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EDITORIAL

Computational management science special issue on "Robust Optimization and Applications"

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Celebrating almost 20 years of active research in the area of robust optimization, this special issue presents six articles discussing compelling new insights along three important dimensions of the topic: computation, modeling, and applications.

In the first computational paper "Polyhedral Approximation of Ellipsoidal Uncertainty Sets via Extended Formulations—a computational case study—" by Andreas Bärmann, Andreas Heidt, Alexander Martin, Sebastian Pokutta, and Christoph Thurner, the authors investigate whether computational speed-up can be achieved by "linearizing" the second-order cone constraints that emerge when deriving the robust counterpart of a linear function under ellipsoidal uncertainty. This question becomes especially relevant when binary decision variables are involved, since it allows employing mixed integer linear programming solvers instead of their second-order conic programming analog. The speed-up is shown to be significant in a portfolio selection problem with cardinality constraint. On the other hand, a number of mixed integer linear programming problems seem to discourage this use, especially in cases where the constraints that are robustified involve a large number of uncertain parameters.

The next paper "Reformulations versus cutting planes for robust optimization: A computational study" by Dimitris Bertsimas, Iain Dunning, and Miles Lubin, presents a comparative study of the two most popular solution schemes for solving static robust optimization problems: schemes based on reformulation using duality theory and schemes based on decomposition techniques and constraint generation. The paper

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presents evidence that supports the idea that reformulation schemes are preferred when the uncertainty set is ellipsoidal and the decision variables continuous. More generally, though, the empirical observations do not favor any of the two schemes. Hence, given that most modern computers employ multi-threaded central processing units, the authors suggest that employing both schemes in parallel might be the most efficient way of using available resources.

In the third paper "Decomposition for adjustable robust linear optimization subject to uncertainty polytope" by Josette Ayoub and Michael Poss, the authors present a novel decomposition scheme for solving exactly a class of adjustable robust linear optimization problems under polytope uncertainty. Unlike previously proposed schemes, the authors suggest casting the separation problem as a bi-linear optimization problem through the use of Farkas lemma. Numerical experiments that involve a large telecommunication network design problem with a budgeted uncertainty set provide surprising evidence that the relative performance of a row generation algorithm and a column-and-row generation algorithm is highly sensitive to whether the budget is fractional or integer.

The paper "Likelihood Robust Optimization for Data-Driven Problems" by Zizhuo Wang, Peter W. Glynn, and Yinyu Ye offers a modeling perspective on decision problems where the uncertainties are characterized by a random vector with support on a finite set of values, but with unknown distribution. The authors assume that historical samples are available, and propose a technique based on the likelihood function for constructing uncertainty sets for the unknown probabilities. They prove that the resulting distributionally robust model remains tractable, and provide simple guidelines for calibrating the size of the uncertainty set based on the confidence levels of particular hypothesis tests. Simulations conducted for a newsvendor problem and a portfolio selection problem suggest the approach is highly tractable, and yields high quality solutions.

The application paper "New Product Launch Decisions with Robust Optimization" by Elcin Cetinkaya and Aurélie Thiele discusses the problem faced by a company that seeks to launch multiple products in the market. The paper builds on the Bass diffusion model by allowing uncertainty in the adoption rates. This leads to a highly challenging problem, with uncertainty sets involving binary variables. The authors show that a conservative approximation of the robust problem can be reformulated as a mixed integer linear programming problem, which can be solved using commercially available software. The approach is tested in several numerical experiments, which show promise.

Finally, our last paper "On the average performance of the adjustable RO and its use as an offline tool for multi-period production planning under uncertainty" by Michal Melamed, Aharon Ben-Tal, and Boaz Golany examines the performance of affine replenishment policies in the context of a single-product, multi-stage production planning problem. While such affine policies are known to perform very well under a robust (i.e., worst-case) performance measure, the authors argue that the policies also perform well *on average*, even when compared against affine replenishment policies specifically designed to optimize average-case costs.

We wish to thank all the authors that submitted papers to this special issue, in particular those that had the patience and determination necessary to go through the multiple rounds of review. Finally, we are grateful to all our anonymous referees for devoting a significant portion of their time and suggesting constructive comments that have improved the quality of the manuscripts.