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Airport Security: The Issue of Profiling vs. Screening

In the paper "Optimal Allocation of Resources in Airport Security: Profiling vs. Screening," A. Bagchi and J. Paul examine the role of intelligence gathering and screening in airport security using a game between the government and a terrorist. An intelligence report improves the quality of the information that the government has, whereas screening involves searching a passenger. Interestingly, the authors find that under certain circumstances an increase in the investment in intelligence can induce a more devious terrorist to attack with a higher probability. Another interesting implication is that, everything else remaining constant, the optimal investment in intelligence is higher for a developed economy than for a developing economy. Finally, an increase in the opportunity cost of resources in security may cause the investment in intelligence to go either way. However, programs such as PreCheck help cushion the adverse effect of budgetary shortages.

Cap-and-Trade Schemes for Greenhouse Gas Emissions Targets

Reducing greenhouse gas emissions has been a fundamental problem for most countries around the globe for some years now. Industrialized countries are required to reach a domestic target, as ratified in the Kyoto Protocol. Various methods have been developed to achieve this. In "Market-Consistent Modeling for Cap-and-Trade Schemes and Application to Option Pricing," P. Barrieu and M. Fehr propose a model of futures price dynamics for cap-and-trade schemes designed in the spirit of the European Union Emissions Trading Scheme (EU ETS). Historical price dynamics for the EU ETS suggest that European Emission Allowances (EUAs) and Certified Emission Reductions certificates (CERs), generated by a nondomestic offset mechanism, are significantly related. The authors use an equilibrium framework to demonstrate that compliance regulation singles out special price dynamics. They propose an arbitrage-free model and apply it to the pricing of spread options between EUAs and CERs.

Correlations in Product Evaluations and Nested Logit Choice Model

The utility maximization principle provides an attractive framework for modeling the choice of customers among offered products. Under this principle, a customer associates random utilities with the products and chooses the product with the largest utility. The well-known multinomial logit model is based on the utility maximization principle, where the utilities of the products are independent and Gumbel distributed. However, the assumption of independent utilities can sometimes be undesirable, particularly in settings where the evaluation of a customer for a certain product gives an indication of how she would evaluate other similar products. The nested logit model extends the multinomial logit model to allow dependent utilities. In "Assortment Optimization Under Variants of the Nested Logit Model," J. Davis, G. Gallego, and H. Topaloglu provide algorithms to find an assortment of products that maximizes the expected revenue obtained from each customer when customers choose under the nested logit model. They characterize when such assortment problems can be solved efficiently. When efficient solutions are not available, they construct approximation algorithms.

A Robustness Framework to Optimize Event-Scheduling Against Delay Propagation

For many years, it was assumed that the first thing to consider when tackling an optimization problem is complete knowledge of the data. Yet real-world optimization problems are often subject to uncertainty: measurement errors, implementation errors, system disturbances, or incomplete available data at the moment of planning. For this reason, many approaches to deal with uncertainty have been developed. A large class of real-world problems (e.g., train platforming in railway optimization) can be modeled as event-scheduling problems, i.e., a set of activities for which one has to decide "when" and/or "where" to take place. In "Delay Robust Event Scheduling," A. Caprara, L. Galli, S. Stiller, and P. Toth present a mathematical framework to optimize event scheduling against delay propagation. Computational experiments on real-world data provided by RFI (the main Italian Railway Infrastructure Manager) show that the proposed model can significantly reduce the average propagated delay retaining high-quality solutions.

Managing Prices and Inventories for Perishables

Pricing and inventory management of perishables are two critical levers for the profitability of grocery retailing. A key feature of perishable inventory is that a product has a finite shelf life, and hence the inventories of different ages for the same product may coexist on the same shelf. Advances in information and communication technologies (e.g., RFID) allow firms to collect real-time inventory information accurately and explore innovative dynamic pricing strategies. The authors analyze how to coordinate dynamic pricing and inventory management for perishables in such an environment and show that dynamic pricing strategies can significantly improve profitability and reduce disposals of perishable inventories.

Using Operations Research Tools to Achieve Equity and Efficiency in Food Distribution

Thirty-seven million Americans rely on Feeding America and their network of pantries, shelters, and soup kitchens for food. The largest suppliers to these agencies are regional and local food banks. Food banks are large distribution centers that collect,

store, and distribute food, much of which is donated by sources of surplus food, such as supermarkets and restaurants. In "Sequential Resource Allocation for Nonprofit Operations," R. Lien, S. Iravani, and K. Smilowitz study the food rescue operations of one food bank, in which donated food is redistributed to agencies in a single vehicle tour. The authors develop a resource allocation model to achieve both equitable and efficient service when determining allocation amounts for agencies. Furthermore, the paper identifies characteristics of agencies to consider when designing vehicle tours.

A Learning-While-Doing Algorithm for Revenue Management Problems

Pricing without knowing the exact demand function is a common situation faced by the retailer. In "Close the Gaps: A Learning-While-Doing Algorithm for Single-Product Revenue Management Problems," Z. Wang, S. Deng, and Y. Ye provide a solution for the decision maker facing this dilemma by proposing a dynamic learning-while-doing algorithm to learn the demand function and maximize the revenue concurrently. Their algorithm performs price experimentations in a shrinking sequence of price intervals and integrates learning and doing in a concurrent procedure. By doing so, their algorithm achieves near-best performance among all the possible algorithms. They also show that the parametric information about the demand function as well as each customer's exact valuation may be less important than prior literature suggests because the asymptotic performance of the optimal algorithm is identical with or without that information.

Retailer Inventory Competition

What happens when rival retailers compete away prices? On what basis do consumers then choose a retailer? Often it is on the basis of inventory availability. For example, consumers experiencing a stockout may defect to a rival retailer. Thus, how retailers manage their inventory in the presence of competition is critically important. In "On Markov Equilibria in Dynamic Inventory Competition," T. Olsen and R. Parker conduct a formal treatment of inventory competition in a truly dynamic fashion (because the inventory is durable). Conditions under which a popular but weak equilibrium is equivalent to a rigorous Markovian equilibrium are established. Interestingly, when these conditions are not satisfied, the Markovian equilibrium can give rise to behaviors including cycling, nonstationarity, and sabotage. Most interestingly, a commitment value to inventory is identified as an entirely new reason for holding inventory. In short, a firm may overstock in one period with the hope of reaping the rewards of capturing more demand, from its own customers and those of its rivals, in future periods.

One-Machine Sequencing to Minimize Total Tardiness: A Fourth Theorem for Emmons

Forty years ago, H. Emmons reported in Operations Research on the development of three theorems for helping to solve the single-machine total tardiness problem. "One-Machine Sequencing to Minimize Certain Functions of Job Tardiness: A Fourth Theorem for Emmons" provides a new theorem that can be used in combination with Emmons' original three theorems. J. Kanet shows that the new theorem is a generalization of a well-known theorem by Elmaghraby dating back to 1968.

When Process Flexibility Meets Production Postponement

In markets with multiple sources of demand uncertainty, two widely used approaches are process flexibility and production postponement. Although partial flexibility with full postponement and full flexibility with partial postponement have each been well studied in the literature, the question remains on the performance of partial flexibility with partial postponement. In "On the Performance of Sparse Process Structures in Partial Postponement Production Systems," M.C. Chou, G.A. Chua, and H. Zheng establish that while the popular two-chain performs nearly as well as full flexibility under the extreme environments of zero postponement and full postponement, it may not be as effective under intermediate levels of postponement. Fortunately, by adding a little more flexibility, say turning two-chain into three-chain, the system can perform almost as well as full flexibility under all postponement levels. Moreover, the first-stage speculative capacity for such a system can be allocated as if the postponed reactive capacity is fully flexible.

Under Uncertain Traffic Congestion, Risk-Averse Users May Prefer Longer Routes with Low Variability

Congestion is ever increasing, and one of the biggest inconveniences experienced by commuters is the uncertain time it takes to complete a trip. This forces people with strict deadlines to leave very early, creating a buffer to minimize the chances of arriving late. In "A Mean-Risk Model for the Traffic Assignment Problem with Stochastic Travel Times," E. Nikolova and N. Stier-Moses propose a model that captures the travel time uncertainty inherent in transportation networks and the risk aversion of users to this uncertainty. The novel model can be used by planners to analyze traffic equilibria and forecast congestion, factoring these two key elements present in all transportation systems. One key insight arising from the model is that risk-averse users may trade off a route with high variability for a longer one whose time can be more accurately predicted. However, comparing the resulting flows to a socially optimal solution, risk aversion overall does not degrade the system's congestion significantly, and in particular not more than the corresponding situation without risk aversion.

Planning Railroad Services and Schedules

Railroads make up a major component of the transportation system, moving large volumes of freight over long distances, with performance and profitability depending for a large part on an offer of services meeting customer cost and quality criteria, as well as on efficient and coordinated terminal and long-haul transport operations. Operations are complex, however, economies of scale being reached through a double consolidation policy that groups loaded and empty cars into blocks, which are then grouped again to make up trains. E. Zhu, T. Crainic, and M. Gendreau address the challenge of planning rail services and operations and propose in "Scheduled Service Network Design for Freight Rail Transportation" the first comprehensive model to select the train services and schedules to operate over the contemplated schedule length, car classification policies, the blocks to build in each terminal and make up each train, and the car routings using these services and blocks. They also propose an innovative solution methodology to address the large-size mixed-integer programming formulation, which integrates exact and meta-heuristic principles.

Dynamic Programming with Risk Measures

In "Computational Methods for Risk-Averse Undiscounted Transient Markov Models," Ő. Çavuş and A. Ruszczyński discuss the use of dynamic measures of risk in Markov decision processes. They focus on the total risk problem for transient models and discuss differences between the risk-averse and the expected value versions. After presenting risk-averse dynamic programming equations, they propose risk-averse analogues of the classical numerical methods for solving these equations. In particular, they prove convergence of the value iteration and policy iteration methods. In the latter method, the policy evaluation (the calculation of the total risk) requires solution of a nonsmooth equation. The authors propose a specialized version of Newton's method and a convex programming approach to carry out this evaluation. Finally, they illustrate the operation of the methods on an example of controlling credit limits.

How to Optimize a Fabricable Design

A computed solution of an optimization problem often cannot be implemented directly (irrespective of data accuracy) because of technological limitations, deliberate simplification of a model for tractability, and/or human factors. Motivated by this observation, H. Men, R. Freund, N. Nguyen, J. Saa-Seoane, and J. Peraire present a modeling paradigm in "Fabrication-Adaptive Optimization, with an Application to Photonic Crystal Design." Computationally focused theory and algorithms are developed, and computational results for PDE-constrained optimization problems are presented. In particular, the authors study a variety of problems with special structures on functions, feasible regions, and norms, for which computation is tractable, and they develop an algorithmic scheme for solving these problems in spite of the challenges of nonconvexity. The methodology is then applied to compute fabrication-adaptive designs of two-dimensional photonic crystals with a variety of prescribed features.

Integral Simplex Solves Large-Scale Partitioning Problems Rapidly

Since the 1970s, several authors have proposed adaptations of the simplex algorithm to find an optimal solution to the set partitioning problem (SPP) via a sequence of integer solutions with nonincreasing costs. Balas and Padberg proved the existence of such a sequence in 1972, but degeneracy makes it difficult to find the following term of the sequence. A. Zaghrouti, F. Soumis, and I. El Hallaoui introduce a new algorithm called integral simplex using decomposition for the set partitioning problem (ISUD), which efficiently deals with degeneracy and rapidly finds a decreasing sequence leading to an optimal solution. ISUD is more efficient on SPPs than the conventional approach based on solving the linear relaxation and using cuts and branch and bound, even if the latter has been well improved since its introduction 40 years ago. With ISUD, optimal solutions have been obtained for most crew scheduling instances (up to 500,000 variables) in minutes.

Multiproduct Pricing Under Nested Logit Models

Discrete choice modeling has become a popular vehicle to study the purchase behavior of customers who face multiple substitutable products. The generalized nested logit model with unconstrained price sensitivities and nest coefficients receives increasing attention, partially because its two-stage structure can alleviate the independence of irrelevant alternatives property that limits the acceptance and application of multinomial logit models. The pricing problem under the nested logit model was thought impossible to be efficiently solved. In "Multiproduct Price Optimization and Competition Under the Nested Logit Model with Product-Differentiated Price Sensitivities," G. Gallego and R. Wang show that the adjusted markup, defined as price minus cost minus the reciprocal of price sensitivity, is constant for all of the products of each nest at optimality. In addition, the optimal adjusted nest-level markup is also constant for all of the nests. By using these results, the multiproduct and multinest optimization problem is reduced to a single-dimensional maximization of a unimodal function.

Returns to Service Under Speedup

A growing number of service systems allow for servers to increase the service rate at the cost of decreased quality. In some cases, the degradation in quality results in customers returning to service. In "When to Use Speedup: An Examination of Service Systems with Returns," C. W. Chan, G. Yom-Tov, and G. J. Escobar examine the impact of customer returns in a system where customers' service can be sped up. This work establishes a methodological framework to examine the steady-state behavior of state-dependent queueing systems where service rate and customers' return to service increase as congestion grows. This approach uses stochastic modeling, fluid models, analysis of ordinary differential equations (ODEs) with discontinuities, and simulation. The major implication of this work is that in some cases using speedup can help alleviate congestion, whereas in other instances it can create complex dynamics making the use of speedup undesirable.