pittsburgh, PA, 15213, United States, aimeecurtright@yahoo.com, David Keith, Granger Morgan

Expert elicitation is used to assess the future performance of 26 current and emerging photovoltaic (PV) technologies. The likelihood of each achieving specific module price thresholds within given time frames is evaluated. For a subset of the technologies, experts provide insight into technical barriers to success, plausible ranges of efficiencies and prices in 2030, and appropriate policy levers for optimizing PV performance. Development of the survey and results will be discussed.

#### 3 - Uncertainty, Climate Change, and Advanced Solar R&D

Erin Baker, University of Massachusetts, 220 ELab, Amherst, MA, United States, edbaker@ecs.umass.edu, Jeffrey Keisler

Both climate change and technical change are uncertain. In this paper we combine economics and decision analysis to incorporate the uncertainty of technical change into climate change policy analysis. We present the results of an expert elicitation on the prospects for technological change in advanced solar. We combine the expert elicitations on the technology with a technologically detailed Integrated Assessment Model to derive a probability distribution over future abatement cost curves.

#### 4 - Use of Experience Curves to Estimate the Future Cost of Power Plants with CO2 Capture

Sonia Yeh, Research Scientist, University of California-Davis, Institute of Transportation Studies, Davis, CA, 95616, United States, sonia\_yeh@unc.edu, Mike Berkenpas, Matt Antes, Edward Rubin

Given the growing worldwide interest, the expected future cost of power plants with CO2 capture is of significant interest. This study uses historical experience curves as the basis for estimating future cost trends for four types of electric power plants with CO2 capture systems. We estimate future cost reductions that might be achieved by power plants employing CO2 capture. Effects of uncertainties in key parameters are evaluated via sensitivity analysis.

## ■ SA22

### Game Theory and Homeland Security

Sponsor: Decision Analysis Sponsored Session

Chair: Jun Zhuang, PhD Candidate & Research Assistant, Department of Industrial and Systems Engineering, University of Wisconsin-Madison, 3155 Engineering Centers Building, 1550 Engineering Drive, Madison, WI, 53705, United States, jzhuang@wisc.edu

#### 1 - Stochastic Games for the MANPADS Problem

Erin Kardes, USC, USC, Ronald Tutor Hall, 8719 McClintock Ave., Room 314, Los Angeles, CA, 90089, United States, kardes@usc.edu, Randolph Hall

In this paper, we use two-person non-zero sum stochastic games to analyze the cost effectiveness of MANPADS (Man-Portable Air Defense Systems) countermeasures. These countermeasures are electronic devices that can be installed on commercial airplanes. We first present equilibrium results, and then perform sensitivity analyses by fixing attacker's strategies and solving the best response problem for the defender.

#### 2 - Competitive Markov Decision Process Interdiction

Matthew Bailey, Asst. Professor, Bucknell University, Lewisburg, PA, United States, mdbailey@pitt.edu, Halil Bayrak

Consider a problem where an inspector controls a perimeter by installing static detection resources and subsequently devising a dynamic inspection policy, whereas a smuggler attempts to smuggle materials through the perimeter without being detected. We formulate this problem as the interdiction of a competitive Markov decision process and present a linear mixed integer model. In addition, we develop a heuristic algorithm to solve larger problem instances.

#### 3 - Equilibrium Bluffs: A Model of Rational Feints

Santiago Oliveros, Assistant Professor, Haas School of Business-UC Berkeley, 545 Student Services Building #1900, Berkeley, CA, 94720-1900, United States, soliveros@haas.berkeley.edu

We study an attacker-defender game with incomplete information. The attacker can disguise her intentions and pretend to invade one location. Both players are fully rational and both play a pure strategy in equilibrium. We show that, under some conditions, there are equilibria with deception in which the attacker wastes resources to mislead the defender. We show that feints are a luxury good and that targets' natural protection and feints feasibility may be positively or negatively related.

#### 4 - Modeling Secrecy and Deception in Homeland Security Resource Allocation

Jun Zhuang, PhD Candidate & Research Assistant, Department of Industrial and Systems Engineering, University of Wisconsin-Madison, 3155 Engineering Centers Building, 1550 Engineering Drive, Madison, WI, 53705, United States, jzhuang@wisc.edu, Vicki Bier

In this work, we develop a game-theoretical model for whether and how a defender should disclose her resource allocation in the homeland-security context. Our model allows us to explore whether the defender should disclose correct information about her defensive resource allocation, incorrect information, or no information. Although we study secrecy and deception specifically in the homeland-security context, our work could provide insights in other contexts, such as business competition.

## ■ SA23

### Behavioral/Experimental Economics Research in Supply Chain Management

Sponsor: Behavioral Process Management (BPM) Sponsored Session

Chair: Ozalp Ozer, Stanford University, Stanford, CA, 94305, United States, oozer@stanford.edu

Co-Chair: Murat Kaya, Assistant Professor, Sabanci University, Faculty of Engineering and Natural Sciences, MDBF, Tuzla Istanbul, 34956, Turkey, mkaya@sabanciuniv.edu

#### 1 - Supplier and Retailer Behavior and the Effectiveness of Coordinating Contracts

Julie Niederhoffer, Assistant Professor, Whitman School of Management, Syracuse University, 721 University Ave, Syracuse, NY, 13244, United States, jniederh@syr.edu, Panos Kouvelis

Supply chain coordinating contracts are theoretically equivalent when set by risk-neutral expected-profit-maximizing decision makers. However, individual effects of the decision maker interact with the situational effects of the contract framing to reveal differences in contract performance. We study this interaction to identify several key factors which drive the expected profit of the contract.

#### 2 - How Social Reputation Networks Interact with Competition in Anonymous Online Trading

Gary Bolton, Professor, Penn State University, United States, gbolton@psu.edu, Claudia Loebbecke, Axel Ockenfels

Many Internet markets rely on "feedback systems", essentially social networks of reputation, to facilitate trust and trustworthiness in anonymous transactions. Market competition creates incentives that, in theory, may enhance or may curb the effectiveness of these systems. We investigate how market competition and social reputation networks interact to affect trust, trustworthiness and gains-from-trade in a series of laboratory online markets, where sellers face a moral hazard.

#### 3 - Conducting Empirical Research in China

Aleda Roth, Professor, Clemson University, College of Business & Behavioral Science, Clemson, United States, aroth@clemson.edu

China has become a country of interest to researchers in supply chain management. This presentation addresses key cultural in conducting empirical research in China and presents guidance for the conduct of empirical research there.

- 4 - Dual Channel Management with Service Competition  
Murat Kaya, Assistant Professor, Sabanci University, Faculty of Engineering and Natural Sciences, Sabanci Universitesi MDBF, Tuzla Istanbul, 34956, Turkey, mkaya@sabanciuniv.edu, Ozalp Ozer, Kay-Yut Chen

We address a manufacturer's problem of managing its direct online channel together with an independent retail channel. The consumers consider the delivery lead time in the direct channel and product availability in the retail channel in their channel selection. We identify optimal dual channel strategies that depend on the channel environment. We also present an experimental study that investigates whether our analytical model is consistent with human behavior.

## ■ SA24

### Software Demonstration

Cluster: Software Demonstrations

Invited Session

- 1 - JMP Division-SAS Institute - JMP 7.0 for Interactive Data Analysis and Simulation

Curt Hinrichs, JMP Division-SAS Institute, SAS Campus Dr., Cary, NC, 27513, curt.hinrichs@jmp.com, Melodie Rush

JMP is a state-of-the-art data analysis and visualization package from SAS. Developed for those who desire to explore data easily with modern graphics, JMP offers elementary and advanced statistics, business visualization and exploratory data mining. Only JMP offers two-way integration with SAS, including SAS/OR. The demo highlights JMP's key capabilities.

- 2 - statistics.com - Data Mining in Excel - XLMiner

Peter Bruce, statistics.com, 612 No. Jackson St., Arlington, VA, 22201, peter.bruce@statistics.com

XLMiner (data mining add-in for Excel) offers database sampling, stratified sampling, partitioning into training, validation and test samples, missing data imputation, and database scoring. Plus classification/regression trees, logistic regression, neural networks, Bayesian classifier, k-nearest neighbors, multiple linear regression with subset selection, association rules, principal components, hierarchical and k-means clustering.

## ■ SA25

### Management of Complex Service Systems

Sponsor: Service Science

Sponsored Session

Chair: Ruoyi Zhou, Management of Very Complex Service Systems, IBM, 650 Harry Road, San Jose, CA, 95120, United States, ruoyi@us.ibm.com

- 1 - Semantics for Collaborating Organizations' Self-service Technologies

Michael Goul, Professor, Arizona State University, W.P. Carey School of Business, P.O. Box 874606, Tempe, AZ, 85287-4606, United States, michael.goul@asu.edu, Haluk Demirkan

We present the theoretical development and implementation of semantics for federated organizations' governance, design and delivery of complex self-service technologies. The semantics developed integrate technical, human and business value aspects focusing on service network performance and adaptation. Research issues in applying the semantics to service blueprints and aggregators are discussed.

- 2 - How Learning and Forgetting Affect the Optimal Work Allocation Policy

Geoff Ryder, PhD Candidate, University of California - Santa Cruz, 4190 Sophia Way, San Jose, CA, 95134, United States, gryder@gmail.com, Kevin Ross

Service systems often require agents to divide their time between different job functions, and their effective service level for each function changes with experience. We analyze optimal work allocation policies where an agent's efficiency for a job class may increase through experience (learning-by-doing), or decrease due to forgetting (rapidly changing requirements). Policies vary between service-dominated (eg. serve at maximum available rate) and delay-dominated (serve the longest queue).

- 3 - Service Pricing with Knowledgeable Consumers  
Chris Anderson, Cornell University, School of Hotel Administration, Ithaca, NY, United States, cka9@cornell.edu, Leo MacDonald, Rohit Verma

Internet based businesses have appeared which target price sensitive customers with the provision of both price data and potential insight into future prices. We will present the complexities this data rich world has upon service based pricing, illustrating the issues in estimating demand models and discuss approaches to deal with this new found complexity.

- 4 - An Experiment to Increase Magazine Sales in a Supermarket  
Arthur Swersey, Professor of Operations Research, Yale School of Management, 135 Prospect St, New Haven, CT, 06511, United States, arthur.swersey@yale.edu, Gordon Bell, Johannes Ledolter

Experimental design methods have been widely used in manufacturing, but applications to marketing and service operations have been much less common. We describe how we used a Plackett-Burman design to test 10 factors relating to advertising and promotion, and the location of the magazine in a store. We discuss design issues such as number of stores needed and length of the test period. We compare our Plackett-Burman design to fractional factorial alternatives, and discuss our results.

## ■ SA26

### Joint Session DM/ICS/CPMS: Real World Applications of Text Mining

Sponsor: Data Mining (Sponsored), INFORMS Computing Society, The Practice Section of INFORMS

Sponsored Session

Chair: Mary Crissey, SAS Institute, 17030 Vista Park Dr, San Antonio, TX, 78247, United States, Mary.Crissey@sas.com

- 1 - Audio Analysis in Action

Mary Crissey, SAS Institute, 17030 Vista Park Dr, San Antonio, TX, 78247, United States, Mary.Crissey@sas.com, Manya Mayes

With Voice capture technologies it is now possible to text mine conversations and data captured from your call centers. This talk will show how important issues were identified after data was processed through the NICE systems and SAS software. See how to classify/predict customer behavior with predictive advanced analytics. Start and stop lists, concept link diagrams and lessons learned will be cited.

- 2 - Applying Text Mining to Find Optimal Treatment Pathways

Patricia Cerrito, Professor of Mathematics, Univ. of Louisville, Department of Mathematics, Louisville, KY, 40292, United States, pcerrito@louisville.edu

Patients with diabetes require physicians to make a sequence of decisions to treat diabetic foot ulcers and bone infections. Physicians can choose between combinations of antibiotics, amputations, and standard wound care. Text mining is used to compress categories of patient diagnoses and treatment combinations. Survival data mining algorithms are applied to examine multiple patient events. Results indicate that the primary treatment is amputation and that antibiotics are under-utilized.

- 3 - The Impact of Overfitting and Overgeneralization on the Classification Accuracy in Data Mining

Huy Pham, Louisiana State University, Department of Computer Science, 298 Coates Hall, LSU, Baton Rouge, LA, 70803, United States, hpham15@lsu.edu, Evangelos Triantaphyllou

Many classification studies have been developed in the two last decades. No single method outperforms all methods all the time. The performance of a classification method in terms of its false-positive and false-negative rates may be unpredictable. The root to the problem is the overfitting and overgeneralization behaviors. However, it has not been studied from a comprehensive view. This study proposes the Homogeneity-Based Algorithm for optimally controlling the rates with the promising results.

- 4 - Ranking National Football League Teams Using

Google's PageRank

Anjela Govan, North Carolina State University, 27695-8205, United States, aygovan@math.ncsu.edu, Russell Albright, Carl Meyer

The search engine Google uses the PageRanks of web pages to determine the order (rank) in which they are displayed to the user. In this work we expand Google's idea of web page ranking to ranking National Football League teams. The objective is to be able to rank NFL teams by their relative strengths using a new algorithm and to compare the results to existing ranking algorithms. The algorithms are implemented and tested using SAS/IML.

5 - Scio Systems Applies Advanced Text Technologies to Real Estate  
Alex Lupu, Co-founder, Scio Systems, 2881 Idlewood Ln,  
Highland Park, IL, 60035, United States, alupu@sciosystems.com

During this talk I will share the unique niche identified for software that automatically reads and comprehends the meaning of English text as written in legal contracts. Initially, my software application focuses on lease management for commercial property management organizations. This technology touts fast turn around times as it automatically abstracts, analyzes, and monitors contract terms in the dynamic rapidly changing real estate market.

## ■ SA27

### Data Mining and Analysis

Cluster: Data Mining (Invited)  
Invited Session

Chair: Sumit Sarkar, Ashbel Smith Professor of Information Systems, University of Texas at Dallas, 2601 N. Floyd Rd., SM 33, Richardson, TX, 75080, United States, sumit@utdallas.edu

1 - Developing a Measure of Risk Adjusted Revenue (RAR) for Credit Cards

B.P.S. Murthi, Associate Professor, The University of Texas at Dallas, 3.808 SOM, Richardson, TX, 75083-0688, United States, murthi@utdallas.edu, Shweta Singh, Erin Steffes

In customer relationship management, current research focuses on customer lifetime value with a view to optimizing the allocation of acquisition and retention efforts. However, in the credit card market, it is widely known that profitable customers are also more risky. Using credit card data, we develop a measure of risk adjusted revenue using data envelopment analysis. We also assess the role of modes of acquisition and of affinity cards and rewards cards.

2 - Mining Blog Data for Box Office Prediction

Eric Zheng, Assistant Professor, UT Dallas, 3.203 SOM, University of Texas at Dallas, Richardson, TX, 75083, United States, ericz@utdallas.edu, Wei Yue

Sales of products such as movies are often influenced by customers' word of mouth (WOM). Blogs present a new venue to study this WOM effect because they represent consumers' opinions over time across the population. We mine this blog data to predict the box office of movies. A text mining method is proposed to capture online opinions including volume, valence, sentiment and disposition of a blog on a movie. Initial econometric analyses show that blog has a significant effect on box office.

3 - Hide Sensitive Association Rules and Maximizing Accuracy

Syam Menon, Associate Professor of Information Systems, University of Texas at Dallas, 2601 N. Floyd Rd., SM 33, Richardson, TX, 75080, United States, syam@utdallas.edu, Sumit Sarkar

We focus on the problem of hiding sensitive association rules in shared databases. Hiding is usually achieved by altering selected transactions in such a way that they no longer support the sensitive association rules. The database should be altered as little as possible in order to maximize the benefits of sharing. We use accuracy as the measure of the quality of the altered database, and present optimal approaches to maximize the accuracy of the shared database.

4 - Learning Profiles From User Interactions

Pelin Atahan, University of Texas at Dallas, 2601 N. Floyd Rd., SM 33, Richardson, TX, 75080, United States, pxa041000@utdallas.edu, Sumit Sarkar

Personalization and recommendation systems play an important role in online business settings. An important determinant of the performance of these systems is the user profile available to the system. We study how user profiles can be implicitly learnt based on a user's traversal of a web site.

## ■ SA28

### Metaheuristics in Logistics and Transportation

Sponsor: INFORMS Computing Society/ Metaheuristics  
Sponsored Session

Chair: Claudio Cunha, Associate Professor, University of Sao Paulo, Cidade Universitaria ASO, Sao Paulo, SP, Brazil, cbcunha@usp.br

1 - Metaheuristics for the Stochastic Inventory Routing Problem

Arne Lokketangen, Arne.Lokketangen@hiMolde.no,  
Lars Hvattum, Gilbert Laporte

We address the Stochastic Inventory Routing Problem, where the stochasticity is in demands of the customers. Heuristic solution methods are proposed, based on using infinite scenario trees to approximate the underlying Markov Decision

Process. The scenario tree based methods are more general than previously proposed solution methods, and the computational results are promising.

2 - Restricted Dynamic Programming Based Neighborhoods for the Hop Constrained Spanning Tree Problem

Luis Gouveia, CIO and DEIO-FCUL, Edificio C6, Campo Grande, Lisbon, Lx, Portugal, legouveia@fc.ul.pt, Dushyant Sharma, Ana Paia

In the talk we will present a new dynamic program for the hop constrained minimum spanning tree problem. This problem arises in telecommunication network design and package routing in logistics. We will show that searching over node-level based exchanges such as shifts and swaps discussed in the literature is equivalent to search over a restricted dynamic program for the HMSTP. This study suggests new (or variations on the) neighborhood structures for the problem.

3 - A Simple and Efficient Multi-start Tabu Search Heuristic for the Uncapacitated Hub Location Problem

Claudio Cunha, Associate Professor, University of Sao Paulo, Cidade Universitaria ASO, Sao Paulo, SP, Brazil, cbcunha@usp.br, Marcos Silva

In this talk we describe a simple and efficient multi-start tabu search heuristic to solve the uncapacitated single allocation hub location problem, a problem that arises in several contexts, including passenger airlines, postal and parcel delivery, and computer and telecommunication networks. Computational experiments using typical benchmark problems show that our approach consistently returns the best results in very short CPU times.

## ■ SA29

### Free Open-source Software for Operations Research: An Introduction to COIN-OR

Sponsor: INFORMS Computing Society/COIN-OR  
Sponsored Session

Chair: Robin Lougee-Heimer, IBM TJ Watson Research Center, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States, robinlh@us.ibm.com

1 - Open Source and Software Publication

Matthew Saltzman, Clemson University, Department of Mathematical Sciences, Clemson, SC, United States, mjs@clemson.edu

Open source software (OSS) is arguably the most efficient technology transfer mechanism available today. We explain what OSS is and what its benefits are to the OR community. We describe various flavors of OSS licenses, and we discuss various issues related to publishing and using OSS. We also describe several examples of OSS resources available in the OR field.

2 - Introduction to COIN-OR: Open-source for the OR Community

Robin Lougee-Heimer, IBM TJ Watson Research Center, 1101 Kitchawan Road, Yorktown Heights, NY, 10598, United States, robinlh@us.ibm.com

Need a free solver? Modeling system? Interface? Or other computational-OR resource for your teaching, research, or application work? Over two dozen resources are available on-demand, free-of-charge at www.coin-org. Why reinvent when you can re-use? COIN-OR promotes open-source software for OR. We introduce the why, what, and how of COIN-OR.

3 - How to Publish Your Software on COIN-OR

Robert Fourer, Professor, Northwestern University, Dept. of Industrial Eng & Mgmt Sciences, 2145 Sheridan Road, Evanston, IL, 60208-3119, United States, 4er@iems.northwestern.edu

COIN-OR offers an environment tailor-made for disseminating and maintaining OR software. If you have created a software package or library that you are willing and able to open up for use by the OR community, you may want to consider adding it to the over two dozen projects currently supported at COIN-OR. This presentation will detail the steps involved.

## ■ SA30

### Prognostics and Maintenance Management

Sponsor: Quality, Statistics and Reliability  
Sponsored Session

Chair: Nagi Gbraeel, Assistant Professor, Georgia Institute of Technology, 765 Ferst Drive, NW, Atlanta, GA, 30332, United States, nagil@isye.gatech.edu

### 1 - Maintenance Diagnostics, Prognostics and Health Management in Manufacturing

Stephan Biller, Group Manager, General Motors R&D,  
30500 Mound Road, MC 480-106-359, Warren, MI, 48090,  
United States, stephan.biller@gm.com, Leandro Barajas

Maintenance generates one of the highest structural costs in automotive manufacturing. Reducing such costs can achieve results beyond those possible by implementing efficiency improvement programs alone. By integrating diagnostics and prognostics into our maintenance business processes, we have reduced spatio-temporal uncertainties associated with future states and performance of manufacturing systems and therefore enabling us to take informed and effective decisions on maintenance activities.

### 2 - An Optimal Stopping Rule for Sensor-driven Replacement and Spare Parts Inventory Decision Models

Alaa Elwany, PhD Candidate, Georgia Institute of Technology,  
765 Ferst Drive, NW, Atlanta, GA, 30332, United States,  
aelwany@engineering.uiowa.edu, Nagi Gabraeel

A sensor-driven decision model is proposed to determine and dynamically revise optimal replacement and inventory policies for partially degraded components given real-time sensory information. An optimal stopping rule is then developed to decide when to stop updating and implement the most recently updated decision policy. The presented real-world case study demonstrates that this results in better decisions and reduced costs due to the improved prediction accuracy of components' lifetimes.

### 3 - Adaptive Spare Part Replenishment Driven by Condition Monitoring Technique

Haitao Liao, Assistant Professor, Wichita State University, 1845  
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KS, 67260-0035, United States, haitao.liao@wichita.edu

Just-in-time spare part management reduces the total downtime of a machine by carrying minimal spare part inventory and replenishing it only when and as needed. This paper presents a sensor-driven adaptive spare part replenishment strategy for several machines of the same type. A joint estimation approach is utilized to quantify the health status of each machine for updating the system-level replenishment strategy. An example of a bench top CNC milling machine is provided for demonstration.

### 4 - Structured Maintenance Policies for a Non-stationary, Partially Observable Markov Decision Process

Ludmila Zheltova, Case Western Reserve University, 11119  
Bellflower Road, Peter B. Lewis Building, Cleveland, OH, 44106,  
United States, ludmila.zheltova@case.edu, Lisa Maillart

We analyze a partially observable Markov decision process (POMDP) maintenance model and determine conditions under which the optimal inspection/replacement policy exhibits appealing structure. These results generalize existing work by considering the important case in which the system deteriorates according to a known, time-dependent transition probability matrix.

## ■ SA31

### Bayesian Reliability Modeling

Sponsor: Quality, Statistics and Reliability  
Sponsored Session

Chair: Refik Soyer, George Washington University, Decision Sciences  
Dept. Fungler Hall 415, School of Business, Washington, DC, 20052,  
United States, soyer@gwu.edu

#### 1 - Dynamic Bayesian Information Measures for Duration Analysis

Ehsan Soofi, Lubar School of Bus., P.O. Box 742, University of  
Wisconsin-Milwaukee, Milwaukee, WI, 53201, United States,  
esoofi@uwm.edu, Nader Ebrahimi, S.N.U.A. Kirmani

We present measures of information about the parameters provided by observation from the residual life distribution where the support is truncated at the current age. The current age induces a dynamic into the information measures. Dynamic versions of well-known measures of information provided by the data about parameters are studied. These measures are applied to dynamic updating of information about parameters and predictive distributions for some well-known lifetime models.

#### 2 - Bayesian Imperfect Debugging Modeling

Tevfik Aktekin, The George Washington University, 2201 G  
Street, NW, Suite 415, Washington, DC, 20052, United States,  
taktekin@gwu.edu, Toros Caglar

The scope of our research is to develop a bayesian imperfect debugging model in software reliability using MCMC methods. The proposed model will help us to study the behavior of the fault detection rate per fault, number of faults left on the software code over time and the reliability of the software up to a particular time via statistical inference.

#### 3 - A General Bayesian Inference Procedure for Accelerated Tests

Thomas Mazzuchi, George Washington University, 1776 G Street  
NW, EMSE Suite 101, Washington, DC, 20052, United States,  
mazzu@gwu.edu

This talk presents development of a general model for accelerated life testing using the Bayesian paradigm. Both design and inference implications will be discussed. The inference procedure uses the well-known Markov Chain Monte Carlo (MCMC) methods to derive posterior approximations. The approach is illustrated with an example.

#### 4 - Semiparametric Bayesian Decision Models

Refik Soyer, George Washington University, Decision Sciences  
Dept. Fungler Hall 415, School of Business, Washington, DC,  
20052, United States, soyer@gwu.edu, Jason Merrick

We consider a semi-parametric model to describe failure characteristics of a system. Using a gamma process prior for the cumulative intensity function complicates the Bayesian analysis when the updating is based on failure count data. We develop a Bayesian analysis using MCMC methods and determine replacement strategies. Adoption of MCMC methods involves a data augmentation algorithm. We show the use of our approach with actual data.

## ■ SA32

### Logistics Insurance and Risk Management

Cluster: Shipping, Maritime, and Supply Chain Logistics  
Invited Session

Chair: Xianghua Gan, The Hong Kong Polytechnic University,  
Hung Hom, Hong Kong, China, lgtxgan@polyu.edu.hk

#### 1 - Premium-call Policies for Mutual Insurance

Xianghua Gan, The Hong Kong Polytechnic University,  
Hung Hom, Hong Kong, China, lgtxgan@polyu.edu.hk

Mutual insurance (MI) is a type of insurance where those protected by the insurance (policyholders) also have certain "ownership rights in the organization. MI has been the dominant insurance vehicle in marine insurance market for over 150 years. Assuming periodic premium collection, we find the optimal premium-call policy for the mutual insurance organization.

#### 2 - Incentives of Contingent Options in Mutual Insurance

John Liu, Lgtjliu@polyu.edu.hk, Jiguang Yuan

A key drawback of mutual insurance is its indistinguishable principal-agent structure. As a result, typical revelation mechanisms (e.g., non-linear deduction-based premium, etc.) can hardly be implemented in mutual insurance. Intrigued by the fact that P&I Club, a marine mutual insurance with linear premium (i.e., tonnage-based premium rate), has over 150 strong years of history, we in this paper intend to examine alternative revelation scheme in mutual insurance.

#### 3 - Exchange of Demand Information Across Retailers in a Supply Chain

Jianghua Wu, Assistant Professor, Renmin University of China,  
School of Business, 59 Zhongguancun St., Beijing, 100872, China,  
jwu@ruc.edu.cn

We study the impact of information sharing across decentralized retailers in a supply chain. The manufacturer supplies similar products to multiple retailers and each retailer serves its independent end market. We show that, under constant market conditions, the number of retailers may affect their incentives to share information.

## ■ SA33

### Urban Transportation Planning Models I: Models and Methods for Transportation Network Design

Sponsor: Transportation Science & Logistics  
Sponsored Session

Chair: Xuegan (Jeff) Ban, Assistant Research Engineer, CCIT,  
University of California, Berkeley, 2105 Bancroft Way, Berkeley, CA,  
United States, xban@berkeley.edu

#### 1 - Sample Average Approximation and Decomposition Techniques for Stochastic Network Design Problems

Gopal Patil, PhD Candidate, Rensselaer Polytechnic Institute,  
JEC-4002, Dept. of Civil Engineering, Troy, NY, 12180, United  
States, patilg@rpi.edu, Satish Ukkusuri

Stochastic Network Design Problems incorporates stochasticity in network parameters such as demand, capacity and travel time. Introducing stochasticity increases the complexity of already complex network design problems. Our experiences with KNITRO, FILTER<sup>o</sup>the solvers to deal with non-convex problems<sup>o</sup> show that these tools are not capable of handling larger problems. In this study we reduce the complexity of problem using sample average approximation (SAA) and decomposition approaches.

## 2 - Estimating Investment Requirement for Maintaining and Improving Highway Systems

Yafeng Yin, Assistant Professor, University of Florida, 365 Weil Hall, Box 116580, Gainesville, FL, 32611, United States, yafeng@ce.ufl.edu, Siriphong Lawphongpanich, Yingyan Lou

This paper presents an integrated and robust approach for estimating the investment necessary to maintain and/or improve the future levels of service and pavement conditions of facilities in a highway network. The approach assumes that future travel demands and facility conditions are confined to an ellipsoidal uncertainty region. The problem is formulated as a mathematical program with equilibrium constraints and solved via a cutting plane algorithm on the Sioux Falls network.

## 3 - Carrier-carrier Collaborative Networks: A Network Design Formulation

Salvador Hernández, Research Assistant, Purdue University, 550 Stadium Mall Drive, West Lafayette, IN, 47906, United States, shhernan@purdue.edu, Srinivas Peeta

A Less-than-truckload (LTL) carrier has demand it cannot fully serve for multiple origins and destinations. It seeks to collaborate with other carriers who may share all, part, or none of its network. The goal of the LTL carrier is to identify the routes that minimize the sum of the collaborative path costs. A mixed integer formulation is presented which precludes load splitting between arcs. Issues are identified, and solutions are presented and discussed on varying network sizes.

## 4 - A Decomposition Scheme for Bi-level Dynamic Network Design Problem

Dung-Ying Lin, Graduate Research Assistant, The University of Texas at Austin, 1 University Station C1761, ECJ Hall Suite 6.208, Austin, TX, 78712, United States, dylin@mail.utexas.edu, Ampol Karoonsoontawong, S. Travis Waller

The bi-level dynamic network design problem is strongly NP-hard. Solving this problem efficiently is critical in the development of the capacity expansion policies on networks. A Dantzig-Wolfe decomposition based heuristic scheme is proposed to address this issue. Numerical experiments are performed, new solution methodologies are discussed, and insights are presented.

## ■ SA34

### Freight Transportation

Sponsor: Transportation Science & Logistics  
Sponsored Session

Chair: April Kuo, University of Maryland, 1173 Glenn Martin Hall, College Park, MD, United States, aprilkuo@umd.edu

#### 1 - A Nationwide High-speed Rail System for Freight

Russell Meller, Hefley Professor of Logistics, University of Arkansas, Center for Engr Logistics and Distrib., 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States, rmeller@uark.edu, Jen Pazour, Kevin Gue

High-speed rail is often touted as a way to reduce congestion on the nation's highways by removing passenger car traffic. But reducing the amount of freight traffic would also reduce highway congestion. So, given the advances in high-speed rail, the potential exists for developing a nationwide system for freight. We present a network design model that considers transit times and highway traffic and an application of it with data from a major truckload carrier as a potential case study.

#### 2 - Integration of Facility Location and Layout of Intermodal Transportation System with Scheduling

Guven Kaya, Koc University, Department of Industrial Engineering, Sariyer, Istanbul, 34450, Turkey, gukaya@ku.edu.tr, Ceyda Oguz, Metin Turkey

We developed an integrated model for facility layout and scheduling problems arising in intermodal freight logistics for the municipality of Istanbul. After formulating it as an MIP model, we proposed both exact and heuristic algorithms to solve it. This will be applied to the system Istanbul municipality has and the results will be discussed.

#### 3 - Combinatorial Auction for Multi-carrier Freight Transport

April Kuo, University of Maryland, 1173 Glenn Martin Hall, College Park, MD, United States, aprilkuo@umd.edu, Elise Miller-Hooks

We propose a combinatorial auction of rail track capacity among multiple carriers in a spot market. The auction process is analyzed in a simulation platform, where a carrier's bidding behavior is considered. A computationally efficient, approximate method for bid construction (i.e. for solution of the winner determination problem) is developed.

#### 4 - Scheduled Service Network Design for Rail Carriers

Endong Zhu, CIRRELT, University of Montreal, C.P. 6128, succursale Centre-ville, Montreal, QC, H3C 3J7, Canada, endong@crt.umontreal.ca, Michel Gendreau, Teodor Gabriel Crainic

We are addressing the service network design problem in freight rail transportation. The problem simultaneously considers the service selection and scheduling, traffic distribution, blocking policy, and train make-up policy. To explicitly describe the flows of services, blocks, and cars/commodities, a cyclic time-space network structure with three layers is constructed. Based on the network structure, we present a linear mixed-integer formulation. Solution method ideas are also discussed.

## ■ SA35

### Stochastic Multi-Stage Resource Allocation Model with Reservation

Sponsor: Transportation Science & Logistics  
Sponsored Session

Chair: Lijian Chen, Assistant Professor, University of Louisville, Department of Industrial Engineering, Speed School of Engineering, RM312, Louisville, KY, 40292, United States, lijian.chen@louisville.edu

#### 1 - Performance of Zero-Memory Policies in a Single Product Inventory System with Inaccurate Counts

Olga L. Ortiz, Georgia Institute of Technology, School of Industrial and Systems Engineering, oortiz@isye.gatech.edu, Chelsea C. White III, Alan Erera

We model an inventory system with inaccurate counts as a partially observed Markov decision process and show that under certain conditions, a zero-memory policy that is equivalent to an optimal policy for its completely observed counterpart is adaptive. A simulation study is used to assess the value of improved inventory accuracy.

#### 2 - Parallel Machine Scheduling to Minimize Weighted Completion Time Variance

Yang Sun, Assistant Professor, California State University, Sacramento, College of Business Administration, 6000 J Street, Sacramento, CA, 95819, United States, yang.sun@asu.edu, John Fowler, Xueping Li

The parallel machine scheduling problem with the objective of minimizing completion time variance has many structural optimality properties. However, these properties do not hold for cases in which the objective is to minimize weighted CTV. Hence, it is difficult to develop constructive heuristics for the weighted version of the problem. In this research, we use a genetic algorithm and a set of greedy heuristics to search for better solutions. Computational results are also provided.

#### 3 - Inventory Based Allocation Policies for Flexible Servers in Serial Systems

Maria Mayorga, Assistant Professor, Clemson University, Freeman Hall Box 34020, Clemson, SC, United States, mayorga@CLEMSON.EDU, Kevin Taaffe, Ramesh Arumugam

Motivated by industrial applications, we study the allocation of a flexible server in a serial process. Rather than using standard server vacation rules, we consider polling policies that are characterized by endogenous parameters, such as inventory levels, with the goal of maximizing throughput. We analyze this problem using queuing theory and simulation when needed.

#### 4 - Stochastic Multi-stage Resource Allocation Model with Reservation

Lijian Chen, Assistant Professor, University of Louisville, Department of Industrial Engineering, Speed School of Engineering, RM312, Louisville, KY, 40292, United States, lijian.chen@louisville.edu

We propose a resource reservation approach for the stochastic multi-stage resource allocation problem within a fixed time horizon. By reserving and releasing resources by stages, the scenario tree is significantly reduced and the non-convexity is eliminated. As a result, solving the multi-stage stochastic program becomes implementable for business scale problems. In the remaining part of the paper, we present the optimal condition and results.

## ■ SA36

### Transportation I

Contributed Session

Chair: Ramesh Bollapragada, Associate Professor, College of Business, San Francisco State University, 1600 Holloway Avenue, San Francisco, CA, 94132, United States, rameshb@sfsu.edu

#### 1 - Unspecified-Time Airline Tickets

Guoren Zhang, PhD Candidate, Richard Ivey School of Business  
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Peter C. Bell

A new phenomenon in airline industry is that airlines sell Unspecified-Time Airline Tickets (UTAT). UTAT represents a seat purchased by a consumer for travel during some time window on a flight decided by airline the. Low price UTAT can attract leisure travelers who are not time sensitive. In this paper, we study the new pricing problems of UTAT for airline companies. We explore necessary conditions for airline carriers to introduce UTAT under different assumptions.

#### 2 - Model and Algorithm for the Courier Delivery Problem with Uncertainty

Ilgaz Sungur, USC, 3715 McClintock Avenue, GER240, LA, CA, 90089, United States, sungur@usc.edu, Maged Dessouky,  
Fernando Ordonez

We propose a model for VRPTW with uncertainty combining scenario-based stochastic optimization for probabilistic customers and robust optimization for uncertain service times. Our model maximizes customers serviced and similarity of routes in each scenario while minimizing total cost and lateness penalty. We develop a two-phase insertion-based heuristic balancing these objectives. Our experiments study sensitivity of the heuristic and show improvements over a real-life large scale problem.

#### 3 - Ride Service Outsourcing for Profit Maximization

Bruce Wang, Researcher, University of Wisconsin, 1415  
Engineering Dr. Room 2205, Madison, United States,  
wangx@enr.wisc.edu, Yihua Wang, Teresa Adams

Frequently service requests exceed the carrier's available capacity. Advance outsourcing therefore remains an important component of transportation service providers' business. In this paper, we develop a model for ride service outsourcing. Test with sedan ride services data indicates that the optimization techniques dramatically improves the carrier's outsourcing decision and profitability.

#### 4 - Column Generation for Ship Scheduling Problems with Flexible Cargo Sizes

Bjorn Nygreen, Professor, NTNU, Norwegian University of Science  
and Tech, Trondheim, N- 7491, Norway,  
bjorn.nygreen@iot.ntnu.no, Jens Lysgaard, Geir Brønno

We show that introduction of flexible cargo sizes in a column generation framework is not straightforward. We handle the flexible cargo sizes heuristically when solving the subproblems. We have compared our method with an a priori column generation approach, and our computational experiments on real world cases show that our Dantzig-Wolfe approach is faster than the a priori generation of columns, and we are able to deal with larger or more loosely constrained instances.

#### 5 - Slow Progress of FasTrak: Usage Analysis of an Electronic Toll Collection System

Ramesh Bollapragada, Associate Professor, College of Business,  
San Francisco State University, 1600 Holloway Avenue,  
San Francisco, CA, 94132, United States, rameshb@sfsu.edu,  
Sanjit Sengupta, Hector Bedolla

Through quantitative and empirical models, we provide several recommendations that help reduce the traffic congestion problems at all Bay area bridges, through increased usage of FasTrak devices for electronic toll collection (from the current level of 40% to a future level of 70%). Our paper is influencing the government and policy makers such as MTC and BTA in the Bay area, and the work here has appeared in several local television and radio channels, as well as in over a dozen newspapers.

## ■ SA37

### Munition Applications

Sponsor: Military Applications  
Sponsored Session

Chair: James Moore, The Air Force Institute of Technology, AFIT/ENS  
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#### 1 - Communication Models for a Cooperative Networks of Autonomous Agents

Clayton Commander, Air Force Research Laboratory,  
101 W. Eglin Blvd, Ste. 144, Eglin AFB, FL, 32542, United States,  
commandc@eglin.af.mil, Ashwin Arulselman, Panos Pardalos,  
Mauricio G. C. Resende, Michael Hirsch

The cooperative communication problem on mobile ad-hoc networks (CCPM) deals with maximizing the connectivity for a set of wireless agents as they traverse a graph from a set of source nodes to a set of destination nodes. Here we introduce continuous formulations and compare the results of several case studies. This provides a more realistic model of the problem as supported by the numerical evidence.

#### 2 - Information Sharing and Cooperation in Multi-Agent Systems

David Jeffcoat, Eglin AFB, jeffcoatd@eglin.af.mil

This research is concerned with the modeling and analysis of cooperation within a heterogeneous, multi-agent team. Our focus is on a special form of cooperation, namely information sharing. The objective is to develop mathematical models for cooperation via information sharing in complex large-scale systems. The approach is based on the techniques of discrete-state, continuous-time Markov chain models. The primary application context is the search for targets in a combat scenario.

#### 3 - Weapon Target Assignment Problems: An In-depth Survey

Theresa Wilson, AFRL/MNGN, 101 W. Eglin Blvd Suite 341,  
Eglin AFB, FL, United States, wilsona@eglin.af.mil, Panos  
Pardalos, Michael Hirsch

In its most general form, the Weapon Target Assignment problem and the more general resource allocation problem are known to be NP-complete. Numerous formulations exist and many heuristics have been implemented to solve this problem. In this paper, we present a comprehensive survey of the different formulations and heuristics for the Target-Based Weapon Target Assignment Problem.

#### 4 - Scheduling a Single Sensor in a Time-variant Environment

Mesut Yavuz, Shenandoah University, 1460 University Drive,  
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David Jeffcoat

The allocation and scheduling of sensors is a significant problem in military operations research. Recent work in the area focuses on a class of sensors able to observe multiple sites of interest, one at a time. In this research, we consider multiple sites each with time-variant activity rates. We establish computational complexity of the problem and propose both deterministic and stochastic methods for its solution. We also compare the solution methods via a computational study.

## ■ SA38

### Marketing I

Sponsor: Marketing Science  
Sponsored Session

Chair: Gary Erickson, Professor, University of Washington Business  
School, Box 353200, Seattle, WA, 98195-3200, United States,  
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#### 1 - Incorporating Uncertainties into Product Development and Engineering Design

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United States, rjean.ruth@gm.com, Artemis Kloess,  
Sharon Zielinski

For product applications that require balancing competing attributes and features, methods for incorporating uncertainties about consumer market research information and technology capabilities in the future, eliciting expert judgments, and combining sources of information are key. We use vehicle examples to discuss sources of uncertainty and how uncertainties evolve, consider methods for handling key uncertainties, and suggest areas for further research and development of applied methods.

#### 2 - Forecasting New Product Demand Using a Generalized Heterogeneous Model

Michael J. Scott, Associate Professor, University of Illinois at  
Chicago, MIE (MC 251), 842 W. Taylor St., Chicago, IL, 60607,  
United States, mjscott@uic.edu, Joseph A. Donndelinger,  
Jeffery A. Robinson, Luke A. Wissman, Sina Ghotbi

Market research methods for demand forecasting range from conjoint analysis to contingent valuation methods such as the Van Westendorp Price Sensitivity Meter. Their usefulness in new product development is limited by complex relationships between market research methods and market demand models. We investigate the generalization of market demand models to use market research data from a variety of sources and facilitate interpretation by both practitioners and decision-makers.

### 3 - Making MaxDiff More Informative: Statistical Data Fusion by Way of Latent Variable Modeling

Lynd Bacon, SVP Analytics, Polimetrix, Inc., 285 Hamilton Ave, Suite 200, Palo Alto, CA, 94301, United States, lynd@polimetrix.com, Peter Lenk

MaxDiff Scaling (AKA Best/Worst Analysis), is a special kind of choice-based conjoint that has been steadily gaining popularity in recent years. One weakness of it is that individual differences in scale origin are lost. We describe a type of HB model that fuses MaxDiff and rating scales data so that scores relative to a sample-level common origin can be estimated. We compare specifications that are and are not consistent with Random Utility Theory, and provide example applications.

### 4 - Product Line Design Optimization for Heterogeneous Markets: A Decomposition-based Approach

Jeremy Michalek, Assistant Professor, Carnegie Mellon University, Scaife Hall 323, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, jmichalek@cmu.edu

Optimization of product attribute levels using conjoint data is common; however, products with engineering content involve critical tradeoffs in the ability to actually achieve desired levels. We present a method for product line optimization that incorporates consumer heterogeneity and efficiently coordinates positioning and design models to achieve realizable firm-level optima, and we examine the tradeoff between part commonality and product differentiation.

## SA39

### Critical Decisions in Healthcare

Sponsor: Health Applications Section  
Sponsored Session

Chair: Renata Kopach-Konrad, Purdue University Industrial Engineering, 315 N. Grant St., West Lafayette, IN, 47907, United States, rkopach@purdue.edu

#### 1 - A Simulation-based Peri-operative Decision Support System

Daphne Sniekers, PhD Candidate, University of Toronto, 5 King's College Road, Toronto, ON, M5S 3G8, Canada, sniekers@mie.utoronto.ca, Mike Carter

In this study, a simulation tool was created which models the flow of patients through the entire preoperative process; from decision to perform to discharge from the recovery ward. The model will allow users to test varying scenarios such as increased orthopedic block times, on the daily bed census, PACU overload, ward bed availability, and cancellation rates. The model is being piloted at two sites, and is part of a larger project of developing a general framework for a perioperative DSS.

#### 2 - A System Dynamics Resource Allocation Model of an Emergency Department

Sonia Vanderby, PhD Candidate, University of Toronto, 438 Rickard Rd., Bowmanville, ON, Canada, sonia@mie.utoronto.ca, Mike Carter

Can SD be used to model an ED? EDs have previously been modeled via DES, with little history of the use of SD. A high-level simulation of an ED at The Ottawa Hospital was developed to test various scenarios requested by TOH. The goal of the model is to provide hospital administrators with a tool to assist them with making long-term resource allocation decisions in an effort to reduce delays in the ED. Scenario outcomes, as well as the pros and cons of SD in such a model are discussed.

#### 3 - Stochastic Overbooking Model for Outpatient Scheduling Under General Service Time

Santanu Chakraborty, Purdue University, 166 E Stadium Avenue, West Lafayette, IN, 47906, United States, chakrabs@purdue.edu, Mark Lawley, Kumar Muthuraman

Here study a stochastic scheduling problem for outpatient clinics under general service time. Patients are characterized based on their probability of missing an appointment. To compensate this, scheduler overbooks the slots, thereby maximizing profit. Here we propose a numerical technique using a myopic policy for optimal performance. It involves computing multidimensional numerical integrations. As a special case, we propose a simplified approach when the service time distribution is gamma.

## SA40

### Pierskalla Award

Sponsor: Health Applications Section  
Sponsored Session

Chair: Jay Rosenberger, Assistant Professor, University of Texas-Arlington, IMSE Dept., Arlington, TX, United States, jrosenbe@uta.edu

Co-Chair: Julie Simmons Ivy, University of Michigan, jsimmons@bus.umich.edu

#### 1 - Algorithmic Prediction of Health Care Costs and Discovery of Medical Knowledge

Margret Bjarnadottir, MIT, 77 Mass Ave., MIT E40-149, Cambridge, MA, 02139, United States, margret@mit.edu, Grant Wang, Michael Kane, J. Christian Kryder, Rudra Pandey, Santosh Vempala, Dimitris Bertsimas

Rising health care costs are one of the world's most important problems. Correspondingly, predicting such costs with accuracy is a significant first step in addressing this problem. We utilize modern data mining methods and claims data from close to 400,000 members over three years, to provide a) rigorously validated predictions of health care cost and b) an illustration through two examples, that our methods can lead to discovery of medical knowledge.

#### 2 - An Analysis of the General Minimum Cost Vaccine Formulary Selection Problem

Sheldon H. Jacobson, University of Illinois, Siebel Center, 201 N. Goodwin Ave, Urbana, IL, 61801, United States, shj@uiuc.edu, Shane Hall, Edward Sewell

The General Minimum Cost Vaccine Formulary Selection Problem (GMCVFSP) models a general childhood immunization schedule for optimally selecting a vaccine formulary. Both exact algorithms and heuristics are presented. The results reported provide fundamental insights into the structure of GMCVFSP, as well as practical value for the public health community.

#### 3 - Solving Beam Angle Selection and Dose Optimization Simultaneously via High-Throughput Computing

Hao Zhang, University of Wisconsin-Madison, Industrial and Systems Engineering Dept., 1513 University Avenue, Madison, WI, 53706, United States, haoz@cae.wisc.edu, Robert Meyer, Leyuan Shi, Warren D'Souza

In this research we provide a framework for integrating two stages of Radiation Treatment Planning (RTP): Beam Angle Selection (BAS) and Dose Optimization (DO). A metaheuristic approach, Nested Partitions (NP), is applied. Computational efficiency is achieved by utilizing High-Throughput Computing (HTC) via the Condor system. Computational results show that our framework has led to a significant improvement in terms of solution quality and delivery time comparing with current clinic practices.

#### 4 - Maximum Matchings on Graphs for Allocating Kidney Paired Donation

Sommer E. Gentry, Assistant Professor, United States Naval Academy, 572-C Holloway Road, Mailstop 9E, Mathematics Department, Annapolis, MD, 21402, United States, gentry@usna.edu, Dorry L. Segev, T. S. Michael

Kidney paired donation matches a patient and incompatible donor with another patient and donor for an organ exchange. The best donations are a weighted graph matching. A preemptive multiobjective matching problem is: first maximize transplants for a favored group, second maximize transplants for all, and lastly maximize geographic proximity of the donations. Two results about the size of weighted matchings allow solution of the multiobjective problem using standard weighted matching techniques.

## SA41

### Medical Diagnosis and Disease Prediction

Sponsor: Optimization/ Optimization and Computing in Medicine and Life Sciences  
Sponsored Session

Chair: Eva K. Lee, Associate Professor & Director, Georgia Institute of Technology, Center for OR in Medicine & HealthCare, Industrial & Systems Engineering, Atlanta, GA, 30332-0205, United States, evakylee@isye.gatech.edu

### 1 - Chromosomal Mapping Identifies Patterns for Progression of Breast Cancer Molecular Subtypes

Gabriela Alexe, Computational Biologist, PhD, The Broad Institute of MIT and Harvard, 7 Cambridge Center, Cambridge, MA, 02142, United States, galex@broad.mit.edu, Shridar Ganesan, Daniel Scandell, Charles DeLisi, Gul S. Dalgin, Gyan Bhanot, Pablo Tamayo, Jill P. Mesirov, Arnold Levine

In this study we re-analyze gene expression data of matched pairs of ductal carcinoma in situ and invasive ductal carcinoma to discover specific patterns of progression for breast cancer molecular subtypes.

### 2 - Novel Optimization Models for Classification of Brain's Physiological States

W. Art Chaovalitwongse, Assistant Professor, Rutgers University, 96 Frelinghuysen Rd, Piscataway, NJ, 08854, United States, wchaoval@rci.rutgers.edu, Ya-Ju Fan, Rajesh Sachdeo

We present new optimization models used in epilepsy treatment to classify different physiological states of the brain from electroencephalograms (EEGs). The proposed technique is used to select the brain areas that best classify seizure susceptibility (pre-seizure) and normal periods. The empirical results show that the proposed technique achieves an average sensitivity and an average specificity over 80% in 10 patients.

### 3 - Predictive Models for Cardiovascular Disease

Tsung-Lin Wu, Georgia Institute of Technology, Industrial & Systems Engineering, Center for OR in Medicine & HealthCare, Atlanta, GA, 30332-0205, United States, tlwu@isye.gatech.edu, Eva K. Lee

In this talk, we describe an optimization-based predictive model that allows multi-group classification while constraining the inter-group misclassification rate. A feature selection heuristics will be outlined. Applications to cardiovascular disease data and other real-world dataset are provided to illustrate the power of our model.

## ■ SA42

### Combinatorial Optimization in Medicine and Bioinformatics

Cluster: Operations Research in Medicine and Health Care  
Invited Session

Chair: Jim MacGregor-Smith, Professor, Dept. of Mechanical and Industrial Eng., Elab Building, Univ of Massachusetts, 160 Governor's Drive, Amherst, MA, 01003, United States, jmsmith@ecs.umass.edu

#### 1 - Scheduling the Adjuvant Endocrine Therapy for Early Stage Breast Cancer

Sergiy Butenko, Industrial and Systems Engineering, Texas A&M University, College Station, TX, butenko@tamu.edu, Sera Kahruman, Illya Hicks, Kathleen Diehl, Elif Kolotoglu

Based on the data available through published trial results, we build a mixed integer nonlinear programming model in order to find an optimal treatment plan for a given Hr+ early stage breast cancer patient who is postmenopausal. The results of numerical experiments suggest the effectiveness of some of the schedules currently used in practice, as well as indicate some effective alternative treatment plans.

#### 2 - Modeling the IMRT Beam Selection Problem as a Facility Location Problem

Gino Lim, University of Houston, 4800 Calhoun Rd, E211 Engr. Bldg 2, Houston, TX, 77204, United States, ginolim@uh.edu, Josh Reese

The beam selection problem in radiotherapy is to select the best  $n$  gantry angles which treat the tumor while minimizing damage to healthy tissues. We propose a new approach that begins with an optimal  $k$ -beam plan, then use the  $p$ -median problem to prune this plan down to an  $n$ -angle plan ( $n < k$ ) so that the distortion is minimized between the original plan and the final plan. We show that partial least squares approach coupled with  $p$ -median model is able to obtain good treatment plans.

#### 3 - Secondary Structure Prediction in Proteins with a New Dihedral Angle Measure

Jim MacGregor-Smith, Professor, Dept. of Mechanical and Industrial Eng., Elab Building, Univ of Massachusetts, 160 Governor's Drive, Amherst, MA, 01003, United States, jmsmith@ecs.umass.edu, Moon Kim, Yunho Jang

Secondary structure prediction in proteins is a necessary prerequisite for tertiary prediction in the protein folding process. Based upon the combinatorial optimization properties of Steiner trees, a new dihedral angle measure is derived to aid in this process. Numerous experimental results with this new angle measure and its probability distribution are presented in order to characterize the alpha-helix and beta-sheet structures of proteins.

## ■ SA43

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### Probability Management

Cluster: O.R. Practice  
Invited Session

Chair: Sam Savage, Consulting Prof., Stanford University, Dept. of MS&E, 326 Terman, Stanford, CA, 94305, United States, savage@stanford.edu

#### 1 - Quantity and Time Flexible Contracts Under Uncertain Price and Demand

Mohamed Wahab Mohamed Ismail, Assistant Professor, Mechanical and Industrial Engineering, Ryerson University, Toronto, ON, M5B 2K3, Canada, wahab@ryerson.ca, Rongbing Huang

We study two types of supply contracts under uncertain price and demand. Both contracts allow the firm to purchase at discrete intervals over a given period of time. A time-flexible contract requires the firm to specify how many units it will purchase at each time, while the firm does not have commitment to purchase the specified quantity at each time. Quantity flexible contract allows the firm to purchase any discrete quantity within specified quantity window.

## ■ SA44

### Teaching Case Competition 1

Sponsor: INFORM-ED

Sponsored Session

Chair: Chris Zappe, Interim Dean, Bucknell University, 701 Moore Avenue, Lewisburg, PA, 17837, United States, zappe@bucknell.edu

#### 1 - Presentations of Finalists #1 and #2 for the Eighth Annual INFORMS Case Competition

Chris Zappe, Interim Dean, Bucknell University, 701 Moore Avenue, Lewisburg, PA, 17837, United States, zappe@bucknell.edu

The four finalists for the 2007 INFORMS Case Competition will deliver final presentations of their cases to a panel of judges and the audience. All are welcome to attend and observe these presentations as well as ask questions of the finalists. The winner of the competition will be selected by the judges at the end of the four presentations. The winner and the runners-up will be announced at the INFORM-ED Annual Business Meeting.

## ■ SA45

### Financial Services Section Student Paper Competition

Sponsor: Financial Services

Sponsored Session

Chair: Emmanuel Hatzakis, Vice President, Global Equities, Merrill Lynch & Co., 4 World Financial Center, 5th Floor, New York, NY, 10080, United States, manos\_hatzakis@ml.com

#### 1 - The GDEA Model of Fundamental Analysis Under Expert Information and Its Application to U.S. Markets

Xin Zhang, PhD Candidate, University of Tennessee, College of Business Administration, Management Science, Knoxville, TN, 37996, United States, xzhang3@utk.edu, Chanaka Edirisinghe

Stock selection based on fundamental analysis of public firms is addressed. A generalized DEA model is developed to analyze firms' financial statements over time to determine a relative financial strength indicator that is highly correlated with stock returns. The model uses expert information in input/output selection. The correlation maximization binary model is solved via a two-step heuristic algorithm. Computational evidence is presented with over 800 public firms from 9 US sectors.

#### 2 - Price Evolution of Real Assets with Optimal Strategies

Mehmet Saglam, Analyst, First Manhattan Consulting Group, 90 Park Avenue, New York, NY, 10016, United States, ms444@cornell.edu, Yildiray Yildirim, Hazer Inaltekin

We propose a new model for the evolution of real estate prices with changes in the market structure over time. Our model considers a wide range of inputs, including stochastic interest rates, demand for the asset, and random shocks to observe the sale process at the micro level. The holder of the asset makes optimal decisions in the face of changing market conditions by considering the level of interest rates, demand and keeping the asset in the sale market for optimal amount of time.

- 3 - A New Modeling Approach to Price Employee Stock Options  
Premal Shah, MIT, E40 - 115, 77 Massachusetts Avenue,  
Cambridge, MA, 02139, United States, premal@mit.edu,  
Dimitris Bertsimas

We propose a new risk management based framework to model an exercise strategy for Employee Stock Options. The framework leads to an intuitive barrier based exercise policy under which the cost of issuing an Employee Stock Option can be bracketed by narrowly separated bounds. Moreover, the approach can also be applied to price a portfolio of options.

- 4 - Optimizing Dynamic Portfolio Selection by Reinforcement Learning

Haleh Valian, PhD Candidate, Rutgers University, Department of Industrial and Systems Eng, 96 Frelinghuysen Road, Piscataway, NJ, 08854, United States, valian@rci.rutgers.edu, Mohsen Jafari, Davood Golmohammadi

In this research a decision making model proposed for dynamic portfolio management. An agent who has some initial wealth invests in a market. Two types of asset are considered, riskless asset (bank account or bond), and risky asset (stock). The agent should choose an action to change the portfolio based on the environment. An action may have a fixed space or unfixed space. If the agent does not take any action, events (observable and unobservable) will change the market and value of portfolio. The general problem is how to enable an agent to maximize an external reward signal by taking an action in an environment. Here, dynamic portfolio management is studied as mathematically modeled by a Semi-Markov Decision Processes (SMDP). To optimize this model, Q-learning as reinforcement learning technique has been applied.

- 5 - Option Pricing Under a Hyper-exponential Jump-diffusion Model  
Ning Cai, Columbia University, 313A Mudd, Dept. of Ieor,  
Columbia University, New York, NY, 10027, United States,  
nc2118@columbia.edu, Steven Kou

We propose a jump diffusion model with jump sizes having a hyper-exponential distribution. This model provides a link between asset pricing models with exponential tails and power tails, and leads to analytical solutions for lookback, barrier and perpetual American options. This is made possible by using martingale methods to study some multi-dimensional integro-differential equations, and by solving related first passage time problems and optimal stopping problems.

## SA47

### Agent Based Modeling

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

Chair: Daniel J. Veit, Professor, University of Mannheim, Schloss, Mannheim, BW, 68131, Germany, veit@uni-mannheim.de

- 1 - Agent-based Modeling and Simulation for Logistics Markets and Co2 Reduction

Han La Poutre, Professor, CWI, Kruislaan 413, 1098 SJ, P.O. Box 94079, Amsterdam, 1090 GB, Netherlands, Han.La.Poutre@cwi.nl, Valentin Robu, Pieter Jan 't Hoen, Han Noot

We present research results on the reduction of CO<sub>2</sub> emission by intelligent truck usage, as part of the Dutch research program Energy, Ecology, and Technology. We describe market-based, automated techniques for cargo allocation to trucks and transportation companies. We present agent-based models and interactive simulation systems. We model the players by agents and design bidding strategies. We also describe how to get robustness in the results of adaptive simulation systems.

- 2 - A Reinforcement Learning Approach to Finding Nash Equilibrium of Multi-player Matrix Games

Tapas K. Das, Professor, University of South Florida, 4202 E. Fowler Avenue, ENB 118, Tampa, FL, 33620, United States, das@eng.usf.edu, Vishnu Nanduri

With the advent of e-commerce, the contemporary marketplace has evolved significantly toward competition-based trading of goods and services. Many such market scenarios can be modeled as matrix games. This paper presents a computational algorithm to obtain Nash equilibria of n-player matrix games. The RL algorithm is tested on a set of sixteen matrix games with up to four players and sixty four action choices.

- 3 - Electricity Generation Portfolios and Market Prices

Augusto Ruperez Micola, Research Fellow, IMD - Institute for Management Development, Chemin de Bellerive, 23, Lausanne, 1007, Switzerland, Augusto.RuperezMicola@imd.ch, Albert Banal-Estanol

We use an agent-based simulation to study how the diversification of electricity generation portfolios influences wholesale prices. The results suggest that: diversification leads to lower market prices; the influence of diversification is mediated by the supply to demand ratio; in each demand case there is a

threshold where pivotal dynamics change; pivotal dynamics pre- and post-threshold are the cause of non-linearities in the influence of diversification on market prices.

- 4 - Energy Systems Modeling Using Complex Adaptive Systems Techniques

Michael North, Argonne National Laboratory, Decision and Information Sciences Division, 9700 S. Cass Avenue, Argonne, IL, 60439, United States, north@anl.gov, Charles Macal

This presentation will discuss the application of complex adaptive systems representation techniques, such as agent-based simulation, to energy systems modeling.

## SA47

### Forestry I: Harvest Scheduling with Spatial Constraints

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

Chair: Sam Pittman, Operations Research Analyst, Weyerhaeuser Timber Company, WTC 1B20 P.O. Box 9777, Federal Way, WA, 98063, United States, sam.pittman@weyerhaeuser.com

- 1 - Does the Size of the ARM Matter?

Marc McDill, Associate Professor, Pennsylvania State University, School of Forest Resources, University Park, PA, 16802, United States, mem14@psu.edu, Sandor Toth, Sandor Toth

We explore the question of how factors like problem size, formulation type, characteristics of the forest, and side constraints affect solution times for spatially explicit area-restricted (ARM) forest planning problems. Conclusions are based on a synthesis of the literature and an experiment using both hypothetical and real forest planning problems.

- 2 - Economic and Fragmentation Effects of Multiple Adjacencies in the Area Restriction Model

Juan Pablo Vielma, Georgia Institute of Technology, 765 Ferst Drive, NW, Atlanta, GA, 30332, United States, jvielma@isye.gatech.edu, Marcos Goycoolea

In this work we consider the Area Restriction Model and study the effects of using different adjacency definitions on the optimal objective value and the fragmentation of the optimal solution. We consider several definitions of adjacency based on distance and length of the intersection between forest stands and we also study the effect of simultaneously using more than one adjacency definition. Results presented are based on several real forest data sets available in the FMOS repository.

- 3 - Computational Comparison of Stand-centered versus Cover-constraint Formulations

Joseph Wilck, PhD Candidate, Pennsylvania State University, Leonard Building, Department of Industrial Engineering, University Park, PA, 16802, United States, jhw157@psu.edu, Marc McDill, Steven Mills, Sandor Toth

The computational performance of applying the stand-centered versus the cover-constraint formulations for the area restriction model is examined on seven forests, each with two maximum harvest opening sizes. The stand-centered formulation applied as both constraints and cutting planes is examined. The cover constraints as cutting planes for the stand-centered formulation is also investigated. Formulation and solution times are reported, along with spatial feasibility of those solutions.

- 4 - Integer Models for Tactical Planning in Forestry

Evelyn Richards, Associate Professor, Faculty of Forestry and Environmental Management, University of New Brunswick, Fredericton, NB, E3B6C2, Canada, ewr@unb.ca, Eldon Gunn

We present a system of integer programming models supplemented with local heuristics to solve tactical planning problems in a hierarchical forest management system. The models provide decision support to managers for assessment of spatial tradeoffs.

- 5 - Applying Price Directed Decomposition to Hierarchical Forest Planning Models

Sam Pittman, Operations Research Analyst, Weyerhaeuser Timber Company, WTC 1B20 PO Box 9777, Federal Way, WA, 98063, United States, sam.pittman@weyerhaeuser.com, Bruce Bare, D. Briggs

Hierarchical production models offer a means of better managing large and complex forest planning models dealing with forest-wide and landscape level detail. In this talk, Lagrangian relaxation is used to formulate a hierarchical model that maximizes the net present value of harvest incomes while recognizing specific geographical units that are subject to harvest flow and green-up constraints. The model is solved using a modified Dantzig-Wolfe decomposition/column generation routine.

## ■ SA48

### Optimization via Simulation I

Sponsor: Simulation  
Sponsored Session

Sigrun Andradottir, Professor, Georgia Tech, Stewart School of ISYE, Atlanta GA 30332, United States, sa@isye.gatech.edu

- 1 - Optimization via Simulation with Industrial Strength COMPASS  
Barry L Nelson, Professor, Northwestern University, Department of Ind. Eng. & Mgmt. Sci., 2145 Sheridan Road, Evanston, IL, 60208, United States, nelsonb@northwestern.edu, Jeff Hong, Jie Xu

Industrial Strength COMPASS (ISC) is a particular implementation of a general framework for optimizing the expected value of a performance measure of a stochastic simulation with respect to integer-ordered decision variables. ISC provides convergence guarantees and statistical inference when it terminates while addressing problems of practical size and complexity. We describe the framework behind ISC and compare it to a popular commercial solver.

- 2 - Evolutionary Optimization with Controlled Random Search  
Jiaqiao Hu, State University of New York at Stony Brook, Dept. of Applied Math and Stat., Stony Brook, NY, 11794, United States, jqhu@ams.sunysb.edu, Steven Marcus, Michael Fu

We consider an optimization technique, where a population of probabilistic models are maintained at each iteration. The key question in the proposed approach is how to distribute a given sampling budget among different models. We formulate this problem as an MDP model and derive an optimal sampling scheme. The sampling scheme is then further used to update the current population to produce improving models. Numerical studies are carried out to illustrate the method.

- 3 - Ranking and Selection Techniques with Overlapping Variance Estimators  
Christopher Healey, Doctoral Student, H. Milton Stewart School of Industrial and Systems Engineering, Georgia Tech, 765 Ferst Drive, Atlanta, GA, 30332, United States, chealey@isye.gatech.edu, David Goldsman, Seong-Hee Kim

Some ranking and selection (R&S) procedures for steady-state simulation require an estimate of the asymptotic variance parameter of each system. We show that the performance of such procedures depends highly on the quality of the variance estimates that are used. We study the performance of R&S procedures with two new variance estimators - overlapping area and overlapping Cramér-von Mises - which show better long-run performance than other estimators previously studied in R&S problems.

- 4 - Averaging Frameworks for Discrete Simulation Optimization  
Andrei Prudius, PhD Student, Georgia Tech., Stewart School of ISyE, Atlanta, GA, 30332, United States, apudius@isye.gatech.edu, Sigrun Andradottir

We present two frameworks for designing random search methods for discrete simulation optimization that allow the estimated performance of each system to be the average of all observations collected at that system. The methods within our frameworks may use all available information to decide adaptively on how to expend simulation effort and are almost surely convergent. We also demonstrate the empirical effectiveness of averaging and adaptivity in context of the simulated annealing.

## ■ SA49

### Topics in Price Optimization and Revenue Management

Sponsor: Revenue Management & Pricing- Invited/Sponsored  
Sponsored Session

Chair: Robert Phillips, Nomis Solutions, robert.phillips@nomissolutions.com

- 1 - Optimal Repricing of Financial Services  
Robert Phillips, Nomis Solutions, robert.phillips@nomissolutions.com, Dan Huang

We investigate optimal repricing policies for financial services such as loans when repricing is allowed. The goal of repricing can be to increase profitability or deter competition. Optimal policies are derived under different customer behavior models.

- 2 - Revenue Management in the Airline Industry: An Empirical Study  
Yong-Pin Zhou, University of Washington Business School, Seattle, WA, 98195-3200, United States, yongpin@u.washington.edu, Ming Fan, Minh Cho

In this paper, we use the data from Bureau of Transportation Statistics to empirically examine the revenue management practice in the airline industry. Specifically, we study how the operational policies affect pricing, operational performance and revenue. Our results show that operational policies such as capacity and code-sharing have significant impacts on price dispersion, load-factor, and revenue. We also find that route level revenue increases in price dispersion.

- 3 - A Two-competitor Game with Customers Buying the Lowest Available Fare in the Market

Darius Walczak, PROS Revenue Management, 3100 Main Street, Suite 900, Houston, TX, 77002, United States, dwalczak@prospricing.com

Two airlines in the following competitive setting. Each airline tries to maximize expected revenue from an initial, finite inventory of seats over a finite time horizon. The price point structure is the same for both. Customers seek the lowest price in the market; when the prices match they make a random choice. We allow a nonzero probability that a customer does not buy. All necessary probabilities are known to each airline and the price points can change at each customer request.

## ■ SA50

### Competition and Strategic Behavior in Revenue Management

Sponsor: Revenue Management & Pricing- Invited/Sponsored  
Sponsored Session

Chair: Guillaume Roels, Assistant Professor, UCLA, 110 Westwood Plaza, B511, Los Angeles, CA, 90066, United States, groels@anderson.ucla.edu

- 1 - Dynamic Pricing Under Customer Reluctance Behavior  
Victor Araman, Assistant Professor, Stern School of Business, NYU, 44 West Fourth Street, New York, NY, 10012, United States, varaman@stern.nyu.edu, Vladimir Krasik

This work aims at studying a simple revenue management problem when the seller tracks reluctant customers. In a continuous time setting where arrivals of customers follow a Poisson process, the seller adjusts prices based on remaining inventory but also on number of customers that are considering buying the item. This work is driven by the advanced capabilities of online retailers to trace their potential buyers and suggest ways to incorporate this information in the pricing decisions.

- 2 - Newsvendor Model Under Unknown Dependency Between Inventory Decision and Demand

Soonhui Lee, PhD Student, Northwestern University, 2145 Sheridan Rd C151, Evanston, IL, 60208, United States, s-lee4@northwestern.edu, Tito Homem-de-Mello, Anton J. Kleywegt

We study inventory problems where a decision maker determines the order quantities based on the newsvendor model under the situation of unknown dependency between decision and demand. Because the dependency is unknown to the decision maker, he believes the newsvendor model produces optimal decisions. We study how the order quantities deviate from the true optimal order quantities with repeated application of the model and show situations under which the resulting revenue can be arbitrarily bad.

- 3 - Multi-channel Competition with Opaque Products

Senthil Veeraraghavan, Asst Professor, Wharton School, Philadelphia, PA, United States, senthilv@wharton.upenn.edu, Kinshuk Jerath, Serguei Netessine

Priceline, Hotwire and several other companies popularized selling of opaque travel products whose exact specification is masked from the consumer until the sale is complete. We show that opaque products are effective in dealing with strategic consumers who face a trade-off of buying a transparent product at a higher price now with the chance of getting opaque product at a lower price later.

- 4 - Competing for Shelf Space

Guillaume Roels, Assistant Professor, UCLA, 110 Westwood Plaza, B511, Los Angeles, CA, 90066, United States, groels@anderson.ucla.edu, Victor Martinez de Albeniz

We model the competition for shelf space in a multi-supplier retail point. We consider a retailer that seeks to allocate its shelf space capacity to maximize its profit. Given that products associated with larger profit margin are granted more shelf space, suppliers can offer the retailer financial incentives to obtain larger space allocations. We analyze the competitive dynamics arising from the scarcity of space and investigate the performance of various contracting mechanisms.

## ■ SA51

**Revenue Management Applications in the Hospitality Industry**

Sponsor: Revenue Management & Pricing- Invited/Sponsored Sponsored Session

Chair: Utku Yildirim, Walt Disney World Co., 1375 E Buena Vista Dr., Lake Buena Vista, FL, 32830, United States, Utku.Yildirim@disney.com

- 1 - Revenue Management with Stochastic Programming  
Julia L. Higle, The Ohio State University, Industrial and Systems Engineering, Columbus, OH, United States, higle.1@osu.edu

We present revenue management models based on stochastic programming constructs. Our model is one that combines capacity-based calculations to obtain price-based policies, while explicitly recognizing the stochastic nature of customer demand in the various market segments. Data requirements and computational implications will be discussed.

- 2 - Practical Challenges in Optimizing Room Rates for Hotels and Gaming Resorts  
H. Ahmet Kuyumcu, President, Prorize, LLC, 12138 Madison Drive, Atlanta, GA, 30346, United States, akuyumcu@prorize.com, Amar R. Duggasani

There are many practical challenges in optimizing room rates for hotels and gaming resorts. These include, but not limited to, incorporation of demand uncertainty, rate uncertainty, customer value, price sensitivity, overbooking, groups, promotions, room upgrades, room cross-sells, competitive rates, and market level information. This presentation explores some of these challenges in more detail.

- 3 - Maximum Utility Model with Reservation Prices  
Romy Shioda, Assistant Professor, University of Waterloo, 200 University Ave West, Waterloo, ON, Canada, rshioda@math.uwaterloo.ca, Levent Tuncel

We consider the revenue management problem of pricing a product line with several customer segments, working under the assumption that every customer's product choice is determined entirely by their reservation price. We formulate the problem as a mixed-integer programming problem and develop several heuristics. We test the practical efficacy of our method, in terms of both computation time and impact on revenue, on customer purchase order data from a tourism company.

- 4 - Restaurant Revenue Management  
Utku Yildirim, Walt Disney World Co., 1375 E Buena Vista Dr., Lake Buena Vista, FL, 32830, United States, Utku.Yildirim@disney.com

In this presentation, we investigate the revenue management problem of a restaurant which accepts advanced bookings and walk-ins. We utilize mathematical programming methods to identify the optimal availability for different discount categories and table mix for the restaurant. We conclude with possible extensions of the model.

## ■ SA52

**RASIG Student Paper Session**

Sponsor: Railway Applications Sponsored Session

Chair: Pooja Dewan, General Director Decision Systems, BNSF Railway, Service Design and Performance, 2400 Western Center Boulevard, Fort Worth, TX, 76131, United States, Pooja.dewan@bnsf.com

- 1- RASIG Student Paper Competition  
Pooja Dewan, General Director Decision Systems, BNSF Railway, Service Design and Performance, 2400 Western Center Boulevard, Fort Worth, TX, 76131, Pooja.dewan@bnsf.com

RASIG (Rail Applications Special Interest Group), a subdivision of INFORMS (Institute for Operations Research and Management Science) sponsored a student research paper contest on Management Science in Railroad Applications. Authors of First Place, Second Place, and Honorable Mention papers will be asked to present the papers at this session.

## ■ SA53

**Location Analysis**

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 - The Probabilistic p-Minimax Problem on a Network with Random Demand Weights  
Jiamin Wang, Assistant Professor, Long Island University, Roth Hall 202, 720 Northern Blvd, Brookville, NY, 11548, United States, jiamin.wang@liu.edu, Oded Berman

We study the problem of locating  $p$  facilities to serve clients residing at the nodes of a network with probabilistic demand weights. The objective is to minimize the probability that the maximum weighted distance from a client to the closest facility exceeds a given threshold value. We analyze the problem and develop exact solution procedures and heuristics to solve it.

- 2 - Profit-maximizing Service System Design with Elastic Demand and Congestion  
Robert Aboolian, Professor, California State University San Marcos, College of Business Administration, San Marcos, CA, 92096, United States, raboolia@csusm.edu, Dmitry Krass, Oded Berman

The problem seeks to locate a set of immobile service facilities, allocate service capacity so as to maximize overall profits. Demand is stochastic and elastic. Customer mean demand rate is a function of travel time, and waiting time at the facilities. Problem is formulated and approximate and exact approaches are developed.

- 3 - Impact of Time Sensitive Demand on Facility Location  
Mozart Menezes, Assistant Professor, HEC - School of Management, Paris, 1 Rue de la Liberation, Jouy-en-Josas, 78351, France, menezes@hec.fr, Oded Berman, Dmitry Krass

In this paper we consider the problem when customers patronize the business whenever items ordered can be delivered within certain amount of time. Such problems are often faced by internet-based retailers, such as Amazon.com. We investigate the trade-off between proximity to customers and demand fragmentation. Thus, inventory and location decisions are made, taking into account fixed location, inventory-related and opportunity costs. We present theoretical results and heuristic results.

- 4 - The Lorenz Curve in Location Analysis  
Tammy Drezner, Professor, California State University, Fullerton, Department of ISDS, Fullerton, CA, 92834, United States, tdrezner@fullerton.edu, Zvi Drezner, Jeffrey Guise

We investigate the location of facilities with equity considerations, i.e., minimizing the Gini coefficient of the Lorenz curve. The model is formulated, analyzed and an algorithm that finds the optimal location of one facility in a bounded area in the plane is constructed. Problems involving continuous demand on a segment, square, disk, are investigated. Randomly generated problems with up to 10,000 demand points are successfully solved in a reasonable computer time.

## ■ SA54

**Control of Queueing Systems**

Sponsor: Applied Probability Sponsored Session

Chair: Serhan Ziya, Assistant Professor, Department of Statistics and Operations Research University of North Carolina, Chapel Hill, NC, ziya@email.unc.edu

- 1 - A Call Center Model with Upgrades: An Update  
Mark E. Lewis, Associate Professor, Cornell University, 226 Rhodes Hall, School of Oper. Res. and Inform. Engin., Ithaca, NY, 14853, United States, mel47@cornell.edu, Douglas Down

We consider a two station call center. Station 1 is staffed by a finite set of workers that are cross-trained in the sense that they can work at either station. Station 2 is staffed by a finite set of dedicated workers. At random times, customers from Station 1 are upgraded to Station 2. Optimal allocation policies and stability are considered.

- 2 - Optimal Policies and Bounds for Parallel Server Systems  
Michael Veatch, Gordon College, 255 Grapevine Rd, Wenham, MA, 01984, United States, mike.veatch@gordon.edu

Performance of parallel servers under optimal sequencing control is analyzed using dynamic programming and approximate linear programming. The impact of flexibility is assessed under optimal and longest queue policies. Optimal policy characteristics are found and compared with previous resource pooling conditions.

### 3 - On the Accuracy of Announcing the Delay of Last to Enter Service in Large Call Centers

Achal Bassamboo, Northwestern University,  
a-bassamboo@northwestern.edu, Mor Armony

In recent times, many call-centers announce some estimate of the wait to callers when they are not served immediately. In response to the delay announcement callers may balk or be willing to wait for their service. In this talk we consider a simple delay announcement to a new caller: The delay of the last customer to enter service (DLS). We show that these announcements are quite accurate when the system size is large.

### 4 - An Analysis of a Multi-server Ticket Queue with Abandonment

Kaan Kuzu, PhD Student, The Pennsylvania State University,  
Smeal College of Business, 471B Business Building, University  
Park, PA, 16802, United States, kzk107@psu.edu, Susan Xu

A Ticket Queue is a new technology that manages customer flows in a service system using numbered tickets. We propose an analytical model for a multi-server ticket queue with balking and renegeing customers. We develop the solution procedure, heuristics, and bounds for key system performance measures, and benchmark the ticket and physical queues.

## ■ SA55

### Allocation and Exchange of Airport Slots

Sponsor: Aviation Applications

Sponsored Session

Chair: Michael Ball, Professor, University of Maryland, Robert H Smith School of Business, College Park, MD, 20742, United States, mbal@rsmith.umd.edu

#### 1 - Demand Management: Options for Ensuring the Efficient Use of Scarce Airport Capacity

David Gillen, Professor, University of British Columbia, Sauder School of Business, 2053 Main Mall, Vancouver, BC, V6T1Z2, Canada, david.gillen@sauder.ubc.ca

I provide an assessment of alternative strategies for allocating scarce airport capacity. I include quantitative and qualitative measures. An important difference between the two approaches is prices allocate capacity on the basis of willingness to pay while slot restrictions require a method of allocation. I identify key efficiency and equity issues focusing mostly on market based mechanisms and provide summary tables of the impacts of different approaches as well as their benefits and costs.

#### 2 - Practical Rolling Horizon Airport Slot Auction with Dynamic Quantities

Andrew Churchill, Graduate Research Assistant, University of Maryland, 3117 AV Williams, College Park, MD, 20742, United States, churchil@umd.edu, David Lovell, Michael Ball

We propose an innovative auction mechanism to distribute airport slots. An annual auction is held to distribute a pool of slots. The novelty lies in the application of an integer programming model to determine if slots should be added or removed from the pool each year. These adjustments are undertaken to achieve model targets on the expected delays and cancellation rates. Other features include an initial price-stabilization period and considerations for airport-specific requirements.

#### 3 - The Number of Slots to Submit to Market Mechanisms

David Lovell, Associate Professor, University of Maryland, 1173 Martin Hall, College Park, MD, 20742, United States, lovell@eng.umd.edu, Andrew Churchill, Michael Ball, Avijit Mukherjee

We propose a sequence of three integer programming models to determine the appropriate number of arrival slots to allocate per time period at a slot-controlled airport whose slots are exchanged in a competitive market, e.g. an auction. The models differ in their economic assumptions, calibration requirements, and computational complexity. We offer some recommendations for calibration and show sensitivity analysis for important parameters.

#### 4 - Optimization Models for the Equitable Assignment of Slot Lifetime

Moein Ganji, University of Maryland, 3429 Tulane Dr., Apt 24, Hyattsville, MD, 20783, United States, moein\_g@yahoo.com, Michael Ball

The FAA is investigating new airport slot management policies that involve the use of Operating Authorizations with finite lifetimes. Since expiration dates must be staggered, the initial lifetimes assigned will vary between one and ten years. We develop integer programming and heuristic methods for the equitable assignment of lifetimes. Equity is measured relative to the historic slot ownership/use.

## ■ SA56

### Economics

Contributed Session

Chair: John Mamer, UCLA Anderson Grad. School of Mgmt., 110 Westwood Plaza, D518, Los Angeles, CA, 90095, United States, jmamer@anderson.ucla.edu

#### 1 - Can Realistic Wealth Distributions be Quantitatively Described by Kinetic Models?

Nelson L. Lammoglia, Doctoral Student, Universidad de los Andes, Dep. of Industrial Engineering, Bogotá, Colombia, n-lammog@uniandes.edu.co, Victor Muñoz, José Rogan, Benjamin Toledo, Roberto Zarama, Juan Alejandro Valdivia

Data on wealth distributions in trading markets show a power law behavior at the high end, where in general  $\Sigma$ ; is greater than 1 (Pareto's law). However, current trading models based on kinetic theory, where a saving propensity is assigned to each agent, are claimed to model only a power law tail with an exponent which is always close to 1. In this work we reach the opposite conclusion. We show that a kinetic model for a trading market is able to predict any power law tail behavior, in particular Pareto's law. We use our approach to reproduce (a) the world billionaires wealth distribution, based on Forbes 2006 data, that displays  $\Sigma=1, 4; 1.4$ ; and (b) the World Distribution of Household Wealth, recently published by The World Institute for Development Economics Research (UNU-WIDER), where  $\Sigma=1.5$

#### 2 - A Peer-to-peer System as an Exchange Economy

Christina Aperjis, Stanford University, Terman Engineering Center, Room 391, Stanford, CA, United States, caperjis@stanford.edu, Ramesh Johari

We formulate a peer-to-peer system for filesharing as an exchange economy: a price is associated with each file, and users exchange files only when they can afford it. This formulation solves the freeriding problem, since uploading files is a necessary condition for being able to download. However, we do not explicitly introduce a currency; users must upload files in order to earn a budget for downloading.

#### 3 - Outsourcing Patient Care: A Transaction Cost Analysis

Nahush Chandaver, Student, University of South Florida, 3421, Park Square, W-2, TAMPA, FL, 33613, United States, nchandav@mail.usf.edu, Kingsley Reeves

The aim is to provide a model to predict the most cost efficient organizational form for disease management (DM) programs in health plans by using transaction cost theory and switching regression techniques. Regression models will be constructed using survey data and used to determine whether outsourcing or integrating a DM program is more cost efficient for different types of diseases. The results will also provide empirical evidence regarding which transaction cost factors most affect these programs.

#### 4 - Economic Interpretation of Implied Constraints in the Presence of Indivisible Goods in Resource Allocation

Talat Genc, University of Guelph, Dept. of Economics, Guelph, ON, N1G2W1, Canada, tgen@uoguelph.ca, Suvrajeet Sen

For a special case of 0-1 MILP problems, we show the existence of unique shadow prices and recover the total cost of inputs, even when the underlying model includes indivisibilities that are modeled using integer variables. We also provide an interpretation of valid inequalities (i.e., certain disjunctive cuts) in the form of productivity requirements that must be satisfied for integer programming problems.

#### 5 - Exploding Offers and Search

John Mamer, UCLA Anderson Grad. School of Mgmt., 110 Westwood Plaza, D518, Los Angeles, CA, 90095, United States, jmamer@anderson.ucla.edu, Steven Lippman

We consider the situation of a buyer who makes an offer to purchase a single object from a seller who follows a standard continuous time finite horizon search model. The buyer has two options for framing his offer. Make a permanent offer, good from the time it is made until the object is sold, or make an exploding offer, good only at the instant it is made. Which choice maximizes the buyer's chance of purchasing the object at his offer price with an exploding offer?

## ■ SA57

### Joint Session TELECOM /ICS: Optimization in Wireless Networks

Sponsor: INFORMS Telecommunications Section,  
INFORMS Computing Society  
Sponsored Session

Chair: Kerem Bulbul, Assistant Prof., Sabanci University,  
Manufacturing Systems & Industrial Eng., Orhanli, Tuzla, Istanbul,  
34956, Turkey, bulbul@sabanciuniv.edu

#### 1 - Access Point Diversity for Efficient Packet Forwarding in Wireless LANs

Ozgur Ercetin, Assistant Prof., Sabanci University,  
Electronics Engineering, Orhanli, Tuzla, Istanbul, 34956, Turkey,  
oercetin@sabanciuniv.edu

In 802.11 wireless networks, a user usually has the option of connecting to one of several available access points (APs). We argue that the user can obtain better quality of service by diversifying its traffic among APs. In this work, we consider the optimal packet splitting algorithms that would maximize the user throughput based on the channel loss characteristics, transmission rates and required resiliency to packet loss.

#### 2 - Flow and Cut Models for the Minimum Energy Broadcasting Problem in Ad Hoc Wireless Networks

Dag Haugland, Associate Professor, University of Bergen,  
Department of Informatics, PB. 7803, Bergen, N, 5020, Norway,  
nmidd@uib.no, Joanna Bauer, Di Yuan

We develop flow and cut-based integer programming models for the problem of minimizing the total energy of a broadcast session in wireless ad hoc networks. The strength of the models is analyzed theoretically, and we prove that the strongest flow-based model and its cut-based counterpart are equally strong. By expanding the network, we also show how the problem can be transformed to the minimum Steiner tree problem in digraphs. Reports on numerical experiments comparing the models are provided.

#### 3 - Solving the Minimum Energy Broadcasting Problem in Ad Hoc Wireless Networks by Integer Programming

Keumseok Kang, Krannert School of Management, Purdue  
University, 403 W. State Street, West Lafayette, IN, 47907-2056,  
United States, kangk@purdue.edu, Kemal Altinkemer,  
Sibel Salman

We study the minimum energy broadcasting problem in ad hoc wireless networks. For this NP-hard problem, we propose a new integer programming formulation based on a set covering model and a Lagrangian relaxation procedure to solve the problem. We provide extensive computational tests.

#### 4 - Delay Constrained Minimum Power Broadcasting in Wireless Networks

Kerem Bulbul, Assistant Prof., Sabanci University, Manufacturing  
Systems & Industrial Eng., Orhanli, Tuzla, Istanbul, 34956, Turkey,  
bulbul@sabanciuniv.edu, Ozgur Ercetin, Tonguc Unluhurt

We consider the minimum power broadcasting problem in an ad hoc wireless network operating under a hard constraint on the end-to-end delay between the source and each node in the network. We first characterize the optimal solution to a closely related problem in dense networks using a dynamic programming (DP) formulation. The insights provided by the structure of the optimal DP solution lead to effective algorithms for the original problem, and we demonstrate their performance computationally.

## ■ SA58

### Innovative Approaches to Technology Entrepreneurship

Sponsor: Organization Science  
Sponsored Session

Chair: Ted Baker, Assistant Professor, North Carolina State University,  
Nelson Hall, Box 7229, NCSU Campus, Raleigh, NC, 27695, United  
States, ted\_baker@ncsu.edu

#### 1 - Crying the News of Technology Opportunity: Influence Processes of Boundary Spanners

Lynda Aiman-Smith, North Carolina State University,  
lynda\_aiman-smith@ncsu.edu, Susan Katz

Little is reported in the innovation literature about how science, innovations and technologies originating externally in university-sponsored research centers are disseminated into organizations. In this paper we focus on the role of boundary spanners and the influence processes they use convincing others in their home organizations that they have spotted an opportunity potential they have seen in

a university setting, and that the potential opportunity should be pursued by the home organization. We specifically examine boundary spanners who are working with academics involved in research on nanotechnology. Our exploratory work is based on semi-structured interviews with over 30 boundary spanners from a variety of organizations in a number of industries who have regular interactions with academics in National Nanoscience Centers.

#### 2 - Building Legitimacy for Novel Technologies: The Case of WARF and Human Embryonic Stem Cells

Sanjay Jain, University of Wisconsin-Madison, sjain@bus.wisc.edu

Building legitimacy for novel technologies within a highly institutionalized environment often involves resolving a fundamental paradox: how do actors conform to an institutional regime while simultaneously taking steps to change it? I carry out an in-depth study of the role played by various actors at a prominent mid-West university – most notably WARF, its patenting and licensing office – in supporting the emergence of human embryonic stem cell technology. Through my narrative account, I identify two processes – which I term protecting and influencing respectively – that play a key role in building legitimacy for novel technologies. The implications of these findings for theories of institutional entrepreneurship, technological change and technology transfer are discussed.

#### 3 - Resource Mobilizing in Constrained Environments: A Study of Technology Social Ventures

Geoffrey Desa, University of Washington-Seattle,  
gdesa@u.washington.edu, Suresh Kotha

Non-profit and for-profit technology social ventures mobilize resources and create scalable social innovations despite a scarcity of funding and institutional support. We draw upon bricolage, an emerging perspective in entrepreneurship, which suggests that firms can intentionally make do with existing resources at hand. These resources include junk materials (e.g. technology, machinery, hardware and software), labor (e.g. volunteers, friends and family), and skills (e.g. volunteer knowledge of efficient processes or alternative technologies), and are often available for free or cheaply. Building upon a comparative case study and the resource mobilization literature, we develop propositions to explain how institutional factors and collective agency affect resource-mobilization, and in turn attract beneficiaries and customers to the venture. We test these propositions on a sample of 200 technology social ventures.

#### 4 - In Response to Surprise in New Firms: Interactions of Improvisation and Organizational Memory

Yan Gong, University of California-Irvine, gongy@merage.uci.edu,  
Ted Baker, Anne S. Miner, Dale Eesley

This paper proposes that two key factors related to organizational knowledge use will shape the outcome of responding to a surprise. First, the organization's memory enhances the chances that its surprise response will have a valued outcome. Second, both lower and higher levels of improvisation will have a relatively more positive impact on organizational outcomes than intermediate level of improvisation. We test these ideas using a sample of 141 surprise events.

## ■ SA59

### Issues in Project Management

Sponsor: Technology Management  
Sponsored Session

Chair: Ted Klastorin, Professor, University of Washington, Dept. of  
ISOM, Box 353200, Seattle, WA, 98195-3200, United States,  
tedk@u.washington.edu

#### 1 - Project Scheduling When Success is Uncertain

Gregory Dobson, Associate Professor, University of Rochester,  
Simon School, Rochester, NY, United States,  
greg.dobson@simon.rochester.edu, Joseph Szmerekovsky,  
Vera Tilson

We examine project scheduling when activity success is uncertain and can lead to project cancellation. We look at IP formulations for a variety of special cases and develop lower bounds and heuristics. We report on the performance of heuristics wrt lower bounds. We investigate robustness of solutions when probabilities are difficult to estimate.

#### 2 - Incentive Contracts Under Asymmetric Information: Extension to General Project Networks

Murat Bayiz, University of Southern California,  
murat.bayiz@marshall.usc.edu, Charles Corbett

We consider a set-up where a project manager interacts with multiple subcontractors who work on different tasks of a project. The project manager sets incentives to motivate subcontractors to work harder on their tasks. We study such incentive contracts and compare them with fixed price contracts under general project networks. We also investigate effects of information asymmetry and project network structure on contracting decisions.

- 3 - The Incorporation of Activity Failures in Project Planning: A Formalization and Some Preliminary Results  
Roel Leus, Katholieke Universiteit Leuven, FETEW, KBI, Naamsestraat 69, Leuven, 3000, Belgium, roel.leus@econ.kuleuven.be, Bert De Reyck, Yael Grushka-Cockayne

The goal of this article is to survey the relevant literature on project scheduling with possible activity failures from a number of different disciplines, and to distill from these sources the formulation of a general optimization problem, the further study of which we would like to foster among the scheduling community. The model has been formulated with R&D projects in mind, but its study may be useful also for developing planning methods in other contexts. We discuss a number of different aspects of this task selection and scheduling model with task failures by means of a number of illustrative examples.

- 4 - The Role of Time in Improving Project Performance  
Dwight Smith-Daniels, Arizona State University, dwight.smith-daniels@asu.edu, Vicki Smith-Daniels

Past empirical research on projects reveals that the project initiation phase is particularly challenging and important to project success. This environment is simulated in this research using a multi-period project simulation that involves the planning and execution of a project by a newly formed project team of experienced project professionals. In this controlled experiment, we examine the effects of planning time duration on project performance results.

- 5 - Development of a New Product with Base and Complementary Components in a Duopoly Market  
Ted Klasterin, Professor, University of Washington, Dept. of ISOM, Box 353200, Seattle, WA, 98195-3200, United States, tedk@u.washington.edu, Young Jin Lee

We study a firm that is planning to introduce a new product consisting of both a durable good base product and a complementary consumable component (e.g., printer and ink-cartridges). Consumers initially purchase the initial product with both components but later purchase multiple copies of the complementary component. The innovator firm's products consist of both components while an imitator firm produces only the complementary product. We analyze optimal strategies for both firms.

## ■ SA60

### Innovation and Entrepreneurship

Sponsor: Technology Management

Sponsored Session

Chair: Nile Hatch, Marriott School - BYU, Provo, UT, 84602, United States, nile@byu.edu

- 1 - When Networks Matter: An Examination of Network Content and Firms' Innovation Performance  
Irem Demirkan, Northeastern University, 313 Hayden Hall, College of Business Administration, Boston, MA, 02115, United States, irem@utdallas.edu, David Deeds

In this study we look into the issue of network content - the characteristics of the actors and/or the qualitative nature of the relationships- and its change over time. We explore how the content of relationships within a firm's ego-network affects the focal firm's innovative performance in biotechnology. Data from the biotechnology industry over a span of seventeen years largely support our hypotheses.

- 2 - TMS Dissertation Award Winner: Decoupling Market Incumbency from Organizational Experience: The Case of Anti-Cancer Drugs  
Lourdes Sosa, London Business School, Regents Park, London, United Kingdom, lsosa@london.edu

Focusing on the analysis of differences in R&D performance through a technological change, I discuss two findings based primarily on my dissertation research. First, I discuss the empirical consequences of failing to decouple market incumbency from organizational experience. In particular among those empirical consequences, I explain the resulting distortion on the assessment of competitive advantage in research productivity and in risk-taking behavior. As second finding, I discuss the advantages of separating R&D competences that are application-specific from those that represent technological platforms, since their differential distribution across firm categories significantly explains heterogeneity in R&D performance during a discontinuity.

- 3 - Learning Services for Innovation and Competitive Advantage  
Tom Hill, Director of Learning and Knowledge Management, Genentech, 1 DNA Way, South San Francisco, CA, 94080, United States, hill.thomas@gene.com

Evolving conditions of the biotech industry require regular innovation, transformation, and productivity improvement in product development, patient services, reimbursement, regulatory compliance, and competition. Learning and knowledge management services enable managers to create solutions for our patients and a sustainable competitive advantage for Genentech.

- 4 - Mapping the Growth Path Through Controlled Burn  
Nile Hatch, Marriott School - BYU, Provo, UT, 84602, United States, nile@byu.edu

Balancing growth against profitability is one of the (many) fundamental challenges of entrepreneurial activity. When innovation confers competitive advantage, growth still requires investment that must be funded through margins or investors. With a game theoretic model of rivalry, I analyze the tradeoff between margins and growth and illustrate optimal growth paths for various competitive advantages.

## Sunday, 10:00am - 11:30am

### ■ SB01

### Supply Chain Management II

Contributed Session

Chair: Xuying Zhao, Assistant Professor, University of Notre Dame, Notre Dame, South Bend, IN, United States, xuying.zhao@utdallas.edu

- 1 - Replenishment Coordination in Distribution Systems with Multiple Items and Retailers  
Mustafa Cagri Gurbuz, Professor, MIT-Zaragoza International Logistics Program, Avda. Gomez Laguna, 25, 1a Planta, Zaragoza, 50009, Spain, mgurbuz@zlc.edu.es, Kamran Moinzadeh, Yong-Pin Zhou

We discuss a distribution system with M items, N identical retailers, and a warehouse under random demand. Different inbound/outbound (to/from the warehouse) shipment consolidation policies to reduce logistics related costs are proposed. We analyze the economic impact of shipping several items to a retailer in the same outbound truck in addition to replenishing all the retailers simultaneously via several coordinated replenishment policies.

- 2 - Managing Suppliers' Delivery Performance with Service Level Agreements  
Liping Liang, PhD Student, University of British Columbia, Sauder School of Business, 2053 Main Mall, Vancouver, BC, V6T 1Z2, Canada, liping.liang@sauder.ubc.ca, Derek Atkins

Service-level agreements (SLA) are often observed in practice to manage suppliers' delivery performance. Under a SLA, a supplier agrees to meet a pre-specified service level (e.g., ready rate) over a review period. We investigate the optimal SLA between a supplier and a buyer when the supplier can invest both in inventory and in leadtime reduction to meet the service level target. We compare the performance of a ready-rate contract and a ready-rate-with-window contract.

- 3 - A Game Theoretic Approach for the Evaluation of Delayed Incentives in Supply Chains  
Jing (Jenny) Zhou, Assistant Professor, University of North Carolina at Charlotte, Department of Business Information Systems & Operations Management, Charlotte, NC, 28223, jzhou7@uncc.edu, Moutaz Khouja

We study consumer rebates offered by a manufacturer in a two-stage supply chain. Consumers make purchase and redemption decisions in two scenarios: 1) the manufacturer keeps the wholesale price unchanged when introducing a rebate; 2) both the wholesale price and the rebate are endogenous. We find that the retailer and manufacturer are better off with the rebate, but consumers are worse off. We examine certain incentive schemes to improve the system performance.

- 4 - Production and Admission Control in Assemble-to-Order Manufacturing Systems  
Oben Ceryan, University of Michigan, 2350 Hayward, Ann Arbor, MI, 48109, United States, oceryan@umich.edu, Izak Duenyas, Yoram Koren

We consider the production and admission control of a two-stage assemble-to-order system. Components are produced to stock, and a selection of these components is assembled to order in a shared assembly line. We derive structural results regarding a firm's decision on when to accept an order for a certain product and how many components of each type to produce. These results enable us to develop an effective heuristic solution which is robust with respect to the number of products offered.

- 5 - Dynamic Rolling Knapsacks: Capacity Management in Multi-period Make-to-order Businesses  
Hiroshi Ochiuni, Visiting Assistant Professor, University of Washington, Bothell, Box 358533, 18115 Campus Way NE, Bothell, WA, 98011, United States, ochiuni@marshall.usc.edu, Sriram Dasu

A make-to-order firm receives two types of orders - normal and urgent. Urgent orders fetch a premium, and must be fulfilled using the current capacity. The firm can use either the current or future capacity to produce normal orders. The company is interested in policies for withholding capacity for urgent orders. We identify optimal capacity rationing rules by modeling the problem by a dynamic rolling knapsack problem.

## ■ SB02

### Integrated Operations-marketing Models for Supply Chains

Cluster: Supply Chain  
Invited Session

Chair: Saibal Ray, Associate Professor, McGill University, 1001 Sherbrooke West, Montreal, QC, H3A1G5, Canada, saibal.ray@MCGILL.CA

- 1 - Product Design and Demand Uncertainty  
Qin Geng, Assistant Professor, Robert Morris University, School of Business, 6001 University Boul, Moon Township, PA 15108, United States, qingeng@uiuc.edu, Nicholas Petrucci

Price-setting newsvendor model provides framework for understanding how demand uncertainty affects optimal pricing. The model assumes that the product specifications are designed regardless of whether or not the seller of the product is facing uncertainty in demand. But what if the product design question is given explicit consideration? We investigate how uncertainty affects the product design decision and how this question affects our understanding of how demand uncertainty affects pricing.

- 2 - Optimal Timing of Orders and Pricing in a Periodic Review Model  
Yuyue Song, Assistant Professor, Memorial University of Newfoundland, A1B 3X5, Canada, ysong@mun.ca, Saibal Ray, Manish Verma

In this paper we analyze a profit-maximizing firm using a periodic review model. The decision variables for the firm are: time between the orders, order size and price to charge to the end customers. We first characterize the optimal decisions for an approximate model which is popular in the literature. We then show under what conditions such approximations can result in significant profit penalty.

- 3 - Distributing a Product Line in a Decentralized Supply Chain  
Jing Shao, University of British Columbia, Vancouver, Vancouver, BC, Canada, jing.shao@sauder.ubc.ca, Thomas McCormick, Harish Krishnan

We study a manufacturer who distributes a horizontally differentiated product line through competing retailers. We investigate how retailers' incentives are affected by the substitution between products as well as between retailers. The incentive distortions in a decentralized supply chain are characterized, and various contracts that coordinate the channel are provided.

- 4 - A Sequential Location and Pricing Problem for a Duopoly  
Yue Zhang, McGill University, 1001 Sherbrooke Stree West, Montreal, QC, H3A1G5, Canada, yue.zhang3@mail.mcgill.ca, Saibal Ray, Vedat Verter

We investigate a sequential location and pricing problem for two profit-maximizing firms, which compete on a unit line market. Each customer purchases one unit of the product from the store providing higher utility. We assume that the early-mover first decides its location as a monopoly, and focus on the optimal location and pricing strategy for the later entrant and the adjusted pricing strategy for the early-mover.

## ■ SB03

### Cooperation in Supply Chains and Operations

Cluster: Supply Chain  
Invited Session

Chair: Saif Benjaafar, Professor & Division Director, University of Minnesota, Industrial & Systems Engineering, Department of Mechanical Engineering, Minneapolis, MN, 55455, United States, saif@umn.edu

- 1 - Cost Allocation of Capacity Investment Game  
Xin Chen, University of Illinois at Urbana-Champaign, 104 S. Mathews Ave., Urbana, IL, 61801, United States, xinchen@uiuc.edu

Consider a set of manufacturers, which need to build capacities and then make productions to satisfy their demand. By taking advantage of the economies of scale of capacity investment, the manufacturers may build joint capacity and make joint productions to reduce their operating costs. Under rather general assumptions on the capacity investment cost, we show that the resulting capacity investment game has a nonempty core.

- 2 - On the Benefits of Assortment-based Cooperation Among Independent Producers  
Baris Tan, Professor of Operations Management, Koc University, Rumeli Feneri Yolu, Sariyer, Istanbul, 34450, Turkey, btan@ku.edu.tr, Yalcin Akcay

We consider a market for a set of substitutable products and a number of firms where each firm produces a subset of these products as its assortment. Depending on the assortment and the substitution behavior of the customer, either a product is sold or the sale is lost. We analyze the cooperation of such independent producers which offer a combined set of products to their customers and determine the characteristics of firms and their products that would facilitate a beneficial cooperation.

- 3 - Coordinated Production Strategies for Outsourced Operations  
Tolga Aydinliyim, Assistant Professor, University of Oregon, Lundquist College of Business, Decision Sciences Department, Eugene OR 97403, United States of America, tolga@lcbmail.uoregon.edu, George Vairaktarakis

We consider a model where multiple manufacturers outsource to the same third-party with specialized resources. Such business transactions are increasingly handled online where third-party's available capacity is announced to the manufacturers. As opposed to the current practice of the FCFS booking of the third-party capacity, centralized control generates significant savings, but result to inferior performance individually. We present savings sharing schemes that promote centralization.

- 4 - A Note on Power of Two Inventory Games  
Moshe Dror, Professor, University of Arizona, MIS, Eller College of Management, Tucson, AZ 85721, Tucson, AZ, 85721, United States, mdror@eller.arizona.edu, Bruce C. Hartman

Recently Anily and Haviv (2007) published a study showing that a group of products ordered in subsets using EOQ and a power-of-two rule has a cooperative game which is totally balanced and concave. We show that the game is analogous to the classical airport landing fee games. The solution can be constructed in polynomial time rather than by an integer program. The Shapley value can also be computed in polynomial time.

- 5 - On Service Capacity Pooling and Cost Allocation Among Independent Forms  
Saif Benjaafar, Professor & Division Director, University of Minnesota, Industrial & Systems Engineering, Department of Mechanical Engineering, Minneapolis, MN, 55455, United States, saif@umn.edu, Yigal Gerchak, Yimin Yu

We analyze the benefit of capacity pooling for a set of independent firms. Firms decide jointly on capacity level for the shared facility to minimize capacity investment and delay costs subject to service level requirements. Firms also decide on how costs are allocated. We identify conditions under which firms prefer a grand coalition to any other facility sharing arrangement. We also describe settings when this is not the case.

## ■ SB04

### Tutorial: Operations Research and Homeland Security: From Models to Implementation

Cluster: Tutorials  
Invited Session

- 1 - Operations Research and Homeland Security: From Models to Implementation  
Lawrence Wein, Paul E. Holden Professor of Management Science, Stanford University, Graduate School of Business, Stanford University, Stanford, CA, 94305, United States, lwein@stanford.edu

We give an overview of our research in two areas of homeland security: catastrophic biological events (preparing and responding to a smallpox attack, an airborne anthrax attack, and a botulinum toxin attack on the food supply, and assessing infection control measures for pandemic influenza) and border control (preventing nuclear weapons from entering the country on a shipping container and from entering a city, using biometrics to prevent terrorists from entering the

country, and analyzing U.S. immigration strategy from a homeland security viewpoint). We focus on the modeling, the policy recommendations and the implementation of these recommendations.

## ■ SB05

### 2007 Dantzig Dissertation Award Finalists

Cluster: Dantzig Dissertation Prize

Invited Session

Chair: Jeannette Song, Duke University, Fuqua School of Business, Durham, NC, 27708, United States, jssong@duke.edu

#### 1 - Deriving Value from Customer Networks

Shawndra Hill, Operations and Information Management  
Department The Wharton School of the University of  
Pennsylvania 3730 Walnut Street, Suite 500 Philadelphia, PA,  
shawndra@wharton.upenn.edu

My dissertation addresses the question: How can firms derive value from data on consumer networks? Firms may be able to capitalize on the fact that consumers interact. Firms that collect explicit data on networks of interactions may be able to mine it to increase revenue or to reduce costs. Results of my research show that information in consumer network data improves business outcomes. In this presentation, I will discuss network-based marketing, a collection of marketing techniques that take advantage of links between consumers to increase sales. Using a large telecommunications data set that represents the adoption of a new telecommunications service, I show very strong support for the hypothesis that network linkage can directly affect product/service adoption. Specifically, I show three main results: (1) "Network neighbors"—those consumers linked to a prior customer-adopt the service at a rate 3-5 times greater than baseline groups selected by the best practices of the firm's marketing team. In addition, analyzing the network allows the firm to acquire new customers who otherwise would have fallen through the cracks, because they would not have been identified based on traditional attributes. (2) Statistical models, built with a very large amount of geographic, demographic and prior purchase data, are significantly and substantially improved by including network information. (3) More detailed network information allows the ranking of the network neighbors so as to permit the selection of small sets of individuals with very high probabilities of adoption.

#### 2 - Air Cargo Revenue and Capacity Management

Andreea Popescu, Georgia Institute of Technology, 3186 Alton Rd,  
Atlanta GA 30341, Andreea.Popescu@turner.com

We address two problem categories: Air Cargo Revenue Management, the airlines' problem of managing the capacity available for free sale to generate more revenue; and Air Cargo Capacity Management, the freight forwarders' problem of confirming capacity with the airlines a few days before the flight takes off such that the demand from the shippers is satisfied at minimum cost. We show in the air cargo revenue management section that a discrete estimator for the air cargo show-up rate can result in significant higher revenue than the Normal estimator currently used, and we develop bid prices taking into account the demand lumpiness existent in the air cargo industry. We model the air cargo capacity management problem as a perishable inventory management problem with positive lead times, and show that the optimal policy is stationary for lead times of one and two periods.

#### 3 - Efficient Closed-Loop Optimal Control of Petroleum Reservoirs under Uncertainty

Pallav Sarma, Stanford University, pallav@chevron.com

Real-time model-based oil and gas reservoir management requires efficient computational techniques for optimizing reservoir performance under uncertainty. Such production optimization problems typically involve large, highly complex reservoir simulation models (numerical models of fluid flow behavior in the subsurface reservoir and surface facilities), with thousands of unknowns and many constraints. Further, our understanding of the subsurface oil and gas reservoir is always highly uncertain, and this uncertainty is reflected in the models. As a result, performance prediction and production optimization, which are the ultimate goals of the entire modeling and simulation process, are generally suboptimal. This work discusses a model-based closed-loop approach for efficient and accurate real-time production optimization that consists of three key elements - optimization, uncertainty propagation and model updating, and various algorithms such as adjoint models, kernel principal component analysis and polynomial chaos expansions are proposed/adapted to perform these tasks efficiently.

## ■ SB06

### Integrated Risk Management

Sponsor: Manufacturing & Service Oper Mgmt  
Sponsored Session

Chair: Lingxiu Dong, Associate Professor, Washington University in St. Louis, Olin School of Business, Saint Louis, MO, United States, dong@wustl.edu

Co-Chair: Panos Kouvelis, Professor, Washington University in St. Louis, Olin School of Business, Campus Box 1133,  
1 Brookings Lane, St Louis, MO, 63130, United States,  
kouvelis@wustl.edu

#### 1 - The Relationship Between Capital Structure and Operational Characteristics

John Birge, University of Chicago, Chicago, IL,  
John.Birge@ChicagoGSB.edu

A variety of models have been proposed to explain capital structure. The tradeoff theory is generally interpreted to imply that market leverage increases with firm profitability. Empirical studies suggest that the opposite relationship is, however, true, and, therefore, tend to support other explanations including asymmetric information and agency costs. In this talk, we will discuss an alternative based on a news vendor structure and will present empirical results that support this model.

#### 2 - The Role of Financial Services in Procurement Contracts

Xiang-Feng Chen, Fudan University, 220, Handan Rd., Shanghai,  
200433, China, xchen@stern.nyu.edu, Rene Caldenty

We investigate the interplay between operations and financial decisions in the design of procurement contracts. A budget constrained retailer purchases a product from a supplier and afterwards sells it in a retail market to a random demand. We compare two forms of financing for the retailer: 'External Financing' in the form of a commercial loan and 'Internal Financing' in which the supplier offers financial services to the retailer in the form of a specially tailored procurement contract.

#### 3 - Integration of Operational and Financial Hedging

Rong Li, Assistant Professor, Singapore Management University,  
50 Stamford Road, Singapore, 178899, Singapore,  
rongli@smu.edu.sg, Panos Kouvelis, Qing Ding

We study a multi-period hedging problem for a manufacturer who faces uncertain demand of commodity components. Traditional inventory management studies operational hedging only. In this research, we consider different types of financial hedging together with two operational hedging methods, which include a long-term flexible contract with a supplier and spot market participation. Optimal hedging policies are determined for a risk-averse manufacturer.

#### 4 - Global Facility Network Design Under Price Flexibility

Lingxiu Dong, Associate Professor, Washington University in  
St. Louis, Olin School of Business, Saint Louis, MO, United States,  
dong@wustl.edu, Ping Su, Panos Kouvelis

We consider a global firm who sells as a monopolist in both the domestic and foreign markets. We characterize the optimal global network design, and investigate the impact of price flexibility and the uncertainties in exchange rate and/or demand on the firm's facility location and capacity decisions.

## ■ SB07

### Retail Operations

Sponsor: Manufacturing & Service Oper Mgmt  
Sponsored Session

Chair: Gurhan Kok, Associate Professor, Duke University, One  
Towerview Drive, Durham, NC, United States, gurhan.kok@duke.edu

#### 1 - Incorporating Price and Inventory Endogeneity in Firm Level Sales Forecasting

Vishal Gaur, Cornell University, vg77@cornell.edu,  
Saravanan Kesavan, Ananth Raman

We construct a simultaneous equations model to interrelate sales, inventory, and gross margin for a retailer at the firm level. Using public financial data, we estimate 6 causal effects among these variables. Our model yields insights about these effects that support theoretical literature. It also provides sales forecasts, which in our numerical tests, are more accurate than forecasts from time-series models that ignore inventory and gross margin as well as those from equity analysts.

### 2 - Improving Consumers' Product Valuation under Retail Competition

Olga Perdikaki, The University of North Carolina at Chapel Hill, Kenan-Flagler Business School, CB# 3490, McColl Bldg., Chapel Hill, NC, 27599-349, United States, olga\_perdikaki@unc.edu, Jayashankar Swaminathan

Several retail practices are aimed towards increasing consumer valuation about their product offerings. We consider a stylized model with two retailers where consumers can obtain the informational services provided by one retailer but buy the product from another retailer. We provide managerial insights on how factors such as market expansion, intensity of competition, level of investment as well as direction of consumer flow impact the outcome of competition.

### 3 - The Impact of Fast Response in Inventory-based Competition

Victor Martinez de Albeniz, Assistant Professor, IESE Business School, Av. Pearson 21, Barcelona, 08034, Spain, valbeniz@iese.edu, Felipe Caro

We propose a multi-period extension of the competitive newsvendor model of Lippman and McCardle (1997), to investigate the impact of fast replenishment capabilities on competition. For this purpose, we consider two asymmetric retailers that compete in terms of inventory, i.e., excess demand overflows to the competitor. We visualize this problem as the competition between a traditional retailer that makes-to-stock before the season starts versus a retailer that has a fast response to the market.

### 4 - Optimal Assortment under Product Returns

Alex Gragas, University of Florida, Dept. of Industrial & Systems Engineering, Weil Hall, Gainesville, FL, 32608, United States, agragas@ufl.edu, Elif Akcali, Aydin Alptekinoglu

Motivated with the question of whether retailers should consider product returns when merchandising (as they compose their product lines), we explore the interactions between product assortment and return policy decisions of a firm under both make-to-order (MTO) and make-to-stock (MTS) environments. We show that the structure of the optimal assortment critically depends on the refund fraction and whether the products are supplied on an MTO or MTS basis.

## SB08

### Supply Disruptions and Risk

Cluster: Managing Disruptions in Supply Chains

Invited Session

Chair: Nesim Erkip, Bilkent University, Dept. of IE, Ankara, TR, 06800, Turkey, nesim@bilkent.edu.tr

#### 1 - Contracting Between Downside Risk Averse Supplier and Risk Neutral Retailer

Sudarsan Rangan, The University of Alabama, ISM Department, Alston Hall, The University of Alabama, Tuscaloosa, AL, 35487, United States, srangan@cba.ua.edu, Charles Sox

The objective of this research project is to develop a coordinating contract acceptable to all agents involved. This paper attempts to model and analyze the supplier's downside risk in some existing types of contracts and to identify conditions under which the supply chain can be coordinated in a single period setting under demand uncertainty.

#### 2 - On the Value of Flexible Suppliers in Supply Chains with Disruption Risks

Soroush Saghafian, PhD Student, University of Michigan, Dep. of Industrial and Operations Eng., 1205 Beal Avenue, The University of Mich, Ann Arbor, 48109, United States, soroush@umich.edu, Mark Van Oyen

We analyze the value of a flexible supplier in a supply chain where suppliers have disruption risks. In a two-echelon supply chain, a manufacturer produces two types of products, each having an inflexible and a flexible supplier. We derive optimal sourcing and contracting level and investigate the value of the flexible supplier and the value of information on disruption threat levels of unreliable suppliers.

#### 3 - Managing Supply Disruptions in an Assembly System

Gregory DeCroix, Associate Professor, University of Wisconsin-Madison, 975 University Avenue, Madison, WI, 53706, United States, gdcroix@bus.wisc.edu

This paper studies the management of a supply chain for a product that is assembled from multiple components, some of which are subject to supply disruptions. We evaluate heuristic policies for managing inventories in this system, and explore alternate strategies for mitigating the risk of the supply disruptions.

#### 4 - Computing Default Probabilities for a Three Level Supply Chain

Nesim Erkip, Bilkent University, Dept. of IE, Ankara, TR, 06800, Turkey, nesim@bilkent.edu.tr, Sila Cetinkaya

Consider a buyer facing random demand, a first tier supplier (OEM manufacturer) and a second tier supplier (supplier of the OEM). We investigate the effect of buyer sharing her demand information with the supply chain under arbitrary contract structures all enforcing total satisfaction of the random demand. We are especially interested in computing default probabilities of different parties, as well as the default probability for the supply chain.

## SB09

### Multicriteria Decision Making II

Contributed Session

Chair: Chun-Ting Lin, University of Michigan, Ann Arbor, 1697 Broadway St. Apt # 401, Ann Arbor, MI, 48105, United States, jctlin@umich.edu

#### 1 - A Study of Regret and Rejoicing in Decision-making and a New MCDM Method Based Theme

Xiaoting Wang, Louisiana State University, 3550 Nicholson Dr. Apt. 2118, Baton Rouge, LA, 70802, United States, xwang8@lsu.edu, Evangelos Triantaphyllou

First we discuss how some emotional feelings such as regret and rejoicing may greatly influence people's preferences in decision-making. Next a new MCDM method, which can incorporate the notion of anticipated regret and rejoicing systematically, is proposed. Some essential properties of the new method are also discussed.

#### 2 - Quality Representation of the Solution Set in Biobjective Programming

Stacey L. Faulkenberg, Clemson University, Department of Mathematical Sciences, Clemson, SC, 29634, United States, sfaulke@clemson.edu, Margaret M. Wiecek

As mathematicians engaged in multiple criteria decision making, it is our task to support the decision maker by presenting her with a quality representation of the solution set from which she may choose a final preferred solution. We review quality measures for solution sets of multiobjective programs available in the literature and propose new concepts. For biobjective programs we present methods which produce representations optimizing these measures. Numerical examples are included.

#### 3 - Multicriteria Batch Process Control by Upstream Rescheduling

Abdullah Cerekci, Teaching Assistant, Industrial and Systems Engineering Department/Texas A&M University, 3131 TAMU, College Station, TX, 77843, United States, cerekci@tamu.edu, Amarnath Banerjee

Dynamic scheduling of batch machines is a very complex problem. Policies that reduce cycle time using near future arrival time predictions exist in the literature. Our recent studies improve these approaches by incorporating the schedule of the upstream machines. In this paper, we further extend batch control problem by considering cycle time and tardiness objectives at the same time. Our upstream rescheduling based look-ahead policy gives promising results for this multicriteria problem.

#### 4 - Multi-objective Model for Vendor Selection

Vijay Wadhwa, PSU, 310 Leonhard Building, University Park, PA, 16802, United States, vuw100@psu.edu, A.Ravi Ravindran

In any large organization, millions of dollars are spent on outsourcing. Most large organizations are outsourcing those activities that are either not cost efficient or not core to their businesses. In this work we develop vendor selection methods with Price, lead-time and rejects (quality) are explicitly considered as three conflicting criteria that have to be minimized simultaneously. We present and compare goal programming and compromise programming as multi-objective optimization methods.

#### 5 - Decision Making Using Decision Field Theory and Linear System Model

Chun-Ting Lin, University of Michigan, Ann Arbor, 1697 Broadway St. Apt # 401, Ann Arbor, MI, 48105, United States, jctlin@umich.edu

The psychological Decision Field Theory (DFT) proves capability in illustrating dynamic decision making process. In this paper, we present a Generalized DFT system by considering closed-loop systems with multiple decision makers in decision making process. Simulation of the proposed model provides evidence that individual momentary preferences control organizational overall performance. Case study gives managerial implication in improving group decision making process.

## ■ SB10

### Cooperation in Inventory Management II

Cluster: Inventory

Invited Session

Chair: Jiawei Zhang, Assistant Professor, New York University, 44 West 4 St., Suite 8-66, New York, NY, 10012, United States, jzhang@stern.nyu.edu

#### 1 - P-additive Games: A Class of Totally Balanced Games Arising From Inventory Situations with Temporary

Ana Meca, Professor, Universidad Miguel Harnandez, Edificio Torretamarit, Avda. Universidad s'n, Elche, 03202, Spain, ana.meca@umh.es, Luis Guardiola

We introduce a new class of totally balanced cooperative TU games, namely p-additive games. It is inspired by the class of inventory games that arises from inventory situations with temporary discounts (Toledo, 2002) and contains the class of inventory cost games (Meca et al., 2003, 2004). It is shown that p-additive games are totally balanced. The modified SOC-rule is proposed as a core-allocation for p-additive games.

#### 2 - Large Newsvendor Games

Marco Scarsini, Professor, LUISS, Via O. Tommasini 1, Roma, RM, 00162, Italy, marco.scarsini@gmail.com, Luigi Montrucchio

We consider a game, called newsvendor game, where several retailers, who face a random demand, can pool their resources and build a centralized inventory that stocks a single item on their behalf. Profits have to be allocated in a way that is advantageous to all the retailers. A game in characteristic form is obtained by assigning to each coalition its optimal expected profit. We show that in a game with a continuum of players, under a nonatomic condition on the demand, the core is a singleton.

#### 3 - A Collaborative Decentralized Distribution System with Demand Updates

Ulas Ozen, Researcher, Bell Labs Ireland, Blanchardstown Industrial Park, Blanchardstown, Dublin, Dublin 15, Ireland, U.Ozen@tm.tue.nl, Greys Sosic, Marco Slikker

We consider a distribution system that consists of a manufacturer, a warehouse, and n retailers, which face stochastic demand and order from the manufacturer. The retailers can update their demand forecasts, while their orders are shipped to the warehouse. We analyze cooperation between the retailers with and without information sharing, and we investigate its impact on the retailers and the manufacturer. Afterwards, we focus on coordination of the entire supply chain through buy-back contracts.

## ■ SB11

### Manufacturing System Design for Product Variety

Cluster: Manufacturing

Invited Session

Chair: Jeonghan Ko, University of Michigan, 2350 HAYWARD ST., 2250 G.G. BROWN, Mechanical Engineering, Ann Arbor, MI, United States, jeonghan@umich.edu

Co-Chair: Jack Hu, University of Michigan, Hayward St., 2250 G.G. Brown, Ann Arbor, MI, 48109, United States, jackhu@umich.edu

#### 1 - A Quantitative Approach to Achieving Optimal Balance Between Product Variety and Manufacturability

Jeremy Michalek, Assistant Professor, Carnegie Mellon University, Scife Hall 323, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, jrmichalek@cmu.edu

We incorporate econometric models of consumer demand for product variety with manufacturing investment and production allocation decisions to resolve tradeoffs among product functionality, market performance and manufacturing cost under a profit objective.

#### 2 - Flexible vs. Dedicated Capacity in Serial Processes

Amit Eynan, Professor, University of Richmond, 1 Gateway Rd, Richmond, VA, 23173, United States, aeynan@richmond.edu, Lingxiu Dong

Flexible capacity allows firm to allocate resources following realization of products' demand. This feature, however, comes at a cost as versatile capacity is more expensive than dedicated one. This trade-off received much attention recently and has been explored while implicitly treating the process as a single stage. This study considers this trade-off within a multi-stage context and identifies which stages along the process should be flexible (or dedicated) and their optimal capacity levels.

#### 3 - Manufacturing Line Design for Product Variety Considering Line Flexibility and Task Similarity

Jeonghan Ko, University of Michigan, 2350 Hayward St., 2250 G.G. Brown, Mechanical Engineering, Ann Arbor, MI, United States, jeonghan@umich.edu, Jack Hu

Classical approaches to manufacturing line design have usually concerned serial configurations of identical machines. We developed mixed integer programming models for maximizing (1) cost-effectiveness of line configurations for multiple product models by the appropriate combinations of dedicated and flexible machines, and (2) the similarity of manufacturing tasks assigned to a machine for different product models.

## ■ SB12

### Scheduling Applications & Algorithms

Cluster: Scheduling

Invited Session

Chair: Zhi-Long Chen, Associate Professor, University of Maryland, R.H. Smith School of Business, College Park, MD, 20742, United States, zchen@rhsmith.umd.edu

Co-Chair: Lei Lei, Rutgers University, Rutgers Business School, United States, llei@business.rutgers.edu

#### 1 - Scheduling Truck Arrivals at an Air Cargo Terminal

Chung-Lun Li, Chair Professor of Logistics Management, The Hong Kong Polytechnic University, Department of Logistics, Hung Hom, Kowloon, Hong Kong, China, lgtclli@polyu.edu.hk, Jinwen Ou, Vernon Ning Hsu

We consider the scheduling of truck arrivals at an air cargo terminal. By coordinating arrivals of cargo delivery trucks with outbound flight departure schedules, some of the shipments can be transferred directly to the departing flights, while others will be stored at the terminal's storage facility and incur extra costs. The objective is to obtain a feasible schedule so as to minimize the total cost of operations.

#### 2 - Scheduling Robotic Cells with a Stochastic Processing Time

Neil Geismar, Texas A&M University, Mays Business School, College Station, TX, United States, ngeismar@yahoo.com, Michael Pinedo

We consider the operations of a robotic cell in which one process has a stochastic processing time. We first demonstrate how proximity of the stochastic process to the bottleneck process effects throughput, which leads to formulas for the cell's expected throughput. We also find the distribution function of the robot's cycle time and verify it with simulation results. On-line scheduling schemes to improve throughput are also presented.

#### 3 - Inbound Logistics Scheduling with Milk Runs with Limited Unloading Capacity

Xiangtong Qi, Assistant Professor, Hong Kong University of Science and Technology, Department of Industrial Engineering and, Clear Water Bay, Kowloon, Hong Kong - ROC, ieemqi@ust.hk, Jinwen Ou, Chung-Yee Lee

A 3PL company uses a milkrun system to pick up components from suppliers to an automotive maker. Suppliers are clustered into subsets where each subset is visited by one truck run. One bottleneck of the system is the unloading docks at the warehouse where trucks are waiting for unloading. We formulate the problem as a scheduling problem with unloading servers and develop algorithms to improve system efficiency. The work is partly supported by NSFC/RGC Joint Research Scheme N\_HKUST612/06.

#### 4 - Optimality Proof of the Kise-Ibaraki-mine Algorithm

Zhi-Long Chen, Associate Professor, University of Maryland, R.H. Smith School of Business, College Park, MD, 20742, United States, zchen@rhsmith.umd.edu, Shan-Lin Li, Guo-Chun Tang

Kise, Ibaraki and Mine [Operations Research, 26 (1978), 121-126] give an  $O(n^2)$  time algorithm to find an optimal schedule for the single-machine number of late jobs problem with agreeable job release dates and due dates. We point out that their proof of optimality for their algorithm is incorrect by a counter-example, and give a correct proof of optimality.

#### 5 - Container Vessel Scheduling: Some Solvable Cases

Lei Lei, Rutgers University, Rutgers Business School, United States, llei@business.rutgers.edu, Endre Boros, Selim Bora

Container vessel scheduling in a supply chain environment is a new but difficult optimization problem because of the additional constraints on suppliers' capability and customer-delivery requirements. We introduce some strongly polynomial time solvable cases encountered in such scheduling processes involving customer receiving time-windows, cargo release times and due dates, and capacitated heterogeneous vessels.

## ■ SB13

### Computational Integer Programming

Sponsor: Optimization/ Integer Programming  
Sponsored Session

Chair: Eva K. Lee, Associate Professor & Director, Georgia Institute of Technology, Center for OR in Medicine & HealthCare, Industrial & Systems Engineering, Atlanta, GA, 30332-0205, United States, evakylee@isye.gatech.edu

#### 1 - MIP: Beyond Tradition

Zonghao Gu, Distinguished Scientist, ILOG Inc., 4050 Walnut Creek Trail, Alpharetta, 30005, United States, gu@ilog.com

Traditionally, MIP solvers use a branch-and-cut algorithm to search and return a single optimal solution. We present the progress of our recent MIP developments, including dynamic search and non-traditional parallel algorithm, with benchmarks showing the significant performance improvement, especially on hard models.

#### 2 - Integer Programming Strategies for Large-scale, Cancer Instances

Kyungduck Cha, Georgia Institute of Tech., chacha2000@isye.gatech.edu, Eva K. Lee

In this talk, we will describe integer programming models and computational strategies for some large-scale intractable MIP instances arising from cancer treatment planning.

#### 3 - Solution Approaches for Integer Bilevel Programs

Scott Denegre, Lehigh University, 200 W. Packer Avenue, Mohler Laboratory, Bethlehem, PA, 18015, United States, scd3@lehigh.edu, Ted Ralphs

We consider novel solution approaches for integer bilevel programs (IBPs). Extensions to polyhedral techniques developed for IPs are derived and new classes of valid inequalities are introduced, leading to a branch-and-cut algorithm. Particular emphasis is placed on integer interdiction problems, a subclass of IBPs and a natural extension of the network interdiction problem. Multiobjective programming techniques are used to analyze the tradeoff between resources and interdiction effort success.

## ■ SB14

### Derivative-free Nonlinear Programming

Sponsor: Optimization/ Nonlinear Programming  
Sponsored Session

Chair: Joshua Griffin, Sandia National Laboratories, 4970 Owens Drive Apt 637, Pleasanton, CA, 94588, United States, jgriffi@sandia.gov

#### 1 - Derivative-free Software for Multiagent Hybrid, Optimization in Parallel

Joshua Griffin, Sandia National Laboratories, 4970 Owens Drive Apt 637, Pleasanton, CA, 94588, United States, jgriffi@sandia.gov, Tamara Kolda

We discuss strategies for accelerating convergence of Generating Set Search (GSS) by providing the ability to evaluate externally generated points. These modifications provide several new capabilities: 1) the user may run multiple local searches simultaneously, 2) the user may concurrently use additional (non-GSS) optimization strategies while sharing common point evaluations, and 3) the ability to extend capabilities to global optimization.

#### 2 - Derivative-free Optimization as a Tool for Simulator Calibration

Genetha Gray, Sandia National Laboratories, P.O. Box 969, MS 9159, Livermore, CA, 94551, United States, gagray@sandia.gov

Scientists and engineers use computational simulations in the design and study of complex systems. However, the usefulness of these simulations can hinge on the values of certain simulator parameters. Thus, calibration procedures are applied to improve the quality of the simulations and to minimize underlying model uncertainties. In this talk, we will describe how derivative-free optimization can play a key role in the calibration process and give some real world examples and results.

#### 3 - Algorithm and Application of ORBIT, a Derivative-free, Trust-region Radial Basis Function Optimizer

Christine Shoemaker, Professor, Cornell University, School of Civil and Environmental Eng., Cornell University, Hollister Hall, Ithaca, NY, 14853, United States, cas12@cornell.edu, Stefan Wild, Rommel Regis

We present a new derivative-free algorithm, ORBIT (Optimization by Radial Basis Function Interpolation in Trust Regions), for unconstrained local optimization.

ORBIT is designed for computationally expensive functions, for which a large number of function evaluations is not feasible. We present numerical results for a number of functions, including watershed calibration and optimization of a partial differential equation model for decontamination of groundwater.

## ■ SB15

### Dynamic Variational Inequalities

Sponsor: Optimization/ Linear Programming and Complementarity  
Sponsored Session

Chair: Mihai Anitescu, Computational Mathematician, Argonne National Laboratory, Mathematics and Computer Science Division, 9700 S. Cass Avenue, Argonne, IL, 60439, United States, anitescu@mcs.anl.gov

#### 1 - Gradient-based Algorithms for Finding Nash Equilibria in Extensive Form Games

Andrew Gilpin, Carnegie Mellon University, Computer Science Department, Pittsburgh, PA, 15213, United States, gilpin@cs.cmu.edu, Javier Pena, Samid Hoda, Tuomas Sandholm

We present a gradient-based algorithm for finding Nash equilibria of two-person, zero-sum sequential games. The algorithm is based on modern smoothing techniques for non-smooth convex optimization and requires  $O(1/\epsilon)$  iterations to compute an  $\epsilon$ -equilibrium. Fast iterations enable the approximation of equilibria for games with a tree representation of 100 billion nodes. We develop heuristic improvements and demonstrate their efficacy on a range of real-world games.

#### 2 - A Descent Method for Differential VIs Arising in Non-cooperative Differential Nash Equilibrium

Changhyun Kwon, PhD Candidate, The Pennsylvania State University, 310 Leonhard Building, University Park, PA, 16802, United States, chkwon@psu.edu, Terry Friesz

In this paper, we consider a gap function for differential variational inequalities (DVIs) and study an equivalent optimal control problem. In particular, we employ a differential gap function — the so-called D-gap function — and its gradient to form a descent method for DVIs. An application of DVIs to differential Nash games is also investigated. In particular, we solve an abstract linear-quadratic differential Nash game and a model of oligopolistic competition.

#### 3 - Advances in Evolutionary VI Modeling of Electric Power Supply Chains with Real-Life Applications

Anna Nagurny, John F. Smith Memorial Professor, University of Massachusetts, Finance and Operations Management, Isenberg School of Management, Amherst, MA, 01003, United States, nagurny@gbfin.umass.edu, Zugang Liu

In this paper, we propose a new model of dynamic electric power supply chains with explicit transmission capacities using evolutionary variational inequalities. We then demonstrate an application of the model for ISO New England and show how the model captures dynamic pricing as well as dynamic electric power transactions.

#### 4 - A Differential Variational Inequality Formulation for Rigid Body Dynamics with Polyhedral Bodies

Gary Hart, University of Pittsburgh, 301 Thackeray Hall, Pittsburgh, PA, United States, gdhart@pitt.edu, Mihai Anitescu

We present a differential variational inequality formulation for rigid body dynamics with polyhedral bodies. The formulation is based on a novel measure for depth of penetration between polyhedral bodies that has a linear complexity. Numerical results show that a time-stepping approach based on this formulation achieves constraint stabilization for fixed time steps.

## ■ SB16

### Combinatorial Optimization II

Contributed Session

Chair: Barbara Tocchella, University of Brescia - Department of Electronics for Automation, Via Branze 38, Brescia, 25123, Italy, barbara.tocchella@ing.unibs.it

#### 1 - Solving a General Infrastructure Investment Model Using Column Generation

Matthias Nowak, Post-Doc, NTNU, Alfred Getz veg 3, Trondheim, 7491, Norway, mefju@iot.ntnu.no, Jogeir Myklebust, Asgeir Tomasgard

The motivation for this paper is long term infrastructure development in the energy sector, including natural gas and hydrogen value chains. The model is a mixed-integer linear program that is difficult to solve by branch-and-bound

methods. The solution method is based on the column generation methodology utilizing off-the-shelf branch-and-bound optimization libraries. Numerical results will be presented.

## 2 - Timetabling and Grouping of Project Presentations of Student Teams

Burcin Bozkaya, Asst. Prof., Sabanci University,  
Faculty of Management, Orhanli, Tuzla, Istanbul, Turkey,  
bbozkaya@sabanciuniv.edu, Can Akkan

We present the continuation of our work on timetabling and grouping of student project presentations. The objective is to group students into teams and schedule their presentations into time slots. We use an IP-based model and solve it with a heuristic approach. Our criteria include homogeneity across time slots in terms of student background, and homogeneity within time-slots in terms of presentation material. We present our model, discuss solution methods, and present computational results.

## 3 - Heuristic Algorithms for Multidimensional Multiple-choice Knapsack Problem

Cheng-Huang Hung, Assistant Professor, Department of  
Information Management, National Taiwan University of Science  
and Technology, 43, Keelung Rd., Sec. 4, Taipei, Taiwan - ROC,  
alexhung@cs.ntust.edu.tw, Pei-Chi Chen

We introduce two heuristics (Heu-1 and Heu-2) to solve Multidimensional Multiple-Choice Knapsack Problem (MMKP). We propose a new local search direction and searching scheme. Computational results show that our local search direction is better than Moser's with 99% confidence in small instances or when the number of services is large. Computational results also show HEU-1 is better than Moser's algorithm with 95% confidence, and HEU-2 is better than Khan's algorithm with 99% confidence.

## 4 - The Raw Material Unloading Problem of a Steelworks: Combinatorial Nature

Yunetech Han, Student, Postech, San31, Hyoja-dong, Nam-gu,  
IME Chaos Lab, Pohang, 790-784, Korea, Republic of,  
bluerain@postech.ac.kr, Soo Y. Chang, Byung-In Kim, K  
yung-Kuk Lim, Wooram Kwak

Unloading raw material from ships at the seaport of a steelworks has unique characteristics. The scheduling problem is very complicated due to several factors such as the dynamic nature of berthing eligibility of each ship, the uneven capacities of unloading equipment, the requirement for keeping balance of the ship, and the complexity of belt conveyor operation. In this talk, we discuss the combinatorial nature of the scheduling problem and show that some of sub problems are NP-hard.

## 5 - The Traveling Purchaser Problem with Budget-constraint

Barbara Tocchella, University of Brescia - Department of  
Electronics for Automation, Via Branze 38, Brescia, 25123, Italy,  
barbara.tocchella@ing.unibs.it, Renata Mansini

We analyze a variant of the Traveling Purchaser Problem (TPP) where the purchasing costs of products can not exceed a defined budget threshold. We propose and compare two solution algorithms, a simple local search heuristic and a more elaborated Variable Neighborhood Search. The proposed algorithms have been used to solve both the capacitated and the uncapacitated version of the problem. Test problems have been obtained by adding a budget constraint to known benchmark instances for the TPP.

## SB17

### Online Social Networks

Sponsor: Information Systems Society

Sponsored Session

Chair: Yong Tan, University of Washington, Business School,  
Box 353200, Seattle, WA, 98195-3200, United States,  
ytan@u.washington.edu

#### 1 - Employee Blogs: Is Honesty the Best Policy for a Firm?

Rohit Aggarwal, Doctoral Candidate, University of Connecticut,  
OPIM, School of Business, University of Connecticut, Storrs, CT,  
06269, United States, Rohit.Aggarwal@business.uconn.edu, Ram  
Gopal, Ramesh Sankaranarayanan

Blogs have recently received a lot of attention, especially in the business community, with a number of firms encouraging their employees to blog. Employee blogs can cast a firm in positive (negative) light, thereby enhancing (harming) the firm's reputation. Under certain conditions negative posts can actually help the overall reputation of the firm. The rationale is that negative posts raise the credibility of a blog and attract more readers, who then will also be exposed to the positive posts.

#### 2 - Brand Recognition in a Networked Digital World

Jeongha Cath Oh, University of Washington Business School,  
Box 353200, Seattle, WA, 98195-3200, United States,  
jhoh@u.washington.edu

Sustaining constant demand and achieving channel recognition are especially difficult for online portal sites. The popularity of individual content guarantees neither increased demand nor regular visits. In this paper, we analyze a dataset collected from YouTube.com. Setting the number of subscribers to a channel as the dependent variable, and individual network measures as independent variables, we investigate the dynamics of channel selection by users in networked digital channels.

#### 3 - Collaborative Software Development and the Small World Phenomenon

Param Vir Singh, University of Washington, 5000 22nd Ave NE  
#210, Seattle, WA, 98105, United States,  
psidhu@u.washington.edu

Software developers have traditionally worked in local clusters isolated within firms. The new paradigm of software development, open source, represents a system that allows flow of resources across clusters. With the advent of open source the formerly isolated clusters have become more massively connected networks. In this study, I find evidence that the networks that possess small world properties, high clustering and short average path length, are conducive for software development.

## SB18

### Computational Stochastic Programming

Sponsor: INFORMS Computing Society

Sponsored Session

Chair: Jeff Linderoth, University of Wisconsin-Madison,  
1513 University Avenue, Madison, WI, 53706-1572, United States,  
jtl3@lehigh.edu

#### 1 - Sequential Stopping Rules for Stochastic Programming

Guzin Bayraksan, Assistant Professor, University of Arizona,  
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guzinb@sie.arizona.edu

A critical component of Monte Carlo sampling-based methods is determining when to stop to ensure a desired quality of the solutions. In this talk, we present several rules to stop and increase the sample sizes. We discuss computational issues and compare the empirical performance of different stopping rules on problems from the literature. We also apply variance reduction techniques and test their effectiveness.

#### 2 - Sampling Approaches for Optimization with Probabilistic Constraints

Jim Luedtke, Georgia Institute of Tech., jluedtke@gatech.edu,  
Shabbir Ahmed, George Nemhauser

We study Monte Carlo sampling approaches for obtaining approximate solutions to optimization problems with probabilistic constraints. We show how sample approximation problems can be used to obtain feasible solutions and optimality bounds, without requiring the nominal optimization problem to be convex. We also study the rates of convergence of the approximations.

#### 3 - Branch-and-cut (BAC) Based Decomposition for SIP with Mixed-integer Variables in Both Stages

Yang Yuan, The Ohio State University, Industrial and Systems  
Engineering, Columbus, OH, United States, yuan.65@osu.edu,  
Suvrajeet Sen

A Branch-and-Cut approach to decomposition of SIP problems refers to a class of decomposition methods in which the cost-to-go value function is approximated through branching and cutting within the second stage IP. In this talk, we will discuss a method which allows branching based on objective functions in both stages.

## ■ SB19

### New Directions in Vehicle Routing

Sponsor: INFORMS Computing Society  
Sponsored Session

Chair: Bruce Golden, Professor, University of Maryland, Robert H. Smith School of Business, College Park, MD, 20742, United States, bgolden@rhsmith.umd.edu

Co-Chair: Edward Wasil, Professor, American University, Kogod School of Business, Washington, DC, 20016, United States, ewasil@american.edu

#### 1 - Vehicle Routing with Time Windows and Time-dependent

Rewards: A Problem from the American Red Cross

Jinxin Yi, SAS Institute, Inc., Cary, NC, United States,  
Jinxin.Yi@sas.com, Alan Scheller-Wolf

We describe a vehicle routing problem faced by the American Red Cross (ARC). ARC must decide from which sites to retrieve blood and how their shuttles should be routed in order to provide them with a sufficient amount of platelets at minimum transportation costs. The volume of blood received at a site is time-dependent. We develop a new approach to solve this problem optimally. Application to actual ARC data indicates potential savings of 60%.

#### 2 - A Hybrid Monte Carlo Local Branching Algorithm for the Single VRP with Stochastic Demands

Michel Gendreau, Université de Montreal, Montreal, Canada,  
michelg@crt.umontreal.ca, Walter Rei, Patrick Soriano

We present a new algorithm that uses both local branching and Monte Carlo sampling in a multi-descent search strategy for solving 0-1 integer stochastic programming problems. This procedure is applied to the single vehicle routing problem with stochastic demands. Computational results show the usefulness of this new approach to solve hard instances of the problem.

#### 3 - The Probabilistic Arc Routing Problem

Si Chen, Assistant Professor, Murray State University, CSIS,  
College of Business and Public Affairs, Murray, KY, 42071,  
United States, sichen80@gmail.com, Bruce Golden, Richard Wong,  
Hongsheng Zhong

We study the probabilistic arc routing problem that arises in the small package delivery industry. Each day, drivers traverse streets following a predetermined sequence. The streets that need to be visited vary daily. Our model produces a tour over all the streets, which is used to generate daily routes. We present heuristics for solving this problem.

#### 4 - Balanced Billing Cycles and Vehicle Routing of Meter Readers

Chris Groer, University of Maryland, AMSC Program,  
College Park, MD, 20742, United States, cgroer@comcast.net,  
Bruce Golden, Edward Wasil

Utility companies send their fleets of meter readers out on each day of the billing cycle to determine each customer's usage. Over time, customers are removed and others are added to the existing routes. A utility company must, therefore, adjust its meter-reading routes. We discuss this problem in this paper.

## ■ SB20

### Directions in Machine Learning and Reasoning

Sponsor: Decision Analysis  
Sponsored Session

Chair: Eric Horvitz, Principal Researcher, Microsoft Research, One Microsoft Way, Redmond, WA, United States, horvitz@microsoft.com

#### 1 - Streaming Intelligence: Machine Learning and Reasoning in Daily Life

Eric Horvitz, Principal Researcher, Microsoft Research,  
One Microsoft Way, Redmond, WA, United States,  
horvitz@microsoft.com

I will discuss how technical developments and trends are providing a fertile climate for integrating machine learning and reasoning into applications and services. I will review several illustrative efforts and prototypes that highlight promises with the flow of machine intelligence into daily life, including efforts in traffic forecasting, mobile commerce, search, operating systems, and call routing.

#### 2 - Models of Searching and Browsing: Studies and Applications

Douglas Downey, Doctoral Student, University of Washington,  
Box 352350, Seattle, WA, 98195, United States,  
ddowney@cs.washington.edu, Susan Dumais,  
Eric Horvitz

We describe the formulation, construction, and evaluation of predictive models of human information seeking from a large dataset of Web search activities. Utilizing machine learning techniques, we construct predictive models and

analyze which properties of users, queries, and search sessions are the most predictive of future behavior. We also discuss applications of the predictive models, focusing on the example of performing principled prefetching of content.

#### 3 - Towards Lifelong Machine Learning

Ashish Kapoor, Researcher, Microsoft Research, One Microsoft Way, Redmond, WA, 98052, United States,  
akapoor@microsoft.com, Eric Horvitz

We study principles of lifelong learning with following characteristics: continuous training over long periods, scarce informational resources and non-stationary environments. In such a system, the decision to extend a case library is made continuously by balancing cost of acquiring new information with benefit of increased predictive accuracy. The system adapts to underlying dynamics by caching and recalling information as context changes require. We review key concepts and real-world applications.

#### 4 - Probabilistic Index Maps: Capturing Structure of Natural Signals by Mining Their Self-similarity

Nebojsa Jojic, Senior Researcher, Microsoft Research, One Microsoft Way, Redmond, WA, United States, jojic@microsoft.com

One of the problems in modeling natural signals is that signals with very similar structure may locally have completely different measurements, e.g., images taken under different illumination conditions, or the speech signal captured in different environments. Rather than modeling a signal as an array or a matrix of local measurements, I will argue that interesting structure in signals is better captured when the signal is defined as a matrix whose entries are discrete indices to a separate palette of possible measurements.

## ■ SB21

### Joint Session DAS/ENRE: Decision Analysis and the Environment

Sponsor: Decision Analysis, Energy, Natural Res & the Environment  
Sponsored Session

Chair: Richard Anderson, Asst. Professor, Duke University, Nicholas Sch. of Environment, Box 90328, Durham, NC, 27708, United States, richard.anderson@duke.edu

#### 1 - Using Science and Decision Analysis to Set Water Quality Standards

Melissa Kenney, Water Quality Modeling and Decision Analysis,  
Duke University, Box 90328, Research Dr., LSRC A229, Durham,  
NC, 27705, United States, m.kenney@duke.edu, Robert Clemen,  
Ralph Keeney, Kenneth Reckhow, Craig Stow

One question states struggle with is how to set water quality standards; this is particularly difficult for eutrophication control since different levels of nutrients cause different waterbody responses. We developed a two-step procedure to set nutrient criteria: (1) we determined the most predictive measured variables using structural equation modeling, and (2) we assessed the optimal variable level using multiattribute utility analysis. The procedure was applied to lakes in North Carolina.

#### 2 - A Decision Analysis Framework for Water Quality Management Decision Support

Bill Labiosa, US Geological Survey, 345 Middlefield Rd, MS-531,  
Menlo Park, CA, 94025, United States, blabiosa@usgs.gov

I describe a decision analysis framework for evaluating water quality management strategies using: 1) causal Bayesian networks to predict outcomes; 2) penalty functions on targets; and 3) hypothesis variables to model highly uncertain aspects of the management problem. The framework allows the comparison of strategies, prioritization of studies, and the interpretation of new monitoring results in the context of hypotheses. Since the penalties are parametric, non-consensus is allowable.

#### 3 - Reconciliation of Inconsistencies in MAUT Weights

Richard Anderson, Asst. Professor, Duke University, Nicholas Sch. of Environment, Box 90328, Durham, NC, 27708, United States, richard.anderson@duke.edu, Robert Clemen

Multiple elicitations of MAUT weights by different methods is recommended decision-analytic practice, typically followed by attempts to reconcile any differences. An important question is what happens and what should happen during weight reconciliation. We address this issue, discussing previous research as well as results of a recent pilot study in an environmental decision context.

## ■ SB22

### DEA Theory & Application I

Cluster: Data Envelopment Analysis  
Invited Session

Chair: Joe Zhu, Worcester Polytechnic Institute, Dept. of Management, Worcester, MA, 01609, United States, jzhu@wpi.edu

Co-Chair: John Ruggiero, University of Dayton, 517 Miriam Hall, Dayton, OH, United States, John.Ruggiero@notes.udayton.edu

- 1 - Measuring Energy Efficiency in the Context of an Emerging Economy: The Case of Indian Manufacturing  
Kankana Mukherjee, Department of Management, Worcester Polytechnic Institute, 100 Institute Road, Worcester, MA, 01609, kmukher@wpi.edu

In recent years the Indian economy has been striving to achieve a rapid growth rate. However, one of the challenges facing the economy is the high levels of energy supply that would be needed to sustain this growth path. Hence attaining energy efficiency is crucial for the economy. This paper examines the Indian manufacturing sector and utilizes Data Envelopment Analysis to obtain comprehensive measures of performance given the joint goals of achieving GDP growth as well as energy conservation.

- 2 - Prevalence of Anchor Points in DEA  
Jose Dulá, Virginia Commonwealth University, School of Business, Richmond, VA, 23284, United States, jdula@vcu.edu, Marie-Laure Bougnol

Anchor points define the transition from the efficient frontier to the non-efficient part of the production possibility set. A recent realization is that these points are prevalent. We propose explanations for this phenomenon.

- 3 - Banking Efficiency with Stochastic Data  
John Ruggiero, University of Dayton, 517 Miriam Hall, Dayton, OH, United States, John.Ruggiero@notes.udayton.edu, Alex Totomanov, Erin Landers

We analyze the technical efficiency of U.S. banks while accounting for statistical noise. This is achieved by aggregation of panel data.

## ■ SB23

### Modeling Behavior in Operations with System Dynamics

Sponsor: Behavioral Process Management (BPM)  
Sponsored Session

Chair: Paulo Goncalves, Visiting Assistant Professor, MIT Sloan School of Management, 30 Wadsworth St. E53-339, Cambridge, MA, 02142, United States, paulog@mit.edu

- 1 - System Dynamics as a Structural Theory in Operations Management  
Andreas Groessler, Associate Professor, Radboud University Nijmegen, Nijmegen School of Management, Nijmegen, 6500 HK, Netherlands, a.groessler@fm.ru.nl

The purpose of the paper is to demonstrate the usefulness (1) of system dynamics as a structural theory for and (2) of system dynamics models as content theories in operations management. The key findings are that, although feedback loops, accumulation processes, and delays exist and are widespread in operations management, often these phenomena are ignored completely or not considered appropriately.

- 2 - The Dynamic Interaction of First- and Second-Order Improvement  
Brad Morrison, Assistant Professor, Brandeis International Business School, 415 South Street, Waltham, MA, 02454, United States, jbm@kurtsalmon.com

A mathematical model is developed to formalize the interaction between first-order improvements that boost output from existing processes and second-order improvements that enhance the capability of underlying processes. Results find tipping points in the dynamics of process improvement, identify perverse behaviors likely to thwart the intentions of practitioners, and show how the feedback structure of process improvement presents challenges to manage the dual pressures to produce and improve.

- 3 - Project Screening Biases in a Product Development Pipeline  
Nitín Joglekar, Boston University, Boston, MA, United States, joglekar@bu.edu, Paulo Figueiredo

Product development pipelines, a special case of a service supply chain, suffer from the backlog bullwhip effect. We illustrate that screening can eliminate such backlog bullwhip. Statistical analysis of simulation results addresses a range of relevant decisions for a two-stage pipeline: the number of starts, screen thresholds, global biases towards frontloading the available resources and local biases while adjusting capacity utilization.

- 4 - Over-ordering and Channel Stuffing: Behavioral Causes of Product Returns  
Paulo Goncalves, Visiting Assistant Professor, MIT Sloan School of Management, 30 Wadsworth St. E53-339, Cambridge, MA, 02142, United States, paulog@mit.edu

We study the problem of channel stuffing, caused by sales force attempts to meet short term individual objectives (e.g. meeting quarterly quotas) to the detriment of long term company goals (e.g., low transportation, returns, obsolescence costs), by developing a formal dynamic model of the interaction of sales effort allocation and channel stuffing and retailer over-ordering behavior through a model-based field study of the agribusiness industry.

## ■ SB24

### Software Demonstration

Cluster: Software Demonstrations  
Invited Session

- 1 - Ziena Optimization, Inc. - Recent Developments in the KNITRO Optimization Solver  
Richard Waltz, President, Ziena Optimization, Inc, 1801 Maple Ave, Evanston, IL, 60201, United States, waltz@ziena.com

This software demonstration will highlight recent developments in the KNITRO optimization solver. Particular attention will be paid to new techniques being developed for handling mixed-integer nonlinear programs (MINLP). The demo will also provide an overview of how to effectively use KNITRO in a variety of environments and applications.

- 2 - Lumina Decision Systems, Inc. - Analytica: What It Does That Spreadsheets Can't  
Max Henrion, Lumina Decision Systems, Inc., 26010 Highland Way, Los Gatos, CA, 95033, henrion@lumina.com

A rare chance to see Analytica demonstrated by its originator: users prefer Analytica to spreadsheets because of its transparency, flexibility for multiple dimensions, efficient Monte Carlo, scalability and its powerful new Optimizer. Analytica models are typically 10 to 100 times more compact than equivalent spreadsheets, and correspondingly easier to build, understand and audit.

## ■ SB25

### Panel Discussion: Technology Management in the Service Sector

Sponsor: Service Science  
Sponsored Session

Chair: Ruoyi Zhou, Management of Very Complex Service Systems, IBM, 650 Harry Road, San Jose, CA, 95120, United States, ruoyi@us.ibm.com

- 1 - Panel Technology Management in the Service Sector – Results of the PICMET 07 Symposium  
Moderator: Antonie Jetter, Assistant Professor, Portland State University, P.O. Box 751, Eng. & Tech. Management, Portland, OR, 97207, United States, jettera@cecs.pdx.edu, Panelist: Tugrul Daim

During the 2007 PICMET conference on Technology Management, NSF sponsored a one day symposium on Technology Management in the Service Sector. Practitioners from service industries and researchers in technology management discussed critical research needs in the management of complex, technology-based service systems and jointly outlined future research directions. The key result of the symposium and its final report to NSF will be presented in the talk.

## ■ SB26

### Joint Session DM/ICS/Computational Methods for Data Mining: Statistical Modeling and Machine Learning Algorithms for Data Mining

Sponsor: Data Mining (Sponsored), INFORMS Computing Society, Computational Methods for Data Mining  
Sponsored Session

Chair: Seoung Bum Kim, Assistant Professor, University of Texas at Arlington, 420K Woolf Hall, Arlington, TX, 76001, United States, sbkim@uta.edu

#### 1 - Gaussian Process Models with Qualitative and Quantitative Factors

Zhiguang Qian, Assistant Professor, University of Wisconsin at Madison, zhiguang@stat.wisc.edu

Gaussian process models are prevalent in data mining applications. In this work, we extend such models to accommodate both qualitative and quantitative factors. The proposed methodology is illustrated with some real examples.

#### 2 - Identifying Account Sharing Through Keystroke Dynamics Analysis

Sungzoon Cho, Professor, Seoul National University, Seoul, Korea, Republic of, zoon@snu.ac.kr, Seong-Seob Hwang

When online accounts are shared by users, the service provider suffers from lost revenue, membership under-estimation, and impaired customer understanding. In this work, we propose a biometric based approach. Whenever a user types a password for login, keystroke dynamics is measured and collected. An optimal number of clusters is estimated and then the account is classified as shared if it is larger than 1. An experiment involving 25 passwords and 16 users results in 60% to 90% accuracy.

#### 3 - A New Recursive Family of Discrete Power-series Distributions

Bill Corley, Professor, IMSE Dept., The University of Texas at Arlington, Box 19017, Arlington, TX, 76019, United States, corley@uta.edu, Seoung Bum Kim

A new recursive family of discrete power-series distributions involving the generalized hypergeometric function is proposed. The general probability mass function, mean, variance, and probability generating function are given. New extensions of the Poisson, negative binomial, log-series, uniform, binomial, and hypergeometric distributions with an additional parameter are presented as examples.

#### 4 - A General Framework for Monitoring of Dynamic Systems

Kwok-Leung Tsui, Professor, H. Milton Stewart School of Industrial & Systems Engineering, Georgia Institute of Technology, Atlanta, GA, United States, ktsui@isye.gatech.edu, Wei Jiang

This talk discusses strategies and techniques in data modeling, forecasting, and activity monitoring. We will propose a general strategy for modeling, forecasting, and monitoring of dynamic systems. In particular, we will discuss a statistical process control approach for business activity monitoring. We will also discuss a churn detection procedure for customer profile modeling. Some case studies in telecom and service industries will be used to illustrate the proposed methods.

## ■ SB27

### Optimization and Statistical Approaches to Data Mining

Cluster: Data Mining (Invited)  
Invited Session

Chair: Theodoros Evgeniou, INSEAD, Bd de Constance, Fontainebleau, France, theodoros.evgeniou@insead.edu

#### 1 - Global Optimization and Landscape Analysis for Clustering

Jeffrey Heath, Visiting Assistant Professor, Centre College, 600 West Walnut Street, Danville, KY, 40422, United States, jheath@math.umd.edu, Michael Fu, Wolfgang Jank

We investigate the fitness landscape of clustering problems and provide evidence for why clustering via Gaussian mixtures is a difficult global optimization problem. One of the classical approaches, the Expectation-Maximization algorithm, produces clusters that are only locally optimal. We introduce a new algorithm based on Model Reference Adaptive Search. Numerical experiments illustrate the effectiveness of the proposed algorithm in finding global optima, thereby improving the clustering task.

#### 2 - Information Acquisition in Cost Sensitive Environments

Maytal Saar-Tsechansky, Assistant Professor, University of Texas at Austin, 1 University Station, Austin, TX, 78712, United States, Maytal.Saar-Tsechansky@mcombs.utexas.edu

As a data-driven paradigm data mining relies on the availability of data to derive patterns. Traditional data mining and machine learning does not consider acquisition of information that can be used for pattern induction or inference. In many applications, however, the traditional scenario is too simplistic. The talk discusses recent work on information acquisition policies designed to improve a variety of objectives including prediction accuracy and other decision tasks.

#### 3 - Variational Inference for Large-scale Models of Discrete Choice

Jon McAuliffe, University of Pennsylvania, Wharton School, jon@mcauliffe.com, Michael Braun

We introduce variational methods for discrete-choice models, to conduct inference when datasets are too large for MCMC. Rather than using stochastic approximation, variational methods return a deterministic estimator of known functional form. The variational parameters approximate the posterior distribution more parsimoniously than MCMC, and are quicker to compute. The method avoids concerns like assessing MCMC convergence. We derive the algorithm, discuss some theory, and give results.

#### 4 - Convex Optimization Methods for Understanding Customers Preferences and Recommending Products

Theodoros Evgeniou, INSEAD, Bd de Constance, Fontainebleau, France, theodoros.evgeniou@insead.edu

We present two methods for analyzing customer data using optimization and regularization theory. The first extracts a few product features that are important for all people. The second is a generalization of the first that also generalizes well-known methods for collaborative filtering for product recommendations. Experimental results and theoretical justifications show the potential, relative to state of the art methods, of regularization for parameter estimation using optimization techniques.

## ■ SB28

### Multiple Solutions for Combinatorial Problems

Sponsor: INFORMS Computing Society/ Metaheuristics  
Sponsored Session

Chair: Emilie Danna, ILOG, Inc., 889 Alder Avenue, Suite 200, Incline Village, NV, 89451, United States, edanna@ilog.com

#### 1 - Structural Similarity Measures for the VRP

Arne Lokketangen, Arne.Lokketangen@hiMolde.no, David Woodruff

A decision maker might be equally interested in a set of different, good solutions, than in just the optimal solution. There is thus a need to distinguish between good solutions, based on some other concept than quality alone. We produce measures of difference of the type proposed in the Psychology literature. We suggest several such functions for the class of VRP problems, basing our difference on the underlying structure of solutions.

#### 2 - Diversity of Solutions: Methods and Applications

Stefan Voss, University of Hamburg (IWI), Institute of Information Systems, Von-Melle-Park 5, Hamburg, DE, 20146, Germany, stefan.voss@uni-hamburg.de, Peter Greistorfer

Recently considerable interest has been on finding solutions with good objective function values that are different from each other. Based on applications from telecommunications (e.g., 1+1 protection and fault tolerance in the SDH/WDM context), transportation (e.g., minimizing waiting time of transfer passengers) and evolutionary algorithms we illustrate the need for diverse solutions. Methods to determine them are based on MIP formulations as well as effective tabu search implementations.

#### 3 - Selecting a Small Set of Diverse Solutions to Mixed Integer Programming Problems

David Woodruff, Professor, University of California, GSM, One Shields Avenue, Davis, CA, 95616, United States, dlwoodruff@ucdavis.edu, Emilie Danna

When solving a mixed-integer programming model, it is useful to obtain multiple feasible solutions of good quality rather than just one optimal solution. However, it is often impractical in applications to make use of a very large number of solutions. Instead, a small set of diverse solutions is more valuable. Given an oracle that generates a large number of solutions (CPLEX), we introduce several algorithms to select a small subset of solutions with high diversity.

## ■ SB29

### Interfacing to Coin-OR

Sponsor: INFORMS Computing Society/ICS/COIN-OR  
Sponsored Session

Chair: Bjarni Kristjansson, President, Maximal Software, Inc., 2111 Wilson Boulevard, Suite 700, Arlington, VA, 22201, United States, bjarni@maximalsoftware.com

#### 1 - Stochastic Modeling Interface for COIN-OR

Alan King, IBM Thomas J Watson Research Center, P.O. Box 218, Yorktown Heights, NY, 10598, United States, kingaj@us.ibm.com

This talk presents current status and planned initiatives in the open-source COIN-OR repository [www.coin-or.org](http://www.coin-or.org). COIN-OR now contains a repository for stochastic modeling called Stochastic Modeling Interface, or SMI. Currently, SMI contains example code that converts (some version of) SMPS format to Open Solver Interface (OSI) compatible solvers — including CIP, CPLEX, FortMP, GLPK, Mosek, and Xpress-MP, among others.

#### 2 - COIN-OR/GAMSLinks: Hooking Your Solver to GAMS

Steven Dirkse, GAMS Development Corp., 1217 Potomac St NW, Washington, DC, 20007, United States, sdirkse@gams.com, Stefan Vigerske, Michael Bussieck

The GAMSLinks project at COIN-OR is dedicated to the development of links between GAMS and open source (e.g. COIN-OR) solvers. These links broaden the audience for COIN-OR solvers and provide solver developers with the quality assurance and benchmarking tools that come with GAMS. We show how to use the GAMSLinks project, highlight non-standard features of the present interfaces, give a short introduction on how to link your own solver to GAMS, and speculate about future developments.

#### 3 - CoinMP: Simple C-API Windows DLL Implementation of CLP, CBC, and CGL

Bjarni Kristjansson, President, Maximal Software, Inc., 2111 Wilson Boulevard, Suite 700, Arlington, VA, 22201, United States, bjarni@maximalsoftware.com

The COIN Open Source Initiative has become very popular in the recent years. To make life easier for users that simply want to solve models and not compile C++ applications, we have developed standard C-API Windows DLL CoinMP.DLL that implements most of the functionality of CLP, CBC, and CGL.

## ■ SB30

### Design and Analysis of Reliability Testing

Sponsor: Quality, Statistics and Reliability  
Sponsored Session

Chair: Rong Pan, Assistant Professor, Arizona State University, Department of Industrial Engineering, Tempe, AZ, 85287, United States, Rong.Pan@asu.edu

#### 1 - Optimal Design of Reliability Tests for Multiple Stresses

Rong Pan, Assistant Professor, Arizona State University, Department of Industrial Engineering, Tempe, AZ, 85287, United States, Rong.Pan@asu.edu, Huairui Guo

In this talk, we first review the optimal designs of single stress reliability tests and two-stress reliability tests, which is based on a degenerated single stress design. D-optimal design for multiple-stress reliability tests is then proposed for completed and censored data. Examples are provided for demonstrating the proposed method.

#### 2 - Non-linear Experimental Design Considerations for Reliability Testing with Censoring

Eric Monroe, Statistician, Intel Corporation, 5000 W. Chandler Blvd, Mailstop CH2-117, Chandler, AZ, 85226-3699, United States, eric.m.monroe@intel.com

Use Condition assessments for reliability typically require fitting an empirical model based on accelerated testing and extrapolating results to a less severe environmental condition. This presentation explores the importance of experimental design selection in fitting non-linear response surfaces for reliability testing with heavy censoring. Sensitivity analysis for sample size and interval sampling will be examined through a numerical study and compared to alphabetic optimization techniques.

#### 3 - Explore Equivalence of Accelerated Testing Plans Using a Principal Stress Decomposition Approach

Haitao Liao, Assistant Professor, Wichita State University, 1845 Fairmount St., Industrial & Manufacturing Eng Dept., Wichita, KS, 67260-0035, United States, haitao.liao@wichita.edu, Elsayed Elsayed, Zhaojun Li

One challenge in ALT is to determine an efficient stress profile. We explore the equivalence of various ALT plans involving complex stress profiles. A stress decomposition approach is investigated, which decomposes a complex stress profile into principal stress elements. From the results, equivalent optimal test plans can be determined and optimized. The research finding is validated through a resistor ALT experiment involving both electrical and thermal stresses.

#### 4 - Reliability Performance of Repairable Systems

Wendai Wang, Senior Reliability Methods Manager, Applied Materials, 3320 Scott Blvd., M/S 1117, Santa Clara, CA, 95052, United States, wendai\_wang@amat.com

Many systems are indeed repairable in service. Reliability methodologies for repairables are so incomplete. Most engineering practices were adopted from non-repairable systems. Many assumptions are used consciously or unconsciously. This talk will review the existing methodologies for repairable systems, present studies on the TBF/TTR of the repairable systems, and provide some conclusions. The presentation is also intended to prompt more researches on reliability of repairable systems.

## ■ SB31

### Joint Session HAS/Service Science: Quality and Statistical Decision-making in Healthcare Applications I

Sponsor: Quality, Statistics and Reliability, Health Applications Section, Service Science

Sponsored Session

Chair: Jing Li, Arizona State University, Tempe, AZ, United States, jinglz@umich.edu

Co-Chair: Julie Simmons Ivy, jsimmons@bus.umich.edu

#### 1 - Policies for Prevention and Cure of Cervical Cancer Caused by Human Papilloma Viruses

Natarajan Gautam, Associate Professor, Texas A&M University, 235A Zachry, Mailstop 3131, College Station, TX, 77843, United States, gautam@tamu.edu, Piyush Goel, Hoda Parvin

We consider health care policy issues for prevention and cure of cervical cancer caused by Human Papilloma Virus (HPV) for which individuals can be tested and also given vaccinations. Policymakers are faced with the decision of how many cancer treatments to subsidize, how many vaccinations to be given and how many tests to be performed in each period of a given time horizon. We formulate and heuristically solve a Markov decision process to aid the decision-making.

#### 2 - Theoretical Errors for Individual Measurements, Motivated by Models of Flu Activity

Justin Chimka, University of Arkansas, 4207 Bell Engineering, Fayetteville, AR, United States, jchimka@uark.edu, Jia Zhou

Consider situations in which the sample used for process monitoring consists of an individual unit. Our motivation comes from regression model-based control charts for influenza activity, where individual units are absolute values of residuals assumed to have come from gamma distributions. We have developed probability statements for computing true errors associated with statistical process control of continuously distributed individual measurements.

#### 3 - Algorithm Combination for Improved Performance in Biosurveillance

Inbal Yahav, University of Maryland, Robert H Smith School of Business, College Park, MD, United States, iyahav@rhsmith.umd.edu, Galit Shmueli

Statistical research on disease outbreak detection using syndromic data has focused on modeling background behavior and anomaly detection. Such data contain known patterns and thus algorithms often comprise of initial preprocessing before monitoring the resulting residuals using SPC. Most studies combine one preprocessing technique and one control chart. Our approach combines algorithms via LP: We propose a method for combining preprocessing algorithms and one for combining control charts.

## ■ SB32

### Global Logistics Management

Cluster: Shipping, Maritime, and Supply Chain Logistics  
Invited Session

Chair: Kee-hung Lai, Assistant Professor, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China, lgtmlai@polyu.edu.hk

- 1 - Evaluating Marketing Strategies for International Logistics Zones in Taiwan  
Chin-Shan Lu, Professor, Cheng Kung University, No 1, University Road, Tainan, 701, Taiwan - ROC, luks@mail.ncku.edu.tw

This research empirically evaluates marketing strategies of international logistics zones in Taiwan. Results suggest simplified customs procedures as the most important criterion, followed by efficiency of port operations, port facilities, geographic location, and tax incentives. Theoretical and practical implications of the research findings are discussed.

- 2 - An Integrated Model for Ship Routing and Berth Assignment with Transshipments  
Anthony Pang, Lecturer, The Hong Kong Polytechnic University, M613, Li Ka Shing Tower, Department of Logistics, Hung Hom, HK, Hong Kong - ROC, lgtapang@polyu.edu.hk,  
Chung-Lun Li

Shipping companies that offer feeder services often seek to coordinate their ship routing and berthing operations. In this work, we consider an integrated model to support joint decisions in ship routing and terminal berth assignment, with some terminals serving as transshipment facilities. We propose a mathematical programming based heuristic, together with column generation techniques and local improvement schemes, for solving the problem.

- 3 - Characteristics and Trends of the Third Party Logistics Market in Mainland China  
Mei Sha, Associate Professor and Deputy Director of Logistics Management Program, Shanghai Maritime University, 1550 Pudong Dadao, Shanghai, 200135, China, meissha@cct.shmtu.edu.cn

The paper presents the characteristics and trends of the third party logistics (3PL) Market in Mainland China on the basis of identifying the main factors contributing to the China's logistics development, analyzing 3PL market from demand and supply perspective respectively and putting forward 3PL market structure in Mainland China.

## ■ SB33

### Urban Transportation Planning Models II: Dynamic Routing with Real-time ITS Information

Sponsor: Transportation Science & Logistics  
Sponsored Session

Chair: Alper Murat, Assistant Professor, Wayne State University, 2051 Manufacturing Engineering Bldg., 4815 Fourth St., Detroit, MI, 48202, United States, amurat@wayne.edu

- 1 - Dynamic Traffic Rerouting with Feedback Loop from Infrastructure  
Andrew Even, M.S. Candidate, Grand Valley State University, 301 W Fulton Street, Grand Rapids, MI, 49504, United States, akeven@gmail.com, Shabbir Choudhu, Charles Standridge

In near future, intelligent transportation system will allow real time feedback to the vehicles traveling in a particular route. In case of a distress condition in the downstream, this algorithm will compute the most cost effective route to get back to the original travel path based on the overall traffic conditions in the surrounding arterial routes.

- 2 - Enabling Congestion Avoidance in Stochastic Transportation Networks Under ATIS  
Ali Guner, PhD Candidate, Wayne State University, 4815 Fourth St., WSU Industrial Eng., Detroit, MI, 48201, United States, arguner@wayne.edu, Madhusalini Saripalle, Ratna Babu Chinnam, Alper Murat

In JIT manufacturing environments, on-time delivery is the key performance measure for dispatching and routing of freight vehicles. In this study, we propose exact and heuristic solution approaches for dynamic vehicle routing. Our basic model is a non-stationary stochastic shortest path problem which uses both real-time recurring congestion and incident information. We present computational results for several network scenarios.

- 3 - Modeling Incidents for Dynamic Vehicle Routing Applications  
Madhusalini Saripalle, PhD Candidate, Wayne State University, 471, Kensington Dr., Apt#228, Rochester Hills, MI, 48307, United States, madhusalini@wayne.edu, Ali Riza Guner, Ratna Babu Chinnam, Alper Murat

Over 50 percent of travel time delays are accountable to non-recurrent congestion such as incidents. Despite its importance, state-of-the-art dynamic routing algorithms assume away the effect of these incidents on travel time. We propose alternative models to estimate incident induced delays which can be integrated with dynamic routing algorithms. These models use real-time information from various ITS sources, such as loop-sensors.

- 4 - Web Based Data Repository for Collaboration Among ITS Researchers  
Visnu Yada, M.S. Candidate, Grand Valley State University, 301 W Fulton Street, Grand Rapids, MI, 49504, United States, vishnu\_yada@yahoo.com, Shabbir Choudhu, Charles Standridge

The overall growth in the transportation network, new development in vehicle to vehicle and vehicle to infrastructure communications, and demand for safety has considerably increased the research activity in the related fields. In order to produce the maximum effect, it is essential to provide collaboration opportunities among researchers. This presentation addresses the issue of collaboration over the internet.

## ■ SB34

### Vehicle Routing

Sponsor: Transportation Science & Logistics  
Sponsored Session

Chair: Maciek Nowak, Assistant Professor, Georgia Southern University, P. O. Box 8154, Statesboro, GA, 30460, United States, mnowak@georgiasouthern.edu

- 1 - Capacitated Period Routing  
David Ronen, Professor of Logistics and Operations Management, University of Missouri-St. Louis, 214 Computer Center Bldg., One University Boulevard, St. Louis, MO, 63121-4499, United States, david.ronen@umsl.edu

With increased productivity and expanding demand less and less spare capacity is available in operations. We designed a system for planning store deliveries at a major retailer. This is a Period (Vehicle) Routing Problem with tight constraints on DC picking volume and on transportation capacities. We took a three-stage approach, at the core of which is an ILP model for assigning store clusters to weekly delivery patterns.

- 2 - Effects on Benefit of Split Loads for the Pickup and Delivery Problem  
Maciek Nowak, Assistant Professor, Georgia Southern University, P. O. Box 8154, Statesboro, GA, 30460, United States, mnowak@georgiasouthern.edu, Chip White, Ozlem Ergun

A decrease in cost has been shown when split loads are allowed for the Pickup and Delivery Problem. We show how the following effect the benefit of split loads: load size, load size variability, origin and destination clustering, and the frequency with which loads share origins or destinations. These effects are shown for both randomly generated problem instances and a real world case.

- 3 - Approximations to the Length of VRP Problems  
Miguel Figliozzi, Assistant Professor, Portland State University, 1930 SW 4th Avenue, Suite 200, Portland, OR, United States, figliozzi@pdx.edu

This presentation discusses approximations to the length of Vehicle Routing Problems (VRP). Formulas to approximate the length of vehicle routes are proposed. Instances with different patterns of customer spatial distribution, time windows, customer demands, and depot locations are used to test the proposed approximations. Expressions for the incremental cost of serving an additional customer or increasing the number of routes are derived and estimated.

- 4 - Branch-and-price for Dynamic Drayage Vehicle Routing Problem  
Guangming Zhang, Northwestern University, 2145 Sheridan Rd C231, Evanston, IL, 60201, United States, g-zhang@northwestern.edu, Alan Erera, Karen Smilowitz

This research explores the dynamic nature of drayage operations. A linear approximation function is embedded in the stochastic formulation to quickly calculate the recourse cost, and a branch-and-price solution method along time horizon is applied to provide timely schedules as well as strategies for practical implementation.

## ■ SB35

### Crossdocks and Warehouses

Sponsor: Transportation Science & Logistics  
Sponsored Session

Chair: Hector Carlo, Assistant Professor, University of Puerto Rico - Mayaguez, Department of Industrial Engineering, P.O. Box 9043, Mayaguez, PR, 00981, Puerto Rico, hcarlo@uprm.edu

#### 1 - Order Batching and Vehicle Selection in a Parallel-aisle

Warehouse with Time-Constraints  
Soondo Hong, PhD Student, Dept. of Industrial and Systems Engineering, Texas A&M University, 241 Zachry, 3131 TAMU, College Station, TX, 77843, United States, hong@s.tamu.edu, Brett Peters

We present a small-item order batching model in a parallel-aisle warehouse with multiple constraints and vehicles. An order picker repeatedly travels and collects orders with fixed cycle time and capacity limit. A branch-and-price algorithm is developed for selecting vehicle technologies and batching orders to minimize the total picking time using the S-shape strategy.

#### 2 - Optimal Inbound Trailer Allocation at a Crossdock - Optimizing Operations and Balancing Workload

Claudia Rosales, University of Cincinnati, 523 Lindner Hall  
P.O. Box 210130, Cincinnati, OH, 45221, United States, rosalecr@email.uc.edu, Michael Fry, Rajesh Radhakrishnan

Transfreight, LLC is a third-party logistics provider that supports Toyota's lean manufacturing operations in North America. Our work provides the optimal allocation of inbound trailers to docks at a crossdocking facility operated by Transfreight. We focus on improving the efficiency of operations as well as balancing workload among crossdock workers. Model implementation is performed using both a spreadsheet-based solver and CPLEX. The advantages/disadvantages of each option are discussed.

#### 3 - Cross-dock Design and Door Assignment Properties

Hector Carlo, Assistant Professor, University of Puerto Rico - Mayaguez, Department of Industrial Engineering, P.O. Box 9043, Mayaguez, PR, 00981, Puerto Rico, hcarlo@uprm.edu, Yavuz Bozer

We examine the optimal shape of a rectangular cross-dock and the best door locations relative to travel distances. Also, several properties of optimal outbound trailer-to-door assignments are identified for certain types of flows. Results for some properties pertaining to alternating doors assignments, and volatile and narrow range trailers are presented.

## ■ SB36

### Transportation II

Contributed Session

Chair: L Douglas Smith, Professor, University of Missouri-St. Louis, One University Blvd., St. Louis, MO, 63121, United States, ldsmith@umsl.edu

#### 1 - Strategies for Pruning Stochastic Dynamic Networks:

An Application to Hazmat Route Selection Problem  
Sumeet Desai, University of Houston, 4800 Calhoun Rd, Houston, TX, 77054, United States, sdesai5@uh.edu, Gino Lim

We propose three strategies for pruning stochastic dynamic networks to expedite the process of obtaining optimal routing policies. The strategies for reducing the network size include: use of static upper/lower bounds, preprocessing, and a mix of pre-processing and upper/lower bounds. Our experiments show that while finding optimal routing policies in stochastic dynamic networks, last two of the three strategies have a significant computational advantage over dynamic programming.

#### 2 - Travel Time Estimation Using Regression Trees

Rasaratnam Logendran, Professor, Oregon State University, Dept. of Industrial and Mfg. Engr., 118 Covell Hall, Corvallis, OR, 97331-2407, United States, logendrr@engr.orst.edu, Lijuan Wang, Lei Zhang

We report the use of regression trees for reliably estimating travel times on road segments. Several independent variables are considered to include flow rate and occupancy, along with incidents, work zones and weather for non-recurring congestion, and time of day and day of week for recurring congestion. The loop-detector data on PORTAL, for the I5-I205 loop in Portland, Oregon, is used to demonstrate the applicability of regression trees even when the independent variables are correlated.

#### 3 - Neural Networks for Mode Choice for Long Distance Travel in the USA

Isaradatta Rasmidatta, Wilbur Smith Associates, 4925 Greenville Avenue, Suite 1300, Dallas, TX, 75206, United States, Irasmidatta@wilbursmith.com

Long distance travel (more than 50 miles) has been rapidly increasing every year due to economic growth and activity. In order to improve infrastructure investment strategies and their accuracy, the characteristics that influence long-distance trips in USA are analyzed by Neural Networks to specify mode choices.

#### 4 - A Scheduling Model for the Marshalling Station

Shidong Wang, Department of Industrial Engineering, Tsinghua University, Beijing, 100084, China, ws03@mails.tsinghua.edu.cn

In Chinese marshalling station, the freight cars will be broken-up or made-up indicated by three scheduling plans with different time horizon: 1.daily plan is a master plan which will consider the capacity of a marshalling station; 2.stage plan is a detail plan which determines the detail sequence of the broken-up or made-up trains for the next 3 or 4 hours; 3. shunting operation plan determines how to break up or make up a specific train. These plans have to consider the resources such as the cars, tracks, locomotives, hump and so on. Up to now, these plans are generated by handwork, in the paper we try to establish two mathematic models according to the decision process of generating these plans: 1.the dispatching model which is applied to the car flow dispatching process; 2. single machine scheduling:1/tj/Eu which is used for the decision of break-up or make-up sequence. The objective is to minimize the total detention time of inbound cars. By analyzing the complexity of these models, we propose the heuristic algorithm to solve the problems efficiently for the marshalling station. Finally, we introduce a prototype of decision support system to implement the algorithm of models.

#### 5 - Scheduling To Improve System Performance in a Series of River Locks

L Douglas Smith, Professor, University of Missouri-St. Louis, One University Blvd., St. Louis, MO, 63121, United States, ldsmith@umsl.edu, Dirk C. Mattfeld, Robert Naus

A series of five locks form a transportation bottleneck in the upper Mississippi River navigation system. Scheduling operations for immediate efficiency at individual locks creates problems upstream or downstream and favors some users over others. With computer simulation, we show the effects of scheduling lockage operations with differential consideration to immediate efficiency, future flexibility, and user equity.

## ■ SB37

### Military OR Applications

Sponsor: Military Applications  
Sponsored Session

Chair: James Moore, The Air Force Institute of Technology, AFIT/ENS Bldg 641, 2950 Hobson Way, Wright-Patterson AFB, OH, 45433-7765, United States, james.moore@afit.edu

#### 1 - Classifying Hyperspectral Imagery via a Novel Method for Augmentation by Contextual Information

Robert Brigantic, Pacific Northwest National Laboratory, 902 Battelle Blvd., P.O. Box 999, Richland, WA, 99352, United States, robert.brigantic@pnl.gov, Lawrence Chilton

This presentation summarizes a method for improved performance of Bayesian classifiers for hyperspectral imagery via a novel method for augmentation by considering contextual information. In particular, we present the use of a modified form of the Iterated Conditional Modes (ICM) method. We show this method can significantly outperform standard Bayesian classification techniques. We then generalize this modified approach for performing hyperspectral imagery classification.

#### 2 - Up, Up, and Away: A Network Flow Approach to a Pilot Scheduling Problem

Anthony Illig, Air Force Institute of Technology, AFIT/ENS, Bldg 641, 2950 Hobson Way, Wright-Patterson AFB, OH, 45433-7765, United States, Anthony.Illig@afit.edu, August Roesener

We present a network flow linear program to schedule newly commissioned United States Air Force pilots into initial skills training. The solution schedules pilots graduating from different sources at different times to one of each of the courses in the initial skills training sequence: Air and Space Basic Course, Introductory Flight Screening and Undergraduate Pilot Training. The goal of the optimization is to minimize the total number of unproductive days students spend waiting for training.

### 3 - The Advanced Collaborative System Optimization Model (ACSOM)

Doug Rogers, General Dynamics Land Systems, 38500 Mound Rd., Sterling Heights, MI, 48310, rogersd@gdls.com, Gregory Hartman, Michael Donnell, Jeffrey Czerniak, Stephen Rapp

ACSOM is a tool that mathematically optimizes models representing systems using multi-criteria mathematical optimization (binary). Due to the conflicting nature of criteria there is no single solution that would optimize all objectives simultaneously; a set of optimal non-dominated solutions known as Pareto solutions are determined. ACSOM has been applied to the M-1 Abrams System Enhancement, Future Combat Systems Manned Ground Vehicle and the Marine Corps Expeditionary Fighting Vehicle.

### 4 - Optimization Challenges to Layered Sensing for Persistent ISR

Djuana Lea, Operations Research Analyst, Air Force Research Lab/Sensors Directorate, 2241 Avionics Circle, AFRL/SNAT, Bldg 620, Rm 3BW74, WPAFB, OH, 45433, United States, djuana.lea@wpafb.af.mil, Juan Vasquez, Barry Secrest, Olga Mendoza

The Sensors Directorate of AFRL has initiated research in the area of Layered Sensing that seeks to integrate the sensing, processing and control of sensor assets operating at various altitudes and resolutions. We will present an overview of layered sensing and the optimization challenges associated with its implementation. Specifically, optimization problems in the areas of cooperative control, sensor resource management, and algorithm resource management will be addressed.

## ■ SB38

### Marketing II

Sponsor: Marketing Science  
Sponsored Session

Chair: Gary Erickson, Professor, University of Washington Business School, Box 353200, Seattle, WA, 98195-3200, United States, erick@u.washington.edu

### 1 - An Analysis of Inflationary and Competitive Click Fraud

Kenneth Wilbur, Assistant Professor of Marketing, University of Southern California, Marshall School of Business, 3660 Trousdale Parkway, ACC 306E, Los Angeles, CA, 90089, United States, kwilbur@marshall.usc.edu, Simon Anderson, Yi Zhu

We use an analytical model to investigate the effects of click fraud. We find three main results. First, when inflationary click fraud is deterministic and known to both firms, it does not alter the auction outcome, firms' advertising costs, or gatekeeper revenues. Second, when inflationary click fraud is stochastic, the high bidder may reduce its budget to hedge against high levels of invalid clicks. Third, we show that competitive click fraud may increase or decrease gatekeeper revenues.

### 2 - Quality and Advertising in a Vertically Differentiated Market

Elie Ofek, Associate Professor, Harvard Business School, Boston, MA, 02163, United States, eofek@hbs.edu, Zsolt Katona

We examine firms' quality positions when consumers only consider products they are aware of. Under blanket advertising, we identify conditions for one firm to choose a high quality product, but because its rival positions close by, it selects a low ad expenditure to avoid fierce price competition. Under targeted advertising, we identify conditions such that both firms choose high quality products, but advertise to different segments. This can result in a middle pocket of unserved consumers.

### 3 - Product Durability and Channel Choice Under Extended Producer Responsibility

Sudheer Gupta, Simon Fraser University, 8888 University Drive, Burnaby, BC, Canada, sudheerg@sfu.ca, Ravi Subramanian

As environmental concerns mount, an increasing number of durable goods fall under the umbrella of extended producer responsibility (EPR). We examine the impact of EPR policies on manufacturers' choice of optimal product durability and channel coordination incentives. We show how some commonly used contractual forms, such as two-part tariffs, quantity discounts, leasing, and buy-backs perform under EPR and their effect on the manufacturer's incentive to practice planned obsolescence.

### 4 - Optimal Pricing and Advertising Policies for an Entertainment Event

Steffen Jorgensen, Department of Business and Economics, University of Southern Denmark, Odense, Denmark, stj@sam.sdu.dk, Peter M. Kort, Georges Zaccour

The paper determines optimal pricing and advertising policies for an entertainment event, taking into account diffusion effects and a last-minute market. We consider a setup where period-by-period constant prices are combined with continuous advertising. The organizers of the event sell tickets at regular price and advertise the event during an initial period of time. If tickets

are not sold out by the end of this period, there is a last (short) period before the event in which tickets are sold at a reduced price. In this period no advertising is done. We find that advertising should be decreased over time, as word-of-mouth communication becomes more intensive. Depending on the values of the model parameters, it may be optimal not to advertise at all, to advertise at a positive rate until the end of the regular sales period, or to stop advertising at some earlier instant of time. If word-of-mouth effects are absent, advertising (if any) should be done at a uniform rate. In the last-minute sales period, the organizers implement a feedback pricing policy such that the selected price depends on the number of tickets that have been sold in the regular sales period.

## ■ SB39

### Health Policy for the Care Delivery

Sponsor: Health Applications Section  
Sponsored Session

Chair: Beste Kucukyazici, McGill University, 1001 Sherbrooke West, Montreal, QC, H3A 1G5, Canada, bkucuk@po-box.mcgill.ca

### 1 - Getting OR Tools into the Hands of Users: Development of a Blood Donor Clinic Simulation

John Blake, Associate Professor, Dalhousie University, Industrial Engineering, P.O. Box #1000, Halifax, NS, B3J 2X4, Canada, john.blake@dal.ca, Sean Sangster, Candy Lipton

Optimizing the flow of donors through blood clinics is a difficult management task because of the competing objectives of minimizing donor delay (and thus keeping donors satisfied and likely to return) while containing the cost of operations. In this paper we present the results of a project designed to give clinic planners tools to assist them in the complex task of balancing customer service requirements with cost minimization strategies.

### 2 - Evaluating the Potential of Radio Frequency Ablation for the Treatment of Non-small Cell Lung Cancer

Lauren Cipriano, Research Scientist, Institute for Technology Assessment, 101 Merrimac Street, 10th Floor, Boston, MA, 02114, United States, Lauren@mgh-ita.org, Chung Yin Kong, Pamela McMahon, Scott Gazelle, Jo-anne Shepard, Michael Lanuti

Due to high rates of comorbid disease not all early-stage non-small cell lung cancer patients are eligible for potentially curative surgical resection. Radiofrequency ablation of early stage lung cancers has been demonstrated to be safe and effective in small studies, but long term data are unavailable. Using a microsimulation model of lung cancer we determine the effectiveness and cost effectiveness of using radiofrequency ablation to treat patients ineligible for ideal conventional therapy.

### 3 - Determining Effective Patient Flow Through Petri Nets

Renata Kopach-Konrad, Purdue University Industrial Engineering, 315 N. Grant St., West Lafayette, IN, 47907, United States, rkopach@purdue.edu, Mark Lawley, Imran Hasan

Hospital patient flow has tremendous implications on the delivery of care and on hospital finances. Focusing on overcrowding and resource loading, patient flow models of a hospital are developed using Petri Nets. These models are used to determine the minimum sequence of events leading a hospital from a desirable operating state to an undesirable state such as ambulance diversion. A two-phase mixed-integer programming formulation is used to generate this sequence.

### 4 - Robust Management of Motion Uncertainty in Radiation Therapy Treatments

Timothy Chan, MIT, 77 Massachusetts Ave., E40-130, Cambridge, MA, United States, tcychan@MIT.EDU, Alexei Trofimov, Thomas Bortfeld, John Tsitsiklis

In the context of patient care for life-threatening illnesses, the presence of uncertainty may compromise the quality of a treatment. In this talk, we present a robust framework to optimize radiation therapy treatments (subject to realistic uncertainties) for cancer patients. We illustrate our results on a clinical case where the uncertainty is due to organ motion during treatment.

## ■ SB40

### Stochastic Models in Health Care

Sponsor: Health Applications Section  
Sponsored Session

Chair: Oguzhan Alagoz, Assistant Professor of Industrial and Systems Engineering, University of Wisconsin-Madison, 3162 Engineering Centers Building, 1550 Engineering Drive, Madison, WI, 53706, United States, alagoz@engr.wisc.edu

### 1 - A Markov Decision Process Model for Optimal Timing of Biopsy in Breast Cancer Diagnosis

Jagpreet Chhatwal, University of Wisconsin-Madison, 4126 Mechanical Engineering, 1513 University Avenue, Madison, WI, 53706, United States, jchhatwal@wisc.edu, Oguzhan Alagoz, Elizabeth Burnside

While diagnosing breast cancer, 55-85% of the breast biopsies turn out to be benign, resulting in anxiety for the patients and unnecessary treatments. We use Markov Decision Processes (MDP) to find the optimal timing of the biopsy that maximizes the total quality-adjusted expected life of each patient. Our results also show that optimal biopsy decisions are age-dependent.

### 2 - Identifying the Critical Patient: Finding the Balance Between Undertriage and Overtriage

Serhan Ziya, Assistant Professor, Department of Statistics and Operations Research University of North Carolina, Chapel Hill, NC, ziya@email.unc.edu, Nilay Argon

Two common mistakes during patient triage are undertriage and overtriage, which are assigning a patient respectively a lower and a higher priority than what the patient's condition actually requires. Although a certain level of undertriage and overtriage is unavoidable, one can choose to be lenient towards one way or the other. In this talk, we use queueing models to generate insights on how triage decisions need to be made so as to keep the right balance between undertriage and overtriage.

### 3 - A Shadow Price Framework for Quantifying Health Care Spending and Discrimination

Chris P. Lee, Assistant Professor, The Wharton School, Univ. of Pennsylvania, 3730 Walnut St., Suite 500, Philadelphia, PA, 19104, United States, cpclee@wharton.upenn.edu, Glenn Chertow, Stefanos Zenios

Has health care spending become excessive? What is your life worth? Does the health care system discriminate based on race? Researchers have tried to address these questions empirically. We take on an alternative approach and use a large-scale, population-based optimization model coupled with observed data to answer these questions.

### 4 - Optimizing Liver Allocation System Incorporating Patients' Choices and Disease Evolution

Fatih Safa Erenay, PhD Student, University of Wisconsin-Madison, 501 N Midvale Blvd AptC, Madison, WI, 53705, United States, erenay@wisc.edu, Mustafa Akan, Oguzhan Alagoz, Baris Ata

We propose a more efficient liver allocation system considering patient preferences, where efficiency is measured by various performance measures such as number of wasted organs or total quality adjusted life years of patients. We capture the dynamics of disease evolution by a fluid model, whose solution leads to an intuitive dynamic index policy for assigning livers. The indices depend on acceptance probabilities, immediate rewards, and the shadow prices calculated from a dual dynamical system.

## ■ SB41

### Optimizing Real Life Networks with Catastrophe Consideration

Sponsor: Optimization/ Optimization and Computing in Medicine and Life Sciences

Sponsored Session

Chair: W. Art Chaovalitwongse, Assistant Professor, Rutgers University, 96 Frelinghuysen Rd, Piscataway, NJ, 08854, United States, wchaoval@rci.rutgers.edu

#### 1 - A Dynamic Transportation Decision Support System for Hurricane Evacuation

Tiravat Assavapokee, Assistant Professor, University of Houston, 4800 Calhoun Street, Houston, TX, 77204, United States, tiravat.assavapokee@mail.uh.edu, Arab Naser, Sumana Raghuram

In this work, we describe some mathematical models and heuristics methods for dynamic network optimization based solution framework that effectively integrates the evacuation routing and scheduling and logistics support planning. This tool is expected to provide an intelligent systematic methodology that can be used by transportation planners and emergency management agencies to improve traffic management during hurricane evacuation.

#### 2 - Evacuation Time Estimation in an Emergency Situation for Hospitals

Davood Golmohammadi, Rutgers University, 703 Bevier Rd, Piscataway, NJ, 08854, United States, davood@rci.rutgers.edu, Mohsen Jafari, Haleh Valian

In this paper, a set of functions is presented which estimates the evacuation time in an emergency situation for hospitals instead of developing a complex simulation model. These functions are not for specific layout conditions. They are

flexible so that they can be used in any hospital. The functions are applied for 19 different evacuation scenarios in a hospital as part of a case study. The results are compared to the simulation model, which has been already prepared for the hospital in the case study. The results show how these functions create valuable results without using costly simulation models.

#### 3 - Optimization Framework to Support Always-on Streaming Services: Applications to IPTV Service

W. Art Chaovalitwongse, Assistant Professor, Rutgers University, 96 Frelinghuysen Rd, Piscataway, NJ, 08854, United States, wchaoval@rci.rutgers.edu, Meeyoung Cha, Sue Moon, Zhe Liang

We present a novel optimization model for always-on streaming services, which involve multilayer networks. The objective of provisioning always-on services is to minimize the communication cost subject to security and reliability constraints, in the case of operational failures and catastrophic events. IPTV multicasting is a case study in this talk. We propose two new solution approaches: multi-objective greedy search algorithm and column generation framework with branch-and-price procedure.

## ■ SB42

### Infectious Disease Prevention and Treatment Models

Cluster: Operations Research in Medicine and Health Care  
Invited Session

Chair: Elisa Long, PhD Candidate, Stanford University, 467 Terman Engineering Center, Stanford, CA, 94305, United States, elisa46@stanford.edu

#### 1 - Improving WHO Guidelines: HIV Monitoring Strategies in Resource-Poor Settings

Eran Bendavid, Stanford University, 117 Encina Commons, Stanford, CA, 94305, United States, ebd@stanford.edu, Douglas Owens

The response to the HIV epidemic in Africa is changing from crisis management to a strategic plan. Guidelines about treatment are changing to reflect HIV management as a chronic disease. Monitoring patients with CD4 and viral load counts remain the most important tools for treatment initiation, change, and discontinuation. We present a cost-effectiveness analysis of disease monitoring strategies in South Africa using a simulation model and discuss the implications of our findings.

#### 2 - Optimal Allocation of HIV Prevention and Treatment Resources

Elisa Long, PhD Candidate, Stanford University, 467 Terman Engineering Center, Stanford, CA, 94305, United States, elisa46@stanford.edu, Margaret Brandeau, Douglas Owens

Given a limited budget, the optimal resource allocation among competing HIV prevention and treatment programs can depend on local epidemic factors, such as disease prevalence and the primary transmission modes. We aimed to determine an efficient allocation of funds among interventions including HIV screening, antiretrovirals, preventive and therapeutic vaccines, and male circumcision, and across multiple risk groups. We present our epidemic and economic model and discuss our empirical findings.

#### 3 - Cost Effectiveness of Hepatitis B Screening and Vaccination Among Adult Asian and Pacific Islanders

David Hutton, PhD Student, Stanford University, 380 Panama Street, Stanford, CA, 94305, United States, billdave@stanford.edu, Daniel Tan, Margaret Brandeau, Samuel So

As many as ten percent of adult Asian and Pacific Islanders in the United States are chronically infected with Hepatitis B and about two out of three of those are unaware of their infection. We present a mathematical Markov model that evaluates the cost-effectiveness of screening, treatment, and vaccination policies targeted to Asian and Pacific Islander adults.

#### 4 - Cost Effectiveness of Contact Tracing

Benjamin Armbruster, Stanford University, 121 W. Campus Dr. #1405A, Stanford, CA, 94305, United States, armbruster@stanford.edu, Margaret Brandeau

Contact tracing (also known as partner notification) is a primary means of controlling infectious diseases such as TB, HIV, and STDs. However, little work has been done to determine the optimal level of investment in contact tracing. We develop and apply a simulation model of contact tracing and the spread of an infectious disease among a network of individuals in order to evaluate the cost and effectiveness of different levels of contact tracing.

## ■ SB43

### 2007 Franz Edelman Award Finalists Reprise

Cluster: O.R. Practice  
Invited Session

Chair: Brian Denton, Senior Associate Consultant, Mayo Clinic, 200 First St. SW, Rochester, MN, United States, Denton.Brian@mayo.edu

#### 1 - DaimlerChrysler / J.D. Power: Pioneering Scientific Price Customization in the Automobile Industry

Jorge Silva-Risso, Assistant Professor, University of California, Riverside, 201 Anderson Hall, Riverside, CA, 92521, United States, jorge.silva-risso@ucr.edu, Alexei Khavaev, William Shearin, Irina Ionova, Deirdre Borrego

We present a model developed to improve the effectiveness and efficiency of automakers pricing and promotions decisions (about \$45 billion each year in the US). The approach is based on a random effects multinomial nested logit model of product, acquisition (purchase, lease) and program-type (rebates, reduced APR, etc.) choice. A hierarchical Bayes structure is used to capture response heterogeneity at the local market level. Chrysler estimates annual savings to be about \$500 million.

#### 2 - Procurement Risk Management (PRM) at Hewlett-Packard Company

Venu Nagali, Distinguished Technologist, Hewlett-Packard, 6000 Irwin Road, Mt. Laurel, NJ, 08054, United States, venu.nagali@hp.com, Jerry Hwang, Patrick Scholler

Supply chain risks due to product demand, component cost & availability uncertainties can have a significant impact on a manufacturing company's top- & bottom-line performance. We have employed OR to develop & implement a model, business process, & software in order to measure & manage supply chain risks. In FY'06, the PRM approach helped manage over \$7B of HP's spend, resulting in material-cost savings of \$128M. Over the past 6 years, >\$425M in cumulative total cost savings have been realized.

#### 3 - Operations Research Enhanced Supply Chain Management at ARSC, US Coast Guard

Vinayak Desphande, vinayak@exchange.purdue.edu, Ananth. V. Iyer

We describe a series of projects at the US Coast Guard (USCG) Aircraft Repair and Service Center (ARSC) that demonstrate the value of Operations Research methodologies for efficient Supply-Chain management. These projects provided critical decision support for planning various repair and maintenance activities at ARSC. ARSC has been transformed from a data rich and knowledge poor decision support culture to an OR ingrained decision making environment.

## ■ SB44

### Teaching Case Competition II

Sponsor: INFORM-ED  
Sponsored Session

Chair: Chris Zappe, Interim Dean, Bucknell University, 701 Moore Avenue, Lewisburg, PA, 17837, United States, zappe@bucknell.edu

#### 1 - Presentations of Finalists #3 and #4 for the Eighth INFORMS Case Competition

Chris Zappe, Interim Dean, Bucknell University, 701 Moore Avenue, Lewisburg, PA, 17837, United States, zappe@bucknell.edu

The four finalists for the 2007 INFORMS Case Competition will deliver final presentations of their cases to a panel of judges and the audience. All are welcome to attend and observe these presentations as well as ask questions of the finalists. The winner of the competition will be selected by the judges at the end of the four presentations. The winner and the runners-up will be announced at the INFORM-ED Annual Business Meeting.

## ■ SB45

### Practice of Risk Management

Sponsor: Financial Services  
Sponsored Session

Chair: Gill Eapen, Founder and Managing Principal, Decision Options, LLC, 94 Anchorage Circle, Groton, CT, 06340, United States, geapen@decisionoptions.com

#### 1 - SamsungCard Consumer Lending Model (SCLM)

Jaeyung Huh, PhD Senior Manager, Samsung Card Company, 1-7 Yeonji-Dong, Jongro-Gu, Seoul, Korea, Republic of, jaeyung.huh@samsung.com, Woojin Chang, Jae Yong Lee

The available credit risk assessment models are inadequate for the risk management for consumer lending business. We introduce a Samsung Card's consumer lending model. In this model we can predict cash flow, estimate the management indices reflecting the obligors' delinquency transition behavior, set a management goal through the analysis of actual business record, evaluate the portfolio responding to the change of firm's lending strategy, and conduct more efficient portfolio management.

#### 2 - Real Options

Gill Eapen, Founder and Managing Principal, Decision Options, LLC, 94 Anchorage Circle, Groton, CT, 06340, United States, geapen@decisionoptions.com

Traditional finance based on Capital Asset Pricing Model and Discounted Cash Flow analysis does not work well in situations that present a high level of uncertainty and decision flexibility. In such cases, a more holistic approach, decision options analysis incorporates embedded option like characteristics in decisions. Although this approach has been well researched there are still many misconceptions in practice. This paper illustrates why such misconceptions exist and how to overcome them.

#### 3 - Value Based Management

Ian Williams, Decision Options, LLC, 94 Anchorage Circle, Groton, CT, 06340, United States, iwilliams@decisionoptions.com, Gill Eapen

Pharmaceutical Industry invests large amounts in Research and Development on drug candidates exhibiting high levels of uncertainty and decision flexibility. Allocating capital into these research projects is often inefficient either due to the application of traditional techniques or more qualitative processes at work. Through a series of examples, we illustrate how such companies practice better project selection, portfolio management, and enter into collaborative arrangements with partners.

#### 4 - Long-short Portfolio Optimization with Discrete Asset Choice Constraints and Two Risk Measures

Gautam Mitra, Distinguished Professor and Director, CARISMA-Brunel University/ Optirisk Systems, John Crank Building, Uxbridge, UB8 3PH, United Kingdom, gautam.mitra@brunel.ac.uk, Diana Roman, Ritesh Kumar

We consider long-short portfolio optimization in the presence of two risk measures: variance and CVaR and discrete asset choice constraints of (i) buy and sell thresholds (ii) cardinality restriction on portfolio positions. Our model improves upon the classic mean-variance model by controlling both portfolio variance and CVaR. Our long-short extension to the mean-variance-CVaR model incorporates industry practices regarding short decisions. We test models on real data from the FTSE 100 index.

## ■ SB46

### Agent-based Modelling of Energy Markets

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

Chair: Augusto Ruperez Micola, Research Fellow, IMD - Institute for Management Development, Chemin de Bellerive, 23, Lausanne, 1007, Switzerland, Augusto.RuperezMicola@imd.ch

#### 1 - On Learning in Policy Space by Oligopolists in Electricity Markets

Steve Kimbrough, Professor, Wharton School, 3730 Walnut Street, Suite 500, Room 565, Philadelphia, PA, 19104, United States, kimbrough@wharton.upenn.edu, Fred Murphy

We report on our modeling investigations into bidding by oligopolists in electricity markets. We report in particular on modeling results involving learning in policy space by the oligopolists. In such models, agents are endowed with a consideration set of policies for bidding in the market. The agents then individually engage in learning to discover which policy (or policies) is (are) most profitable.

#### 2 - Adaptive Agents Using Dynamical Systems Learning Algorithm in Electricity Markets

Gerald Sheblé, Professor, University of Iowa, gbsheble@ece.pdx.edu, M.P. Cheong

Electricity market structure is still under design. Market participants are challenged to adapt to changes in the environment. Efforts propose game theory models and evolutionary learning approaches to emulate market participant behaviors. We show data mining to switch between learning schemes. Strategies between companies are modeled. Each firm predicts current and future conditions. Switching criterion between different models seeks to guarantee maximum expected profit over future time horizon. Each scheme is compared with participants that use only one learning scheme.

### 3 - Investigating the Dynamics in Two-settlement Electricity Markets Using Agent-based Model

Daniel J. Veit, Professor, University of Mannheim, Schloss, Mannheim, BW, 68131, Germany, veit@uni-mannheim.de, Anke Weidlich

We investigate a two-settlement electricity market and its economic outcome in comparison with a single-settlement market. Generators sign strategic forward contracts and are involved in spatial oligopolistic competition in the spot market. The spot market is cleared by an ISO who aims at maximizing welfare. The forward market is cleared using a uniform price mechanism. Our simulations show that the introduction of a forward market leads to lower prices in the spot market.

## ■ SB47

### Forestry II: Harvest Scheduling with Spatial Constraints

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

Chair: Matthew Thompson, Graduate Student, Department of Forest Engineering, Oregon State University, Corvallis, OR, matthew.thompson@oregonstate.edu

#### 1 - The Effect of Rule Ordering in Heuristic Performance: A Preliminary Examination

Kevin Boston, Oregon State University, kevin.boston@oregonstate.edu, John Sessions

The effect of rule ordering in a simulated annealing heuristic is examined in a tactical harvest scheduling model. The effect is demonstrated by solving a 91-harvest unit for a twenty period problem of approximately 2690 acre problem from a logging plan prepared for the southern portion of the Oregon State University McDonald-Dunn Research Forests. Results for this case study indicate a 14-40% saving in computational time if spatial feasibility is evaluated before calculating the objective function. Quality of the solution was similar in each case.

#### 2 - Diversity Assessment in Pareto Optimal Solutions for Multi-objective Evolutionary Algorithms

Jeff Hamann, Graduate Student, Department of Forest Engineering, Oregon State University, Corvallis, OR, 97339, United States, jeff.hamann@forestinformatix.com

In order to determine stopping criteria in multi-objective forest planning problems, the distribution quality of the Pareto optimal solution set can be examined to ensure adequate diversification and intensification during the solution space search. This paper examines the application of an information theory metric known as entropy to assess the distribution quality of Pareto optimal solutions in a multi-objective evolutionary optimization algorithm applied to a forest planning problem.

#### 3 - Direct Spatial Management of Old Growth Forest Using a Bevers-Hof Linear Programming Approach

Eldon Gunn, Professor, Dept. of Industrial Engineering, Dalhousie University, P.O. Box 1000, Halifax, NS, B3J2X4, Canada, eldon.gunn@dal.ca

Bevers and Hof pioneered the approach of direct linear programming manipulation of the spatial features of the forest. This paper illustrates the use of that approach to manipulate the amount and connectivity of old growth forest on an actual forest landscape with more than 10,000 stands. The resulting linear programming problems are large but easily solvable.

#### 4 - A Sprint Approach to Large-scale Model I Forest Management Linear Programs

Wei Yang, Graduate Student, Department of Industrial Engineering, Dalhousie University, Halifax, NS, B3J 2X4, Canada, wz209420@dal.ca, Eldon Gunn

The ability of a Model I LP formulation to represent spatial phenomena is becoming increasingly important in an environment where strategic forest management is required to account for a broad variety of forest values. However, these models can easily become quite large. Here we report on the use of an approach similar to Forrest's SPRINT that appears to be well suited to deal with these large models.

#### 5 - Examining Various Tournament Selection Strategies for Spatially Constrained Forest Planning Problems

Matthew Thompson, Graduate Student, Department of Forest Engineering, Oregon State University, Corvallis, OR, matthew.thompson@oregonstate.edu

Most forest planning implementations of Genetic Algorithms have used some form of proportional or ranking-based selection. Use of tournament selection may accelerate the process of evolution and could be a promising strategy for difficult forest planning problems. This research will examine the impact on

solution time and quality from using deterministic and stochastic tournament selection strategies for spatially constrained forest planning.

## ■ SB48

### Optimization via Simulation II

Sponsor: Simulation  
Sponsored Session

Sigrun Andradottir, Professor, Georgia Tech, Stewart School of ISYE, Atlanta GA 30332, United States, sa@isye.gatech.edu

#### 1 - Univariate Stochastic Root-finding for Monotone, Convex Functions

Samuel Ehrlichman, Cornell University, School of ORIE, Rhodes Hall, Cornell University, Ithaca, NY, 14853, United States, se52@cornell.edu, Shane Henderson

We study the one-dimensional root finding problem for increasing convex functions. We give algorithms for both exact, and inexact (stochastic), function evaluations. For the stochastic case, we supply a probabilistic convergence guarantee in the spirit of selection-of-the-best methods. The algorithm's worst-case performance bound is an improvement upon that of its close cousin, stochastic binary search, by a constant factor.

#### 2 - Optimizing Importance Sampling Parameter for Portfolios of Credit Risky Assets

Huiju Zhang, Fitch Ratings, One State Street Plaza, New York, NY, United States, huizhang@rhsmith.umd.edu, Michael Fu

We address the problem of finding the optimal importance sampling measure when simulating portfolios of credit risky assets. We apply a gradient-based stochastic approximation method to find the parameters in the minimum variance problem when importance sampling is used. We also employ the CE method to solve the same minimization problem. Numerical results illustrating the variance reduction are presented for the estimation of the portfolios' expected loss, unexpected loss and quantiles.

#### 3 - Combining Quasi-Monte Carlo and Latin Hypercube Methods in Stochastic Optimization

Tito Homem-de-Mello, Associate Professor, Northwestern University, 2145 Sheridan Rd M235, Evanston, IL, 60208, United States, tito@northwestern.edu, Shane Drew

We discuss the use of non-i.i.d. sampling methods when solving stochastic optimization problems by sample average approximations. We focus on two well known techniques – quasi-Monte Carlo and Latin hypercube sampling. We study algorithms that combine these two approaches, and discuss some properties of the resulting estimators. We present numerical results illustrating the behavior of the algorithms for a collection of problems.

#### 4 - Random Search Methods for Continuous Simulation Optimization

Andrei Prudius, PhD Student, Georgia Tech, Stewart School of ISyE, Atlanta, GA, 30332, United States, aprudius@isye.gatech.edu, Sigrun Andradottir

We present several random search methods for solving continuous parameter simulation optimization problems. We show that our methods are globally convergent with probability one, and also provide some numerical results that demonstrate the performance of the proposed approaches.

## ■ SB49

### Panel Discussion: Issues in Pricing and Revenue Management Education

Sponsor: Revenue Management & Pricing- Invited/Sponsored  
Sponsored Session

Chair: Robert Phillips, Nomis Solutions, robert.phillips@nomissolutions.com

#### 1 - Panel Discussion: Issues in Pricing and Revenue Management Education

Moderator: Robert Phillips, Nomis Solutions, robert.phillips@nomissolutions.com, Panelist: Itir Karaesmen, Costis Maglaras, Ioana Popescu, Nicola Secomandi

The purpose of this panel is to discuss what works and doesn't work in teaching pricing and revenue management. In particular, we will address where the topic fits into the overall curriculum. Does it belong in the business school or in the OR department (or both)? Does it deserve an entire course? What should and should not be taught in the subject? Is it likely to become a lasting part of the Business School curriculum (like Ops Mgt.) or not? Is the airline story still relevant?

## ■ SB50

### New Applications of Pricing and Revenue Management

Sponsor: Revenue Management & Pricing- Invited/Sponsored Sponsored Session

Chair: Soulaymane Kachani, Professor, Columbia University, 334 Mudd Building, 500 W. 120th Street, New York, NY, 10027, United States, kachani@ieor.columbia.edu

#### 1 - Multi-channel Pricing of Subscription-based Products with Consumer Choice

Ali Sadighian, Columbia University, 313 Mudd Building, 500 W. 120th Street, New York, NY, 10027, United States, as2446@columbia.edu, Soulaymane Kachani, Woonghee Tim Huh

We address the problem of a magazine publisher facing stochastic demand over multiple periods. Magazines are offered through both online and traditional channels, and consumers choose their preferred medium based on a specific choice model (e.g. multinomial logit). We model the dynamics of customer subscription and attrition, and derive optimal pricing and production quantity decisions for magazine publishers.

#### 2 - Memory-dependent Pricing and Product Introduction Timing for Multiple Product Generations

Hasan Arslan, Professor of Information Systems & Operations Management, Sawyer Business School, Stahl Center, 73 Tremont St., 7th floor, Boston, MA, United States, harslan@suffolk.edu, Cyril Shmatov, Soulaymane Kachani

We consider introduction timing and pricing for successive product generations, when demand is impacted by the reference price formed by consumers. We characterize the optimal product introduction time and pricing strategies explicitly for two successive generations, and propose a general quasi-analytic solution. We extend the analysis to a competitive environment.

#### 3 - Price of Anarchy in Quadratic Utility Games

Georgia Perakis, Associate Professor, Sloan School, MIT, 50 Memorial Drive, Cambridge, MA, 02139, United States, georgiap@mit.edu, Jonathan Kluberg

We study quadratic utility games (for example, Cournot, i.e. quantity competition) with linear demand price relation. We present a bound on the price of anarchy (ie. comparison of system profit between centralized and decentralized settings) that depends on the number of players and the maximum market power of the players. The bound is independent of the constraints of the game and hence allows multiperiod competition with fixed capacities over the time horizon as a special case.

#### 4 - Dynamic Pricing and Buyer Learning of Product Availability

Misuk Lee, School of Industrial and Systems Engineering Georgia Institute of Technology, gtg438r@mail.gatech.edu, Anton J. Kleywegt

We consider a process in which a seller with limited inventory sets prices in two time periods, and the buyers decide whether to buy in the first time period, second time period, or not at all. Between the two time periods, buyers obtain additional information about their utilities for the product. There may not be sufficient inventory to satisfy all demand in the second time period. Buyers estimate the probability of obtaining product in the second period. We show that the sequences of buyer decisions converge to an equilibrium, in spite of the observations being dependent on past decisions, and thus being neither independent nor identically distributed.

## ■ SB51

### Pricing Issues

Sponsor: Revenue Management & Pricing- Invited/Sponsored Sponsored Session

Chair: Doug Bish, Assistant Professor, Virginia Tech, Dept.. of Industrial and Systems Engg., Blacksburg, VA, 24061-0118, United States, drb1@vt.edu

#### 1 - Complexity Reduction and Price Optimization at a Major Manufacturer of Construction Equipment

Tallys Yunes, University of Miami, Department of Management Science, Coral Gables, FL, United States, tallys@miami.edu, Alan Scheller-Wolf, Masha Shunko, Natalya Trapp, Valerie Tardif, Sridhar Tayur

Companies with broad product lines face a common trade-off: product variety, which entices customers, is positively correlated with elevated costs. We develop an approach to capture customer behavior and complexity costs within an optimization model, and use it to select and price a profitable subset of machines spanning multiple overlapping product lines of a major machinery manufacturer.

We present computational results with real data under a number of managerial and strategic scenarios.

#### 2 - Optimal Product-line Design Using Bundling and Pricing

Chi-Guhn Lee, cglee@mie.utoronto.ca

In this research we study a problem of optimizing a product-line with an objective to maximize the total revenue. Logit model is used to define the discrete choice probability, from which the expected revenue generated from a product-line is derived. Case studies have been performed based on consumer survey done among college students.

#### 3 - Optimal Switching Times for Season and Single Tickets in Sports and Entertainment

Julie Swann, Georgia Tech, Industrial and Systems Engineering, Atlanta, GA, United States, julie.swann@isye.gatech.edu, Serhan Duran

We focus on the Sports and Entertainment industries, where event tickets are sold exclusively as season tickets initially or as single events later in the selling horizon. We study the optimal time to switch between the market segments dynamically as a function of the system state. We find the optimal switching is a set of thresholds that depend on the remaining inventory and time left in the horizon. We apply the results to ticket data and identify other RM problems in the industry.

#### 4 - Revenue Management When Supply is Flexible

Doug Bish, Assistant Professor, Virginia Tech, Dept.. of Industrial and Systems Engg., Blacksburg, VA, 24061-0118, United States, drb1@vt.edu, Ebru Bish, Lingrui Liao

We study the revenue management problem under supply-side flexibility. The firm has the option of swapping capacities between the two service classes when demand uncertainty is partially resolved. We determine the structure of an optimal policy, study the impact of supply flexibility on profits, and perform a comparative statics analysis.

## ■ SB52

### Academic Contributions to Railroad Operations Research

Sponsor: Railway Applications

Sponsored Session

Chair: Christopher Barkan, Associate Professor, University of Illinois at Urbana-Champaign, 1201 NCEL, MC-250, 205 N. Mathews Ave., Urbana, IL, 61801, United States, cbarkan@uiuc.edu

#### 1 - Estimating Congestion Impacts on Rail Lines via Statistical Methods

Michael Gorman, Associate Professor, University of Dayton, School of Business, Dayton, OH, United States, Michael.Gorman@notes.udayton.edu

As railroads become more and more congested with increasing traffic base, it becomes paramount to estimate the congestion impact of new traffic. Well-tested, specialized simulation software is often used for such predictions. However, simulations have some drawbacks and are time consuming to run. We test the viability of statistical methods as a low cost alternative for prediction the impact of additional trains on train running times. Empirical results are presented.

#### 2 - Trolley Assignment Model for a Container Terminal with a Low Viaduct Horizontal Rail System

Anne Goodchild, Assistant Professor, University of Washington, 121E More Hall, Box 352700, Seattle, WA, 98195, United States, annegood@u.washington.edu, Karthik Mohan

This paper looks at improving the efficiency of an automated system, called the Low Viaduct Horizontal Rail Transportation System (LVRTS) existent at a few container terminals in China. The problem of minimizing the operation time of LVRTS is formulated as a non-linear integer programming problem, and solved using Genetic Algorithms.

#### 3 - Capacity Management for Heterogenous Traffic on Double Track Railroads

Steven Harrod, Assistant Professor, University of Dayton, School of Business Administration, 300 College Park, Dayton, OH, 45469, United States, a2soft@aol.com

A well managed double track railroad was once considered adequate for all traffic needs on North American railroads, but traffic levels are now exceeding even those limits. This presentation discusses capacity management and expansion options for double track lines based upon a discrete time network model analysis.

#### 4 - A Decision Support Framework for Railway Capacity Expansion

Yung Cheng Lai, Graduate Research Assistant, University of Illinois at Urbana-Champaign, B-118 NCEL, MC-250, 205 N. Mathews Ave., Urbana, IL, 61801, United States, lai3@uiuc.edu, Christopher Barkan

We develop a decision support framework by using multicommodity flow techniques to determine how to allocate money for capacity expansion in the best possible way. Based on estimated future demands, the model can successfully determine the optimal solution regarding which subdivisions need to be upgraded with what kind of engineering options. The benefit of using the decision support framework is substantial for budget management of North American railroads.

## ■ SB53

### Facility Location and Computing

Sponsor: Location Analysis

Sponsored Session

Chair: Ho-Yin Mak, University of California, Berkeley, 1117 Etcheverry Hall, University of California, Berkeley, Berkeley, CA, 94720, United States, makho@berkeley.edu

#### 1 - A Two-echelon Inventory-location Problem with Service Considerations

Ho-Yin Mak, University of California, Berkeley, 1117 Etcheverry Hall, University of California, Berkeley, Berkeley, CA, 94720, United States, makho@berkeley.edu, Max Shen

We study the design of a two-echelon spare parts inventory system with stochastic demand and service constraints. Facility location and inventory management decisions are jointly optimized using a mixed integer nonlinear programming formulation. We will discuss the proposed solution algorithm, computational results and some managerial insights.

#### 2 - Impact of Cost Uncertainty on the Location of Facilities in a Supply Chain

Seokjin Kim, Assistant Professor of Management, Millersville University, Department of Business Administration, P.O. Box 1002, Millersville, PA, 17551-0302, United States, skim@millersville.edu, Mozart Menezes, Rongbing Huang

We develop a location model for a distribution center on a demand-populated unit line between two suppliers to minimize the production, inbound and outbound transportation costs of one unit of a product. We first assume that two suppliers' production costs are deterministic, and then consider a probabilistic version where the production cost of one supplier follows a distribution. We propose properties of optimal locations and also characterize some distributions under which the properties hold.

#### 3 - Facility Reliability with Site-specific Failure Probabilities

Lezhou (Roger) Zhan, CitationShares Management, 5 American Ln, Greenwich, CT, 06831, United States, zhan@ufl.edu, Max Shen, Mark Daskin

We consider the problem of locating facilities to minimize the expected facility, transport, and failure-to-serve costs when candidate locations have site-specific failure probabilities. Several models are formulated and solution algorithms are outlined. Computational results are provided as are insights obtained from exercising the models.

#### 4 - Approximation Algorithms for the Fixed-Hub Single Allocation Problem

Dongdong Ge, Stanford University, 37 angell ct, Apt 201, stanford, 94305, United States, dongdong@stanford.edu, Jiawei Zhang, Yinyu Ye

we discuss the fixed-hub single allocation problem. In the model hubs are fixed and fully connected; and each terminal node is connected to a single hub which routes all its traffic. The goal is to minimize the cost of routing the traffic in the network. This paper presents linear programming-based algorithms that deliver both high quality solutions and a theoretical worst case bound. The algorithms are based on a new randomized rounding method, which might be of interest on its own.

## ■ SB54

### Models for Designing Service Systems and Understanding Customer Behavior

Sponsor: Applied Probability

Sponsored Session

Chair: Laurens Debo, Tepper School of Business, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, laurdebo@andrew.cmu.edu

#### 1 - Customer Herding in Queuing Services

Senthil Veeraraghavan, Asst Professor, Wharton School, Philadelphia, PA, United States, senthily@wharton.upenn.edu, Laurens Debo

When choosing between service providers whose quality is common knowledge, customers trade off waiting times with service values. Rational customers also examine queue lengths at two competing service providers to make a decision. Customers may ignore their private information and herd. We model herding behavior of customers, in a two-server queuing model. We find that it may be rational in equilibrium to ignore private information and choose the service provider with the longer queue.

#### 2 - Design and Analysis of Diagnostic Call Centers

Xiaofang Wang, Tepper School of Business, Carnegie Mellon University, Pittsburgh, PA, 15213, United States, xiaofanw@andrew.cmu.edu, Laurens Debo, Alan Scheller-Wolf, Stephen Smith

At health insurance company-owned nurse lines as well as many other call centers, diagnostic accuracy is a key performance measure in addition to caller waiting time. Since longer service entails higher accuracy but also more congestion, the manager must decide on the optimal service depth to guide a diagnostic process between an agent and caller. We model these diagnostic call centers, provide structural properties of the optimal solution and managerial insights.

#### 3 - The Value of Congestion

Laurens Debo, Tepper School of Business, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, laurdebo@andrew.cmu.edu, Christine Parlour, Uday Rajan

We provide a model in which a queue for a good communicates the quality of the good to consumers. Agents observe the queue length and a private signal (good or bad) about the good. We find that under specified conditions, both a high quality firm and a social planner maximizing consumer surplus prefer a low service rate to a high one, due to the information externality.

#### 4 - Strategic Information Transmission in Service Systems

Achal Bassamboo, a-bassamboo@northwestern.edu, Gad Allon, Itai Gurvich

Many call center use recorded announcements that encourage callers to wait for an agent to become available, or describe the current state of the system. We study a model of interaction between the customers and the service provider, in a setting where their incentives are misaligned, and where unverifiable, costless and non-binding information can be provided to the customer by the service provider.

## ■ SB55

### Joint Session AAS/TSL: Advances in Airline Decision Support Systems

Sponsor: Aviation Applications, Transportation Science & Logistics  
Sponsored Session

Chair: Diego Klabjan, University of Illinois at Urbana-Champaign, 205 North Mathews Avenue, Urbana, IL, 61801, United States, klabjan@uiuc.edu

#### 1 - Airport Ground Staff Optimization

Peng Duan, Sabre Holdings, peng.duan@sabre.com, Tina Shaw

Traditionally the airport ground staff rostering problem is usually carried out in several stages and built upon aggregate demand. In this work, we present an integrated solution approach working with disaggregate tasks. The solution approach includes a heuristic and a post optimization algorithm. We discuss the integration of shift assignment stage and task assignment stage, and how different running modes and complex business rules are handled.

#### 2 - A Generic Column-generation-based Framework for Airline Planning

Thomas Schickinger, Product Manager, Lufthansa Systems, Fritschestr. 27-28, Berlin, BE, 10585, Germany, thomas.schickinger@lhsystems.com

In this talk we report on recent developments of a framework for airline optimization problems. The core of this framework consists of generic components for solving LP and IP problems, and provides an extensible implementation of a column-generation based solver. We show how this generic part is adapted to different crew and aircraft planning problems and how the structure of the problem at hand is exploited by approximation techniques and problem-specific control of the path search.

### 3 - An Optimization Model for Negotiating Airlines Hard-block Code-share Agreements

Ahmed Abdelghany, Assistant Professor, College of Business, Embry-Riddle Aeronautical University, 600 S. Clyde Morris Blvd., Daytona Beach, FL, 32114, United States, abdel776@erau.edu, Khaled Abdelghany

Code-sharing enables airlines to expand their network and service frequency without additional resources. This paper presents an optimization model to negotiate airlines hard-block code-share agreements. The model determines optimal number of allocated seats and revenue split strategies for all possible code-sharing partners in the different markets. The model captures the trade-off between incremental revenue from code-sharing demand and lost revenue due to displacement of existing passengers.

### 4 - Some New Concepts for Solving Airline Scheduling Problems

Tina Shaw, Chief Scientist, Sabre Holdings, SABRE \$ 1 E. Kirkwood Blvd., Southlake, TX, 76092, United States, tina.shaw@sabre.com

Large-scale IP problems in the airline scheduling arena are typically solved using column generation and specialized branching techniques, such as branching on follow on. We discuss several variations to branch on follow on and their application; including the network implications when using a shortest path pricing problem for delayed column generation. We introduce a new branching concept that can be extended in a number of ways to branch on other aspects not previously considered.

## ■ SB56

### Auction Design

Cluster: Auctions  
Invited Session

Chair: Peter Popkowski-Leszyc, Associate Professor of Marketing, University of Alberta, 4-20 F School of Business, Edmonton, AB, T6G 2R6, Canada, ppopkows@ualberta.ca

#### 1 - Let the Market Decide the Price: The (Non-)Use of Buy-now Price in Online Auctions as a Value Signal

Kursad Asdemir, University of Alberta, School of Business, Edmonton, AB, Canada, kursad.asdemir@ualberta.ca, Chun Qiu, Peter Popkowski-Leszyc

A buy-now price is a feature frequently used by sellers in online auctions. We study buy-now price as a value signal that influences the bidders' beliefs. A rational expectations equilibrium in which high and low buy-now prices are not used is derived. A high buy-now price is detrimental to the seller; because it raises a bidder's expectation of the value; and reduces the credibility of the seller's signal. We provide experiments that support our results.

#### 2 - The Effect of Product Class on the Usage of Buy-now Price in Online Auctions

Chun Qiu, Assistant Professor, McGill University, Desautels Faculty of Management, Montreal, QC, Canada, chun.qiu@mcgill.ca, Peter Popkowski-Leszyc, Kursad Asdemir

We study the moderating effects of product class and ease of assessing the value of an item on the effectiveness of buy-now prices in online auctions. Buy-now prices may serve different purposes, which vary depending on the product class. In particular, buy-now prices may serve as external reference prices for high-end high uncertain products. On the other hand buy-now options may serve to accelerate sales for low-end products. We provide empirical results to support our conjectures.

#### 3 - When Zero Search Cost is too High: What Does it Take to Make Consumers Search?

Ernan Haruvy, The University of Texas at Dallas, School of Management, SM 32, 2601 North Floyd Road, Richardson, TX, United States, eharuvy@utdallas.edu, Peter Popkowski-Leszyc

We examine individual choice between pairs of simultaneous auctions that are either ex-ante identical or that differ in one of the following respects: direct incentives to search, shipping costs, minimum starting bid, duration and secret reserve. We also included an incentive to search for some of the pairs. We investigate the extent to which individuals bidding in these auctions choose optimally over auctions, the extent they switch between auctions, and factors that influence these outcomes.

#### 4 - Procurement Auctions with Costly Supplier Qualification Screening

Zhixi Wan, PhD candidate, University of Michigan, 701 Tappan Street, Ann Arbor MI 48109, United States of America, wanzhixi@umich.edu, Damian Beil

We consider reverse auctions in combination with supplier qualification screening to determine which qualified supplier will be awarded a contract. The buyer seeks to minimize the contract payment plus qualification costs. We explore ben-

efits of qualifying some suppliers only after the auction, and the role of fully pre-qualified incumbents.

## ■ SB57

### Optimization in the Internet

Sponsor: INFORMS Telecommunications Section  
Sponsored Session

Chair: Hui Liu, Distinguished Member of Technical Staff, Verizon Communications, 40 Sylvan Road, Waltham, MA, 02451, United States, hui.liu@verizon.com

#### 1 - Internet Service Resource Optimization

Marcelo Torres, Akamai Technologies, Inc, 8 Cambridge Center, Cambridge, MA, 02139, United States, mtorres@akamai.com, Andrew Vakhutinsky

We describe a cost optimization model that can be applied to establish location usage targets and control traffic to meet performance requirements within a distributed Internet service platform. We describe the common structure used to price resource utilization per deployed location. The structure of the model shares much in common with a large scale stochastic mathematical program. We conclude by describing how the model can be applied to manage resource costs across a billing period.

#### 2 - Wavelength Routing, Assignment and Translation in an All-optical Network

Dave Allen, Distinguished MTS, Verizon, 2400 North Glenville, Richardson, TX, 75082, United States, dave.allen1@verizon.com

An all-optical network requires selection of routes and wavelengths between nodes. Even in an optimized design, wavelength contention on fibers can occur, requiring expensive design modifications. We present a novel method to optimize routing, wavelength assignment and translation at user-specified nodes so that overall cost is minimized. The model is applicable to both new designs and incremental changes. Results for 1+1 protection show significant savings compared to expedient selections.

#### 3 - Delivery of Video-on-demand Over a Transport Channel with Limited Capacity

Peter Kubat, Distinguished MTS, Verizon Technology, 40 Sylvan Rd, Waltham, MA, 02451, United States, peter.kubat@core.verizon.com

Two video-on-demand delivery schemes (a) streaming and (b) fast load and store are compared. It is shown that under moderate traffic loads fast load and store method is more efficient, namely having a better throughput, less blocking and provides a better transport utilization.

#### 4- Decentralized Load Balancing

Marco Bijvank, VU University Amsterdam, De Boelelaan 1081a, Amsterdam - 1081 HV, Netherlands, mbijvank@few.vu.nl, Vivek Rai, Wemke van der Weij

Current IT services are built using three tier architectures where requests arriving at web servers are routed to application servers that are further routed to a database. A load balancer is required to route these requests to the application servers. The objective is to design decentralized load balancing algorithms based on partial load information such as power of two choices, thresholding based algorithms, and age based server selection. We use an MDP formulation for our analysis.

## ■ SB58

### Institutions, Innovation and Entrepreneurship

Sponsor: Organization Science  
Sponsored Session

Chair: Raghu Garud, Penn State University, rgarud@psu.edu

#### 1 - Structuring Intellectual Property: The Case of Carbon Nanotubes

Mike Lounsbury, University of Alberta, Michael.Lounsbury@ualberta.ca, P. Devereaux Jennings, Tyler Wry

In this paper, we examine the sources of intellectual property development in the carbon nanotube (CNT) field-one of the most well developed areas of nanotechnology. While much intellectual property research focuses on patent level analysis, we underscore the importance of patent categories as key cognitive elements that organize the different knowledge domains within the world of CNT patenting. We investigate a number of factors that may contribute to patent creation including spatial characteristics related to geographic clustering and the role of universities and corporations, and knowledge structure characteristics including importance, generality, density, and centrality. Our

results indicate that, at least in the context of the CNT field, spatial characteristics have limited explanatory value, while the knowledge structure characteristics of density of patents within patent categories and the centrality of categories in the overall knowledge structure are robust drivers of patent creation. We discuss the importance of patent category analysis and the need to seek integration across various theoretical traditions that span socio-cognitive approaches, evolutionary economics and economic geography.

## 2 - Conferences as Venues for the Configuration of Emerging Organizational Fields: The Case of Cochlear Implants

Raghu Garud, Penn State University, rgarud@psu.edu

I examine how conferences can be occasions for the configuration of emerging organizational fields by describing three that I attended during the development and commercialization of cochlear implants. These conferences served as venues for a variety of activities to unfold ranging from the exchange of information to the enactment of technological possibilities. A full appreciation of conferences as holistic events, I argue, offers us a particularly valuable entry point into gaining a deeper understanding of how new fields are assembled in real time.

## ■ SB59

### Empirical Research in Supply Chain Management

Sponsor: Technology Management  
Sponsored Session

Chair: Aleda Roth, Professor, Clemson University, College of Business & Behavioral Science, Clemson, United States, aroth@clemson.edu

#### 1 - The State of Global Leanness: Insights from Long-range Inventory-turnover Data

Richard Schonberger, 177 107th Ave. NE, #2101, Bellevue, WA, 98004, United States, sainc17@qwest.net

At least 15 years of inventory-turnover data for more than 1,200 global manufacturers, retailers, and distributors provide insights into the changing state of leanness among select groups of those companies. More probing analysis suggests widespread over-emphasis on internal applications of the lean core, in contrast to the much greater lean opportunities that reside in the supply pipelines.

#### 2 - Effect of Supply-demand Base Adaptivity on Business Performance

M. Murat Kristal, Assistant Professor, York University, Schulich School of Business, 4700 Keele Street, Toronto, ON, M3J 1P3, Canada, mkristal@schulich.yorku.ca, Aleda Roth

We empirically investigate the underlying structure of supply-demand base adaptivity in terms of exploration and exploitation activities, and assess its effect on business performance. Our evidence suggests that exploratory adaptivity activities are as important as those of exploitative adaptivity. Though pressured by short-term performance measures, supply chain managers should not be forced to focus only on short-term efficiency plans for their supply chains.

#### 3 - Does ISO 9000 Reduce Quality Risk? A Longitudinal Study

John Gray, Assistant Professor, Ohio State University, Fisher College of Business, Columbus, OH, 43210, United States, gray.402@osu.edu, Aleda Roth, Enno Siemsen

ISO 9000 certification is often considered a proxy for strong quality capability. However, empirical support for the effect of ISO 9000 on quality performance has been mixed. In this research, we use multiple years of Food and Drug Administration inspection data to determine if, in fact, ISO 9000 reduces quality risk. We assess quality risk before, during and after ISO 9000 certification on a sample of firms in the medical device industry.

#### 4 - Feedback for Process Improvement in B2B E-commerce: Constructs and Measurement

Hua-Hung (Robin) Weng, Doctoral Student, Clemson University, College of Business and Behavioral Science, 101 Sirrine Hall, Clemson, SC, 29634-1305, United States, whua@clemson.edu, Aleda Roth, Janis Miller

Feedback systems are important for quality improvement because they offer companies the opportunity to interface with customers and suppliers, and as a result believed to facilitate the double-loop learning. The purpose of this research is to present a conceptual model of B2B feedback systems, B2B service quality, and customer satisfaction. Using Roth and Menor's rigorous, two-stage approach, we operationally define the key constructs and operational measures with good psychometric properties.

## ■ SB60

### Entrepreneurship

Sponsor: Technology Management  
Sponsored Session

Chair: Moren Levesque, Associate Professor, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, levesque@engmail.uwaterloo.ca

#### 1 - Research Collaboration Networks and Innovation Output

David Deeds, dx054000@utdallas.edu, Irem Demirkan

We explore the evolution of co-authorship networks of the firms in the biotechnology industry. We use social network theory to develop a model of the structure and dynamics of interorganizational research collaboration networks. This paper also demonstrates how this evolution affects focal firms' successive performance in terms of the firms' innovative output.

#### 2 - Valuation of Startup Firms Under Market, Technology and Time Uncertainties

Leonardo Santiago, Assistant Professor, Federal University of Minas Gerais - UFMG, Production Engineering Department, Av. Antonio Carlos, 6627.Pampulha., Belo Horizonte, MG, 31270-901, Brazil, lsantiago@ufmg.br, Henrique Mendes Silva

We consider the problem of valuating a startup firm in the early stages of its creation under market, technology, and development time uncertainties. Our model takes into account the management value of the startup development process, and the opportunity created by those uncertainties. We analyze the impact of these uncertainties on the value of a startup and discuss the model's practical implementation.

#### 3 - Timing Managerial Hires for New Venture Expansion

John Angelis, Case Western Reserve University, 2680 Euclid Heights Blvd., #107E, Cleveland, OH, 44106, United States, john.angelis@case.edu

As entrepreneurs develop their new business ventures, they typically face a larger pool of qualified managerial candidates to help them successfully grow these ventures. But delaying top management hiring limits the speed at which these ventures can expand. We investigate this timing-of-hiring and talent-availability tradeoff and offer recommendations as to when and who entrepreneurs should hire.

#### 4 - Entrepreneurial Types and Economic Growth

Moren Levesque, Associate Professor, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, levesque@engmail.uwaterloo.ca, Maria Minniti

Economic growth models focus on R&D expenditure due to its ability to produce technological change. But they fail to account for the exceptional growth exhibited in recent years by countries such as China where R&D expenditure is virtually non-existing and for the lack of growth observed in countries such as Japan where R&D expenditure is significant. We show that the presence of a high number of imitative (not incurring R&D expenditure) entrepreneurs can be sufficient to generate economic growth.

## Sunday, 1:30pm - 3:00pm

## ■ SC01

### Supply Chain Management III

Contributed Session

Chair: Alex Ruiz-Torres, University of Texas El Paso, 500 W. University Ave., El Paso, TX, 79902, United States, aruiztor@utep.edu

#### 1 - RFID Selection and Implementation: An Expert Panel

Moderators: Peter Haug, Professor of Operations, Western Washington University, Department of Decision Sciences, 516 High Street, Bellingham, WA, 98225.9077, United States, peter.haug@wwu.edu, Stella Hua, Professor, Western Washington University, Manufacturing and Supply Chain Management, stella.hua@wwu.edu, Panelist: Doug Newell, Mike Nichols, Mark Wehrle

This panel discusses experiences with RFID technology. The panelists will concentrate on three topics: 1) long-term strategies on RFID selection and implementation; 2) integration of RFID into ERP systems; and 3) impact of RFID on supply chain performance. The panelists are Doug Newell, Naval Supply Systems, SUBASE Bangor; Mike Nichols, Global RFID Systems Manager, Intermec; Mark Wehrle, IBM Client Manager, Boeing Commercial Airplanes. The moderators are Professors Peter Haug and Stella Hua.

- 2 - Designing Semiconductor Supply Chains using a New Hybrid Push-pull Model with Multiple Pulling Point  
Seung-Hwan Kim, Arizona State University, 809 W.Grove Pkwy #1102, Tempe, AZ, 85283, United States, shkim@asu.edu, John Fowler, Joong-In Kim, Dan Shunk

We present a new hybrid push-pull supply chain design model with multiple pulling points, in the context of semiconductor products, processes, and organization forms. Feasible areas for placing pulling points are generated by product-process-organization form matrix. Then feasible designs are mathematically formulated and encapsulated into a model-based decision support tool. Robust and cost-effective designs against various external factors are identified based on user-specific scenarios.

- 3 - A Process Oriented Model for Assessing Usability of Supplier Selection Methods  
Cuneyt Altinoz, Assistant Professor, East Carolina University, 3134 Bate Building, ECU, Greenville, NC, 27858, United States, altinozc@ecu.edu, Scott Dellana

Since supplier selection is an applied practice, it is critical that researchers consider and incorporate usability elements in their work if the proposed methodologies will ever be adopted for use in industry. In this paper, we integrate focus group interviews with the existing usability literature to explore the requirements for successful adoption and continued use of supplier selection methodologies. We also propose a usability model to guide researchers.

- 4 - The Product Warranty and Quality as Competitive and Coordinate Strategies  
Yue Dai, Associate Professor, School of Management, Fudan University, Shanghai, China, Guoshun Road 670, Shanghai, 200433, China, yuedai2002@gmail.com, Sean Zhou

We study the product quality and warranty strategies of a two-echelon supply chain, while the demand is warranty-sensitive and the warranty cost is shared between the supplier and the retailer. We consider both cases when the product warranty is determined by the supplier and by the retailer. For each case, we derive the existence and uniqueness of a Nash equilibrium. We compare the performance of the decentralized and centralized systems and analyze the impact of channel coordination.

- 5 - Outsourcing Decision Considering Production Failure and Operating Costs  
Alex Ruiz-Torres, University of Texas El Paso, 500 W. University Ave., El Paso, TX, 79902, United States, aruiztor@utep.edu, Farzad Mahmoodi

This paper presents a model that considers two critical characteristics relevant to the outsourcing decision-making process: failure costs due to not meeting the production requirements (resulting in lost orders and customers), and operating costs attributed to managing the internal and outsourced production systems. The proposed model determines the optimal manufacturing network consisting of in-house and contract manufacturers.

## ■ SC02

### Empirical Research

Cluster: Supply Chain  
Invited Session

Chair: Vinayak Deshpande, Purdue University, 4024 Rawls Hall, West Lafayette, IN, 47907, United States, vinayak@purdue.edu

- 1 - A Demand Forecasting Model Using Financial Indicators and Experts' Input  
Vishal Gaur, Cornell University, vg77@cornell.edu, Nikolay Osadchiy, Sridhar Seshadri

We propose a forecast evolution model to investigate the correlation between the sales volume of a retailer and the state of the economy, characterized by the return on an aggregated financial index. We test this model on a panel data of sales forecast evolution for 214 US retailers over 10 years, each year containing multiple forecasts of varying terms. Our model is useful for demand forecasting, operational planning, and hedging demand risk.

- 2 - An Empirical Investigation into the Causes of Airline Flight Delays  
Kamalini Ramdas, Ramdask@Darden.virginia.edu, Jonathan Williams

We examine why airlines differ systematically in their on time performance. By testing fundamental queuing theory results via regression analysis, we quantify how expected delays increase with aircraft utilization, and also how capacity flexibility and variance in travel time along a route impact flight delays at any level of aircraft utilization. We also analyze scenarios that provide useful insights into airline scheduling decisions.

- 3 - Structural Estimation of Retail Demand Under Unobserved Out of Stocks

Marcelo Olivares, Assistant Professor, Columbia Business School, 3022 Broadway, Uris Hall #417, New York, NY, 10027, United States, molivares@columbia.edu, Eric Bradlow, Christian Terwiesch, Andres Musalem, Daniel Corsten

We develop a structural model to measure the effect of stock-outs on retail sales. We use a random coefficient logit model of consumer choice and estimate it using Bayesian methods. The methodology is tested using actual data on sales and availability of a product category (shampoo) collected from multiple stores of a Spanish retailer.

- 4 - Impact of Flight Schedules on Airline Flight Delays: An Empirical Investigation  
Vinayak Deshpande, Purdue University, 4024 Rawls Hall, West Lafayette, IN, 47907, United States, vinayak@purdue.edu, Mazhar Arikian

We analyze Airline on-time performance data posted by FAA. On-time performance is significantly affected by flight schedules set by airlines. We use the newsvendor model to test several hypotheses on airline scheduling policies.

## ■ SC03

### Service Outsourcing, Procurement, and Contract Design

Cluster: Supply Chain  
Invited Session

Chair: Fuqiang Zhang, Assistant Professor, University of California, Irvine, CA, United States, fzhang@uci.edu

- 1 - Outsourcing Service Processes to a Common Service Provider Under Price and Time Competition  
Gad Allon, Assistant Professor, Kellogg School of Management, 2001 Sheridan Road, Evanston, IL, 60208, United States, g-allon@kellogg.northwestern.edu, Awi Federgruen

In many industries, firms consider the option of outsourcing an important service process associated with the goods or services they bring to the market. We develop analytical models to characterize the benefits and disadvantages of outsourcing in service industries in which the retailers compete with each other in terms of the price they charge and/or the waiting time expectations and standards which they adopt and sometime advertise.

- 2 - Quality and Information Asymmetry in Service Outsourcing  
Fuqiang Zhang, Assistant Professor, University of California, Irvine, CA, United States, fzhang@uci.edu

This paper studies how to design service outsourcing contracts with quality consideration and the presence of asymmetric information. The results suggest that outsourcing companies can use relatively simple and yet robust contracts to assure a high level capacity and quality service even when they do not have perfect information about the service provider.

- 3 - Push or Pull? Auctioning Supply Contracts  
Cuihong Li, University of Connecticut, School of Business, Storrs, CT, United States, Cuihong.Li@business.uconn.edu, Alan Scheller-Wolf

Consider a buyer that sources from multiple potential suppliers via a competitive bidding process. The suppliers have heterogeneous production costs, which are private information. The buyer faces uncertain demand, and the winning supplier has to invest in production capacity before this uncertainty is resolved. We analyze and compare the outcomes of auctions for push and pull contracts.

## ■ SC04

### Tutorial: When More is Better

Cluster: Tutorials  
Invited Session

- 1 - When More is Better  
David Simchi-Levi, Professor, Massachusetts Institute of Technology, 77 Massachusetts Ave., Building 1-171, Cambridge, MA, 02139, United States, dslevi@mit.edu

A supply chain setting is inherently characterized by interactions between multiple products and agents seeking to maximize their own utility. In this presentation we use an axiomatic approach to explore the impact of product variety on customer demand, product price, system revenue and inventory levels. These results are applied to two supply chains. The first is a decentralized

multi-retailer system where each retailer sells a single product and retailers compete on price. The second supply chain is a single retailer selling multiple competitive products. We use the insight from our analysis to answer the question of whether more consumer choices is better for the customers or the seller.

## ■ SC05

### Nicholson Student Paper Prize Competition, I

Cluster: Nicholson Student Paper Prize  
Invited Session

Chair: Max Shen, Associate Professor, University of California, Department of IEOR, Berkeley CA 94720-1777, United States of America, shen@ieor.berkeley.edu

1- Percentile Optimization for Markov Decision Processes with Parameter Uncertainty  
Erick Delage, Stanford University edelage@stanford.edu

Abstract not available at this time.

2- Adaptive Jackknife Estimators for Stochastic Programming  
Amit Partani, University of Texas, partani@mail.utexas.edu

We discuss an adaptive jackknife estimator to reduce bias. It does not require a priori knowledge regarding the order of bias. We discuss convergence properties and apply it in the context of Monte Carlo-based simulation procedures in stochastic programming. We provide a bias reduction strategy for the optimality gap estimator of a candidate decision and optimal cost estimator based on the adaptive estimator. Computational results are presented to evaluate the performance of the adaptive estimator.

3- Encouraging Cooperation in Sharing Supermodular Costs  
Nelson Uhan, Ph.D Candidate, Massachusetts Institute of Technology, Operations Research Center, 77 Massachusetts Avenue, E40-130, Cambridge MA 02139, United States of America, uhan@mit.edu, Andreas Schulz

The least core value of a cooperative game is the minimum penalty for defection that encourages agent cooperation. We study complexity and algorithmic aspects of the least core value of cooperative games with supermodular costs. We also provide motivation for studying these games by showing that a particular class of optimization problems has supermodular optimal costs. This class includes many problems in machine scheduling, and more generally, combinatorial optimization.

## ■ SC06

### Operations Management and Security

Sponsor: Manufacturing & Service Oper Mgmt  
Sponsored Session

Chair: Noah Gans, OPIM Dept. - Wharton - Penn, 3730 Walnut St, Suite 500, Philadelphia, PA, 19104, United States, gans@wharton.upenn.edu

1 - Economic Analysis of the Registered Traveler Program  
Alan Scheller-Wolf, Tepper School of Business, Carnegie Mellon University, Pittsburgh, PA, 15213, United States, awolf@andrew.cmu.edu, Vineet Kumar, Ramayya Krishnan

The registered traveler program allows participants to use special, faster lines for security checks if they submit additional information to the government. We use a game-theoretic framework to model such travelers who value shorter wait times, but face a loss of utility if they reveal private information. We find conditions under which having a registered traveler program is socially suboptimal, and characterize the optimal level of information revelation when such a program is desirable.

2 - Economics of Supply Chain Security Management  
Mehmet Sekip Altug, PhD Candidate, Columbia University, 3022 Broadway, Uris Hall 4J, New York, NY, 10027, United States, msa2104@columbia.edu

We motivate the important problem of security management within supply chains. We approach the problem in a game theoretical setting distinguishing it from risk management problems. By defining it as a special case of Interdependent Security Problem, we show the existence of Nash Equilibrium for both the non-cooperative and the cooperative case between industry and the government. We propose to study different ways to coordinate the actions of supply chain partners with government initiatives.

3 - Pricing and Production Planning Under Supply Uncertainty with Multiple Customer Segments

Burak Kazaz, Associate Professor, Syracuse University, Whitman School of Management, Syracuse, NY, 13244, United States, bkazaz@syr.edu, Brian Tomlin, Nenad Jukic

We consider a firm that determines the production quantity, but obtains only a fraction due to supply uncertainty. The realized amount is allocated to two customer segments (high and low-level). The price for high-level customers is set before production occurs, and the price for low-level customers is determined after observing the supply. Using a poly-instantiated database, high-level customers have access to both prices, however, low-level customers can access the price only at their level.

4 - Securing the Containerized Supply Chain: An Economic Analysis of C-TPAT

Nitin Bakshi, Doctoral Student, Univ. of Pennsylvania, 3730 Walnut Street, Ste 500, Philadelphia, PA, 19104, United States, nbakshi@wharton.upenn.edu, Noah Gans

Companies that comply with the Customs-Trade Partnership Against Terrorism (C-TPAT) take extra security measures with their shipping containers and, in return, enjoy preferential treatment at entry points into the US. We model C-TPAT as a Stackelberg game, characterize the structure of the equilibrium, and provide comparative statics results.

## ■ SC07

### Contemporary Issues in Supply Chain Management

Sponsor: Manufacturing & Service Oper Mgmt  
Sponsored Session

Chair: Kamran Moinzadeh, Professor, U. of Washington Business School, Box 353200, Seattle, WA, 98195-3200, United States, kamran@u.washington.edu

1 - A Single Period Model with Multiple Ordering Opportunities and Fixed Ordering Cost

Kamran Moinzadeh, Professor, University of Washington Business School, Box 353200, Seattle, WA, 98195-3200, United States, kamran58@comcast.net, Yong-Pin Zhou, Apurva Jain

We consider a fixed-life cycle product with random demand. Orders can be placed at any time, and the replenishment cost has both fixed and variable components. At the end of the product's life cycle, leftover has salvage value and shortage incurs penalty cost. Examples of such products exist in retailing, hi-tech products, and healthcare. We first propose an optimal replenishment policy for a single retailer location, and then expand to include the case with one supplier and many retailers.

2 - Bullwhip Mitigation with Advance Forecast Sharing and Order Updates

Hau Lee, Professor, Stanford University, Graduate School of Business, Stanford, CA, 94305, United States, lee\_hau@gsb.stanford.edu, Li Chen

How does advance demand information reduce the supply chain bullwhip effect? How about if the retailer simply places advance orders but updates it over time? Using a very general demand model, we can show that both can reduce the bullwhip, but the advance order update approach eliminates the need for the supplier to guess the retailer's underlying ordering policy.

3 - Inventories with Multiple Supply and Demand Sources and Networks of Queues with Overflow Bypasses

Jeannette Song, Duke University, Fuqua School of Business, Durham, NC, 27708, United States, jssong@duke.edu, Paul Zipkin

Consider an inventory system with several supply sources having different costs and leadtimes. Under a plausible heuristic policy, the supply system becomes a network of queues with a special routing mechanism called an overflow bypass. The solution has a simple product form.

4 - Advance Orders and Market Segmentation in a Multi-product Supply Chain

Ozalp Ozer, Stanford University, Stanford, CA, 94305, United States, oozzer@stanford.edu, Holly Lutze

We consider a generalized model of a multi-product manufacturer selling to multiple non-identical retailers over a finite planning horizon. Retailers place orders for immediate delivery or place orders in advance of their needs, thereby accepting a particular demand lead time. We determine an optimal menu of demand lead times and corresponding payments that maximize the manufacturer's profit. We explore the impact of design issues, such as postponement, on optimal contract parameters.

## ■ SC08

### Measuring Risks and Benefits of Mitigation Strategies

Cluster: Managing Disruptions in Supply Chains  
Invited Session

Chair: Sanjay Kumar, University of Texas at Dallas, Richardson, TX, United States, Skumar@utdallas.edu

#### 1 - A DEA-based Method for Uncertain Productions

Regina Fuchs, University of Hohenheim, Lehrstuhl  
Industriebetriebslehre (510A), Schloss, Osthof Nord, Stuttgart,  
70599, Germany, regfuchs@uni-hohenheim.de

Production is often influenced by uncertain variables which cannot be quantified. Thus at different moments we may observe different values of output for the same input and vice versa. This contribution discusses a DEA-based methodology that considers this uncertainty in efficiency measurement. Instead of comparing one single observation for each plant with the production possibilities we will use a sample of observations, which describes the production possibilities of the plant itself.

#### 2 - Cost-benefit Analysis of Supply Chain Risk Management Strategies

Arief Adhitya, Research Engineer, Institute of Chemical and  
Engineering Sciences, 1 Pesek Road, Jurong Island, Singapore,  
627833, arief\_adhitya@ices.a-star.edu.sg,  
Rajagopalan Srinivasan, Iftekhar Karimi

Today's supply chain operations are subject to various risks. Supply chain risks can be quantified in terms of potential loss of money, time, or material through simulation. Consequently, risk management strategies can be optimized through a simulation-optimization methodology and evaluated by performing a cost-benefit analysis. In this paper, the proposed approach is demonstrated using a refinery supply chain case study.

#### 3 - A New Dual Representation of Entropic Risk Measures

Andrew Lim, Associate Professor, IEOR Department, 4141  
Etcheverry Hall, University of California, Berkeley, CA, 94720,  
United States, lim@ieor.berkeley.edu, Peng Li, George  
Shantikumar

We present a new duality result for entropic risk measures which generalizes in a non-trivial way the well known relationship between relative entropy and exponential utility.

## ■ SC09

### Joint Session Homeland/DAS: Decision Models for Homeland Security

Cluster: Homeland Security, Decision Analysis  
Invited Session

Chair: Robin Dillon-Merrill, Assistant Professor, Georgetown  
University, 418 Old North, Washington, DC, 20057, United States,  
rld9@georgetown.edu

#### 1 - Using Probabilistic Terrorism Risk Modeling For Regulatory Benefit-Cost Analysis

Henry Willis, Policy Researcher, RAND Corporation,  
4570 Fifth Avenue, Suite 600, Pittsburgh, PA, 15217,  
United States, hwillis@rand.org, Tom LaTourrette

The White House Office of Management and Budget directs agencies to use benefit-cost analyses to evaluate proposed regulations. However, data and methods for estimating the benefits of terrorism security regulations cannot at present support such analysis. This paper demonstrates a framework for using probabilistic terrorism modeling in a break-even analysis of a regulatory action and discusses how this type of analysis can be further integrated into the regulatory review process.

#### 2 - Optimal Resource Allocation for Defense of Multiple Targets

Vicki Bier, University of Wisconsin-Madison, Dept. of Industrial  
and Systems Eng., 1513 University Avenue, Madison, WI, 53706,  
bier@engr.wisc.edu, Jaime Menoyo, Naraphorn Haphuriwat

Allocating a fixed budget to defense of multiple targets is a challenging task. We apply a rigorous model to the problem of identifying optimal allocations. In particular, we explore how the optimal allocation depends on the cost effectiveness of security investments, the defender's valuations of the targets, and the defender's uncertainty about the attacker's target valuations. Our results show that the cost effectiveness of defensive investment has a huge impact on the optimal allocation.

#### 3 - Bioterrorism Risk Analysis

Gregory Parnell, Professor of Systems Engineering, United States  
Military Academy, Mahan Hall 432, West Point, NY, 10996,  
United States, gregory.parnell@usma.edu

This presentation reports on the National Research Council Study on Methodological Improvements to the Department of Homeland Security's Biological Agent Risk Analysis. Over the past year, the committee reviewed the DHS bioterrorism risk methodology and provided recommendations for improvement. The committee's recommendations will also influence DHS's strategic, integrated Chemical, Biological, Radiological and Nuclear risk assessment due in June 2008.

#### 4 - Challenges in Security Risk Analysis

Robin Dillon-Merrill, Assistant Professor, Georgetown University,  
418 Old North, Washington, DC, 20057, United States,  
rld9@georgetown.edu, Robert Liebe

Security decisions must be based on threat scenario likelihoods, facility vulnerabilities, and the impacts of a successful attack in terms of mission loss, personnel loss, and economic loss. While the need for a threat x likelihood x consequence approach is well documented, implementing such a process is not simple. This presentation discusses several approaches to risk-based decision making as well as organizational consequences and challenges encountered implementing the processes.

## ■ SC10

### Algorithms, Complexity and Computational Issues in Inventory Games

Cluster: Inventory  
Invited Session

Chair: Mahesh Nagarajan, Asst. Professor, University of British  
Columbia, 2053 Main Mall, Vancouver, BC, v6t 1z2, Canada,  
mahesh.nagarajan@sauder.ubc.ca

#### 1 - Cost Allocation for Joint Replenishment Models

Jiawei Zhang, Assistant Professor, New York University,  
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We consider the one-warehouse multiple retailer model with a submodular joint setup cost. We focus on how the cost, under an optimal power-of-two policy, should be allocated to the retailers. This question generates an interesting class of cooperative games. We prove that such cooperative games have non-empty cores. The key to our results is a strong duality theorem for the one-warehouse multiple retailer problem under power-of-two policies.

#### 2 - Inventory Centralization Games with Price-dependent Demand and Quantity Discount

Xin Chen, University of Illinois at Urbana-Champaign,  
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xinchen@uiuc.edu

Consider a distribution system consisting of a set of retailers, which are facing a single period price dependent demand of a single product. The retailers may place joint orders and share inventory to reduce their operating costs. Under rather general assumptions, we prove that the resulting inventory centralization game has a nonempty core. We also show how to compute an allocation in the core.

#### 3 - Solving Partially Observable Markov Decision Processes (POMDP) by Computational Geometry

Hao Zhang, Assistant Professor, University of Southern California,  
3670 Trousdale Pkwy, Bridge Hall 401, Los Angeles, CA, 90089,  
United States, hao.zhang@marshall.usc.edu

The POMDP model has wide applications but is often hampered by the intractability of the solution algorithms. We show that this problem can be decomposed into several standard problems in computational geometry. Thus, any advancement on the latter can improve the efficiency in solving the former. The proposed method provides a new perspective to the POMDP problem.

#### 4 - Stable Coalitions in Inventory Games

Mahesh Nagarajan, Asst. Professor, University of British Columbia,  
2053 Main Mall, Vancouver, BC, v6t 1z2, Canada,  
mahesh.nagarajan@sauder.ubc.ca

We analyze consider a class of inventory games in which players have incentives to form coalitions. We analyze stable outcomes in such games as fixed points of suitably defined set valued maps. This framework captures several of the existing dynamic concepts of stability, facilitates efficient, exact and approximate characterizations, where calculating the set of stable outcomes is usually computationally intractable.

## ■ SC11

### Manufacturing Complexity Management for Product Variety

Cluster: Manufacturing  
Invited Session

Chair: Jack Hu, University of Michigan, Hayward St., 2250 G.G. Brown, Ann Arbor, MI, 48109, United States, jackhu@umich.edu

Co-Chair: Jeonghan Ko, University of Michigan, 2350 Hayward St., 2250 G.G. Brown, Mechanical Engineering, Ann Arbor, MI, United States, jeonghan@umich.edu

#### 1 - On the Boundaries of Mass-customization: A Real World Case Study

Silvia Ponce, Associate Professor, HEC Montreal, 3000, Ch. Cote-Ste-Catherine, Montreal, QC, H3T 2A7, Canada, Silvia.Ponce@hec.ca, Valerie Paquin

Mass-customization departs from traditional production systems and manufacturing strategies as described by Hayes & Wheelwright's product-process matrix and Skinner's focused-factories. Trade-offs between variety and volume, and among manufacturing-outputs, seem meaningless. Ulrich's theory of boundary critique helps to understand a real-world case showing that mass customization boundaries are not always sharp.

#### 2 - Complexity Analysis of Assembly Supply Chain Configurations

Hui Wang, Graduate Student Research Assistant, University of Michigan, 1932 White Oak Ln, Ypsilanti, MI, 48198, United States, johnwang@umich.edu, Jack Hu, Goker Aydin

We propose a metric for the complexity of an assembly chain. This metric takes into account the supply chain configuration, product variety offered by the supply chain, and the demand split among the products. We investigate how this complexity metric relates to the cost of the supply chain and show that complexity and cost are equivalent under certain conditions. We illustrate how this complexity measure can be used as a proxy for cost in decision making.

#### 3 - Managing The Product Variety Through Information Sharing:

##### A Case Study from the Automotive Industry

Sang Hwa Song, Professor, University of Incheon, 7-46 Songdo-dong, Yeonsu-gu, Incheon, 406840, Korea, Republic of, songsh@incheon.ac.kr, Seockjin Hong, Taebok Kim

Manufacturers are trying to increase product variety to improve customer service levels. Many researches focused on managing supply since the increased variety means the increased complexity which causes problems in supply chain. These efforts include component modularity and delayed customization strategy. However, managing supply complexities typically entails costs. Instead we present a demand side management method based on the case study in the automotive industry.

#### 4 - Measuring Complexity in Mid-range Products

Kevin Caskey, Associate Professor, State Univ of New York at New Paltz, 1 Hawk Drive, School of Business, New Paltz, NY, 12561, United States, caskeyk@newpaltz.edu

Product complexity impacts sourcing. For mid- complexity and volume products, we have found that some manufacturers prefer to source locally while others source from lower cost countries. Complexity includes: size, capturing the density of the design network or the number of engineering specifications; frequency, quantifying how often and how much of the design is altered; precision, measuring tightness of design specifications. We will discuss complexity measures and initial field results.

## ■ SC12

### Distributed Computing and Stochastic Models

Cluster: Scheduling  
Invited Session

Chair: Jay Sethuraman, Associate Professor, Columbia University, Dept. of IEOR, New York, NY, 10012, United States, js1353@columbia.edu

#### 1 - An Optimizing Scheduler for Large-Scale Stream-Based Distributed Computer Systems

Joel Wolf, IBM Research, IBM T.J. Watson Research Center, Hawthorne, NY, 10532, United States, jlwolf@us.ibm.com, Nikhil Bansal, Lisa Fleischer, Kirsten Hildrum, Deepak Rajan

Stream processing systems pose unique scheduling challenges. Jobs process unending streams of data. The same job may be done in multiple ways, and may be interconnected in various ways to other jobs. This is very different from traditional scheduling. We present a mathematical overview of a scheduler for a distributed stream processing system. The scheduler chooses which jobs to

accept, how to connect them, how much processing to allocate to them, and how to distribute this work on the system.

#### 2 - Stochastic Scheduling Subject to Preemptive-repeat Breakdowns with Incomplete Information

Xian Zhou, Associate Professor, The HK Polytechnic University, AMA Department, Hung Hom, Kowloon, Hong Kong - ROC, maxzhou@polyu.edu.hk, Xiaoqiang Cai, Xianyi Wu

We address a stochastic scheduling problem subject to preemptive-repeat machine breakdowns with incomplete information on the processing times and machine up/downtimes. We investigate the probabilistic characteristics of the model and apply the results to derive the optimal static and dynamic policies for a large class of performance measures. Under proper conditions, the optimal dynamic policies can be determined by one-step reward rates.

#### 3 - Analysis of Join-the-Shortest-Queue Routing in Web Server Farms

Mor Harchol-Balter, Associate Professor, Carnegie Mellon University, Computer Science Dept., 5000 Forbes Ave., Pittsburgh, PA, 15213, United States, harchol@cs.cmu.edu, Varun Gupta, Ward Whitt, Karl Sigman

We present the first analysis of the Join-the-Shortest-Queue task assignment policy for Web server farms. Web server farms involve Processor-Sharing servers. This work introduces a new technique: Single-Queue-Approximation (SQA), and uses the technique to prove some interesting insensitivity properties for Web server farms.

## ■ SC13

### Integer Programming and Applications

Sponsor: Optimization/ Integer Programming  
Sponsored Session

Chair: Yanjun Li, Assistant Professor, Purdue University, 403 W. State Street, West Lafayette, IN, 47907, United States, li14@purdue.edu

#### 1 - Maximum Commonality Problems: Applications and Analysis

Milind Dawande, Associate Professor, University of Texas at Dallas, School of Management, Richardson, TX, 75083, United States, milind@utdallas.edu, Vijay Mookerjee, Subodha Kumar, Chelliah Sriskandarajah

Motivated by applications in extreme programming, we discuss algorithmic results for the problem of assigning pairs of developers to modules so as to maximize a graph-theoretic notion of commonality — a measure of the extent to which common developers work on related modules — subject to a load-balancing constraint.

#### 2 - Simple-set Cutting Planes for Mixed-integer Programming

Ismael Regis de Farias JR., State University of New York, Dept. of Ind. and Syst. Eng., 403 Bell Hall, Buffalo, NY, 14260, United States, defarias@buffalo.edu, Ming Zhao

We present extensions of mixed-integer rounding (MIR) and mixing-MIR inequalities to mixed-integer programming. In addition, we show how to apply our mechanism to generate inequalities in nonconvex nonlinear and mixed-integer nonlinear programming.

#### 3 - A Greedy Bound for the Change-making Problem

Ping Heidi Huang, PhD Candidate, Krannert School of Management, Purdue University, 403 W. State Street, West Lafayette, IN, 47907, United States, huang74@exchange.purdue.edu, Kwei Tang, Thomas Morin

The goal of the generalized changing-making problem is to minimize the total cost of using a set of coins to make a change. We obtain a greedy bound that exists in all coin systems, and then propose a partial greedy method. Its run time is independent of the change amount. The greedy bound can also be used in testing whether a coin system is canonical, and it outperforms existing bounds. Finally, an algebraic structure of compositions is presented to simplify the analysis of large coin systems.

## ■ SC14

### Systems of Systems Optimization

Sponsor: Optimization/ Nonlinear Programming  
Sponsored Session

Chair: William Crossley, Associate Professor, Purdue University, School of Aeronautics and Astronautics, 315 N Grant St, West Lafayette, IN, 47907-2023, United States, crossley@purdue.edu

#### 1 - Systems of Systems Optimization Applied to Simultaneous Aircraft Design and Fleet Allocation

Paul Frank, The Boeing Company, P.O. Box 3707, MC 7L-21, Seattle, WA, 98124-2207, United States, paul.d.frank@boeing.com, Evin Cramer, John Sabino, Sharon Arroyo

We examine optimization issues for systems of systems. This includes addressing the tradeoff of the strength of the central authority versus component autonomy and predictive modeling of components' input-output responses. The problem of simultaneous aircraft design and fleet allocation is used to illustrate a solution approach to these issues.

#### 2 - Allocation of Variable Resources as a System of Systems Problem

William Crossley, Associate Professor, Purdue University, School of Aeronautics and Astronautics, 315 N Grant St, West Lafayette, IN, 47907-2023, United States, crossley@purdue.edu, Muharrem Mane

This study investigates the problem formulation of resource allocation and aircraft design as a System of Systems problem. The presence of a yet-to-be-designed aircraft in the problem statement makes this problem one of allocation of variable resources. The resulting statement is a Mixed-Integer, Non-Linear Programming (MINLP) problem. The study uses a problem in the context of fractional operations and investigates the impact of a new, yet-to-be-designed aircraft on the fleet operating cost.

#### 3 - Aircraft Sizing & Allocation as a System-of-systems Problem via Surrogates & Multiobjective Design

Joshua Frommer, The Boeing Company, P.O. Box 3707 MC 0R-MK, Seattle, WA, 98124-2207, United States, joshua.b.frommer@boeing.com, William Crossley

Choosing the best mixture of systems to provide desired capabilities is a system-of-systems problem. A multiobjective MINLP problem formulation describes simultaneous aircraft sizing and fleet allocation to maximize a capability objective and minimize a cost objective. Surrogate models replace the analysis for predicting characteristics of new aircraft, and a genetic algorithm generates solutions to the problem. This formulation allows a fleet-level assessment of a new aircraft technology.

#### 4 - Modeling Multiple Infrastructure Systems

Srinivas Peeta, Professor, Purdue University, Civil Engineering, 550 Stadium Mall Drive, West Lafayette, IN, 47907-2051, United States, peeta@purdue.edu, Pengcheng Zhang

This presentation focuses on the analysis of multiple infrastructure systems from a holistic view using the system of systems framework. The interactions among the various systems are analyzed from spatial economics perspective under both equilibrium and dynamic disequilibrium settings. Application of proposed models in network design and infrastructure security problems is briefly discussed.

## ■ SC15

### Games, Equilibrium, and Variational Inequality Problems

Sponsor: Optimization/ Linear Programming and Complementarity  
Sponsored Session

Chair: Paul Tseng, Professor, University of Washington, Department of Mathematics, Box 354350, Seattle, WA, 98195-4350, United States, tseng@math.washington.edu

#### 1 - Parallel Optimization and the Toolkit for Advanced Optimization

Todd Munson, Dr., Argonne National Laboratory, Mathematics and Computer Science Division, Argonne National Laboratory, Argonne, IL, 60439, United States, tmunson@mcs.anl.gov

We begin by presenting information on the design and implementation of the Toolkit for Advanced Optimization (TAO), and how the reuse of common optimization components is facilitated within the framework. We then discuss some of the algorithms bundled with TAO for solving complementarity and optimization problems. Results for these methods are given along with an indication of their parallel performance.

#### 2 - MPEC Approaches to Estimation of Pricing Games

Che-Lin Su, Post-Doc Research Fellow, CMS-EMS, Kellogg School, Northwestern Univ, CMS-EMS, Kellogg School of Management, 580 Leverone Hall, 2001 Sheridan Road, Evanston, IL, 60208-2014, United States, c-su@kellogg.northwestern.edu, Kenneth Judd

Maximum likelihood estimation of structural models is regarded as computationally difficult. This impression is due to a focus on the Nested Fixed-Point method. The NFXP approach is inappropriate for estimating games since it requires finding all Nash equilibria of a game for each parameter vector considered. We present an MPEC approach to the structural estimation problem. We illustrate with an example that the MPEC approach is immediately applicable to games with multiple equilibria.

#### 3 - Some Continuity Properties of Affine Variational Inequalities

Stephen Robinson, Professor, University of Wisconsin-Madison, ISyE/UW-MADISON, 1513 University Ave Rm 4161A, Madison, WI, 53706-1539, United States, smrobins@wisc.edu

We present some results about continuity of solutions of affine variational inequalities when the polyhedral convex sets over which they are posed may change. Certain matrix classes make these properties possible, and we demonstrate some of these relationships. This permits identification of entire classes of problems whose solutions remain stable when resource or performance constraints change.

#### 4 - Linear Complementarity Problems: Matrix Classes, Algorithms and EP-theorems

Tibor Illes, Associate Professor, Eotvos Lorand University, Pázmány Péter Sétány 1/C, Budapest, Hungary, illes@cs.elte.hu

In this talk we compare pivot and interior point algorithms for different classes of linear complementarity problems (LCP). Using duality theorem of LCP in EP-form, we generalize our algorithms in the following way: we start to solve LCP, without a priori information about the property of the matrix (sufficiency, bisymmetry, positive definiteness). We either solve the LCP problem, or solve its dual problem, or give a certificate that the input matrix is not sufficient.

## ■ SC16

### Discrete Optimization

Contributed Session

Chair: Yash Aneja, Professor, University of Windsor, 401 Susnet, Odette School of Business, Windsor, ON, N9B3P4, Canada, aneja@uwindsor.ca

#### 1 - Computational Performance of a New Disaggregated Formulation of the Generalized Assignment Problem

Ishwar Murthy, Professor, IIM Bangalore, IIM Campus, Bannerghatta Rd, Bangalore, KA, 560076, India, ishwar@iimb.ernet.in, Saby Mitra, Sam Ransbotham

We present a new disaggregated formulation of the Generalized Assignment Problem (GAP). We also introduce strong inequalities which are specific to this formulation. We test the strength of this formulation on standard benchmark problems. We show the new formulation to be significantly stronger than other known formulations.

#### 2 - Comparison of Linear Formulations of the 0-1 Quadratic Knapsack Problem

Richard Forrester, Assistant Professor, Dickinson College, College and Louthier Streets, Carlisle, PA, 17013, United States, forrestr@dickinson.edu

There exists a variety of linear formulations of 0-1 Quadratic Programs in the literature, each designed with an emphasis for either conciseness or strength of the continuous relaxation. In this talk we examine a number of different linear models of the 0-1 Quadratic Knapsack Problem, including those that combine the attributes of conciseness and bounding strength. Extensive computational results are presented, and they indicate the superior formulation.

#### 3 - Cardinality Cuts: Extension to General Integer Variables

Osman Oguz, Bilkent University, 06800 Bilkent, Ankara, Turkey, ooguz@bilkent.edu.tr

It is usually assumed that valid inequalities/cuts are usable for integer programs with general integer variables, based on transformation of integer variables into 0-1 variables. We show that the cardinality cuts developed recently, may be used for problems with general integer variables without resorting to variable transformation.

#### 4 - Revisiting the Greedy Approach to Submodular Set Function Maximization

Pranava Goundan, Consultant, Analytics Operations Engineering, 111 Devonshire Street, 8th Floor, Boston, MA, 02109, United States, pranava@alum.mit.edu, Andreas Schulz

We consider maximizing a nondecreasing submodular set function over matroids. Classical results on the greedy algorithm to solve this problem assume the

existence of an optimal oracle that identifies at each step an element of maximum incremental value to the solution. With only an approximate oracle, we generalize the performance bounds of the greedy algorithm. Thereby we reinterpret, unify, and improve on results for generalized assignment, combinatorial auctions and related problems.

- 5 - Pure Fixed Charge Transportation Problem: A Polyhedral Study  
Yash Aneja, Professor, University of Windsor, 401 Susnet,  
Odette School of Business, Windsor, ON, N9B3P4, Canada,  
aneja@uwindsor.ca, Yogesh Agarwal

We give a set covering formulation of the Pure Fixed Charge Transportation Problem (PFCTP). Here we are given  $m$  sources and  $n$  sinks with  $a(i)$  units available at source  $i$ , and  $b(j)$  units needed at sink  $j$ . There is a fixed cost  $f(i,j)$  to open the route from  $i$  to  $j$ , and unlimited amount can be shipped on this open route with no variable cost. We give conditions for a constraint to be a facet and provide a branch-and-cut algorithm. Some computational experience with this approach is presented.

## ■ SC17

### Social and Technical Aspects of Information Assurance

Sponsor: Information Systems Society  
Sponsored Session

Chair: Raj Sharman, Assistant Professor, SUNY, Buffalo, NY, 325 F. Jacobs Management Center, Buffalo, NY, 14260, United States, rsharman@buffalo.edu

- 1 - Information Theoretic Approach for Characterization of Network Traffic

Sanjay Goel, Assistant Professor, SUNY, Albany, NY,  
1400 Washington Avenue, Albany, NY, 12222, United States,  
goel@albany.edu, Adnan Baykal

This work presents a novel approach of deep packet inspection by using algorithmic complexity for classification of packet content. Complexity is inherently incomputable however measures for approximating complexity are available. Complexity is computed for packet payload to classify them as benign or malicious. Intrusion data from the 1999 DARPA dataset is used for validation of the approach. This measure that may be useful for detection of previously unknown attacks.

- 2 - Specifying Digital Forensics: Formalizing Forensics Policies  
Barbara Endicott-Popovsky, Director, Center for Information Assurance and Cybersecurity (CIAC), University of Washington, Box 354985 4311-11th Ave NE, Seattle, WA, 98199, United States, endicott@u.washington.edu,  
Deborah Frincke, Carol Taylor

Digital forensic practice is often ad-hoc and generally lacks widely accepted models or principles. As the field matures, advances are needed in how forensic capabilities are specified, implemented and verified. In this paper we propose a method for specifying forensic properties borrowed from the computer security domain. Our previous work stated forensic policies informally; here we formalize forensic policies in order to add preciseness and eliminate potential fuzziness in policy definition.

- 3 - Critical Risk Factors Affecting the Effectiveness of Public Health Information Systems Infrastructure  
Raj Sharman, Assistant Professor, SUNY, Buffalo, NY, 325 F. Jacobs Management Center, Buffalo, NY, 14260, United States, rsharman@buffalo.edu, Radhika Kasturi, Shambhu Upadhyaya, Insu Park, Deepa Velu, H. R. Rao

This study explores factors affecting hospital information infrastructure in the context of emergencies. Specifically, this study addresses issues relating to risks to hospital information infrastructure, infrastructure effectiveness, mitigating factors across stakeholders and how disasters affect the stakeholders' perception of risks? This study develops a framework on risk mitigation with a goal of reducing risks and costs relating to provisioning of health services by hospitals during major critical incidents.

## ■ SC18

### Topics in Mixed Integer Nonlinear Programming

Sponsor: INFORMS Computing Society  
Sponsored Session

Chair: Jeff Linderoth, University of Wisconsin-Madison, 1513 University Avenue, Madison, WI, 53706-1572, United States, jtl3@lehigh.edu

- 1 - Conic Mixed-integer Programming with Bounded Integer Variables

Vishnu Narayanan, University of California, Berkeley, IEOR Department, UC Berkeley, 4141 Etchevery Hall (Mail Code 1777), Berkeley, CA, 94720, United States, vishnu@ieor.berkeley.edu, Alper Atamturk

We present valid inequalities for conic mixed-integer programs with bounded integer variables via sequence independent lifting. We also analyze the special case of binary variables and present computational results on solving these problems.

- 2 - Heuristics for Mixed Integer Nonlinear Programming  
Kumar Abhishek, Lehigh University, 200 W Packer Avenue, Bethlehem, PA, 18015, United States, kua3@lehigh.edu

We present extensions of well-known primal heuristics for mixed integer linear programming such as feasibility pump, local branching and RINS, to mixed integer nonlinear programs. The heuristics have been implemented within FilMINT, a branch-and-cut solver for MINLPs. Results of detailed computational experiments will be presented.

- 3 - MIQCP: In Between QCP and MILP

Christian Bliet, Principal Scientist, ILOG, 1681 HB2  
Route des Dolines, Valbonne, 06560, France, bliet@ilog.fr

A natural approach for solving Mixed Integer Quadratically Constrained Programs (MIQCP) is to solve a Quadratically Constrained Program (QCP) at each node in the tree. An alternative is to solve them as MILP using branch and cut. In this talk, we will describe and compare both approaches, which are now implemented in ILOG CPLEX.

## ■ SC19

### ICS Leading Edge Tutorials

Sponsor: INFORMS Computing Society  
Sponsored Session

Chair: Robert Dell, Professor, Operations Research Department, Naval Postgraduate School, Monterey, CA, 93943, United States, Dell@nps.edu

- 1 - Critical Thinking for Complex Network Systems: Trends, Tools, and Techniques for the OR Analyst

David Alderson, Assistant Professor, Naval Postgraduate School, Operations Research Department, 1411 Cunningham Rd, Monterey, CA, 93943, United States, dlalders@nps.edu

Recent attention toward the large-scale structure of many important complex network systems has led to the proliferation of new theories that attempt to explain, predict, and control their ongoing development and behavior. This tutorial will present the origins, contributions, and trends in the emerging field of network science. It will contrast the predominant perspective in the existing network science literature with that of decision science and highlight opportunities for contribution.

- 2 - (Almost) Transparent Parallel and Distributed Optimization

Pascal Van Hentenryck, Brown University, Box 1910, Providence, RI, United States, pvh@cs.brown.edu

The availability of commodity multi-core and multi-processor machines and the inherent parallelism in optimization applications offer significant opportunities for high-performance systems. They also present a fundamental challenge: how to exploit parallelism transparently to speed up optimization algorithms. This tutorial shows how to parallelize optimization algorithms almost transparently by using advanced programming language concepts.

## ■ SC20

### Multiattribute Utility: Theory and Practice

Sponsor: Decision Analysis

Sponsored Session

Chair: Ali Abbas, Assistant Professor, University of Illinois at Urbana-Champaign, Industrial and Ent. Systems Engineering, 104 S. Mathews Ave, Urbana, IL, 61801, United States, aliabbas@uiuc.edu

#### 1 - Invariance Relations for N-switch Utility Functions with Multiple Attributes

Ali Abbas, Assistant Professor, University of Illinois at Urbana-Champaign, Industrial and Ent. Systems Engineering, 104 S. Mathews Ave, Urbana, IL, 61801, United States, aliabbas@uiuc.edu

We extend Pfanzagl's invariance principle to multiple attributes. We discuss invariance on all attributes; a proper subset; and invariance with identical shift parameters. We show that any continuous and monotonic MAU with mutual utility independence is an invariant utility function to a multivariate transformation. We discuss the functional equations whose solutions yield n-switch multiattribute utility functions between multivariate lotteries when modified by monotonic transformations.

#### 2 - Using MAU to Build Consensus for Addressing a Major Environmental Problem

Lee Merkhofer, lmerkhofer@comcast.net

The Faro Mine in the Canadian Yukon has, reportedly, created a toxic nightmare that will pose risks for hundreds of years and cost millions to manage. Multi-attribute utility analysis is being used to engage technical experts, the government, and impacted parties in a collaborative process to evaluate alternatives for addressing the problem.

#### 3 - Multiattribute Utility as a Mixture of Exponential Utilities and Stochastic Dominance

Ilia Tsetlin, Assistant Professor of Decision Sciences, INSEAD, 1 Ayer Rajah Avenue, Singapore, 138676, ilia.tsetlin@insead.edu, Robert L. Winkler

Suppose that a decision maker prefers more of any attribute to less, and prefers combining good random variables with bad ones. We show that her utility is then a mixture of multiattribute exponential utilities. We consider dominance implications for multivariate distributions and relations to multiattribute utilities based on various independence assumptions. The results can be important for utility assessment and decision making.

#### 4 - Normative Decision Making with Multiattribute Targets

James Matheson, SmartOrg Inc., 855 Oak Grove Ave, Menlo Park, CA, 94025, United States, jmatheson@smartorg.com, Ali Abbas

A normative multiattribute target is a deterministic region in the space of multiattribute outcomes and has two properties: (1) the probability the outcome lies within it is equal to the expected utility, and (2) all outcomes within the target region are preferred to all outcomes outside it. These properties lead to a unique characterization of multiattribute targets in terms of the value aspiration equivalent, which extends the duality between probability and utility to multiple attributes.

## ■ SC21

### Graphical Models for Decision Analysis

Sponsor: Decision Analysis

Sponsored Session

Chair: Barry Cobb, Virginia Military Institute, Scott Shipp Hall, Lexington, VA, United States, cobbbr@vmi.edu

#### 1 - Arc Reversals in Hybrid Bayesian Networks with Deterministic Variables

Esma Nur Cinicioglu, PhD Candidate in Operations Management, University of Kansas School of Business, 1300 Sunnyside Avenue, Summerfield Hall, Lawrence, KS, 66045-7585, United States, esmanur@ku.edu, Prakash P. Shenoy

We discuss arc reversals in hybrid Bayesian networks with deterministic variables. Hybrid Bayesian networks contain a mix of discrete and continuous chance variables. A chance variable is said to be deterministic if its conditional distributions have zero variances. Arc reversals are important in making inferences in hybrid Bayesian networks and influence diagrams.

#### 2 - Maximum Likelihood vs. Least Squares for Estimating Mixtures of Truncated Exponentials

Antonio Salmeron, Associate Professor, University of Almeria, Carrera de Sacramento s/n, Almeria, AL, E-04120, Spain, antonio.salmeron@ual.es, Helge Langseth, Thomas Nielsen, Rafael Rumi

Mixtures of truncated exponentials (MTEs) have become one of the main tools for dealing with discrete and continuous variables simultaneously in probabilistic graphical models. Existing estimation methods for MTEs are based on least squares (LS). In this work we compare them with numerical maximum likelihood (ML) estimation, with the aim of determining whether or not the LS approximation can be used to substitute ML in more elaborated procedures.

#### 3 - Computing the Full Distribution of the Max of Two Gaussians Using Hybrid Bayesian Networks

Prakash P. Shenoy, Distinguished Professor, University of Kansas School of Business, 1300 Sunnyside Avenue, Summerfield Hall, Lawrence, KS, 66045-7585, United States, pshenoy@ku.edu, Esma Nur Cinicioglu

We describe a procedure for computing the full distribution of the max of two Gaussians using hybrid Bayes nets. We represent the max of two Gaussians as a Bayesian network, convert it to a mixture of Gaussians Bayesian network, and use the Lauritzen-Jensen algorithm to compute the full distribution exactly.

#### 4 - Evaluating Influence Diagrams Using Decision Circuits

Debarun Bhattacharjya, Stanford University, Terman Engineering Center, Stanford University, Stanford, CA, 94305, United States, debarunb@stanford.edu, Ross Shachter

We introduce decision circuits as a means to exploit the local structure as well as the conditional independence found in decision problems and to improve the performance of influence diagram analysis. We build on the probabilistic inference algorithms using arithmetic circuits to represent Bayesian belief networks as developed by Darwiche.

#### 5 - Influence Diagrams for Pricing and Capacity Planning Under Uncertainty

Barry Cobb, Virginia Military Institute, Scott Shipp Hall, Lexington, VA, United States, cobbbr@vmi.edu

Influence diagrams are used to model capacity and pricing decisions for a monopolist facing uncertain demand. We examine how the optimal solution changes based on the timing of demand information and the flexibility to augment initial capacity. Comparisons are made to analytical solutions available in economics literature.

## ■ SC22

### JFIG Paper Competition Finalists I

Sponsor: Junior Faculty Interest Group

Sponsored Session

Chair: Sunil Kumar, Stanford University, skumar@stanford.edu

#### 1 - JFIG Paper Competition Finalists

In these two sessions the finalists of the 2007 JFIG paper competition will present their research. The paper competition is organized by the Junior Faculty Interest Group (JFIG) forum in INFORMS. JFIG was created in 2001 to promote the career development of tenure-track faculty in INFORMS. The goals of the paper competition are to encourage research among junior faculty and to increase the visibility of research conducted by junior faculty within the fields of operations research and management science. Six finalists are selected by the award committee and their papers are presented in these two sessions. The papers submitted for the competition are evaluated based on the importance of the topic, appropriateness of the research approach, and the significance of research contribution. Winners are announced at the JFIG lunch on Sunday at the INFORMS Annual Meeting.

## ■ SC23

### Behavioral Issues in Market Design

Sponsor: Behavioral Process Management (BPM)

Sponsored Session

Chair: Elena Katok, Associate Professor, Penn State University, 465 Business Building, Penn State University, University Park, PA, 16802, United States, ekatok@psu.edu

- 1 - Rank versus Price Feedback in Open Auctions  
Wedad Elmaghraby, UMD, Van Munching Hall, College Park, MD, United States, Wedad\_Elmaghraby@rhsmith.umd.edu, Elena Katok

Via interviews with auction practitioners, we learned that the use of rank feedback is increasing and now overshadows the use of full disclosure feedback. Practitioners have found that rank feedback stimulates more aggressive behavior from suppliers, particularly those that are in second or third place, since a supplier does not have to be the least cost supplier, but merely one of the least cost bidders. In this talk we report on experiments ran in the Netcentricity Behavioral Lab.

- 2 - Supply Contracts with Competition  
Richard Engelbrecht-Wiggans, eplus17@uiuc.edu, Elena Katok, Valery Pavlov

We present an analytical and an experimental investigation of several supply chain contracts, with full and incomplete information. Our main finding is that with competition, wholesale price contracts can perform well, and in some cases better than coordinating contracts.

- 3 - An Experimental Investigation of Buyer Determined Auctions  
Elena Katok, Associate Professor, Penn State University, 465 Business Building, Penn State University, University Park, PA, 16802, United States, ekatok@psu.edu, Ernan Haruvy

We present a laboratory study of buyer determined auctions with non-monetary exogenous attributes. We find that generally sealed-bid auctions generate higher buyer surplus levels than dynamic auctions. We also find that when suppliers' non-monetary attributes are known to all suppliers, dynamic auctions perform particularly poorly.

- 4 - Corporate Budgeting: Lindahl Auctions and Return-on-Investment Auctions  
Matthias Hild, matthias@hild.org

Company-internal markets suffer from imperfect competition and externalities, while VCG mechanisms create a complex bidding task in the case of heterogeneous resources. We propose two auction designs in which truth-telling is weakly dominant in the limit. The first operationalizes Lindahl's markets with individualized prices, the second adjusts quantities based on return-on-investment bids. Both designs build on Ausubel's payment rule and Shor's subgradient algorithm.

## ■ SC24

### Software Demonstration

Cluster: Software Demonstrations  
Invited Session

- 1 - GAMS Development Corporation - Rapid Application Prototyping with GAMS  
Steven Dirkse, GAMS Development Corp., 1217 Potomac St NW, Washington, DC, 20007, United States, sdirkse@gams.com

GAMS Development will demonstrate how an application can be built using GAMS. We'll use both fundamental modeling practices, our state-of-the-art solvers and the latest in data access and application integration tools to quickly produce a working application: a Sudoku calculator sure to impress friends and family!

- 2 - AMPL Optimization LLC - Enhanced Solver Support in the AMPL® Modeling Language  
Robert Fourer, Professor, Northwestern University, Dept. of Industrial Eng & Mgmt Sciences, 2145 Sheridan Road, Evanston, IL, 60208-3119, United States, 4er@iems.northwestern.edu

AMPL has set the standard for optimization modeling languages that handle complex models naturally and large models efficiently. AMPL's co-developer will give a quick but lucid tour of AMPL's current solver support, with emphasis on less well-known enhancements for global optimization and for constructs such as logical constraints, discrete and semi-continuous variable domains, and piecewise-linear functions.

## ■ SC25

### Service Science: Research and Practice

Sponsor: Service Science  
Sponsored Session

Chair: Fugee Tsung, Dept. of Industrial Eng & Logistics Mgt, HK Univ. of Science & Technology, Clear Water Bay, Kowloon, HK, Hong Kong - ROC, season@ust.hk

- 1 - Introduction to Service Science: A Research Perspective  
Robin Qiu, Associate Professor, Penn State University, 30 E. Swedesford Road, Malvern, PA, 19355, United States, gxq102@gv.psu.edu

Service can not be held, and is typically intangible, perishable, difficult to port, hard to measure, and co-production with customers. This talk introduces a new thinking of design and deployment of competent and competitive service systems by taking account of service's unique characteristics. It aims to help promote and advance Service Science that will empower enterprise service systems and make them highly adaptable and sustainable to the service environment to meet the future challenge.

- 2 - Service Six Sigma  
Fugee Tsung, Dept. of Industrial Eng & Logistics Mgt, HK Univ. of Science & Technology, Clear Water Bay, Kowloon, Hong Kong - ROC, season@ust.hk

Since 1997, Citibank has begun its Six Sigma initiative for defect reduction and cycle time reduction. After that, AIG, American Express, Bank of America, JPMorgan, Chase, Merrill Lynch and Vanguard are all in various stages of Six Sigma deployment. People now realize that Six Sigma is every bit as applicable to service processes as it is to manufacturing. This talk will give an introduction to Service Six Sigma and demonstrate some real cases from the service industry in Hong Kong and China.

- 3 - Preventing Piracy: The Role of Service Enhancements versus Digital Rights Management.  
Rajiv Sinha, Center for Services Leadership, Arizona State University, Box 874106, Tempe, AZ, United States, rajiv.sinha@asu.edu, Collin Sellman, Raghu Santanam, Fernando Machado

Piracy is considered to be a serious problem for digital content providers. Based on 3 econometric studies conducted over 4 years, we demonstrate that service enhancements by content providers (such as content management and content delivery) are significantly more effective than Digital Rights Management (DRM) in reducing music piracy and increasing consumers' Willingness to Pay for legal downloads.

- 4 - Service Outsourcing: Information Asymmetry and Service Quality  
Justin Ren, Boston University School of Management, 595 Commonwealth Ave, Boston, MA, United States, ren@bu.edu, Fuqiang Zhang

In this paper we study service outsourcing under information asymmetry. Particularly, there is a user company and a service provider that does outsourcing work for the user company. However, the service provider's cost structure is not perfectly observed by the user. Our results suggest that outsourcing companies can use relatively simple and yet robust contracts to assure a high level of capacity and service quality even when they do not have perfect information of the service provider.

## ■ SC26

### Tutorial: Innovation Science: Frameworks and Industrial Practices

Sponsor: Data Mining (Sponsored)  
Sponsored Session

- 1 - Innovation Science: Frameworks and Industrial Practices  
Andrew Kusiak, Professor, University of Iowa, 3131 Seamans Center, Industrial Engineering, Iowa City, IA, 52242-1527, United States, andrew-kusiak@uiowa.edu

The research and practice of innovation are fragmented and centered on specific cases. The tutorial contributes to better understanding of the process of innovation by the introduction of basic models. The ideas outlined in the tutorial provide a roadmap for areas of future studies of innovation. The emphasis is on data driven innovation. Some of the concepts introduced in the tutorial are illustrated with industrial innovation practices.

## ■ SC27

### Recommendation and Personalization

Cluster: Data Mining (Invited)  
Invited Session

Chair: Zan Huang, Assistant Professor, Pennsylvania State University, 419 Business Building, University Park, PA, 16870, United States, zanh Huang@psu.edu

### 1 - Filling in the Component Ratings That the Users Left Out

Ramayya Krishnan, rk2x@andrew.cmu.edu, Nachiketa Sahoo

Collection of multi-component ratings from the users often results in missing values for the components. A dataset collected from Yahoo! Movies shows that 32% of the records had missing values for the component ratings. We demonstrate a method to elicit user-ratings for these components from the user's and his peers, other observed ratings. We also argue that this task is a generalization of the task of predicting unknown ratings in one component rating collaborative filtering.

### 2 - Optimizing Composition of the Consideration Set to Maximize Payoffs From Web-based Personalization

Monica Johar, msjohar@email.uncc.edu, Sumit Sarkar

We study the problem of optimally designing the composition of the consideration set for firms engaging in web personalization, in order to maximize payoffs over an interaction period  $T$ . An important decision problem faced by firms is how to choose between advertising items that help learn about a consumers preferences in order to better profile the customer (i.e., advertisements towards learning) versus advertising items that are targeted for immediate sales (advertisements towards sales).

### 3 - Providing Better Recommendations by Using Aggregate Ratings

Alexander Tuzhilin, New York University, Stern School, New York, NY, United States, atuzhili@stern.nyu.edu, Akhmed Umyarov

This talk describes a method that uses aggregate ratings provided by various segments of users for various categories of items to derive better estimations of unknown individual ratings. This is achieved by converting the aggregate ratings into constraints on the parameters of a selected rating estimation model. It is shown that these additional constraints reduce rating estimation errors resulting in better rating estimations.

### 4 - Selectively Acquiring Ratings for Product Recommendation

Zan Huang, Assistant Professor, Pennsylvania State University, 419 Business Building, University Park, PA, 16870, United States, zhanhuang@psu.edu

We propose proactively acquiring ratings from customers for a newly introduced product to quickly improve the accuracy of the predicted ratings generated by a collaborative filtering recommendation algorithm for the entire customer population. We propose an active learning sampling method that is generic to any recommendation algorithm for this rating acquisition problem and report experimental results on movie rating data.

## SC29

### Integer Programming Models and Applications

Cluster: Joint Cluster Metaheuristics/ ICS: Metaheuristics  
Invited Session

Chair: Haibo Wang, School of Business School, Texas A&M International University, P.O.Box 451373, Laredo, TX, 78045, United States, hwang@tamiu.edu

#### 1 - Integer Programming Formulation for Graph and Network Optimization Problems

Bahram Alidaee, Professor, The University of Mississippi, School of Business Administration, University, MS, 38677, United States, balidaee@bus.olemiss.edu, Haibo Wang, Mustafa Altinakar

Graph and networks optimization have been powerful tools in solving complex problems arising in social sciences, mathematics, engineering, and sciences. Formulating a graph problem as a natural integer program (IP) is often a challenging task. The present study provides a unified framework for IP formulation of graph optimization problems. Application of the framework in several areas including homeland security, disasters management, coding theory, etc. will be discussed.

#### 2 - Multi-skilled Workforce Constrained Preventive Maintenance Scheduling

Hongman Gao, Assistant Professor, King College, 1350 King College Road, Bristol, TN, 37620, United States, hgao@king.edu, Bahram Alidaee, Haibo Wang

We present a new integer programming (IP) model without computing craft-combinations for multi-skilled workforce constrained preventive maintenance (PM) scheduling. Comparison of the computational efforts of the new IP model with the existing model to obtain optimal solutions for 45 small and 36 large scale problems shows the increased effectiveness of the new IP model to yield optimal solutions. The new IP model reduces the average optimality gap for the test problems from 0.240% to 0.005%.

#### 3 - The Page Ranking and Path Analysis of Web Site Traffic

Mark Lewis, Associate Professor, Missouri Western State University, mlewis14@missouriwestern.edu, Barbara Jo White  
A new approach for rank ordering web pages by calculating the Most Common Paths (MCP) as created over time by web site traffic is presented. MCP refers to a sequencing of web pages into a maximal linear ordering according to the number

of votes made by users moving to a new page from a referring one, as recorded in a transition matrix. The approach to discover the MCP utilizes server-side, anonymous, non-intrusive means to collect and analyze web user traffic.

#### 4 - Simple, Fast Heuristics Based on Preferable Intervals for the Single-Sink, Fixed-Charge Transportation

Runchang Lin, Assistant Professor, Texas A&M International University, 5201 University Blvd, CH 313 M, Laredo, TX, 78041, United States, rlin@tamiu.edu, Haibo Wang, Bahram Alidaee, Gary Kochenberger

A new concept of preferable intervals is introduced and utilized in the context of single-sink fixed-charge transportation problems (SSFCTP). Properties of optimal solutions to the SSFCTP are investigated and necessary conditions for selecting suppliers are obtained in terms of preferable intervals. Several heuristics of polynomial time complexity are provided. Computational results are given showing that proposed method is both efficient and effective.

## SC29

### New COIN-OR Projects

Sponsor: INFORMS Computing Society/ICS/COIN-OR  
Sponsored Session

Chair: Kipp Martin, Professor, University of Chicago, 5807 South Woodlawn, Chicago, IL, 60637, United States, kipp.martin@chicagogsb.edu

#### 1 - The COIN-OR Optimization Services Project

Kipp Martin, Professor, University of Chicago, 5807 South Woodlawn, Chicago, IL, 60637, United States, kipp.martin@chicagogsb.edu, Robert Fourer, Jun Ma

Optimization Services (OS) provides a set of standards for representing optimization instances, results, solver options, and communication between clients and solvers in a distributed environment. We provide source code for libraries that implement OS standards. The project includes an executable, OSSolverService, for communicating instances (OSIL XML format, AMPL nl format, MPS format) to solvers. Software is provided for communication with Cbc, Clp, Cplex, Glpk, Ipopt, Knitro, and LINDO.

#### 2 - POAMS: The Platform for Object-algebraic Modeling Systems

Leo Lopes, University of Arizona, University of Arizona - SIE, Tucson, AZ, United States, leo@sie.arizona.edu, Victor Foulk  
POAMS is a non-commercial, object-oriented linear optimization modeling environment leveraging the versatility of Python. It is a test bed for new modeling constructs and offers set-based modeling syntax and instance level manipulation capabilities. POAMS also provides access to external data sources such as Excel, OpenOffice.org, and most DBAPI 2.0 databases, as well as computational environments such as MATLAB, and R.

#### 3 - Creating a Testbed of Industry Problems for OR Model and Algorithm Development

Ben Lowe, Bell Labs Ireland, Alcatel-Lucent, Blanchardstown Industrial Park, Blanchardstown, Dublin 15, Ireland, blowe@alcatel-lucent.com, Robin Lougee-Heimer

Many researchers are challenged with developing algorithms and models for industrial problems — without representative data and information related to the market characteristics that make the problem real. (Data access can influence the applicability and impact of research.) We propose an approach to exchanging real problems and data between solution seekers & solution providers using an open-source philosophy.

## SC30

### System Reliability Modeling and Optimization I

Sponsor: Quality, Statistics and Reliability  
Sponsored Session

Chair: Qianmei (May) Feng, Assistant Professor, University of Houston, Houston, TX, United States, qmfeng@uh.edu

#### 1 - Network Optimization with High Failure Probability Using Redundancy Allocation

Paola A. Hernandez-Ramirez, MSE Student Department Industrial Engineering, University of Puerto Rico at Mayaguez, University of Puerto Rico at Mayaguez, Industrial Eng. Department PO.Box9043, Mayaguez, PR, 00681, Puerto Rico, paitohr@yahoo.com, Noel Artiles-Leon

This research develops a methodology to optimize the reliability of a network whose arcs are not necessarily in series or in parallel and have low known reliability. Network reliability is improved by using redundant arcs with a budgetary restriction. Two heuristic optimization algorithms are used and

compared to solve this redundancy allocation problem: a genetic algorithm and an algorithm developed by the authors based on sequential integer linear programming.

## 2 - Design and Maintenance Optimization of Multi-state Parallel Systems

Zhigang Tian, Assistant Professor, Concordia Institute for Information Systems Engineering, Concordia University, 1515 Ste-Catherine Street West, EV-7.637, Montreal, QC, H3G 2W1, Canada, tian@ciise.concordia.ca, Gregory Levitin, Ming J. Zuo

The design and maintenance optimization of multi-state parallel systems is studied. The key point is technical and organizational actions can affect the state transition rates of a multi-state component, and thus affect the state distribution of the component and the availability of the system. An approach is presented to determine the optimal versions and numbers of components and the optimal set of technical and organizational actions to optimize the system cost and availability.

## 3 - New Performance Measures for Multi-state System Reliability

Kailash Kapur, Professor, University of Washington, Industrial Engineering, Seattle, WA, 98195, United States, kkapur@u.washington.edu, Carlos Solorio Magana

Most of the systems degrade over time and have multiple levels of performance. The traditional binary models are not realistic to capture the accurate level of performance of these systems. We present some new measures for system performance where the system and the components have multiple levels of performance. These measures combine traditional reliability measures in terms of probability with economics using utility theory from the viewpoint of the customer.

## 4 - A Two-stage Approach for Solving Multi-objective System Reliability Optimization Problems

Haitao Liao, Assistant Professor, Wichita State University, 1845 Fairmount St., Industrial & Manufacturing Eng Dept., Wichita, KS, 67260-0035, United States, haitao.liao@wichita.edu, Zhaojun Li

This research addresses multi-objective system reliability optimization problems. A two-stage approach is proposed to facilitate the optimization process. The first stage identifies implicit solutions followed by the second stage that selects only limited explicit solutions. A multi-objective heuristic method and a relative efficiency evaluation method are applied to reduce the size of Pareto optimal solutions for such system reliability optimization problems.

## 5 - Concurrent Quality and Reliability Optimization for MEMS

Qianmei (May) Feng, Assistant Professor, University of Houston, Houston, TX, United States, qmfeng@uh.edu, Hao Peng, David Coit

The new technology of MEMS shows great promise for many critical applications. For a MEMS system designed with degrading components, quality and reliability need to be both considered concurrently over the product life cycle to benefit the manufacturer and the consumer. By rewarding the high system reliability and penalizing the quality loss, we developed probability and optimization models for a MEMS system to determine the burn-in period, specification limits, and system replacement intervals.

## ■ SC31

### Joint QSR/Simulation Session

Sponsor: Quality, Statistics and Reliability, Simulation Sponsored Session

Chair: Hong Wan, Purdue University, 315 N. Grant Street, West Lafayette, IN, United States, hwan@purdue.edu

#### 1 - Strong: A Response-surface-based Algorithm in Simulation Optimization

Hong Wan, Purdue University, 315 N. Grant Street, West Lafayette, IN, United States, hwan@purdue.edu, Kuohao Chang, Jeff Hong

Response Surface Methodology (RSM) is a metamodel-based optimization method that has been used widely in simulation optimization. However, the method is not automated and does not have convergence guarantee. This paper propose STRONG algorithm that takes a similar framework as RSM but solves these two problems traditional RSM has. Combining with appropriate experimental designs, STRONG has the potential of handling high-dimensional problems efficiently.

#### 2 - Metamodeling for Cycle Time-throughput-product Mix Surfaces

Feng Yang, Assistant Professor, West Virginia University, Morgantown, WV, 26505, United States, Feng.Yang@mail.wvu.edu, Mustafa Tongarl, Bruce Ankenman, Barry Nelson, Jingang Liu

A simulation-based methodology is proposed to map the mean of steady-state cycle time as a function of throughput and product mix for manufacturing systems. Nonlinear regression models motivated by queueing analysis are assumed for the underlying response surface. To insure efficiency and control estimation error, simulation experiments are built up sequentially using a multistage procedure to collect data for the fitting of the models.

#### 3 - Distribution-free Tabular CUSUM Charts with Quick-and-dirty Autoregressive Variance Estimators

Joongsup Lee, PhD Student, H. Milton Stewart School of Industrial and Systems Engineering, Georgia Tech, 765 Ferst Drive, Atlanta, GA, 30332, United States, jlee@gatech.edu, Christos Alexopoulos, David Goldsman, Kwok-Leung Tsui, James Wilson, Seong-Hee Kim

We present the Quick-and-dirty autoregressive (QDARVE) and overlapping standardized time series (OSTS) methods for the estimation of the variance parameter required for the distribution-free tabular CUSUM (DFTC) chart. Then we investigate the performance of DFTC with estimated parameters. Our experimental results show that the performance of DFTC with estimated parameters is comparable to the known parameter case.

#### 4 - A Simulation-based Technique to Estimate Component Residual Life for Gamma Prior

Santanu Chakraborty, Purdue University, 144 E Stadium Avenue, Apt # 710, West Lafayette, IN, 47906, United States, santanu@purdue.edu, Nagi Gebraeel, Mark Lawley, Hong Wan

In this work we derive an expression for the residual life distribution of a linear degradation model with iid normal error and gamma distributed stochastic parameter, using Bayesian updating technique. We also propose a simulation based algorithm to estimate the residual life. Finally, we extend our application to monitoring the degree of stenosis in the Arterio-Venous access of hemodialysis patients, to predict the time of next intervention.

## ■ SC32

### Panel Discussion: Seth Bonder's Keynote Address: Some Thoughts on Our Profession

Cluster: Rebuttal Session on Seth Bonder's Keynote Invited Session

Chair: Lawrence Seiford, Professor and Chair, University of Michigan, 1205 Beal Avenue, Ann Arbor MI 48109-2117, United States of America, seiford@umich.edu

#### 1 - Panel Discussion: Seth Bonder's Keynote Address: Some Thoughts on Our Profession

Moderator: Lawrence Seiford, Professor and Chair, University of Michigan, 1205 Beal Avenue, Ann Arbor MI 48109-2117, United States of America, seiford@umich.edu, Panelist: Brenda Dietrich, Saul I. Gass, Leon McGinnis

The Keynote address is expected to present some controversial ideas and recommendations. In this session panelists will provide their reactions regarding the utility and feasibility of the ideas and recommendations, and then all attendees will be provided the opportunity to participate in the debate.

## ■ SC33

### Urban Transportation Planning Models III: Computational and Theoretical Extensions of the UTP Paradigm

Sponsor: Transportation Science & Logistics Sponsored Session

Chair: David Boyce, Professor Emeritus, University of Illinois at Chicago, Chicago, IL, 60607, United States, dboyce@uic.edu

#### 1 - New Computational Results on Solving the Sequential Procedure with Feedback

David Boyce, Professor Emeritus, University of Illinois at Chicago, Chicago, IL, 60607, United States, dboyce@uic.edu, Christopher O'Neill, Wolfgang Scherr

This talk presents findings for alternative feedback solution procedures applied to a 1,000 zone model. Three methods were tested: Naïve Feedback (no averaging of trip matrices or link flows); Averaging with Constant Weights, applied to the trip matrices; Method of Successive Averages (MSA), also applied to trip matrices.

## 2 - Developing and Calibrating the Transims Model: A Case Study of Chittenden County, Vermont

Adel Sadek, Associate Professor, Center Co-Director, University of Vermont, Computer Science Department, 33 Colchester Avenue, Burlington, VT, 05405, United States, asadek@cems.uvm.edu, Ross Gortner, Shan Huang, Stephen Lawe, John Lobb

This paper describes the development and calibration of the Transportation Analysis and Simulation System (TRANSIMS), an agent-based model for transportation and air quality forecasting, for Chittenden County, Vermont, an area of about 1,400 square kilometers and a population of 146,000. Lessons learned in the process are summarized and discussed.

## 3 - An Integer Programming Approach for Synthetic Population Generation

Jessica Guo, Assistant Professor, University of Wisconsin, 1206 Engineering Hall, 1415 Engineering Drive, Madison, WI, 53706, United States, jyguo@wisc.edu

This study proposes an integer programming (IP) model for synthetic population generation (SPG). The SPG is a problem of creating a microdata set to represent the individual households and their members in a population for the purpose of microsimulation. The proposed IP formulation will be presented and illustrated using US census data. The empirical results will be compared with those obtained by the conventional solution approach based on the iterative proportional fitting procedure.

## 4 - Calibration of Mesoscopic Traffic Simulation Models Using Population Based Evolutionary Algorithms

Fabrice Marchal, Laboratory of Transportation Economics (LET), Lyon, France, fabrice.marchal@let.ish-lyon.cnrs.fr

This paper presents a methodology to calibrate dynamic traffic simulation models with real data acquired from traffic counts and travel time measurements acquired from GPS devices. The methodology is demonstrated on the city of Lyon with the mesoscopic traffic simulation tool METROPOLIS that features a departure time choice model based on the work of W.Vickrey. The methodology calibrates the demand and supply parameters as well as the departure time choice parameters.

## ■ SC34

### Topics in Vehicle Routing

Sponsor: Transportation Science & Logistics  
Sponsored Session

Chair: Okan Ozener, H. Milton Stewart School of Industrial and Systems Engineering at the Georgia Institute of Technology, 765 Ferst Drive, NW, Atlanta, GA, 30332, United States, orsan@gatech.edu

#### 1 - Allocating Costs in Inventory Routing Problem

Okan Ozener, H. Milton Stewart School of Industrial and Systems Engineering at the Georgia Institute of Technology, 765 Ferst Drive, NW, Atlanta, GA, 30332, United States, orsan@gatech.edu, Ozlem Ergun, Martin Savelsbergh

We consider an inventory routing problem where a single product is distributed to several customers from a single facility over a finite or infinite horizon. Assuming that the historical delivery routes and the volumes delivered to each customer with these routes are known, we attempt to identify the high cost customers. This information may be of value when allocating costs to the customers, marketing to new customers, or revisiting the routing/volume decisions.

#### 2 - Constructing Fixed Routes for Vehicle Routing Problems with Stochastic Demands

Emrah Uyar, Georgia Institute of Technology, Industrial and Systems Engineering, Atlanta, GA, United States, emrah@gatech.edu, Martin Savelsbergh, Alan Erera

We study the construction and operation of fixed routes for delivery problems with uncertain customer demands. A customer may or may not place an order on a particular delivery day; the probability that a customer places an order is known. Sample-based feasibility evaluation techniques are developed to accommodate delivery time windows. A novel feature is the flexibility, at the operational level, for a customer to be visited by one of two vehicles.

#### 3 - Stochastic Combinatorial Truckload Procurement Auctions

Shervin AhmadBeygi, PhD Student, University of Michigan, 1205 Beal Avenue, Ann Arbor, 48109, United States, shervin@umich.edu, Amy Cohn, Damian Beil, Amitabh Sinha, Richard Chen

We consider a stochastic multi-commodity-flow formulation in order to solve the winner determination problem for combinatorial procurement auctions in which the carrier costs are uncertain. This research has implications in the areas of applied transportation planning, auction theory, and stochastic programming.

## 4 - Fixed Tours vs. Complete Reoptimization Strategies for the Online Inventory Routing Problem

Ricardo Giesen, Assistant Professor, Universidad Catolica de Chile, Vicuna Mackenna 4860, Macul, Santiago, Chile, giesen@ing.puc.cl, Patrick Jaillet, Hani Mahmassani

We study strategies for the online inventory routing problem (OIRP). We propose two decomposition approaches for the OIRP, in which a simplified version of either the control or the routing side is solved first, and then that solution is used as a soft constraint when solving the other. For each approach, different rolling horizon strategies are proposed. The performance of proposed strategies is simulated and the impacts of using real-time information are discussed.

## ■ SC35

### Facility Logistics I

Sponsor: Transportation Science & Logistics  
Sponsored Session

Chair: Sunderesh Heragu, Professor and Duthie Chair in Engineering Logistics, University of Louisville, Room 309, JB Speed Building, Department of Industrial Engineering, Louisville, KY, 40292, United States, s.heragu@louisville.edu

#### 1 - A Design Model for Optimized Unit-load Warehouse Aisles

Russell Meller, Hefley Professor of Logistics, University of Arkansas, Center for Engr Logistics and Distrb., 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States, rmeller@uark.edu, Kevin Gue, Letitia Pohl

Newfound attention is being placed on unit-load warehouse aisles due to the introduction of new aisle designs that have been shown to reduce the travel times by up to 20 per cent. These aisle designs are constructed to minimize single- or dual-command for a given space. However, there is a need for a design model that can consider the uniqueness of each unit-load warehouse's storage, space and throughput constraints. We present such a model and compare its results to a traditional design.

#### 2 - Identifying Likely Efficiency Improvement Paths for Warehouses in Data Envelopment Analysis

Andrew Johnson, Assistant Professor, Texas A&M University, 237K Zachry Engineering Center, Department of Industrial and Engineering, College Station, TX, 77843, United States, ajohnson@tamu.edu

Inefficiency, as measured by the input oriented data envelopment analysis model, assumes two warehouses that can reduce different inputs by the same proportion are equally inefficient. A new directional distance model (DDM) has recently been developed that allows contraction of inputs at different rates. However, methods for identifying the direction of improvement are currently lacking. We will discuss how to identify the direction to use in the DDM for the case warehouse evaluation.

#### 3 - Open Queuing Network Model for Autonomous Vehicle Storage and Retrieval Systems (AVSRS)

Sunderesh Heragu, Professor and Duthie Chair in Engineering Logistics, University of Louisville, Room 309, JB Speed Building, Department of Industrial Engineering, Louisville, KY, 40292, United States, s.heragu@louisville.edu, Cai Xiao

We discuss application of an open queuing network model for a warehouse with multiple storage levels. The storage and retrieval are done by autonomous vehicles that are restricted to travel within a designated level. To move pallet loads between different levels, a mechanism to transfer the pallet load from a vehicle to an elevator and from the elevator to another vehicle at another level is assumed to be available.

## ■ SC36

### Measuring and Managing Risk, Vulnerability and other Emergency Measures

Sponsor: Transportation Science & Logistics  
Sponsored Session

Chair: Yueyue Fan, Assistant Professor, University of California, Department of CEE, Davis, CA, 95616, United States, yufan@ucdavis.edu

#### 1 - An Efficiency Measure for Dynamic Networks with Application to the Internet and Vulnerability

Anna Nagurny, John F. Smith Memorial Professor, University of Massachusetts, Finance and Operations Management, Isenberg School of Management, Amherst, MA, 01003, United States, nagurny@gbfin.umass.edu, Qiang Qiang

In this paper, we propose an efficiency measure for dynamic networks, including the Internet, which captures demands, flows, and costs over time, and which allows for the identification of the importance of the nodes and links and their rankings. We provide both continuous time and discrete time versions of the efficiency measure. We illustrate the efficiency measure for the time-dependent Braess paradox and demonstrate how it can be used to assess the most vulnerable nodes and links.

- 2 - Flexibility and Fragility in Supply Chain Network Design  
Michael Lim, Northwestern University, Department of IE/MS, Northwestern University, Evanston, IL, 60208, United States, m-lim2@northwestern.edu, Mark Daskin, Achal Bassamboo, Sunil Chopra

We examine the impact of disruptions on alternative chained manufacturing/product configuration. We introduce fragility to quantify the change in system performance resulting from a disruption. Simulation insights for both node and link failures are discussed as is a decomposition scheme for systems with multiple disruptions.

- 3 - Flexibility of Intermodal Freight Transport Network  
Lichun Chen, University of Maryland, University of Maryland, College park, MD, 20742, United States, lchen@umd.edu, Elise Miller-Hooks

The problem of measuring flexibility (i.e. ability to continue operations, adapt to changing circumstances and return to normal operations) of intermodal freight transport networks is addressed. Results of experiments conducted to illustrate the proposed flexibility concept and proposed methodology for its characterization are given for the freight transport corridor between New York and Washington.

- 4 - Reinforcement Learning in Post-disaster Management and Response  
Yueyue Fan, Assistant Professor, University of California, Department of CEE, Davis, CA, 95616, United States, yufan@ucdavis.edu

Post-disaster relief and rescue activities are often carried out when information about damages is not completely revealed. In this situation, decisions need to be made simultaneously as the environment being learned. In this presentation, we will introduce reinforcement learning that integrates exploring and exploiting the environment and will demonstrate its potential applications in post-disaster management and response activities through examples of goal finding and resource allocation.

## ■ SC37

### Social Network Analysis Methods for Military Operations

Sponsor: Military Applications  
Sponsored Session

Chair: Marcus Perry, Assistant Professor, Florida International University, 10555 West Flagler Street EC 3172, Miami FL 33174, United States, perrym@fiu.edu

- 1 - Characterizing and Detecting Unrevealed Elements of Network Systems  
James Leinart, Air Force Institute of Technology, 2950 Hobson Way, Bldg 641, Wright Patterson AFB, OH, 45433, United States, james.leinart@afit.edu, Richard Deckro, James Moore, David Denhard, Robert Mills, Marcus Perry

A method to identify hidden nodes that connect network components is presented. A procedure to reconstruct networks from partial information using a stochastic observation process is also introduced. Associated analysis includes network characteristics impacting reconstruction, and accuracy assessment of the reconstructed network. The procedure implements causality, reconstructability analysis and graph theoretic concepts.

- 2 - Critical Node Detection in Sparse Graphs  
Ashwin Arulsevan, University of Florida, 1111 SW 16th Avenue, #106, Gainesville, FL, 32601, United States, ashwin@ufl.edu, Clayton Commander, Panos Pardalos, Lily Elefteriadou

In the critical node detection problem, we seek a set of nodes in a graph with a specific cardinality whose deletion results in maximum disconnectivity. The problem has applications in several fields including biomedicine, telecommunications, and military strategic planning.

- 3 - Applying the Key Player Problem Negative to Clandestine Networks

Travis Herbranson, Captain, U. S. Air Force,  
Travis.Herbranson@maxwell.af.mil, Richard Deckro,  
James W. Chrissis, Jonathan T. Hamil

We introduce new models based on the key player problem negative that model network disruption. The mathematical programs we developed generate sets to lengthen paths, fragment networks, and create isolated components. The sets identify key nodes and arcs whose removal from the network has the potential to cause effective disruption.

- 4 - Detecting Edge Structure in Noisy Networks  
Marcus Perry, Assistant Professor, Florida International University, 10555 West Flagler Street EC 3172, Miami, FL, 33174, United States, perrym@fiu.edu, Richard Deckro

In this talk, we present a tractable hypothesis testing framework for detecting, characterizing and estimating edge-set structure and strengths between vertices in an undirected network. It is assumed that the edge set is only observable through a noisy adjacency matrix. Application of the proposed method can provide analysts with valuable insight into the true edge structure with a given level of confidence. The proposed method is demonstrated using a real-world terrorist friendship network.

## ■ SC38

### Marketing III

Sponsor: Marketing Science  
Sponsored Session

Chair: Gary Erickson, Professor, University of Washington Business School, Box 353200, Seattle, WA, 98195-3200, United States, erick@u.washington.edu

- 1 - The Dimensions of Reputation in Electronic Markets  
Anindya Ghose, aghose@stern.nyu.edu, Arun Sundararajan, Panos Ipeirotis

Prior studies of word-of-mouth have examined their impact on market outcomes using the average numerical rating reported by prior buyers. Our study is based on the conjecture that the information in textual feedback plays a substantial role in establishing reputation and the pricing power of sellers. This paper is the first study that integrates economic and text mining techniques toward a more complete analysis of the information captured by word-of-mouth systems.

- 2 - Next Generation (seriously) Sales Force Allocation and SC Network Design  
Alan Dybvig, Owner, Dybvig Consulting, 77 Adams Drive, Princeton, NJ, alan@dybvigconsulting.com, Jon Hosking

Lodish et al described an Edelman-prize winning modeling approach addressing how large the sales force should be and how it should be deployed in INTERFACES (18:1 Jan-Feb 1988, review suggested). By making a variety of changes to the original model's formulation, important benefits accrue including: i) a response curve-driven, optimal enterprise-wide, continuous planning and budgeting modeling capability and ii) next generation supply chain network design functionality.

- 3 - When Quantity Matters: A Multivariate Tobit Model  
Sri Duvvuri, Assistant Professor, University of Iowa, S348 PBB, Iowa City, IA, 52242, United States, sri-duvvuri@uiowa.edu

Integrating quantity decisions into the choice framework is essential to overcome the selectivity bias and infer consumer behavior more accurately. We propose a multivariate tobit model that simultaneously accounts for purchase incidence and quantity decisions of consumers across multiple categories. We estimate a Hierarchical Bayes econometric specification of this complex model using MCMC methods. Scanner panel data across several categories are used for model calibration.

- 4 - Selecting Distribution Channel Strategies for Non-profit Organizations  
Annie Niu, University of Alberta, PhD Program, School of Business, Edmonton, AB, T6H 4M5, Canada, rniu@ualberta.ca, Ignacio Castillo, Xuan Zhao

Many non-profit organizations have been turning to commercial activities to increase revenues due to declining government/donor support. By selling products or services related to its institutional mission using a particular distribution channel strategy, a non-profit organization might reach more people. We analyze how a non-profit organization should select its distribution channel strategy under certain market conditions and consider a non-profit organization's channel strategy when competing with a fully integrated or decentralized for-profit channel.

## ■ SC39

### System Approach to Healthcare Delivery System

Sponsor: Health Applications Section

Sponsored Session

Chair: Yuehwern Yih, Professor, Purdue University, School of Industrial Engineering, 315 N Grant Street, West Lafayette, IN, 47907, United States, yih@purdue.edu

#### 1 - A Simulation of ER Operation and Its Impact on Hospital Diversion

Tze Chao Chiam, Graduate Assistant, Purdue University, School of Industrial Engineering, 315 N. Grant Street, Rm 210, West Lafayette, IN, 47907, United States, tzechao@purdue.edu, Yuehwern Yih

This research studies the impact of operation of an ER on hospital diversion. It also investigates the relationship between time of diversion and the ease for the ER to resume normal working conditions. Although not widely studied, diversion has great impact on the quality of care as well as ER operation.

#### 2 - A Regression Tree Approach for Assessing Perceived Usefulness of Computerized Clinical Reminders

Sze-jung Sandra Wu, Graduate Assistant, Purdue University, School of Industrial Engineering, 315 N Grant Street, West Lafayette, IN, 47907, United States, swu@purdue.edu, Mark Lehto, Bradley Doebbeling, Yuehwern Yih

Computerized clinical reminders (CCRs) are useful tools for alerting healthcare providers of upcoming or overdue events. We conducted a cross-sectional survey of CCRs users from 104 different VA facilities using a 5-point Likert scale. The survey data were analyzed using a cross-validated regression tree algorithm to measure the factors affecting clinician's perceived usefulness of CCRs.

#### 3 - A Simulation Study of the Effects of Patient Dispatching Rules in a Centralized Check-in Process

Daiki Min, Graduate Assistant, Purdue University, School of Industrial Engineering, 315 N Grant Street, West Lafayette, IN, 47907, United States, dmin@purdue.edu, Yuehwern Yih

This study examines how patient dispatching rules in a centralized check-in affect the performance of outpatient clinics. To investigate the performance of dispatching rules, simulation experiments have been conducted with three different rules which include newly proposed Flow rate-based rule, FIFO and EDD. The simulation results provide guidelines for designing centralized check-in on the criteria of clinic makespan, patient tardiness for appointment and patient waiting time for check-in.

#### 4 - Assessment of UHF Passive RFID for Workflow Analysis in a Clinical Environment

David Frankenfield, Graduate Assistant, Purdue University, School of Industrial Engineering, 315 N Grant Street, West Lafayette, IN, 47907, United States, dfranken@purdue.edu, Daiki Min, Yuehwern Yih

In the attempt to collect data for the purpose of workflow analysis many healthcare organizations have been exploring the possible opportunities of utilizing Radio Frequency Identification (RFID) technology. Our research consists of a technology assessment conducted to identify factors that impact the use of UHF passive RFID technology and optimal sensor network design in clinical environments. The analysis concludes with identifying obstacles and what is necessary to ensure system reliability.

## ■ SC40

### Advances in Health Care Operations Research

Sponsor: Health Applications Section

Sponsored Session

Chair: Martin Puterman, Professor, University of British Columbia, Sauder School of Business, 2053 Main Mall, Vancouver, BC, V6T 1Z2, Canada, marty@chcm.ubc.ca

#### 1 - Liver Transplantation Timing with Ambiguous Health Transition Probabilities

David Kaufman, University of Pittsburgh, 1048 Benedum Hall, Pittsburgh, PA, 15261, United States, davidlk@enr.pitt.edu, Andrew Schaefer

The living-donor model (LDM) for the optimal timing of liver transplantation requires the estimation of underlying health transition probabilities from clinical data. Such estimation may be a source of ambiguity. We account for ambiguity in a robust DP formulation of the LDM in which the decision-maker plays a max/min sequential game against nature. Structural results and a robust modified policy iteration algorithm are presented. Numerical examples with clinically obtained data are discussed.

#### 2 - Service Allocation in a Network of Hospitals

Pablo Santibanez, Planner, Business Engineering, Fraser Health Authority, #102 - 10334 152A Street, Surrey, BC, V3R 7P8, Canada, pablo.santibanez@fraserhealth.ca, Kenneth Yip, Georgia Bekiou

This talk presents a service allocation model developed to support a long-term planning exercise in Fraser Health, a British Columbia Health Authority with a population of over 1.5 million and overseeing the operation of 12 acute care hospitals in a vast geographic region. An optimization model is used to decide the clinical service mix and capacity to be allocated at each hospital in the network in every decision period, based on population needs and leading clinical practices.

#### 3 - Optimizing Patient Movement Within a Hospital

Jonathan Patrick, Assistant Professor, University of Ottawa, 163 Fifth Ave, Ottawa, ON, K1S2M8, Canada, jonathan.patrick@sauder.ubc.ca, Martin Puterman

Capacity planning within hospitals remains largely a matter of reaction and budgetary limitations. We seek to help hospital administrators balance the cost of base capacity against overtime. Recognizing that capacity requirements depend on patient scheduling and placement policies, we build a model that determines the optimal patient scheduling and placement as well as the resource capacity required to meet pre-specified service targets (usually in the forms of wait time targets).

#### 4 - Forecasting Radiation Therapy Demand for Head and Neck Cancers in British Columbia

Greg Werker, PhD Student, Sauder School of Business, UBC, 3869 W 18th Avenue, Vancouver, BC, V6S1B4, Canada, greg.werker@sauder.ubc.ca, John French, Antoine Saure

The British Columbia Cancer Agency (BCCA) has difficulty dealing with highly variable demand for radiation therapy (RT) treatment. We develop models for predicting RT starting volumes. Data from the BCCA patient database were used in regression models to examine patient data and other upstream indicators that may be useful in predicting RT starting volumes. We found that a basic model using site admits from the prior three months is a good predictor for RT starting volumes.

## ■ SC41

### Joint Session B&SB/HAS: Optimization in Biology

Sponsor: INFORMS Computing Society/ Bioinformatics & Systems Biology, Health Applications Section

Sponsored Session

Chair: Stephen Billups, Associate Professor, University of Colorado at Denver and Health Science Center, Dept. of Mathematical Sciences, Campus Box 170, P.O. Box 173364, Denver, CO, 80217-3364, United States, Stephen.Billups@cudenver.edu

#### 1 - A Special Case of the Euclidean Distance Problem that Arises in the Protein 3-Dimensional Conformation

Changhui Choi, Post Doc., The University of Colorado at Denver, Campus Box 170, Denver, CO, 80217-3364, United States, laplacia@hotmail.com, Samuel Burer

The protein 3-dimensional conformation problem is to predict the 3-dimensional structure that a protein takes in a certain fluid. We solve one of the sub-problems, which looks for the 3-dimensional coordinates of atoms that satisfy all the given equality and inequality distance constraints. This problem can be formulated as quadratically constrained quadratic programming problems. We solve this problem via semidefinite programming relaxations and some local search methods.

#### 2 - An Optimization Model for Owl Habitat Reserve Management

Bala Krishnamoorthy, Washington State University, 103 Neill Hall, P.O. Box 643113, WSU, Pullman, WA, 99164-3113, United States, kbala@wsu.edu, Natalie Baerlocher, David Allen

We develop a model for the problem of designing habitat reserve areas to support endangered species. For the Northern Spotted Owl (NSO), we model the occupancy of a patch of land by a 0-1 variable. We develop a function called the Habitat Connectivity Index (HCI), which measures the overall suitability of a habitat to sustain the owls. The decisions of which patch is to be sustained and which cleared from among candidate ones is modeled as a non-linear integer program that maximizes HCI.

#### 3 - Analyzing Time Course Microarray Data With Temporal Uncertainty

Stephen Billups, Associate Professor, University of Colorado at Denver and Health Science Center, Dept. of Mathematical Sciences, Campus Box 170, P.O. Box 173364, Denver, CO, 80217-3364, United States, Stephen.Billups@cudenver.edu

When conducting time-course microarray experiments, one is usually interested in measuring time relative to some biological process of interest. But, it is often difficult to measure this biological time accurately. Such temporal uncertainty negatively impacts both the accuracy and power of data analysis. In this talk, I will describe a method for handling temporal uncertainty based on the premise that microarray data itself can be used to refine our estimates of biological time.

**4 - Classification of Drug Activities for the Treatment of Prostate Cancer Using MILP**

Metin Turkay, Asst. Prof., Koc University, Department of Industrial Engineering, Sariyer, Istanbul, 34450, Turkey, mturkay@ku.edu.tr, M. Emre Ozdemir, Pelin Armutlu, Pinar Kahraman, Halil Kavakli

An important consideration in structure based drug design is the early estimation of drug activities using molecular descriptors. We address early prediction and classification of activities of drug candidates using the MILP based hyper-box approach with partial least squares regression to determine the most significant molecular descriptors of the drug molecules for an efficient classification. Our results indicate that it is possible to obtain a 100% classification accuracy.

■ **SC42**

**OR Models for Infectious Diseases**

Cluster: Operations Research in Medicine and Health Care  
Invited Session

Chair: Atul Bhandari, Post-Doctoral Associate, University of Pittsburgh, 1178c Benedum Hall, University of Pittsburgh, Pittsburgh, PA, 15261, United States, abhandari79@gmail.com

**1 - Analysis of Disease Transmission and Mitigation Strategies in a Point-of-Dispensing**

Eva K. Lee, Associate Professor & Director, Georgia Institute of Technology, Center for OR in Medicine & HealthCare, Industrial & Systems Engineering, Atlanta, GA, 30332-0205, United States, evakylee@isye.gatech.edu, Chien-Hung Chen, Joseph Wu

We consider a local outbreak of a highly infectious disease (e.g., smallpox, pneumonic plague, pandemic flu), analyze the potential of disease propagation within a vaccination/drug distribution clinic, and provide insights on how to minimize this risk. We will demonstrate how mathematical modelling can help quantify this risk and assist in the design of an emergency clinic, and show the use of a real-time simulator for mounting an effective monitoring and response against such an event.

**2 - Analyzing the Control of Mosquito-borne Diseases by a Dominant Lethal Genetic System**

Michael Atkinson, Institute for Computational and Mathemat, Stanford, CA, 94305, United States, mpa33@stanford.edu, Paul Coleman, Zheng Su, Nina Alphey, Luke Alphey, Lawrence Wein

We formulate a model to assess the impact on the spread of mosquito-borne diseases of a strategy that releases male insects homozygous for a lethal genetic trait. A dynamic model for the female mosquito population, which incorporates the competition for female mating between released mosquitoes and wild mosquitoes, density-dependent competition during the larval stage, and realization of the lethal trait either before or after the larval stage, is embedded into a human-vector epidemic model.

**3 - Stopping Pandemic Flu: Government & Community Interventions in a Multi-community Model**

Karima Nigmatulina, MIT, Cambridge, MA, United States, knigmatu@MIT.EDU, Richard Larson

Using a new model of infection spread between contiguous heterogeneous communities we evaluate the implementation and timing of primarily non-pharmaceutical intervention strategies. We also include changes in human behavior by introducing a feedback parameter into the model. We find, among other conclusions, that spatial quarantine and isolation strategies are unlikely to succeed.

**4 - The Effect of Adherence and Toxicity on HIV Therapy Initiation**

Andrew Schaefer, University of Pittsburgh, Department of Industrial Engineering, 1048 Benedum Hall, Pittsburgh, PA, 15261, United States, schaefer@enr.pitt.edu, Mark Roberts, Steven Shechter, Andrew Schaefer, R. Scott Braithwaite

Highly active anti-retroviral therapy (HAART) can extend the lifetime of an HIV patient, but at the cost of introducing a toxic element to the body. Further complicating this issue is that patients rarely adhere to HAART perfectly. Combining the effects of poor adherence and toxicity allows the body's resistance to HAART to develop rapidly leading to poor patient outcomes. We use a discrete event simulation to examine how poor adherence and toxicity can lead to delaying the initiation of HAART.

■ **SC43**

**Show Me the Money: Managing Value in Software and Systems Development**

Cluster: O.R. Practice  
Invited Session

Chair: Peri Tarr, IBM Watson Research, 19 Skyline Drive, Hawthorne, NY, 10532, United States, tarr@us.ibm.com

**1 - Value in Development Organizations: A Complex Systems View**  
Clay Williams, IBM Watson Research, 19 Skyline Drive, Hawthorne, NY, 10532, United States, clayw@us.ibm.com, Tim Klinger, Peri Tarr

We discuss a framework for exploring the alignment between business and technology goals and for mapping these goals to projects using development governance patterns. These patterns are then applied to the organization performing the development projects. We describe how concepts from complex systems theory can be used to understand the behavior of these organizations and to help develop a valuation model for the projects underway within the organization.

**2 - Building IT Services Contract Portfolios with Value-at-risk Analysis**

Robert Kauffman, W. P. Carey Chair in Information Systems, Arizona State University, W. P. Carey School of Business, Tempe, AZ, 85287, United States, rob7585@gmail.com, Ryan Sougstad

We analyze a value-at-risk model for trade-offs between contract profits and losses in service-level agreements for IT and software services management. We model contract duration and cost driver correlations, and illustrate how managers can control risk by forgoing revenue-maximizing contracts in lieu of more conservative service-level commitments, yet achieve higher profitability. Our research offers a financial economics basis for IT services governance.

**3 - Assessing the True Value of Enterprise IT Projects**

Joseph Kramer, IBM Research, 19 Skyline Drive, Hawthorne, NY, 10532, United States, kramerjo@us.ibm.com, Vijay Iyengar, Ignacio Terrizzano, John Vergo, Dan Milch

Traditionally managing value in software development has been focused on controlling cost, time, function and quality. We posit that true value is assessed when an organization understands the interplay between the project portfolio and the enterprise level business model. In this paper we illustrate a Portfolio Management method that leverages a business decomposition technique (CBM) to simultaneously address value, uncertainty and resources. A running example illustrates our approach.

**4 - Risk-averse Forward Indicator Metrics for Valuing and Managing R&D Projects**

Scott Mathews, Assoc. Technical Fellow, The Boeing Company, P.O. Box 3707 MS 42-50, Seattle, WA, 98124, United States, scott.h.mathews@boeing.com

Executing well on R&D projects is fundamental to implementing corporate strategic intent and a demanding management task also. New methods and metrics derived from real options technology can provide a mathematical foundation for an engineering-like approach to risk identification and quantification, investment effectiveness, and forward-looking value assessment. These tools enhance the R&D project managers confidence in risk reduction and value shaping through targeted incremental investments.

**5 - APM - Theory and Practice**

Gil Nechushtai, Research Staff Member, IBM, IBM Research Lab, Haifa University, Haifa, 31905, Israel, GILN@il.ibm.com, Eli Luboshitz, Pablo Srabstein, Emmanuel Zarpas, Jacek Maryan

Application Portfolio Management (APM) is an approach for managing current investments in IT applications as a portfolio that can be optimized and aligned with business benefit. While APM borrows ideas from financial investments, still there are significant differences that challenge traditional PM techniques. In this session, we will present a practical approach and a system for APM. We will discuss theory and practice as well as future work and the applicability for other kinds of portfolios.

## ■ SC44

**Bring OR into your Local High School:  
Mission Not Impossible**

Sponsor: INFORM-ED  
Sponsored Session

Chair: Kenneth Chelst, Department Chair, Wayne State University, Industrial and Manufacturing Engg., 4815 Fourth St., Detroit, MI, 48201, United States, kchelst@wayne.edu

1 - Bring OR to Local High Schools: Mission Not Impossible & NSF \$3 Million

Kenneth Chelst, Department Chair, Wayne State University, Industrial and Manufacturing Engg., 4815 Fourth St., Detroit, MI, 48201, United States, kchelst@wayne.edu, David Goldsman, Donna Llewellyn

We present OR activities designed to enrich high school math. The session will provide guidance as to how to reach out to your local high schools and offer short workshops. The goal of INFORMS is to create an OR network interested in outreach. All attendees who commit to outreach receive the book *Does this line ever move? Everyday Applications of OR*. We will also discuss a \$3 million NSF grant we received to develop and implement a yearlong math course based on OR starting in MI and NC.

## ■ SC45

**Trading Strategies and Hedge Funds**

Sponsor: Financial Services  
Sponsored Session

Chair: Ivilina Popova, Assistant Professor, Seattle University, 901 12th Avenue, Seattle, WA, 98122, United States, popovai@seattleu.edu

1 - The Art and Science of Creating a Trading Strategy

Elmira Popova, Associate Professor, The University of Texas at Austin, 1 University Station C2200, ETC 5.120, Austin, TX, 78712, United States, elmira@mail.utexas.edu, Ivilina Popova

A quant joining a trading team is expected to use his theoretical knowledge and create a profitable trading strategy. Having walked the path from theoretical idea to trading platform, we illustrate the hard process of trading strategy creation. The end result - a platform that generates signals and executes trades - could be a product of art and science. We identify practical questions and attempt answers. We present the general framework, and the individual steps to creating a strategy.

2 - Scenario-based and Mean-variance Hedge Fund Portfolio Allocation with High Watermarks

Ivilina Popova, Assistant Professor, Seattle University, 901 12th Avenue, Seattle, WA, 98122, United States, popovai@seattleu.edu, David Morton

In this analysis we show that using a scenario-based approach for portfolio allocation is preferable to a mean-variance approach when constructing a fund of hedge funds. The performance fee charged by hedge funds is often linked to high watermarks and if the objective is to increase the fees received, the utility function should incorporate a subsistence level. We show that the scenario-based approach is the better methodology when optimizing utility functions with subsistence levels.

3 - High-frequency Trading in the Presence of Long-term Stochastic Dependencies

Alexander Galenko, Graduate Student, University of Texas at Austin, Department of Mechanical Engineering, 1 University Station C2200, Austin, TX, 78712, United States, agalenko@mail.utexas.edu, Ivilina Popova, Elmira Popova

We model the long term stochastic dependencies via co-integration and prove a necessary and sufficient conditions theorem. This theoretical result is then used to construct a trading strategy which performance will be presented.

4 - Active Equity Managers in the U.S.: Do the Best Follow Momentum Strategies?

Woo Chang Kim, PhD Candidate, ORFE, Princeton University, E312, ORFE, E-Quad, Princeton University, Princeton, NJ, 08544, United States, wookim@princeton.edu, John M. Mulvey

Empirical evidence shows that momentum strategies have outperformed passive equity benchmarks, especially since publication of the momentum effects. This paper discusses the role of momentum in the performance of active equity managers. We show that the performance of the best managers in the growth and core domains are highly correlated with momentum strategies at the industry level, whereas the worst performing managers has low correlation with momentum.

## ■ SC46

**Pricing and Risk Management in Energy Markets**

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

Chair: Shi-Jie Deng, Assc. Professor, Georgia Inst. of Tech., 755 Ferst Dr., Atlanta, GA, United States, deng@isye.gatech.edu

1 - Pricing Weather Derivatives: A Multicommodity Market Equilibrium Approach

Yongheon Lee, Graduate Student, IEOR Dept. University of California at Berkeley, Berkeley, CA, 94720, United States, yhlee@newton.berkeley.edu, Shmuel Oren

Risk averse agents are exposed to correlated price and quantity risk in single commodities, which in turn are correlated with weather. They hedge their revenue risk using price based instruments on their commodity and weather derivatives. The equilibrium price of the weather derivative emerges from the supply by the issuer who attempts to controls the risk premium on these derivatives and the net demand resulting from the revenue hedging activities of the commodity traders.

2 - Continuous-time Optimal Stopping Formulation of Power Plant Valuation with Start-up Costs

Jieyun Zhou, Graduate Student, Georgia Institute of Technology, 500 Northside Cir NW, Apt. PP4, Atlanta, GA, 30309, United States, jieyun@gatech.edu, Shi-Jie Deng

We propose a real options model for valuing electric power plants which have fixed generation costs. Under a general continuous-time electricity price model and operational characteristics such as a convex start-up cost structure in the number of re-starts, we derive a market-based valuation and the corresponding optimal operational strategy.

3 - Capacity Investment in Electricity Markets: Perfect Competition

Gul Gurkan, Associate Professor, Tilburg University, Warandelaan 2, Tilburg, 5037 AB, Netherlands, ggurkan@uvt.nl, Yves Smeers, Ozge Ozdemir

We analyze investment choices of firms using a two-stage game; capacities are installed in stage one and production takes place in an energy-only market at stage two. Under deterministic demand, we show equivalence of the two-stage game and a single optimization problem. Under demand uncertainty, we essentially have a two-stage stochastic game and an equilibrium point can be found by solving a two-stage stochastic program. Extensions to a forward capacity .. and .. with reliability markup.

4 - Electricity Price Curve Modeling by Manifold Learning

Shi-Jie Deng, Assc. Professor, Georgia Inst. of Tech., 755 Ferst Dr., Atlanta, GA, United States, deng@isye.gatech.edu, Jie Chen, Xiaoming Huo

We propose a novel non-parametric approach for the analysis and prediction of electricity price curves by applying the manifold learning methodology. Cluster analysis is employed to identify characteristics of the price curve shape. The proposed price curve model performs well in forecasting both short-term price such as the day-ahead prices and longer term price such as the week-ahead prices. The forecast accuracy is demonstrated by numerical results.

## ■ SC47

**Forestry III: Transportation and Logistics**

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

Chair: Mikael Ronnqvist, Department of Finance and Management Science, Norwegian School of Economics, NHH, Helleveien 30, NO-5045, Bergen, Norway, mikael.ronnqvist@nhh.no

1 - Integrating Road Building Decisions in Harvest Scheduling Models

Victor Valdebenito, School of Forest Resources, The Pennsylvania State University, 236 Forest Resources Building, University Park, PA, 16802, United States, vav112@psu.edu, Marc McDill

We incorporated road building decisions in a mixed integer harvest schedule model, where two different potential road network structures were used as model inputs. In one case, the potential road network is allowed to have cycles, while in the other case the potential road network follows a simpler dendritic structure. For each of these scenarios, different formulations were evaluated, considering the tradeoff produced in quality of solution and computational effort required.

**2 - Harvesting with Uncertain Price Scenarios**

Martin Quinteros, Sloan School of Management, Massachusetts Institute of Technology, E53-356, Cambridge, MA, 02142, United States, mquinter@mit.edu, Andres Weintraub, Monique Guignard, Laureano Escudero, Antonio Alonso-Ayuso

We present a tactical problem where main decisions are blocks to harvest each period and access roads to build. Future prices and demands are uncertain, reflected through scenarios for each period with estimated probabilities. We present a coordinated branching approach to this MIP which efficiently finds a solution that maximizes expected returns while guaranteeing feasibility under all scenarios. We compare with a classical deterministic approach using data from a Chilean forest industry.

**3 - Hard Wood Supply Chain Tactical Planning in a Furniture Company Using a Time Decomposition Approach**

Mustapha Ouhimmou, FORAC, CIRRELT, University Laval, Quebec, PQ, G1K7P4, Canada, mustapha.ouhimmou@cirrelt.ca, Sophie D'Amours

We study the wood supply chain tactical planning problem of an integrated furniture company. The goal is to define manufacturing and logistics policies that allow the company to have a competitive level of service at minimum cost. Supply chain planning is formulated as a large MIP model. We solved small size MIP problems and propose a heuristic using a time decomposition approach for larger problems. Computational results are reported as well as an application to a real industrial case.

**4 - Global Carbon Markets and Implications for Forestry**

Darek Nalle, Assistant Professor, University of Idaho, Dept. of Forest Products, Moscow, ID, 83844, United States, nalle@uidaho.edu, Miguel Henry

The new commodity of carbon may be difficult to value in that its contract prices are largely a function of evolving regulations within separate market places about the globe. Opportunities and challenges in maximizing NPV from a carbon portfolio will be highlighted, using the University of Idaho's membership in the Chicago Climate Exchange as a specific example.

**5 - Optimization of Forest Fuel Logistics**

Mikael Ronnqvist, Department of Finance and Management Science, Norwegian School of Economics, NHH, Helleveien 30, NO-5045, Bergen, Norway, mikael.ronnqvist@nhh.no, Mikael Frisk

The use of forest fuel in combined heat and power plants is increasing, and procurement and transportation of fuel is a large part of the overall cost. The planning must consider different chipping systems that can be located at harvest areas, terminals or mills and a large variation in demand. Several truck systems are included and there are specific capacities for both transportation and chipping. We describe DSS together with results from a case study at a large forest company in Sweden.

**■ SC48****Simulation Modeling; and Tutorial on Agent Based Simulation**

Sponsor: Simulation  
Sponsored Session

Chair: Michael Kuhl, Associate Professor, Rochester Institute of Technology, Industrial & Systems Engineering Dept., 81 Lomb Memorial Drive, Rochester, NY, 14623, United States, mekeie@rit.edu

**1 - Pathwise Estimation of Greeks for Options with Discontinuous Payoff**

Nan Chen, Chinese University of Hong Kong, 709A, William Mong Engineering Building, Chinese University of Hong Kong, Shatin, Hong Kong - ROC, nchen@se.cuhk.edu.hk, Jeff Hong, Guangwu Liu

Estimating Greeks for options with discontinuous payoffs, such as digital options and barrier options, could be challenging when no closed forms exist. In this paper we establish analytical forms of Greeks for options with discontinuous payoffs, in terms of conditional expectations and also propose a nonparametric method to estimate Greeks based on these analytical forms. The method can be easily implemented and is valid for general diffusion models.

**2 - A Cyber Attack Simulator for Evaluating Information Fusion Network Security Tools**

Michael Kuhl, Associate Professor, Rochester Institute of Technology, Industrial & Systems Engineering Dept., 81 Lomb Memorial Drive, Rochester, NY, 14623, United States, mekeie@rit.edu, Kevin Costantini, Katie McConky, Moises Sudit

Cyber security techniques such as Information Fusion are being developed to identify and assess cyber threats on computer networks. A Cyber Attack Simulator is developed to model networks and to simulate cyber attacks over

time. The resulting data in the form of Intrusion Detection System alerts can be used to test Information Fusion tools including fusion engines, threat and impact assessment tools, and sensor management strategies.

**3 - Tutorial on Agent-based Modeling and Simulation**

Charles Macal, Argonne National Laboratory, 9700 S. Cass Ave., Bldg 900-DIS, Argonne, IL, 60439, United States, macal@anl.gov, Michael North

Agent-based modeling and simulation (ABMS) is a new approach to modeling systems comprised of autonomous, interacting agents. Complex adaptive systems, emergent behavior, and self-organization are a few of the notions from ABMS. Applications are growing rapidly in fields ranging from modeling the stock market to predicting the spread of epidemics. This tutorial covers the foundations of ABMS, development toolkits and methods, practical aspects, and the relationship of ABMS to conventional OR.

**■ SC49****Product Assortment Optimization**

Sponsor: Revenue Management & Pricing- Invited/Sponsored  
Sponsored Session

Chair: Paat Rusmevichientong, Assistant Professor, Cornell University, 221 Rhodes Hall, Ithaca, NY, 14853, United States, paatrus@cornell.edu

**1 - An Adaptive Algorithm for Dynamic Assortment Optimization**

Paat Rusmevichientong, Assistant Professor, Cornell University, 221 Rhodes Hall, Ithaca, NY, 14853, United States, paatrus@cornell.edu, Max Shen, David Shmoys

We consider the problem of dynamic assortment optimization. In our model, a retailer does not have any prior knowledge about the demand for each product, and must learn the demand by offering different product assortments and observing customer purchases. We propose an adaptive algorithm that integrates demand learning with assortment optimization, and establish convergence properties of the algorithm. Numerical results validate the performance of the algorithm.

**2 - Optimal Assortment Planning Under Dynamic Substitution:****A Homogeneous Population Model and Extension**

Dorothee Honhon, University of Texas, Dorothee.Honhon@mcombs.utexas.edu

We consider the problem of determining the optimal assortment and inventory levels for a discrete set of products with varying prices and costs in order to maximize expected profit in a single-period setting. Customer preferences are modeled through the definition of consumer types, where a type is a ranking of the potential products by order of preference. We first address the case in which all customers are of the same type, extend the results to more general choice models.

**3 - Dynamic Assortment Planning**

Rene Caldenty, Prof., New York University Stern School of Business, 44 West 4th str., New York, NY, 10012, United States, rcaldent@stern.nyu.edu, Felipe Caro

We investigate optimal assortment planning strategies for a retailer with limited shelf space. Market demand is stochastic in terms of (a) the pattern of customers' arrival and (b) their preferences over the menu of products. The retailer's objective is to maximize the long-term value of the retail business by dynamically adjusting the menu of products in display together with their prices.

**4 - A Product Line Extension Problem with Inventory Considerations**

Shan Li, PhD Candidate, Department of Industrial Engineering & Operations Research, University of California, Berkeley, Berkeley, CA, 94720, United States, lisapine@berkeley.edu, Max Shen

We consider a product line extension introduction problem in an integrated inventory (supply) and diffusion (demand) framework. The model determines whether and when to introduce the line extension and the corresponding production quantities, while accounting for substitution, diffusion and market segmentation effects.

## ■ SC50

### Game Theoretical Models of Competitive Networks

Sponsor: Revenue Management & Pricing- Invited/Sponsored  
Sponsored Session

Chair: Nicolas Stier-Moses, Assistant Professor, Columbia Business School, Uris 418, New York, NY, 10027, United States, ns2224@columbia.edu

Co-Chair: Asu Ozdaglar, Professor, EECS/MIT, 77 Massachusetts Avenue, Cambridge, MA, United States, asuman@mit.edu

#### 1 - Competition in Prices and Service Level Guarantees

Gabriel Weintraub, Columbia Business School, gweintraub@columbia.edu, Ramesh Johari

We consider a model of oligopoly competition for service industries where providers choose prices and service level guarantees. Consumers are sensitive to the sum of price and the congestion experienced. We show that this game can be reduced to standard oligopoly models, greatly simplifying the analysis. For example, for loss systems it is equivalent to a standard pricing game with constant marginal costs. We conclude by comparing this game to one where firms set prices and investment levels.

#### 2 - Quantifying the Loss of Profit in Price Competition for Differentiated Products

Georgia Perakis, Associate Professor, Sloan School, MIT, 50 Memorial Drive, Cambridge, MA, 02139, United States, georgiap@mit.edu, Amr Farahat

We provide bounds on the ratio of decentralized to centralized profits in price competitive markets with substitutable differentiated products. The lower bound is based on the minimum eigenvalue of the demand sensitivity matrix and the upper bound is based on comparing diagonal elements of two derived matrices. We then develop simpler bounds based on the maximum market clout. We show this bound is typically not too large.

#### 3 - Social Learning with Partial Observations

Asu Ozdaglar, Professor, EECS/MIT, 77 Massachusetts Avenue, Cambridge, MA, United States, asuman@mit.edu, Daron Acemoglu, Munther Dahleh, Ilan Lobel

We study a model of social learning with partial observations from the past. Each individual receives a private signal about the correct action he should take and also observes random samples of past actions. We characterize conditions under which asymptotic learning occurs and study the role that asymmetry between conditional signal distributions plays on asymptotic learning.

#### 4 - Stackelberg Routing in Competitive Networks

Nicolas Stier-Moses, Assistant Professor, Columbia Business School, Uris 418, New York, NY, 10027, United States, ns2224@columbia.edu, Jose Correa

We consider an oligopolistic network game where one player has more market power than the rest. The almost-monopolistic player can predict what price-taker players will do. Hence, it can make decisions before others, which allows us to use the framework of Stackelberg games. Instead of studying Nash equilibria as previous work has done, we make use of Stackelberg equilibria, and identify easy-to-characterize strategies for the leader that have good performance guarantees.

## ■ SC51

### Dynamic Pricing and Revenue Management: New Models

Sponsor: Revenue Management & Pricing- Invited/Sponsored  
Sponsored Session

Chair: Serhan Ziya, Assistant Professor, Department of Statistics and Operations Research University of North Carolina, Chapel Hill, NC, ziya@email.unc.edu

#### 1 - Dynamic Pricing of Fashion Goods:

The Effect of Risk-sharing Between Retailers and Suppliers  
Itir Karaesmen, University of Maryland, College Park, MD, United States, ikaraes@rhsmith.umd.edu

Our research brings together two important practical issues in fashion retail: Dynamic pricing and vendor-supplier relations. We determine the optimal price path for a single fashion good given a risk-sharing contract between a vendor and a supplier. We show how the optimal price path is different for the vendor when the vendor ignores the contract terms in making pricing decisions. We study different forms of contracts and discuss their impact on dynamic pricing.

#### 2 - A Model of Consumer Inertia with Applications to Dynamic Pricing

Xuanming Su, University of California, Haas School of Business, Berkeley, 94720, United States, xuanming@haas.berkeley.edu

Consumers often wait until the last minute before making a purchase. This indicates strategic behavior if they can secure a last-minute discount. Yet, consumers sometimes wait even when doing so is suboptimal (e.g., there may be higher prices or lower availability later). We show that such behavior is consistent with several well-established behavioral regularities and study its implications on dynamic pricing strategies.

#### 3 - Innovative Pricing Strategies Under Strategic Consumer Behavior

Yossi Aviv, Professor, Washington University, The Olin School of Business, Campus Box 1133, 1 Brookings Dr., St. Louis, MO, 63130, United States, aviv@olin.wustl.edu

In recent years, there has been an increasing interest in using OR models to explore strategic consumer behavior in the context of revenue management. In this talk, we will discuss ways in which sellers can adopt creative pricing schemes to optimally price products in the face of strategic consumer behavior. Such innovative pricing schemes should be tailored to discourage strategic waiting for price discounts, but should not harm the sellers' ability to segment customers.

#### 4 - Coordinating Positioning and Pricing in a Supply Chain

Garrett van Ryzin, Columbia University, 412 Uris Hall, New York, NY, 10027, United States, gjv1@columbia.edu, Wei Ke

We study the incentives to optimally differentiate and price products in a supply chain when manufacturers sell through intermediaries (retailers). The model has interesting implications for category management and related supply chain contracting mechanisms.

## ■ SC52

### Rails to the Sea: Current Issues in Railway-port Interchange (Roundtable)

Sponsor: Railway Applications  
Sponsored Session

Chair: Steven Harrod, Assistant Professor, University of Dayton, School of Business Administration, 300 College Park, Dayton, OH, 45469, United States, a2soft@aol.com

#### 1 - Matching and Forecasting US Inland Trade

Bengt Muten, Principal, Global Insight, 24 Hartwell Ave, Lexington, MA, 02421, United States, bengt.muten@globalinsight.com

We have matched and reconciled a number of public and private data sources to show and forecast commodity flows through US ports by ultimate origin, destination, and commodity. The author will present some of the data sources, describe the methodology used to match them, discuss assumptions, and present samples of the results.

#### 2 - Advances and Operating Strategies for Green Intermodal Container Terminals

Vaibhav Govil, Transportation Analyst, JWD Group, DMJM Harris, 300 Lakeside Drive, Suite #750, Oakland, CA, 94612, United States, Vaibhav.Govil@dmjmharris.com

The author discusses recent advances in automation for intermodal container terminals. The paper describes benefits of automation in relation to the environment, safety, increasing terminal throughput, and decreasing operating costs. There is analysis about different operating strategies and intermodal terminal layouts that consider a broad range of factors.

#### 3 - How Ports and Railroads Must Work Together to Support Projected Traffic Growth

Larry St. Clair, Port of Tacoma, P.O. Box 1837, Tacoma, 98401, United States, lstclair@portoftacoma.com

As cargo growth continues in the Pacific Northwest, what investments must be made by the ports, railroads, the state of Washington and other rail stakeholders to ensure the rail system remains fluid? Included - Future plans for the Port of Tacoma facility build out. - The current rail capacity in the state. - The role of the state of Washington in assisting ports and railroads. - The Class I railroad expansion plans as understood at present.

#### 4 - Driving the Renaissance of Rail Transportation with Marine Container Growth

Cary Helton, VP Service Planning, CSX Transportation, 500 Water St., Jacksonville, FL, 32202, United States, cary\_helton@csx.com

Rail transportation planning for intermodal traffic as a result of expanding global trade and the subsequent import and export growth. Creating service and value for the evolving intermodal customer.

■ SC53

**Location, Allocation, and Computing**

Sponsor: Location Analysis  
Sponsored Session

Chair: Tingting Cui, UC Berkeley, 4141 Etchevery Hall, UC Berkeley, Berkeley, CA, 94720, United States, tingting@ieor.berkeley.edu

1 - Solving the Min-max Multi-depot Vehicle Routing Problem

John Carlsson, Stanford University, 238 Ayrshire Farm Ct, apt. 201, Stanford, CA, 94305, United States, johnnyc@stanford.edu

The Multi-Depot Vehicle Routing Problem is a generalization of the Single-Depot Vehicle Routing Problem in which vehicles start from multiple depots and return to their depots of origin at the end of their assigned tours. The traditional objective in MDVRP is to minimize the total length of all the tours. We explore the notion of minimizing the maximal length of a tour in MDVRP (min-max MDVRP). A comparison of the computational implementations for different heuristics is included.

2 - Finding Equitable Convex Partitions and Resource Allocation Applications

Benjamin Armbruster, Stanford University, 121 W. Campus Dr. #1405A, Stanford, CA, 94305, United States, armbruster@stanford.edu, Yinyu Ye, John Carlsson

Motivated by a multi-depot vehicle routing heuristic and other resource allocation problems, we look at the problem of equitably partitioning a convex polygon and a set of  $n$  points. We seek a partition of the polygon into  $n$  convex pieces of equal area, each containing one point. We demonstrate a new algorithm that finds an exact solution to our problem in  $O(Nn \log N)$  time or arithmetic operations, where  $n$  is the number of points,  $m$  the number of vertices of the polygon, and  $N=n+m$  the sum.

3 - On the Reliable Facility Location Problem

Tingting Cui, UC Berkeley, 4141 Etchevery Hall, UC Berkeley, Berkeley, CA, 94720, United States, tingting@ieor.berkeley.edu, Max Shen

We consider the problem of locating facilities to minimize the expected facility, transport, and capacity reservation costs when candidate locations are subject to failure with certain probabilities. Various modeling and solution techniques are outlined with extensive computational studies.

4 - Fortifying the Existing Unreliable Facilities and Monotonic Optimization

Lezhou (Roger) Zhan, CitationShares Management, 5 American Ln, Greenwich, CT, 06831, United States, zhan@ufl.edu, Max Shen

We consider the problem of fortifying the existing unreliable facilities. Various modeling and solution techniques, including a monotonic branch-reduce-bound algorithm, are outlined with extensive computational studies.

■ SC54

**Joint Session AP/ICS: Approximate Dynamic Programming I**

Sponsor: Applied Probability, INFORMS Computing Society  
Sponsored Session

Chair: Sandjai Bhulai, VU University Amsterdam, Department of Mathematics, De Boelelaan 1081a, Amsterdam, 1081 HV, Netherlands, sbhulai@few.vu.nl

1 - Cost Function Approximation Methods in Dynamic Programming

Huizhen Yu, Postdoctoral Researcher, Univ. of Helsinki, P.O. Box 68 (Gustaf Hallstromin Katu 2b), University of Helsinki, Helsinki, 00014, Finland, janey.yu@cs.helsinki.fi, Dimitri Bertsekas

We overview approximate dynamic programming methods, which are suitable for very large-dimensional problems. The cost function is approximated by simulation and projection on a low-dimensional subspace generated by basis functions. Recent extensions involving Q-learning algorithms for optimal stopping problems, and general linear systems of fixed-point equations will also be discussed.

2 - Average-Cost Approximate Dynamic Programming for the Control of Birth-Death Processes

Dennis Roubos, VU University Amsterdam, Department of Mathematics, De Boelelaan 1081a, Amsterdam, 1081 HV, Netherlands, droubos@few.vu.nl, Sandjai Bhulai

Approximate dynamic programming when applied to average-cost decision problems with a countably infinite state space suffers from several computational issues. In particular, the algorithm may converge to non-stable solutions and requires knowledge on the average cost in advance. We address these issues by

providing a theoretical basis for the approximation structure such that the unique stable solution will be attained. We illustrate this for the broad class of birth-death processes.

3 - Policy Evaluation Algorithms Using Function Approximations

Angelia Nedich, Assistant Professor, University of Illinois at Urbana Champaign, 104 S Mathews Avenue, Urbana, IL, 61801, United States, angelia@uiuc.edu

We consider policy evaluation algorithms for infinite horizon dynamic programming problems with discounted cost. The focus is on discrete time dynamic systems with a large number of states. We discuss methods for policy evaluation that use temporal differences and function approximations. The methods update parameters of the function approximation on-line incrementally based on observations of system states from an infinite trajectory.

■ SC55

**Methods of Airline Network Analysis**

Sponsor: Aviation Applications  
Sponsored Session

Chair: Laurie Garrow, Assistant Professor, Georgia Institute of Technology, School of Civil & Envr Engineering, 790 Atlantic Drive, Atlanta, GA, 30332-0355, United States, laurie.garrow@ce.gatech.edu

1 - Methods of Measuring Airline Network Value

Roger A Parker, Chief of Technology, Marketing Commercial Airplanes, The Boeing Company, P.O. Box 3707 MC 21-33, Seattle, WA, 98124-2207, United States, roger.a.parker@boeing.com, Fred Ervin, Richard Lonsdale

Several measures of the effectiveness and value of the world's airline network are described. These include measure of consumer surplus (the Network Value Index), measures of market share structure, including q-derivatives, the Herfindahl index, and entropy notions, and measures of hub and spoke concentration, such as spoke density. These measures will be compared and contrasted, and evaluated as vehicles for in-depth studies of the world's airline network. Computing algorithms are outlined.

2 - The Evolution of the World's Airline Network

Kemp Harker, Boeing Commercial Airplanes, kemp.d.harker@boeing.com, Roger A Parker

Using some of the measures discussed in the previous presentation, the evolution of the world's airline network over the last 25 years is analyzed. The rates of recovery from system shock (e. g. SARS outbreak or terrorist attack) are characterized with time series methods. The emergence of hub and spoke network structure is portrayed, leading to the proliferation of point-to-point service. The demand structures and network response underlying the network's evolutionary pattern are examined.

3 - Generating Artificial Airline Schedules with a Genetic Algorithm Approach

Zhengjie Zhang, Boeing Commercial Airplanes, zhengjie.zhang@boeing.com, Roger A Parker

Using the measures discussed previously, and the computing systems built by BCA for network analysis, the creation of artificial airline schedules using genetic algorithm techniques is presented. The aim is to produce airline schedules that mimic the evolution of the airline network so that its future structure can be studied. Airline schedule generation both with and without the presence of competition are offered. The effects of various fitness measures on the results are described.

■ SC56

**Valuation Uncertainty and Revenue Monotonicity**

Cluster: Auctions  
Invited Session

Chair: Kevin Leyton-Brown, University of British Columbia, 201-2366 Main Mall, Vancouver, BC, V6T1Z4, Canada, kevinlb@cs.ubc.ca

1 - Reducing Costly Information Acquisition in Auctions

Kate Larson, University of Waterloo, 200 University Ave W, Waterloo, ON, N2L 3G1, Canada, klarson@cs.uwaterloo.ca

Most auction research assumes that potential bidders have private information about their willingness to pay for an item. In reality, bidders often have to go through a costly information-gathering process in order to learn their valuations. We will discuss ways of alleviating the strategic-burden placed on bidders faced with this information-gathering.

## 2 - Valuation Uncertainty and Imperfect Introspection in Sealed-Bid Auctions

David Thompson, University of British Columbia, 201-2366 Main Mall, Vancouver, BC, V6T 1Z4, Canada, daveth@cs.ubc.ca,  
Kevin Leyton-Brown

In auctions, agents might not know their exact valuations because of transaction costs or bounded rationality. We show settings where if agents don't coordinate value discovery, it can affect efficiency and revenue. For sealed-bid auctions, we show revenue and value-of-information bounds and where revenue equivalence applies.

## 3 - Revenue Monotonicity in Combinatorial Auctions

Baharak Rastegari, University of British Columbia, 201-2366 Main Mall, Vancouver, BC, V6T1Z4, Canada, baharak@cs.ubc.ca,  
Kevin Leyton-Brown, Anne Condon

Intuitively, one might expect that an auction's revenue weakly increases as the number of bidders grows, as this increases competition. However, it is known that for combinatorial auctions that use the VCG mechanism, a seller can sometimes increase revenue by dropping bidders. We show that such failures of revenue monotonicity can occur under a broad class of dominant-strategy mechanisms that includes affine maximizers and mechanisms that always select strongly Pareto efficient allocations.

## ■ SC57

### Joint Session TELECOM /ICS: Optimization Models for Routing in Telecommunication Networks

Sponsor: INFORMS Telecommunications Section,  
INFORMS Computing Society  
Sponsored Session

Chair: Eli Olinick, Associate Professor, EMIS Department, SMU, P.O. Box 750123, Dallas, TX, 75275, United States, olinick@engr.smu.edu

#### 1 - Traffic Engineering over Hop-constrained Node Survivable Networks

Luis Gouveia, CIO and DEIO-FCUL, Edificio C6, Campo Grande, Lisbon, Lx, Portugal, legouveia@fc.ul.pt, Pedro Patricio, Amaro de Sousa

We address a traffic engineering problem of routing a new demand matrix  $R$  over a dimensioned network, complying with the installed bandwidth on each edge and guaranteeing  $D$  node disjoint hop-constrained paths for every commodity. An optimal routing is the one that minimizes i) the average number of hops or ii) the largest number of hops of all paths supporting every commodity.

#### 2 - Internet Routing Under Active Congestion Control

Stanko Dimitrov, University of Michigan - Ann Arbor, 2812 IOE Building, 1205 Beal Avenue, Ann Arbor, MI, 48109-2117, United States, sdimitro@umich.edu, Marina A. Epelman, Dushyant Sharma

We present a mathematical model of Internet routing that incorporates congestion control techniques such as random early detection (RED). We show that several model instances are NP-hard and present numerical results comparing current routing policies to the routing policies corresponding to the optimal solution of our model.

#### 3 - Minimizing Maximum Link Utilization in OSPF Network

Anusha Madhavan, Student, Southern Methodist University, 6425 Ownby Drive, Room 356, Dallas, TX, 75205, United States, amadhava@engr.smu.edu, Jeffery Kennington

Open Shortest Path First (OSPF) is a popular internet routing protocol. One of the main challenges in routing data is to minimize the maximum link utilization in order to limit the congestion in a network. In this investigation, we present an arc-path column generation procedure and a modified arc-path optimization model with an objective of minimizing link congestion. An empirical analysis and comparison of the node-arc version and our arc-path procedure is also presented.

#### 4 - IP-based Heuristics for Incremental Demand Rerouting

Eli Olinick, Associate Professor, EMIS Department, SMU, P.O. Box 750123, Dallas, TX, 75275, United States, olinick@engr.smu.edu

Network managers are reluctant to make wholesale changes to an established routing assignment; complete modification to obtain an optimal assignment is viewed as highly risky. Therefore, we consider the problem of making incremental changes to a given routing assignment to maximize throughput metric based on residual capacity. We present IP-based heuristics for this problem and empirical results showing that the incremental approach finds near-optimal results within a reasonable CPU time limit.

## ■ SC58

### Learning, Innovation and Entrepreneurship

Sponsor: Organization Science  
Sponsored Session

Chair: Suresh Kotha, University of Washington, UW Business School, Management and Organization Department, Seattle, WA, 98195, United States, skotha@u.washington.edu

#### 1 - External Venturing for Strategic Renewal: Towards Understanding Who Makes Corporate Venture Capital Investments and Why

Sandip Basu, University of Washington, sb4@u.washington.edu,  
Corey Phelps, Suresh Kotha

This study examines the conditions under which firms participate in corporate venture capital (CVC), an important mode of exploration and strategic renewal. Based on extant literature and our field research, we conceptualize CVC investments as growth options. We integrate insights from real options research with an inducements and opportunities perspective of interfirm relationship formation to explain CVC participation. We use longitudinal data on 477 firms from the 1990 Fortune 500 list for the period 1990-2000 to investigate this question. We find that firms in industries with rapid technological change, high competitive intensity and weak appropriability engage in greater CVC activity. We also find that weak appropriability has a more pronounced effect on CVC activity when competitive intensity is high. Regarding firm characteristics, we show that firms that possess strong technological and marketing capabilities and resources developed from prior venturing experience engage in greater CVC activity. Finally, we find the combination of both strong technological and marketing capabilities reduces subsequent CVC activity. Our findings suggest that the exploration of new competences involves the exploitation of established resources and capabilities. We discuss the implications of these results for research into corporate entrepreneurship, VC syndication networks and real options.

#### 2 - Pre-entry Knowledge and the Survival of New Firms

Sonali K. Shah, University of Illinois Urbana-Champaign, sonali@uiuc.edu, John C. Dencker, March Gruber

New firms are endowed with knowledge and experience at birth – through the human capital of their founder(s). Existing empirical research suggests that this pre-entry knowledge and experience will influence the firm's chances of survival; however the mechanisms underlying this relationship have yet to be investigated. We seek to better understand and unpack this relationship. Specifically, we study the extent to which a founder's pre-entry knowledge of the business activity and pre-entry management experience influence the effectiveness of two subsequent learning activities, namely early-stage business planning and product line change. We find that pre-entry knowledge and management experience jointly increase firm survival through moderating the effects of these subsequent learning activities. We also find that learning activities are not always beneficial; in our sample, early-stage business planning decreased firm survival and product line change increased firm survival. We examine these patterns using survey data collected from 436 individuals in the Munich region who founded their own firms as an alternative to continued unemployment.

#### 3 - Learning from What Others Have Learned from You:

The Effects of Knowledge Spillovers on Originating Firms  
Kevin Steensma, University of Washington, steensma@u.washington.edu, Hongyan Yang, Corey Phelps

When an originating firm's spillovers are recombined with complementary knowledge by recipient firms, a knowledge pool is formed that is inherently related to the originating firm's knowledge base. This relevant knowledge pool contains valuable opportunities for the originator to vicariously learn from recipients' recombinatorial activities. In a longitudinal study of 87 telecommunications equipment manufacturers, we find that firms with larger relevant knowledge pools that are similar to the firm's existing knowledge base are more innovative.

#### 4 - The Role of Absorptive Capacity and Industry Context in the Search for New Competencies

Arvin Sahaym, University of Washington, arvin@u.washington.edu, Jeff Barden, Kevin Steensma

Research and development (R&D) and corporate venture capital (CVC) are two fundamental modes by which capabilities are developed within industries. However, there is some debate regarding how resources are allocated between these two modes of capability development, and the conditions under which internal R&D influences CVC. On the one hand, these modes of investment may be substitutes for each other. The choice between developing capabilities in house and accessing them in the venture capital marketplace represents a classic make or buy decision. On the other hand, these modes of investments may be complementary. Internally-developed knowledge can increase the ability to recognize and assimilate valuable technologies in potential venture targets. In this study, we examine the relationship between R&D investments and industry CVC deals. We find that R&D investments increase the number of CVC deals in an industry. Moreover, we find that industry growth combined with rapid technological change enhances the complementary relationship between R&D and CVC.

## ■ SC59

### Joint Session TM/Health: Hospital Process Change and Improvement

Sponsor: Technology Management, Health Applications Section  
Sponsored Session

Chair: David Moore, PhD, KLICNET.ORG, The Knowledge, Learning and Intellectual Capital Network, 3788 Davidson Place, Boulder, CO, 80305, United States, dmoore@klicnet.org

- 1 - The Impact of New Technology on Hospital Supply Chains  
Mike Magazine, Professor, University of Cincinnati, Dept. of QAOM, Univ. of Cincinnati, Cincinnati, OH, 45221, United States, mike.magazine@uc.edu

I will describe a proof of concept of implementing a new technology in a hospital setting. Specifically, Pyxis machines were tested in a pilot study to see if we could get the right products to the right place in a hospital setting at the right cost. Metrics will be described in the study before and after a pilot project. In addition, I will discuss some of the current issues, both managerial and technical, faced by the hospital.

- 2 - The Verdict is in: Toyota-based Process Improvements Work in Health Care

Naida Grunden, Medical Communications Consultant, 1910 Ponderosa Drive, Bellingham, WA, 98229, naidag@comcast.net

For 6 years all around Pittsburgh, the nonprofit Pittsburgh Regional Health Initiative (PRHI) conducted pilot projects in various hospitals using a health-oriented form of TPS. PRHI has even developed its own curriculum and teaches Toyota-based process improvements to healthcare workers across the nation. Naida Grunden, former PRHI Communications Director now residing in Bellingham, details numerous examples in her talk.

- 3 - Process Management, Patient Outcomes and Hospital Efficiencies: A Model Joint Replacement Program

Mary Ziemba-Davis, Research Director, St. Vincent Center for Joint Replacement, 2001 W. 86th Street - Entrance #8, Indianapolis, IN, 46260, United States, mxziemba@stvincent.org, Lisa Brandt, Jeffery Pierson

Our success relies on preoperative patient assessment, education, and team-based planning; streamlined patient registration; dedicated aftercare planning; postoperative team rounding; standardized medical protocols; evidence-based procedures; board-certified surgeons; and empirical research to streamline processes, reduce cost and resource use and enhance patient care. We show impact on patient satisfaction; length of stay; complications; case delays, volume and duration; and process variances.

- 4 - Engineering Improvements in Efficiency, Patient Flow and Care in a Hospital Surgical Suite

David Moore, PhD, KLICNET.ORG, The Knowledge, Learning and Intellectual Capital Network, 3788 Davidson Place, Boulder, CO, 80305, United States, dmoore@klicnet.org

This hospital case study follows process improvements from conception through implementation, identifies engineering and analytical techniques leveraged and describes obstacles faced and successful change management tactics applied. The ongoing improvement effort combines interviews, archival data and hundreds of hours of direct observation with process mapping, statistical and Pareto analysis, simulation, optimization and heuristics to improve metrics of efficiency, patient flow, and care.

## ■ SC60

### Knowledge, Learning, Intellectual Capital-I: Knowledge Systems

Sponsor: Technology Management  
Sponsored Session

Chair: Charles Weber, Assistant Professor of Engineering and Technology Management, Portland State University, P.O. Box 751, Portland, OR, 97207, United States, webercm@gmail.com

- 1 - Real-time Learning in Semiconductor Manufacturing  
Asser Fayed, Senior Staff Engineer, Cypress Semiconductor, yed@cypress.com, Charles Weber

The complexity of semiconductor manufacturing systems forces semiconductor manufacturers to manage product mix, cycle-time and throughput in near real time. Profitability depends upon accurate simulation of the cycle-time/throughput curve.

- 2 - Scale, Scope and Learning in Technological Development  
Jeffrey Macher, Assistant Professor, Georgetown University, G-04 Old North, Washington, DC, 20057, United States, jtm4@georgetown.edu

This paper examines how knowledge resulting from firm experience and scale and scope economies affect performance in technological development. Knowledge that results from greater experience within a particular technological area, when combined with knowledge spillovers from greater scope in other technological areas, significantly improves development performance. The results suggest that experience shapes and facilitates firms' abilities to absorb knowledge spillovers.

- 3 - The Fragile Foundations of Regional Scientific Advantage?  
Jeffrey L. Furman, Boston University, 595 Commonwealth Ave - 653a, Boston, MA, 02215, United States, furman@bu.edu, Fiona Murray, Scott Stern

This paper evaluates the impact of restrictions on the use of embryonic stem cell lines in US Federally funded scientific research on the geography of scientific discovery. It exploits an exogenous shock to the process of step-by-step scientific discovery to assess the sensitivity of regional scientific agglomeration to a temporary revision in the knowledge production process.

- 4 - Coordinating Search in Modular Systems:  
The Value of Temporary Integration

Oliver Baumann, Research associate and PhD Candidate, Institute for Information, Organization and Management, LMU Munich, Ludwigstr. 28, Munich, Germany, baumann@lmu.de

As complex systems are at best near-decomposable, decentralized search in modular structures requires coordination. Yet how much should efforts to provide for system-level fit constrain the independence of the module-level units, and what role do the specifics of the decomposition play? Using agent-based simulation, I suggest that intensive coordination is beneficial in the short-run, while module-level independence and punctuated system-level integration yield the highest long-run performance.

## Sunday, 4:30pm - 6:00pm

## ■ SD01

### Supply Chain Management IV

Contributed Session

Chair: Jayant Rajgopal, University of Pittsburgh, Department of Industrial Engineering, Pittsburgh, PA, 15261, United States, rajgopal@pitt.edu

- 1 - Optimal and Approximate Policies for Inventory Systems with Multiple Supply Options

Mahesh Srinivasan, The Pennsylvania State University, 463A Business Bldg., Dept. of Supply Chain and Info. Systems, University Park, PA, 16802, United States, maheshs@psu.edu, Douglas Thomas

We consider a single item periodic-review system with lost sales having iid demand and lead times. There is an option to use either a slower source of supply which is more economical or an expedited source, which is more expensive. We use dynamic programming based optimization and simulation to investigate optimal and near-optimal inventory policies and supply choices. We also provide insights to the cost threshold limit &#948; below which the fast supply option is preferred.

- 2 - Challenges of Humanitarian Logistics on Supply Chain Management: Perspectives from Southern Africa  
Ozias Ncube, Lecturer - Operations Research, University of South Africa, Department of Decision Sciences, P O Box 392 Unisa, Pretoria, 0003, South Africa, ncubeo@unisa.ac.za, Sarma Yadavalli, Jacomine Grobler

Relief organisations face challenges in effective planning and delivery of aid to persons affected by emergencies, ranging from coordination of efforts, human resources requirement and technical know-how. This coordination can be studied using the supply chain management paradigm. In this paper, we show the challenges faced by relief organisations in Southern Africa, and use the ideas of commercial SCM to address these challenges.

- 3 - Supply Chain Dynamics Under Extended Warranty Sales  
Seb Heese, Indiana University, 1309 E 10th St, Bloomington, IN, 47405, United States, hheese@indiana.edu

Consider two competing manufacturers selling their products through the same retailer. If this retailer derives profits from extended warranty sales, the manufacturers face a dilemma: While they have incentive to increase their warranties to make their products attractive to consumers, the retailer might prefer selling lower-warranty products to enhance sales of extended warranties. We develop a stylized model to determine and analyze optimal manufacturer and retailer strategies in this setting.

- 4 - Imposing Minimum Cycle Times on Single Server Queues  
Diederik Claerhout, K.U.Leuven Campus Kortrijk,  
E. Sabbelaan 53, Kortrijk, 8500, Belgium,  
Diederik.Claerhout@kuleuven-kortrijk.be, Nico Vandaele

In order to evaluate time phased release mechanisms in stochastic manufacturing systems we study the impact of imposing minimum cycle times on single server queues without blocking servers in open queueing networks. A conditional probability analysis provides the probability density function, distribution function and SCV of the modified M/M/1 interdeparture times. We report on our search for approximating numerical results for the SCV of the modified G/G/1 interdeparture times.

- 5 - Maximizing Read Accuracy of RFID Readers in Supply Chain Applications  
Jayant Rajgopal, University of Pittsburgh, Department of Industrial Engineering, Pittsburgh, PA, 15261, United States, rajgopal@pitt.edu, Bryan Norman, Lin Wang

There has been a sharp growth in interest in the use of RFID tags for tracking the movement of goods within the supply chain. While tag costs have been steadily declining, a major inhibitor to their adoption that remains is their relatively low read accuracy. In this presentation we formulate and analyze a model to study read-accuracy at a typical portal used in a warehouse or a store, and to optimize the number and locations of interrogator antennas at the portal.

## ■ SD02

### Contracts in Multi-tier Supply Chains with Information Asymmetry

Cluster: Supply Chain  
Invited Session

Chair: Feryal Erhun, Assistant Professor, Stanford University, MS&E, Stanford, CA, 94305, United States, ferhun@stanford.edu

- 1 - Outsourcing Structures, Commitment and Contracts in a Three-tier Supply Chain  
Pengfei Guo, Assistant Professor, The Department of Logistics, Hong Kong Polytechnic University, Hung Hum, Kowloon, Hong Kong - ROC, pengfei.guo@polyu.edu.hk,  
Jeannette Song, Yulan Wang

We consider a three-tier supply chain consisting of an original equipment manufacturer (OEM), a contract manufacturer (CM) and a component supplier. We analyze and compare two outsourcing structures currently implemented by top-tier OEMs: consignment and turnkey. We study the two-period bargaining games with one-sided information and one-sided offer among the three parties. We show that the gain of turnkey depends on cost priors and parties' commitment power.

- 2 - The Role of Distributors as an Information Intermediary in Distribution Systems  
Ying-Ju Chen, Assistant Professor, University of California at Berkeley, 4141 Etchevery Hall, Berkeley, CA, United States, ychen0@stern.nyu.edu, Mingcherng Deng, Ke-Wei Huang

We consider the capacity allocation problem in a decentralized distribution system with retailers, distributors, and a supplier. Retailers privately observe local demands, distributors own information technology that generates segment data of the retailers' demands, and the supplier builds capacity. We study this informational effect on the supply chain structure as well as the optimal contract design.

- 3 - Towards a Unified Theory of Procurement Contract Design: Production Flexibility, Spot Market Trading and the Structure of Sales and Options Contracts  
Pamela Pen-Erh Pei, PhD Candidate, MIT, 30A Mount Auburn Street, Cambridge, MA, 02138, United States, ppei@mit.edu

We examine pricing of capacity options with post-contract production and information asymmetry under spot trading. We derive the optimal price scheme for capacity contracts and show that it is governed by three main pricing regimes. We identify the regions under which each regime is preferred by a supplier. We also explore the effects of spot market characteristics on contract design.

- 4 - Delegation vs. Control of Component Procurement  
Enis Kayis, PhD Candidate, Stanford University, Management Science and Engineering, Stanford, CA, United States, ekayis@stanford.edu, Feryal Erhun, Erica Plambeck

Should manufacturers delegate component procurement to their tier-1 suppliers, or control component procurement by contracting with both tier-1 and tier-2 suppliers? We consider a model in which suppliers have asymmetric cost information and manufacturers have alternative sources of supply with cost known only to them. We study how the complexity of contracts, the manufacturers' beliefs about the suppliers' costs as well as the underlying supply chain structure influences the optimal decision.

## ■ SD03

### Issues in Supply Chain Management

Cluster: Supply Chain  
Invited Session

Chair: Greys Sosis, Marshall School of Business, University of Southern California, Los Angeles, CA, United States, sosis@marshall.usc.edu

- 1 - Modeling Consumer Returns Policies in Retail Operations  
Xuanming Su, University of California, Haas School of Business, Berkeley, 94720, United States, xuanming@haas.berkeley.edu

For many products, consumers are unable to assess their value until after purchase. Returns policies help to stimulate demand by insuring consumers against potential product misfit. However, this increases the chances that firms will be left with excess stock when unwanted items are returned. We develop an integrated model to address consumers' purchase and keep-or-return decisions, as well as firms' operational decisions.

- 2 - Capacity Investment and Pricing Strategy Under Technology Evolution  
Xiao Huang, PhD Candidate, University of Southern California, Los Angeles, CA, 90089, United States,  
Xiao.Huang.2009@marshall.usc.edu, Greys Sosis

Consider a market with two products, in which the new technology is on some attributes inferior to the old one. Our model consists of an entrant who can use only the new technology, and an incumbent who can use both. A segment of the customers is loyal to the old technology, while the rest can purchase either product. We study how the firms strategically determine their capacities and prices under technology evolution, and determine equilibria under different assumptions about the capacity cost.

- 3 - Implementing High-powered Contracts to Motivate Intertemporal Effort Supply  
Leon Chu, Marshall School of Business, University of Southern California, Bridge Hall 401, Los Angeles, CA, 90089, United States, leonyzhu@usc.edu, David Sappington

We characterize the optimal contract when the wealth-constrained agent acquires information over time. The optimal contract is more steeply-sloped for the largest output levels than that in either the standard moral hazard setting or the standard adverse selection setting. This reflects an important intertemporal effort externality: inducing higher levels of effort after the agent acquires more information also motivates the agent during the earlier periods when the agent has little information.

- 4 - Solution to an Infinite-Horizon Principal-Agent Problem by Direct Construction  
Hao Zhang, University of Southern California, 3670 Trousdale Pkwy, Bridge Hall 401, Los Angeles, CA, 90089, United States, zhanghao@marshall.usc.edu

A principal delegates the control of a Markovian system to an agent. She offers a long-term contract to the agent in order to maximize her expected profit, but the system states can only be observed by the agent. Through a two-state example, we demonstrate that the optimal contract may be directly constructed from certain pivotal points. It is more efficient than backward induction and helps uncover the structure of the optimal contract.

## ■ SD04

### Tutorial: A Tutorial on Safe Scheduling

Cluster: Tutorials  
Invited Session

- 1 - A Tutorial on Safe Scheduling  
Kenneth Baker, Tuck School, Dartmouth College, Hanover, NH, 03755, Kenneth.R.Baker@Dartmouth.EDU, Dan Trietsch

Safe scheduling augments the traditional approach to sequencing and scheduling models by recognizing safety times explicitly. In this paper, we give a brief review of the basic results in scheduling theory, describe how these results have been extended to stochastic cases, and demonstrate how safe scheduling models sharpen our ability to formulate stochastic problems. Although scheduling theory has historically been driven by optimization methods, we demonstrate how stochastic scheduling problems can be approached with a powerful spreadsheet-based heuristic procedure.

## ■ SD05

### Nicholson Student Paper Prize Competition, II

Cluster: Nicholson Student Paper Prize  
Invited Session

Chair: Chung-Piaw Teo, Professor, Department of Decision Sciences, National University of Singapore, Singapore, bizteocp@nus.edu.sg

- 1- Submodular Set Function Maximization Revisited  
Pranava Goundan, Consultant, Analytics Operations Engineering, 111 Devonshire Street, 8th Floor, Boston MA 02109, United States of America, pranava@alum.mit.edu

Abstract not available at this time.

- 2- Sequential-Merge Facets for High-Dimensional Infinite Group Problems  
Santanu Dey, Purdue University, 105 East Oak Street, West Lafayette IN, United States of America, sdey@purdue.edu

Although numerical and theoretical studies suggest that group cuts like Gomory Mixed Integer Cuts can be significantly improved by considering higher-dimensional groups, the discovery of facet-defining inequalities for high-dimensional infinite group problems has remained an open problem for 35 years. In this paper, we present the sequential-merge operator that creates a very large family of facet-defining inequalities for high-dimensional infinite group problem.

- 3- Robust Management of Motion Uncertainty in Radiation Therapy Treatments  
Timothy Chan, MIT, 77 Massachusetts Ave., E40-130, Cambridge MA, United States, tcychan@MIT.EDU, Thomas Bortfeld, Alexei Trofimov, John Tsitsiklis

In the context of patient care for life-threatening illnesses, the presence of uncertainty may compromise the quality of a treatment. In this talk, we present a robust framework to optimize radiation therapy treatments (subject to realistic uncertainties) for cancer patients. We illustrate our results on a clinical case where the uncertainty is due to organ motion during treatment.

## ■ SD06

### Advances in Call-center Research

Sponsor: Manufacturing & Service Oper Mgmt  
Sponsored Session

Chair: Mor Armony, Associate Professor, NYU, 44 West 4th Street, New York, NY, 10012, United States, marmony@stern.nyu.edu

- 1 - Modeling Call Centers with Delay Information  
Zeynep Aksin, Koc University, Rumeli Feneri Yolu, Istanbul, Is, Turkey, zaksin@ku.edu.tr, Oualid Jouini, Yves Dallery

We consider call center models with impatient customers and study how informing customers about their anticipated delays affects performance. A method for modeling the customer reaction with regard to delay information is developed. We propose and analyze a method of delay announcement labeled as announcement by increments.

- 2 - Asymmetric Information and Economies of Scale in Service Contracting  
Baris Ata, Associate Professor, Northwestern University, Evanston, IL, b-ata@kellogg.northwestern.edu, Mustafa Akan, Martin Lariviere

We consider the implications of economies of scale for service outsourcing when one party is better informed about demand. Economies of scale reverses standard results. While asymmetric information generally leads to distorted actions for an unfavorable type, here actions are distorted for favorable, high-volume customers.

- 3 - Service-Time Heterogeneity in an Inbound Call Center  
Noah Gans, OPIM Dept. - Wharton - Penn, 3730 Walnut St, Suite 500, Philadelphia, PA, 19104, United States, gans@wharton.upenn.edu, Haipeng Shen

Service times in call centers are highly variable. Still, a number of factors – e.g. which agent it is, the current level of system congestion – are associated with systematic changes in handle times. We investigate the sources of variation, as well as the potential effect on the agent staffing.

- 4 - Fair Dynamic Routing Policies in Large-scale Service Systems with Heterogeneous Servers  
Mor Armony, Associate Professor, NYU, 44 West 4th Street, New York, NY, 10012, United States, marmony@stern.nyu.edu, Amy Ward

Modern call centers typically have many agents answering calls with different skill levels. It has been shown that routing customers to the fastest agent first asymptotically minimizes steady-state customer waiting times. Unfortunately, this policy penalizes the faster agents by keeping them busy at all times, and only allowing the slower agents to idle. We address the question of how to optimize system performance subject to fairness with respect to server utilization.

## ■ SD07

### Competitive Models in Operations Management

Sponsor: Manufacturing & Service Oper Mgmt  
Sponsored Session

Chair: Terry Taylor, Associate Professor, UC Berkeley, Haas School of Business, 545 Student Services #1900, Berkeley, CA, 94720, United States, taylor@haas.berkeley.edu

- 1 - Quality Competition Under Yield Uncertainty  
Awi Federgruen, Professor, Columbia University, 419 Uris Hall, 3022 Broadway, New York, NY, 10027, United States, af7@columbia.edu, Nan Yang

We characterize the equilibrium behavior in an industry with  $N$  potential suppliers with uncertain yields, competing for the business of  $M$  buyers, in a single sales season. Suppliers can select (i) the yield reliability, as measured by an appropriately chosen decreasing function of the coefficient of variation of the yield factor, (ii) a yield target, i.e. the mean of the yield distribution, or (iii) both. We discuss mechanisms by which suppliers can be induced to adopt higher quality standards.

- 2 - Incentive Compensation and the Choice of Inventory Buffer in Production Systems  
Serguei Netessine, Associate Professor, University of Pennsylvania, 3730 Walnut St. Suite 500, Philadelphia, PA, 19104, United States, netessin@wharton.upenn.edu, Stanley Baiman, Richard Saouma

The inventory buffer (kanban) is an essential part of Toyota production system. We model a two-stage (tandem) production system in which the principal needs to motivate two workers. We show that the size of kanban is an effective mechanism by which the principal can motivate the downstream worker to work harder as well as to motivate the upstream worker to help the downstream worker.

- 3 - Competition in Large Scale Service Systems: Do Waiting Time Standards Matter?  
Gad Allon, Assistant Professor, Kellogg School of Management, 2001 Sheridan Road, Evanston, IL, 60208, United States, g-allon@kellogg.northwestern.edu, Itai Gurvich

We study the equilibrium behavior in a market with both small- and large-scale service providers that compete on both price and service level attributes. Applying the epsilon-Nash equilibrium framework to a sequence of markets with growing aggregate demand allows us to identify key properties of these markets. When restricting the demand models under consideration, we show that competition forces the firms to operate in the Quality and Efficiency Driven (QED) operational regime.

- 4 - Regulating Through Rivalry  
Terry Taylor, Associate Professor, UC Berkeley, Haas School of Business, 545 Student Services #1900, Berkeley, CA, 94720, United States, taylor@haas.berkeley.edu, Erica Plambeck

Under new product-based environmental regulations in the electronics industry, firms have incentive to test their competitors' products and reveal violations to a regulator so as to block competing products from the market. Paradoxically, we show that relying on competitive testing is only effective in uncompetitive markets. We characterize more broadly when regulating through rivalry is effective.

## ■ SD08

### Flexibility and Disruptions Reduction in Supply Chains

Cluster: Managing Disruptions in Supply Chains  
Invited Session

Chair: Kathryn Stecke, Professor, The University of Texas at Dallas, School of Management, Richardson, TX, 75083, United States, kstecke@utdallas.edu

#### 1 - On Measuring Supply Chain Resilience

Nitin Bakshi, Doctoral Student, Univ. of Pennsylvania, 3730 Walnut Street, Ste 500, Philadelphia, PA, 19104, United States, nbakshi@wharton.upenn.edu, Paul Kleindorfer, Howard Kunreuther

We study how characteristics of supply chains and markets in which a firm operates determine the impact of a major natural disaster. These characteristics include disaster preparedness, supplier-switching costs, interconnectedness, competition in the market for the final product, financial health of the firm, and historical trends in sales and profitability.

#### 2 - Engineering Changes and Quality Spills in Long Supply Chains

Daniel Reaume, Staff Researcher, General Motors Operations Research, M/C 480-106-155, 30500 Mound Road, Warren, MI, 48090, United States, daniel.reaume@gm.com, Bob Bordley

Long supply chains tend to make engineering changes and quality spills more difficult to manage because disruptions lead to long pipelines of unusable parts. We present an analytic model of such disruptions, taking into account production rates, supplier capacity, pipeline length, premium freight and part reparability.

#### 3 - IS-enabled Reduction of Disruptions in Supply Chains

Pamela Rogers, Teaching Fellow, University of North Texas, Department of Management, PO Box 305429, Denton, TX, 76203, United States, RogersP@unt.edu, Arun Madapusi

A tightly integrated supply chain is crucial to the sustainability of a firm's competitive advantage. However, failure to integrate the objectives of all the supply chain members results in sub-optimal supply chain performance. This study examines the use of information systems (IS) as a solution to reduce supply chain disruptions.

## ■ SD09

### Aviation Security Applications

Cluster: Homeland Security  
Invited Session

Chair: Laura McLay, Assistant Professor, Virginia Commonwealth University, Statistics & Operations Research, 1001 W Main Street, Richmond, VA, 23284, United States, lamclay@vcu.edu

#### 1 - Air Marshals Scheduling Problem

Xiaofeng Nie, University at Buffalo (SUNY), 438 Bell Hall, Buffalo, NY, 14260, United States, xnie2@buffalo.edu, Rajan Batta, Colin Drury, Li Lin

We propose a two-level formulation where flights are classified into several risk levels. The first level relates to TSA who will decide which flights from each risk level to be covered and construct the air marshals pairings such that the expected exposure is minimized. The second level relates to a threat source who will decide the probability of attaching one flight from each risk level with two objectives: maximizing the expected exposure and minimizing probability of apprehension.

#### 2 - Designing Aviation Security Systems Using a Sequential Decision Process

Alexander Nikolaev, Dept. of Computer Science, Univ of Illinois, 201 N Goodwin Ave, Siebel Center, Room 1218-4, Urbana, IL, 61801-2302, anikolae@uiuc.edu, Laura McLay, Sheldon H. Jacobson

This paper introduces the sequential stochastic security design problem (SSSDP) for aviation security screening operations. SSSDP is formulated as a two-stage model, where in the first stage security devices are purchased, and in the second stage a policy determines how passengers are screened, with the objective to maximize the total security of all passenger-screening decisions.

#### 3 - A Problem to Sequentially Screen Passengers for Aviation Security

Laura McLay, Assistant Professor, Virginia Commonwealth University, Statistics & Operations Research, 1001 W Main Street, Richmond, VA, 23284, United States, lamclay@vcu.edu, Sheldon H. Jacobson, John Kobza, Adrian Lee

Passenger screening systems have become an important component in the design and operation of aviation security systems. This presentation introduces the Sequential Stochastic Multilevel Passenger Screening Problem (SSMPSP), which allows passengers to be optimally assigned (in real-time) to aviation security resources. SSMPSP is formulated as a Markov Decision Process, and an optimal policy is found using dynamic programming. The model is illustrated with computational results.

## ■ SD10

### Inventory Inaccuracy and Value of Information

Cluster: Inventory  
Invited Session

Chair: Kevin Shang, Fuqua School of Business, Duke University, Durham, NC, United States, khshang@duke.edu

#### 1 - Firm Competition Under Supply Uncertainty

Fuqiang Zhang, Assistant Professor, University of California, Irvine, CA, United States, fzhang@uci.edu, Shaoxuan Liu, Rick So

We use a game-theoretical framework to study the impact of supply uncertainty on the joint marketing and inventory decisions between two competing retailers. We derive some analytical results that provide managerial insights on the equilibrium behavior of these joint decisions and the corresponding profitability of the two retailers

#### 2 - A Break-even Analysis for RFID Technology for Inventory Sensitive to Shrinkage

Karel van Donselaar, Eindhoven University of Technology, P.O. Box 513, Eindhoven, NB, 5611 PT, Netherlands, K.H.v.Donselaar@tm.tue.nl, Ton de Kok, Tom van Woensel

With RFID tags retailers try to control for shrinkage. Current inventory control systems do not take into account the inventory data inaccuracy resulting from shrinkage. Therefore costly audits are performed in which actual inventory is counted. The research in this paper adapts the inventory policy by including the impact of both shrinkage and RFID technology. An exact analytical expression as well as a simple rough-cut approximation is derived for the break-even prices of an RFID tag.

#### 3 - Evaluation of Supply Chains with Cycle-count Policies and Its Implication on IT Investments

Kevin Shang, Fuqua School of Business, Duke University, Durham, NC, United States, khshang@duke.edu, Gurhan Kok

This paper examines the impact of cycle count policies on multi-location supply chains with inventory record inaccuracy. We examine the impact of RFID technology on system performance and reveal insights on selecting choke points in supply chains.

#### 4 - Information-sensitive Inventory Management When Records Are Inaccurate

Adam Mersereau, Assistant Professor, Kenan-Flagler Business School, University of North Carolina, Campus Box 3490, McColl Bldg., Chapel Hill, NC, 27599-3490, United States, amersere@chicagogsb.edu

We consider replenishment policies in a lost sales inventory system with imperfect inventory records, where the decision-maker maintains a Bayesian record of her inventory position. We formulate the replenishment problem as a partially observed Markov decision process, and we compare single-period to forward-looking policies. We show the impact of data uncertainty on optimal replenishment. We also develop approximations for making near-optimal replenishment decisions.

## ■ SD11

### Pricing in Competitive Environment

Cluster: Manufacturing  
Invited Session

Chair: Shu Zhou, Assistant Professor, San Jose State University, San Jose, CA, 95192, United States, zhou\_s@cob.sjsu.edu

#### 1 - Slotting and Pricing Decisions in a Durable Product Supply Chain

Xiuli He, UT-Dallas, School of Management, SM 30, Dallas, TX, 75080, United States, xiulihe@gmail.com, Suresh Sethi

Consider a supply chain in which a manufacturer sells an innovative durable product to a retailer. The product demand follows a Bass-type diffusion process and is determined by the market influences, retail price, and shelf-space allocated to it. We consider the myopic and far-sighted retailer profit strategies. We characterize the optimal dynamic shelf space allocation and optimal pricing policies. Surprisingly, the manufacturer, and even the retailer, may be better off with a myopic strategy.

- 2 - Capacity and Price Competition Under Imperfect Information  
Bing Jing, Assistant Professor of Marketing, Cheung Kong Graduate School of Business, Oriental Plaza, 3F, Tower E3, 1 East Chang An Avenue, Beijing, 100738, China, bjing@stern.nyu.edu, Yuxin Chen

We examine capacity-then-price competition in a duopoly where some (the remaining) consumers are uninformed (informed) about prices. The central result is the following. Even in the absence of capacity costs, in the sub-game perfect equilibria each firm in general chooses a capacity below its maximum demand and thus has to undertake rationing when its prices below its competitor. The price equilibrium in the first stage is of independent interest.

- 3 - Bundling and Pricing in a Duopoly Environment  
Shu Zhou, Assistant Professor, San Jose State University, San Jose, CA, 95192, United States, zhou\_s@cob.sjsu.edu, Srinagesh Gavirneni

In a duopoly with two products, when the companies are allowed to use the mixed bundling strategies, the leader no longer dominates the follower in terms of gaining a competitive edge. This is in complete contrast to the setting in which only pure bundling strategies are allowed. We explore the main reasons for this behavior and also evaluate the impact of randomness on these results.

- 4 - Competitive Pricing and Due-Date Quotation with No Tardiness  
Ling Wang, Assistant Professor, University of Miami, liwang@exchange.sba.miami.edu

We consider a competitive model in which two make-to-order firms quote non-stable prices and lead-times to incoming customers. No tardiness is allowed. We identify and explain a seemingly counter-intuitive behavior - "lose-for-now" - in which the firm with smaller backlog chooses to lose the current customers to the rival.

## ■ SD12

### Contemporary Scheduling

Cluster: Scheduling

Invited Session

Chair: Joseph Y.-T. Leung, Distinguished Professor, New Jersey Institute of Technology, University Heights, Newark, NJ, 07102, United States, leung@cis.njit.edu

- 1 - The Coordination of Pricing and Scheduling Decisions  
Nicholas G. Hall, Professor, Ohio State University, Fisher College of Business, 2100 Neil Avenue, Columbus, OH, 43210-1144, United States, hall\_33@cob.osu.edu, Zhi-Long Chen

We consider the coordination of pricing and scheduling decisions to maximize revenue less scheduling cost. We develop an optimal algorithm and an FPTAS for solving three related problems. Our computational results estimate the value of coordination. This work is apparently the first study of pricing and job level scheduling coordination.

- 2 - Parallel Machine Scheduling with S-precedence Constraints  
Marc Posner, Professor, Ohio State University, Integrated Systems Engineering, Columbus, OH, 43210, United States, posner.1@osu.edu, Eun-Seok Kim

For s-precedence constraints, a job cannot start processing until all preceding jobs have started. While not discussed in the scheduling literature, S-precedence constraints have wide applicability in real world settings such as FIFO processing systems. We study an identical parallel machine problem where the objective is to minimize the makespan.

- 3 - Machine Scheduling with Deliveries to Multiple Customers to Minimize Total Number of Tardy Jobs  
Guohua Wan, Professor, University of Macau, Faculty of Business Administration, Taipa, Macau, gh\_wan@china.com

We consider several scheduling problems with order deliveries to multiple customers. Each customer has a due date for his/her order. The order completion time is the time when a customer receives his/her order. The objective of the problems is to minimize the number of tardy orders. We study the complexity issues and provide polynomial time algorithms or heuristic algorithms to solve the problems.

- 4 - Better Online Buffer Management  
Jay Sethuraman, Associate Professor, Columbia University, Dept. of IEOR, New York, NY, 10012, United States, js1353@columbia.edu, Cliff Stein, Fei Li

We design effective buffer management policies for network switches supporting Quality of Service (QoS) guarantees. Specifically, we consider a model in which each packet has a deadline by which it must be sent, and a value reflecting the payoff for sending it on-time. The goal is to maximize the value of the packets sent. In this talk, we shall discuss several online algorithms for this problem and some well-studied variants.

## ■ SD13

### Development and Application of Mixed Integer Programming

Sponsor: Optimization/ Integer Programming

Sponsored Session

Chair: Bo Zeng, Purdue University, Arnold Drive, 223-3, West Lafayette, IN, 47906, United States, bzeng@ecn.purdue.edu

- 1 - A Computational Study of the Maximum Co-2-plex Problem  
Benjamin McClosky, Rice University, 6100 Main St. - MS 134, Houston, TX, 77030, United States, bjm4@rice.edu, Balabhaskar Balasundaram, Illya Hicks

2-plexes are cohesive subgraphs which were introduced to relax the structure of cliques. A co-2-plex is the complement of 2-plex and is therefore similar to a stable set. We present an exact algorithm for solving the maximum co-2-plex problem.

- 2 - A Framework for Implementing Parallel Tree Search Algorithms  
Yan Xu, Optimization Developer, SAS Institute Inc, yax2@lehigh.edu, Matthew Saltzman, Ted Ralphs, Laszlo Ladanyi

COPS is a framework for implementing and parallelizing tree search algorithms. It employs a number of features to improve scalability and support the implementation of data intensive algorithms. Implementing such algorithms in a scalable manner is challenging. We describe the design of COPS and how the design addresses these challenges. We present several applications built with COPS and some computational results of solving integer programs.

- 3 - Solving Set Covering Problems with Symmetry  
James Ostrowski, Lehigh University, 200 W Packer Ave, Bethlehem, PA, 18015, United States, jao204@lehigh.edu, Jeff Linderoth

In this talk we discuss methods that could be used to potentially solve hard set covering problems. Our particular focus will be on Steiner triple systems and covering design problems. We generate collections of non-isomorphic feasible partial solutions with specific properties. By considering the symmetry of the constraints, we can use these partial solutions to break the original problem into several smaller subproblems. These subproblems are much easier to solve and can be done in parallel.

- 4 - Optimization Models and Applications in United Airlines Irregular Operations: Now and Future  
Jianhong Qiao, Senior Analyst, United Airlines, 1200 E Algonquin Rd, Elk Grove Village, IL, 60007, United States, jianhong.qiao@united.com, Shraavanth Gongireddy, Zhifeng Chen, David Newton, Qiang Gong, Joseph Mathews

Real time irregular operations in airline industry lack sophisticated optimization models and integrated implementation due to prohibitively large problem size, system complexity, and running time limitation. Good solutions against unexpected events, e.g. weather, should efficiently and effectively rebook passengers, reassign pilots and flight attendants, and balance aircrafts. A future system integrates optimization models and pursues globally optimal solutions with reasonable solving time.

## ■ SD14 Session Moved to MA32

### Large-scale Optimization

Sponsor: Optimization/ Nonlinear Programming

Sponsored Session

Chair: Michael Saunders, Stanford University, Dept. of Management Science & Engineering, 380 Panama Way, Stanford, CA, 94305-4026, United States, saunders@stanford.edu

- 1 - Iterative Methods for Generalized Saddle-point Problems  
Philip Gill, Professor, University of California, San Diego, 9500 Gilman Drive, # 0112, La Jolla, CA, United States, pgill@ucsd.edu, Joshua Griffin, Anders Forsgren

We consider iterative methods for generalized saddle-point problems that arise in interior methods for general nonlinear optimization. We focus on the application of the preconditioned conjugate-gradient method to a certain "doubly-augmented system" that is positive definite with respect to both the primal and the dual variables.

## 2 - An Augmentation Preconditioner for Linear Systems Arising from Interior Point Methods

Chen Greif, University of British Columbia, 2366 Main Mall, Vancouver, BC, V6T 1Z4, Canada, greif@cs.ubc.ca

We introduce a preconditioning technique for saddle point linear systems arising from primal-dual interior point algorithms in linear and quadratic programming. The preconditioner has the attractive property of improved eigenvalue clustering with increased ill-conditioning of the (1,1) block of the matrix. We analyze spectral characteristics and demonstrate performance on problems from the NETLIB and CUTER test suites. The numerical experiments include results based on inexact inner iterations.

## 3 - A Unified Theorem on SDP Rank Reduction

Yinyu Ye, Professor, Stanford University, Dept. of Management Science & Engineering, Stanford, CA, 94305-4026, United States, yinyu-ye@stanford.edu

We consider the problem of finding a low-rank approximate solution to a system of linear equations in symmetric, positive semidefinite matrices, where the approximation quality of a solution is measured by its maximum relative deviation, both above and below, from the prescribed quantities. We present a randomized polynomial time algorithm to compute such a solution with provable bounds, and show such bounds are tight.

## 4 - Improving Parameter Optimization Performance

Mark Abramson, Associate Professor, Air Force Institute of Technology, AFIT/ENC, Building 641, 2950 Hobson Way, Wright-Patterson AFB, OH, 45433, United States, Mark.Abramson@afit.edu, Thomas Asaki, John Dennis, Jr., Raymond Magallanez, David Betha

We study the numerical solution of optimization problems, in which the time required to compute a function value may vary greatly within the domain. Our approach applies a surrogate-based mesh adaptive direct search algorithm, in which surrogates are based on previously stored CPU times, rather than objective function values. Examples come from industrial problems, including one that requires a hydrodynamic simulation and an image registration process for each function evaluation.

## SD15

### Linear Programming and Linear Complementarity Problems

Sponsor: Optimization/ Linear Programming and Complementarity Sponsored Session

#### 1 - A New Class of Polynomial Interior-point Algorithms for $P^*(\kappa)$ -linear Complementarity Problems

Goran Lesaja, Associate Professor, Georgia Southern University, Department of Mathematical Sciences, P.O. Box 8093, Statesboro, GA, 30458, United States, goran@GeorgiaSouthern.edu, Kees Roos, Yanqin Bai

We present a new class of short- and long-step polynomial interior-point algorithms for  $P^*(\kappa)$ -Linear Complementarity Problems based on a new class of parametric kernel functions. This class is fairly general and includes the classical logarithmic function, the prototype self-regular function, and non-self-regular kernel functions as special cases. The iteration bounds obtained in this paper are very favorable and they match the best known existing iteration bounds.

#### 2 - Strong Duality and a Dual Method for Nonconvex Spectrum Optimization of Multicarrier Systems

Tamas Terlaky, McMaster University, Department of Computing and Software, Hamilton, ON, Canada, terlaky@mcmaster.ca, Jiaping Zhu

Yu and Liu's strong duality theorem under the time-sharing property requires the Slater condition to hold for the considered general nonconvex problem, what is satisfied for the specific application. We further extend the scope of the theorem under Ky Fan convexity which is slightly weaker than Yu&Lui's time-sharing property.

#### 3 - On the Global Solution of Linear Programs with Linear Complementarity Constraints

John E. Mitchell, Professor, Department of Mathematical Sciences, Rensselaer Polytechnic Institute, 110 Eighth St. AE325, Troy, NY, 12180, United States, mitchj@rpi.edu, Jong-Shi Pang, Kristin P. Bennett, Gautam Kunapuli, Jing Hu

This talk presents a parameter-free integer-programming based algorithm for the global resolution of a linear program with linear complementarity constraints (LPEC). The cornerstone of the algorithm is a minimax integer program formulation that characterizes and provides certificates for the three outcomes— infeasibility, unboundedness, or solvability—of an LPEC. Computational results demonstrate that the algorithm can handle infeasible, unbounded, and solvable LPECs effectively.

## 4 - The Colourful Feasibility Problem

Tamon Stephen, Simon Fraser University, 14th Floor Central City Tower, 250-13450 102nd Ave., Surrey, BC, V3T0A3, Canada, tamon@sfu.ca, Sui Huang, Tamas Terlaky, Antoine Deza

A colourful version of the linear programming feasibility problem is to find a feasible basis that respects a given colouring (partition) of the vertices. This problem was presented by Barany and Onn in 1997, it is still not known if a polynomial time algorithm exists. We compare their methods with new methods. We show that some algorithms can lead to cycling or slow convergence, but we provide extensive numerical experiments which show that others perform much better than predicted.

## SD16

### Meta-control Applications to Optimization

Cluster: Optimization (Invited)

Invited Session

Chair: Wolf Kohn, CTO and Founder, ClearSight Systems, 12828 Northup Way, Suite 310, Bellevue, WA, 98005, United States, wolf.kohn@clearsightsystems.com

#### 1 - Continualized Approximation Method for Binary Integer Programming

Kathrine von Haartman, PhD Student and Systems Analyst, University of Washington, Industrial Engineering, Box 352650, Seattle, WA, 98195, United States, meggie.vonhaartman@clearsightsystems.com, Wolf Kohn, Zeld Zabinsky

This paper uses continualization techniques to find approximate solutions to binary integer programming problems. The algorithm emphasizes the construction of sequential approximations to a solution using a meta-control approach that has low polynomial time complexity. This algorithm will be illustrated with an example.

#### 2 - Advanced Demand Forecasting Algorithm

Yanfeng Shen, Chief OR Analyst, ClearSight Systems, 12828 Northup Way, Suite 310, Bellevue, WA, 98005, United States, yanfang.shen@clearsightsystems.com, Vladimir Brayman, Wolf Kohn

This paper proposes a distributed algorithm for the real-time estimation of product demand as a function of sensory data (RFID, Bar code readers). The algorithm includes building a sub-process that learns the parameters of the model, and scheduling their incorporation as a function of observed behavior quality of the forecast. We will describe the algorithm and theoretical aspects of the technology. We will illustrate the technology with an example.

#### 3 - Rule-based Supply Chain Forecasting and Control

Hongrui Liu, PhD Student, University of Washington, Industrial Engineering, Box 352650, Seattle, WA, 98195, United States, hrlui@u.washington.edu, Zeld Zabinsky, Wolf Kohn

We develop a rule-based method to formulate a stochastic supply chain flow problems that includes forecasting and control. We explore the use of quantum logic to transform the IF-THEN-ELSE type rules to quantum states and perform inferences with a quantum operator. This has the potential to drastically reduce computation, so we hope for a real-time efficient methodology for supply chain management.

#### 4 - Quantum Dynamic Programming Using Hybrid Automata

Wolf Kohn, CTO and Founder, ClearSight Systems, 12828 Northup Way, Suite 310, Bellevue, WA, 98005, United States, wolf.kohn@clearsightsystems.com, Zeld Zabinsky

We describe early results about implementing dynamic decision processes using quantum reasoning techniques. The processes are represented by hybrid automata. The reasoning techniques use quantum observables as inference operators. These operators are the edges of an automaton whose states are quantum states of the decision process. We provide several examples, such as inventory, replenishment management, resource scheduling and dispatch, using this paradigm.

## SD17

### Information Systems Economics

Sponsor: Information Systems Society

Sponsored Session

Chair: Vidyanand Choudhary, University of California, Irvine, SB 313, Irvine, CA, 92697, United States, veecee@uci.edu

### 1 - Impact of Competition from Open Source Software on Proprietary Software Quality and Social Welfare

Zach Zhou, The Paul Merage School of Business, UC Irvine, Irvine, CA, 92697, United States, zzhou01@gsm.uci.edu, Vidyand Chandhary

We analyze the impact of competition from open source on the quality of proprietary software. Whereas prior research showed that competition from open source causes proprietary software quality to increase, we find that proprietary software quality can be higher or lower than the quality of a proprietary monopoly. We also find that competition from open source can reduce social welfare even in the absence of network effects.

### 2 - Does Online Information Substitute or Complement Traditional Quality Signals?

Siva Viswanathan, Assistant Professor, University of Maryland, 4313 Van Munching Hall, RH Smith School of Business, College Park, MD, 20742, United States, sviswana@rhsmith.umd.edu, Vandana Ramachandran

We analyze an extensive dataset of consumers who obtained vehicle and transaction information from online sources in their used-car purchase process, to examine the impact of online information on the choice of certification, and price paid. We compare outcomes involving certified purchases, with outcomes where there was no certification. Our findings highlight interesting relationships between different information categories and the likelihood of a certified purchase, as well as price paid.

### 3 - Digitization of Music: An Empirical Study of Dis-intermediation and the Long-tail Phenomenon

Ramnath Chellappa, ram@bus.emory.edu, Shivendu Shivendu, Vallabhajosyula Sambamurthy, Benn Konsynski

Digitization of content has led to significant changes in the structure of the music industry. Theoretical research argues that record-labels are being increasingly displaced and consumers' music purchasing behavior has been fundamentally altered. Our work investigates the impact of content digitization through an empirical examination of the role of traditional players in this entertainment industry.

## SD18

### Real-time Integer Programming

Sponsor: INFORMS Computing Society  
Sponsored Session

Chair: Jeff Linderoth, University of Wisconsin-Madison, 1513 University Avenue, Madison, WI, 53706-1572, United States, jtl3@lehigh.edu

#### 1 - Parallel Local Search Methods for Mixed Integer Programs

Andrew Miller, University of Wisconsin-Madison, 3156 Engineering Centers Building, 1550 Engineering Drive, Madison, WI, United States, amiller@enr.wisc.edu, Mahdi Namazifar

We discuss frameworks that use ideas from MIP heuristics such as local branching and RINS to search for feasible solutions simultaneously on many different processors on a grid or high performance computing architecture. Our frameworks are designed to ensure that the work done on different processors does not significantly overlap. Computational evidence suggests that such frameworks can obtain good solutions for many problems faster than commercial solvers.

#### 2 - Approximating the Stability Region of Binary Variables with Linear Objectives

Martin Savelsbergh, Professor, H. Milton Stewart School of Industrial and Systems Engineering, Georgia Tech, 765 Ferst Dr, Atlanta, GA, 30332-0205, United States, mwps@isye.gatech.edu, Shabbir Ahmed, Fatma Kilinc Karzan, George Nemhauser, Alejandro Toriello

We study sensitivity and stability analysis for NP-hard optimization problems. We focus an optimal solution's sensitivity to changes in the cost coefficients of binary variables. We establish inner- and outer approximations of the region in the cost-vector space for which the optimal solution remains optimal. Furthermore, we investigate techniques to quickly re-optimize when the current solution is no longer optimal.

#### 3 - Warm Starting for Mixed Integer Linear Programs (MILPs)

Menal Guzelsoy, Lehigh University, 200 West Packer Ave, Room 362, Bethlehem, PA, 18015, United States, megb@lehigh.edu, Ted Ralphs

Warm starting is a technique used to start the solution procedure of a modified MILP from an advanced state using data generated from execution of a previous solution procedure. Methods for warm starting are useful in cases where solution of a family of related MILPs is required. In this talk, we will consider various

warm starting approaches appropriate for MILP families parameterized over different parts of the input data.

#### 4 - Multi-stage Process Models and Grid Computation

Michael Ferris, Professor, University of Wisconsin-Madison, Department of Computer Sciences, 1210 West Dayton Street, Madison, WI, 53706, United States, ferris@cs.wisc.edu

We consider the solution of a time critical application using grid computation. A hierarchical model involving batching, assignment and scheduling for an chemical process application will be described and new tools for its solution will be outlined. In particular, the use of the GAMS/grid interface, the condor resource manager, and a variety of mixed integer programming solvers, coupled with domain expertise will be demonstrated.

## SD19

### Joint Session ICS/INFORMS-ED: Recommendations of the INFORMS Computing Society Education Committee

Sponsor: INFORMS Computing Society, INFORM-ED  
Sponsored Session

Chair: Jill Hardin, Virginia Commonwealth University, 1001 W. Main St., P.O. Box 843083, Richmond, VA, 23284-3083, United States, jrhardin@vcu.edu

#### 1 - Panel Discussion: Recommendations of the INFORMS Computing Society Education Committee

Moderator: Jill Hardin, Virginia Commonwealth University, 1001 W. Main St., P.O. Box 843083, Richmond, VA, 23284-3083, United States, jrhardin@vcu.edu, Panelist: David Rader, Cesar Rego, Kevin Furman, Allen Holder

At its January 2007 business meeting, the INFORMS Computing Society proposed forming an Education Committee. This committee has been charged with recommending a model undergraduate curriculum which would produce graduates who are well prepared for work at the OR/CS interface. The draft report detailing the committee's recommendations and rationale will be presented, followed by a panel discussion with the members of the committee.

## SD20

### DA Practice Award Finalists

Sponsor: Decision Analysis  
Sponsored Session

Chair: Karen Jenni, Insight Decisions LLC, 2200 Quitman Street, Denver, CO, 80212-1116, kjenni@insightdecisions.com

#### 1 - DAS Practice Award Finalists

Karen Jenni, Insight Decisions LLC, 2200 Quitman Street, Denver, CO, 80212-1116, kjenni@insightdecisions.com

The DAS Practice Award was established to recognize, promote, and publicize outstanding decision analysis practice. Finalist for the award will present their work during this session, and the winner will be announced at the DAS Awards session.

## SD21

### Behavioral Aspects of Decision Making Under Uncertainty

Sponsor: Decision Analysis  
Sponsored Session

Chair: Bob Bordley, General Motors Operations Research, M/C 480-106-256, 30500 Mound Road, Warren, MI, 48090, United States, robert.bordley@gm.com

1 - High Stakes Risk Preference Experiment With Actual Payout  
Sam Bodily, John Tyler Professor, Darden- Univ. of Virginia, 100 Darden Boulevard, Charlottesville, VA, 22903, United States, bodilys@virginia.edu, Phil Pfeifer

We report an experiment where 319 MBA students gave certainty equivalents (CEs) for a real 50/50 lottery involving identical briefcases containing \$17,500 and \$0. Students gave binding statements of the least they would accept for their briefcase from a banker offering cash. We expected that the CEs from actual payouts would be systematically lower than students' earlier CEs elicited using a hypothetical lottery. In fact, there is a complex story to be told.

## 2 - Using a Combination of Forecasts Approach to Resolve Partition-dependence Bias

Bob Bordley, General Motors Operations Research, M/C 480-106-256, 30500 Mound Road, Warren, MI, 48090, United States, robert.bordley@gm.com

Elicited probabilities vary with partition. This paper treats each partition's elicited probability as an estimate of the individual's true underlying subjective probability. Assuming forecast error has a Dirichlet distribution (which reproduces some of known biases toward the uniform prior) leads to a combined estimate of the subjective probability. This is applied to a real problem in missing survey data. This Bayesian solution has some Shaferian-aspects.

## 3 - Decision Making Under Uncertainty: Representational and Psychometric Measures

John Aloysius, University of Arkansas, 204 WCOB, Fayetteville, AR, 72701, United States, JAlloysius@walton.uark.edu, Srinivasan Venkatraman, Fred Davis

Decision analysis has normative foundations, but understanding linkages with descriptive information processing is key to develop prescriptive recommendations. Our experiment varies the number of plays and parameters of binary gambles. We analyze the relationships between abstract properties (e.g., expected value), psychological perceptions (riskiness and ambiguity) of these multiple prospects, decision behavior (e.g., certainty equivalents) and individual differences (e.g., risk attitude).

## SD22

### JFIG Paper Competition Finalists II

Sponsor: Junior Faculty Interest Group

Sponsored Session

Chair: Sunil Kumar, Stanford University, skumar@stanford.edu

#### 1 - JFIG Paper Competition Finalists

In these two sessions the finalists of the 2007 JFIG paper competition will present their research. The paper competition is organized by the Junior Faculty Interest Group (JFIG) forum in INFORMS. JFIG was created in 2001 to promote the career development of tenure-track faculty in INFORMS. The goals of the paper competition are to encourage research among junior faculty and to increase the visibility of research conducted by junior faculty within the fields of operations research and management science. Six finalists are selected by the award committee and their papers are presented in these two sessions. The papers submitted for the competition are evaluated based on the importance of the topic, appropriateness of the research approach, and the significance of research contribution. Winners are announced at the JFIG lunch on Sunday at the INFORMS Annual Meeting.

## SD23

### Behavioral Queuing

Sponsor: Behavioral Process Management (BPM)

Sponsored Session

Chair: Ken Schultz, Associate Professor, University of Alberta, 340-G Business School, Edmonton, Ab, T6G 2R6, Canada, klschult@ualberta.ca

#### 1 - Willingness to Pay and the Waiting Experience

Diane Bischak, Associate Professor, University of Calgary, Haskayne School of Business, 2500 University Drive NW, Calgary, AB, T2N 1N4, Canada, diane.bischak@haskayne.ucalgary.ca, Robert Oxoby

We present results from a simple willingness-to-pay (WTP) experiment in which individuals' preferences for a good of known value were elicited. Three time treatments were used to assess the effects of an occupied or unoccupied wait prior to the elicitation of WTP values. Our results indicate that an unoccupied wait has a significant effect on WTP, with implications for the cost of customer waiting time in service operations.

#### 2 - Perceived Wait Time, Satisfaction and the Effect of Wait Time Fillers

Kelly McGuire, Cornell University, 105 Cobb St, Ithaca, NY, 14850, United States, kam63@cornell.edu, Sheryl Kimes, Mellie Pullman, Mike Lynn

Previous research into the impact of waiting time fillers on perceived wait time and satisfaction has failed to establish a consistent effect. A series of computer-based, laboratory experiments were conducted to first establish the processes that contribute to the relationship between perceived wait time and satisfaction, and then to test the impact of different types of time filling activities on these processes.

## SD24

### Software Demonstration

Cluster: Software Demonstrations

Invited Session

#### 1 - ATEJI - Object-Oriented Modeling and Integration with OptimJ

Patrick Viry, ATEJI, 14 Rue Soleillet, Paris, 75020, France, patrick.viry@ateji.com

The OptimJ object-oriented modeling language provides a radical new approach to integrating optimization techniques in general IT environments. See how easy it is to integrate your models in web-based database-enabled applications. Discover OptimJ bulk processing operators for data feeding and cleaning. Understand how OptimJ can significantly improve collaboration between software developers and OR experts.

#### 2 - Responsive Learning Technologies, Inc. - Online Games for Operations Courses

Sam Wood, Responsive Learning Technologies, Inc., 10181 Parlett Place, Cupertino, CA 95014, wood@responsive.net

See a demonstration of online games that are used in operations management courses and supply chain management courses in more than 100 undergraduate and MBA-level programs to teach topics like capacity management, lead time management, inventory control, and supply chain design and logistics.

## SD25

### Service Planning, Modeling and Assessment

Sponsor: Service Science

Sponsored Session

Chair: Kwang-Jae Kim, Professor, Pohang Univ of Science and Technology, Industrial and Management Engineering, Pohang, KY, 790-784, Korea, Republic of, kjk@postech.ac.kr

#### 1 - An Extended QFD Planning Model for Goal Attainment

Considering Longitudinal Effect

Terry Friesz, Harold and Inge Marcus Chaired Professor, Penn State University, 310 Leonhard Building, University Park, PA, 16802, United States, tlf13@psu.edu, Changhyun Kwon, pupamin@postech.ac.kr, Kwang-Jae Kim

This paper proposes an extended QFD planning model for goal attainment that considers longitudinal effect. In the longitudinal effect case, the level of goal is determined by a series of effects over a certain period of time rather than by the effect at a specific point of time. In the proposed model, the longitudinal effect is incorporated by introducing a time dimension into the existing house of quality structure. The proposed model is illustrated using a case in high-speed internet service.

#### 2 - Computation of Prices in Competitive, Dynamic Service Networks

Terry Friesz, Harold and Inge Marcus Chaired Professor, Penn State University, 310 Leonhard Building, University Park, PA, 16802, United States, tlf13@psu.edu, Changhyun Kwon, Matthew Rigdon

In this presentation we review a family of dynamic, game-theoretic models for pricing, resource allocation and demand management related to the provision of competitive services offered over networks. An algorithm based on gap functions is proposed and numerically tested.

#### 3 - A Baldrige Model Based Assessment Strategy for Management Systems of Telecommunication Industries

Wan-Seon Shin, SungKyunKwan University, Dept.. of Systems Management Engineering, Suwon-city, Korea, Republic of, wsshin@yurim.skku.ac.kr, Taeho Kim

This paper proposes a management system assessment strategy for telecommunication industries using the Baldrige criteria. It first introduces how the criteria have been used as an organization wide assessment tool in KT, Korea. A number of key issues such as the assessment schema, checklists, web based self-assessment aids, and reporting templates are explained with illustrations. A step-wise assessment procedure is then proposed.

#### 4 - A Model of Rapid New Service Development Process: Rapid-NSD

Kwang-Jae Kim, Professor, Pohang Univ of Science and Technology, Industrial and Management Engineering, Pohang, KY, 790-784, Korea, Republic of, kjk@postech.ac.kr, Kwangsoo Kim, Byung-In Kim, Deok-Hwan Kim

The new service development (NSD) process defines the what and the how of a new service. This paper proposes a systematic model for NSD process. The proposed model consists of three phases, namely, service concept development, service process design, and service performance verification. A special focus is placed on improving the rapidity of the NSD process.

## ■ SD26

### Joint Session DM/ Computational Methods for Data Mining: Recent Advances in Data Mining and Machine Learning

Sponsor: Data Mining (Sponsored), Computational Methods for Data Mining

Sponsored Session

Chair: Zhiguang Qian, Assistant Professor, University of Wisconsin at Madison, zhiguang@stat.wisc.edu

#### 1 - Active Learning via Sequential Design with Applications to Anti-money Laundering

Xinwei Deng, PhD Student, Georgia Institute of Technology, xdeng@isye.gatech.edu, Roshan Vengazhiyil, Agus Sudjianto, C. F. Jeff Wu

Anti-money laundering is an important responsibility. There are millions of transactions happening each day. Investigating each transaction and classifying an account to be suspicious or not is time-consuming. In this article, we propose an active learning method using Bayesian sequential designs to detect money-laundering. The sequential nature helps to identify suspicious accounts with minimal effort. An application to real banking data is used to demonstrate the performance of the method.

#### 2 - A Bayesian Approach for the Registration of High-resolution NMR

Seoung Bum Kim, Assistant Professor, University of Texas at Arlington, 420K Woolf Hall, Arlington, TX, 76001, United States, sbkim@uta.edu

We propose a new registration method for high-resolution NMR spectra within the Bayesian modeling framework. The proposed method allows us to estimate the amplitude and phase shifts simultaneously and to obtain robust in the existence of noise.

#### 3 - Evidence Contrary to the Statistical View of Boosting

David Mease, Assistant Professor, San Jose State University, mease\_d@cob.sjsu.edu, Abraham Wyner

The statistical perspective on boosting focuses on optimization, drawing parallels with logistic regression. We present empirical evidence that raises questions about this view. Although the statistical perspective provides a theoretical framework within which it is possible to derive theorems and create new algorithms for general contexts, we show that there remain many unanswered important questions.

#### 4 - GIS-based Data Mining On Performance of ATM Transaction: An Empirical Study

Ming Xie, IBM China Research Laboratory, Diamond Building, ZGC Software Park #19, Dong Beiwang Road, Shang Di, Beijing, 100094, China, xieming@cn.ibm.com, Jia Chen, Wenjun Yin, Jin Dong

In banking industry, ATM is quite important for commercial banks to extend their business. This paper presents a case study of one of the biggest Chinese banks. Firstly the performance of ATM is analyzed from transaction flow by statistical analysis. Then the market potential around ATM is evaluated in terms of the Geographical Information System. Finally a comparative study provides insights on the relationship between ATM transaction characteristics and its environmental factors.

## ■ SD27

### Business Data Mining Applications

Cluster: Data Mining (Invited)

Invited Session

Chair: Wolfgang Jank, Assistant Professor, University of Maryland, Robert H. Smith School of Business, College Park, MD, 20742, United States, wjank@rhsmith.umd.edu

Co-Chair: Galit Shmueli, University of Maryland, Robert H Smith School of Business, College Park, MD, United States, gshmueli@rhsmith.umd.edu

#### 1 - Using Virtual Stock Exchanges to Forecast Box-Office Revenue via Functional Shape Analysis

Wolfgang Jank, Assistant Professor, University of Maryland, Robert H. Smith School of Business, College Park, MD, 20742, United States, wjank@rhsmith.umd.edu, Natasha Foutz

We propose a novel model for forecasting box office revenue success based on virtual stock markets. Our forecasting model uses novel statistical methodology from the area of functional data analysis. It uses the entire trading path rather than only its final value and it employs trading dynamics and it teases out differences between different trading paths using functional shape analysis. Our

results show that the model has strong predictive power and improves over competitors.

#### 2 - A Family of Growth Models for Representing Price Evolution in Online Auctions

Galit Shmueli, University of Maryland, Robert H Smith School of Business, College Park, MD, United States, gshmueli@rhsmith.umd.edu, Wolfgang Jank, Valerie Hyde

Bids in online auctions arrive at discrete timepoints. We represent the continuous price-process as a functional object. Typical nonparametric smoothing (e.g., p-splines or monotone splines) used to estimate price curves from observed discrete bid data has several limitations. We present a parametric family of growth models that overcomes these limitations. It is parsimonious, insightful, and useful. A measure of fit and automated fitting algorithm are provided. eBay data used for illustration.

#### 3 - Active Information Acquisition for Clustering and Classification

Maytal Saar-Tsechansky, Assistant Professor, University of Texas at Austin, 1 University Station, Austin, TX, 78712, United States, Maytal.Saar-Tsechansky@mcombs.utexas.edu

The role of data-driven intelligence is becoming critical for supporting business decisions. Often the underlying data available for induction can be enhanced by acquiring unknown values. I will discuss and present experimental results of policies that aim to improve induction by acquiring new information cost-effectively. The policies employ estimations to enable effective ranking of potential acquisitions in settings where relatively little information is available about the underlying domain.

#### 4 - Challenges in Large Scale Detection of Accounting Irregularities

Krishna Kumaraswamy, krishna.kumaraswamy@us.pwc.com, Stephen Bay, Markus Anderle, David Steier

In this talk we present a system, Sherlock, that uses machine learning techniques for detecting accounting fraud and error in a company's general ledger data. In developing Sherlock, we addressed challenges in creating efficient processes for using data from heterogeneous sources, learning classification models with few known cases of fraud and in evaluating the effectiveness of our methods. We also show how anomaly detection complements the classification approach when using unlabeled data.

## ■ SD28

### Metaheuristics for Location Problems

Cluster: Joint Cluster Metaheuristics/ ICS: Metaheuristics  
Invited Session

Chair: Mauricio G. C. Resende, Lead Member of Technical Staff, AT&T Labs Research, 180 Park Avenue, Room C241, Florham Park, NJ, 07932, United States, mgcr@research.att.com

#### 1 - Meta-heuristics for Strategic and Tactical Facility Location

Michael Bucci, Doctoral Candidate, North Carolina State University, CB # 7906, Daniels Hall, Raleigh, NC, 27695, United States, mbucci@nc.rr.com, Michael Kay, Jeffrey Joines, Don Warsing

We develop and compare several meta-heuristic methods for solving facility location-allocation problems that include costs related to both strategic and tactical level decisions. Problem parameters cover inventory and transportation economies of scale, uncertainty in supply and demand, and multiple product classifications. Various empirical tests are used to measure heuristic performance by comparing solution cost, solution time, and solution complexity.

#### 2 - A Fast Swap-based Local Search Procedure for Location Problems

Renato Werneck, Researcher, Microsoft Research Silicon Valley, 1065 La Avenida, Mountain View, CA, 94043, United States, renatow@microsoft.com, Mauricio G. C. Resende

We present a new implementation of a widely used swap-based local search procedure for the P-median problem, proposed in 1968 by Teitz and Bart. It produces the same output as the best alternatives described in the literature and, even though its worst-case complexity is similar, it can be significantly faster in practice: speedups of up to 3 orders of magnitude were observed. We also show that our method can be easily adapted to implement path-relinking and tabu search.

#### 3 - A Hybrid Heuristic for the P-median Problem

Mauricio G. C. Resende, Lead Member of Technical Staff, AT&T Labs Research, 180 Park Avenue, Room C241, Florham Park, NJ, 07932, United States, mgcr@research.att.com, Renato Werneck

We present a multistart hybrid heuristic that combines elements of several traditional metaheuristics to find near-optimal solutions to the P-median problem. Empirical results on instances from the literature attest the robustness of the algorithm, which performs at least as well as other methods, and often better in terms of both running time and solution quality. In all cases the solutions obtained by our method were within 0.1 percent of the best known upper bounds.

#### 4 - A Hybrid Multistart Heuristic for the Uncapacitated Facility Location Problem

Renato Werneck, Researcher, Microsoft Research Silicon Valley, 1065 La Avenida, Mountain View, CA, 94043, United States, renatow@microsoft.com, Mauricio G. C. Resende

We present a multistart heuristic for the uncapacitated facility location problem, based on a method we originally developed for the P-median problem. Empirical evidence shows the effectiveness of our algorithm in practice. For most instances in the literature, we obtain solutions that are either optimal or a fraction of a percentage point away from it. For instances created with the sole purpose of being hard to tackle, our algorithm can get very close to optimality if given enough time.

## ■ SD29

### Optimization Services and Third Party Software

Sponsor: INFORMS Computing Society/ICS/COIN-OR  
Sponsored Session

Chair: Kipp Martin, Professor, University of Chicago, 5807 South Woodlawn, Chicago, IL, 60637, United States, kipp.martin@chicagosb.edu

#### 1 - C++ Algorithmic Differentiation by Operator Overloading

Brad Bell, Mathematician, Applied Physica Laboratory, University of Washington, 1013 NE 40th Street, Seattle, WA, 98105-6698, United States, bradbell@washingtton.edu

Reverse mode algorithmic differentiation calculates a gradient using a small multiple of the number of operations required to compute an objective. This requires storing the operations and values corresponding to the objective. As memory gets larger, reverse mode can be efficiently applied in more cases. We present a C++ templated objective and use it with float, double, and the AD types defined by ADOLC, CppAD, and FADBAD. The gradient computation time using these AD packages is compared.

#### 2 - Setting Up and Hosting Your Solver as Web Services via Optimization Services (OS)

Jun Ma, Northwestern University, Dept. of Industrial Eng & Mgmt Sciences, 2145 Sheridan Road, Evanston, IL, 60208-3119, United States, maj@northwestern.edu, Robert Fourer, Kipp Martin

Optimization Services (OS) is a unified framework for new generation distributed optimization systems. We provide the open source OS library which is based on a set of Optimization Services Protocols (OSP). The library supports the solution of a wide variety of optimization problem types in a loosely coupled distributed environment. We also provide OS server software for users to host their own Optimization Services. In particular, we demo the OS integration in Apache's Tomcat Web server.

#### 3 - Hooking Optimization Services to Modeling Languages and Solvers

Robert Fourer, Professor, Northwestern University, Dept. of Industrial Eng & Mgmt Sciences, 2145 Sheridan Road, Evanston, IL, 60208-3119, United States, 4er@iems.northwestern.edu, Kipp Martin, Jun Ma

The OS framework is designed to avoid duplication of effort by means of a new standard for representing optimization problem instances. Once adopted, this standard will require only one interface to be written for each modeling system and each solver. At the heart of our proposal are OsIL, an XML-based representation for optimization problem instances, and OSInstance, a corresponding in-memory representation, together with an object-oriented library of methods for working with these forms.

#### 4 - Optimization Services and Nonlinear Optimization

Kipp Martin, Professor, University of Chicago, 5807 South Woodlawn, Chicago, IL, 60637, United States, kipp.martin@chicagosb.edu

We describe how to use Optimization Services (OS) with third party nonlinear solvers. The OS library contains an OS instance class that provides a flexible API for solvers. The OSInstance class has a method to generate instance representations in postfix format. This is illustrated with the LINDO solver. There are also calculate methods that use the CppAD package to provide gradient and Hessian values using algorithmic differentiation. This is illustrated with Knitro and Ipopt.

## ■ SD30

### System Reliability Modeling and Optimization II

Sponsor: Quality, Statistics and Reliability  
Sponsored Session

Chair: Qianmei (May) Feng, Assistant Professor, University of Houston, Houston, TX, United States, qmfeng@uh.edu

Co-Chair: Yong Chen, University of Iowa, Iowa City, IA, United States, yongchen@engineering.uiowa.edu

#### 1 - MoPriGA: A Multiple Objective Prioritized Genetic Algorithm

Heidi Taboada, Assistant Professor, The University of Texas at El Paso, 500 W. University Av., El Paso, TX, 79902, United States, hataboada@utep.edu, David Coit

A newly developed multiple objective evolutionary algorithm is presented. MoPriGA, a multiple objective prioritized genetic algorithm, incorporates the knowledge of the decision-maker objective function preferences directly within the evolutionary algorithm. The idea behind this algorithm is to more intensely focus on the region of the Pareto set of interest to the decision-maker.

#### 2 - Evaluation of Linear Sensor System Reliability Using Monte Carlo Methods

Yong Chen, University of Iowa, Iowa City, IA, United States, yongchen@engineering.uiowa.edu, Qingyu Yang

Linear sensor systems have broad applications in manufacturing fault diagnosis, array signal processing, and wireless sensor networks. Evaluating the reliability of linear sensor systems is an NP hard problem. In this paper, Monte Carlo methods are applied to evaluate/approximate the linear sensor system reliability and their performances are compared.

#### 3 - Robust System Reliability Design

Jose Ramirez-Marquez, Assistant Professor, Stevens Institute of Technology, Castle Point on Hudson, Hoboken, NJ, 07030, United States, Jose.Ramirez-Marquez@stevens.edu

Recently developed bounding strategies that improve confidence interval estimation for system reliability are used to provide a new reliability allocation perspective with the goal of developing a robust system reliability design. Research efforts have been focused : developing models for general series-parallel robust reliability analysis and, based on these models, generating heuristic methods for obtaining quasi optimal solutions to the best system design.

#### 4 - The Decision Model for the Optimal Time Points to Repair Aging Multistate Systems

Yung-Wen Liu, Assistant Professor, University of Michigan-Dearborn, 4901 Evergreen Road, Dearborn, MI, 48128, United States, ywliu@umich.edu

Customers may consider repairing the system when they are dissatisfied with how it works even before it reaches the failure. However, repairing costs and other factors may make customers hesitate to repair it. The nonstationary stochastic processes are used to model the deterioration and repairing processes for aging multistate systems, and customers' disutility functions, costs and other factors are used to build the optimization model for customers to decide when a system should be repaired.

## ■ SD31

### Joint Session QSR/HAS/Service: Quality and Statistical Decision-making in Healthcare Applications II

Sponsor: Quality, Statistics and Reliability, Health Applications Section, Service Science  
Sponsored Session

Chair: Jing Li, Arizona State University, Tempe, AZ, United States, jinglz@umich.edu

Co-Chair: Julie Simmons Ivy, University of Michigan, jsimmons@bus.umich.edu

#### 1 - Including Culture in Resource Allocation Models of HIV/AIDS Prevention Methods

Rupa Valdez, University of Wisconsin-Madison, 1513 University Avenue, Madison, WI, 53706, United States, rsvvaldez@wisc.edu

Models of resource allocation of HIV/AIDS prevention methods have not explicitly included cultural factors. Evidence of the impact of culture on these decisions may be found in the literature. A pilot study conducted at the University of Wisconsin-Madison offers guidance as to dimensions of culture that should be included.

## 2 - Coordinating Anesthesia Appointments and Scheduling Milestones Using Enterprise-Wide Scheduling

Franklin Dexter, Professor, University of Iowa, Dept. of Anesthesia, 6JCP, Iowa City, IA, 52242, United States, franklin-dexter@uiowa.edu

We implemented scheduling of anesthetics outside of operating rooms by clerks and nurses from other departments using the hospital's enterprise-wide scheduling system. Experimental studies investigated how tabular and graphical displays affected the scheduling of milestones (e.g., NPO times) and appointments before anesthetics. Results apply to other problems of patients arriving just in time (e.g., for non-OR anesthesia, surgery, or regional block placement at facilities with limited space).

## 3 - Analysis of the Consistency of a MIP-based Multigroup Constrained Discriminant Model

Paul Brooks, VCU, Dept. of Stat. Sci. and O.R., P.O. Box 843083, Richmond, VA, 23284, United States, JPBrooks@vcu.edu, Eva K. Lee

A Bayes optimal classifier minimizes the probability of misclassification. Even if a Bayes optimal classifier can be obtained, the inter-group misclassification rates may be higher than desirable. Constrained discrimination models are classification models that allow for the non-classification of observations until more information is collected. We analyze the consistency of a mixed-integer programming formulation of a constrained discrimination model.

## 4 - Designing a Decision-making System for Medical Disaster Mutual Aid

Jeffrey W. Herrmann, Associate Professor, University of Maryland, Dept. of Mechanical Engineering, College Park, MD, United States, jwh2@umd.edu

A medical disaster requires effective decision-making to coordinate the response. For designing a decision-making system for this type of exceptional event, we present a systematic, scenario-based methodology that is based on the operational procedure methodology, which has been used to develop avionics systems. We apply this approach to the case of medical disaster mutual aid, in which multiple hospitals must coordinate activities to respond to a mass casualty incident.

## SD32

### Airport Benchmarking and Air Transport Logistics

Cluster: Shipping, Maritime, and Supply Chain Logistics

Invited Session

Chair: John Liu, Lgtjliu@polyu.edu.hk,

Co-Chair: Tae Oum, Professor, University of British Columbia, 2053 Main Mall, Vancouver, BC, V6P4P8, Canada, Tae.Oum@sauder.ubc.ca

#### 1 - Competition and Social Welfare: Effects of Airport Concession Revenue Sharing

Xiaowen Fu, Assistant Professor, Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, lgtxfu@polyu.edu.hk

This paper studies the competitive and welfare implications when an airport offers the option of sharing its concession revenue with airlines. It is found that such revenue sharing allows airlines and airports to internalize positive demand externality, which could lead to substantial welfare gains. However, such practice may cause negative effects to airline competition. In addition, while sharing concession revenue with airlines an airport may still prefer to increase airport charge.

#### 2 - Are the Low Cost Carriers More Efficient than the Full Service Airlines: Evidences from the US Airline Market

Jia Yan, Assistant Professor, Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China, lgtjiay@inet.polyu.edu.hk

Airlines provide differentiated services. For example, the services from the full service airlines (FSA) are different with the ones from the low cost carriers (LCC). The nature of product differentiation is ignored in the airline efficiency studies. This paper measures the airline efficiency by estimating a stochastic cost frontier model, which incorporates the multiple and differentiated outputs of the airlines.

#### 3 - How Airlines Compete

Bill Swan, Chief Economist, Seabury Airline Planning Group, 2232 157th PL SE, Bellevue, WA, 98008, United States, bill.swan@cyberswans.com

Each airline in the market plans a schedule of departure times and offers a series of fares. The fundamentals of airlines competing are this: customers choose based on price and time, and those customers who find both airlines equal choose based on secondary characteristics we call quality. This simple model of the

demand side leads to some compelling consequences on the supply side. The preferred airline strongly dominates in fare in the peaks and in load in the off peaks.

#### 4 - Competitive Revenue Management with Customer Choice Behavior

Michael Li, Associate Professor, Nanyang Technological University, Nanyang Avenue, 639798, Singapore, ZFLI@ntu.edu.sg

This paper studies the dynamic pricing models for two substitutable and perishable products with customer choice behavior under monopoly and duopoly respectively. We characterize the structural properties of the value function and the optimal control policy under monopoly. We examine the optimal pricing policy with discrete price set and study the equilibrium in duopoly with finite strategy spaces.

#### 5 - Travelers Prefer Airline Frequent Flier Programs Over Hotel Frequent Guest Programs

Rex Toh, Professor, Director of the Marketing Program, Seattle University, 901 12th Avenue, P.O. Box 222000, Seattle, WA, 98122, United States, rextoh@seattleu.edu, Frederick DeKay

Based on a survey of 304 hotel guests, 81% belong to frequent flier programs, while only 62% belong to hotel frequent guest programs. And of those who belong to frequent guest programs, 90% belong to airline frequent flier programs while only 69% of airline frequent fliers who stay in hotels belong to hotel frequent guest programs. Why have hotels lagged the airlines in attracting hotel guests to their loyalty programs?

## SD33

### Urban Transportation Planning Models IV: Pricing and Tolls

Sponsor: Transportation Science & Logistics

Sponsored Session

Chair: Yafeng Yin, Assistant Professor, University of Florida, 365 Weil Hall, Box 116580, Gainesville, FL, 32611, United States, yafeng@ce.ufl.edu

#### 1 - Converting HOV to HOT: Efficiency, Profit, and Equity

Yueyue Fan, Assistant Professor, University of California, Department of CEE, Davis, CA, 95616, United States, yyfan@ucdavis.edu, Hemant Bhargava, N.P. Raghavender

We present an optimization model for evaluating the merits of converting HOV to HOT lanes. The important issue of income inequity is addressed at the planning stage by imposing limits on the benefits/ costs of each group. Preliminary results on the trade-offs between equity and multiple objectives are presented.

#### 2 - Toll Policies for Mitigating Hazardous Materials Transport Risk

Anne Mercier, CRT, Université de Montréal, C.P. 6128, Succursale Centre-ville, Montréal, Canada, anne.mercier@gerad.ca, Patrice Marcotte, Gilles Savard, Vedat Verter

We propose toll setting as an alternative policy tool to regulate the use of roads for dangerous goods shipments. We propose a bilevel programming formulation as well as a solution method. Based on a comparative analysis, we show that toll policies can be more effective than network design policies that identify road segments to be closed. We present a summary of computational experiments on a problem instance from Western Ontario, Canada.

#### 3 - Loops and the Existence of Traffic Tolls

Jane Hagstrom, Professor, University of Illinois at Chicago, Dept. of Information & Decision Sciences, 601 S. Morgan, (MC 294), Chicago, IL, 60607, United States, hagstrom@uic.edu, Robert Abrams

Given desired feasible flows in a multi-commodity traffic network, we provide a characterization in terms of loops of the conditions under which commodity-independent tolls exist to enforce those flows. Such tolls exist if and only if the flow contains no removable single- or multiple-commodity loop in the sense of Gallager (1977).

#### 4 - Profit-Maximizing and Socially Optimal Pricing of Advanced Traveler Information Services

Lei Zhang, Assistant Professor, Oregon State University, School of Civil & Construction Eng., 220 Owen Hall, Corvallis, OR, 97331, United States, lei.zhang@oregonstate.edu

This paper theorizes users' willingness to pay for advanced traveler information services (ATIS). For each user, information provided by ATIS is valuable if its price is lower than the subjective gain from the information, and lower than the perceived cost of other information-acquisition means. The profit-maximizing and socially optimal prices of ATIS, which correspond to different levels of ATIS market penetration, are analyzed and computed for a real-world transportation system.

## ■ SD34

### Dynamic and Stochastic Models in Transportation and Logistics

Sponsor: Transportation Science & Logistics

Sponsored Session

Chair: Sumit Kunnumkal, Cornell University, 292 Rhodes Hall, Ithaca, NY, United States, smk68@cornell.edu

#### 1 - Solving Single-round, Fully Enumerated Combinatorial Truckload Procurement Auctions to Optimality

Richard Chen, PhD Student, University of Michigan, Ann Arbor, 1205 Beal Avenue, Ann Arbor, MI, 48109, United States, richchen@umich.edu, Damian Beil, Amitabh Sinha, Amy Cohn, Shervin AhmadBeygi

We apply an implicit bidding mechanism to optimally solve in a single round, a fully enumerated combinatorial truckload procurement auction. We present tractable network models for solving winner determination, with extensions for operational considerations. We demonstrate tractability via computational results for random instances of varying sizes, networks, and operational considerations.

#### 2 - Computing Bid-prices in Revenue Management via Stochastic Approximation

Huseyin Topaloglu, Cornell University, Rhodes Hall, Ithaca, NY, United States, ht88@cornell.edu

We present a stochastic approximation method to compute bid prices in network revenue management problems. The idea is to visualize the total expected revenue as a function of the bid prices and to use sample path-based derivatives to search for a good set of bid prices. Computational experiments demonstrate that our method is especially advantageous when the bid prices are not recomputed frequently.

#### 3 - An Alternative to Clark and Scarf's Balance Assumption for Inventory Distribution Systems

Sumit Kunnumkal, Cornell University, 292 Rhodes Hall, Ithaca, NY, United States, smk68@cornell.edu, Huseyin Topaloglu

We present a new method to make the inventory replenishment decisions in a distribution system consisting of multiple retailers and a single warehouse. Our method is based on relaxing the constraints that ensure the nonnegativity of the shipments to the retailers by associating Lagrange multipliers with them. Numerical studies show that our method can provide significant improvements over traditional methods when the balance assumption of Clark and Scarf (1960) is not satisfactory.

#### 4 - Optimal Pricing and Consolidation Cycle for a Shipper

M. Ali Ulku, PhD Candidate, University of Waterloo, Dept. of Management Sciences, 200 University Avenue West, Waterloo, ON, N2L 3G1, Canada, mauku@engmail.uwaterloo.ca, James H. Bookbinder

Consider a shipper whose customers are sensitive to both price and delivery guarantee. For various pricing schemes and a for-hire carrier, we maximize the shipper's profit per unit time through optimal choice of consolidation cycle. We find that charging according to an order's time of arrival is not necessarily the best pricing scheme.

## ■ SD35

### Facility Logistics II

Sponsor: Transportation Science & Logistics

Sponsored Session

Chair: Sunderesh Heragu, Professor and Duthie Chair in Engineering Logistics, University of Louisville, Room 309, JB Speed Building, Department of Industrial Engineering, Louisville, KY, 40292, United States, s.heragu@louisville.edu

#### 1 - Integration of Operational Policies into the Design Phase of a Material Handling Network

Ardavan Asef-Vaziri, Assistant Professor, California State University, 18111 Nordhoff Street, Northridge, CA, 91330—824, United States, aa2035@csun.edu

We develop exact formulations for the concurrent design of a material handling network and station locations. A primary interest of our work is to illustrate the superiority of the deterministic shortest-trip-distance-first over the stochastic first-come-first-served when integrated into the design phase. The take-away of this talk is to design the loop and stations under shortest-trip-distance-first, and operate the fleet of the vehicles under first-encountered-first-served dispatching.

#### 2 - A Model and an LP-based Rounding Heuristic for the Facility Layout Problem

Zeynep Kirkizoglu, University of Arkansas, 4207 Bell Engineering Center, Fayetteville, AR, 72701, United States, zkirkizo@uark.edu, Haldun Sural

We propose a mixed integer programming model for the facility layout problem. It uses the sequence-pair representation for department overlap prevention constraints and epsilon-accurate representation of the department areas. We analyze the LP relaxation of the model and propose an LP-based rounding heuristic for solving the problem. Computational results are provided.

#### 3 - Hybrid Predictive Control for the Dynamic Vehicle Routing Problem Based on EMO

Cristian Cortes, Assistant Professor, Universidad de Chile, Blanco Encalada 2002, Santiago, SA, Chile, ccortes@ing.uchile.cl, Doris Saez, Alfredo Nuñez, Marcela Riquelme

A new hybrid adaptive predictive control (HAPC) approach for the dynamic pickup and delivery problem (DPDP) is presented. The approach is solved through an Evolutionary Multiobjective Optimization (EMO) algorithm, considering the opposite interests of users and operators, both included in the dynamic dispatch objective function. EMO is utilized to find the dynamic Pareto Front, and take the real dispatch decision based on different optimization criteria. Promissory simulation results are reported.

#### 4 - Constraint Programming and B&P for a Joint Depot Location, Fleet Design and Routing Problem

Jaime Miranda, Universidad Diego Portales, Ejercito Libertador 441, Santiago, Chile, jaime.miranda@udp.cl, Cristian Cortes, Sebastian Souyris, Pablo Rey, Jose Robles

In this paper we propose a Branch and Price scheme to solve a joint depot location, fleet design and routing problem, required for the application of the standardized evaluation exam SIMCE over all schools located in Santiago-Chile. This exam is conducted every year by the Ministry of Education. The master problem is an extension of a standard VRP, while the resulting subproblem is solved with Constraint Programming. Promissory preliminary results have been obtained so far.

## ■ SD36

### Evacuation Planning

Sponsor: Transportation Science & Logistics

Sponsored Session

Chair: April Kuo, University of Maryland, 1173 Glenn Martin Hall, College Park, MD, United States, aprilkuo@umd.edu

#### 1 - Evacuation Planning Based on Lane Reversal and Crossing Elimination

Mark Turnquist, Cornell University, mat14@cornell.edu, Chi Xie

We describe a bi-level program for network evacuation that includes both lane reversal and elimination of traffic stream crossings at intersections. Traffic assignment is done using stochastic user equilibrium on the congested network. Provision for inbound access by emergency vehicles is also included. Solutions are illustrated for a case study in an area surrounding a nuclear power plant.

#### 2 - An Optimization-Simulation Approach to Model the Routing of Public Transit Systems for No-notice Mass

Fatemeh Sayyady, Research Assistant, Mississippi State University, 350 McCain Engineering Building, Department of Industrial and Systems Eng, Mississippi State, MS, 39762, United States, fs131@msstate.edu, Sandra Duni Eksioglu

This study investigates how the public transit system can be used in no-notice mass evacuation using an optimization-simulation approach. In optimization stage, a mixed integer linear programming formulation is used to model the routing of the public transit system. A heuristic tabu search algorithm finds the near-optimal solution shortly. In simulation stage, a dynamic traffic network analysis and evaluation tool, DYNASMART-P, is used to evaluate the effectiveness of the developed routing plan.

#### 3 - Transit Vehicle Routing for Evacuation of the Carless

Mark Hickman, Associate Professor, University of Arizona, P.O. Box 210072, Tucson, AZ, 85721-0072, United States, mhickman@enr.arizona.edu

There is a role for public transit vehicles in evacuating low-mobility persons during an emergency. We explore the problem of how buses might be routed dynamically to evacuate the carless. In this on-line problem context, various vehicle routing heuristics are proposed and compared.

- 4 - Large-scale Modeling and Analysis for Contraflow and Phased Evacuation Operations in Central Texas  
Yi-Chang Chiu, Assistant Professor, University of Arizona, 1209 E. 2nd St., Tucson, AZ, United States, [chiu@email.arizona.edu](mailto:chiu@email.arizona.edu),  
Hong Zheng, Russell Henk, Walter Peacock

We discuss the modeling process and results for planning for evacuating several millions of evacuees out of Galveston and Houston, Texas inland to other major Texas cities through the central Texas highway network. Model formulation and computational analysis are conducted for both contraflow and phased evacuation operational strategies. DYNASMART-P was modified enhanced as the computational platform for this research.

## ■ SD37

### Defense Supply Chain Analysis

Sponsor: Military Applications  
Sponsored Session

Chair: Alan Johnson, Associate Prof of Logistics, Air Force Institute of Technology, AFIT/ENS, 2950 Hobson Way, Bldg 641, W-P AFB, OH, 45433-7765, United States, [alan.johnson@afit.edu](mailto:alan.johnson@afit.edu)

- 1 - Developing An Entire Public Health Campaign Modeling Suite  
James Burke, Systems Scientist, Argonne National Laboratory, 9700 S. Cass Ave, Building 900, Argonne, IL, 60439, United States, [jay@anl.gov](mailto:jay@anl.gov), Charles Van Groningen

Public Health Preparedness Models rarely bring focus to an entire Mass Prophylaxis Campaign. Public Health needs models to consider all of the supply, behavioral and disease issues across an entire jurisdiction for a total campaign closure analysis. Our modeling method and Chicago test scenario will be presented.

- 2 - Multiobjective Simulation Optimization: A Comparison of Methods  
Hugh Medal, Department of Industrial Engineering, University of Arkansas, Fayetteville, AR, United States, [hmedal@uark.edu](mailto:hmedal@uark.edu), Ed Pohl

Large-scale complex systems are characterized by complex input-output relationships and often have multiple performance measures. The many decision variables and system complexity render simulation and classic optimization techniques inadequate if used alone for optimization. We give a multi-objective genetic algorithm for simulation-based optimization, and compare the performance of this algorithm versus OptQuest commercial software when optimizing a military aircraft transportation model.

- 3 - Modeling Chem-Bio Effects at Airports and Seaports  
Phil Collins, Sr. Scientist, BBN, 1337 Park Plaza #3, O'Fallon, IL, 62269, United States, [pcollins@bbn.com](mailto:pcollins@bbn.com)

U.S. Transportation Command's Airport and Seaport Simulation Tools (AST/SST) have been modified to provide detailed APOD and SPOD modeling of chemical and biological effects and the resulting impacts on installation capabilities. This is accomplished as part of the Joint Operation Effects Federation (JOEF) which includes agent dispersion, deposition, exposure, and human effects models.

- 4 - High-Level Model of the DoD Supply Chain:  
The MIDAS Multi-Echelon Sustainment Simulation  
Soraya Stevens, Division Engineer, BBN Technologies, 10 Moulton Street MS 6/3A, Cambridge, MA, 02138, United States, [sstevens@bbn.com](mailto:sstevens@bbn.com), Carroll Keyfauber, Jeffrey Tustin, Daniel Hazen

MIDAS is a composite simulation of linked sub-simulations that together model global deployments of large-scale scenarios over multiple theaters. We will present MIDAS' sustainment capabilities for tracking and delivering multi-echelon resupply using opportunistic mode selection to satisfy demands at all nodes within complex supply chains. This includes discussion of setup, tracking consumption and safety stockage demands, capacity-constrained planning, and discussion of future directions.

- 5 - USSOUTHCOM Channel Airlift Commercialization  
Carmen Oeltjen, Operations Research Analyst, Northrop Grumman, Joint Distribution Process Analysis Ctr, US Transportation Command, Scott AFB, IL, 62225, United States, [Carmen.Oeltjen.ctr@ustranscom.mil](mailto:Carmen.Oeltjen.ctr@ustranscom.mil)

USTRANSCOM's JDPAC analysis team was asked to evaluate distribution options for USSOUTHCOM requirements currently moved by Channel air. The requirement is small making reliable frequent service more challenging and costly as efficiencies normally attributed to volume may not be realized. Cargo was examined to determine its eligibility for commercial movement, recognizing some items must remain on MILAIR. The analysis resulted in an overall strategy customized for regional considerations.

## ■ SD38

### To the Memory of Frank Bass

Cluster: To The Memory of Frank Bass  
Invited Session

Chair: Peter Popkowski-Leszyc, Associate Professor of Marketing, University of Alberta, 4-20 F School of Business, Edmonton, AB, T6G 2R6, Canada, [ppopkows@ualberta.ca](mailto:ppopkows@ualberta.ca)

- 1 - Frank's M. Bass' Key Contributions to Choice Modeling and Stochastic Behavior

Peter Popkowski-Leszyc, Associate Professor of Marketing, University of Alberta, 4-20 F School of Business, Edmonton, AB, T6G 2R6, Canada, [ppopkows@ualberta.ca](mailto:ppopkows@ualberta.ca)

This talk will provide a brief overview of some of Frank M. Bass's major achievements, and will focus on his key contributions in the area of choice modeling and stochastic behavior. An Introduction to this session will be provided by key members of the INFORMS and Marketing community.

- 2 - The Bass Model: A Timeless Classic  
Demetrios Vakratsas, Associate Professor, McGill University, 1001 Sherbrooke W, Montreal, QC, H3A 1G5, Canada, [demetrios.vakratsas@mcgill.ca](mailto:demetrios.vakratsas@mcgill.ca), Trichy Krishnan

This paper takes a historical perspective on the Bass Model (BM) of diffusion of innovations and discusses its contribution to multiple disciplines, its applications and extensions. It also explores possibilities for future research including new application domains and estimation-related issues.

- 3 - Research Contributions of Dr. Frank Bass in Marketing Econometrics  
Shuba Srinivasan, Associate Professor and University Scholar, University of California, Riverside, A. Gary Anderson School of Management, Riverside, CA, 92521-0203, United States, [shuba.srinivasan@ucr.edu](mailto:shuba.srinivasan@ucr.edu)

Dr. Frank M. Bass was one of the first marketing scholars to apply econometric methods in developing statistical estimates of the effects of advertising, promotions, and prices upon sales. His research in marketing econometrics and that of his intellectual descendants include seminal works in the field. This talk will highlight his key contributions to this area of research in marketing.

- 4 - Frank Bass and Future Dissertation Topics  
Mark Parry, Professor, University of Missouri-Kansas City, 321 Bloch School, 5110 Cherry Street, Kansas City, MO, 64110, United States, [parryma@umkc.edu](mailto:parryma@umkc.edu), John Norton

Frank Bass is well known for his work in diffusion modeling, stochastic processes, and applications of the scientific method to business data, with an emphasis on econometric testing and modeling. However, one can make a strong case that his most singular pursuit was the development of doctoral students. In this session we discuss possible extensions of his research that might serve as dissertation topics for future doctoral students.

## ■ SD39

### Health Care Systems Optimization

Sponsor: Health Applications Section  
Sponsored Session

Chair: Gorkem Saka, PhD Candidate, University of Pittsburgh, 1048 Benedum Hall, Pittsburgh, PA, 15261, United States, [gos2@pitt.edu](mailto:gos2@pitt.edu)

- 1 - Using Artificial Neural Networks to Predict the Risk of Breast Cancer

Turgay Ayer, University of Wisconsin-Madison, 1513 University Ave. Mechanical Eng., Building, ISyE Department, Madison, WI, 53706, United States, [tayer@wisc.edu](mailto:tayer@wisc.edu), Charles E. Kahn, Oguzhan Alagoz, Elizabeth Burnside, Jagpreet Chhatwal

Although breast cancer is the most common cancer affecting women in the US, current methods in practice for diagnosis have low positive predictive values. We developed an artificial neural network (ANN) to predict breast cancer risk from standardized mammographic findings and demographic risk factors.

## 2 - Optimal Design of Regions for Liver Transplantation: Balancing Allocation Efficiency and Equity

Mehmet C Demirci, University of Pittsburgh, Department of Industrial Engineering, 1048 Benedum Hall, Pittsburgh, PA, 15261, United States, demirci@ie.pitt.edu, Edwin Romeijn, Andrew Schaefer

Currently the in the U.S., a harvested liver is offered hierarchically to patients, first within the local OPO, then regionally and finally nationwide. By using a multi-objective optimization approach, we aim to balance the efficiency of the system and geographic equity throughout the nation. We use two integer programming models, one of which aims to maximize the efficiency of the allocation mechanism, while the other tries to maximize the equity measure across all OPOs.

## 3 - Analysis of Patient Triage in Urban Pediatric Emergency Departments

Michael DeGuzman, Children's HealthCare of Atlanta, Michael.DeGuzman@choa.org, Eva K. Lee

In this talk, we describe the challenges of pediatric patient triage to correct level of acuity in the emergency departments. Two approaches: conventional 4-tier triage versus the 5-tier emergency severity index (ESI) will be described and contrasted. Preliminary work using OR approaches to improve proper patient categorization will be described.

## 4 - In Which OPOs Should an End-stage Liver Disease Patient List?

Gorkem Saka, PhD Candidate, University of Pittsburgh, 1048 Benedum Hall, Pittsburgh, PA, 15261, United States, gos2@pitt.edu, Andrew Schaefer, Mark Roberts, Oguzhan Alagoz, Lisa Maillart

Multiple listing refers to the practice where patients may join waiting lists in multiple OPOs. The important research question is where should a patient multiple list? By multiple listing, the patient in essence chooses a liver arrival matrix. We model this problem as a continuous-time MDP. We propose a modified branch-and-bound algorithm to optimally solve this decision problem where the problem to be solved at every iteration of the algorithm is an MDP.

## SD40

### Stochastic Models in Health Care

Sponsor: Health Applications Section  
Sponsored Session

Chair: Burhaneddin Sandikci, University of Pittsburgh, 1048 Benedum Hall, Pittsburgh, PA, 15217, United States, bus2@pitt.edu

#### 1 - An Analytical Framework for Managing Community-based Care Delivery Processes for Chronic Diseases

Beste Kucukyazici, McGill University, 1001 Sherbrooke West, Montreal, QC, H3A 1G5, Canada, bkucuk@po-box.mcgill.ca, Vedat Verter, Nancy Mayo

In this study, we develop a Markov modeling framework to represent the community-based care delivery process of chronic diseases. This approach enables us to represent the patient flow information in a compact form and to analyze the care delivery process in terms of the flow patterns and to assess the impact of the flow patterns on health outcomes. The model constitutes a tool for clinicians and system planners in developing an understanding of the disease-specific community care process.

#### 2 - Timing of Testing and Treatment of Hepatitis C and Other Diseases

Daniel Faissol, PhD Student, Georgia Institute of Technology, 755 Ferst Drive, Room 425F, Atlanta, GA, 30332-0205, United States, dfaissol@isye.gatech.edu, Paul Griffin, H. Eser Kirkizlar, Julie Swann

We develop a Markov Decision Process (MDP) model for diseases where our goal is to determine the best timing for testing (and treatment) decisions when the presence of the disease is not known in advance. We focus on minimizing the cost from a societal perspective, and additionally produce an efficient frontier of timing decisions with respect to the cost per quality adjusted life year (QALY) measure. We apply the model to Hepatitis C, and we discuss the insights for healthcare practice.

#### 3 - Optimal Liver Acceptance Policies for Risk-sensitive Patients

Atul Bhandari, Post-Doctoral Associate, University of Pittsburgh, 1178c Benedum Hall, University of Pittsburgh, Pittsburgh, PA, 15261, United States, abhandari79@gmail.com, Andrew Schaefer, Mark Roberts

For liver transplantation, patients join UNOS's waiting list. When a liver is offered, the patient decides between transplanting and waiting. We formulate the decision problem as a risk-sensitive finite-horizon MDP. We model risk preferences and maximize the total expected utility for any  $v, N-M$  utility

function. We use age-dependent transition probabilities and rewards and establish structural properties. We extend the model to infinite-horizon for patients with exponential utility function.

#### 4 - Estimating the Patient's Price of Privacy in Liver Transplantation

Burhaneddin Sandikci, University of Pittsburgh, 1048 Benedum Hall, Pittsburgh, PA, 15217, United States, bus2@pitt.edu, Oguzhan Alagoz, Lisa Maillart, Andrew Schaefer, Mark Roberts

In the United States, ESLD patients join a waiting list for cadaveric liver transplantation. The details of the composition of this list are not publicly available. We consider the benefits associated with creating a more transparent list by studying the organ accept/reject decision as a Markov decision process. We define the concept of the patient's price of privacy to measure the cost of keeping the list private. We also present the results of numerical experiments based on clinical data.

## SD41

### Strategies for Pandemic Response

Sponsor: Optimization/ Optimization and Computing in Medicine and Life Sciences  
Sponsored Session

Chair: Eva K. Lee, Associate Professor & Director, Georgia Institute of Technology, Center for OR in Medicine & HealthCare, Industrial & Systems Engineering, Atlanta, GA, 30332-0205, United States, evakylee@isye.gatech.edu

#### 1 - Optimizing the Dose of Pre-pandemic Influenza Vaccines to Reduce the Infection Attack Rate

Joseph Wu, The University of Hong Kong, 21 Sassoon Road, Pokfulam, Hong Kong - ROC, joewu@hku.hk

For many countries, the principal constraint for human pre-pandemic vaccine stockpiles will be the total mass of antigen maintained. We hypothesize that lower individual doses may provide extra community-level benefits because they permit wider coverage for a given size of antigen stockpile. We use a mathematical model to predict infection attack rates under different policies. We find that substantial reductions in the attack rate are likely if vaccines are given to more people at lower doses.

#### 2 - Simulation to Assess Quarantine Station Continuity of Operations in Response to Pandemic Influenza

Robert Brigantic, Pacific Northwest National Laboratory, 902 Battelle Blvd., P.O. Box 999, Richland, WA, 99352, United States, robert.brigantic@pnl.gov, John Malone, James Campbell

This presentation summarizes efforts conducted for DHS to simulate the flow of aircraft and passengers arriving from international destinations under an assumed Pandemic Influenza Federal Government Response Stage 2 which activates domestic quarantine stations. Starting with the CDC Quarantine Station Seattle, this research assesses current capabilities and examines the requirements for effective quarantine and isolation of people potentially infected with a pandemic strain of influenza.

#### 3 - Multi-modality Mass Dispensing Strategies for Biodefense and Infectious Disease

Eva K. Lee, Associate Professor & Director, Georgia Institute of Technology, Center for OR in Medicine & HealthCare, Industrial & Systems Engineering, Atlanta, GA, 30332-0205, United States, evakylee@isye.gatech.edu, Ferdinand Pietz, Bernard Benecke, Yang Zhang

In this talk, we will describe our experience with the Centers for Disease Control and Prevention, and with state and county public health and emergency response administrators on large-scale dispensing of prophylactic medication in response to biological and infectious disease outbreaks. Locations of dispensing facilities, optimal facility staffing and resource allocation, routing of the population, and various dispensing modalities will be discussed and analyzed.

#### 4 - A Simulation-Based Optimization Model for Dynamic Resource Utilization at Federal and Local Levels During Cross-Regional Pandemic Outbreaks

Alex Savachkin, Assistant Professor, University of South Florida, Dep. of IMSE, Tampa, FL, 33620, United States, savachki@eng.usf.edu, Andres Uribe, Tapas K. Das, Diana Prieto

Optimal dynamic allocation of limited resources at the federal and local levels during emergence of a multi-city pandemic outbreak is an open research challenge. We develop a simulation based two-tier optimization strategy for allocation of vaccines, antiviral drugs, medical personnel, and hospital beds, to minimize the total cost of the pandemic.

## ■ SD42

### Operations Research in Health Care

Cluster: Operations Research in Medicine and Health Care  
Invited Session

Chair: Yifan Liu, 4400 University Dr., MS 4A6, Fairfax, VA, 22030, United States, yliu9@gmu.edu

- 1 - Vaccine Inventory Design for a Break out of Epidemic Disease  
Yifan Liu, 4400 University Dr., MS 4A6, Fairfax, VA, 22030, United States, yliu9@gmu.edu

We aim at deriving the necessary stockpile levels for vaccine, in order to meet the urgent need, due to a natural breakout of an epidemic disease, or due to a bio-terror attack. We produce the relation between the optimal inventory levels and the decisive properties of vaccine production and the infectious disease, including the usual production and shipment rate, and the population dynamics of the infectious disease in the potential regions of vaccine shortage, etc.

- 2 - Improving the Behavioral Health of Youth in the Juvenile Justice System

Michael Foster, Professor of Maternal and Child Health; and Health Policy, University of North Carolina, School of Public Health, Rosenau Hall, Chapel Hill, NC, 27599, United States, emfoster@email.unc.edu, Nomesh Bolia, Serhan Ziya

In this article, we examine the impact of mental health services on the functioning of the juvenile justice system and on crime in a community. The authors have developed a complex, dynamic model of crime and delinquency in a hypothetical community and of the impact of adding a rehabilitative service to the juvenile justice system. The authors have populated the key parameters of the model using data from the Fast Track, a large, longitudinal study of youth in four communities.

- 3 - The Effects of Electronic Health Record (EHR) Implementation on Health Care Delivery Processes

Sharon Johnson, Associate Professor, WPI, Department of Management, Worcester, MA, 01566, United States, sharon@wpi.edu, Diane Strong, Isa Bar-On, Lori Pelletier

This pilot project at a multi-specialty, multi-site clinic examines process and productivity changes and their implications on service quality and physician/staff and patient satisfaction at several clinic locations, resulting from the implementation of the EpicCare EHR in examination rooms. In this presentation, results from a grounded theory analysis of interview data is combined with process analysis to explore baseline expectations and short-term implementation effects.

## ■ SD43

### Things That Go Bump in the Project: Risk Management in Software and Systems Development

Cluster: O.R. Practice  
Invited Session

Chair: Clay Williams, IBM Watson Research, 19 Skyline Drive, Hawthorne, NY, 10532, United States, clayw@us.ibm.com

- 1 - Measuring and Monetizing Development Risk  
Murray Cantor, Distinguished Engineer, IBM, 209 Burgess Ave, Westwood, MA, 02090, United States, mcantor@us.ibm.com

Standard risk management practices take a qualitative approach: having staff score the likelihood of occurrence and impact, prioritizing high occurrence/impact risks for mitigation. The practice is rarely followed as it is not central to the project focus on delivery. I introduce a quantitative approach for measuring development risk that is a basis for measuring development project health and for monetization supporting informed go/no-go decisions for undertaking and continuing risky projects.

- 2 - Active Risk Management for Value-creation Optimization in Software and Systems Development

Michel Benaroch, Professor of IS, Whitman School of Management, 721 University Avenue, Syracuse University, Syracuse, NY, 13224, United States, mbenaroc@syr.edu, James Goldstein

We develop an economic optimization model for managing IT investment risk, building on two research streams. One offers solid ways to control granular cost risks in software development, devoid from this activity's value-creation aspect. Another uses real options theory to model risk and flexibility in relation to value creation throughout the IT investment lifecycle, devoid from software development details. Our model unifies micro- and macro-level risk management practices in both streams.

- 3 - Adding Project Value by Creating Information That Reduces Risk  
Tyson Browning, Assistant Prof. of Enterprise Operations, Dept. of Information Systems and Supply Chain Management, Neeley School of Business, Texas Christian University, Fort Worth, TX, 76129, United States, T.Browning@tcu.edu

The goal of project management is to enable activities whose results will decrease the risk of the project failing to meet stakeholder expectations. We will present a method for project planning and control, the Risk Value Method, that enables managers to connect activity costs and durations with the benefits they provide towards this goal.

- 4 - A Value-driven Perspective to Architectural Stability and Evolution

Rami Bahsoon, Dr, School of Engineering and Applied Sc, Aston University in Birmingham, Aston Triangle, Birmingham, UK, United Kingdom, r.bahsoon@aston.ac.uk, Wolfgang Emmerich

We describe ArchOptions, a model that uses real options theory to value the flexibility of an architecture in face of likely changes. We highlight the model use on two cases: (i) informing the selection of middleware-induced software architecture guided by the value added in supporting likely changes in load and (ii) valuing the cost-effectiveness of investing in a refactoring exercise. We reflect on our experience in using a value-driven approach to architecture evolution decision making.

- 5 - Six Sigma & Monte Carlo Simulation to Improve Service Delivery while Optimizing Profits

Tayfun (Ty) Avni, IBM Global Business Services, SCM Operations Analytics, tavni@us.ibm.com

IBM is engaged in providing Information Technology Outsourcing Services at global corporations. Level of service delivered not only impacts client satisfaction, but IBM's bottom line through contract obligations. Six Sigma tools are combined with Monte Carlo simulation analysis to not only improve IT Service Level Availability through variation reduction, but also quantify and mitigate risk of contract defaults to optimize profits.

## ■ SD44

### Classroom Games from INFORMS Transactions on Education

Sponsor: INFORM-ED  
Sponsored Session

Chair: Paul Griffin, Georgia Institute of Technology, School of Industrial and Systems Engineering, Atlanta, GA, 30332, United States, paul.griffin@isye.gatech.edu

- 1 - The Stock Portfolio Classroom Game  
J Rene Villalobos, Associate Professor, Arizona State University, Department of Industrial Engineering, Arizona State University, Tempe, AZ, 85281, United States, rene.villalobos@asu.edu

The objective of the game is to introduce undergraduate engineering students to the application of optimization techniques for stock portfolio selection. The game is played in four rounds within an hour-long session. The teams are provided with an initial virtual investment fund, which they have to allocate or reallocate based on the information presented. The results of the game are used in the last part of the session to put the investment game in the perspective of an optimization problem.

- 2 - Inventory Control at Spiegel Grove  
Matt Drake, Assistant Professor, Duquesne University, School of Business, Pittsburgh, PA, United States, drake987@duq.edu, John Mawhinney

In this presentation we detail a classroom game designed to show students the impact of uncertainty related to transportation lead time and product quality on inventory control strategies in a serial supply chain.

- 3 - The Inventory Routing Game  
Christos Alexopoulos, Associate Professor, H. Milton Stewart School of Industrial & Systems Engineering, Georgia Institute of Technology, Atlanta, GA, 30332-0205, United States, christos@isye.gatech.edu, Martin Savelsbergh, David Goldsman, Ralph Mueller

The inventory routing problem is concerned with the distribution of products from various facilities to a set of customers. Customers consume products and can maintain inventories. The game provides an environment in which users can simulate various strategies on different problem instances. Players compose delivery routes and determine the delivery quantities at these customer sites. A player can make routing decisions online. At the end of the game, a detailed performance report is generated.

## 4 - What Makes a Good Game?

Joel Sokol, Associate Professor, School of ISyE, Georgia Institute of Technology, Atlanta, GA, 30332-0205, United States, jsokol@isye.gatech.edu

Creating educational games is hard. Creating good educational games is even harder. In this talk, we suggest some guidelines for making good games (including a definition of what good is), and illustrate using examples of our own games (including several bad ones).

## ■ SD45

## Performance Evaluation and Risk Management

Sponsor: Financial Services

Sponsored Session

Chair: Bruce Weber, Professor of Information Management, London Business School, Regents Park, London, NW1 4SA, United Kingdom, bweber@london.edu

## 1 - Data Envelopment Analysis in Mutual Fund Evaluation: A Critical Review

Tarja Joro, Adjunct Assistant Professor, University of Alberta, School of Business, Canada, tarja.joro@ualberta.ca, Paul Na

Recently, there has been interest in using Data Envelopment Analysis (DEA) in the evaluation of Mutual Funds. This paper discusses the benefits and pitfalls of using DEA in this context and reviews the ways in which DEA can be used to extend the evaluation of Mutual Funds beyond the traditional mean-variance framework.

## 2 - Applications of Genetic Algorithms to Risk Management and Client Segmentation in Financial Services

Russell Walker, President, Walker Bernardo, LLC, 1617 W Grace Street, Richmond, VA, 23220, United States, russell@walkerbernardo.com

New data mining techniques enable managers in financial services to exploit large amounts of data. We demonstrate how our new proprietary, genetic algorithm-based approach, increases the predictive value of models for credit risk management, and in resolving the general customer segmentation dilemma. Applications of such models need not tax the analytical team and can process large amounts of data and consider and identify numerous interaction and non-linear realities in the underlying data.

## 3 - Valuation Impacts of IT Weaknesses in SOX Reports

Bruce Weber, Professor of Information Management, London Business School, Regents Park, London, NW1 4SA, United Kingdom, bweber@london.edu

Effective financial control systems ensure the integrity of financial reporting. SOX disclosures of ineffective internal control over financial reporting from 47 U.S. companies show abnormal returns of -1.52% over a (0,+1) window around the FY2005 10K filing date. The 2005-06 return on an equally weighted portfolio of the firms reporting ineffective control due to IT problems is -2.6%, a 32% underperformance relative to the CRSP EW index.

## ■ SD46

## Risk Management 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@stats.ucl.ac.uk

## 1 - Hydroelectric Scheduling: Empirical Evidence

Stein-Erik Fleten, Norwegian U of Science and Technology, Alfred Getz v. 3, Trondheim, Norway, stein-erik.fleten@iot.ntnu.no, Jussi Keppo

Electricity companies owning storage hydroelectric plants have a complex task of scheduling the release of water from reservoirs, under uncertainty of prices and inflows. Optimization problems are solved every week to support this activity. Using weekly data from 13 Norwegian power plants in the period 2000-2006, we investigate the factors that drive the production schedules and how scheduling is performed.

## 2 - How to Proceed with the Thorium Reactor Technology:

A Real Options Analysis

Afzal Siddiqui, University College London, Gower Street, London, United Kingdom, afzal@stats.ucl.ac.uk, Stein-Erik Fleten

The advantage of a thorium nuclear reactor is that it is easier to stop or control the process, and it produces less long-lived nuclear waste than existing reactors. However, there are a number of technical challenges that need to be overcome,

and the current costs of building a thorium reactor would be very high. We analyse how a government may proceed with a staged development of meeting the need for electricity as fossil fuel sources are being phased out.

## 3 - A Comparison of Regime-switching Models for Electricity Spot Price

Dipeng Chen, PhD Candidate, London Business School, Regent's Park, London, NW1 4SA, United Kingdom, dipengchen.phd2004@london.edu, Derek Bunn

Through analysing the complex relationship between British spot price dynamics and fundamental/strategic factors under Markov regime-switching and logistic smooth transition modelling frameworks, we gain a better understanding of the market. In addition to including conventional fundamentals, this work also studies the influence from high-frequency market structure variables as well as the carbon emission trading on spot price. Two models' forecasting performances are also compared.

## 4 - Impact of the Unavailability of a Power Unit on Its Forward Contracting

Antonio J. Conejo, Professor, Universidad de Castilla - La Mancha, Electrical Engineering, Campus Universitario s/n, Ciudad Real, 13071, Spain, Antonio.Conejo@uclm.es, Salvador Pineda

As a complement of selling in the pool, a power unit engages in forward contracting to hedge against the risk of profit variability due to pool price volatility. Unavailability of the unit due to its force outage rate results in the need of buying in the pool the contracted energy that cannot be supplied by self-production, which in turn might result in a significant loss and profit variability. This presentation explores how forward contracting is influenced by unit unavailability.

## ■ SD47

## Forestry IV: Wildfire Management

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

Chair: Jeremy Fried, USDA Forest Service Pacific Northwest Research Station, P.O. Box 3890, Portland, OR, 97208, United States, jsfried@fs.fed.us

## 1 - Considering the Economics of Performance Metrics in Fire Management Planning

Doug Rideout, Dept. of Forest, Rangeland, and Watershed Stewardship, Colorado State University, Fort Collins, CO, 80523, United States, doug.rideout@colostate.edu

The shift to ecosystem management has important implications for fire policy and how the performance of fire systems are perceived and analyzed. While economists have improved the measurement theory and technology for non-market valuation, development of theory and techniques for performance metrics has lagged. This paper addresses the need for sound performance metrics in fire management planning. Key principles applicable to economically sound performance metrics are addressed.

## 2 - Contract Crew Forecasting Models and Potential Agency Cost Savings

Geoffrey Donovan, USDA Forest Service Pacific Northwest Research Station, 620 SW Main St. Suite 400, Portland, OR, 97205, United States, gdonovan@fs.fed.us

Suppressing wildfires requires significant funds for inputs in advance of uncertain fire seasons. The benefits of improved information about the severity of an upcoming season can be quantified using ex post analyses. We report the potential gains to the U.S. Forest Service of using a new forecasting method that exploits historical information about cost-minimizing input choices for type II hand crews. Our analysis documents that potential gains far outweigh their research and development costs.

## 3 - A Simulation and Stochastic Programming Approach to Resource Deployment for Wildfire Containment

Lewis Ntaimo, Assistant Professor, Industrial and Systems Engineering, Texas A&M University, 3131 TAMU, College Station, TX, 77843, United States, ntaimo@tamu.edu, Ewelina Zwierzykowski

We present a simulation and stochastic programming approach to wildfire suppression resource deployment under uncertainty. Simulation is used to generate scenarios of daily fire occurrence and growth. These are input to a two-stage stochastic mixed-integer programming model to determine the mix of resources to deploy to bases in the first stage, and resources from each base to dispatch to a reported fire in the second stage. The objective is to minimize expected cost plus net value change.

#### 4 - Strategic Budgeting for Initial Response and Fuel Management in Wildfire Management

Tarun Kumar, IBM TJ Watson Research Center, Room 32-238, Yorktown Heights, NY, 10598, United States, ktarun@us.ibm.com, Steven Carty, Andy Kirsch, Yan Liu, Gyana Parija

We present a new multi-criteria budget allocation model for assigning national budgets across multiple Fire Planning Units. Causal relationships between the various effectiveness measures and underlining historical funding allocation decisions are learned from detailed FPU-level analyses. These causal relationship functions are posted as constraints in the Goal Program framework to optimally allocate budgets nationally.

#### 5 - Linked Models Predict Climate Change Effects on Wildfire Containment as Subtle but Consequential

Jeremy Fried, USDA Forest Service Pacific Northwest Research Station, P.O. Box 3890, Portland, OR, 97208, United States, jsfried@fs.fed.us

Using stochastic and deterministic modeling and bridging the coarse scale output of general circulation models of climate and fine-scale models of initial attack, effects of climate change on wildfire severity and outcomes in California were modeled for a base case and multiple greenhouse gas scenarios. Subtle shifts in fire behavior that might be induced by the climate changes are of sufficient magnitude to generate an appreciable increase in the number of fires that escape initial attack.

## ■ SD48

### Advances in Simulation Output Analysis

Sponsor: Simulation  
Sponsored Session

Chair: Preston White, Professor, University of Virginia, P.O. Box 400747, 151 Engineers' Way, Charlottesville, VA, 23901, United States, kpwhite@virginia.edu

Co-Chair: Roy Creasey, Assistant Professor, Longwood University, 201 High Street, Farmville, VA, 23901, United States, creaseyrr@longwood.edu

#### 1 - Verifying Limit Standards Based on Binary Outcomes Derived from Monte Carlo Simulation

Preston White, Professor, University of Virginia, P.O. Box 400747, 151 Engineers' Way, Charlottesville, VA, 23901, United States, kpwhite@virginia.edu, Roy Creasey

We illustrate the use of acceptance sampling by attributes (ASA) to probabilistic requirements verification using Monte Carlo simulation. Given the required probability of attaining a specified limit and the required confidence that this probability is achieved, ASA can determine a family of appropriate (n,c) sampling plans. We illustrate how this approach to statistical inference can be implemented with an example from aerospace engineering.

#### 2 - Agent-based Simulation Output Analysis

Charles Macal, Argonne National Laboratory, 9700 S. Cass Ave., Bldg 900-DIS, Argonne, IL, 60439, United States, macal@anl.gov

Agent-based simulations (ABS) produce results similar to conventional simulations, but the agent focus adds some new dimensions not addressed in discrete event simulation output analysis. A goal of agent-based simulation is to better understand how system behavior at the macro-level results from the agents' behavioral rules at the micro-level. Another challenge is to recognize and characterize emergent behavior. This presentation identifies unique aspects of ABS output analysis.

#### 3 - A Bayesian Approach to Output Analysis of Limit Standards

Roy Creasey, Assistant Professor, Longwood University, 201 High Street, Farmville, VA, 23901, United States, creaseyrr@longwood.edu, Preston White

Limit standards have been defined as probabilistic requirements that specify confidence on the maximum proportion of simulation runs yielding values of an output variable above or below a desired threshold. Typical analysis methods utilize the binomial distribution. This research investigates the relationship between the binomial and beta distributions, and develops a Bayesian sequential approach to analysis of limit standards.

#### 4 - Classification of Discrete Event Simulation Models and Output: Creating a Sufficient Model Set

Kathryn Hoad, Research Fellow, Warwick Business School, The University of Warwick, Coventry, CV4 7AL, United Kingdom, kathryn.hoad@wbs.ac.uk, Ruth Davies, Stewart Robinson

This presentation describes the creation of a representative and sufficient set of models/output data that can be used by discrete event simulation researchers to test their research ideas. The identification of certain DES model/output characteristics is described, as is the creation of a classification system for each

general type of model/output encountered in 'real life' DES modelling. The process of setting up this classification system is explained and the classification tables outlined.

## ■ SD49

### Applications in Airline Alliances

Sponsor: Revenue Management & Pricing- Invited/Sponsored  
Sponsored Session

Chair: Lori Houghtalen, Babson College, Math/Science Division, Babson Hall 316, Babson Park, MA, 02457, United States, lhoughtalen@babson.edu

#### 1 - Fairness Considerations in Allocation Mechanisms for Carrier Alliances

Lori Houghtalen, Babson College, Math/Science Division, Babson Hall 316, Babson Park, MA, 02457, United States, lhoughtalen@babson.edu, Joel Sokol, Ozlem Ergun

In an alliance among cargo carriers, a key issue to resolve is the allocation of alliance benefit among participating members. The notion of fairness in allocation will be explored beyond traditional cooperative game theoretic ideas; a methodology for adapting an allocation mechanism to include fairness considerations will be discussed, and several measures for quantifying fairness will be proposed and evaluated.

#### 2 - Dynamic Revenue Management in Airline Alliances

Christopher Wright, PhD Candidate, William E. Simon Graduate School of Business Administration, Carol Simon Hall 4-341, University Of Rochester, Rochester, NY, 14627, United States, wrightc1@simon.rochester.edu, Harry Groenevelt, Robert Shumsky

Currently, most airline alliances use static contracts for revenue-sharing. We propose and analyze several dynamic contracts that adjust sharing proportions based on the changing state of the system. Framing a two-airline alliance as a finite-horizon Markov game, we find the equilibrium policies for each contract. We compare revenues under these policies with those under static proration contracts and with those of a centralized controller, providing insight into when each performs well.

#### 3 - Contracting Mechanisms for Airline Code Share Alliances

Achal Bassamboo, Northwestern University, a-bassamboo@northwestern.edu, Sunil Chopra, Sandeep Juneja, Milind Sohoni

We study revenue-sharing contracts for airline alliances. An airline privately observes local demand on a single leg and reveals information about remaining capacity, which is used to accept passengers with 2-flight itineraries (thru-passengers.) We show conditions under which the max-allocation contract, for thru-passengers, is an optimal truth-telling contract. We develop conditions when the min-allocation contract achieves optimality. We extend the results for larger alliances.

#### 4 - Options, Spot Prices, and Buyer Learning

Jinpyo Lee, School of Industrial and Systems Engineering Georgia Institute of Technology, jplee@isye.gatech.edu, Anton J. Kleywegt

A seller sells options, and later also sells on the spot at a price chosen by the seller. The spot price may depend on the number of options sold, as well as some random demand data that was observed after the options were sold but before the spot price was determined. In the first stage buyers decide how many options to buy, not knowing what the spot price will be, and not knowing the seller's spot pricing policy. In the second stage buyers decide how many options to exercise and how much to buy on the spot. Buyers use past observations of spot prices to estimate a spot price distribution. Spot prices depend on previous decisions, and thus the sequence of spot prices is neither independent nor identically distributed. We study the convergence of decisions and distribution estimates, and compare the limits with the Nash equilibrium.

## ■ SD50

### Data-driven and Learning-based Methods in Revenue Management

Sponsor: Revenue Management & Pricing- Invited/Sponsored Sponsored Session

Chair: Itir Karaesmen, University of Maryland, College Park, MD, United States, ikaraes@rhsmith.umd.edu

#### 1 - Optimal Timing of Price-Quote Revisions

Miguel Sousa Lobo, Duke University, Fuqua School of Business, 1 Towerview Dr, Durham, NC, 27708, United States, mlobo@duke.edu

While most work in optimal pricing has focused on posted-price transactions, in many if not most transactions in the economy the seller may offer individualized discounts. In our model buyers contact the seller for a price quote, while simultaneously searching for alternatives. A seller can significantly increase revenue by correctly managing the timing of subsequent individual discounts offered to each buyer as an incentive to complete the transaction. We also discuss estimation procedures.

#### 2 - Sequential Pricing and Demand Learning

Rene Caldentey, Prof., New York University Stern School of Business, 44 West 4th St., New York, NY, 10012, United States, rcaldent@stern.nyu.edu, Victor Araman

A seller is endowed with a finite amount of inventory that can sell in market with stochastic and price-sensitive demand. The probability distribution of this demand is partially known. We characterize dynamic pricing strategies that simultaneously balance market exploitation (revenue maximization) and market exploration (demand learning).

#### 3 - Revenue Management for Products with Unknown Quality and Observable Price and Sales History

Laurens Debo, Tepper School of Business, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA, 15213, United States, laurdebo@andrew.cmu.edu, Nicola Secomandi

This paper studies pricing strategies of a monopolist when customers are strategic and infer the product quality from historical sales and price paths. The monopolist can sell a finite amount of inventory during a finite horizon. Its pricing policy controls the inventory as well as the customer learning. We derive the structure of the optimal pricing strategy and discuss the implications of strategic customer behavior.

#### 4 - A Provably Near-optimal Sampling-based Algorithm for the Capacity Allocation Problem

Thiam Lee, IEOR Department, Columbia University, 500 West 120th St, Mudd 323, New York, NY, United States, thl2102@columbia.edu, Woonghee Tim Huh, Retsef Levi

We consider yield management capacity allocation with monotonic fare classes and independent demands, but with unknown demand distributions. Instead, we assume access to a black box that generates uncensored samples from the true distributions. We give an algorithm to compute from samples a nested protection level policy, and prove an upper bound for the number of samples needed to guarantee that that policy is epsilon-optimal with probability  $1 - \delta$  for any  $\epsilon > 0$  and  $\delta > 0$ .

## ■ SD51

### Pricing, Revenue Management and Applications

Sponsor: Revenue Management & Pricing- Invited/Sponsored Sponsored Session

Chair: Juan-Carlos Ferrer, Assistant Professor, P. Universidad Catolica de Chile, Casilla 306 Correo 22, Santiago, 00, Chile, jferrer@ing.puc.cl

#### 1 - Non-cooperative Competition Among Revenue Maximizing Service Providers with Demand Learning

Changhyun Kwon, PhD Candidate, The Pennsylvania State University, 310 Leonhard Building, University Park, PA, 16802, United States, chkwon@psu.edu, Terry Friesz, Baichun Feng, Reetabrata Mookherjee, Tao Yao

This research recognizes that, in many decision environments in which revenue optimization is attempted, an actual demand curve is generally unobservable. We describe the dynamics of demand as an evolutionary differential equation. The resulting model takes the form of a differential variational inequality (DVI). We then observe realized sales data to obtain estimates of parameters that govern the evolution of demand. We present an algorithm for solving the DVI based on a gap function.

#### 2 - Optimal Pricing for Services Bundles with Down-payments: Monopoly vs. Duopoly

Juan-Carlos Ferrer, Assistant Professor, P. Universidad Catolica de Chile, Casilla 306 Correo 22, Santiago, Chile, jferrer@ing.puc.cl, Hugo Mora, Gabriel Bitran

We examine the pricing decision of a provider that offers a bundle that includes a physical product with a high setup cost, and its associated services by means of a subscription. A two-part tariff scheme is used which consists on a down-payment (a fraction of the setup cost) and a periodic fee. We examine the monopoly and duopoly market scenarios, finding near optimal fixed-price policies, and that duopoly firms use the down-payment to protect themselves from the effect of customers switching.

#### 3 - Risk Averse Selective Newsvendor with All-or-nothing Orders

Kiran Chahar, PhD Candidate, Clemson University, 110 Freeman Hall, Clemson, SC, 29634, United States, kchahar@clemson.edu, Kevin Taaffe

Consider a firm offering its product for a single selling season to various unconfirmed demand sources each with unique forecasted demand and revenue. The order may either come in at a predefined level or not come in at all (all-or-nothing), and the firm can choose to pursue the order or not. We propose an order selection approach minimizing the risk of incurring losses below some threshold value. We employ multiple optimization models, including a Conditional Value-at-Risk (CVaR) approach.

## ■ SD52

### Rails to the Sea - Continuation

Sponsor: Railway Applications Sponsored Session

Chair: Steven Harrod, Assistant Professor, University of Dayton, School of Business Administration, 300 College Park, Dayton, OH, 45469, United States, a2soft@aol.com

#### 1 - Panel Discussion: Rails to the Sea - Continuation

Moderator: Steven Harrod, Assistant Professor, University of Dayton, School of Business Administration, 300 College Park, Dayton, OH, 45469, United States, a2soft@aol.com

Steven Harrod will introduce an exciting panel discussion of current issues in marine-rail intermodal service and port management.

## ■ SD53

### Economic Location Models

Sponsor: Location Analysis Sponsored Session

Chair: Tammy Drezner, Professor, California State University, Fullerton, Department of ISDS, Fullerton, CA, 92834, United States, tdrezner@fullerton.edu

#### 1 - Revenue-driven Elastic Demand and Congestion Location Model

Dmitry Krass, Professor, University of Toronto, Rotman School of Management, 105 St. George Street, Toronto, ON, M5S 3E6, Canada, krass@rotman.utoronto.ca, Dehui Tong, Oded Berman

A revenue-maximizing firm must select price, service capacity and facility locations. Customer demand is affected by prices and service levels. A closed-form solution is given for one-facility case. Multi-facility problem is formulated as system optimization model and as user optimization models. System optimization assumes customers cooperate with a central authority to achieve the best performance of the system; in user optimization model customers act individually in making their decisions.

#### 2 - Subsidy Strategies in a Location Model

H.A. Eiselt, Professor, University of New Brunswick, P.O. Box 4400, Fredericton, NB, Canada, HAEiselt@unb.ca, Joy Bhadury, Steve Peng

The paper considers a location model with three levels of decision makers: customers who purchase products, firms that locate, and a regional planner who awards subsidies. Customers buy at the cheapest source, firms maximize profits from sales plus subsidies and planners maximize social benefit. The resulting location patterns are examined.

### 3 - Capacitated Facility Location for Disbursement of Supplies in a Large-scale Emergency

Fernando Ordonez, University of Southern California,  
3715 McClintock Avenue, GER-240, Los Angeles, CA, 90089,  
United States, fordon@usc.edu, Pavankumar Murali,  
Maged Dessouky

We propose a model for the facility location problem with capacity constraints, with the objective being to minimize unmet demand. We then extend this problem to the scenario with stochastic demands, for which we propose a chance-constrained model. The performance of the locate-allocate heuristic combined with LP-rounding procedures is evaluated for both these problems for the case of locating emergency medical supplies in Los Angeles.

### 4 - Gradual Coverage in Location Set Covering Problem (LSCP)

Vladimir Marianov, Professor, Department of electrical  
Engineering, Pontificia Universidad Católica de Chile,  
Santiago, RM, Chile, marianov@ing.puc.cl, H.A. Eiselt

We review and propose different forms to soften the coverage function in the LSCP. The formulations either penalize excessive customer – facility distances, or require some proportion of customers to receive service within a specified distance, while the remaining customers receive at least a secondary level of service, or maximize the minimum level of service. We also analyze the case in which there is congestion. The approaches are compared with respect to their practicability.

## ■ SD54

### Joint Session AP/ICS: Approximate Dynamic Programming II

Sponsor: Applied Probability, INFORMS Computing Society  
Sponsored Session

Chair: Sandjai Bhulai, VU University Amsterdam, Department of  
Mathematics, De Boelelaan 1081a, Amsterdam, 1081 HV, Netherlands,  
sbhulai@few.vu.nl

#### 1 - Robust Dynamic Programming for Markov Decision Processes with Uncertain Transition Matrices

Baohua Li, Research Associate, Arizona State University,  
Department of Electrical Engineering, Tempe, AZ, 85287,  
United States, Baohua.Li@asu.edu, Jennie Si

Markov decision processes with uncertain stationary transition matrices are discussed. These matrices are classified into independent and correlated cases. A new criterion of quadratic total value function is proposed to formulate robust dynamic programming solutions. Approximate robust policy iterations are developed to obtain stationary near-optimal policies surely or in the probability sense. Under some assumptions, such solutions are near-optimal in the deterministic policy space.

#### 2 - Dynamic Programming for Bayesian Reinforcement Learning

Pascal Poupart, Assistant Professor, University of Waterloo,  
200 University Avenue West, Waterloo, ON, N2L 3G1, Canada,  
ppoupart@cs.uwaterloo.ca, Nikos Vlassis

Dynamic programming can be used to optimize the policy of Bayesian reinforcement learning problems. However, since the form of the value function is unknown, existing techniques tend to avoid dynamic programming. We derive an analytic solution, revealing that the optimal value function is the upper envelope of a set of linear combinations of Dirichlets. We also propose an effective approximate dynamic programming algorithm, called Beetle, which takes advantage of this analytical form.

#### 3 - A Linear Programming Based Reinforcement Learning Algorithm

Vivek Borkar, Professor, School of Technology and Computer  
Science, Tata Institute of Fundamental Research, Homi Bhabha  
Road, Mumbai, Ma, 400005, India, borkar@tifr.res.in, Jervis Pinto,  
Tarun Prabhu

A new reinforcement learning algorithm for Markov decision processes is proposed, based on the dual linear program associated with it. A linear function architecture is used to approximate this linear program and the saddle point of the associated Lagrangian is learnt using a stochastic approximation version of a primal-dual scheme operating on two time scales. Convergence with probability one is established.

## ■ SD55

### Research Challenges in Aviation

Sponsor: Aviation Applications  
Sponsored Session

Chair: Stefan Karisch, VP Operations Research, Jeppesen Systems AB,  
1800 McGill College Avenue, Suite 1930, Montreal, QC, H3A 3J6,  
Canada, stefan.karisch@jeppesen.com

#### 1 - Panel Discussion: Research Challenges in Aviation

Moderator: Stefan Karisch, VP Operations Research, Jeppesen  
Systems AB, 1800 McGill College Avenue, Suite 1930, Montreal,  
QC, H3A 3J6, Canada, stefan.karisch@jeppesen.com, Panelist:  
Barry Smith, Amy Cohn, Michael Ball, Timothy L. Jacobs

The panel discussion will address current research challenges in aviation. Representatives from industry, regulators, suppliers, and academia will present current and future challenges for the research community, and engage the audience in a discussion.

## ■ SD56

### Auction Design - Efficiency and Optimality

Cluster: Auctions  
Invited Session

Chair: Wedad Elmaghraby, UMD, Van Munching Hall, College Park,  
MD, United States, Wedad\_Elmaghraby@rhsmith.umd.edu

#### 1 - Auctions in Which Losers Set the Price

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We study auctions of a single asset among symmetric bidders with affiliated values. We show that the second-price auction minimizes revenue among all efficient auction mechanisms in which only the winner pays, and the price only depends on the losers' bids. We compute bidding functions and revenue of the  $k$ -th price auction for an illustrative example much used in the experimental literature to study first-price, second-price and English auctions.

#### 2 - Utilization of Uniform Price Auctions in Supply Chain

Coordination with Forecast Investment  
Tunay Tunca, Professor, Stanford University, 518 Memorial Way,  
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We study supply chain coordination with investment in demand forecasting. We show that, when competing downstream retailers invest in private forecasts, common contracting schemes fail to coordinate the supply chain and cause overinvestment, as well as large supply chain inefficiencies. We analyze uniform price supply auctions as a remedy. We study the optimal design and characteristics of such auctions, and demonstrate that their utilization can achieve supply chain efficiency.

#### 3 - Does it Make Sense to Favor Incumbent Suppliers in an Auction?

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Oh, J. Daniel Aromi

We consider a game in which a buyer must repeatedly procure an input from a set of firms. In our model, the buyer is able to sign long term contracts that establish the likelihood with which the next period contract is awarded to an entrant or the incumbent. We find that the buyer finds it optimal to favor the incumbent, this generates more intense competition between suppliers. In a two period model we are able to completely characterize the optimal mechanism.

#### 4 - Optimal Procurement Auctions under Product Differentiation

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The paper derives the optimal procurement mechanism in the presence of heterogeneous preferences over alternative goods. Implementation can be achieved with simple auction mechanisms subject to properly choosing bidding credits. The paper also analyzes variants of the request for bid mechanisms, looking at sleeve auctions which combine competitive price allocation with the unfettered product choice by the buyer.

## ■ SD57

### Joint Session TELECOM /ICS: Network Design

Sponsor: INFORMS Telecommunications Section, INFORMS Computing Society  
Sponsored Session

Chair: Raghu Raghavan, raghavan.umd@gmail.com

#### 1 - The Generalized Regenerator Location Problem

S. Raghavan, University of Maryland, 4345 Van Munching Hall, College Park, MD, 20742-1815, United States, raghavan@umd.edu, Ivana Ljubic, Si Chen

In the generalized regenerator location problem (in optical networks) we are given a set of terminal nodes  $T$  that need to communicate. It is necessary to install regenerators if the distance between a pair of nodes in  $T$  is greater than  $L$ . Regenerators can only be installed at a subset of nodes in the network. We wish to minimize the number of regenerator (or a weighted combination). We describe heuristics for the problem, and an MIP model, and our computational experiences with both.

#### 2 - Dual-ascent for the Connected Facility Location Problem

Gisela Bardossy, University of Maryland, Van Munching Hall, College Park, MD, 20742-1815, United States, mgbardossy@yahoo.com, S. Raghavan

We consider four well known problems in the network design literature. The Steiner-Star Tree problem, the Generalized Steiner-Star Tree Problem, the Connected Facility Location Problem, and the Rent or Buy Problem. We show how the latter three problems can be modeled as Steiner-Star Tree problems. Based on this observation and a transformation of the Steiner-Star Tree problem to a degree constrained Steiner Tree problem we discuss experiments with a dual-ascent procedure for the four problems.

#### 3 - Modelling the Hop-constrained Minimum Spanning Tree Problem Over a Layered Graph

Luis Gouveia, CIO and DEIO-FCUL, Edificio C6, Campo Grande, Lisbon, Lx, Portugal, legouveia@fc.ul.pt, Eduardo Uchoa, Luidi Simonetti

In this talk we show that the Hop-constrained Minimum Spanning Tree Problem (HMSTP) that can be viewed as Steiner Tree Problem (STP) in a layered graph. We present formulations that correspond to well known formulations for the STP and here adapted for the layered graph and compare the linear programming relaxation of the new models with the linear programming relaxation of best models presented so far. The so called Diameter Constrained Minimum Spanning Tree will also be mentioned.

#### 4 - A Solution Procedure for Broadband Convergence Access Network Design Problem

Youngho Lee, Professor, Korea University, Division of Information Management Eng., SungBuk Ku Anam Dong, Seoul, Korea, Republic of, itmsl@dreamwiz.com, Youngjin Kim, Junghe Han, Kyunam Chang, Hyunjung Yun, Youngwook Kim, Bongju Kwon, Kyungsoo Kong

We present a physical network design problem of broadband convergence access network. We formulate the problem as a three-level capacitated facility location-allocation model that minimizes the total cost, while satisfying nonlinear QoS constraints. The proposed branch and bound procedure finds the optimal solution within ten minutes for real problem instances.

## ■ SD58

### Innovation: Entry, Learning and Change

Sponsor: Organization Science  
Sponsored Session

Chair: Andy King, Dartmouth University, Andrew.A.King@tuck.dartmouth.edu

Co-Chair: Miguel Campo-Rambado, Dartmouth University, miguel.a.campo-rembado@dartmouth.edu

#### 1 - Causes and Consequences of Entrepreneurial Entry in Bail Bonds

A.M. Knott, Washington University in St. Louis, knott@wustl.edu

Entrepreneurial entry is one of the boldest moves in the economy and we don't really understand it very well. Even Bresnahan and Reiss's, Entry and Competition in Concentrated Markets isn't really about entry per se, it's about the equilibrium number of firms. While there is prior work examining when we obtain excess entry and whether that entry is beneficial to the economy, that work was in an industry (banking) where entry restrictions are so severe (11 million dollars, prior executive experience, a business plan and demonstrated market void) that firm turnover rates are an order of magnitude lower than in the broader economy. This study examines a complementary setting (Bail Bonds) where entry is quite liberal (rates are twice the economy average). This allows us

to examine 1) how cross-market variance in regulations affect the rate of entry and 2) how that entry affects innovation (improvement in economic outcomes: incarceration rates, failure to appear rates and fugitive rates).

#### 2 - Bringing Context to the Explore-Exploit Trade-Off: Considering the Impact of Selection and Turbulent Environments

H. Posen, University of Michigan, hposen@bus.umich.edu, Daniel Leventhal

Strategy and organization scholars have argued that firms should pursue strategies that balance exploitation and exploration. Since March's seminal paper, research has focused significant attention on the mechanisms by which firms might pursue balance (e.g. ambidexterity). In this paper, we direct attention to an equally important question that has garnered much less attention in the literature: what factors affect the level of exploration? We employ a computational model based on the canonical  $n$ -armed bandit formulation. We examine the two basic rationales for exploration: static and dynamic. While the static rationale focuses on exploration as a mechanism for the identification of a good choice from the set of alternatives, the dynamic rationale focuses on exploration as enabling a firm to adjust in a turbulent world. Our counterintuitive result is that in the presence of environmental turbulence, the optimal balance requires less, not more, exploration (i.e. exploit in the face of turbulence).

#### 3 - Innovation Differences Among Industries and Over the Technology Life-cycle

Scott Rockart, Duke University, srockhart@duke.edu, Michael Lenox, Arie Lewin

The nature and extent of firms' innovation efforts is extremely important to social welfare and known to vary across industries and over the technology life-cycle. In this paper, we use a computational model to replicate existing stylized facts and to develop novel predictions about how and why innovation efforts vary across industries and over time. Specifically, we argue that inter-industry differences in the interdependencies in products or production processes influence competitive intensity and firms' ability to innovate and imitate one another, thus conditioning firms' choices of innovation policies as well as their innovative success.

#### 4 - Relative Technological Discontinuities: Insights from the Identification of Shifts in Innovation

Miguel Campo-Rambado, Dartmouth University, miguel.a.campo-rembado@dartmouth.edu, A.H. Taylor

In this paper, we conceptualize change in technological innovation as a continuous process where discontinuities are periods of greater change relative to other periods. Periods of high relative discontinuities are captured by identifying the unexpected, or residual, component in the trajectory of new innovative activity. Using our definition of relative discontinuities, we conduct cross-industry longitudinal analyses of technological innovation. Overall, we find that discontinuities are associated with tipping points in which the production of knowledge by organizations becomes self-reinforcing (e.g., new knowledge is produced that facilitates the production of more new knowledge). Firms accelerate their knowledge production during technological discontinuities and decelerate after. During discontinuities, firms use newer knowledge sources that, surprisingly, reinforce the existing knowledge trajectory. The results suggest that the accumulated effort of active innovators is what drives discontinuities.

## ■ SD59

### Hospital Process Improvement

Sponsor: Technology Management  
Sponsored Session

Chair: Jose Zayas-Castro, Professor & Chair, University of South Florida, 4202 E Fowler Avenue, Industrial Engineering Department, Tampa, FL, 33620, United States, josezaya@eng.usf.edu

#### 1 - Learning Orientation and Resident Physicians' Medical Treatment Errors

Eitan Naveh, Technion - Israel Institute of Technology, Faculty of Industrial Engin. & Manage., Haifa, 32000, Israel, naveh@ie.technion.ac.il, Tal Katz-Navon, Zvi Stern

Every organization is confronted with employee errors. In order to eliminate errors organizations emphasize a learning-orientation, which refers to the importance given within the organization to increasing each employee's knowledge and competence. This study explored the concepts of learning-orientation, employee autonomy, and employee voice (employee's perception that speaking up in the organization is wise), and the interactions among them as predictors of resident physicians' medical errors.

#### 2 - Improving Operational Quality of Care in Healthcare Inpatient Processes

Abhik Bhattacharya, Graduate Student, University of South Florida, 4202 E Fowler Ave., ENB 118, Industrial Engineering, Tampa, FL, 33620, United States, abhattac@mail.usf.edu, Jose Zayas-Castro

Various departments within a hospital have to interact to treat an inpatient. Hospitals are facing rising demands that have led to increased waiting time for patient admission and other inpatient processes. A study at the VA Hospital in Tampa is being conducted with the aim of reducing the waiting time and process delays. Improved information and patient flows between departments would help to decrease the length of stay of patients.

## ■ SD60

### Knowledge, Learning, Intellectual Capital-II: Human Learning

Sponsor: Technology Management  
Sponsored Session

Chair: David Moore, PhD, KLICNET.ORG, The Knowledge, Learning and Intellectual Capital Network, 3788 Davidson Place, Boulder, CO, 80305, United States, dmoore@klicnet.org

#### 1 - Workforce Knowledge Management and the Investment in New Technology

Cheryl Gaimon, Regents' Professor, Georgia Institute of Technology, College of Management, 800 West Peachtree Street, NW, Atlanta, GA, 30308-0520, United States, cheryl.gaimon@mgt.gatech.edu, Karen Napoleon, Gulru Ozkan

We demonstrate the importance of managing workforce knowledge when considering the purchase and implementation of a technology upgrade. We introduce a holistic treatment of how workforce knowledge changes over time including phenomena such as knowledge depreciation, forgetting and obsolescence. The manager invests in learning-before-doing to reduce the extent of workforce knowledge obsolescence that occurs at a technology upgrade.

#### 2 - Learning and Technology Adoption: A Structural and Behavioral Analysis

Brent Zenobia, Doctoral Candidate, Portland State University, Engineering and Technology Management, P.O. Box 751, Portland, OR, 97207, United States, bcapps@hevanet.com, Charles Weber

What is the relationship between learning and technology adoption? A case study of alternative transit mode choice suggests that adoption is one member of a family of learning processes which also includes choice framing and technology selection. Structural and behavioral analysis is applied to uncover the properties, dimensions, and behavioral primitives of these processes. Technology adoption and selection are cognitively distinct mental processes with different information requirements.

#### 3 - Surgeon, Surgical Team and Surgery-recovery System Knowledge Generation and Learning in a Hospital

David Moore, PhD, KLICNET.ORG, The Knowledge, Learning and Intellectual Capital Network, 3788 Davidson Place, Boulder, CO, 80305, United States, dmoore@klicnet.org, Nile Hatch

Learning curves of surgeons, surgical teams and the surgery-recovery system of a hospital are analyzed using data collected over a five year period. We explore potential interactions between surgeons, surgical teams, and the surgery-recovery system learning processes. Interviews with surgeons, staff, unit managers and C-level administrators plus hundreds of hours of direct, protocol-guided observation provide foundations for designing empirical studies and interpreting empirical results.

#### 4 - Cutting Your Teeth: Learning from Rare (One or More) Experiences

Chuck Eesley, MIT Sloan, 50 Memorial Dr. E52-557, Cambridge, 02139, United States, eesley@mit.edu, Edward Roberts

We explore whether learning occurs from one or more complex experiences. We examine organizational and entrepreneurial founder characteristics to test hypotheses related to learning from small sets of prior experiences. We use data from survey responses of 964 entrepreneurs to assess performance of startup firms as a measure of outcomes produced by knowledge acquired from prior founding experience. Results indicate substantial performance benefits from small sets of prior experience.