האגודה הישראלית לחקר ביצועים

(אילי"ב)

הכינוס השנתי 2019

14 – 13 במאי

שפיים

הוועדה המארגנת:

ניב בוכבינדר(יו"ר)

שושי אנילי

טל רביב

הכנס השנתי של האגודה הישראלית לחקר ביצועים

שפיים, 14 - 13 במאי 2019

Monday			Tuesday		
09:00-09:30	*Registration*		09:00-09:15	*Registration*	
09:30-09:40	**Opening Session**	ראשונים	09:15-10:45	**Parallel Sessions T1**	
09:40-10:35	**Naor Plenary Lecture** **Daniel Kuhn**	ראשונים		Game Theory 2 Energy Scheduling 2 Transportation 2	ראשונים יערה חצב חבצלת
10:35-11:00	*Break*		10:45-11:05	*Break*	
11:00-12:10	**Parallel Sessions M1**		11:05-11:20	**Prize Award Ceremony**	ראשונים
	Continuous Optimization 1 Transportation 1 Sustainable Supply Chains Applied OR 1 Supply Chains	ראשונים חצב יערה רותם חבצלת	11:20-12:10	**Prize session**	ראשונים
12:10-13:40	*Lunch* *& ORSIS General Assembly* (13:20)	חדר אוכל מלון	12:10-13:40	*Lunch*	חדר אוכל מלון
13:40-14:30	**Plenary Lecture** **Yuval Emek**	ראשונים	13:40-14:30	**Plenary Lecture** **Moshe Haviv**	ראשונים
14:35-15:20	**Semi-Plenary Tutorial M1** Opher Baron Hillel Bar-Gera	ראשונים יערה	14:35-15:20	**Semi-Plenary Tutorial T1** Shoham Sabach Yigal Gerchak	ראשונים יערה
15:20-15:40	*Break*		15:20-15:40	*Break*	
15:40-17:10	**Parallel Sessions M2** Combinatorial Optimization Applied OR 2 Scheduling 1 Queuing 1 Game Theory 1	רותם חבצלת חצב יערה ראשונים	15:40-17:10	**Parallel Sessions T2** Strategic Queuing HealthCare Continuous Optimization 2 Transportation 3	ראשונים יערה חצב חבצלת
17:10-22:00	**Evening Program** 17:20: Bus leaves Shefayim. 17:30: Guided tour at the Apollonia National Park (in English). 19:30: Dinner at Bistro 56 in Herzliya. Return by bus to Shefayim hotel.				

מיקום: הכנס יתקיים במרכז הכנסים "ראשונים" ליד מלון שפיים. חנייה למכוניות מאחורי מרכז הכנסים (לא בחנייה לפארק המים).

Detailed Program - Monday, 13.5

09:00-09:30	*Registration*

09:30-09:40 **Opening Session** **ראשונים**

09:40-10:35 **Naor Plenary Lecture** **ראשונים**

Speaker: ***Daniel Kuhn***

Chair and opener: ***Shimrit Shtern***

10:35-11:00	*Break*

11:00-12:10 **Parallel Sessions M1**

Continuous Optimization 1 Chair: Shimrit Shtern	Nadav Hallak, Marc Teboulle	A Simple Second-Order Feasible Direction Method for Constrained Smooth Problems
	Rafał Zalas, Victor I. Kolobov, Simeon Reich	Finitely Convergent Projection Methods
	Eyal Gur, Shoham Sabach, Shimrit Shtern	Globally Convergent First-Order Methods for Sensor Localization
Transportation 1 Chair: Yuval Cohen	Ran Etgar, Erel Avineri, Yuval Cohen	Improving Personal Rapid Transportation system by utilizing smart distribution rules
	Yuval Cohen, Erel Avineri	Polynomial Time Optimization of Road Construction Portfolio Selection under Limited Local Authorities Budgets
	Erel Avineri,Yuval Cohen, Ran Etgar	Simulating Elevated Rapid Transit System for Performance Analysis
Sustainable Supply Chain Management Chair: Yael Perlman	Konstantin Kogan, Tatyana Chernonog	Competition under Industry-Stock-Driven Prevailing Market Price: Environmental Consequences and the Effect of Uncertainty
	Gal Raz, Gil (Gilvan) Souza	Recycling as a Strategic Supply Source
	Yael Perlman, Hilla Caspi	Consumer environmental awareness and privatization
Applied OR 1 Chair: Yahel Giat	Shany Azaria, Boaz Ronen, Noam Shamir	Justice In Time: Applying Operations Theory to Court Systems – The Case of the Jerusalem District Court
	Yahel Giat	A single-sided location model for boycotting with an application to restaurants' kosher certification
	Michael Naor	Deployment of Field Hospitals to Disaster Regions
Supply Chains Chair: Tal Avinadav	Tal Avinadav	The effect of decision rights allocation on a supply chain of perishable products under a revenue-sharing contract
	Nelly Bart, Tatyana Chernonog, Tal Avinadav	A survey on revenue sharing contracts in operations management
	Tatyana Chernonog	Inventory and marketing policy in a supply chain of a perishable product

12:10-13:40	*Lunch & ORSIS General Assembly* (13:20)	חדר אוכל

13:40-14:30 **Plenary Lecture** **ראשונים**

Speaker: ***Yuval Emek, Technion***

Chair and opener: ***Yale T. Herer***

14:35-15:20 **Semi-Plenary Tutorial** **M1**

Speaker: ***Opher Baron*, *University of Toronto*** **ראשונים**
Chair and opener: ***Yoav Kerner***

Speaker: ***Hiller Bar-Gera*, *Ben-Gurion University*** **יערה**
Chair and opener: ***Tal Raviv***

15:20-15:40	*Break*

15:40-17:10 **Parallel Sessions** **M2**

Combinatorial Optimization Chair: Danny Segev	Nir Halman, Giacomo Nannicini	Toward Breaking the Curse of Dimensionality: An FPTAS for Stochastic Dynamic Programs with Multidimensional Action and Scalar State
	Noam Goldberg, Shlomo Karhi, Michael Poss	Multi-type Bin Packing and Extensions for Robust Bin Packing
	Ali Aouad, Danny Segev	Display Optimization for Vertically Differentiated Locations under Multinomial Logit Preferences
	Michal Stern, Nili Guttmann-Beck, Rony Rozen	Removal of vertices in Clustered Spanning Tree
Applied OR 2 Chair: Yale T. Herer	Noemie Balouka, Izack Cohen	A Robust Optimization Approach for the Multi-mode Resource Constrained Project Scheduling Problem
	Claudio Szwarcfiter, Avraham Shtub, Yale T. Herer	Value Stability in Multi-Mode Projects with Stochastic Activity Durations
	Scott Rodilitz, Edward H. Kaplan	Snapshot Models of Undocumented Immigration: Inference from the Mexican Migration Project
	Elise Miller-Hooks	Optimal investment for a resilient global port network
Scheduling 1 Chair: Dvir Shabtay	Baruch Mor, Gur Mosheiov, Dana Shapira	Flowshop scheduling with learning-effect and job-rejection
	Gur Mosheiov, Enrique Gerstl	Minimizing the number of tardy jobs on parallel machines with generalized due-dates
	Nir Halman, Uriel Vinetz	An FPTAS for two variants of "Relocation scheduling subject to fixed processing sequences"
	Ehud Ikar, Tal Grinshpoun, Elad Shufan, Hagai Ilani	Modeling a Complex Real World Manufacturing Scheduling Problem
Queueing 1 Chair: Gabi Hanukov	Efrat Perel, Nir Perel, Uri Yechiali	A Non-Preemptive Polling System with 'Join the Shortest Queue – Serve the Longest' Policy
	Yonit Barron	A threshold policy in a Markov-modulated production system with server vacation: The case of continuous and batch supplies
	Yael Perlman, Uri Yechiali	Tandem Stochastic Networks with Time-Deteriorating Product
	Gabi Hanukov, Uri Yechiali	To App or not to App
Game Theory 1 Chair: Eran Hanany	Nitsan Perach, Shoshana Anily	Stable matching with entrance criterion for teams
	Yael Deutsch, Arieh Gavious	The Profiling Game in Border Crossings
	Igal Milchtaich	Correlated Polyequilibrium
	Eran Hanany, Peter Klibanoff, Sujoy Mukerji	Incomplete Information Games with Ambiguity Averse Players

17:20-22:00	**Evening Program (bus leaves at 17:20)** **17:30:** Guided tour at the Apollonia National Park (in English) **19:30:** Dinner at Bistro 56 in Herzliya. Return by bus to Shefayim hotel.

Detailed Program - Tuesday, 14.5

09:00-09:15	*Registration*

09:15-10:45 Parallel Sessions T1

Game Theory 2 Chair: Ella Segev	David Lagziel, Ehud Lehrer	Anomalies of Screening
	Galit Ashkenazi-Golan, Eilon Solan	The value functions of constrained Markov decision processes
	Gal Cohensius, Urban Larsson, Reshef Meir, David Wahlstedt	Cumulative subtraction games
	Sanjith Gopalakrishnan, Daniel Granot, Frieda Granot	Consistent Allocation of Emission Responsibility in Energy Supply Chains
Energy Chair: Adi Sarid	Adi Sarid, *Michal Tzur*	Power Grid Expansion in Developing Countries: Planning for Equity
	David Raz, Ariel Daliot,, Yuval Beck	Various Approaches to Volt-Var Optimization through Integration of Grid Edge Devices with Traditional Methods
	Irena Milstein, Asher Tishler,	Optimal capacity, production and prices in competitive electricity markets when the effective use of PV varies over the day
	Arik Sadeh, Idan Babay and Cristina Feniser	Optimal Dynamic Pricing of Quality Based Products under Stochastic Preferences
Scheduling 2 Chair: Dvir Shabtay	Hagai Ilani, Lior Aronshtam	Expected Average Attendance in Conferences which are Scheduled by Personalized Approach
	Chen Kaminer, Hussein Naseraldin, Liron Yedidsion	Scheduling Under Uncertainty: the Due-Date Assignment Problem
	Danny Hermelin, Mike Pinedo, Dvir Shabtay and Nimrod Talmon	On the parameterized tractability of single machine scheduling with rejection
	Miri Gilenson, Dvir Shabtay, Liron Yedidsion	Multi-scenario scheduling with an aggregable condition between scenarios
Transportation 2 Chair: Michael Dreyfuss	Yuval Klein, Menachem Sperka, Michael Dreyfuss	Reducing Transportation Cost by Optimizing Freight Utilization - With a Case Study for Intel's supply chain
	Shira Vahav, Mali Sher	Data mining on road accidents and traffic report databases for better operation of the Traffic Police's resources
	Erella Eisenstadt-Matalon, Amiram Moshaiov	Solving the multi-criteria competing TSP using the rationalizability solution concept
	Benjamin Baran, Fabio López-Pires, Daisy Kang	Multi-Objective Government Perspective for Three-Echelon Vehicle Routing

10:45-11:05	*Break*

11:05-12:10 Prize Award Ceremony and Talks ראשונים

Chair and opener: ***Amir Beck***

Prize Session Chair: Amir Beck	Jérôme Bolte, Shoham Sabach, Marc Teboulle and Yakov Vaisbourd	First Order Methods Beyond Convexity and Lipschitz Gradient Continuity with Applications to Quadratic Inverse Problems
	Ohad Eisenhandler, Michal Tzur	The Humanitarian Pickup and Distribution Problem

12:10-13:40	*Lunch* חדר אוכל

13:40-14:30 **Plenary Lecture** **ראשונים**

Speaker: ***Moshe Haviv*, *Hebrew University***

Chair and opener: ***Benny Oz***

14:35-15:20 **Semi-Plenary Tutorial** **T1**

Speaker: ***Shoham Sabach*, *Technion*** **ראשונים**

Chair and opener: ***Michal Penn***

Speaker: ***Yigal Gerchak*, *Tel Aviv University*** **יערה**

Chair and opener: ***Michal Tzur***

15:20-15:40	*Break*

15:40-17:10 **Parallel Sessions** **T2**

Strategic Queuing Chair: Yoav Kerner	Yair Shaki, Uri Yechiali and Michael Dreyfuss	A note on the double parking problem
	Laurens G. Debo and Ran I. Snitkovsky	Tipping as a Social Norm in Service Systems
	Moshe Haviv and Binyamin Oz	Social cost of deviation: new and old results on optimal customer behavior in queues
	Antonio Castellanos, Galit B. Yom-Tov, Yair Goldberg	Estimating Patience with Silent Abandonment
Healthcare Chair: Dan Yamin	Nitzan Carmeli, Galit Yom-Tov, Avishai Mandelbaum	Balancing of Load (Operational, Emotional, Cognitive) in Service System (Hospitals, Contact Centers)
	Zvi Lapp, Ariel Rosenfeld	Optimizing Medical Imaging Exposure in Radiologist Worklist
	Hanan Rosemarin, Ariel Rosenfeld	Emergency Department Online Patient-Caregiver Scheduling
	Yakir Berchenko	Optimal Control and Surveillance of Disease
Continuous Optimization 2 Chair: Tomer Shushi	Alexander J. Zaslavski	Optimal control problems arising in the forest management
	Tomer Shushi, Zinoviy Landsman, Udi Makov	Analytic solution of a portfolio optimization problem in a mean-variance-skewness model
	Royi Jacobovic, Offer Kella	Steady-state optimization of an exhaustive Levy storage process with intermittent output and random output rate.
	Michael Dreyfuss, Yahel Giat	Allocating spares to maximize the window fill rate in a periodic review inventory system
Transportation 3 Chair: Tomer Toledo	Edison Avraham, Tal Raviv	Data driven optimization of the time dependent travelling sales person with soft time windows
	Ayelet Gal-Tzur	Exploring the potential of Bluetooth-based trajectory clustering for providing personalized transit services
	Nicole Adler, Amir Brudner	Hotelling and aviation: The case of a multi-airport system
	Oren E. Nahum, Guy Wachtel, Yuval Hadas	Planning tourists' evacuation routes with minimal navigation errors

Plenary Lectures

Naor Plenary Lecture

Chair and opener: ***Shimrit Shtern***

Speaker: ***Daniel Kuhn, EPFL***

"Dice"-sion Making under Uncertainty: When Can a Random Decision Reduce Risk?

Stochastic programming and distributionally robust optimization seek deterministic decisions that optimize a risk measure, possibly in view of the most adverse distribution in an ambiguity set. We investigate under which circumstances such deterministic decisions are strictly outperformed by random decisions which depend on a randomization device producing uniformly distributed samples that are independent of all uncertain factors affecting the decision problem. We find that in the absence of distributional ambiguity, deterministic decisions are optimal if both the risk measure and the feasible region are convex, or alternatively if the risk measure is mixture-quasiconcave. We show that several classes of risk measures, such as mean (semi-)deviation and mean (semi-)moment measures, fail to be mixture-quasiconcave and can therefore give rise to problems in which the decision maker benefits from randomization. Under distributional ambiguity, on the other hand, we show that for any ambiguity averse risk measure there always exists a decision problem (with a nonconvex—e.g., mixed-integer—feasible region) in which a randomized decision strictly dominates all deterministic decisions.

Plenary Lecture

Chair and opener: ***Yale T. Herer***

Speaker: ***Yuval Emek, Technion***

Approximating Generalized Network Design under (Dis)economies of Scale with Applications to Energy Efficiency

In a generalized network design problem, a set of resources are assigned (non-exclusively) to multiple requests.
Each request contributes its weight to the resources it uses and the total load on a resource is then translated to the cost it incurs via a a resource specific cost function.
Motivated by energy efficiency applications, recently, there is a growing interest in (generalized) network design using cost functions that exhibit (dis)economies of scale, namely, cost functions that appear subadditive for small loads and superadditive for larger loads.

In this talk, we discuss a new generic technique that yields improved approximation results for a wide family of requests, including routing requests and various types of Steiner tree and Steiner forest requests in both directed and undirected graphs.
Our technique is based on associating each request with a strategic player, transforming the centralized optimization problem into a game, and then, obtaining the desired solution via a best response dynamics.
Relying on Roughgarden's smoothness toolbox (JACM 2015), we show that this inherently decentralized process outperforms the state-of-the-art centralized algorithms, thus demonstrating the possible usefulness of this toolbox in the area of approximation algorithms

Based on a joint work with Shay Kutten, Ron Lavi, and Yangguang Shi (STOC 2018).

Plenary Lecture

Chair and opener: ***Benny Oz***

Speaker: ***Moshe Haviv, Hebrew University***

Externalities, optimization and regulation in queues

This year we celebrate 50 years for P. Naor seminal paper which established the area of research on strategic customers' behavior in queues, how it differs from the socially optimal one and how the two can be aligned. The source of this discrepancy is due to the fact that customers mind only their own waiting and ignore the externalities they inflict on others in the form of adding them extra waiting times. The academic research on queues deals mostly with waiting. Yet, the externalities, are of no less, if not of more, importance. The talk will deal mostly with how the analysis of externalities leads to the socially optimal behavior, while solving queueing dilemmas such as whether or not to join a queue, when to arrive to a queue, or from which server to seek service at. Customers, being selfish, do not mind the externalities they impose on others. We show how in queues too, internalizing the externalities leads to self regulation. In this setting selecting the service regime is one of the tools in one's arsenal. The talk will deal with both unobservable queues, as well as with observable ones, where Naor's model will be revisited.

(Joint with Binyamin Oz)

Semi-Plenary Tutorials

M1

Chair and opener: ***Yoav Kerner***

Speaker: ***Baron Opher, University of Toronto***

Data Driven Forecasting and Revenue Management under Reference Prices with Exposure Effect

We use data on the retail business of TMall to consider revenue management in the presence of reference prices and its scalable implementation, i.e., tractability for thousands of items. We consider questions as: Does reference price improve demand forecasts and revenue management? And, does considering exposure effect in the formation of reference price forecasts benefit their accuracy and revenue management? Revenue management considers the impact of prices on current and future sales via forecasts. The related literature uses reference price to study this impact empirically and theoretically. It ignores the exposure effect on reference price. Moreover, the scalability of revenue management in the presence of reference price effect is not well established. We (I) develop scalable, data driven methodologies to compare the effectiveness of different forecasts, (II) demonstrate these methodologies, (III) introduce models capturing the exposure effect on reference price, and (IV) formulate and study theoretically and numerically the revenue management problem when forecasts are reference price-dependent. We provide a foundation for systematic implementation of revenue management in the presence of reference price effects. We (I) formulate the impact of exposure effect on reference price and demonstrate the effectiveness of forecasts with reference price effects; and (II) based upon theoretical results demonstrate that revenue management could benefit from exposure-dependent reference price models in practice. The improved accuracy and robustness of revenue management performance of our forecasting models with reference price affected by customers' exposure support their usage in practice.

(Joint with Deng Chang, He Simai, Yuan Hongsong)

M2

Chair and opener: ***Tal Raviv***

Speaker: ***Hillel Bar-Gera, Ben-Gurion University***

The roles of ownership and service in mobility: trends, opportunities and challenges

Disruptive technological innovation in transportation is attracting increasing attention in recent years. Leading mega-trends include driving automation, electric propulsion, and Mobility as a Service (MAAS). This presentation will focus on current changes in mobility services, and their influence on vehicle ownership and on the overall performance of the transportation system.

Similar to the housing market, mobility was always provided partly by ownership and partly as a service. As ownership approaches saturation, ownership motivations are declining (especially among younger generations). At the same time, Transportation Network Companies (TNC), like UBER, LYFT, DIDI and others, offer low-cost on-demand personal mobility solutions. Their impact appears to be less ownership and more congestion. Shared mobility services are offered by the above mentioned TNC's, as well as other companies (e.g. VIA). The scope and prospects of such services are yet to be determined. There are many research questions in this domain, such as: What are the best niches for shared mobility solutions? What are the roles of competition and scale? What should be the commitment of service providers and users?

In addition to ride-sharing, new vehicle-sharing options are also advancing. Passenger cars are available for short-term rentals from companies (e.g. Car2Go) as well as peer-to-peer (e.g. TORO). Micro-mobility rental solutions include bikes (e.g. Tel-O-Fun, mobike) and scooters (e.g. BIRD, LYME). Some are docked and some are dockless. Research questions include balancing supply and demand, traffic safety, parking footprint, and more.

The new trends challenge the role of traditional mobility services, i.e. buses and trains. Should they focus on low-cost mobility for captive users, or on efficient mobility in high-volume corridors? Are there effective solutions for the first-and-last mile that can enable competitive door-to-door service? Should subsidies continue in their present form?

The exploding multitude of mobility services raises the need for aggregators (e.g. WHIM in Helsinki). Door-to-door trip planning is becoming a challenging combinatorial problem, making mobility service literacy (or public transport literacy) a non-trivial competence. Additional roles of aggregators could be pricing, ticketing, bundling mobility packages, and more. Market structure, competition, collaboration and commitment are core issues yet to be explored.

In summary, the strong trends associated with MAAS offer exciting opportunities as well as challenging policy and research questions.

T1

Chair and opener: ***Michal Tzur***

Speaker: ***Yigal Gerchak, Tel Aviv University***

Bargaining over Allocations of Uncertain Future Profits

We address the following basic question: How should two parties, with possibly different risk-attitudes and/or beliefs, who are contemplating creating a partnership, divide uncertain future profits? We assume here that the formula for division of profits is a result of negotiations, and model it first via Nash-bargaining-like (NBLS) solution, that reverts to the NBS for risk-neutral parties. After characterizing the optimal contract using calculus of variations, we assume a linear contract (most common in practice) and find its optimal parameter values for various cases of interest. We then consider division based on the Raiffa-Kalai-Smorodinsky-like (KSL) solution (which reverts to the KS solution for risk-neutral parties. We also address asymmetric NBSL and asymmetric KSL solution.

T2

Chair and opener: ***Michal Penn***

Speaker: ***Shoham Sabach, Technion***

Proximal minimization algorithms for nonconvex and nonsmooth problems

We introduce a self-contained convergence analysis framework for first-order methods in the setting of nonconvex and nonsmooth optimization problems.
Our approach builds on the powerful Kurdyka-Lojasiewcz property. It allows for analyzing, under mild assumptions, various classes of nonconvex and nonsmooth problems with semi-algebraic data, a property shared by many optimization models arising in various fundamental applications. We illustrate our results by deriving a new and simple proximal based algorithm, which exploits structure and data information relevant to important applications and paves the ways to the derivation other interesting algorithmic variants

Prize Session

Prize Session Chair: ****	Jérôme Bolte, Shoham Sabach, Marc Teboulle and Yakov Vaisbourd	First Order Methods Beyond Convexity and Lipschitz Gradient Continuity with Applications to Quadratic Inverse Problems
	Ohad Eisenhandler, Michal Tzur	The Humanitarian Pickup and Distribution Problem

Prize Session- Chair: *****

Jérôme Bolte, Shoham Sabach, Marc Teboulle and Yakov Vaisbourd

First Order Methods Beyond Convexity and Lipschitz Gradient Continuity with Applications to Quadratic Inverse Problems

We focus on nonconvex and nonsmooth minimization problems with a composite objective, where the differentiable part of the objective is freed from the usual and restrictive global Lipschitz gradient continuity assumption. This longstanding smoothness restriction is pervasive in first order methods, and recently was circumvented for convex composite optimization by Bauschke, Bolte and Teboulle, through a simple framework which captures, all at once, the geometry of the function and of the feasible set. Building on this work, we tackle genuine nonconvex problems. We first complement and extend their approach to derive an extended descent lemma by introducing the notion of smooth adaptable functions. We then consider a Bregman-based proximal gradient methods for the nonconvex composite model with smooth adaptable functions, which is proven to globally converge to a critical point under natural assumptions on the problem's data, and in particular for semi-algebraic problems. To illustrate the potential of our general framework and results, we consider a broad class of quadratic inverse problems with sparsity constraints which arises in many fundamental applications, and we apply our approach to derive new globally convergent schemes for this class.

Ohad Eisenhandler, Michal Tzur

The Humanitarian Pickup and Distribution Problem

Food rescue, i.e., the collection of perishable products from food suppliers who are willing to make donations and their distribution to welfare agencies that serve individuals in need, has become increasingly widespread in recent years. This is due to economic crises that have increased the demand for nutritional aid, and the benefit to donors who can avoid in this way the costs of destroying excess production while reflecting a social-aware image.
The problem we study focuses on the logistic challenges of a food bank coordinating this operation on a daily basis, using vehicles with limited capacity whose travel time cannot exceed an imposed maximal duration (defined by the driver's working hour regulations). We model this problem as a routing–allocation problem, with the aim of maintaining equitable allocations to the different agencies in each period, while delivering as much as possible in total. We discuss an appropriate objective function that promotes effectiveness and equity. We show how these two measures can be combined in a way that satisfies desired properties of the allocation, that is easy to compute and implement within a mathematical formulation, and that balances effectiveness and equity acceptably. We discuss alternative objectives prevalent in the literature and how they relate to our objective. We also present characteristics of the optimal solution to the problem, an efficient algorithm to solve the allocation sub-problem, as well as exact and heuristic approaches to solve the problem.

Book of abstracts (grouped by session)

Monday, 13.5

M1

Continuous Optimization Chair: Shimrit Shtern	Nadav Hallak, Marc Teboulle	A Simple Second-Order Feasible Direction Method for Constrained Smooth Problems
	Rafał Zalas, Victor I. Kolobov, Simeon Reich	Finitely Convergent Projection Methods
	Eyal Gur, Shoham Sabach, Shimrit Shtern	Globally Convergent First-Order Methods for Sensor Localization

Continuous Optimization - Chair: Shimrit Shtern

Nadav Hallak, Marc Teboulle

A Simple Second-Order Feasible Direction Method for Constrained Smooth Problems

This talk presents a simple second order feasible directions method to obtain the second order optimality condition for the problem of minimizing a twice continuously differentiable smooth function over closed convex set. The second-order optimality condition is especially important when solving nonconvex problems, as it serves as a better indicator for local optimality, compared to the first order optimality condition. Notwithstanding, obtaining points satisfying the second order condition is usually hard in unconstrained optimization, and even harder in constrained optimization. Accordingly, in order to obtain second order points, methods appearing in the literature require substantial assumptions and complex steps. In this talk I will present a second-order feasible direction method whose limit points satisfy the second order condition, in the worst-case, up to a degree of precision. For the unconstrained case, the method is reduced to a very simple procedure whose limit points satisfy the second order condition without any precision dependencies. The method employs, as a part of its procedure, a generic first order step that is based on the notion of closed map algorithms, making it versatile and adjustable. A convergence rate of the proposed method is also derived. Numerical experiments demonstrate the performance of the method in nonconvex problems. Our guiding principle is simplicity, so over-complicated special assumptions are avoided.

Rafał Zalas ,Victor I. Kolobov, Simeon Reich

Finitely Convergent Projection Methods

In this talk we propose a finitely convergent method for solving the convex feasibility problem. Following other works in this area, for example, by Polyak (2001) and more recently, by Baushcke et al. (2015), we assume that the interior of the solution set is nonempty and that certain parameters form a divergent series. Due to the infinite pool of operators (cutters) that we allow in our method, we introduce a new cardinality condition which holds naturally for many known projection and subgradient projection methods as we demonstrate in this talk. In particular, it is satisfied for methods governed by cyclic, almost cyclic and even repetitive controls. Moreover, it is almost surely satisfied for random controls.

Eyal Gur, Shoham Sabach, Shimrit Shtern

Globally Convergent First-Order Methods for Sensor Localization

A wireless sensor network consists of several sensors deployed in a given area, for purposes such as environment monitoring, battlefields surveillance and more. Each sensor is a low-powered radio transceiver which monitors its immediate surroundings (e.g., for temperature, sound, etc.), and the data is collected by a processor. Therefore, the location of each sensor has a significant role. Since the number of sensors in a network can be large (even thousands of sensors), it is not cost effective to equip each of them with a GPS device, nor to deploy the sensors in a known logged location. In the sensor localization problem, we aim to find the location of all sensors in the network based on a few anchor sensors that have an approximate known location (e.g., via GPS devices), and noisy distance measurement from each sensor to its neighbors. We focus on a statistically based formulation of the sensor localization problem, which is non-smooth and non-convex. We develop several first-order iterative algorithms for this problem, which can all be applied in a distributed or centralized configuration. To the best of our knowledge, we are the first to establish a globally convergent, computationally efficient algorithms, that are based on a non-relaxed model formulation and can be applied to large-scale networks.

Transportation 1 Chair: Yuval Cohen	Ran Etgar, Erel Avineri, Yuval Cohen	Improving Personal Rapid Transportation system by utilizing smart distribution rules
	Yuval Cohen, Erel Avineri	Polynomial Time Optimization of Road Construction Portfolio Selection under Limited Local Authorities Budgets
	Erel Avineri,Yuval Cohen, Ran Etgar	Simulating Elevated Rapid Transit System for Performance Analysis

Transportation 1 - Chair: Yuval Cohen

Ran Etgar, Erel Avineri, Yuval Cohen

Improving Personal Rapid Transportation system by utilizing smart distribution rules

Personal Rapid Transportation (PRT) is a new concept in urban transportation. PRT utilizes the third dimension to provide a quick and reasonably-priced solution to the 'last mile' transportation problem. The PRT combines a network of elevated routes and fast-moving automated pods containing a person or two.
Literature on the subject of PRT capacity tend to ignore the stochastic nature of the demand and also ignore the asymmetrical demand patterns. Thus, artificially increasing the network capacity far beyond its actual capabilities.
By means of a detailed simulation model, the research proved that a typical asymmetrical demand decreases system performance significantly. However, some of this reduction can be obtained back using smart pod re-distribution rules. The research aims to search for optimal, yet simple rules to increase the performance of PRT network.

Yuval Cohen, Erel Avineri

Polynomial Time Optimization of Road Construction Portfolio Selection under Limited Local Authorities Budgets

During the last decades, road network design experienced intensive proliferation of models and research. In most cases, a limited budget must be spent over time in a balanced way to build the best subset of road links from a large set of possible road links. This paper tackles a special case where budgets of separate local entities located in the same geographical area of a regional authority that tries to optimize the selection of a road projects subset to be built. Such problem arises in places where local authorities, regions, or towns allocate annual budgets for regional road construction, or in cases where several boroughs in the same urban area earmark budgets for that purpose. The non-polynomial complexity of existing formulations is prohibitive and dictates the use of search techniques for solutions. This research presents a polynomial time technique to model and optimize the selection of a subset of new road links for construction.
While the original problem could be formulated as a type of a knapsack problem (which is NP), using monetary units as the only measure is a key for getting a network flow formulation leading to a polynomial time solution. We discuss the considerations and possibilities of converting driving time, utility, and demand to monetary units.
The technique uses a transfiguration of the problem into a minimum cost network flow problem which ensures optimal solution in a polynomial time. A variation of the formulation for network design is presented which finds the optimal flow of the network. The paper presents a small example to illustrate the technique and some of its variations

Erel Avineri,Yuval Cohen, Ran Etgar

Simulating Elevated Rapid Transit System for Performance Analysis

In this research we explore the feasibility and the performance of a rather innovative way to travel in our cities: Personal rapid transit (PRT). PRT combines the benefits of personal (car) travel with the operational benefits of transit. PRT main elements are small automated vehicles (sometimes referred to as podcars) operating on a network of specially built guideways. The research is looking at a specific concept of elevated PRT system.
Literature review has revealed the drawbacks PRT modelling and simulation approaches, mainly due to the lack of consideration of technical and operational features of the system (such as headways, acceleration, safety issues); the detailed design of infrastructure (guideways, stations and docks); the stochastic and sessional characteristics of demand; and safety regulations – all of them have a strong effect on the system performance.
A highly detailed model of the system, developed in this research, is applying a discrete event simulation combined with an agent-based approach, to represent the system elements and the podecars movement logic. Applying a case study approach, the simulation model is used to study the capacity of the system, the expected throughput of the system, the utilization, and the level of service (journey time, waiting time, etc.).

Sustainable Supply Chain Management Chair: Yael Perlman	Konstantin Kogan, Tatyana Chernonog	Competition under Industry-Stock-Driven Prevailing Market Price: Environmental Consequences and the Effect of Uncertainty
	Gal Raz, Gil (Gilvan) Souza	Recycling as a Strategic Supply Source
	Yael Perlman, Hilla Caspi	Consumer environmental awareness and privatization

Sustainable Supply Chain Management - Chair: Yael Perlman

Konstantin Kogan, Tatyana Chernonog

Competition under Industry-Stock-Driven Prevailing Market Price: Environmental Consequences and the Effect of Uncertainty

We address competition between several firms that cause pollution when producing fully substitutable products. These firms comprise the industry and each individual firm charges for its products the market price determined by the difference between cumulative market supply and demand, i.e., by the industry's stock. We find that although the greater the number of firms competing for the same primary market, the lower the market price and the higher the industry inventory surplus, the reduction in price at market equilibrium is insufficient to stimulate greater aggregate sales. That is, greater competition does not necessarily induce higher industry output and pollution.

Gal Raz, Gil (Gilvan) Souza

Recycling as a Strategic Supply Source

We investigate how recycling can be a strategic source of supply in the presence of a changing supply market. This research is inspired by the metal cutting tools industry, where challenges regarding a key raw material present an opportunity for the manufacturers to create an alternative supply source by recycling. In this study, there is a virgin material market that supplies two manufacturers differentiated in their recycling ability. The problem is formulated as a game, where the manufacturers first make a decision to recycle or not, and then decide on their respective production quantities, and recycling rates. Depending on the fixed recycling cost relative to the unit cost of the virgin material, as well as the recycling cost structure of the two manufacturers, there are four possible equilibria: both manufacturers recycle, neither manufacturer recycles, only the more recycling-capable manufacturer recycles, or a scenario with two Nash equilibria (either manufacturer recycles whereas the other does not). We show that recycling is indeed a strategic supply source resulting in higher quantities and profits. Interestingly, a manufacturer may recycle less if the unit cost of the virgin material increases, at high recycling rates. This result emphasizes the importance of carefully modeling the recycling cost structure. Although a recycled unit has necessarily a lower life-cycle environmental impact than a unit made of virgin materials, the industry-wide environmental impact can be higher in a recycling scenario due to higher production quantities overall. Welfare, however, is higher with recycling.

Yael Perlman, Hilla Caspi

Consumer environmental awareness and privatization

We investigate the impact of consumers' environmental awareness on the level of privatization in a duopolistic market. A two-stage game model is developed where the government first chooses the degree of privatization of the public firm by deciding on the weight that the public firm should give to the social welfare. In the second stage, both firms determine simultaneously and independently the eco-friendly investment level and the production quantity level. For different government's objectives, we identify the conditions for partial or full privatization to be beneficial.

Applied OR 1 Chair: Yahel Giat	Shany Azaria, Boaz Ronen, Noam Shamir	Justice In Time: Applying Operations Theory to Court Systems – The Case of the Jerusalem District Court
	Yahel Giat	A single-sided location model for boycotting with an application to restaurants' kosher certification
	Michael Naor	Deployment of Field Hospitals to Disaster Regions

Applied OR 1- Chair: Yahel Giat

Shany Azaria, Boaz Ronen, Noam Shamir

Justice In Time: Applying Operations Theory to Court Systems – The Case of the Jerusalem District Court

Operations management has had a significant impact on production, supply-chain management, service organizations, healthcare systems and much more. However, in spite of the great contributions of this field, there has been little attempt to apply insights from operations management to improve the legal process.
Research shows that law court systems worldwide typically have a resource constraint that leads to long lead times, low throughput, low service quality, and dissatisfaction of customers and the public. As in other systems, all these operational deficiencies also have a negative impact on the judicial quality. At the same time, the demand for judicial intervention is increasing constantly, and so are the costs of law court systems. Clearly, a suitable methodology for managing the operations of law courts to improve their efficiency without impairing judicial professionalism is required. The law community has developed many tools and practices for court management, and even case-flow management. They did not, however, lean on the vast knowledge that the OR community has built over the years.
Given these circumstances, we suggest examining the suitability of implementing tools from various disciplines in OR to the court system, and more importantly the potential effect it would have.
We report in this research the results of a pilot implementation conducted on civil cases in the Jerusalem district court in Israel. The pilot, initiated by former chief justice Dorit Beinisch in 2008, focused on methods of reducing Lead Time (LT) and reducing waste by implementing three methodologies: (1) Complete Kit (CK) alongside Interdisciplinary Project Team principles; (2) case-level FIFO scheduling policy; (3) oral summations as a method to reduce waste.
Our econometrical analysis shows a significant reduction in the trial time of over 8 months, 40% improvement, which translates to 19% reduction in the total life cycle of a case. These results, based on a before-after comparison, show the potential of using operational methods to improve the efficiency of the judicial process.

Yahel Giat

A single-sided location model for boycotting with an application to restaurants' kosher certification

In this research we develop a theoretical single-sided location model that predicts the ethical behavior of firms when they operate in a market with consumer boycotts and apply it to a practical issue in Israel. In this model, consumer boycotting implies that if they perceive some of the firm's activities as unethical, then they will refuse to purchase from it even products that are not the result of the unethical behavior. In our continuous model we assume that consumers are distributed along a line segment that represents an ethical scale and they purchase only at firms that meet their ethical level. Firms locate themselves on the ethical scale with the sole purpose of maximizing profits. We begin by developing the profit-maximization necessary conditions for equilibrium. Next, we consider the simple case in which consumers are uniformly distributed, and show that the equilibrium is unique. Further, we show numerically that when customers are distributed uniformly then in equilibrium, the firms will be distributed symmetrically – but not uniformly - around the center location. Additionally, we demonstrate how the effectiveness of boycotts diminishes as the number of firms increases. In our model's application, we consider a discrete version of the theoretical model that models the issue of restaurant kosher certification in Israel. In this application, we view kosher-keeping customers as boycotting non-certified restaurants since these customers generally refuse to dine in these restaurants even menu items that are (presumably) kosher. We derive the relationship between the percent of kosher-keeping consumers and the equilibrium number of certified restaurants. Using population and restaurant data from Israel's eight largest cities we estimate the implied cost of certification and the relative purchasing power of kosher-keeping customers. Despite the significant implied cost of certification, we find that the percentage of kosher restaurants is usually considerably higher than the percent of kosher-keepers in the population. This happens because the necessity of certification forces kosher-keeping customers to boycott non-certified restaurants and as a result restaurants have a powerful incentive to certify. Interestingly, this problem demonstrates how a limiting restriction (i.e., being restricted to certified restaurants) may turn out to be an empowerment. In contrast to kosher-keeping customers, vegetarian customers are more

agreeable to eating vegetarian dishes in restaurants that also serve non-vegetarian food. As long as this is the case there will be little incentive for purely vegetarian restaurants to open.

Michael Naor

Deployment of Field Hospitals to Disaster Regions

The Israeli Defense Force (IDF) Medical Corps developed a model of airborne filed hospital. This model was structured to deal with disaster settings, requiring self-sufficiency, innovation and flexible operative mode in the setup of large margins of uncertainty regarding the disaster environment. The current study is aimed to critically analyze the experience gathered in international missions.

Supply Chain Management Chair: Tal Avinadav	Tal Avinadav	The effect of decision rights allocation on a supply chain of perishable products under a revenue-sharing contract
	Nelly Bart, Tatyana Chernonog, Tal Avinadav	A survey on revenue sharing contracts in operations management
	Tatyana Chernonog	Inventory and marketing policy in a supply chain of a perishable product

Supply Chain Management- Chair: Tal Avinadav

Tal Avinadav

The effect of decision rights allocation on a supply chain of perishable products under a revenue-sharing contract

Using the framework of an economic order quantity (EOQ) model, we study marketing and operational decisions in a two-echelon supply chain in which a retailer and a manufacturer use a revenue-sharing contract to sell a perishable product. The demand function is sensitive to price, sales effort and the age of the product on shelf. We take into account the issue of decision rights allocation with respect to both sales-effort investment and replenishment policy. In particular, we investigate and compare the performance of the individual parties and of the total supply chain across six scenarios: three in which the investment in sales effort is made by the retailer, and three in which the investment in sales effort is made by the manufacturer, where in each group the cycle length is set either by the retailer, by the manufacturer or in a cooperative manner. We show that when one party determines the cycle length, there are certain conditions under which a two-part tariff contract can be used by the other party in order to influence the cycle length decision, and thus to increase its profits. In addition, we show that there are cases in which both parties benefit when the manufacturer is responsible for investing in sales effort, such that it is in the retailer's interest to give up her decision right in this regard

Nelly Bart, Tatyana Chernonog, Tal Avinadav

A survey on revenue sharing contracts in operations management

This paper is the first to review the issue of revenue-sharing contract (RSC) in a supply chain management. This contract has gained excessive popularity over the last two decades, since it coordinates the supply chain. Two formats of this contract are primarily used in practice and thoroughly investigated in the literature: (i) a wholesale-price contract with an added revenue-sharing mechanism; (ii) a consignment contract with revenue sharing. The latter format is used by mega platform distributors such as Apple iTunes, Google Play and Amazon. To evaluate developments and directions of this research area, this survey provides a content analysis of 106 carefully identified papers that address various aspects of RSC in Operations Research and Management. Our survey classifies the reviewed papers according these aspects and provides mathematical formulation for different variants of these two major formats of RSC. It also provides opportunities to identify gaps in the literature that could be fulfilled as well as potentials for further research directions.

Tatyana Chernonog

Inventory and marketing policy in a supply chain of a perishable product

We investigate a two-echelon supply chain comprising a manufacturer and a retailer, who are negotiating a wholesale price contract for a perishable product. Product demand depends on the selling price, the level of advertising, and the time a unit spends on the shelf before being sold. The investment in advertising can be made either by the manufacturer, by the retailer or in a cooperative manner. The parties apply an economic order quantity policy, where the cycle length is being set endogenously by the leader of the supply chain. Different power balances between the parties and their effect on the supply chain measures are investigated. In particular, we analyze two cases: manufacturer leader and retailer leader. For each one, equilibrium is obtained for two demand forms: additive and

multiplicative advertising effects. We find that for a given type of advertising investment (cooperative/non-cooperative) and a given cycle length, the variable profit of each party is determined only by its role (leader/follower) and not by its identity (manufacturer/retailer). This result is valid for a general cost function of advertising and a general marketing demand form. Interestingly, the participation of each party in the advertising investment is independent of the model parameters, but depends only on the sequence of decisions, and thus, even if the parties have different beliefs regarding the values of the model parameters, it will not affect their investment shares.

M2

Combinatorial Optimization Chair: Danny Segev	Nir Halman, Giacomo Nannicini	Toward Breaking the Curse of Dimensionality: An FPTAS for Stochastic Dynamic Programs with Multidimensional Action and Scalar State
	Noam Goldberg, Shlomo Karhi, Michael Poss	Multi-type Bin Packing and Extensions for Robust Bin Packing
	Ali Aouad, Danny Segev	Display Optimization for Vertically Differentiated Locations under Multinomial Logit Preferences
	Michal Stern, Nili Guttmann-Beck, Rony Rozen	Removal of vertices in Clustered Spanning Tree

Combinatorial Optimization - Chair: Danny Segev

Nir Halman, Giacomo Nannicini

Toward Breaking the Curse of Dimensionality: An FPTAS for Stochastic Dynamic Programs with Multidimensional Action and Scalar State

We propose an FPTAS for stochastic dynamic programs with multidimensional action, scalar state, convex piecewise linear costs and linear state transition function. The action spaces are polyhedral and described by parametric linear programs. The FPTAS relies on the solution of polynomial-sized linear programs to recursively compute an approximation of the value function at each stage. Our paper enlarges the class of dynamic programs that admit an FPTAS by showing how to deal with multidimensional action spaces and with vectors of continuous random variables under suitable conditions, therefore getting one step closer to overcoming the curse of dimensionality of dynamic programming.

Ali Aouad, Danny Segev

Display Optimization for Vertically Differentiated Locations under Multinomial Logit Preferences

We introduce a new optimization model, dubbed the display optimization problem, that captures a common aspect of choice behavior, known as the framing bias. In this setting, the objective is to optimize how distinct items (corresponding to products, web links, ads, etc.) are being displayed to a heterogeneous audience, whose choice preferences are influenced by the relative locations of items. Once items are assigned to vertically differentiated locations, customers consider a subset of the items displayed in the most favorable locations, before picking an alternative through Multinomial Logit choice probabilities.

The main contribution of this paper is to derive a polynomial-time approximation scheme for the display optimization problem. Our algorithm is based on an approximate dynamic programming formulation that exploits various structural properties to derive a compact state space representation of provably near-optimal item-to-position assignment decisions. These properties include unimodality of the expected revenue function, precedence order across subsets of items, and parametric rounding techniques, just to name a few. As a by-product, our results improve on existing constant-factor approximations for closely related models, and apply to general distributions over consideration sets. We also develop the notion of “approximate assortments”, that may be of independent interest and applicable in additional revenue management settings. In computational experiments, our algorithm dominates various benchmarks, including natural heuristics – greedy methods, local-search algorithms, and priority rules – as well as state-of-the-art algorithms proposed for closely-related problems.

Noam Goldberg, Shlomo Karhi, Michael Poss

Multi-type Bin Packing and Extensions for Robust Bin Packing

We consider a multi-type bin packing problem motivated by different requirements of items that could be shipped in either standard or costlier refrigerated containers and items that must be shipped in refrigerated containers. We

generalize our previous results in the online setting for two item sizes to general item sizes. Our results include a 1.781 lower bound and 1.930 upper bound on the absolute competitive ratio. We next model the problem as a robust two-stage two-item type offline bin packing problem. In the first stage, bins of different types are acquired. In the second stage, the items are packed into bins. The bins that are secured in the first phase must allow for all of the items to be packed in the worst-case scenario. We develop closed-form solutions for the optimal solution and an algorithm for some special cases of this problem. We conclude with some approximation algorithm results for robust classical bin packing with uncertain item sizes under the budgeted and knapsack uncertainty models.

Michal Stern, Nili Guttmann-Beck, Rony Rozen

Removal of vertices in Clustered Spanning Tree

Let H=<G, S > be a hypergraph, where G=(V,E) is a complete undirected graph and S is a set of non-disjoint clusters S1,S2,…,Sm such that each Si is contained in V. The Clustered Spanning Tree problem is to find a spanning tree of G which satisfies that each cluster induces a subtree, when it exists.

We consider hypergraphs with no feasible solution. For these hypergraphs we suggest a way to choose vertices to be removed in order to gain feasibility, using a special layers graph which represents the clusters' intersections. This paper presents algorithms which find a possible list of vertices whose removal creates a new hypergraph, which has a feasible solution tree, and construct the corresponding solution tree. When all intersections contain more than half of the vertices in V, we prove that the given hypergraph has a feasible solution tree and no vertices removals are required. For slender reduction graphs, where no intersection set contains another intersection set, our algorithms achieve a minimum cardinality list of vertices removals.
We also present algorithms which either ensure that after the vertices removals, every vertex will stay in at least one cluster, or that every cluster will still contain at least one vertex.

Applied OR 2 Chair: Yale T. Herer	Noemie Balouka, Izack Cohen	A Robust Optimization Approach for the Multi-mode Resource Constrained Project Scheduling Problem
	Claudio Szwarcfiter, Avraham Shtub, Yale T. Herer	Value Stability in Multi-Mode Projects with Stochastic Activity Durations
	Scott Rodilitz, Edward H. Kaplan	Snapshot Models of Undocumented Immigration: Inference from the Mexican Migration Project
	Elise Miller-Hooks	Optimal Investment for a Resilient Global Port Network

Applied OR 2 – Chair: Yale T. Herer

Noemie Balouka, Izack Cohen

A Robust Optimization Approach for the Multi-mode Resource Constrained Project Scheduling Problem

We formulate a robust optimization model for the multi-mode resource-constrained project scheduling problem (MRCPSP) with uncertain activity durations. The objective is to define a project plan that includes selected modes, resource allocations and a project schedule that minimize the worst-case project duration, under polyhedral uncertainty sets. A Benders decomposition approach is proposed to solve the robust counterpart of the suggested model. The solution approach involves iterative solutions of two optimization problems: A master problem that selects activity modes and allocates resources to activities to minimize the project duration using nominal activity durations, and a subproblem that uses the master solutions to find the longest network path for a given uncertainty set.
We develop valid and optimality cuts, which are added in each iteration to the master problem and guarantee convergence to the optimal solution. Within a budgeted uncertainty set, characterized by a parameter that controls the level of conservativeness, the subproblem is polynomially solvable.
We conduct computational experiments for analyzing the price of robustness under varying levels of uncertainty. The results provide managerial insights regarding to the performance of robust policies under various conditions, compared to their respective utopian and deterministic policies. These demonstrate the conditions under which the robust approach may be favorable with respect to deterministic policies and the general conditions under which the price of robustness is relatively low.

Claudio Szwarcfiter, Avraham Shtub, Yale T. Herer

Value Stability in Multi-Mode Projects with Stochastic Activity Durations

We developed a reinforcement learning-based algorithm to maximize project value or benefit subject to due date and budget constraints in multi-mode projects. Each activity mode, apart from containing cost and duration data, may be

associated with one or more value attributes, thus integrating project scope and product scope. The activity durations are stochastic and we find solutions that satisfy given on-time and on-budget probabilities. By selecting a mode for each activity, the value of the project is determined, and stability is achieved by the insertion of time buffers according to the modes selected. In our experiments, our algorithm outperformed a previously published genetic algorithm.

Scott Rodilitz, Edward H. Kaplan

Snapshot Models of Undocumented Immigration: Inference from the Mexican Migration Project

The Mexican Migration Project (MMP) is a nearly 40 year study that includes samples of undocumented Mexican immigrants to the United States after their return to Mexico. Of particular interest are the departure and return dates of a sampled migrant's most recent sojourn in the United States, and the total number of such journeys undertaken by that migrant household, for these data enable the construction of data-driven undocumented immigration models. The probability distribution of the sojourn time undocumented immigrants spend in the United States on a given visit is of independent interest to demographers and migration scholars, and is also critical for estimating the population of such undocumented immigrants in the US. Recently, demographers attempted to represent this distribution directly from sample sojourn time frequencies in the MMP. However, such data are subject to an extreme physical bias, for to be included in such a sample, a migrant must have returned to Mexico by the time of the survey, excluding those undocumented immigrants still in the US. In our analysis, we account for this bias by jointly modeling trip timing and duration to produce the likelihood of observing the data in such a "snapshot" sample. Our analysis goes beyond estimating the sojourn time distribution to characterizing undocumented migration flows including single visit migrants, repeat visitors, and for repeaters "retirement" from circular migration. Starting with 1987, we apply our models to 30 annual random snapshot surveys of returned undocumented Mexican migrants accounting for undocumented Mexican migration from 1980–2016. Contrary to published estimates based on these same data, our results imply migrants remain in the US much longer than previously estimated based on analysis that ignored the physical snapshot bias. Scaling to population quantities, we produce lower bounds on the total number of undocumented immigrants that are much larger than conventional estimates based on US-based census-linked surveys, and broadly consistent with the estimates reported by Fazel-Zarandi, Feinstein and Kaplan in PLOS (2018).

Elise Miller-Hooks

Optimal Investment for a Resilient Global Port Network

Ports are critical components of the global supply chain, providing key connections between land- and maritime-based transport modes. They operate in cooperative, but competitive, i.e., co-opetitive, environments wherein the throughput of individual ports is linked through an underlying transshipment network. This network is inherently vulnerable to disruptions of natural, accidental and anthropogenic cause. With increasing reliance on information and automation, risks and consequences to ports of cyber attack, loss in access to information systems, and power outages have also increased. To ensure that effective port services can be provided or quickly restored in an incident or disruption to critical power and communications lifelines, entitites charged with designing, constructing, managing and operating ports of the future must consider new strategies to prevent or mitigate their effects. Given the importance of ports to world-wide maritime freight transport and thus global economies, it is crucial that ports of the future be resilient to existing and changing disruptive forces. This presentation proposes optimization and equilibrium techniques for developing multi-stakeholder, protective investment and collaboration strategies aimed at enhancing resilience of this marine-based IM system to disruption while protecting the market share of individual ports. For this purpose, a multiplayer, multi-scenario protective port investment problem is formulated and a diagonalization methodology is proposed for its solution. A number of alternative objective functions, each managing uncertainty in different ways or providing a benchmark for comparison, were developed. These techniques account for the existence of differing stakeholders, varying governing principles and variations in investment sources. The methodology applied under the alternative objectives is illustrated on a global port network representing portions of Asia and Europe.

Scheduling 1 Chair: Dvir Shabtay	Baruch Mor, Gur Mosheiov, Dana Shapira	Flowshop scheduling with learning-effect and job-rejection
	Gur Mosheiov, Enrique Gerstl	Minimizing the number of tardy jobs on parallel machines with generalized due-dates
	Nir Halman, Uriel Vinetz	An FPTAS for two variants of "Relocation scheduling subject to fixed processing sequences"
	Ehud Ikar, Tal Grinshpoun, Elad Shufan, Hagai Ilani	Modeling a Complex Real World Manufacturing Scheduling Problem

Scheduling 1- Chair: Dvir Shabtay

Baruch Mor, Gur Mosheiov, Dana Shapira

Flowshop scheduling with learning-effect and job-rejection

We study scheduling problems on a proportionate flowshop. Three objective functions are considered: minimum makespan, minimum total completion time and minimum total load. We consider a learning process, thus the processing time of a job processed later in sequence is reduced. The scheduler has the option of job rejection, i.e., he may process only a subset of the jobs, and be penalized for the rejected jobs. An upper bound on the total permitted rejection cost is assumed. Since the single machine versions of these problems were shown to be NP-hard, we focus on the introduction of pseudo-polynomial dynamic programming algorithms, indicating that the problems are NP-hard in the ordinary sense. We provide an extensive numerical study verifying that the proposed solution algorithms are efficient for medium size instances.

Gur Mosheiov, Enrique Gerstl

Minimizing the number of tardy jobs on parallel machines with generalized due-dates

We focus on scheduling problems with generalized due-dates, where the *j*-th due-date is a point in time by which at least *j* jobs have to be completed. The objective function is minimum number of tardy jobs. The machine settings are parallel identical and uniform machines. We introduce pseudo polynomial dynamic programming algorithms for these NP-Hard problems. Both algorithms are shown numerically to perform very well: the worst case running time required for solving a 2-machine 1000-job problem does not exceed 1 second.

Nir Halman, Uriel Vinetz

An FPTAS for two variants of "Relocation scheduling subject to fixed processing sequences

In this talk we present a first FPTAS for two NP-hard variants of the resource-constrained scheduling subject to fixed processing sequences problem formulated in [Lin, Hwang and Kononov, Journal of Scheduling 2016]. We derive our FPTAS by using the recent technique of K-approximation sets and functions, thus answering in the affirmative the question of whether approximation schemes exist for these two NP-hard resource-constrained problems, raised by [Lin, Hwang and Kononov, Journal of Scheduling 2016].

Ehud Ikar, Tal Grinshpoun, Elad Shufan, Hagai Ilani

Modeling a Complex Real World Manufacturing Scheduling Problem

We present a real-world manufacturing setting that consists of many features, each of which adds complexity to the underlying scheduling problem. The problem is composed of identical jobs. A partially ordered set of operations must be applied to each job. Each operation requires a resource, in the form of a laboratory in which the dedicated machine resides. Each operation is processed by an employee, chosen from a subset of employees eligible to perform this operation. Additional features include set-up times between laboratories, capacity-restricted queues before/after an operation, varying processing times of the different employees, and a requirement to re-process an operation due to stochastic manufacturing failures. The problem is related to several existing NP-hard scheduling problems – reentrant flow shop scheduling, flexible shop scheduling, and cyclic shop scheduling.

Queueing 1 Chair: Gabi Hanukov	Efrat Perel, Nir Perel, Uri Yechiali	A Non-Preemptive Polling System with 'Join the Shortest Queue – Serve the Longest' Policy
	Yonit Barron	A threshold policy in a Markov-modulated production system with server vacation: The case of continuous and batch supplies
	Yael Perlman, Uri Yechiali	Tandem Stochastic Networks with Time-Deteriorating Product
	Gabi Hanukov, Uri Yechiali	To App or not to App

Queueing 1 - Chair: Gabi Hanukov

Efrat Perel, Nir Perel, Uri Yechiali

A Non-Preemptive Polling System with 'Join the Shortest Queue – Serve the Longest' Policy

We consider a Markovian service system comprised of two non-identical and separated queues attended by a single server that alternates between them. An arriving customer joins the shortest queue, while the server, upon completion of a non-preemptive service in a queue, will next serve the current longest queue. Switching takes zero time. The arriving process is Poissonian, and service times in each queue are exponentially distributed with different parameters. We analyze the two un-bounded dimensions system via both probability generating functions and matrix geometric methods, and derive the system's performance measures. Comparisons to a closely-related model, but with a preemptive switching policy, are discussed.

Yonit Barron

A threshold policy in a Markov-modulated production system with server vacation: The case of continuous and batch supplies

We consider a Markov-modulated fluid flow production model under D-policy, that is, as soon as the storage reaches level 0, the machine becomes idle until the total storage exceeds a predetermined threshold D. Thus, the production process alternates between a busy and an idle machine. During the busy period the storage decreases linearly due to continuous production and increases due to supply; during the idle period no production is rendered by the machine and the storage level increases only by supply arrivals. We consider two types of models with different supply process patterns: continuous inflows with linear rates (fluid type), and batch inflows, where the supplies arrive according to a Markov additive process and their sizes are independent and have phase-type distributions depending on the type of arrival (MAP-type). Four types of costs are considered: a setup cost, a production cost, a penalty cost for an idle machine, and a cost for the storage. Based on tools from multi-dimensional martingales and hitting times theory, we derive explicit formulas for these cost terms in the discounted case. we further apply a fluid-type approximated model to the MAP-type to deal with situations where different inflow processes are considered. A numerical comparison emphasizes the uniqueness of each model and highlights the differences.

Yael Perlman, Uri Yechiali

Tandem Stochastic Networks with Time-Deteriorating Product

We consider an *n*-site tandem stochastic production network where each product moves sequentially through the sites, and the product's quality deteriorates with its sojourn time in the system. At each site the product goes through two stages: the first stage is a processing operation with a generally-distributed random duration. This operation either does or does not conclude successfully; in the latter case, the operation is repeated immediately. Once the processing operation concludes successfully, the product goes through an inspection stage lasting a generally-distributed random duration. At the end of the inspection the product's state is determined as follows: either (i) it requires additional processing and moves forward to the next site; or (ii) it is found 'good' and exits the network with quality value depending on its total sojourn time in the system; or (iii) it is declared 'failed', discarded, and exits the network with zero quality value. Two scenarios are analysed: (i) a new product enters the system only after the preceding product has exited, and (ii) the network is a tandem Jackson-type system.
For each scenario, we construct both time-dependent and quality-dependent performance measures. In the case where the sites can be arranged in an arbitrary order, we derive easy to implement optimal index-type policies of ordering the sites so as to maximize the quality rate of the production network.

Gabi Hanukov, Uri Yechiali

To App or not to App

The use of smartphone applications (App) to order (fast) food is becoming more and more popular. In this talk we address the dichotomy of whether to use such an application or not. Specifically, we consider a coffee shop (such as

Aroma, Arcafe, Café café, Greg and alike) where a typical service is comprised of two sequential stages: (i) waiting in line to order food, in the first stage and (ii) waiting in line for the order to be executed. There are two type of customers: (i) old-fashion customers who will never use smartphone applications, and (ii) more sophisticated customers who are willing to use Apps to make food orders. The first type of customers always passes through the two stages described above. The second type is confronted with the decision whether to use the App or not. They may not use the App and act like old-fashion customers, or they can use the App, namely, perform the first stage of the ordering before arrival to the coffee shop and, upon arrival, join directly the second service stage.
We analyze this stochastic system, calculate its steady state probabilities and derive its performance measures (such as mean queue size and mean waiting time). We than investigate (i) optimal joining strategies of non-sophisticated customers; (ii) the dichotomy of whether to use or not use the App by sophisticated customers; and (iii) optimal discount policies by the coffee shop operator in order to encourage App use by sophisticated customers.

Game Theory 1 Chair: Eran Hanany	Nitsan Perach, Shoshana Anily	Stable matching with entrance criterion for teams
	Yael Deutsch, Arieh Gavious	The Profiling Game in Border Crossings
	Igal Milchtaich	Correlated Polyequilibrium
	Eran Hanany, Peter Klibanoff, Sujoy Mukerji	Incomplete Information Games with Ambiguity Averse Players

Game Theory 1 - Chair: Eran Hanany

Nitsan Perach, Shohana Anily

Stable matching with entrance criterion for teams

In this talk we generalize former results about the assignment of students to dormitories at the Technion, under an entrance criterion. Here, we consider the case where students may apply in groups, thereafter called teams, each consisting of at least one student. A team-application means that students from any given team, want to be assigned to the same dormitory-group, and they prefer living off-campus rather than living in different dormitory-groups.
We assume that the dormitory-groups share a common preference over the teams, which is given by a strictly increasing ranking of the teams' credit scores. We adjust the definition of a quasi-stable outcome to incorporate team applications, and show that a quasi-stable outcome always exists. An algorithm that finds all the quasi-stable outcomes, will be presented. Apparently, some of the properties of the model for teams of a single student, continue to hold under the model of team applications. Finally, we consider the incentive compatibility property of the outcomes generated by the proposed algorithm, and show, in particular, that the algorithm that produces a specific quasi-stable outcome, is manipulation-proof, i.e., no subset of teams can gain by misrepresenting their preferences over the dormitory-groups.

Yael Deutsch, Arieh Gavious

The Profiling Game in Border Crossings

Developing effective screening processes in border crossings, in order to identify violators within large groups of mostly innocent people, is an important and difficult task, as it is not possible nor effective to screen every passenger with the same intensity required to detect a violator. Profiling has been applied for several decades as a tool to deal with this task, but there is still no proof of its effectiveness. Our main motivation is to study whether profiling is indeed helpful, and if so, how it should be used. As such, we consider an interaction that takes place in some crowded border crossing, where passengers can be affiliated into different groups. We offer a sequential game-model with three players: a defender, who acts firstly and decides on a screening process, an attacker, who acts secondly and may recruit a passenger as a violator, and the recruited violator, who acts last and may choose not to violate, as it has its own private violating motivation. We will study different variants of the base game, which differ by the choice of screening policy (an announced profiling, an unannounced profiling, no-profiling), the attacker's knowledge of the screening policy, the defender's and the attacker's received signals regarding the violators' private motivations, the recruiting costs of passengers of different groups, and how to manage the tradeoff between security and congestion. These variants will help us to understand the extremely challenging social and strategic questions regarding the controversy over the need of profiling.

Igal Milchtaich

Correlated Polyequilibrium

Polyequilibrium (Milchtaich, Games and Economic Behavior, 2018) is a set-valued generalization of Nash equilibrium that differs in specifying strategies that players do not choose, such that for each excluded strategy of each player there is a non-excluded strategy that responds at least as well as the first one does to every profile of non-excluded strategies. This paper introduces a corresponding generalization of correlated equilibrium, correlated

polyequilibrium, which is defined as a polyequilibrium in an "augmented" game where players choose their action only after receiving random private signals from some correlation device, or mechanism. The players' choices yield a set of distributions of strategy profiles, which may not include any correlated equilibrium distribution. Correspondingly, some results that do not hold in any correlated equilibrium are obtained in a correlated polyequilibrium.

Eran Hanany, Peter Klibanoff, Sujoy Mukerji

Incomplete Information Games with Ambiguity Averse Players

We study incomplete information games with ambiguity averse players. Our focus is on equilibrium concepts satisfying *sequential optimality* – each player's strategy is optimal at each information set given opponents' strategies. We show sequential optimality, which does not make any explicit assumption on updating, is equivalent to sequential optimality with respect to beliefs updated using a particular generalization of Bayesian updating. Ambiguity aversion expands the set of equilibria compatible with players sharing common ambiguous beliefs. We connect ambiguity aversion with belief robustness. Examples illustrate new strategic behavior, including strategic use of ambiguity, under ambiguity aversion.

Tuesday, 14.5

T1

Game theory 2 Chair: Ella Segev	David Lagziel, BGU	Anomalies of Screening
	Galit Ashkenazi-Golan, TAU	The value functions of constrained Markov decision processes
	Gal Cohensius, Technion	Cumulative subtraction games
	Sanjith Gopalakrishnan, Daniel Granot, Frieda Granot	Consistent Allocation of Emission Responsibility in Energy Supply Chains

Game Theory 2 - Chair: Ella Segev

David Lagziel and Ehud Lehrer

Anomalies of Screening

This paper continues the work of Lagziel & Lehrer (AER: Insights 2019) by focusing on two anomalies of screening. Our screening problem begins with a decision maker who, based on noisy unbiased assessments, screens elements from a general set. First, we compare one-stage screening with two-stage screening while fixing the required mass of accepted elements. Our analysis shows that one-stage screening could be superior to two-stage screening although the latter is based on additional sampling. Second, we study how additional unbiased noise affects the screening process. It appears that the preliminary noise carries no screening-related advantages, while additional independent noise can indeed improve the screening.

Galit Ashkenai-Golan and Eilon Solan

The value functions of constrained Markov decision processes

We consider the value functions of a Markov decision problem with constraints, as a function of the discount factor λ. We prove that any piecewise-rational continuous function can be approximated. A necessary and sufficient condition to obtain the piecewise-rational function accurately is proven. This condition is about the derivatives of any two consecutive rational functions.

Gal Cohensius, Urban Larsson, Reshef Meir and David Wahlstedt

Cumulative subtraction games

We study a variant of classical Subtraction Games (Nim), called Cumulative Subtraction, in which two players alternate in moving, and get points for taking pebbles out of a joint pile. We present the optimal play (a PSPE) in the case of two possible actions. In addition, we prove that when the pile is large enough, the maximal action is optimal.

Sanjith Gopalakrishnan, Daniel Granot, Frieda Granot

Consistent Allocation of Emission Responsibility in Energy Supply Chains

Canada's federal government, since 2016, has pledged to factor in upstream emissions during the environmental impact assessment of fossil fuel energy projects. The upstream emissions attributable to a proposed project could be compared against a rejection threshold - a maximum permissible level of emissions, or the firm could be mandated to offset the attributed emissions. We adopt a cooperative game-theoretic model, and propose the nucleolus to attribute upstream emission responsibilities in energy supply chains. The nucleolus allocation avoids the distortionary effects of double counting and exhibits a certain consistency property that is especially important in a regulatory context wherein energy supply chains span multiple legal jurisdictions. Further, among other results, (i) we develop an O(n^2) algorithm to compute the nucleolus, where n is the number of firms in the supply chain, (ii) we prove that the nucleolus is the unique strong-Nash equilibrium in a non-cooperative game associated with the emission allocation problem, (iii) we provide a non-cooperative implementation framework for the nucleolus allocation, in terms of two easily stated and verifiable policies, (iv) we prove that the nucleolus allocation is piecewise linear and increasing in the direct emission of a firm, (v) and we extend our base model by introducing carbon pricing and investigate the power of the nucleolus allocation to incentivize firms to adopt abating technologies.

Energy Chair: Adi Sarid	Adi Sarid, *Michal Tzur*	Power Grid Expansion in Developing Countries: Planning for Equity
	David Raz, Ariel Daliot,, Yuval Beck	Various Approaches to Volt-Var Optimization through Integration of Grid Edge Devices with Traditional Methods
	Irena Milstein, Asher Tishler,	Optimal capacity, production and prices in competitive electricity markets when the effective use of PV varies over the day
	Arik Sadeh, Idan Babay and Cristina Feniser	Optimal Dynamic Pricing of Quality Based Products under Stochastic Preferences

Energy- Chair: Adi Sarid

Adi Sarid, *Michal Tzur*

Power Grid Expansion in Developing Countries: Planning for Equity

Electricity is a day to day necessity, and in developed countries it is supplied to the entire population. However, the supply of electricity in developing countries, mostly rural areas, is a privilege still deprived from many. Technological developments of the last decade, and the decreasing price of technology allows us to provide these areas with solutions ranging from small and portable generation devices that use renewable energy sources, through more complex solutions such as micro-grids which can supply whole areas, and eventually up to main power grid connectivity.
The different infrastructure solutions come with varying prices and benefits. For example, photovoltaic cells can provide electricity during daytime. Coupled with investments in energy storage the supply can be extended to night. Full grid connectivity is much more expensive, but can provide an uninterrupted supply.
We study the allocation of resources for power grid upgrades in developing countries, such that the resulting plan will reflect “fairness”, i.e. equity in power distribution between the population and over time.
Specific infrastructure decisions include where and when to establish (or upgrade) certain elements of the grid: power facilities, while the constraints include budget, capacity, and the physical nature of the DC load flow model.
We present the results of a numerical experiment designed to examine the impact of fairness on the allocation of resources and on the chosen grid expansion plan.

David Raz, Ariel Daliot,, Yuval Beck

Various Approaches to Volt-Var Optimization through Integration of Grid Edge Devices with Traditional Methods

Traditionally, distribution systems include Volt-Var Control (VVC) devices, such as capacitors banks and transformer tap changers, which target to maintain the voltage within allowable limits. The revolution of smart grid introduced smart equipment and edge technologies up to the distribution transformer and even inside the facilities and customer premises. In this work we present various novel approaches for Volt-Var Optimization (VVO) through integrating VVC resources with Distributed Energy Resources (DERs), such as photovoltaic farms and customer premises batteries, as well as other edge devices. The optimization is utilized for achieving various VVC target functions such as Conservation voltage reduction (CVR), zero VAr flow at the transformer or minimal grid losses.

Power-flow studies have traditionally been used to perform VVC and VVO, but have various limitations, especially relating to performance and the availability of a full network model of the distribution system. We introduce a method for reduction of complex distributions system into a simplified form, which enables the fast execution of the power flow calculations. We also introduce a preliminary method for utilizing an existing power flow simulation as an input for a deep learning machine, which replaces the power flow study. We analyze various multi-objective approaches and show how these methods can be used or assessing the trade-off between the different objectives. Examples supporting these approaches are shown, demonstrating the capabilities of the method.

Irena Milstein, Asher Tishler

Optimal capacity, production and prices in competitive electricity markets when the effective use of PV varies over the day

This study derives the optimal capacity, and the hourly electricity production and price in competitive electricity markets with substantial capacity of PV that, naturally, can be used to produce electricity only during the day hours (when the sun is shining). Accounting for the demand uncertainty and the large variation of the effective use (usability) of the PV capacity during different hours of the day is at the focus of our two-stage model, which employs PV and natural gas technologies during the day hours, and natural gas technology during the night hours. In the first (construction) stage, firms decide on their generating capacity. The second stage is quantity and price determination.
We show that the PV technology produces electricity at full capacity during the early morning and late afternoon hours, and at less than full capacity during mid-day when the sun radiation is at its maximum. Natural gas technology is used during the night and, occasionally, during the day hours when the PV technology is at full capacity and even when the PV technology is at less than full capacity. The main role of the natural gas technology during the day is to reduce the long term PV capacity and avoid large price spikes during the day hours.

Arik Sadeh, Idan Babay and Cristina Feniser

Optimal Dynamic Pricing of Quality Based Products under Stochastic Preferences

Many technology companies are coping with the increasing demand of consumers for new and diverse products. This demand has led to an increase in the competition of companies in the local and global markets,
Many companies in the technological field, as well as in other areas, adopted the dynamic pricing models to adapt their product prices optimally to the market demand situation thereby maximizing the company's profits. The dynamic pricing models have different characteristics that describe the behavior of the consumer, the nature and quality of the products, the prices of the products, the definition of the planning horizon, competition among the various companies, and more.
This work deals with the development of a dynamic stochastic optimization model that weighs product qualities and inventory quantities, customer preferences, and random demand.
The study will focus on stochastic demand, where the expression of consumer choice will be made by using a linear utility function. The assumption is that a consumer will strive to maximize his benefit from the purchase of the product when the benefit function for the consumer receives the price of the product and the quality of the product. The consumer has a defined sensitivity parameter for the quality of the product. This parameter is randomized with a specified probability function.
The proposed model is a dynamic, multi-item, dynamic stochastic optimization model for optimum management and pricing based on the dynamic programming framework. Model characteristics refer to the inventory of known consumable items that carry a defined cost over a final sales period.
The model can provide company managers with decision support tools, pricing policy insights, product lifecycle management, and product inventory management to maximize profitability for company owners.
After optimization and optimal decision-making, an investigation of the model's characteristics was conducted, using simulation and sensitivity analysis.
The model was applied to a real-world problem of an American technology company for the development and manufacture of components in the semiconductor sector, with elements having a varying level of quality defined according to various technological and physical parameters.

Scheduling 2 Chair: Dvir Shabtay	Hagai Ilani, Lior Aronshtam	Expected Average Attendance in Conferences which are Scheduled by Personalized Approach
	Chen Kaminer, Hussein Naseraldin, Liron Yedidsion	Scheduling Under Uncertainty: the Due-Date Assignment Problem
	Danny Hermelin, Mike Pinedo, Dvir Shabtay and Nimrod Talmon	On the parameterized tractability of single machine scheduling with rejection
	Miri Gilenson, Dvir Shabtay, Liron Yedidsion	Multi-scenario scheduling with an aggregable condition between scenarios

Scheduling 2 - Chair: Dvir Shabtay

Hagai Ilani, Lior Aronshtam

Expected Average Attendance in Conferences which are Scheduled by Personalized Approach

Conference scheduling is a challenge which is well known to organizers of academic conferences. Traditionally, the scheduling process is done as follows: after the excepted papers are collected, they are gathered to sessions according to the different topics of the conference. Then, the sessions are assigned to time-slots so sessions of the same track will not be scheduled parallelly. In recent years, a personalized approach has been suggested and tested in few conferences. In this scheduling approach, after all sessions have been settled, all participants are asked in advance to choose their k preferred sessions. Then, the sessions are assigned to time-slots with the objective of maximizing the opportunity of participants to attend their preferred sessions. Here we analyze the expected average attendance in preferred sessions of a participant as a function of the conference parameters: number of participants, number of sessions, number of time slots. We use tools of Extreme Combinatorics for the analysis. In addition, we conduct simulations for conferences with various parameter instances. The results can suggest schedulers who use the personalized approach to decide what number, k, of preferred sessions to let each participant to choose in advance and declare what they expect the average attendance to be.

Chen Kaminer, Hussein Naseraldin, Liron Yedidsion

Scheduling Under Uncertainty: the Due-Date Assignment Problem

Scheduling problems, where due dates are decision variables, are referred to as Due Date Assignment (DDA) Problems. In this set of problems, the objective is to minimize the cumulative jobs' earliness, tardiness, and due date assignment costs. The classic DDA problem refers to the jobs' processing times as deterministic values. However, jobs' processing times may vary due to uncertainties in the input data. While stochastic programming is a common approach when the distribution of the processing times is assumed to be known and given, other approaches are needed when no distribution assumption is made. In this research, we study the uncertain DDA problem. Our goal is to determine the due dates and the sequence so as to minimize the total earliness, tardiness, and due date penalties for the worst-case realization in face of the uncertainty. We show that the generally weighted uncertain DDA problem is NP-hard. However, if the weights are job independent, then the problem is polynomially solvable in O($n\log n$) time. Moreover, we show how adding buffers can significantly reduce the worst-case cost and reduce the cumulative impact of the uncertainty on the jobs' earliness and tardiness.

Danny Hermelin, Mike Pinedo, Dvir Shabtay and Nimrod Talmon

On the parameterized tractability of single machine scheduling with rejection

We study a single machine scheduling problem with rejection. In such a scheduling problem, the scheduler can reject to process a job in the shop at a certain cost. Our objective is to minimize the total completion time of the jobs to be processed in the shop, given that the total rejection cost will not exceed a certain predefined threshold. The problem is known to be NP-hard, and to better investigate its hardness our objective is to study whether the problem becomes tractable when some specific natural parameters are of a limited size. The analysis is done by using the theory of parameterized complexity and includes the following parameters: the cardinality of the set of accepted jobs, the number of different processing times, the number of different rejection costs, the maximal processing time, and the maximal rejection cost. We show that the problem is W[1]-hard for the first parameter, while it is fixed-parameterized tractable for all other parameters.

Miri Gilenson, Dvir Shabtay, Liron Yedidsion

Multi-scenario scheduling with an aggregable condition between scenarios

In the literature of multi-scenario scheduling problems, it is assumed that (*i*) each scenario defines a different possible realization of the job's parameters; and that (*ii*) the value of each parameter is arbitrary for any job in any scenario.

Under these assumptions many multi-scenario scheduling problems were proven to be NP-hard. We study a special case of this set of problems, in which there is an aggregable condition between scenarios on a given set of scenario-dependent parameters. Accordingly, the value of a given parameter under scenario *i* is at most its value under scenario *i*+1, for *i*=1,…*q*-1. We note that this special case may be very common in practice. One example is the case where each scenario corresponds to a differently skilled worker that processes the jobs. As another example, consider the case where one out of two scenarios corresponds to a strike in a port that delays the release date of a shipment which is used as a subassembly of different jobs in an assembly line. We study several NP-hard multi-scenario scheduling problems on a single machine. Our aim is to see if the special case of an agreeable condition on a scenario-dependent parameter (e.g. processing time) makes these hard problems easier to solve. We found that while some of them remains NP-hard, other become polynomially solvable.

Transportation 2 Chair: Michael Dreyfuss	Yuval Klein, Menachem Sperka, Michael Dreyfuss	Reducing Transportation Cost by Optimizing Freight Utilization - With a Case Study for Intel's supply chain
	Shira Vahav, Mali Sher	Data mining on road accidents and traffic report databases for better operation of the Traffic Police's resources
	Erella Eisenstadt-Matalon, Amiram Moshaiov	Solving the multi-criteria competing TSP using the rationalizability solution concept
	Benjamin Baran, Fabio López-Pires, Daisy Kang	Multi-Objective Government Perspective for Three-Echelon Vehicle Routing

Transportation 2 - Chair: Michael Dreyfuss

Yuval Klein, Menachem Sperka, Michael Dreyfuss

Reducing Transportation Cost by Optimizing Freight Utilization - With a Case Study for Intel's supply chain

In this model we use a mixed integer programming approach to optimize the international transportation schedule of a big manufacturing plant in order to reduce shipping cost while meeting requested delivery times. The following three components compose the total cost: First, the storage costs at the manufacturer's facility. Sometimes, it may be beneficial to leave the ready shipments at the origin location. Second, the transportation cost from the origin to the destination. There are two different ways of transportation; by air with a short transportation time and a high transportation cost and by sea with a long transportation time and a low transportation cost. The shipping cost by sea is only advantageous if the boxes (parts of the working machines) add up to a high volume shipment. And third, the holding cost for storing the machines at the destination when arriving early.
The transportation data includes: transportation schedule, transportation and inventory rates, shipping durations and tools dimensions.
Finally, we present a real-life application at Intel's manufacturing plant in Kiryat Gat. We show that using this model can significantly reduce the transportation cost while meeting requested delivery times.

Shira Vahav, Mali Sher

Data mining on road accidents and traffic report databases for better operation of the Traffic Police's resources.

The main goals of the Israel Police Traffic Division are:

1. Minimizing road accidents in general and fatal accidents in particular.
2. Improving the road user's quality of life.

In order to achieve these goals, the Research and Development Department of the Traffic Police is in charge of analyzing data and forwarding conclusions and recommendations to policy makers, so as to develop the traffic police and operate it effectively and effectively.

In this research, we present several analyses that were made by the WEKA software with data mining methods that are based on the police's operational databases:

1. Road accident databases (types of accidents, casualty details, and details about the involved vehicles).
2. Traffic report databases (type of traffic violation, offender details, and details about the vehicles involved).

   All data includes location and time.

In conclusion, in this research we present models that answer different research questions, and in doing so, contribute to the Traffic Division's work.

Erella Eisenstadt-Matalon, Amiram Moshaiov

Solving the multi-criteria competing TSP using the rationalizability solution concept

The presented study concerns a novel method for solving Multi-Objective Games (MOGs). The considered MOGs are static, non-cooperative, two-persons, zero-sum games with pure strategies, in which each player has self-conflicting objectives and none of the players has a-priori objective preferences. Yet, each player knows all the available strategies of the opponent and all the payoff vectors that result from all possible interactions between their own and their opponent's strategies. The main assumption is that of the common knowledge of rationality [1].
The considered MOGs involve incomplete information that induces partial order to the outcomes of the game. Traditionally, such MOGs have been solved either by an equilibrium solution concept or by a MiniMax solution concept. Yet, existing studies suffer from not considering performance trade-offs. Namely, they assume that the players have no preference of objectives when selecting a strategy. In contrast, this study is based on the assertion that in general decision-makers should take into account performance trade-offs when making a decision. In view of the aforementioned assertion and the state-of-the-art, a novel solution concept to MOGs has been recently suggested by the authors [2]. The approach in [2] involved the idea of a one-sided rationalizability which does not take into account the common knowledge of rationality. In contrast, following [3] and [4], here the solution concept is revised into mutual-rationalizability that involves the assumption of common knowledge of rationality.
The proposed approach, for solving MOGs, involves two-stages. In the first stage, a Set of Rationalizable Strategies (SRS) and their associated payoff vectors are sought for each of the players. This is done using Pareto-based best replies of the opponent, with an iterative search technique that accounts for mutual-rationalizability. The proposed mutual-rationalizability approach results with trade-off information at the end of the first stage. In the second stage, as in [2], Multi-Criteria Decision Analysis (MCDA) techniques are used to select a strategy out of the obtained SRSs based on the trade-off information that is revealed in the first stage.
To demonstrate the proposed solution concept a MOG version of the Traveling Salesperson Problem (TSP) is employed. The latter game type (TSP MOG) amalgamates two known versions of the TSP including the competing TSP and the selective TSP. The demonstrations include several case studies with a relative small network of cities, which allows full sorting that results in the exact SRSs.
The main conclusion from this study is that the proposed solution concept, as amalgamated with the suggested MCDA techniques, provides players of MOGs with a novel approach to support justified strategy selection based on trade-off information.
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Benjamin Baran, Fabio López-Pires, Daisy Kang

Multi-Objective Government Perspective for Three-Echelon Vehicle Routing

Current trends of urbanization in modern cities and growing global economies bring with them rising levels of traffic congestion and pollution; therefore, city governments need innovative strategies to deal with those modern city problems from a renewed perspective.
Classical formulations of the *Two-Echelon Vehicle Routing Problem* (2E-VRP) consider the perspective of a single provider, who takes its own routing decisions without considering routing decisions of other parties. Typically, the first echelon (or level) routes goods from the factories (or providers) to each *City Distribution Center* (CDC), usually with large trucks. The second echelon routes goods from each CDC to customers, usually using smaller trucks. In this habitual 2E-VRP context without a central coordination among providers, each provider decides its individual schedule and, consequently, the lack of a holistic approach to urban traffic may cause further problems. Additionally, the various stakeholders (as clients, citizens represented by the city government and providers) may have conflicting objectives.
In this context, a city government may have a central role for coordinating the actions of different stakeholders with probable conflicting objectives, globally optimizing different objective functions in a pure multi-objective context. With this centralized approach, *Urban Goods Movement* (UGM) of the city may be improved, considering simultaneously several different objectives as the minimization of traveling cost and time, reduction of pollution (produced by the trucks moving goods) as well as the minimization of the number (and size) of vehicles moving goods in congested areas.

To further improve the potential optimization of the whole multi-objective problem thanks to the city government central role, it may also coordinates the use of available load / unload bays in public areas as a third echelon (or level), minimizing (or even avoiding) conflicts among providers delivering goods to the same city congested area. This third echelon of routing leads to what we call *Three-Echelon Vehicle Routing Problem* (3E-VRP) routing goods from de load / unload bays to the final customers, typically with human powered small vehicles as bicycles and wheelbarrows.
To solve those three interrelated *Vehicle Routing Problems* (VRP), globally named as 3E-VRP, this work proposes a *Multi-Objective Evolutionary Algorithm* (MOEA), proving that the proposed algorithm finds reasonable solutions in a pure multi-objective context, simultaneously considering several different (sometimes conflicting) objective functions as total gasoline consumption, city traffic and pollution, among other possible objective alternatives.
In summary, this work formulates for the first time a *Multi-objective Three-Echelon Vehicle Routing Problem* (M3E-VRP) from a city government perspective, solving the problem using a MOEA, which does not assure finding all optimal solutions; therefore, as future work the authors plan to work on other alternative algorithms and to practically prove the use of the proposed MOEA in a pilot project for the city of Asuncion, capital of Paraguay.

T2

Strategic queueing Chair: Yoav Kerner	Yair Shaki, Uri Yechiali and Michael Dreyfuss	A note on the double parking problem
	Laurens G. Debo and Ran I. Snitkovsky	Tipping as a Social Norm in Service Systems
	Moshe Haviv and Binyamin Oz	Social cost of deviation: new and old results on optimal customer behavior in queues
	Antonio Castellanos, Galit B. Yom-Tov, Yair Goldberg	Estimating Patience with Silent Abandonment

Strategic queueing - Chair: Yoav Kerner

Yair Shaki, Uri Yechiali and Michael Dreyfuss

A note on the double parking problem

A parking lot of size M serves both private cars and busses. A private car occupies a single spot, while a bus occupies double spots. If, upon arrival, a private car finds a full lot, it waits until a parking spot becomes available, while a blocked bus leaves never to return. The problem is formulated as a QBD process and its steady-state probabilities, as well as the system's performance measures, are derived while applying matrix geometric analysis. Numerical examples are presented and the system's effectiveness is compared to an alternative system where the lot is split into two separate lots.

Laurens G. Debo and Ran I. Snitkovsky

Tipping as a Social Norm in Service Systems

We study the impact of tipping in a service facility on the server's tipping wage, in the presence of an endogenously formed social norm. The problem is modeled as a two-stage tipping game: In the first stage, delay-sensitive customers arrive at an M/M/1 facility and decide whether to join or not, and if so, how much to tip. In the second stage customers who joined meet in a social market, compare their tip amounts, and are penalized on tipping differently from one another. All customers are homogeneous in terms of their valuation of the service and waiting cost rate. Yet, some customers visit the facility repeatedly and can therefore obtain a shorter waiting time by tipping more. Other customers visit only once and hence, cannot influence their waiting time via their tip. We find that in the presence of a social norm, the server cannot extract the optimal social welfare through tipping, because of (i) rents that the repeat customers can accrue and (ii) the variability in tips, introduced by repeat customers, which causes the social costs to be strictly positive. Nevertheless, in some limiting cases, the tipping wage approaches the optimal welfare when (i) the social norm is weak and there are many repeat customers such that no one-time customers join; or when (ii) the social norm is strong and there are few repeat customers who join.

Moshe Haviv and Binyamin Oz

Social cost of deviation: new and old results on optimal customer behavior in queues

We revisit some of the classic optimization problems in single- and multi-server queueing systems. We look at these problems as strategic games, using the concept of social cost of deviation (SCoD), which is the extra cost associated with a customer who deviates from the socially prescribed strategy. In particular, we show that a necessary condition for a symmetric profile to be socially optimal is that any deviation from it, if done by a single customer, is suboptimal;

that is, the corresponding SCoD is nonnegative. We exemplify this by characterizing the socially optimal strategies for unobservable and observable ``to queue or not to queue" problems and for multi-server selection problems. We then use the SCoD concept to derive the symmetric socially optimal strategy in a two-person game of strategic timing of arrival. Furthermore, we show that this strategy is also the symmetric Nash equilibrium strategy if the service regime is of random order with preemption.

Antonio Castellanos, Galit B. Yom-Tov, Yair Goldberg,

Estimating Patience with Silent Abandonment

Customer (Im)Patience has proven to be a significant factor in modeling service systems and making staffing decisions. A customer who is waiting for service in a queue has finite patience and after a certain amount of wait might abandon the system. Generally, abandonments have been regarded as uni-type; However empirical evidence from contact centers has contradicted this assumption, which enables us to classify them into two separate groups: known and silent abandonments. Known abandonment appears when the customer gives a clear indicator that she just left (patience time is observed). In contrast, silent abandonment occurs when a customer left the system, but the service provider is unaware of that fact until the agent communicates with the customer and receives no reply (patience time is left censored). Notice that in silent abandonments some server time is wasted until abandonment is realized; for this reason, they should be taken into account when making staffing decisions.
In the current research, we propose a queuing model with silent abandonments for two environments: one where we know exactly which customer silently abandoned the queue and another where we are unable to clearly distinguish these customers from customers that had very short service (i.e. finished service in a single interaction). We develop a prediction model to classify customers in the second case and develop estimators of customer patience for both environments. We discuss how silent abandonment influences performance measures and staffing recommendations.

Healthcare Chair: Dan Yamin	Nitzan Carmeli, Galit Yom-Tov, Avishai Mandelbaum	Balancing of Load (Operational, Emotional, Cognitive) in Service System (Hospitals, Contact Centers)
	Zvi Lapp, Ariel Rosenfeld	Optimizing Medical Imaging Exposure in Radiologist Worklist
	Hanan Rosemarin, Ariel Rosenfeld	Emergency Department Online Patient-Caregiver Scheduling
	Yakir Berchenko	Optimal Control and Surveillance of Disease

Healthcare- Chair: Dan Yamin

Nitzan Carmeli, Galit Yom-Tov, Avishai Mandelbaum

Balancing of Load (Operational, Emotional, Cognitive) in Service System (Hospitals, Contact Centers)

Operational offered-load of servers, and its calculated agents utilization through queueing theory, support the design, staffing and routing of congestion-prone service systems. However, in many such systems, and healthcare in particular, service providers experience additional features of load such as emotional and cognitive – these cause stress and fatigue even when the offered load is low. How does one balance such load among servers, in a way that accommodates its multi-features? In our research we develop a novel theoretical framework that supports answers to this question. More concretely, we consider a queueing system with several agent skills/groups and customer classes (e.g. multiple patient type and several hospitalization wards in a hospital), within which we optimally and fairly balance multi-feature load.

Zvi Lapp, Ariel Rosenfeld

Optimizing Medical Imaging Exposure in Radiologist Worklist

The operation of managing and optimizing the performance of radiologist teams is a complex problem, due to the stochasticity present in the incoming studies and radiologist's behavior. To date, most hospitals do not limit the exposure of studies to their radiologist teams. This leads to several inefficiencies, such as valuable time wasted sorting through a long list of studies to read and less reads done by the specialty of radiologists. In our work, we propose a solution which optimizes the performance of a radiologist team by increasing throughput efficiency and medical quality. We approach the exposure of studies to radiologists as a learning to rank problem and limit the number of studies exposed to a subgroup of studies. Our solution takes inspiration from model free Deep Reinforcement Learning techniques, introduced by Google's Deep Mind Lab in AlphaZero, in order to learn a recommendation policy.

Hanan Rosemarin, Ariel Rosenfeld

Emergency Department Online Patient-Caregiver Scheduling

Emergency Departments (EDs) provide an imperative source of medical care. Central to the ED workflow is the patient-caregiver scheduling, directed at getting the right patient to the right caregiver at the right time. Unfortunately, common ED scheduling practices are based on ad-hoc heuristics which may not be aligned with the complex and partially conflicting ED's objectives. In this talk, we propose a novel online deep-learning scheduling approach for the automatic assignment and scheduling of medical personnel to arriving patients. Our approach allows for the optimization of explicit, hospital-specific multi-variate objectives and takes advantage of available data, without altering the existing workflow of the ED. In an extensive empirical evaluation, using real-world data, we show that our approach can significantly improve an ED's performance metrics.

Yakir Berchenko

Optimal Control and Surveillance of Disease

Here we discuss optimal surveillance for detection of an epidemic outbreak and costs minimization. Clearly, if monitoring the population is expensive and the costs of the disease itself are low we might consider leaving the population un-monitored; and conversely, if monitoring is relatively cheap we should monitor extensively. Our motivation is to support decisions regarding the level of monitoring in a quantitative and rigorous manner. We begin by discussing the basic concepts of optimal control we require and introducing an advanced stochastic version for the epidemic dynamics and its costs and controls (akin to a continuous-time birth-death process). We then solve our model for several interesting special cases.

Continuous Optimization 2 Chair: Tomer Shushi	Alexander J. Zaslavski	Optimal control problems arising in the forest management
	Tomer Shushi, Zinoviy Landsman, Udi Makov	Analytic solution of a portfolio optimization problem in a mean-variance-skewness model
	Royi Jacobovic, Offer Kella	Steady-state optimization of an exhaustive Levy storage process with intermittent output and random output rate.
	Michael Dreyfuss, Yahel Giat	Allocating spares to maximize the window fill rate in a periodic review inventory system

Continuous Optimization 2 - Chair: Tomer Shushi

Alexander J. Zaslavski

Optimal control problems arising in the forest management

We study a class of optimal control problems arising in the forest management.
The forest management problem is an important and interesting topic in mathematical economics which was studied by many researchers including the Nobel laureate P. A. Samuelson.
As usual, for this problem the existence of optimal solutions over infinite horizon and the structure of solutions on finite intervals are under consideration.
In our previous research we studied a class of discrete-time optimal control problems which describe many models of economic dynamics except of the model of the forest management. This happens because some assumptions posed for that class of optimal control problems, which are true for many models of economic dynamics, do not hold for the model of the forest management. By this reason, the forest management problem is not a particular case of general models of economic dynamics and is studied separately in the literature. In this talk we study the forest management problem using the approach introduced and employed in our recent research and show the existence of turnpike properties and solutions of the corresponding infinite horizon problems.

Tomer Shushi, Zinoviy Landsman, Udi Makov

Analytic solution of a portfolio optimization problem in a mean-variance-skewness model

In portfolio theory, it is well-known that the distributions of stock returns are often unimodal, asymmetric distributions. Therefore, many studied have suggested considering the skew-normal distribution as an adequate model in Quantitative Finance. Such asymmetry explains why the celebrated mean-variance theory, which does not account to the skewness of the distribution of returns, frequently fails to provide an optimal portfolio selection rule. In this study, we offer a novel approach for solving the problem of optimal portfolio selection for asymmetric distributions of the stock returns, by putting it into a framework of a mean-variance-skewness measure. Moreover, our optimal solutions are explicit and are closed-form. In particular, we provide an analytical portfolio optimization solution to the

exponential utility of the well-known skew-normal distribution. Our analytical solution can be investigated in comparison to other portfolio selection rules, such as the standard mean-variance model. The new methodology is then empirically analyzed.

Royi Jacobovic, Offer Kella

Steady-state optimization of an exhaustive Levy storage process with intermittent output and random output rate.

Consider a regenerative storage process with a nondecreasing Levy input (subordinator) such that every cycle may be split into two periods. In the first (vacation) the output is shut off and the workload is accumulated. This continues until some stopping time. In the second, the process evolves like a subordinator minus a positive drift (output rate) until it hits the origin. In addition, we assume that the output rate of every busy period is a random variable which is determined at the beginning of this period. For example, at each period, the output rate may depend on the workload level at the beginning of the corresponding busy period. We derive the Laplace-Stieltjes transform of the steady state distribution of the workload process and then apply this result to solve a steady-state cost minimization problem with holding,setup and output capacity costs. It is shown that the optimal output rate can be determined as a nondecreasing deterministic function of the workload level at the beginning of the corresponding busy period. This function is given explicitly up to a solution of a certain equation. Finally, numerical results are provided for special cases.

Michael Dreyfuss, Yahel Giat

Allocating spares to maximize the window fill rate in a periodic review inventory system

We study the spares allocation problem in a multiple-item, multiple-location inventory system with periodic review. The system allocates spares with the objective of maximizing the window fill rate, which is the probability that a random customer is served within a given time window. The advantage of the window fill rate as a service performance measure is that it takes into account that customers may tolerate a certain wait before they are served. We develop the window fill rate formula and show that, depending on the tolerable wait, it is either a constant, concave or convex-concave with the number of spares. We use this result to develop an efficient algorithm to find the optimal spares allocation for a given budget or for a given target window fill rate. We show that when the tolerable wait or the budget are small, spares will be clustered in a subgroup of the locations (or item-types), while the other locations (or item-types) do not receive any spares. In addition, we numerically illustrate the spares allocation problem using two different synthetic large-scale examples. In particular, we use these examples to demonstrate the additional spares needed due to the periodic review compared with a continuous review. The numerical illustration also highlights the complexity of the window fill rate and the savings gained by using it as an optimality criterion.

Transportation 3 Chair: Tomer Toledo	Edison Avraham, Tal Raviv	Data driven optimization of the time dependent travelling sales person with soft time windows
	Ayelet Gal-Tzur	Exploring the potential of Bluetooth-based trajectory clustering for providing personalized transit services
	Nicole Adler, Amir Brudner	Hotelling and aviation: The case of a multi-airport system
	Oren E. Nahum, Guy Wachtel, Yuval Hadas	Planning tourists' evacuation routes with minimal navigation errors

Transportation 3 - Chair: Tomer Toledo

Edison Avraham, Tal Raviv

Data driven optimization of the time dependent travelling sales person with soft time windows

We consider the problem of optimizing the route and schedule of a field service personnel in a stochastic environment. The joint distribution of the travel times is time dependent. Each customer is scheduled for service in a particular time window, but due to randomness, it is generally impossible to consistently serve all the customers within their service time window. A non-linear penalty is associated with any violation of the time windows (late arrival at customers). The goal is to minimize the total duration of the working day and the penalties for late arrivals over a given set of scenarios that are based on historical data.
We introduce exact and heuristic solution methods for the problem. Namely, a branch and bound algorithm that is capable of solving instances with up to 30 customers in several hours and an adaptive large neighborhood search heuristic that can deliver near optimal solutions in a very short time.
The travel times between a set of customers were sampled using Google Maps API, multiple times a day, over a period of 60 working days. Each day represents a scenario. The first 40 days were used as a training set for the

algorithm and the rest, as a test set. Our experiment demonstrates that it possible to significantly improve the routes and the schedules of the field service personnel in terms of punctuality and/or total work time compare with the traditional method of planning according to the average travel and service times.

Ayelet Gal-Tzur

Exploring the potential of Bluetooth-based trajectory clustering for providing personalized transit services

Effective planning of Demand Responsive Transit, and specifically directing such services towards changing the travel behavior of commuters using private vehicles, relies on understanding the travel patterns of these travelers. Bluetooth data can be used for identifying clusters of origin-to-destination trips. Moreover, characterizing recurrent trips of specific commuters within limited time windows can serve as a basis for Pattern Based Transit (PBT) services, i.e., provide subscribers of the PBT personalized push notifications in addition to a dial-a-ride option and information about return journey options.

Using Sequence Alignment Method, we explore the potential of data originated from Bluetooth sensors installed within Haifa's urban network as an input for trajectory clustering. Although the research is in its early stages, initial results indicate that recurrent travel patterns can be identified and provide the necessary grounds for offering commuters effective PBT.

Nicole Adler, Amir Brudner

Hotelling and aviation: The case of a multi-airport system

In this research we utilize the GPS records generated by mobile phones to estimate distance and ground access times to airport facilities. Our analysis highlights the role of both ground transportation and the socio-demographic background of passengers in choosing between alternative airports. This brought us to the important question which has arisen in the literature over the last decade, namely do airports compete? This is significant because the answer is likely to impact the potential need to regulate airport charges among other issues. In 2008, the UK Competition Commission forced the ownership separation of the three largest London airports in an attempt to encourage greater competition between the facilities. Today airports in the UK, except for London Heathrow, are not economically regulated. We present the methodology and the algorithms required to create the dataset which leads to a detailed catchment area analysis only available with Information and Communications Technologies (ICT) data. The data source which is used for the analysis of passenger mobility is mobile phone data and specifically anonymized GPS data-points from which a trajectory to one of the six airports in the greater London area (City, Gatwick, Heathrow, Luton, Stansted and Southend) was formed. We than aggregate the behavior of anonymized users at the census level covering the whole of England and Wales. Subsequently, we develop a Hotelling style game in order to understand the behavior of producers (airlines and airports) and the likely impact on consumer surplus. We find strong potential for vertical collusion between an airline and an airport whereas horizontal collusion between airports is theoretically less likely. Fortunately, vertically collusive strategies contribute to consumer surplus as compared to horizontal collusion. Consequently, operational ICT data may be used by regulators and transport infrastructure planners to improve decision making at the strategic level.

Oren E. Nahum, Guy Wachtel, Yuval Hadas

Planning Tourists Evacuation Routes with Minimal Navigation Errors

Tourism is one of the largest growing industries worldwide, and so are the increased safety concerns. This is due to increasingly frequent and severe natural hazards as well as terrorism, where large crowds of tourists can be targeted. Furthermore, tourists are often less informed and are therefore more vulnerable to be trapped in chaotic situations. In such situations, normally we are interested with fast evacuation routes. However, tourists, especially during emergency situations, are prone to orientation and navigation errors. Such errors can be avoided by providing electronic guidance at various intersections along the evacuation path (controlled intersections). This study formulates the above-mentioned situation as the shortest path problem with stochastic routing. The stochastic routing is the probabilistic selection of an outgoing arc at each node. As it is practically difficult to equip every intersection with guidance devices, a multi-objective model is developed. The model simultaneously minimizes the number of controlled intersections and minimizes the gap between the actual evacuation route and the optimal evacuation route. The problem is formulated as a stochastic multi-objective problem. A Pareto-front of solutions is obtained using a genetic algorithm and a simulation.

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