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In This Issue

Finding the Optimal Road Network and Machinery Location in Forest Harvesting

In the process of forest harvesting, a main task is to bring felled trees to the roadside, where they will be loaded into trucks to be delivered to their destinations. There are mainly two ways to carry out this task: on flat areas tractors or skidders haul the logs, while on steeper slopes cable logging or towers are used, generally with cables to bring logs up. Planning is needed to decide on the location of the machinery and the optimal road network to connect these locations with the public road network. Typically forest engineers use topographic maps. This is time consuming, tedious work, with limited ability to lead to the best solution. In “A Combinatorial Heuristic Approach for Solving Real-Size Machinery Location and Road Design Problems in Forestry Planning,” R. Epstein, A. Weintraub, P. Sapunar, E. Nieto, J. B. Sessions, J. Sessions, F. Bustamante, and H. Musante present a system that significantly improved the decision process. It uses GIS data on topography, tree inventory and natural accidents, and a heuristic algorithm. Several forest firms in Chile have used the system and report both important monetary savings as well as more environmentally friendly solutions, mostly due to the need for fewer roads.

Using Maintenance Information for Managing Service Parts Supply Chains

Products such as aircraft, ships, automobiles, elevators, engines, etc., contain parts that may have to be replaced or repaired based on their usage in order to optimize product performance or guarantee safety. The optimal stocking of spare parts and managing the associated repair process constitutes an important logistics function in companies selling/servicing such equipment. In “Efficient Supply Chain Management at the U.S. Coast Guard Using Part-Age Dependent Supply Replenishment Policies,” V. Deshpande, A. Iyer, and R. Cho use empirical data from the U.S. Coast Guard to identify how part condition information (e.g., accumulated flight hours), obtained from maintenance records, can be used to estimate upcoming demand, and thus be used to proactively manage parts inventory. They show that use of their scheme has the potential to decrease inventory costs significantly while improving in-stock availability. Their research also provides an easy-to-use mechanism to operationally realize the estimated savings. The structure of their proposed policies enables applications in service-parts inventory management environments.

Online Low-Price Guarantees: A Real Options Analysis

Service firms can reach consumers through an ever-increasing set of distribution channels—from their own websites, online and offline travel intermediaries, call centers and traditional global distribution systems. Each of these channels affords new opportunities to reach consumers, but typically at a cost. Numerous firms have created price guarantees to encourage consumers to make purchases or reservations through their own channels in an effort to control costs and better manage inventory. In “Online Low-Price Guarantees: A Real Options Analysis,” B. Marcus and C. K. Anderson value a price guarantee through analogies to financial options. They value price guarantees as financial lookback options, extending the traditional financial framework to one where these guarantees are not freely traded. The valuation is illustrated with application at a major U.S. car rental firm.

A Robust Approach to Handle Options in Portfolio Optimization

The crucial information for a practical implementation of portfolio optimization concerns the future returns. Unfortunately, these returns are unknown. Stock returns are predicted with econometric models. But lack of consensus on the models and limited data to estimate the models lead to uncertainty in these predictions. It is well known that disregarding the uncertainty leads to poor and unstable portfolios. A robust approach explicitly takes uncertainty into account. Experience has shown promising results of a robust approach to form *stock* portfolios. An option is in essence a leveraged investment in a stock. Hence, for portfolio optimization involving options, a robust approach to handle uncertainty may prove even more fruitful. In “Robust One-Period Option Hedging,” F. Lutgens, J. Sturm, and A. Kolen lay out a framework to deal with options in robust portfolio optimization problems. They illustrate the framework on a hedging problem: an investor strives to robustly hedge a written option by investing in existing stocks and options.

Effective Dimension Reduction for High-Dimensional Financial Problems

Problems in computational finance are often of high nominal dimension due to the multiple state variables and/or large number of time steps. For example, some option

pricing and bound valuation problems can be formulated as high-dimensional integrals. Such integrals are usually approximated by quasi-Monte Carlo algorithms based on quasi-random numbers (such as digital nets and good lattice points). Quasi-random points have extremely good quality in the initial dimensions and one-dimensional projections, while the higher-dimensional projections may have poor quality. Dimension reduction techniques are developed to reduce the effective dimensions of the problem, such that the advantages of quasi-random points can be fully exploited. In “On The Effects of Dimension Reduction Techniques on Some High-Dimensional Problems in Finance,” X. Wang explores what happens through the use of Brownian bridge and principal component analysis algorithms for pricing options and bonds. By using ANOVA (analysis of variance) decomposition, the author shows how and to what extent the Brownian bridge and principal component analysis change the weighted properties and the dimension structure of the functions such as the effective dimensions, the mean dimension, the degree of additivity, and their limiting behavior. The investigation provides new insight into dimension reduction techniques and into high-dimensional problems in finance.

Effective Inventory Planning with Forecast Updates

Every inventory manager faces the challenge of how to use demand forecast effectively in adjusting inventory decisions, creating a need for efficient, scientific methods to help managers make such decisions. Because it is well known that inventory models with demand-forecasting features are very hard to solve, most of the literature resort to simpler heuristics, such as the myopic policy that minimizes one period cost. In “Inventory Planning with Forecast Updates: Approximate Solutions and Cost Error Bounds,” X. Lu, J.-S. Song, and A. Regan present a methodology to evaluate the effectiveness of simple heuristics. They also present bounds on the optimal policy that generalize and improve the previous results in the literature.

A Closed-Form Optimal Dynamic Pricing Strategy

Dynamic pricing has been prevalent for many years in the airline, hotel, retail, and other industries. But only recently has the operations research literature begun to incorporate pricing into decision models. One reason for this is that the complex nature of dynamic pricing has made closed-form optimal pricing strategies rare. In “A Monopolistic and Oligopolistic Stochastic Flow Revenue Management Model,” X. Xu and W. J. Hopp offer a closed-form optimal dynamic pricing strategy for an iso-elastic demand function coupled with a geometric Brownian motion customer flow. They show that this strategy forms a cooperative weak perfect Bayesian equilibrium under oligopolistic competition.

Managing Supply Chains of Complementary Products

Firms offering complementary products or services interact with each other strategically in a unique way when making their individual marketing and operations decisions. This is true because (1) the demand for one firm’s product is influenced not only by the firm’s own pricing strategy but also by the pricing strategies of other firms, and (2) the sales of one firm’s product are constrained not only by the availability of the firm’s own product but also by the availability of all other firms’ products. In “Joint Pricing-Production Decisions in Supply Chains of Complementary Products with Uncertain Demand,” Y. Wang presents a game-theoretic model framework to capture the strategic interactions of such firms. Through the analyses of the resulting gaming problems, he explores the effects of channel structure and parameters on firms’ decisions and performance, leading to important managerial insights.

How Much Do You Gain from Knowing Demand Distribution in the Newsvendor Problem?

What would be a good order quantity for the classical newsvendor problem when only partial information about customer demand is available? Herbert Scarf answered the question elegantly in 1958 by providing bounds on the profit function for each potential order quantity and suggesting a distribution-free decision based on the min-max decision criterion. In “Expected Value of Distribution Information for the Newsvendor Problem,” J. Yue, B. Chen, and M. C. Wang extend this classical result by identifying and calculating the maximal potential gain from knowing the demand distribution information for any order quantity. In addition, they provide an optimization procedure to obtain another well-behaved distribution-free order quantity based on the min-max regret decision criterion.

Coping with Long Component Procurement Lead Times and Limited Assembly Capacity When Responding to Demands with Strict Delivery Requirements

In a highly competitive global business environment, contract manufacturers need to promptly respond to demands from their customers, who often require short delivery lead time and impose sharp penalties on late delivery and supply shortage. However, they often face critical challenges of long component procurement lead times and limited assembly capacity, which may render production time insufficient to assemble total order quantity and undermine their ability to win customer orders. To cope with these difficulties, an assemble-to-order manufacturer may need to procure components or even assemble some quantities of the final product before receiving the confirmation of the actual order

quantity. This “pre-stocking” strategy has the advantage of hedging against possible assembly capacity shortage, but it also has the risk of inventory overage. Due to varying component procurement lead times and the fact that there is a chance to replenish some of the needed components after the demand is confirmed, managing inventory and production is nontrivial. In “Inventory and Production Decisions for an Assemble-to-Order System with Uncertain Demand and Limited Assembly Capacity,” K. Fu, V. N. Hsu, and C.-Y. Lee present models and analysis that can help contract manufacturers make their optimal inventory and production decisions.

An Analytical Model for Traffic Delays and the Dynamic User Equilibrium Problem

The importance of understanding how traffic distributes in a network has been widely recognized in recent years. This will allow transportation authorities to deploy effective ways of reducing congestion in a transportation network. Dynamic user equilibrium is a model of traffic assignment in which each traveler seeks to minimize travel time in a noncooperative fashion. In order to determine such equilibrium, it is important to evaluate the impact of congestion on a driver’s travel time. In “An Analytical Model for Traffic Delays and the Dynamic User Equilibrium Problem,” G. Perakis and G. Roels derive an analytical travel time function based on the theory of kinematic waves and integrate it within a dynamic user equilibrium setting.

Optimizing Operations at Different Levels

It is often the case that costly and resource-consuming operations can be done at different levels: for instance, a mechanical operation can be executed by different tools, yielding different levels of accuracy; a scientific experiment can be repeated several times, achieving different levels of precision in estimating the parameters of a system under study; a project can be financed at different levels, causing different investments, risks, and returns. In general, the higher the level, the better the outcome in terms of quality and the larger the amount of resources consumed. The OR literature is quite rich in papers dealing with a variety of problems concerning the optimal assignment of operations to agents with limited resources; the generalized assignment problem (GAP) is a paradigmatic optimization problem of this kind. In “A Branch-and-Price Algorithm for the Multilevel Generalized Assignment Problem,” A. Ceselli

and G. Righini describe a successful mathematical programming approach for an extension of the GAP to the case in which the operations can be performed at different levels. The experimental results include the computation of provably optimal solutions for problem instances previously solved only in a heuristic way.

Dealing with Errors in DNA Sequencing

Finding an accurate sequence of DNA molecules is one of the major concerns in bioinformatics. Biologists desire to construct the original sequence as close to 100% similarity as possible, given a set of short sequences of molecules from which it came. DNA sequencing by hybridization is a relatively new method used for this purpose. The challenge in developing an algorithm for the combinatorial part of the DNA sequencing by hybridization is to handle errors of exclusion and inclusion, which are the results of the biochemical experiment, while satisfying the biologists’ main objective. In “DNA Sequencing by Hybridization via Genetic Search,” J. Blazewicz, C. Oguz, A. Swiercz, and J. Weglarz take advantage of a new biochemical approach (isothermic oligonucleotide library) and develop a novel genetic algorithm to overcome the challenge. The results of extensive experiments, carried on real DNA data, clearly show the outstanding improvement of this approach over others known so far. The significance of the algorithm is due to its particular design, specifically the crossover operator. The design of the crossover operator allows intelligent combination of solutions and can also be of value for some other combinatorial problems for which the solution is represented as a permutation.

Target Search

Rectangular regions are easy to search uniformly, but unfortunately most distributions for target position are elliptical in nature, rather than rectangular. The ideal method of searching such distributions is complicated, so there must be a compromise between effectiveness and easiness. In World War II, the idea of searching a sequence of overlapping rectangles, or “piled slabs,” was developed as an easy way to approximate the ideal method. In “Piled-Slab Searches,” A. Washburn presents a continuation of this line of research. Optimal slab sequences are designed for the case where search of each slab is random. The implications of slab search in accord with the inverse cube law are also investigated.