Operations Research Society of Israel (ORSIS)

Annual Meeting 2017

May 21-22

Bar-Ilan University
Department of Management

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ORSIS 2017
SCIENTIFIC PROGRAM

Bar-Ilan University, 21 – 22 May 2017

Sunday 21st

8:30-9:00	**Registration & Gathering**
9:00-9:20	**Opening**
	BIU President Prof. Hershkowitz
9:20-10:05	**Naor Plenary Lecture** **Yonina Eldar**
10:10-11:10	**Parallel Sessions S1**
	Decision Analysis
	Game Theory 1
	Transportation & Logistics 1
11:10-11:30	**Coffee Break**
11:30-12:30	**Parallel Sessions S2**
	ClickSoftware Challenge
	Optimization & Data
	Game Theory 2
12:30-13:30	**Lunch**
13:30-14:15	**Plenary Lecture** **Ehud Lehrer**
14:15-14:30	**Prize Ceremony**
14:30-15:15	Lifetime achievement award
	Aharon Ben-Tal
15:15-15:35	**Coffee Break**
15:35-16:15	**Tutorials**
	Shoshana Anily
	Tamer Boyaci
16:20-17:20	**Parallel Sessions S3**
	Stochastic Processes
	Prize Session
	Transportation & Logistics 2
	Group Decisions and Games
17:30	**Evening program**

Monday 22nd

9:00-9:15	**Gathering**
9:15-10:00	**Plenary Lecture** **David Simchi-Levi**
10:05-11:25	**Parallel Sessions M1**
	Strategic Queueing
	Scheduling
	Supply Chain 1
	Optimization & Uncertainty
11:25-11:45	**Coffee Break**
11:45-12:45	**Parallel Sessions M2**
	Approximation Methods in OR
	Water Management & Energy
	Simulation
	Game Theory 3
12:45-13:45	**Lunch**
13:45-14:00	**ORSIS General Assembly**
14:00-14:45	**Plenary Lecture** **Jacek Blazewicz**
14:45-15:05	**Coffee Break**
15:05-15:45	**Tutorials**
	Dvir Shabtay
	Atalay Atasu
15:50-17:15	**Parallel Sessions M3**
	Queueing Theory
	Combinatorial Optimization
	Games & Dynamic Models
	Supply Chain 2

DETAILED PROGRAM — SUNDAY 21.05

8:30-9:00	**Registration & Gathering**

9:00-9:20	**Opening Session**	Room: 202 Feldman Hall
	BIU President Prof. Daniel Hershkowitz	

9:20-10:05	**Naor Plenary Lecture**	Room: 202 Feldman Hall
	Yonina Eldar – Phase Retrieval and Analog to Digital Compression	

10:10-11:10	**Parallel Sessions**		**S1**
Decision Analysis Chair: Michael Masin Room: Weissfeld Hall	Nadav Lavi, Hanoch Levy	Operational Dilemmas Upon Server Failures on the Cloud	
	Eugene Khmelnitsky, Yigal Gerchak	Partnership's Profit Sharing: A Principal-Agent Approach	
	Michael Masin, Rotem Dror, Amir Kantor, Segev Shlomov	Finding Preferable Pareto-Efficient Solutions Without Interrogating Decision Makers	
Game Theory 1 Chair: Igal Milchtaich Room: 202	Eran Hanany, Peter Klibanoff, Sujoy Mukerji	Incomplete Information Games with Ambiguity Averse Players	
	Yuval Heller, Erik Mohlin	Social Learning and the Shadow of the Past	
	Igal Milchtaich	Internalization of Social Cost in Congestion Games	
Transportation & Logistics 1 Chair: Tal Raviv Room: 201	Ohad Eisenhandler, Michal Tzur	A Novel Formulation and a Solution Procedure for a Rich Humanitarian Logistic Problem	
	Irith Ben-Arroyo Hartman, Luk Knapen, Tom Bellemans	Enumerating Minimum Path Decompositions to Support Route Choice Set Generation	
	Avraham Edison, Tal Raviv	The Stochastic Time-Dependent Orienteering Problem with Soft Time Windows	

11:10-11:30	**Coffee Break**

11:30-12:30	**Parallel Sessions**		**S2**
ClickSoftware Challenge Room: Weissfeld Hall	Announcement and presentation of the winners of ORSIS-ClickSoftware (OC) 2017 challenge		
Optimization & Data Chair: Zilla Sinuani-Stern Room: 201	Oksana Svinik, Hagai Ilani, Elad Shufan, Tal Grinshpoun, Hillel Bar-Gera	Integer Programming Formulations for the Fixed Route Dial-A-Ride Problem (FRDARP)	
	Yifat Douek Pinkovich, Tal Raviv, Irad Ben-Gal	A Combinatorial Approach for Optimal Sensor Selection	
	Zilla Sinuani-Stern, Lea Friedman	Second Stage Statistical Analysis in the DEA Context and Stochastic DEA	
Game Theory 2 Chair: Arieh Gavious Room: 202	Gail-Gilboa Freedman, Ido Erev, Yefim Roth	On the Impact of Rewarding Repentance	
	Shani Alkoby, David Sarne, Igal Milchtaich	Strategic Signaling and Free Information Disclosure in Auctions	
	Arieh Gavious, Oded Berman, Opher Baron	A Game Between a Terrorist and a Passive Defender	

12:30-13:30	**Lunch**	

13:30-14:15	**Plenary Lecture**	Room: 202 Feldman Hall
Ehud Lehrer – Reward Schemes: Designing Strategic Competition in Financial Markets		

14:15-14:30	**Prize Ceremony**	Room: 202 Feldman Hall

14:30-15:15	**Lifetime achievement award**	Room: 202 Feldman Hall
Aharon Ben-Tal – Some Highlights of my Lifetime (So Far…) as an Optimizer		

15:15-15:35	**Coffee Break**	

15:35-16:15	**Tutorials**	
Shoshana Anily – Cooperative Games: Theory and Applications in Operations Management		Room: 202
Tamer Boyaci – Rational Inattention to Choice And Implications on Firm Decisions		Room: Weissfeld Hall

16:20-17:20	**Parallel Sessions**	**S3**
Stochastic Processes Chair: Yair Shaki Room: 102	Ely Merzbach, G. Aletti, N. Leonenko	The Fractional Poisson Process and Martingales
	Yair Shaki, Avidan Rebibo, Tegegne Bazezew	Parking Lot as Service System and the Double Parking Problem
Prize Session Chair: Michal Tzur Room: 202	Dan Yamin, Forrest K. Jones, John P. De vincenzo, Shai Gertler, Oren Kobiler, Jeffrey P. Townsend, Alison P. Galvani	Vaccination Strategies Against Respiratory Syncytial Virus
	Binyamin Oz	Strategic Behavior in Queues
Transportation & Logistics 2 Chair: Tal Raviv Room: 201	Nurit Oliker, Shlomo Bekhor	Appraisal of Optimization Methods for the Transit Network Design Problem
	Shlomo Beychok, Hillel Bar-Gera, Tal Raviv, Gad Rabinowitz	Share A Ride to the Train Station Using a Demand-Responsive Feeder Service
	Yuval Hadas, Giorgio Gnecco, Marcello Sanguineti	An Approach to Transportation Network Analysis Via Transferable Utility Games
Group Decisions and Games Chair: Ella Segev Room: Weissfeld Hall	Tzvi Alon, Moshe Haviv	Sharing the Gains of Risk Reduction Due to Cooperation
	Yigal Gerchak, Christian Schmid	Comparison of Strategies of Assigning a Project to Agents When Activities Can Succeed or Fail
	Ella Segev, Pnina Feldman, Yiangos Papanastasiou	Social Learning and the Design of New Experience Goods

17:30	**Evening program**

A guided walking tour of Nachalat Binyamin. We will hear about the history of the neighborhood, street of artists, stories of undiscovered houses, and the crafts fair. The tour is guided by an English-speaking guide and performer. At the end of the tour (20:00) we will have dinner at Goshen restaurant.

The bus returns to Bar-Ilan University via the Kfar Maccabiah Hotel.

DETAILED PROGRAM — MONDAY 22.05

9:00-9:15	**Gathering**	
9:15-10:00	**Plenary Lecture**	Room: 202 Feldman Hall
David Simchi-Levi - Data-Driven Research in Revenue Management		

10:05-11:25	**Parallel Sessions**	**M1**
Strategic Queueing Chair: Liron Ravner Room: 202	Ran Snitkovsky, Refael Hassin	Self, Social and Monopoly Optimization in Queues with General Utility Functions
	Moshe Haviv	Some Queueing Paradoxes
	Noam Shamir, Liron Ravner	Pricing Strategy, Capacity Level and Collusion in A Market with Delay Sensitivity
	Liron Ravner, Amihai Glazer, Refael Hassin	Equilibrium and Efficient Clustering of Arrival Times to a Queue
Scheduling Chair: Shlomo Karhi Room: Weissfeld Hall	Stanislaw Gawiejnowicz, Wieslaw Kurc	A New Bound for a Time-Dependent Scheduling Problem
	Gur Mosheiov, Enrique (Tzvi) Gertsl	Batch Scheduling on a Flow-Shop with Unit Time Jobs and Machine-Dependent Setup Times
	Baruch Mor, Gur Mosheiov	A Two-Agent Single Machine Scheduling Problem with Due-Window Assignment and a Common Flow-Allowance
	Shlomo Karhi, Danny Hermelin, Dvir Shabtay	New Algorithms for Minimizing the Total Weighted Number of Tardy Jobs on a Single Machine
Supply Chain 1 Chair: Tatyana Chernonog Room: 201	Yonit Barron, Dror Hermel	Shortage Decision Policies for a Fluid Production Model with Map Arrivals
	Shirly Varem, Hussein Naseraldin, Aharon Ben-Tal	The Integrated Lateral Transhipments and Routing Problem in a Single-Commodity Supply Chain
	Shuvael Cahana, Avi Herbon	Hierarchical Model for Evaluating Long-Term Contracts of Imported Products Under Promised Fixed-Price
	Michael Dreyfuss, Yahel Giat	Pooling Spares to Maximize the Window Fill Rate in a Two-Echelon Exchangeable-Item Repair-System
Optimization & Uncertainty Chair: Eliran Sherzer Room: 102	Krzysztof Postek, Aharon Ben-Tal, Dick Den Hertog, Bertrand Melenberg	Robust Optimization with Ambiguous Stochastic Constraints Under Mean and Dispersion Information
	Arik Sadeh, Dar Kronenblum,	Finding Portfolios with Optimal Gamma and Theta
	Shai Goren, Gad Rabinowitz, Yoav Kerner	Optimization of Resources Allocation in a Complex Stochastic Environment
	Eliran Sherzer, Hanoch Levi, Gail-Gilboa Freidman	Plan Your Cloud for a Rainy Day

11:25-11:45	**Coffee Break**

11:45-12:45	**Parallel Sessions**	**M2**
Approximation Methods in OR Chair: Danny Segev Room: 202	Moran Feldman, Christopher Harshaw, Amin Karbasi	First Sample, then Be Greedy: An Improved Way to Use the Greedy Algorithm
	Liron Yedidsion, Miri Gilenson-Zalevsky, Hussein Naseraldin	PTAS For the Bi-Scenario Sum of Completion Times Trade-Off Problem
	Danny Segev, Ali Aouad	The Ordered *K*-Median Problem: Surrogate Models and Approximation Algorithms
Water Management & Energy Chair: David Raz Room: 102	Amos Bick, Fei Yang, Ying Wang, Leonid Gillerman, Jack Gilron, Asher Brenner, Moshe Herzberg, Gideon Oron	Partial Ranking of Membrane Bio-Reactors for Recommendation Systems in Wastewater Treatment
	Irena Milstein, Asher Tishler, Nurit Gal, C.K. Woo	The Effects of Uncertainty in Capacity Availability, Fuel Cost and Demand on Capacity Mix in Competitive Electricity Markets
	David Raz	A Multi-Objective Approach for Water Pump Scheduling Optimization
Simulation Chair: Yaniv Mordecai Room: 201	Joseph Kreimer	Marked Objects Identification in Different Maps – Maps Comparison
	Eyal Tenzer, Tal Raviv	Small Parcel Routing in A Crowdsourced Physical Internet
	Yaniv Mordecai	A Different Matrix-Based Risk Analysis Technique
Game Theory 3 Chair: Yizhaq Minchuk Room: Weissfeld Hall	Priel Levi, David Sarne, Igor Rochlin	Contest Design with Uncertain Performance and Costly Participation
	Ariel Rosenfeld, Oleg Maksimov, Sarit Kraus, Mali Sher	Towards Optimal Traffic Enforcement Allocation in Israel
	Yizhaq Minchuk, Baruch Keren, Yossi Hadad	Sabotaging in Contests with Monitoring Efforts

12:45-13:45	**Lunch**	
13:45-14:00	**ORSIS General Assembly**	Room: 202 Feldman Hall
14:00-14:45	**Plenary Lecture**	Room: 202 Feldman Hall
Jacek Blazewicz - Origins of Life: How Can OR Help to Understand Them?		
14:45-15:05	**Coffee Break**	
15:05-15:45	**Tutorials**	
Dvir Shabtay - On the Parameterized Tractability of Machine Scheduling Problems		Room: 202
Atalay Atasu - Operational Perspectives on Environmental Regulation		Room: Weissfeld Hall

15:45-17:15	**Parallel Sessions**	**M3**
Queueing Theory Chair: Uri Yechiali Room: Weissfeld Hall	Yael Perlman, Amir Elalouf, Uri Yechiali	Dynamic Allocation of Stochastically-Arriving Flexible Resources to Random Streams of Objects with Application to Organ Cross-Transplantation
	Amit Jolles, Uri Yechiali	Alternating Server with Non-Zero Switch-Over Times and Opposite-Queue Threshold-Based Switching Policy
	Gabi Hanukov, Tal Avinadav, Tatyana Chernonog, Uriel Spiegel, Uri Yechiali	A Queueing System with Decomposed Service and Inventoried Preliminary Services
	Rachel Ravid, David Perry	A New Look on the Shortest Queue System with Jockeying
Combinatorial Optimization Chair: Enrique (Tzvi) Gerstl Room: 102	Eugene Levner, Amir Elalouf, Daniel Ng, Edwin Cheng, A Da Che, Vladimir Katz	A Fast Energy-Efficient Routing Algorithm for Emergency Evacuation in Smart Building
	Marta Szachniuk, Mariusz Popenda, Tomasz Zok	RNA Pseudoknots and Graph Coloring Problem
	Benjamin Baran	A Many-Objective Optimization Approach to the Maximum Diversity Problem
	Enrique (Tzvi) Gerstl	Scheduling on Parallel Uniform Machines with The Options of Job - and Machine - Rejection
Games & Dynamic Models Chair: Konstantin Kogan Room: 202	Beatrice Venturi, Giovanni Bella	Shilnikov Chaos in the Lucas Model of Endogenous Growth
	Gila E. Fruchter, Thomas Reutterer	Evolution of Customers' Quality Expectations: Who Tends to be the Satisfied in The Long Run?
	Yaacov Ozinci, Yael Perlman, Sara Westreich	Different Channel and Product Preferences in a Supply Chain of Organic and Conventional Goods
	Konstantin Kogan, Fouad El Ouardighi	Production Learning and Forgetting Dynamics in a Competitive Environment
Supply Chain 2 Chair: Yael Deutsch Room: 201	Dina Smirnov, Assaf Avrahami, Yale T. Herer	The Two-Phase Multilocation Newsvendor Problem with a Joint Additional Replenishment
	Noam Goldberg, Tatyana Chernonog	Nonlinear Continuous and Mixed-Integer Programming Formulations for Constrained Multi-Item Newsvendor with Extensions For Display Capacity Constraints
	Nir Halman, Giacomo Nannicini	Fully Polynomial Time Approximation Schemes for the Continuous Nonlinear Newsvendor Problem
	Yael Deutsch, Oded Berman, Opher Baron	Service Network Design Under Congestion

PLENARY SESSIONS

Chair and opener: **Amir Beck** (Technion)

Speaker: **Yonina Eldar** (Technion)

PHASE RETRIEVAL AND ANALOG TO DIGITAL COMPRESSION

The problem of phase retrieval, namely – the recovery of a function given the magnitude of its Fourier transform - arises in various fields of science and engineering, including electron microscopy, crystallography, astronomy, and optical imaging. Due to the loss of Fourier phase information, this problem is generally ill-posed. In this talk we review several modern methods for treating the phase retrieval problem which are based on advanced optimization tools and statistical analysis. We then show how these concepts can be used to tackle a very different set of nonlinear problems: low-rate analog to digital conversion without assuming any structure on the signal being sampled. This is possible by careful design of the measurement scheme, together with advanced nonlinear recovery methods. We end by demonstrating our sub-Nyquist methods via several prototypes developed in our lab for cognitive radio and ultrasound imaging.

Chair and opener: **Uri Yechiali** (Tel Aviv University)

Speaker: **Ehud Lehrer** (Tel Aviv University)

REWARD SCHEMES: DESIGNING STRATEGIC COMPETITION IN FINANCIAL MARKETS

An investor has some funds invested through portfolio managers. By the end of the year, she reallocates the funds among these managers according to the managers' performance. While the investor tries to maximize her subjective utility (that depends on the total expected earnings), each portfolio manager tries to maximize the overall amount of funds bestowed in his hands to manage. A reward scheme is a rule that determines how funds should be allocated among the managers based on their performance. A reward scheme is optimal if it induces the (self-interested) managers to act in accordance with the interests of the investor. We show that an optimal reward scheme exists under quite general conditions.

We also design incentives schemes for portfolio managers that filter out suboptimal portfolio managers: only the best portfolio managers, in terms of expected payoffs, agree to participate in the single period investment. The results hold in general financial markets, where uninformed investors face managers of different capabilities, and can only observe their one shot realized returns. Policy implications are derived accordingly.

Chair and opener: **Michal Tzur** (Tel Aviv University)

Speaker: **Aharon Ben-Tal** (Technion)

SOME HIGHLIGHTS OF MY LIFETIME (SO FAR…) AS AN OPTIMIZER

Chair and opener: **Yael Perlman** (Bar Ilan University)

Speaker: **David Simchi-Levi** (MIT)

DATA-DRIVEN RESEARCH IN REVENUE MANAGEMENT

In a dynamic pricing problem where the demand function is unknown a priori, price experimentation or product bundling can be used for demand learning. In practice, however, online sellers are faced with a few business constraints, including the inability to conduct extensive experimentation, limited inventory and high demand uncertainty.

Collaborating with Groupon, we developed a dynamic pricing model where the demand function is unknown but belongs to a known finite set. The data suggested that we can approximate the true demand function by a collection of linear demand functions. Groupon allows for a limited number of price changes during the selling season and the objective is to minimize the regret, i.e. the expected total revenue loss compared to a clairvoyant who knows the demand distribution in advance. We demonstrate a pricing policy that incurs the smallest possible regret, up to a constant factor. Implementation of our algorithm at Groupon shows significant impact on revenue and market share.

In the second part of the presentation we extend the model to a network revenue management problem where an online retailer aims to maximize revenue from multiple products with limited inventory. This model is motivated by collaboration with retailer Rue La La where the retailer does not know the expected demand at each price point and must learn the demand information from sales data. We propose an efficient and effective dynamic pricing algorithm, which builds upon the Thompson sampling algorithm used for multi-armed bandit problems by incorporating inventory constraints into the pricing decisions. The algorithm proves to have both strong theoretical performance guarantees as well as promising numerical performance results when compared to other algorithms developed for the same setting.

In the last part, we are motivated by a new checkout recommendation system at Walmart's online grocery, which offers a customer an assortment of up to 8 items that can be added to an existing order, at potentially discounted prices. We formalize this as an online assortment planning problem under limited inventory, with customer types defined by the items initially selected in the order. We present an algorithm with bounded competitive ratio when the arrival sequence is chosen adversarially. This algorithm outperforms existing benchmarks.

Throughout the presentation, I will spend time characterizing exactly what I mean by data driven research, why it is relevant today more than ever before, and why it provides new opportunities for more creativity and a bigger and sometimes surprising impact on the organization. As you will see, this line of research can be quite different from what some in our profession refer to as empirical research.

Chair and opener: **Konstantin Kogan** (Bar Ilan University)

Speaker: **Jacek Blazewicz** (Poznan University of Technology)

ORIGINS OF LIFE: HOW CAN OR HELP TO UNDERSTAND THEM?

One of the most recognized hypotheses for the origins of life is the RNA world hypothesis. Laboratory experiments have been conducted to prove some assumptions of that hypothesis.
However, despite some successes in the "wetlab" experiments, we are still far from a complete explanation. Bioinformatics, supported by operations research, appears to provide perfect tools to model and test various scenarios of the origins life where wetlab experiments cannot reflect the true complexity of the problem.
Bioinformatics simulations of early preliving systems may give us clues to the mechanisms of evolution. Whether or not this approach succeeds is still an open question.
However, it seems likely that linking efforts and knowledge from the various fields of science into a holistic perspective gives the opportunity to come one step closer to a solution to this question, which is one of the greatest mysteries of humanity.
This paper illustrates some recent advancements in that area and points out possible directions for further research.

TUTORIALS

Chair and opener: **Noam Goldberg** (Bar Ilan University)

Speaker: **Shoshana Anily** (Tel Aviv University)

COOPERATIVE GAMES: THEORY AND APPLICATIONS IN OPERATIONS MANAGEMENT

This tutorial presents the main principles of cooperative games with transferable utility that are applicable in bargaining and negotiations within a supply chain, where the goal is to ensure the stability of the chain through a fair cost/profit allocation among its parties. The two main stability solution concepts that are useful in operations management are the core and the Shapley value. We will present the main known sufficient conditions for non-emptiness of the core, as well as a new condition that deals with centralizing aggregation games that we have recently proved. Concave games are well-known to have nonempty cores. Nevertheless, we present some games in queueing, scheduling, and production that are non-concave but still they have nonempty cores. This is done by reducing them to either market games or to centralizing aggregation games.

Chair and opener: **Yigal Gerchak** (Tel Aviv University)

Speaker: **Tamer Boyaci** (ESMT Berlin)

RATIONAL INATTENTION TO CHOICE AND IMPLICATIONS ON FIRM DECISIONS

Facing an abundance of product choices and related information, but with only limited time and attention to evaluate them, consumers have to come to grips with how much and what type of information to pay attention to (and what to ignore), and make choices and decisions based on this partial information. Evidently, it is often times easier to obtain information about some products than others, and there may be similarities among products such that as the customer learns about a particular product, he/she may do so about another one.

In this talk, we introduce rational inattention theory from the economics, which is increasingly utilized to analyze the trade-offs customers face in obtaining better information with the time and hence cost associated with it. Based on this theory, we present a general characterization of optimal choice behavior of customers who acquire information about available options with ex-ante uncertain values through potentially different channels with different costs. Some special cases of this model will be analyzed to illustrate key properties. We then turn our attention to the applications of this choice model to business operations. We take a look at assortment decisions of a seller as well as pricing decisions, demonstrating the implications of salient factors such as limited attention, cost of information, and correlations among products. Finally, we show how limited time and attention shapes the learning behavior of the seller and its ordering strategies in a newsvendor setting.

Chair and opener: **Gur Mosheiov** (The Hebrew University)

Speaker: **Dvir Shabtay** (Ben Gurion University)

ON THE PARAMETERIZED TRACTABILITY OF MACHINE SCHEDULING PROBLEMS

Parameterized complexity facilitates the analysis of computational problems in terms of various instance parameters that may be independent of the total input length. This area has enjoyed tremendous success since its first developments in the early 90s, contributing many new techniques to the area of algorithmic design. However, one field that has been very much neglected by the researchers in the parameterized complexity community is the area of scheduling. This is rather disappointing considering that (i) scheduling is one of the most classical areas of combinatorial optimization, with several important problems that direct real life applications, and that (ii) typical scheduling problems have many natural parameters associated with them that can be relatively small in practice compared to the total instance length. Our goal is to bridge this gap by analyzing various scheduling problems through the parameterized complexity lens by consider common scheduling parameters such as the number of different processing times, due-dates, and weights.

Chair and opener: **Ella Segev** (Ben-Gurion University)

Speaker: **Atalay Atasu** (Georgia Tech)

OPERATIONAL PERSPECTIVES ON ENVIRONMENTAL REGULATION

In this semi plenary talk, I will share a perspective on how operations research can contribute to environmental policy making. More specifically, I'll talk about my experience with takeback regulation (e.g., the Waste Electrical and Electronic Equipment (WEEE) Directive of the European Commission and similar laws in other parts of the world) to demonstrate how some fundamental operational tradeoffs drive the economic and effectiveness of such policy implementations. I will then introduce the results of some of my recent research collaborations to demonstrate how traditional operations research and game theoretic models can be leveraged to address those tradeoffs and contribute to effective environmental policy design.

BOOK OF ABSTRACTS (GROUPED BY SESSIONS)

SUNDAY – 21.5

SESSION S1

DECISION ANALYSIS Chair: Michael Masin

- OPERATIONAL DILEMMAS UPON SERVER FAILURES ON THE CLOUD

Nadav Lavi, Hanoch Levy

Abstract

Cloud computing reliability is an acute problem for the Cloud Computing Centers (CCC) operator. Although cloud computing is perceived as a reliable always on service, behind the scenes tens of thousands of general computing platforms, i.e., servers, operate under continuous load. These servers may fail due to either a component failure, or due to a software glitch. With the large number of servers and components in CCC, failure probability has significant impact on system performance. Such failures derive additional complexity on the CCC task management mechanism, as it is now required to handle both admission of new tasks and preservation of existing tasks that their servers failed.

The operational dilemmas of admission and preservation seem to be strongly coupled. If a new task is admitted and served by an available idle server, then that server cannot be used for preserving existing tasks in the event their server fails. Similarly, if a task is preserved upon the failure of its server, which requires the allocation of an idle server, then the idle server cannot be held for new arrivals. The admission and preservation decisions of the task management are not trivial, and require consideration of the system settings as well as future projections of the system behavior and the interplay between them. Thus, the CCC task management faces a tradeoff between admitting new tasks (which will be beneficial in the immediate future) versus keeping certain number of servers idle for future failures (which will be beneficial in the long run).

In this paper we construct a new modeling framework which provides a holistic optimization scheme for the combined problems of new task admission and existing task preservation. We base our model on a queuing-loss multi-server system with failures and address the optimal operation of the CCC. We formulate a cost minimization problem, based on a reward and cost model. Based on this formulation, we evaluate the optimal policy of the combined admission/rejection and preservation/dropping decisions using a Markov Decision Process (MDP). For the problem composition as an MDP, we construct and analyze a new operator: the preservation operator. Our analysis reveals that despite the complexity of the system, the problem simplifies as the decision rules can be decoupled. We first show that the optimal admission and preservation rules are based on a double switching-curve. We then prove that, unexpectedly, the two rules can be effectively be decoupled. That is, we show that the problem can be reduced to a set of problems, in each of which one rule is of a switching-curve type and the other rule takes the trivial form.

The outcome of our analysis enables us to derive a simple policy based on the system cost-structure, which simplifies the CCC management. This is due to the fact that task management is now based only on a single rule. Hence, our scheme significantly simplifies the task management operation as it eliminates the need for complex real-time mechanisms.

- PARTNERSHIP'S PROFIT SHARING: A PRINCIPAL-AGENT APPROACH
  Eugene Khmelnitsky, Yigal Gerchak

Abstract

Suppose that one party proposes to another a contract for sharing an uncertain profit which maximizes the former's expected utility, with respect to its beliefs, subject to a constraint on the latter's expected utility, with respect to the latter's beliefs. It turns out that the optimal contract, which we find, can be non-monotone, as well as non-linear, in the realized profit. To avoid the implausible lack of monotonicity, we formulate and solve a model constrained to have monotone increasing profits for both partners. If beliefs are identical, the (unconstrained) contract is shown to be monotone, and under certain conditions, linear. That might explain one famous contract from the history of jazz. If the other party can be assumed risk neutral, the linear contract reduces to the former receiving a constant amount, and the latter the residual net profit, as in the case of another famous contract from the history of jazz. Since in the type of partnerships we have in mind the partners are always motivated to exert high effort due to other factors like reputation, our setting has no moral hazard or adverse selection, and the partnerships do not involve a large initial investment.

- FINDING PREFERABLE PARETO-EFFICIENT SOLUTIONS WITHOUT INTERROGATING DECISION MAKERS
  Michael Masin, Rotem Dror, Amir Kantor, Segev Shlomov

Abstract

Multi-objective optimization is concerned with optimization problems involving more than one objective function to be optimized simultaneously. Usually, there is no a single solution that simultaneously optimizes all the objectives; rather, one may find a set of Pareto-efficient solutions, called the Pareto frontier. Decision makers, as well as certain algorithms, often need to find preferable solution(s) from the frontier. In the context of evolutionary multi-objective algorithms, this is tightly related to the fitness of various solutions.

In this paper, we introduce a probabilistic model and algorithms for finding a small number of preferable options from the Pareto frontier, based upon its mathematical structure. This can be done with no prior knowledge of the decision maker's preferences, and yet our model also equally supports incorporating aggregate or approximate knowledge of decision makers' preferences to obtain more targeted solutions. We present several related methods that belong to the class of stochastic multi-criteria acceptability analysis (SMAA) methods, and which are collectively referred to as **Set-SMAA**. Some of these have been recently implemented in a decision support tool by IBM.

SESSION S1

GAME THEORY 1 Chair: Igal Milchtaich

- INCOMPLETE INFORMATION GAMES WITH AMBIGUITY AVERSE PLAYERS
  Eran Hanany, Peter Klibanoff, Sujoy Mukerji

Abstract

We study incomplete information games of perfect recall involving players who perceive ambiguity about the types of others and may be ambiguity averse as modeled through smooth ambiguity preferences (Klibanoff, Marinacci and Mukerji, 2005). Our focus is on equilibrium concepts satisfying sequential optimality -- each player's strategy must be optimal at each stage given the strategies of the other players and the player's conditional beliefs. We show that for the purpose of identifying strategy profiles that are part of a sequential optimum, it is

without loss of generality to restrict attention to beliefs generated using a particular generalization of Bayesian updating. We also propose and analyze strengthenings of sequential optimality. Comparative statics in ambiguity aversion are provided, and we show that robustness to increases in ambiguity aversion implies a type of belief robustness. Examples illustrate new strategic behavior that can arise under ambiguity aversion. Our concepts and framework are also suitable for examining the strategic use of ambiguity.

- SOCIAL LEARNING AND THE SHADOW OF THE PAST

Yuval Heller, Erik Mohlin

Abstract

In many environments new agents learn from the experience of others. Specifically, new agents base their decisions, at least in part, on the observed past behavior of a few other agents. In this paper we analyze a broad kind of social learning processes, and study in which environments the initial behavior in the distant past has substantial influence on the behavior today. Our main result shows that population converge to the same behavior regardless of initial state, provided that the expected number of actions observed by each new agents is less than one. Moreover, in any environment in which the expected number of observed actions is more than one, there is a learning rule for which the initial states has long impact on future's behavior. Next, we present a tighter bound that also considers the responsiveness of new agents to the observed actions. Finally, we apply our results also to non-stationary learning processes.

- INTERNALIZATION OF SOCIAL COST IN CONGESTION GAMES

Igal Milchtaich

Abstract

Congestion models may be studied from either the users' point of view or the social one. The first perspective examines the incentives of individual users, who are only interested in their own, personal payoff or cost and ignore the negative externalities that their choice of resources creates for the other users. The second perspective concerns social goals such as the minimization of the mean travel time in a transportation network. This paper studies a more general setting in which individual users attach to the social cost some weight r that is not necessarily 1 or 0, and may also be negative. It examines the comparative-statics question of whether higher r necessarily means higher social welfare at equilibrium.

SESSION S1

TRANSPORTATION & LOGISTICS 1 Chair: Tal Raviv

- A NOVEL FORMULATION AND A SOLUTION PROCEDURE FOR A RICH HUMANITARIAN LOGISTIC PROBLEM

Ohad Eisenhandler, Michal Tzur

Abstract

We address a problem which is inspired by the logistic challenges of food banks in Israel and in the US. The food bank determines a vehicle route in order to collect products from suppliers in the food industry and deliver them to welfare agencies, and simultaneously sets allocation quantities so as to balance considerations of effectiveness and equity. Previous work has focused on modeling a suitable objective function so that the problem can be formulated as a MILP, and on developing an LNS metaheuristic based on the special structure of a sub-problem.

In this work, we further exploit this structure to present a new mathematical formulation of the problem. We substitute the "classical" site-based routing decisions variables, i.e., whether the vehicle should proceed from a certain site to another, with new variables which indicate whether the vehicle should proceed from a certain sequence of sites to another. These sequences are defined in a way that guarantees that the allocation decision which they dictate, can be made independently of the other sequences that are chosen in the solution. We believe that this novel approach, which has not been used previously in the literature, to the best of our knowledge, has two main advantages: (1) It provides a tighter bound compared to the site-based formulation used in previous work; (2) It gives rise to a new solution methodology for the problem. Numerical experiments to assess the performance of these methods are currently underway.

- ENUMERATING MINIMUM PATH DECOMPOSITIONS TO SUPPORT ROUTE CHOICE SET GENERATION

Irith Ben-Arroyo Hartman, Luk Knapen, Tom Bellemans

Abstract

This paper concerns the structure of movements as were recorded by GPS traces and converted to routes by map matching. Each route in a transportation network corresponds to a collection of directed paths or cycles in a digraph. When considering only directed paths, corresponding to utilitarian trips, the path is not necessarily a shortest path between its origin and destination, and can be split up into a small number of segments, each of which is a shortest or least cost path. Two consecutive segments are separated by split vertices. Split vertices act as intermediate destinations in the mind of travellers who try to hop between them using minimum cost paths. Hence they provide useful information to build route choice models.

In this paper we identify and enumerate all possible decompositions of a path into a minimum number of shortest segments. This gives us an indication of the importance of split vertices occurring in particular sets of revealed routes that belong either to a single traveller or to a specific group. The proposed technique allows for automatic extraction of frequently used intermediate destinations (way-points) from revealed preference data.

Finding and enumerating all possible decompositions of a path into a minimum number of shortest subpaths relates to the problem of finding some minimum clique covers in a proper interval graph. We give an efficient way of enumerating all minimum decompositions.

- THE STOCHASTIC TIME-DEPENDENT ORIENTEERING PROBLEM WITH SOFT TIME WINDOWS

Avraham Edison, Tal Raviv

Abstract

We consider the stochastic time-dependent orienteering problem with soft time windows. The problem consists of a single vehicle that wishes to maximize its net profit during a single working day. For this end, the vehicle may or may not serve any customer belonging to the set of N relevant customers. Each customer is characterized by a reward, a soft time window for service beginning and delay penalty function. That is, arriving at a customer after the end of the time window incurs a penalty which is determined by the extent of the delay. If the customer is skipped, the reward is not collected.

The problem is motivated by recent development in the domain of mobile computing and location aware applications. This technology allows collecting much more accurate data that is needed to estimate the time-dependent distribution of travel times.

Both the travel time and service time are stochastic and drawn from a general joint distribution. In addition, the distribution of the travel time between each pair of locations is time dependent. The goal is to select a subset of

the customers and a sequence to visit them so as to maximize the total reward net of the expected penalty for the vehicle.

The stochasticity of the travel and service times is modeled using a set of scenarios of a single working day. Such scenarios can capture the intricate dependencies between the various parameters of the problem.

A Branch-and-Bound algorithm, as well as a Tabu-Search heuristic, are devised to solve the problem. Numerical experiments show that the Tabu-Search heuristic can obtain effective solutions to instances with up to 15 customers in reasonable time.

SESSION S2

ClickSoftware CHALLENGE

- In this session we announce the winners of ORSIS-ClickSoftware (OC) 2017 challenge, designed to strengthen ties between industry and academia in the field of Operations Research. The winning team(s) will present their results.

SESSION S2

OPTIMIZATION & DATA Chair: Zilla Sinuani-Stern

- INTEGER PROGRAMMING FORMULATIONS FOR THE FIXED ROUTE DIAL-A-RIDE PROBLEM(FRDARP)

Oksana Svinik, Hagai Ilani, Elad Shufan, Tal Grinshpoun, Hillel Bar-Gera

Abstract

The dial-a-ride problem (DARP) is a demand responsive transportation solution in which passengers' requests for traveling are known in advance and the vehicles' routes and schedules are built accordingly. DARP in general is an NP-hard optimization problem. Recently, a DARP model with fixed routes was introduced and shown to be polynomially solvable, yet with a high degree polynomial. In the present research we introduce two binary Linear Programming formulations for the FRDARP. The first is a simple 1-index formulation with exponential number of variables. This formulation is served as a master problem for the Column Generation technique. The second formulation is a more complicated 3-index formulation but with a polynomial number of variables and constraints. The model was tested with CPLEX for instances with up to 1000 passengers and was solved to optimality in a few seconds.

- A COMBINATORIAL APPROACH FOR OPTIMAL SENSOR SELECTION

Yifat Douek Pinkovich, Tal Raviv, Irad Ben-Gal

Abstract

In complex systems such as cars, aircraft, and even smart cities, it is possible to install a large number of sensors that can be used to monitor their state and make decisions about their operation and maintenance. Similar optimization problems are encountered in other situations, for example when constructing a panel of medical tests. However, since the sensors bear their costs and increase the complexity of the system, it is desirable to select the cheapest set of sensors that is sufficient to provide an accurate and reliable information. Since the number of possible configurations grows exponentially with the number of potential sensors, the designers of these systems may benefit from a robust model and methodology to select sensors.

We formulate the optimal sensor selection problem as an integer linear program and prove that the problem is strongly NP-Hard and APX-Complete. Then, we present an effective solution method that is based uses the special structure of the problem to reduce the dimension of the integer program significantly. The applicability of this

solution method and superiority over commercial integer programming solver is demonstrated via an extensive numerical experiment.

Finally, we demonstrate, using widely used test datasets, how the method can be used as an effective feature selection method that works well with various classification techniques. To the best of our knowledge, this the first effective feature selection method that is based on exact combinatorial optimization algorithms.

- SECOND STAGE STATISTICAL ANALYSIS IN THE DEA CONTEXT AND STOCHASTIC DEA

Zilla Sinuani-Stern, Lea Friedman

Abstract

This paper deals with Data Envelopment Analysis (DEA), where we have several organizational units or Decision Making Units (DMUs). Each DMU has data regarding its performance consisted of the same type of multiple inputs and the type of multiple outputs. DEA is based on the ratio between the sum of the weighted output and the sum of the weighted inputs, where the weights of the inputs and the outputs are not given. DEA calculates the relative efficiencies of DMUs via ratio optimization problems which are formulated as linear programming problems. Various versions of DEA were developed over the years.

Although DEA is a deterministic model, during the last two decades statistical methods are used in conjunction with DEA in three main dimensions: 1. In preparing the input and output data and DMUs, 2. As a stochastic alternative method to derive DMUs efficiencies, 3. As a second stage after the efficiencies are derived to test the relationship between the efficiency and various environmental parameters. Our paper explores the use of the various statistical methods in the DEA context covering these three main dimensions. Examples from the literature, using various statistical methods in the DEA context, will be presented along the above three dimensions.

We do not attempt to cover all DEA versions available in the literature. However, our examples cover a wide spectrum of DEA models as follows: DEA under constant return to scale (CRS) assumption, DEA under variable return to scale (VRS) assumption, input-oriented DEA, output-oriented DEA, non-oriented (additive) DEA, cross-efficiency, Malmquist, Window analysis, and bootstrap stochastic DEA.

We also cover a wide spectrum of statistical models. The major statistical methods we present are: comparisons including parametric and non-parametric tests, correlation and regression, analyses of variance, and multivariate analyses including: discriminant analysis, clustering, canonical correlation, and principle components analysis.

To show the richness of the applications applying various combinations of the deterministic DEA and the statistical methods we covered the following types of applications evaluating the performance of variety types of DMUs as follows: school programs sate-wide, academic departments within a university, cities nation-wide, industrial branches nation-wide, postal services branches, international airline networks, hospitals nation-wide, specific hospital ward nation-wide, specific orthopedic operation nation-wide, operation rooms within a specific hospital, juvenile delinquency programs, Social service, police stations nation-wide, electric companies in various countries, accident prevention program by municipality nation-wide. Evidently, most of the examples are in the public sector and non-profit organizations.

The examples we covered from the literature were applied worldwide. Obviously, most of the applications we chose are in Israel. However, we also present examples from other countries: USA, EU, UK, China, Japan, Turkey, Taiwan, and Spain.

SESSION S2

GAME THEORY 2 Chair: Arieh Gavious

- ON THE IMPACT OF REWARDING REPENTANCE

Gail-Gilboa Freedman, Ido Erev, Yefim Roth

Abstract

The Research Problem: Our study takes the point of view of a leader whose followers can choose between behaviors that the leader classify as "Good" or "Bad." The leader considers the option of rewarding agents that move from Bad to Good. The influence of such a "Repentance-Rewarding-Policy" is two-sided as it motivates "sinners" to repent but it can also motivate non-sinners to sin, because of the possibility to repent.

The Model: We describe the problem as a sequential Principal Agent game. Principal chooses a policy first. Her policy implies the magnitude of a reward to repentance: Rep-Reward. We analyze the effectiveness of choosing a strictly positive Rep-Reward in two threads—considering deterministic or stochastic versions of the game.

In the stochastic version, we add an assumption that the choice of "not good" strategies (Bad and Repentance) is risky, involving some small probability p for a very large loss. For example, p can represent the probability of being killed if you join a terror organization. Analytic result: Analysis of the behavior of agents that rely on small samples of experiences suggests that the Repentance-Rewarding-Policy can be highly effective.

Experimental study: We conduct an experimental study to evaluate the hypothesis that Repentance-Rewarding-Policy is highly effective. Methods: The participants are 60 undergraduate students who responded to ads for participation in a decision-making experiment in a computer lab at the Technion. The experiment examines behavior in two realizations of the Stochastic Game, differing by their Rep-Reward levels: $\Delta = 0$, and $\Delta = 1$. The experiment uses two steps, two buttons clicking a paradigm to study the effect of 200 trials of repeated experience in this game. At the first step of each trial, the choice of the right button (button_1) will force the subject to choose Good (button_C) at the second step; while the choice of the left button (button_2) will lead the subject to choose between a button that represents Bad (button_A) and a button that represents Repentance (button_B). Participants get no description of the payoff rule. Rather, they are told that the experiment includes many trials, and their task is to select between the buttons in each trial. They base their decisions on the complete feedback at the end of each trial. Feedback includes the obtained payoff (from the selected buttons) and the forgone payoffs (from the unselected buttons). Results: Our study support the prediction of our model, demonstrating that positive Rep-Reward significantly increases the principal's expected payoff:

Conclusions: When Bad and Repentance choices are risky, the range of situations where rewarding repentance is effective is broader than expectation under assumption of rational agents. Our results suggest that the impact of forgiveness in these settings is likely to depend on the process that led to the problematic reckless behavior. Forgiveness is likely to be particularly effective in stochastic settings when the reckless behavior is likely to be a reflection of reliance on small samples.

- STRATEGIC SIGNALING AND FREE INFORMATION DISCLOSURE IN AUCTIONS

Shani Alkoby, David Sarne, Igal Milchtaich

Abstract

With the increasing interest in the role information providers play in multi-agent systems, much effort has been dedicated to analyzing strategic information disclosure and signaling by such agents. This paper analyzes the problem in the context of auctions (specifically for second-price auctions). It provides an equilibrium analysis to the case where the information provider can use signaling according to some pre-committed scheme before

introducing its regular (costly) information selling offering. The signal provided, publicly discloses (for free) some of the information held by the information provider. Providing the signaling is thus somehow counter intuitive as the information provider ultimately attempts to maximize her gain from selling the information she holds. Still, we show that such signaling capability can be highly beneficial for the information provider and even improve social welfare. Furthermore, the examples provided demonstrate various possible other beneficial behaviors available to the different players as well as to a market designer, such as paying the information provider to leave the system or commit to a specific signaling scheme. Finally, the paper provides an extension of the underlying model, related to the use of mixed signaling strategies.

- A GAME BETWEEN A TERRORIST AND A PASSIVE DEFENDER

Arieh Gavious, Oded Berman, Opher Baron

Abstract

In the last two decades, terrorism has become a major issue around the world. We analyze a continuous conflict between a terrorist (Terrorist) and a passive defender (Defender). Defender is passive as her actions can only influence the costs (damages) when Terrorist attacks. We focus on the conflict between Israel and the various terrorist groups in the Gaza Strip in accordance with scientific principles. We first consider three sources of data on the conflict and based on these data we make several observations on the sustainability of cease fires, the use of technologies, different attacks and the level of violence. Trying to explain these observations, we present several simple game theoretical models. Specifically, we consider single and multi-period games. In each period, Terrorist may attack Defender who may try to prevent damage. We show that given this conflict's political situation our models are in agreement with the observations from the data.

We also present extensions that consider: a defender with intelligence on the actions of the terrorist, an active defender, and a terrorist that learns from his past performance. These extensions further agree with the observations from the data.

SESSION S3

STOCHASTIC PROCESSES Chair: Yair Shaki

- THE FRACTIONAL POISSON PROCESS AND MARTINGALES

Ely Merzbach, G. Aletti, N. Leonenko

Abstract

We present new properties for the Fractional Poisson process and the Fractional Poisson field on the plane. A martingale characterization for Fractional Poisson processes is given. We extend this result to Fractional Poisson fields, obtaining some other characterizations. The fractional differential equations are studied.

- PARKING LOT AS SERVICE SYSTEM AND THE DOUBLE PARKING PROBLEM

Yair Shaki, Avidan Rebibo, Tegegne Bazezew

Abstract

In this work, we study the double parking problem as service system with a customer who uses by two servers. We present the birth-death equations of this system. This system is two-dimensional Markov process. We use a Generating Function approach, in order to solve these equations.

SESSION S3

PRIZE SESSION Chair: Michal Tzur

- VACCINATION STRATEGIES AGAINST RESPIRATORY SYNCYTIAL VIRUS

Dan Yamin to present the Rothblum Prize winning work

Additional authors: Forrest K. Jones , John P. De Vincenzo, Shai Gertler, Oren Kobiler, Jeffrey P. Townsend, Alison P. Galvani

Abstract

Respiratory syncytial virus (RSV) is the most common cause of US infant hospitalization. Additionally, RSV is responsible for 10,000 deaths annually among the elderly across the United States, and accounts for nearly as many hospitalizations as influenza. Currently, several RSV vaccine candidates are under development to target different age groups. To evaluate the potential effectiveness of age-specific vaccination strategies in averting RSV incidence, we developed a transmission model that integrates data on daily infectious viral load and changes of behavior associated with RSV symptoms. Calibrating to RSV weekly incidence rates in Texas, California, Colorado, and Pennsylvania, we show that in all states considered, an infected child under 5 y of age is more than twice as likely as a person over 50 y of age to transmit the virus. Geographic variability in the effectiveness of a vaccination program across states arises from interplay between seasonality patterns, population demography, vaccination uptake, and vaccine mechanism of action. Regardless of these variabilities, our analysis showed that allocating vaccine to children under 5 y of age would be the most efficient strategy per dose to avert RSV in both children and adults. Furthermore, due to substantial indirect protection, the targeting of children is even predicted to reduce RSV in the elderly more than directly vaccinating the elderly themselves. Our results can help inform ongoing clinical trials and future recommendations on RSV vaccination.

- STRATEGIC BEHAVIOR IN QUEUES

Binyamin Oz to present the Mehrez Prize winning work

Abstract

In this talk, I will present my PhD dissertation supervised by Prof. Moshe Haviv. I will briefly present the first two chapters entitled “Regulation of queues” and Optimization of a network of parallel queues with strategic routing”. Special attention will be given to the third chapter entitled “State-dependent queues”, co-authored with Ivo Adan. In this chapter, we develop a novel method based on rate conservation argument and exemplify its use in the analysis of non-memoryless queues with state dependent arrival and service processes. Such models typically arise when considering strategic joining to observable non-memoryless queues. I will describe the method, named Rate Balance Principle (RBP), and will use it to derive well-known as well as new results for the G/M/1, G/Mn/1, and $Mn/G_n/1$ models. More examples including batch arrivals and server vacations will be presented if time permits.

SESSION S3

TRANSPORTATION & LOGISTICS 2 Chair: Tal Raviv

- APPRAISAL OF OPTIMIZATION METHODS FOR THE TRANSIT NETWORK DESIGN PROBLEM

Nurit Oliker, Shlomo Bekhor

Abstract

The transit network design problem (TRNDP) is to find the best transit network for a given infrastructure network topology and fixed public transport demand represented by an origin-destination matrix. Most models for the TRNDP formulates the decision variables as the routes and corresponding frequencies, while optimizing some system measure as the total travel time or system cost. Common constrains are minimal frequency, route's minimal and maximal length, fleet size and vehicle capacity.

The TRNDP has a bi-level structure; the upper problem includes the network design (i.e., a set of routes and frequencies), and the lower problem includes the transit assignment (i.e., mapping the demand on the suggested transit network). The design problem includes the generation of candidate routes. Due to the complexity of the problem, route generation is commonly conducted as a preliminary step of the optimization, producing a large candidate route set.

Two elements of the TRNDP were investigated so far: route set generation and transit assignment. The presented study aims on integrating the previously developed route set generation and assignment models, into a complete transit network design model. As a first step of the design modelling we are assessing the suitability of several metaheuristic optimization methods for the TRNDP. The methods are applied on an example network and their results are compared.

- SHARE A RIDE TO THE TRAIN STATION USING A DEMAND-RESPONSIVE FEEDER SERVICE

Shlomo Beychok, Hillel Bar-Gera, Tal Raviv, Gad Rabinowitz

Abstract

Demand Responsive Transit (DRT) is a form of flexible public transportation in which the routes and schedules are determined per ride, based on the needs of passengers. Different forms of the DRT concept have been in use throughout the last few decades. Nevertheless, modern technology is gradually making it a more viable solution by easily allowing users to input the origin and destination of the trip, and their required departure or arrival time. Using the collected data, the system can coordinate the optimal combination of routes that best satisfies the needs of the users within the given constraints.

Rail networks provide fast and frequent service that covers long distances, bringing passengers from one point to another efficiently. However, they do not offer a complete solution that includes first and last mile connectivity. Many train stations, located on the outskirts of cities and in rural areas, are not easily accessible by public transport, leading many passengers to prefer traveling to the station using their car. As a result, parking lots at the stations tend to quickly reach their maximum capacity and cannot fully support the demand.

We propose a DRT system that serves as a feeder service for train stations. An optimization model is introduced to evaluate the proposed service's effectiveness and characteristics. The model takes into account various parameters such as expected ridership, the size and capacity of the fleet, required time window for pickup and the geography of the road network. The objective is to minimize overall travel time of all vehicles, while reducing passenger waiting and travel times, fuel consumption and pollution, traffic and parking costs.

An automated platform has been developed to enable large-scale experimentation. Experiments were designed using actual survey data collected at train stations. Passengers were divided into groups according to the train

schedule, while each instance included the number of requests for service and the location for each pickup. The experiments were then executed and their results were assembled and analyzed.

The described model and platform can be used to assess the feasibility and advisability of establishing the proposed service at specific train stations. Once such a service is established and has proved itself, it can be expanded to include additional applications with similar features such as educational institutions, industrial parks, and commercial and recreational centers. In the longer term, it can become a standard and widespread method of transportation within a metropolitan area and its surrounding suburbs.

- AN APPROACH TO TRANSPORTATION NETWORK ANALYSIS VIA TRANSFERABLE UTILITY GAMES

Yuval Hadas, Giorgio Gnecco, Marcello Sanguineti

Abstract

Network connectivity is an important aspect of any transportation network, as the role of the network is to provide a society with the ability to easily travel from point to point using various nodes. A basic question in network analysis concerns how "important" each node is. An important node might, for example, greatly contribute to short connections between many pairs of nodes, handle a large amount of the traffic, generate relevant information, represent a bridge between two areas, etc. In order to quantify the relative importance of nodes, one possible approach uses the concept of centrality. A limitation of classical centrality measures is the fact that they evaluate nodes based on their individual contributions to the functioning of the network. In the present paper a game theory approach is introduced, based on cooperative games with transferable utility. Given a transportation network, a game is defined taking into account the network topology, the weights associated with the arcs, and the demand based on an origin-destination matrix (weights associated with nodes). The nodes of the network represent the players in such a game. The Shapley value, which measures the relative importance of the players in transferable utility games, is used to identify the nodes that have a major role. For several network topologies, a comparison is made with well-known centrality measures. The results show that the suggested centrality measures outperform the classical ones, and provide an innovative approach for transportation networks analysis.

SESSION S3

GROUP DECISIONS AND GAMES Chair: Ella Segev

- SHARING THE GAINS OF RISK REDUCTION DUE TO COOPERATION

Tzvi Alon, Moshe Haviv

Abstract

Consider a set of players $N = \{1, \dots, n\}$. Suppose that each player i holds a random variable θ_i and a number x_i such that the player's debt is $x_i\theta_i$. When a coalition S forms, its members reallocate the overall debt in order to minimize the risk, i.e. minimize the standard deviation of $\sum_{i\in S} z_i\theta_i$ over the vectors z that satisfies $\sum_{i\in S} z_i = \sum_{i\in S} x_i$. By solving this optimization problem, we define a cooperative game that can be applicable in various fields, among them inventory management and short selling of shares. We deal with the case when the random variables are independent and when they are not.

We show some properties of the core, in particular we show that the core of the game, and the core of every sub-game, is not empty. In addition, we present the structure of the Shapley and Banzhaf value of this game.

- COMPARISON OF STRATEGIES OF ASSIGNING A PROJECT TO AGENTS WHEN ACTIVITIES CAN SUCCEED OR FAIL
  Yigal Gerchak, Christian Schmid

  Abstract
  We address the following question concerning R&D projects, consisting of multiple activities which can fail, but all need to succeed for the project to succeed. Under what conditions should each activity of the project be assigned to a different agent (which might be a team), rather than all activities to one agent, where in the latter case several (teams of) agents are working on the entire project in parallel, and it is sufficient if one of them succeeds? We consider the effect of advantageous specialization, of a deadline, and of heterogeneous activities.

- SOCIAL LEARNING AND THE DESIGN OF NEW EXPERIENCE GOODS
  Ella Segev, Pnina Feldman, Yiangos Papanastasiou

  Abstract
  Consumers often consult the reviews of their peers when deciding whether to purchase a new experience good; however, their initial quality expectations are typically set by the product's observable attributes. This paper focuses on the implications of social learning for a monopolist firm's choice of product design. In our model, the firm's design choice determines the product's ex ante expected quality, and designs associated with (stochastically) higher quality incur higher costs of production. Consumers are forward-looking social learners, and may choose to strategically delay their purchase in anticipation of product reviews. We demonstrate that the endogenous nature of social learning gives rise to a complex tradeoff between accelerating consumer learning (through a design of higher expected quality) and appropriating consumer learning (through a design of lower expected quality). We show that this tradeoff results in an interesting phenomenon: in the presence of SL, the firm opts for a design of lower expected quality. Moreover, we find that the relationship between social learning and product design holds significant implications for both firm profit and consumer surplus: contrary to conventional knowledge, we show that social learning can have a net negative impact on the firm's ex ante profit, in particular when the consumers are sufficiently forwardlooking; conversely, we establish that unless the consumers are sufficiently forward-looking, the net impact of social learning on the consumers' ex ante surplus cannot be positive.

MONDAY – 22.5

SESSION M1
STRATEGIC QUEUEING Chair: Liron Ravner

- SELF, SOCIAL AND MONOPOLY OPTIMIZATION IN QUEUES WITH GENERAL UTILITY FUNCTIONS
  Ran Snitkovsky, Refael Hassin

  Abstract
  Naor's celebrated paper studies customers' decisions in an observable M/M/1 queue when the utility is a linear function of queue length, and derives the optimal threshold strategies for the individuals, the social planner and monopoly. The optimal threshold imposed by a monopoly is not greater than the socially optimal threshold, which is not greater than the individual's threshold. Studies show that this triangular relation holds in a more general setup and extended non-linear utility functions. Many of these extensions share common features. We point out the features that imply the aforementioned result, and apply it to a new model motivated by order-driven markets. In the new model, customers choose between joining and balking when they might be forced to abandon the system before service completion, and their utility depends on the service completion probability, which is not linear in the observed queue size.

- SOME QUEUEING PARADOXES
  Moshe Haviv

  Abstract
  The talk will review three queueing paradoxes: Jevons' (where increasing efficiency leads to more work), Downs-Thomson's (where increasing capacity of service leads to more congestion) and the Breass' (where adding servers leads to all having to wait longer).

- PRICING STRATEGY, CAPACITY LEVEL AND COLLUSION IN A MARKET WITH DELAY SENSITIVITY
  Noam Shamir, Liron Ravner

  Abstract
  We study price collusion between two firms providing service to delay-sensitive customers. The framework is a discounted repeated game in which the firms set a price in every time period and the customers choose between the servers according to the announced prices. The public perfect equilibrium is fully characterized along with specific conditions for the minimal discount factor that enables collusion. The effect of service value on the firm's revenue and ability to collude is further analysed. In particular, we find that in some cases higher customer delay sensitivity (or lower service value) can lead to collusion and in turn to higher revenue for the firms.

- EQUILIBRIUM AND EFFICIENT CLUSTERING OF ARRIVAL TIMES TO A QUEUE
  Liron Ravner, Amihai Glazer, Refael Hassin

  Abstract
  We consider a game of decentralized timing of jobs to a single server (machine) with a penalty for deviation from some due date and no delay costs. The jobs sizes are homogeneous and deterministic. Each job belongs to a single decision maker, a customer, who aims to arrive at a time that minimizes his deviation penalty. If multiple customers arrive at the same time then their order is determined by a uniform random draw. If the cost function has a weighted absolute deviation form then any Nash equilibrium is pure and symmetric, that is, all customers arrive together. Furthermore, we show that there exist multiple, in fact a continuum, of equilibrium arrival times, and provide necessary and sufficient conditions for the socially optimal arrival time to be an equilibrium. The base model is solved explicitly, but the prevalence of a pure symmetric equilibrium is shown to be robust to several relaxations of the assumptions: inclusion of small waiting costs, stochastic job sizes, random sized population, heterogeneous due dates and non-linear deviation penalties.

SESSION M1

SCHEDULING Chair: Shlomo Karhi

- A NEW BOUND FOR A TIME-DEPENDENT SCHEDULING PROBLEM
  Stanislaw Gawiejnowicz, Wieslaw Kurc

  Abstract
  We consider an open time-dependent scheduling problem, in which a set of independent jobs has to be scheduled on a single machine. Job processing times are linear increasing functions of the job starting times. The aim is to find a schedule minimizing the total completion time. We lower the previous bound on the cardinality of the set containing all possible optimal schedules for this problem by a multiplicative factor proportional to the reciprocal of the square root of the number of jobs.

- BATCH SCHEDULING ON A FLOW-SHOP WITH UNIT TIME JOBS AND MACHINE-DEPENDENT SETUP TIMES
  Gur Mosheiov, Enrique (Tzvi) Gertsl

  Abstract
  We study a batch scheduling problem on an *m*-machine flow-shop. The objective function is makespan minimization. We consider: unit processing time jobs, batch availability and machine-dependent setup times. A dynamic programming algorithm which is polynomial in the number of jobs is introduced. For instances consisting of a large number of machines, an efficient heuristic is presented. The numerical results obtained by both the dynamic programming algorithm (running times) and the heuristic (optimality gaps) are reported.

  When integer batch sizes are not required, we identify the necessary conditions for the optimal schedule to consist of an arithmetic sequence of the batch sizes. A simple rounding procedure is introduced to convert this solution into a feasible integer solution.

- A TWO-AGENT SINGLE MACHINE SCHEDULING PROBLEM WITH DUE-WINDOW ASSIGNMENT AND A COMMON FLOW-ALLOWANCE

Baruch Mor, Gur Mosheiov

Abstract

We study a single-machine scheduling model combining two competing agents and due-date assignment. The basic setting involves two agents who need to process their own sets of jobs, and compete on the use of a common processor. Our goal is to find the joint schedule that minimizes the value of the objective function of one agent, subject to an upper bound on the value of the objective function of the second agent. The scheduling measure considered in this paper is minimum total (earliness, tardiness and due-date) cost, based on common flow allowance, i.e., due-dates are defined as linear functions of the job processing times. We introduce a simple polynomial time solution for this problem (linear in the number of jobs), as well as to its extension to a multi-agent setting. We further extend the model to that of a due-window assignment based on common flow allowance.

- NEW ALGORITHMS FOR MINIMIZING THE TOTAL WEIGHTED NUMBER OF TARDY JOBS ON A SINGLE MACHINE

Shlomo Karhi, Danny Hermelin, Dvir Shabtay

Abstract

Scheduling and parameterized complexity are two important fields that attract a lot of research by the combinatorial optimization community. Surpassingly, although the two steams are closely related, the analysis of scheduling problems form parameterized complexity perspective hardly exists. In this paper we study the parameterized tractability of the classical single machine scheduling problem with the objective of minimizing the weighted number of tardy jobs. Our analysis is restricted to three very natural parameters, which are the number of different due dates, processing times and weights. We show that the problem belongs to the class of fixed parameterized tractable (FPT) problems, when combining any two out of the three parameters. We also show that the problem is W[1]-hard with respect to the number of different due dates, and belongs to the XP class with respect to each of the two other parameters. We leave open, however, the question if the problem belongs to the FPT class with respect to the number of different processing times or the number of different weights

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SESSION M1

SUPPLY CHAIN 1 Chair: Michael Dreyfuss

- SHORTAGE DECISION POLICIES FOR A FLUID PRODUCTION MODEL WITH MAP ARRIVALS

Yonit Barron, Dror Hermel

Abstract

We consider on a continuous production/inventory process where a single machine produces a certain product into a finite buɾer. The demands arrive according to a Markov Additive Process (MAP) governed by a continuous-time Markov chain, and their sizes are independent and have phase-type distributions depending on the type of arrival. Two shortage policies are considered: the backorder policy, in which any demand that cannot be satisfied immediately is backlogged, and the order policy, in which any demand that cannot be satisfied immediately is supplied (alternatively, the latter policy can be considered as lost sales). We assume that the total cost includes a production loss cost, a penalty cost, a fixed cost for an order, and a

variable cost for the ordered amount. By applying the regenerative theory, we use tools from the exit-time theorem for fluid processes to obtain the discounted cost functionals under both policies. In addition, the models

are extended to include a non-zero safety stock. Numerical examples, sensitivity analysis, and comparative study are included.

- THE INTEGRATED LATERAL TRANSHIPMENTS AND ROUTING PROBLEM IN A SINGLE-COMMODITY SUPPLY CHAIN

Shirly Varem, Hussein Naseraldin, Aharon Ben-Tal

Abstract

Inventory control is an influential aspect in operations management for it directly and significantly affects the financial results. We discuss a system comprised of retailers facing unknown demand. In each period, replenishments are made according to a predetermined order-up-to quantity. Lateral transshipments are performed after demand is realized but not yet materialized, in order to minimize expected excess and shortage of inventory and costs at the retailers. However, transshipments have a non-negligible cost. Thus, a routing aspect arises as an important decision. Lateral transshipments literature provides recommendations on what quantities to deliver between locations. Those recommendations usually cannot be performed "as is" and managers must plan the route by themselves, which can be a complex decision. In Figure 1 on the right, we present an example where routing is considered as a decision variable, but not in the figure on the left.

- HIERARCHICAL MODEL FOR EVALUATING LONG-TERM CONTRACTS OF IMPORTED PRODUCTS UNDER PROMISED FIXED-PRICE

Shuvael Cahana, Avi Herbon

Abstract

This paper considers a supply chain consisting of a buyer (e.g., retailer or supplier) who imports products from a manufacture over a given planning horizon (e.g. contract length), whereas the prices of the products are online determined according to the market prices at the moment of purchasing. The buyer, on the other hand is committed through a long-term contract to her customers to a pre-determined promised fixed-price, whereas the imported products are supplied on-line over the planning horizon.

Nowadays, business environment is dynamic and is characterized by cost components which continuously change over time. These changes expose decision makers (e.g., buyers) to risk of accepting or rejecting specific deals basing on inaccurate predicting future costs. Poor costing might lead to either deficient costing – the product is sold at a low price and in some cases with incurred loss, or to excessive costing – the product is sold at a high price that decreases buyer's ability to compete and eventually deteriorates her profits.

We suggest in this research an approach including two main hierarchical stages, the costing model and the decision making model. The costing model includes two steps, where the first is carried off-line and is associated with characterizing the organizational business indication about the historical relative weight of indirect costs. In this step all costs components are classified into key organization levels, similarly to the common costing approaches in production and determining the indirect costs coefficient. The second step is carried on-line due to the incoming information about a specific deal. In this step a costing formula, termed DIMC (Dynamic Imported Material Costing) is developed in order to compute the expectation and the variance of the buyer's profit at the end of the planning horizon (e.g., end of the contract). The decision making model includes two steps as well. The first is carried off-line, and is associated with characterizing the organizational business indications about its risk attitude. The second step is carried on-line and includes an operational research model to support the buyer's decision model regarding accepting or rejecting a given deal (i.e., to import or not).

We mathematically analyze the model and show the conditions that are necessary in obtaining uniqueness of the optimal solution. Through extensive computerized simulations as well as with the support real-life case-study we validate the model and show its efficiency.

- POOLING SPARES TO MAXIMIZE THE WINDOW FILL RATE IN A TWO-ECHELON EXCHANGEABLE-ITEM REPAIR-SYSTEM

Michael Dreyfuss, Yahel Giat

Abstract

The fill rate is a widely used service measure that describes the fraction of customers whose demand is met immediately upon arrival to the inventory system. Since, however, customers will usually tolerate a certain wait time, managers should consider the window fill rate in lieu of the fill rate. That is, they should maximize the fraction of customers that are served within the tolerable wait time. We consider the spares allocation problem in a two-echelon, multi-location, exchangeable-item repair system in which the higher echelon comprises a single depot and the optimization criterion is the window fill rate. We provide a near-optimal algorithm that solves this problem in polynomial time and show that by using a small number of simulations the algorithm's accuracy may be significantly improved. The optimal solution is characterized by its degree of pooling and concentration. Pooling happens when spares are allocated to the depot so they can be shared by all the lower-echelon locations. In the lower echelon, the optimal solution may be concentrated or distributed. A concentrated solution happens when spares are allocated to only few locations, whereas in a distributed solution all the locations receive spares. We use a numerical example to show that pooling and concentration are antithetical so that when it is optimal to concentrate spares in the lower echelon then pooling spares at the depot is disadvantageous. We use the numerical example to illustrate how budget size, shipment time, local repair and customer patience affect the optimal solution in varying ways.

SESSION M1

OPTIMIZATION & UNCERTAINTY Chair: Eliran Sherzer

- ROBUST OPTIMIZATION WITH AMBIGUOUS STOCHASTIC CONSTRAINTS UNDER MEAN AND DISPERSION INFORMATION

Krzysztof Postek, Aharon Ben-Tal, Dick den Hertog, Bertrand Melenberg

Abstract

In this paper we consider ambiguous stochastic constraints under partial information consisting of means and dispersion measures of the underlying random parameters.

Whereas the past literature used the variance as the dispersion measure, here we use the mean absolute deviation from the mean (MAD). This makes it possible to use the old result of Ben-Tal and Hochman (1972) in which tight upper and lower bounds on the expectation of a convex function of a random variable are given. We use these bounds to derive exact robust counterparts of expected feasibility of convex constraints and to construct new safe tractable approximations of chance constraints. Numerical examples show our method to be applicable to numerous applications of Robust Optimization, e.g., where implementation error or linear decision rules are present. Also, we show that the methodology can be used for optimization the average-case performance of worst-case optimal Robust Optimization solutions

- FINDING PORTFOLIOS WITH OPTIMAL GAMMA AND THETA

Arik Sadeh, Dar Kronenblum

Abstract

Large gamma portfolio of options is attractive for investors in order to get benefits from either an increase or a decrease in the value of the underlying asset. On the other hand, a large gamma portfolio has a negative theta which may lead to losses over time as theta reflects the impact of time costs. In this study, a delta neutral portfolio with maximum gamma and constrained theta was defined in order to capture opportunities with limited risk. An optimization model was designed and solved for small time steps within a planning horizon. The model was run for many simulation scenarios as well as real world data, followed by statistical tests.

- OPTIMIZATION OF RESOURCES ALLOCATION IN A COMPLEX STOCHASTIC ENVIRONMENT

Shai Goren, Gad Rabinowitz, Yoav Kerner

Abstract

In this study we address the allocation of limited inspection and repair resources among multiple heterogeneous production cells. Most importantly, both yield and flow-time, which are the two vital production performance measures, are considered. Furthermore, it is assumed that production, inspection and repair activities take random durations and are subject to errors.

Each cell is formulated, and its steady state distribution is obtained, via semi Markovian model. The multi-cell bi-criteria (yield and flow-time) problem is based on the cells solutions and solved through a customized non-linear pseudo-optimal algorithm. The results reveal interesting and useful insights for practitioners, such as parameters' influence on cells' performance, and parameters inter-dependency.

- PLAN YOUR CLOUD FOR A RAINY DAY

Eliran Sherzer, Hanoch Levi, Gail-Gilboa Freidman

Abstract

Today’s large-scale services and applications use distributed cloud computing to serve their geographically distributed users cost-effectively. As such, cloud based data centers form an attractive target for malicious entities who aim at attacking these services. We address the problem of how to manage one’s resources on a distributed cloud environment as to provide the best service for its geographically distributed users while keeping it resilient to equipment failures due to attacks. The problem requires devising a resource placement mechanism that accounts for uncertainty both in the demand and the supply. We suggest a scheme for this problem and provide results on conditions under which this scheme is optimal. Particularly, we provide a set of attacks for which such efficient algorithms are guaranteed to find optimal allocation for any stochastic demand in which the conditions are satisfied. An attack is expressed by the supply distribution. We identify that the cumulative-cumulative distribution function plays a major role in the analysis. Moreover, we provide an alternative scheme for finding if the conditions are not satisfied. Our analysis is relevant to many interesting problems of resource and inventory allocation and repositioning under uncertainty.

SESSION M2

APPROXIMATION METHODS IN OR Chair: Danny Segev

- FIRST SAMPLE, THEN BE GREEDY: AN IMPROVED WAY TO USE THE GREEDY ALGORITHM

Moran Feldman, Christopher Harshaw, Amin Karbasi

Abstract

The greedy algorithm is used in practice to solve a wide range of problems, and often presents a very good performance. For maximization problems this good practical performance can often be attributed to theoretical guarantees on the approximation ratio of the greedy algorithm for maximization of linear and submodular functions subject to many families of constraints. In particular, such theoretical guarantees are known for any constraint which can be represented as the intersection of matroid and matching constraints. In this talk we present a recent work studying an algorithm that first samples a subset of the ground set, and then applies the greedy algorithm to this sample rather than applying it to the entire ground set. Quite surprisingly, it turns out that for a large family of constraints, including the above mentioned constraints that can be represented as the intersection of matroid and matching constraints, the theoretical approximation obtained by running greedy on the sample is as good as the corresponding guarantee for running greedy on the entire ground set (as long as the sample is large enough). This finding has two important implications. First, it provides an easy way to make the greedy algorithm much faster. Second, it yields an improved approximation algorithm for maximization of non-monotone submodular functions subject to a wide range of constraints because, unlike running greedy on the entire ground set, running greedy on a sample of the ground set yields a theoretical approximation guarantees for many such problems.

- PTAS FOR THE BI-SCENARIO SUM OF COMPLETION TIMES TRADE-OFF PROBLEM

Liron Yedidsion, Miri Gilenson-Zalevsky, Hussein Naseraldin

Abstract

An influential aspect of any scheduling problem is the processing time of the tasks (jobs). In this research, we assume the processing times of the jobs to come from two different scenarios. Hence, each sequence yields two different competing objective values, one for each scenario. We study the Sum of Completion Times criterion for which we develop a 2-approximation algorithm and show that it is asymptotically tight. We use this approximation to develop PTAS that approximates the Pareto-optimal set of solutions for the two scenarios and introduce a data-dependent analysis to examine the sensitivity of the model parameters.

- THE ORDERED *k*-MEDIAN PROBLEM: SURROGATE MODELS AND APPROXIMATION ALGORITHMS

Danny Segev, Ali Aouad

Abstract

In the last two decades, a steady stream of research has been devoted to studying various computational aspects of the *ordered k-median* problem. Given a finite metric space, once *k* facilities are located, the ordered median cost function penalizes the coverage distance of each vertex by a multiplicative weight, depending on its *relative ranking* (or percentile) in the overall list of ordered distances. Motivated by applications in supply chain, network management, and machine learning, this modeling framework develops a uniform and standardized approach to location theory, subsuming well-known problems such as *k*-median, *k*-center, *k*-centdian, and *k*-facility *p*-centrum.

Nevertheless, in spite of substantial work on mathematical properties of ordered median functions, polynomial-time algorithms for special cases, integer programming methods, and various heuristics, obtaining any non-trivial approximation guarantee for this problem is still an intriguing open question, even on simple network topologies, such as trees or line graphs.

The main contribution of this paper is to devise the first provably-good approximation algorithms for the ordered *k*-median problem. We develop a novel approach that relies primarily on a surrogate model, where the ordered median function is replaced by a *ranking-invariant* functional form. By employing local-search methods on a smooth variant of the surrogate function, we derive an $O(\log n)$-approximation on general metrics. In addition, an improved guarantee of 2+ε is obtained on tree metrics by optimally solving the surrogate model via dynamic programming ideas, while showing that this gap is tight up to an $O(\varepsilon)$ term.

SESSION M2

WATER MANAGEMENT & ENERGY Chair: David Raz

- PARTIAL RANKING OF MEMBRANE BIO-REACTORS FOR RECOMMENDATION SYSTEMS IN WASTEWATER TREATMENT

Amos Bick, Fei Yang, Ying Wang, Leonid Gillerman, Jack Gilron, Asher Brenner, Moshe Herzberg, Gideon Oron

Abstract

The research compares four types of different designs of membrane bio-reactors: A) with 295 mm draft tube and without plastic carriers; B) plastic carriers and 295 mm draft tube; C) plastic carriers and 235 mm draft tube with two meshes around the bottom and top of a draft tube; D) plastic carriers without a draft tube. The feed for the reactors was artificial wastewater made from domestic wastewater and chicken manure, and membrane test data were based on a hollow fiber membrane module under ambient desert conditions. Process operation type D is the optimal choice. Mathematical analysis using total ranking methods, multi-indicator decision making, and Hasse diagram support this choice. Concerning analysis by the different tools, inconsistencies between the rankings are noticed. Partial order ranking, as a method without any pre-assumptions concerning the possible relation between the single parameters, proves to be an elegant ranking method.

- THE EFFECTS OF UNCERTAINTY IN CAPACITY AVAILABILITY, FUEL COST AND DEMAND ON CAPACITY MIX IN COMPETITIVE ELECTRICITY MARKETS

Irena Milstein, Asher Tishler, Nurit Gal, C.K. Woo

Abstract

Higher production efficiency and, consequently, lower average electricity price have been the main justification for electricity market deregulation. Initial estimates suggest that indeed small efficiency gains in electricity generation have been achieved in some deregulated electricity markets. However, electricity markets face uncertainties causing regulators and politicians to either (a) maintain a regulated electricity sector with sufficient generating capacity and stable electricity prices, or (b) heavily intervene in the process of price setting in competitive electricity markets.

First, an electricity market has to operate under daily demand uncertainty. Building a new power plant is a slow process, requiring a long lead time. However, daily and seasonal electricity demands fluctuate: day-time demands are higher than night-time demands, summer and winter demands exceed spring and autumn demands, and this seasonal and time-of-day demand variability is further exacerbated by extreme temperatures. If the installed capacity aims to serve projected peak demands, a large share of it is frequently idle during many hours of the day

and year. Without reserve capacity to absorb demand surges, the short-term demand volatility and the very slow construction process make price spikes inevitable.

Second, renewable energy is becoming an ever-increasing feature of the landscape worldwide. Research on renewable energy suggests, however, that the road to a "green world" is not yet fully paved and the potential and limits of renewable energy remain insufficiently explored and understood. It also points out that, on the one hand, the high costs of producing electricity from renewable energy will likely raise electricity prices substantially, unless new technologies of electricity generation are developed and adopted. On the other hand, renewable energy sources, such as photovoltaic cells, are weather dependent. The fact that electricity power cannot be economically stored implies that electricity demand cannot be efficiently managed, which may cause price spikes and increase the average electricity price and price volatility.

Third, large-scale natural gas developments (e.g., shale gas in the USA) have caused a price decline that helps expand the use of natural gas in electricity generation. Natural gas fired generation faces large fuel cost risks because: (a) natural gas constitutes about 80% of the relevant variable costs, and (b) natural gas price volatility is large, substantially more so than coal and oil. Natural gas price volatility is mainly caused by transportation constraints and storage limitations.

This paper develops a two-stage model with endogenous capacity. We allow generation flexibility during periods of high demand by distinguishing between base and peaking technologies and solve for equilibrium (long-term) capacity investments and (short-term) daily (or hourly) electricity production by each generating technology. Our model is focused on demand and supply uncertainties. The theoretical properties of the model are illustrated using stylized data for the Texas and California electricity markets. Our model provides the regulator with analytical and empirical tools to decide whether it should intervene to reduce highly volatile daily electricity prices because of demand or supply uncertainty, to promote renewable technologies, or to affect a well-functioning spot market for natural gas.

- ## A MULTI-OBJECTIVE APPROACH FOR WATER PUMP SCHEDULING OPTIMIZATION

David Raz

Abstract

Energy costs, and specifically, energy used by pumps to extract water and to carry it, comprises the largest component of the operational costs of most Water Supply Systems (WSS). It is therefore much desired to optimize the operation of WSS through scheduling of pumps and other operational elements, to take advantage of time-varying energy tariffs and minimize energy costs, and a considerable body of work exists in this field. In contrast, in some cases, a stated secondary (or sometimes even primary) objective for optimization is the minimization of the carbon footprint of operations due to electricity manufacturing. In practice, a choice is often made between the two objectives, and either energy costs or carbon footprint are minimized.

We start by demonstrating, through a mock water distribution setup that includes water extraction and transportation, that these two objectives may coincide, but may also contradict. In fact, there is sometimes a trade-off between optimizing for energy costs and for carbon footprint. We consider several multi-objective methods for reconciling these two objectives. These include lexicographical ordering with discount, monetization of the carbon footprint, and finally, $\alpha/1-\alpha$ weighting. We start with the simple case of homogeneous sources of electricity, where the carbon footprint objective is equivalent to minimizing the energy consumption. We then move on to the more complex case of heterogeneous sources (e.g. coal and natural gas). The results may be used by policy makers to weight both energy costs and carbon footprint in WSS operations.

SESSION M2

SIMULATION Chair: Yaniv Mordecai

- MARKED OBJECTS IDENTIFICATION IN DIFFERENT MAPS – MAPS COMPARISON

Joseph Kreimer

Abstract

In many cases it is necessary to compare different maps of the same area (e.g. land or naval warfare, etc.), when these maps are obtained from different sources/platforms. If there are reference points in these maps one can use various methods to exploit their existence.

The purpose of this work is to compare the maps in the absence of reference points in order to identify the marked real/legitimate object/target. These objects can be military or civilian, real targets or fakes, etc., but these characteristics do not exist in one of the maps under consideration. Only their locations are known.

Each map contains a specific number of objects. Due to time differences between the maps and/or different detection tools/sensors (optics, radars, IR, etc.) the number of objects varies from map to map. New objects (e.g. fake targets) may enter the area and others to leave it or disappear due to destruction. The location of the same object in different maps may be different due to possible movements or inaccurate measurements.

We consider both the case of unique marked object and the case of multiple marked objects. We provide algorithms based on a "principle of a maximum number of coincidences" and show their efficiency via simulation.

- SMALL PARCEL ROUTING IN A CROWDSOURCED PHYSICAL INTERNET

Eyal Tenzer, Tal Raviv

Abstract

We envision a new logistic process for delivering parcels by crowdsourcing curriers. It is based on a network of automatic service points, which are used as drop-off, pickup and intermediate transfer point. The system offers the occasional curriers monetary rewards for stopping by the service points and for transferring parcels between them during their regular trips.

In this talk, we will present an online routing algorithm that matches parcels to occasional curriers. Parcels can be transferred to their destination in several legs by several different occasional curriers, hence the term physical internet.

The economic viability of the proposed method is demonstrated via a simulation study that is based on realistic data about car journeys and small parcel shipments. The ratio between the rewards paid to the occasional curriers and our conservative estimate of the time needed to handle the parcels is well above the average hourly wage while the average cost of delivering a parcel is significantly lower than the price of parcel delivery service in the same market.

- A DIFFERENT MATRIX-BASED RISK ANALYSIS TECHNIQUE

Yaniv Mordecai

Abstract

We introduce an innovative approach for capturing and evaluating risk in complex settings, using a multi-matrix approach. The multi-matrix covers conditional probabilities of utility values of programmatic and technical objectives, based on the probabilistic occurrence of hazards at varying impacts. The estimation of hazard impact

probabilities, as well as the conditional probabilities of objective utility values, is based on Raiffa's Fractile Method. The aggregate score of each intersection of hazard and objective is equal to the complementary of the conditional expected utility. The assumption of hazard and impact independence and the highlighting of the risk score allows for the evaluation of severe hazards across multiple objectives and of jeopardized objectives due to various hazards, and for the proposal and consideration of risk mitigation alternatives. Each application or selection of a risk mitigation path generates a revised multi-matrix, and the gradual evolution of the multi-matrix can be tracked, optimized, and predicted. This approach is a complete departure from the currently predominant and standard-fostered risk analysis approach – the disproved probability-severity matrix for risk estimation. We demonstrate the applicability of this approach to an ongoing program in the area of climate emergency.

SESSION M2

GAME THEORY 3

Chair: Yizhaq Minchuk

- CONTEST DESIGN WITH UNCERTAIN PERFORMANCE AND COSTLY PARTICIPATION

Priel Levi, David Sarne, Igor Rochlin

Abstract

This paper studies the problem of designing contests for settings where a principal seeks to optimize the quality of the best performance obtained, and potential contestants only strategize about whether to participate in the contest, as participation incurs some cost. This type of contest can be mapped to various real-life settings (e.g., an audition, a beauty pageant, technology crowdsourcing). The paper provides a comparative game-theoretic based solution to two variants of the above underlying model: parallel and sequential contest, enabling a characterization of the equilibrium strategies in each. Special emphasis is placed on the case where the contestants are homogeneous which is often the case in real-life whenever the contestants are basically alike and their ranking in the contest is mostly influenced by some probabilistic factors (e.g., luck). Here, several (somehow counter-intuitive) properties of the equilibrium are proved, in particular for the sequential contest, leading to a comprehensive characterization of the principal preference between the two.

- TOWARDS OPTIMAL TRAFFIC ENFORCEMENT ALLOCATION IN ISRAEL

Ariel Rosenfeld, Oleg Maksimov, Sarit Kraus, Mali Sher

Abstract

Efficient traffic enforcement is an essential, yet complex, component in preventing road accidents. In this paper, we present a novel model and an optimizing algorithm for mitigating some of the computational challenges of real-world traffic enforcement allocation in large road networks. Our approach allows for scalable, coupled and non-Markovian optimization of multiple police units. In an extensive empirical evaluation we show that our approach favorably compares to several baseline solutions, achieving a significant speed-up, using both synthetic road network as well as the real-world Israeli road network. Our proposed solution is currently being prepared for field deployment in collaboration with the Israeli Traffic Police.

- SABOTAGING IN CONTESTS WITH MONITORING EFFORTS
  Yizhaq Minchuk, Baruch Keren, Yossi Hadad

  Abstract
  This paper considers a three stage contest with both sabotage and monitoring efforts that aim to reduce sabotage. In the first stage, the regulator sets his monitoring efforts for each contestant. In the second stage, each contestant determines his sabotaging efforts, based on the monitoring efforts that were imposed on him by the regulator. In the third stage, each contestant determines his productive efforts in the contest. The paper calculates, in equilibrium, the optimal monitoring efforts with and without a budget constraint. The paper states that the utilities of contestants increase with the monitoring efforts. However, monitoring efforts beyond the optimal level do not help the contestants and harm the regulator. Furthermore, the paper defines the conditions where exerting monitoring efforts would be worthwhile.

SESSION M3
QUEUEING THEORY Chair: Uri Yechiali

- DYNAMIC ALLOCATION OF STOCHASTICALLY-ARRIVING FLEXIBLE RESOURCES TO RANDOM STREAMS OF OBJECTS WITH APPLICATION TO ORGAN CROSS-TRANSPLANTATION
  Yael Perlman, Amir Elalouf, Uri Yechiali

  Abstract
  Two distinct random streams of discrete objects flow into a system and queue in two separate lines. In parallel, two distinct types of resources arrive stochastically over time. Upon arrival, each resource unit is matched with a waiting object. One resource type is 'flexible' and can be allocated to either one of the object types. However, units of the other, non-flexible, resource type can be allocated only to units of one specific object type. The allocation probabilities are not fixed and may depend on both queue sizes of the two objects. If a resource unit is not allocated immediately, it is lost. The goal is to find an optimal state-dependent probabilistic dynamic allocation policy. We formulate the system as a two-dimensional Markov process, analyze its probabilistic behavior, and derive its performance measures. We then apply the model to the problem of organ cross-transplantation and propose a new measure of system effectiveness, called Expected Value of Transplantation (EVT), based on the histocompatibility between organs and candidates. We further show that it is possible to balance the objectives of achieving equity in candidates' waiting times (EW) and maximizing EVT by equating the value of EW/EVT between the two groups.

- ALTERNATING SERVER WITH NON-ZERO SWITCH-OVER TIMES AND OPPOSITE-QUEUE THRESHOLD-BASED SWITCHING POLICY
  Amit Jolles, Uri Yechiali

  Abstract
  A single server alternates between two Markovian queues with non-zero switch-over times. The server's switching instants are determined by the number of customers accumulated at the unattended queue. Specifically, when queue i, $i = 1,2$, is attended and the number of customers in queue j ($j = 1,2$; $j \neq i$) reaches a threshold, the server starts switching to queue j, unless the number of customers in queue i is equal to or above the latter threshold. A switch-over duration is exponentially distributed. However, if during a switch-over period from queue i to queue j the former reaches its threshold, the switch-over is nullified, and the server immediately returns to

queue i and continues to serve the customers there. We analyze the system via Matrix Geometric methods while deriving explicitly the rate matrix R, and thus eliminating the need for successive substitutions. Expressions for the system's performance measures are derived, and numerical results are presented. The effects of the various parameters and the switch-over times are examined, and seemingly counter-intuitive phenomena are discussed. Finally, various extreme cases are investigated.

- A QUEUEING SYSTEM WITH DECOMPOSED SERVICE AND INVENTORIED PRELIMINARY SERVICES

Gabi Hanukov, Tal Avinadav, Tatyana Chernonog, Uriel Spiegel, Uri Yechiali

Abstract

We study a Markovian single-server queue in which the service time of each customer is composed of two independent stages. The first stage can be performed either prior to or after the customer's arrival, whereas the second requires the customer to be present. In order to improve the system's overall performance, the server utilizes its idle time to produce an inventory of first-stage preliminary services (PSs). The inventoried PSs are used to reduce the overall sojourn times of customers. We analyze the combined queueing-inventory process and derive its steady-state probabilities by using the matrix geometric method. We calculate explicitly all the entries of the rate matrix R and eliminate the successive substitution procedure usually required to calculate them. Those entries are closely related to Catalan numbers. We find that the system's stability is independent of the production rate of PSs, and show what seems as a paradox, that under a certain condition the fraction of time the server is idle when PSs are possible is greater than that without PSs. Performance measures are calculated, including the PDF of customers sojourn time, and special cases are discussed.

- A NEW LOOK ON THE SHORTEST QUEUE SYSTEM WITH JOCKEYING

Rachel Ravid, David Perry

Abstract

We introduce a Markov queueing system with Poisson arrivals, exponential services and jockeying between two of parallel and equivalent servers. An arriving customer admits to the shortest line (when the lines are equal the customer admits to any line with probability 1/2). Every transition, of only the last customer in line, from the longer line to the shorter line is accompanied by a certain fixed cost. Thus, a transition from the longer queue to the shorter queue occurs whenever the difference between the lines reaches a certain discrete threshold ($T = 2,3, \ldots$). In this study we focus on the stochastic analysis of the number of transitions of an arbitrary customer

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SESSION M3

COMBINATORIAL OPTIMIZATION Chair: Enrique (Tzvi) Gerstl

- A FAST ENERGY-EFFICIENT ROUTING ALGORITHM FOR EMERGENCY EVACUATION IN SMART BUILDINGS

Eugene Levner, Amir Elalouf, Daniel Ng, Edwin Cheng, A da Che, Vladimir Katz

Abstract

Organization and management of evacuation operations in large-scale buildings in the case of emergency (such as fire, smoke, flood, explosion, etc.) are usually carried out under responsibility of an emergency manager who needs to efficiently allocate the available resources, communicate information to all inhabitants and take/distribute decisions regarding planning and execution of the response operations. However, severe time and

energy constraints related to decision making and response operations imply that fast classical routing algorithms, like Dijkstra's, become inefficient and invalid in practice. This paper focuses on the design of a new and very fast constrained routing algorithm belonging to the family of so-called fully polynomial-time approximation schemes (FPTAS) adjusted for specificity of energy-efficient routing in smart buildings. We treat the stability of routing where the stability radius of the route is defined as the largest quantity of variations in the input times within which the route can still be executed as expected. We consider the bicriteria optimization problem which consists of minimizing the route length and maximizing the stability radius. The objective is to handle the two criteria simultaneously, that is, to find their Pareto front. We propose a new strongly polynomial algorithm for finding the minimum route length for *all* possible values of stability radius with time complexity of $O(m^4)$, where m is the number of nodes in the underlying graph. This implies that we can find the entire Pareto front of the problem in polynomial time.

- RNA PSEUDOKNOTS AND GRAPH COLORING PROBLEM

Marta Szachniuk, Mariusz Popenda, Tomasz Zok

Abstract

Many real-world problems can be represented using graph models. Especially, scientists with background in operations research, often go back to graph theory in solving interdisciplinary issues. A lot of such problems appear in bioinformatics and computational biology – a discipline that draws from life sciences (including biology, biochemistry and biophysics), mathematics and computing science. One such problem will be outlined in our presentation.

From a decade, we have been involved in the research addressing RNA (ribonucleic acid), being one of the molecules of life. Our interests focus i.a. on this molecule structure and its relationship with different roles that RNA plays in cellular processes. The three-dimensional shape of RNA, its atom arrangement in space, bending angles, interactions between nucleotides, nucleotide sequence, characteristic structural motifs – these questions have been the subject of our study. Recently, our attention has been caught by pseudoknots which are often found in large RNAs. These motifs are not well recognized and – to our knowledge – their identification, representation and classification is ambiguous. Some models proposed for RNA structure representation prevent a description of pseudoknots in the structure. Most structural databases do not provide an information about pseudoknots appearing in RNAs, although the other motifs are well represented. In our research, we have decided to standardize the concept of pseudoknots, to define their classes and propose a method for their identification, classification and representation. Following the idea of modeling the RNA secondary structure by means of graph theory, we have proposed a new graph model of the structure which allows to represent different types of pseudoknots. Additionally, we have applied vertex coloring to identify and assign pseudoknot order. This feature refers to the motif complexity and the order of nucleobase bounding when the RNA molecule was folded. By solving the problem of finding chromatic number for our graph, we optimize an assignment of pseudoknot classes and we provide a clear procedure of motif encoding for further processing of structure data.

- A MANY-OBJECTIVE OPTIMIZATION APPROACH TO THE MAXIMUM DIVERSITY PROBLEM

Benjamin Baran

Abstract

The *Maximum Diversity Problem* (MDP) is a combinatorial problem consisting in choosing a subset $\boldsymbol{S}$ of a given set $\boldsymbol{U}$ of $\boldsymbol{n}$ elements, maximizing the diversity of $\boldsymbol{S}$. The MDP is known to be an NP-hard decision problem with several

applications in biology, drug discovery and design, working team formation, data analysis and finance, among other areas.

Several heuristics and exact algorithms have already been proposed in a pure mono-objective context optimizing a single objective function. However, there is no universal consensus on a unique formal definition of diversity, what gives rice to several alternative formulations, mainly based on a given measure of distance (or dissimilarity) between any pair of elements of the set $\boldsymbol{U}$. To complicate even more agreement among experts, dozens of different definitions of distance (or dissimilarity) may be considered when dealing with real world problems. Therefore, each decision maker may prefer a different measure of diversity with alternative definitions of distance among elements, giving rise to many different objective functions. To alleviate this situation, this work proposes for the first time the simultaneous optimization of as many objective functions (or different criteria) as needed, in a pure multi-objective context, using the Pareto dominance relation or other comparison relations, as the preference relation, to choose an optimal Pareto set of solutions. In this multi-objective context, a solution $\boldsymbol{x}$ is said to dominate another solution $\boldsymbol{y}$ if it is not worse in any objective function and it is strictly better in at least one objective function.

An Evolutionary Algorithm based on the well-known NSGA-II algorithm is used to calculate a Pareto set approximation of the Maximum Diversity Problem in the proposed pure multi-objective context considering many (four to dozens) different objective functions, helping decision makers in the task of choosing compromised solutions under many different criteria. Experimental results prove the viability of this proposal.

- SCHEDULING ON PARALLEL UNIFORM MACHINES WITH THE OPTIONS OF JOB - AND MACHINE - REJECTION
  Enrique (Tzvi) Gerstl

Abstract

We study scheduling problems on parallel uniform machines. Usage of the machines require both a setup time and a setup cost. In addition to the classical decisions regarding job sequencing and scheduling, the scheduler may decide (i) to use only a subset of the machines (i.e., machine rejection), and (ii) to process only a subset of the jobs (i.e., job-rejection). The number of machines to be used is either a given parameter or a decision variable. The objective functions consist of combinations of a scheduling measure, the total machine setup cost and the total job rejection cost. We consider minimum weighted completion time and weighted tardiness. All the problems are proved to be NP-Hard and pseudo-polynomial dynamic programming algorithms are introduced. The special case of identical jobs is shown to be solvable in polynomial time.

SESSION M3

GAMES & DYNAMIC MODELS Chair: Konstantin Kogan

- SHILNIKOV CHAOS IN THE LUCAS MODEL OF ENDOGENOUS GROWTH
  Beatrice Venturi, Giovanni Bella

Abstract

This article is aimed at developing some results on the existence of chaotic behavior in a quite familiar context: the continuous-time standard Lucas endogenous-growth model (1988). This paper shows that chaotic dynamics may characterize the Lucas's (1988) two-sector continuous time endogenous growth model. Our "route to chaos" exploits the existence of a family of homoclinic orbits in the effective dimension spanned by the dynamics of the model. The Ramsey-Euler conditions arising from Lucas's model imply a non-linear three-dimensional system of first order conditions which is already know to possesses a rich spectrum of dynamic behavior that goes, as the

parameters of the model are tuned, from a stable equilibrium point to a Hopf cycles, either super-critical or sub-critical. Our route to chaos exploits the existence of a homoclinic orbit to a saddle-focus equilibrium. In this situation, Shilnikov (1965) proved that if the saddle quantity is positive, the homoclinic orbit shapes and organizes the flow of trajectories in a relatively wide region around it, determining irregular transitional dynamics and high sensitivity to initial conditions. Implications are noteworthy.The striking complexity of the dynamics near these homoclinic orbits has been discovered and investigated by Shilnikov. This involves hyperbolic horseshoes close to the homoclinic orbit, but possibly also periodic attractors and strange attractors. On the one hand, our results imply a weakened role of the intertemporal equilibrium theory in providing indications about future economic conditions, given the initial state of the economy. There emerges the possibility of interesting dynamic phenomena, such as irregular cycles and bursts of volatility in a quite standard growth setting.

- EVOLUTION OF CUSTOMERS' QUALITY EXPECTATIONS: WHO TENDS TO BE THE SATISFIED IN THE LONG RUN?
  Gila E. Fruchter, Thomas Reutterer

  Abstract

  The evolution of quality expectations over time is an important driver of customer satisfaction and retention. This study investigates the dynamic properties of customers' quality expectation updating from an analytical perspective. We develop a mathematical expectation updating model that is well grounded in behavioral theories and empirical evidence from customer satisfaction research. Using a nonlinear complex systems approach, our findings reveal some novel insights into how customers learn their quality expectations and to appropriately align them with the product/service quality levels delivered by a company. We show that the capability to correctly calibrate quality expectations is an important prerequisite for being satisfied with a specific product or service. However, our theoretical findings suggest the existence of individuals who fail to do so, and those customers tend to be dissatisfied in the long run. We show that merely delighting customers does not help to prevent this tendency, but firms can assist some of their customers in becoming more "realistic" in their post-consumption quality evaluations by being more attuned to customer expectations. However, such a customer-oriented quality strategy entails a higher risk of negative disconfirmation for other customer groups. We discuss the theoretical, empirical and managerial implications of our findings and the predictions derived from our analytical model.

- DIFFERENT CHANNEL AND PRODUCT PREFERENCES IN A SUPPLY CHAIN OF ORGANIC AND CONVENTIONAL GOODS
  Yaacov Ozinci, Yael Perlman, Sara Westreich

  Abstract

  This paper considers two vertically differentiated substitutable products, an organic versus a conventional version, each manufactured by a dedicated supplier. The two suppliers sell to a single retailer while at the same time maintain individual direct channels. The retailer, on his part, offers additional benefit in the form of service or "shopping experience". The valuation of this service as well as for the extra benefit obtained from the superior product are continuously distributed among consumers. The two individual valuations of product and service give rise to a two dimensional demand scheme. Proceeding to examine symmetric and asymmetric equilibria, we find that the service provided by the retailer may manipulate consumer preferences when deciding between organic and conventional versions, thus influencing version market shares.

- PRODUCTION LEARNING AND FORGETTING DYNAMICS IN A COMPETITIVE ENVIRONMENT
  Konstantin Kogan, Fouad El Ouardighi

Abstract
It has been shown that learning-by-doing enables firms to reduce marginal production costs, but that this effect weakens due to organizational forgetting. In order to assess the impact of both learning and forgetting on long-term competitiveness and a firm's profitability, we model an experience accumulation process with depreciation and consider two competing firms that produce fully substitutable products. In this model, unit production costs decrease with the firm's experience due to the proprietary learning process as well as the spillover of experience from the competing firm. Firms can either share or hide from each other their information about the state of their respective experience throughout the game. We found that in an equilibrium steady state, if the organizational forgetting is sufficiently large (larger than the spillover rate value), then information sharing, compared to information hiding, results both in less competitiveness and increased profits for firms. Accordingly, firms are better off in the long term by deliberately limiting (expanding) their experience accumulation process whenever organizational forgetting is relatively large (small). A high ability of proprietary learning, however, can interfere in this relationship so that limiting the firms' experience process will always be compatible with higher profitability.

SESSION M3
SUPPLY CHAIN 2 Chair: Yael Deutsch

- THE TWO-PHASE MULTILOCATION NEWSVENDOR PROBLEM WITH A JOINT ADDITIONAL REPLENISHMENT
  Dina Smirnov, Assaf Avrahami, Yale T. Herer

Abstract
The print industry traditionally employs mature technology and standard inventory models. Today, however, due to market pressures, e.g., increasing competition from Internet-based content, the industry must streamline and reduce operational costs to make a profit. We propose a new model that exploits newly available sales information in order to address this challenge. In particular, we propose utilizing in-cycle sales information together with the existing flexibility in the printing process and to divide the sales period into two parts by adding an additional review (and possibly an additional production run). We implemented our innovative model in a pilot field study at a market-leading media group. We detail how we addressed company-specific challenges in the implementation process. The results are dramatic, and indicate that the proposed model achieves an increase of 4%-24% in profits compared to the current policy. Our model is general enough to be applied to other printing houses and other industries.

- NONLINEAR CONTINUOUS AND MIXED-INTEGER PROGRAMMING FORMULATIONS FOR CONSTRAINED MULTI-ITEM NEWSVENDOR WITH EXTENSIONS FOR DISPLAY CAPACITY CONSTRAINTS
  Noam Goldberg, Tatyana Chernonog

Abstract
We consider a multi-product newsvendor problem with uniform and triangular demand distributions. We formulate the problem as nonlinear program. In the case of the triangular distribution the problem is also reformulated as an equivalent convex conic formulation in order to solve it using convex optimization solvers. In both cases, for the sake of managerial insight we prove a bound on the number of guaranteed shortage items, whose order quantity is less than the distribution lower bound. As an extension to handle fixed costs, we

reformulate the resulting mixed-integer program (MIP) as a mixed-integer second order program (MISOCP) to solve it more efficiently. In computational experiments we investigate the running times of alternative mathematical programming formulations as well as properties of the optimal solutions determined.

- FULLY POLYNOMIAL TIME APPROXIMATION SCHEMES FOR THE CONTINUOUS NONLINEAR NEWSVENDOR PROBLEM

Nir Halman, Giacomo Nannicini

Abstract

We study the continuous nonlinear newsvendor problem (CNNV) where costs are not necessarily linear in the order size, and the amount ordered is of non-discrete nature. We show that CNNV does not admit relative-error approximation.

To circumvent this hardness result, we generalize the concept of fully polynomial-time approximation scheme, allowing arbitrarily-small additive and multiplicative error at the same time, while requiring a running time polynomial in the input size and the error parameters.

We develop approximation schemes of this type for CNNV. In light of our hardness result, such approximation schemes are ``best possible''.

- SERVICE NETWORK DESIGN UNDER CONGESTION

Yael Deutsch, Oded Berman, Opher Baron

Abstract

We consider the problem of service network design: choosing the optimal number of facilities, their locations, and service capacities, taking into account that facilities may have a finite or an infinite waiting room. Accordingly, our service measure is either the percentage of blocked customers or the percentage of customers who need to wait.

The goal is to minimize the total cost, which consists of traveling, blocking or waiting, service capacities, and setup costs.

We derive structural results when facilities are on a single edge network, and then use them to investigate the problem on a general network.

We prove that the cost of service capacity and the cost of blocking or waiting are independent of the number of opened facilities.

We then use our results to develop an efficient algorithm that solves the problem on general networks. Finally, to demonstrate the applicability of our results and tractability of our algorithm, we discuss as an example an industrial-size problem, which considers the drive-through operation of McDonalds in the Toronto metropolitan area.

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קפה גרג
בניין פלדמן
כאן יוקם מתחם מעונות, מרכז ספורט ומרכז שירותים נלווים לסטודנטים
רח' דיבוסינסקי
רח' מקס ואנה ווב
כביש 4 נהה
כביש מכבית 471
שער 10
שער 20
שער 5
שער 25
שער 3
שער 2
שער 1
שער 40
שער 30
אוניברסיטת בר-אילן
Bar-Ilan University

Notes...

האגודה הישראלית לחקר ביצועים
(איל"ב)
הכינוס השנתי 2017

22 – 21 במאי כ"ה – כ"ו באייר

אוניברסיטת בר-אילן
המחלקה לניהול

בתמיכת:

הוועדה המארגנת:

יעל פרלמן (יו"ר)

נועם גולדברג

שרה וסטרייך

אורי יחיאלי

קונסטנטין קוגן