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Majority Voting Often Fails!

"Majority decision" is the heartbeat of democracy. But what exactly is it? Countries—and juries of competitions—use a multitude of different rules to determine the winner and the order-of-finish (that typically lead to different decisions). Measurement is at the root of them all. In their article "Judge: Don't Vote!" Michel Balinski and Rida Laraki show via practical instances including figure skating and presidential elections, that the traditional approaches measure badly—sometimes very badly—even in a competition between only two candidates or competitors. They propose a simple remedy that naturally emerges from a new model. The traditional paradigm has voters compare the relative merits of competitors. When instead the basic paradigm has voters and judges evaluate the merits of competitors on a well defined ordinal scale, and majorities determine societies' and juries' collective evaluations of each, the most important paradoxes and impossibility theorems of the traditional methods are overcome.

Quantity-Based Dynamic Price

Dynamic pricing combined with quantity discount has been adopted by a growing number of industries. Although the dynamic pricing strategy has been widely studied and its advantage over the fixed pricing strategy is well understood, the same is not true for the strategy of combined dynamic pricing and quantity discount, or the quantity-based pricing strategy. Under the dynamic pricing strategy, the firm sells items with a unit price in each period, while the firm can sell items in different sales modes under the quantity-based pricing strategy. The firm needs to make three decisions: to replenish the inventory, to set the unit selling price, and to choose the quantity discount at the beginning of each period to maximize its total expected profit over a planning horizon. In "Optimal Pricing and Inventory Control Policy with Quantity-Based Price Differentiation," Y. Lu, Y. Chen, M. Song, and X. Yan identify general conditions under which this problem has a well structured optimal inventory control policy and selling/pricing strategy. They show that substantial profit improvement can be gained as a result of shifting from dynamic pricing to quantity-based pricing. They also study how the quantity-discount amount depends on the optimal inventory level.

System Design of Nonmonetary Trade Economies

Scrip systems provide a nonmonetary trade economy for exchange of resources and are often used to govern online peer-to-peer networks and shared resource allocation networks. In many cases, the number of scrips (coupons) injected in the system appears to be a key determinant of the success—or failure—of the system. In "Analyzing Scrip Systems," K. Johnson, D. Simchi-Levi, and P. Sun ask whether there is an optimal quantity of scrips such as to guarantee the success of the system while maximizing system performance. In addition, how can a system designer strategically match trade partners to further improve performance? To answer these questions, the authors model a scrip system as an infinite-horizon stochastic game. Interestingly, they show conditions under which the maximum social welfare achieved in a scrip system under centralized control can actually be achieved in a system with decentralized control, i.e., a system where players decide individually whether to trade in each time period.

The Newsvendor Facing Risk and Ambiguity

Extant investigation of the classical newsvendor problem can be cast into four categories: (1) risk- and ambiguity-neutral, (2) risk-neutral and ambiguity-averse, (3) risk-averse and ambiguity-neutral, and (4) risk- and ambiguity-averse. In "A Risk- and Ambiguity-Averse Extension of the Max–Min Newsvendor Order Formula," Q. Han, D. Du, and L. F. Zuluaga derive and analyze a closed-form solution for a risk- and ambiguity-averse newsvendor model where newsvendors may be risk-averse when they prefer an order quantity that avoids profit volatility unless adequately compensated, and ambiguity-averse when they prefer an order quantity that is immune against incomplete knowledge of the demand's distribution. Their results imply an order quantity offering the distributionally robust Sharpe ratio, along with an unconventional observation that a risk- and ambiguity-averse newsvendor may increase the optimal order quantity as the risk aversion increases when the profit margin is low.

Efficient Empirical Estimation of Marginal Cost

Since the contribution of Alfred Marshall, one of the most fundamental and widely used concepts in economics and management sciences is marginal cost. However, in most industries, the marginal cost of firms cannot be readily observed in the data. Thus, researchers and practitioners have to rely on estimates that might not be robust. In "On the Estimation of Marginal Cost," M. Delis, M. Iosifidi, and E. Tsionas propose the estimation of cost functions using nonparametric techniques. They use data and implications from studies on one of the few industries where the true values of marginal cost can be readily observed from the available data and estimated from the same data set: California's electricity industry. They then compare the values of the true marginal cost to those of its nonparametric estimates and show that the two are very similar. They also show that marginal cost estimates using parametric methods are relatively worse approximations of true marginal costs as compared to the nonparametric methods.

The Structure of a Large Class of Hub Location Problems

Hub location problems lie at the heart of network design planning in transportation, telecommunication, and computer systems, where hub-and-spoke architectures are used to efficiently

route commodities between origin and destination pairs. In "Hub Location as the Minimization of a Supermodular Set Function," I. Contreras and E. Fernández consider a large class of hub location problems, which includes a number of well known hub-node and hub-arc location problems. They model this class of problems as the minimization of a real-valued supermodular set function, propose a formulation that exploits properties of supermodular functions, and develop worst-case bounds for a greedy and a local improvement heuristic. They present an efficient separation of the subset of constraints that model the supermodularity, which is used in a branch-and-cut solution algorithm. Computational experiments on a large set of benchmark instances confirm the superiority of the supermodular formulation over a traditional one, which employs the usual path-based variables.

A Novel Optimal Policy Structure for Managing Inventory in Assemble-to-Order Systems

Assemble-to-order (ATO) systems are popular in many industries, including, but not limited to, automotive, consumer electronics, and online retailing, where offering customized products and services within a short response window plays a vital role. Although popular in practice, characterizing optimal control policies for ATO systems has remained a longstanding challenge in the field of operations management. In "Optimal Structural Results for Assemble-to-Order Generalized M-Systems," E. Nadar, M. Akan, and A. Scheller-Wolf move one step closer to solving this challenging issue: The authors study the problem of inventory replenishment and allocation for a manufacturer who sells an assembled product as well as individual spare parts. They model the problem as a Markov decision process, with state space consisting of component inventory levels. By partitioning the state space into multiple disjoint lattices based on products' component requirements, they establish the optimality of base-stock production and stock rationing policies on each lattice.

A Passenger-Centric Approach to Quantifying Air Travel Delays

Many of the existing methods for evaluating an airline's on-time performance are based on flight-centric measures of delay, such as on-time flight performance. These metrics, while adequately measuring flight delays, do not capture the impacts on passengers from other sources of delays, such as flight cancellations and missed connections due to delayed arriving flights. In "Modeling Passenger Travel and Delays in the National Air Transportation System," C. Barnhart, D. Fearing, and V. Vaze model, estimate, and analyze historical travel and delays for U.S. domestic passengers. They develop passenger-centric approaches, including a multinomial logit model for estimating historical passenger travel and a multi-airline passenger recovery heuristic for reassigning disrupted passengers to alternative itineraries and estimating corresponding passenger delays. By applying these methodologies, the authors are able to analyze and develop insights into some of the key factors affecting passenger air travel performance.

The Effect of Federal Intervention on Interest Rate Securities

This paper examines the effect that a nation's central bank can have on long-term interest rate securities. Typically a central bank intervenes in the short-term, overnight, interest rate market; however, these interventions have lasting effects on longer-term bonds, such as 5- or 10-year bonds. This paper models the overnight rate as a stochastic process and endows the national bank with a control mechanism (impulse control). The paper assumes that the national bank is able to precisely quantify its objectives and then develops a computational method to find the optimal intervention policy. Given this optimal intervention policy the paper then uses a no-arbitrage argument to study the effect of the intervention policy on the yield curve of interest rates.

Monte Carlo Sensitivity for Stochastic Optimization Problems with Model Uncertainty

In the applications of stochastic optimization, decision makers typically rely on some parametric models to determine optimal policies for a complex stochastic system. The modeling parameters are estimated through empirical data and therefore are subject to considerable statistical errors. How should they evaluate the robustness of a policy in the presence of such "model risk"? In "American Option Sensitivities Estimation via a Generalized IPA Approach," N. Chen and Y. Liu develop an efficient Monte Carlo simulation-based method to conduct sensitivity estimation for stochastic optimization problems. Its applications include American option hedging and dynamic inventory management. Their method demonstrates significant numerical advantages for high-dimensional problems. Furthermore, their analysis casts a new insight on the classical infinitesimal perturbation analysis (IPA): Path-wise continuity is not necessary for developing IPA estimators.

Concave Value Functions and Multicriteria Choice

In "CUT: A multicriteria approach for concavifiable preferences," N. Argyris, A. Morton, and J. R. Figueira explore the use of concave value functions in multicriteria choice problems. Concave value functions over single attributes are used in practice to model satiation and have a strong grounding in normative decision modeling. The case of multiple attributes has received less attention, both in theory and in practice. The paper introduces an axiomatization for multiattribute concave value functions, based on intensities of preference. Furthermore, it introduces technical machinery for working with elicited preferences when the value function is assumed concave; this is then used to structure an interactive procedure for multicriteria choice problems. The approach has two useful features. First, it can handle elicited preference intensities. Second, it can derive a bound on the opportunity cost (in terms of loss in value) of prematurely terminating the interactive search. Both features are reported to be useful and practically implementable.

Combinatorial Games for Dark Winter Nights

In "Combinatorial Benders' Cuts for the Strip Packing Problem," Côté, Dell'Amico, and Iori approach the so-called strip packing problem. They propose a new exact method based on a Benders' decomposition, in which the master problem cuts the rectangles into unit-width slices and packs them contiguously in the board, while the slave problem attempts to reconstruct the rectangles by fixing the vertical positions of their unit-width slices. Tailored pre-processing, lower and upper bounding techniques,

combinatorial Benders' cuts, a lifting procedure, and several other improvements allow the solution of a large number of the open benchmark instances within a limited computational effort. The overall method represents a substantial breakthrough with respect to previously published algorithms. The authors also note that this problem can form the basis of an exciting game that can save parents from winter night cabin fever.

Reducing the Sample Complexity of the Scenario Approach

The scenario approach is a recently introduced methodology to address chance-constrained optimization problems. It relies on random sampling of the constraints and provides a solution bearing precise guarantees of chance-constrained feasibility. In "FAST—Fast Algorithm for the Scenario Technique," Algo Carè, Simone Garatti, and Marco C. Campi introduce a new variant of the scenario approach that exhibits a considerable reduction of the sample complexity while preserving rigorous feasibility guarantees. The paper provides theoretical results and a demonstration of the method in a weighted distribution problem. The findings of this paper enhance the applicability of the scenario approach to medium- and large-scale problems.

Robust Linear Optimization Can Now be Solved for Any Convex Uncertainty Set

For some convex uncertainty sets, a tractable formulation of the robust counterpart of a linear program does not exist. In "Deriving Robust and Globalized Robust Solutions of Uncertain Linear Programs with General Convex Uncertainty Sets," B. L. Gorissen, J. P. C. Blanc, D. den Hertog, and A. Ben-Tal show that the dual of the robust counterpart can be formulated as a convex problem with a finite number of variables and constraints. The KKT vector of this convex problem gives the optimal solution of the original robust counterpart. The practical consequences are that robust linear optimization problems can now be solved for any convex uncertainty set, that the derivation of the robust counterpart becomes easier, and that the globalized robust counterpart—which is shown to be a special case of a normal robust counterpart—becomes tractable for any convex distance function.

Reverse-Engineering Objective Function Weights

An inverse optimization problem determines the values of the cost coefficients given a solution to the original forward optimization problem. Inverse optimization problems have generally been studied under the assumption that a given solution is a candidate to be an optimal solution; other solutions would render the inverse problems ill posed or infeasible. In "Generalized Inverse Multiobjective Optimization with Application to Cancer Therapy," T. C. Y. Chan, T. Craig, T. Lee, and M. B. Sharpe propose a new generalized inverse optimization model that accommodates any input solution and determines the coefficients that make it near-optimal. The authors consider this problem in a multiobjective framework, where they provide an exact relationship between a given solution and the inversely optimized objective function weights. Their computational results show that the proposed method can be used to determine objectives that most heavily influence the quality of a given solution.

Restless Bandits with a Knapsack

The main interest of retail companies is net revenue maximization. Managers are facing the problem of a good choice of products to sell, which are often associated with a lifetime during which they can only be sold. The regular selection of some products to be allocated to a limited promotion space is expected to attract more customers than the standard shelves and thus increase the revenues. In "Generalized Restless Bandits and Knapsack Problem for Perishable Inventories," P. Jacko and D. Graczova derive an implementable and nearly optimal policy based on product-defined priority index values. Assuming a certain structure of the optimal policy for the single-inventory control (which might well approximate the true one), they establish indexability and develop an efficient, linear-time algorithm for computing the index values. By a systematic computational study they show that the performance of the proposed index-knapsack heuristic is nearly optimal and that it outperforms the conventional index rule.