Operations Research

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

In This Issue

To cite this article:
(2015) In This Issue. Operations Research 63(1):ii-iv. https://doi.org/10.1287/opre.2015.1362

OPERATIONS RESEARCH
Vol. 63, No. 1, January–February 2015, pp. ii–iv
ISSN 0030-364X (print) | ISSN 1526-5463 (online)

http://dx.doi.org/10.1287/opre.2015.1362

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Inspection Policies and Disclosure Incentives for Regulating Upset Emissions

Many environmental violations occur due to random incidents such as equipment failures. Since many of these "upset emissions" go unreported, one of the biggest challenges facing regulators is designing an efficient inspection policy that simultaneously provides incentives for voluntary disclosure. To study this problem, S. Kim develops a game-theoretic model that combines the features from reliability theory and law enforcement economics in "Time to Come Clean? Disclosure and Inspection Policies for Green Production." In the model, a regulator decides when and how often inspections should be performed, and a firm decides when to disclose a noncompliance event. The author identifies a tradeoff between efficient detection of noncompliance and the firm's opportunistic disclosure behavior. It is found that there are situations where scheduled inspections are preferred to random inspections, and that inspection intensity and penalty may act as complements. Both results reverse the common beliefs found in the law economics literature.

Selfish Dynamic Routing

In many real-world settings, including urban traffic and the Internet, a steady state is rarely observed and thus more realistic models need to consider the propagation of flow across the network by tracking the position of each particle along time. Furthermore, in these situations the lack of central coordination implies that each flow particle needs to be interpreted as a player seeking to complete its journey in the least possible time. In "Dynamic equilibria in fluid queueing networks," R. Cominetti, J. Correa, and O. Larré establish existence and uniqueness of equilibria in single origin-destination networks with the fluid-queue congestion model, in which the time to traverse an edge is composed of a flow-dependent waiting time in a queue plus a constant travel time after leaving the queue. The approach is constructive and provides a finite algorithm to compute the equilibrium. In the multi-commodity setting, they prove existence of equilibrium in a nonconstructive way.

Consumer Memory Drives Pulsing Advertising

Apple's 1984 advertisement retains an iconic position in the pantheon of successful ad campaigns because viewers continue to remember it even though it was aired only once. While most ads lack such a lasting effect, and some of them might even be forgotten immediately, many ads are remembered for a span of time. Standard awareness models assume that awareness decline commences instantaneously, resulting in constant optimal advertising policies for monopolists. In "Understanding the Memory Effect in Pulsing Advertising," Aravindakshan and Naik consider the case when awareness dynamics for a monopolist's brand advertising involves delay due to consumers' memory for ads. This change converts the standard awareness model from an ordinary differential equation to a delayed differential equation. They prove that pulsing advertising is optimal for monopolists and that the optimal ad policy permits several different shapes from constant spending to blitz to various pulsing patterns, depending on the memory span.

Exact Optimization in Train Dispatching

Trains movements in railway networks are regulated, almost everywhere, by human operators (the dispatchers) with little or no help from automatic tools. In many cases, dispatchers must, in real-time, take complicated decisions regarding re-routing and re-scheduling trains in order to recover from delays and disturbances and regain compliance with the official timetable. In "An Exact Decomposition Approach for the Real-time Train Dispatching Problem," Mannino and Lamorgese developed an exact optimization model for train dispatching and an algorithm able to solve real-life instances. As these turned out to be hard to tackle in practice, the authors deployed various effective techniques from integer programming, such as Benders' decomposition and delayed row and column generation. The algorithm is embedded in a decision support tool currently in operation in a control center in Stavanger, Norway.

The Post-Disaster Debris Clearance Problem Under Incomplete Information

Debris management is one of the most time consuming, costly, and complicated operations in disaster response. Debris clearance activities consist of pushing the debris to the sides of the roads so that relief distribution and search-and-rescue operations can be done in a timely manner. In many post-disaster situations, the debris amounts on the roads are not known exactly and the initial estimates are updated as clearance proceeds, making parts of the road network accessible. Hence, debris clearance not only enables disaster response but also increases the accuracy of the information on the road conditions, improving efficiency and effectiveness of future disaster response activities. In "The Post-Disaster Debris Clearance Problem under Incomplete Information," M. Çelik, Ö. Ergun, and P. Keskinocak propose an exact procedure based on a Partially Observable Markov Decision Process model and heuristic techniques using local and regional information updates to address the decision of how to determine the sequence of roads to clear over multiple periods under limited clearance capacity. Through computational experiments based on earthquake scenarios, the authors show that using local updates brings most benefits when initial estimates on the debris amounts are good. Otherwise, a regional update scheme improves the results by aiding learning.

What Happens When Competitors Use Monopoly Models to Choose Prices

Monopoly models are widely used in revenue management research and in revenue management systems, even when revenue managers are well aware that they face competitors in their markets and that these competitors' prices affect demand in the market. It has been conjectured that if revenue managers calibrate monopoly models

with demand data collected in such a competitive setting, then the resulting models will implicitly capture the effect of competition. In "Learning and Pricing with Models that Do Not Explicitly Incorporate Competition," W. L. Cooper, T. Homem-de-Mello, and A. J. Kleywegt explore learning processes of competitors who use monopoly models. They show that the conjectured Market Response Hypothesis does not hold in general. Nevertheless, they find that in many cases competitors attain a better equilibrium by using monopoly models than by using models that explicitly incorporate competition.

Simulating Credit Risk Contributions

In credit risk management, capital allocation plays a central role, which involves allocating economic capital at the portfolio level to risk contributions at individual obligor or transaction level. In practice, one usually has to resort to Monte Carlo simulation to calculate the risk contributions, which is computationally challenging due to the rare-event feature of the problem. In "Simulating risk contributions of credit portfolios," G. Liu proposes an importance sampling method to simulate the risk contributions, when the portfolio risk is measured by value-at-risk. The proposed method may serve as a useful tool in proactive credit risk management.

How to Search for a Small Object

Have you ever lost a small item (contact lens, earring), which might be in one of several locations? You can move between the locations at normal walking speed (or running, if you are keen to find it quickly), but to actually locate it you must go slowly, perhaps getting on all fours to find a contact lens. Can this trade-off between speed and visual acuity be modeled in the context of a search game, where we assume the object is located by Nature according to a worst case probability distribution? The paper by S. Alpern and T. Lidbetter, "Optimal trade-off between speed and acuity when searching for a small object," accomplishes this and shows how to search optimally in such a situation. The search patterns they find may be useful for de-mining operations as well as the more familiar everyday problems of finding lost objects.

Optimal Inventory Levels with Censored Demand

Estimating demand while simultaneously determining optimal inventory levels is a major challenge for most retailers. This problem is further exacerbated by censoring of demand information due to stock-outs. On a practical level, this loss of information forces retailers to carry excess inventory to reduce censoring and its impact. On analytical level, censoring leads to complex sufficient statistics that summarizes historical data, making multi-period inventory optimization intractable. In "Demand Estimation and Ordering under Censoring: Stock-out Timing Is (Almost) All You Need," A. Jain, N. Rudi and T. Wang propose using observations on timing of sales and stock-out to correct for censoring of demand information. This method achieves the dual objective of analytical simplicity as well as reduction in excess inventory a retailer needs to carry. Furthermore, this method reduces the loss in expected profit due to censoring by significant amount.

Efficient Allocation of Congestible Resources

Some resources are less desirable when they are overused. For example, service facilities might be prone to congestion that deteriorates the quality of the service or induces delays in the jobs. In "Auction Design for the Efficient Allocation of Service Capacity Under Congestion," Barrera and Garcia propose an auction design that finds the efficient allocation of these type of resources. In this auction, users with private information regarding their willingness to pay for service, find the right incentives to cooperate in an iterative auction that results in a service capacity allocation that maximizes the social welfare.

Process Flexibility Design From a Worst-Case Point-of-View

Process flexibility is a very effective strategy that enables manufacturing firms to match available capacity with variable demand. Unfortunately, despite recent advances in the understanding of process flexibility under stochastic demand, finding the optimal process flexibility design in realistic settings remains difficult. In "Worst-case Analysis of Process Flexibility Designs," D. Simchi-Levi and Y. Wei take a different approach from the traditional approach applied in the literature and study the design of process flexibility from worst-case perspective. They introduce a new set of flexibility indices, and prove that these indices can be used to compare the worst-case performances of different flexibility designs with little specifications on the demand uncertainty. Using this result and its underlying intuition, the authors improve the celebrated Jordan and Graves index, and propose a heuristic that generates flexibility designs that perform well under both stochastic and worst-case performance measures. They also verify the robustness of the traditional chaining strategy, showing that it is superior to many other sparse designs.

Coping with Inventory Systems Faced with Multiple Uncertainties

A firm's decision-making depends on a variety of unpredictable economic and non-economic forces. As supply chains become increasingly global, for example, firms are affected by international economic forces as well as by domestic considerations. In this context it is unclear whether or not the classic inventory replenishment policies are still optimal, or how firms should adjust their inventory stocking decisions. In "New Sufficient Conditions for (s, S) Policies to be Optimal in Systems with Multiple Uncertainties," Chen et al. investigate the optimal inventory replenishment strategies when facing economic as well as demand uncertainties. They establish conditions under which (s, S) policies remain optimal, and discuss the strategic implications of these conditions. They also provide examples that demonstrate the optimality of non-trivial policies when these conditions are absent.

Transitivity in Decision under Uncertainty

Most theories of decision making assume that preferences are transitive. Since the 1950s, behavioral scientists have uncovered systematic violations of transitivity, but recent evidence has challenged these violations and argued that they were due to methodological problems. A limitation of all previous tests of transitivity is that they use the same stimuli for all subjects and ignore heterogeneity in individual preferences. In "A Tailor-Made Test of Intransitive Choice," A. Baillon, H. Bleichrodt and A. Cillo use individual measurements of intransitive choice models to derive individual-specific tests of transitivity that maximize the likelihood of observing intransitive choices. Despite these features, intransitive choices

were thin on the ground and within statistical error. Deviations from subjective expected utility were better predicted by models that abandon event-separability, such as prospect theory, than by models that abandon transitivity.

Sales Based Network Revenue Management under a General Attraction Model

In the paper "A General Attraction Model and Sales-based Linear Program for Network Revenue Management under Customer Choice," G. Gallego, R. Ratliff, and S. Shebalov present new customer choice and optimization models for handling demand dependencies in network revenue management problems. The first is a general attraction model (GAM) that encompasses both the multinomial-logit and the independent demand model as special cases. The authors justify the GAM axiomatically and as a limit of a nested-logit model where customers first select products and then vendors. The authors also present a sales-based linear program (SBLP) for the network revenue management problem under the GAM that has essentially the same number of variables as the well-known formulation for the independent demand model. This avoids the exponential number of variables of the choice-based linear program, where a variable is needed for each possible subset of offered products. At Sabre, the SBLP has been successfully deployed in practice for both airline revenue management and flight scheduling products.

The Benefit of Service Time Variability in Queueing

Conventional wisdom held that increasing service time variability lengthens waiting in single-server queues. However, in "The Benefit of Introducing Variability in Single-Server Queues with Application to Quality Based Service Domain," Y. Xu, A. A. Scheller-Wolf and K. Sycara show that this conventional wisdom may be false. The authors prove that a centralized single-server system can benefit from a static service differentiation policy that randomly assigns customers different service rates independent of system state: This static differentiation policy can reduce the average waiting time without affecting the mean service time. Such differentiation does introduce more service time variability, but it also creates information that enables the implementation of service-rate-based scheduling, which mitigates the increased variance and may even reduce the total waiting time. The authors also illustrate how to apply the static differentiation policy in the context of quality-based service domains.

Equilibrium Arrival and Routing Behavior in Queueing Networks

Queueing networks models typically assume that the arrival process is exogenous, and unaffected by admission control, scheduling policies, etc. In many situations, however, users choose the time of their arrival and route through a network of queues strategically, taking delay and other metrics into account. In the paper "Strategic Arrivals into Queueing Networks: The Network Concert Queueing Game," Honnappa and Jain develop a framework to study such strategic arrivals into queueing networks. In particular, they model this situation as a population game, and prove the existence and uniqueness of the mean-field equilibrium arrival-time profile and routing profile for several structured network topologies. For general network topologies, the authors provide an algorithm to compute the equilibrium profiles, but in general this solution is not unique.