Preface

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This special issue is focused on recent developments in modelling and optimization of engineering systems in an uncertain environment. Special attention is paid to stochastic optimization with controlled tails of the distributions. Traditionally, tails of the distributions in engineering applications are measured by Probability of Exceedance (POE) and quantile, which is called Value-at-Risk (VaR) in finance. Risk constraints on POE and quantile are equivalent (with the same threshold and confidence levels). The majority of engineering areas use POE (e.g., material strength certification and nuclear engineering), and quantile (VaR) is mostly used in finance. Although these characteristics are very popular, they are suitable for measurement rather than for active control and optimization of the risk. POE and quantile are difficult to optimize in problems with discrete distributions.

Moreover, risk constraints based on POE and quantiles can miss large outcomes in the tails. These shortcomings were mostly studied in the context of financial engineering. In other areas these issues are not much discussed. For instance, in certification of materials, the so-called A-basis requires that at least 99% of the population equals or exceeds a specified value, and, therefore, small outcomes below the threshold are not controlled.

Significant progress in understanding theoretical properties of risk measures was made with the introduction of the axiomatic approach by Artzner et al. (1999), where axioms laying out sensible standards for a measure of risk are proposed and the notion of *coherent measures of risk* is defined. It was demonstrated that VaR is *not* a coherent risk measure. Shortcomings of VaR in risk management were corrected by replacing VaR by the so-called Conditional Value-at-Risk (CVaR), which is also called superquantile, Conditional Tail Risk, and Expected Shortfall in finance. CVaR is a coherent measure of risk which can be optimized

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with convex optimization approaches as long as the underlying random loss is convex with respect to decision variables.

This special issue addresses applications of risk management in logistics, finance, defense, and other areas. Several papers are devoted to applications of technology and extensions of the optimization of coherent risk measures. In particular, we want to attract attention to an important paper by Rockafellar and Royset on the “Second Order Theory” for CVaR. The paper considers a new *error* function with *statistic* equal to CVaR in the sense of a *risk quadrangle* paradigm (Rockafellar and Uryasev 2013). With this new error function, it is possible to build efficient linear regression algorithms for CVaR estimation.

In addition to the paper of Rockafellar and Royset, this special issue includes other papers dealing with coherent risk measures and CVaR. The paper of Ang, Sun, and Yao adds insight to the studies of coherent risk measures, especially, its dual representation and the connection with robust optimization. The paper of Barnard, Pearce, and Trindade studies the efficiency of the estimations of VaR and CVaR for exponential power distribution. As an extended use of CVaR, the paper of Pavlikov and Uryasev develops a method for measuring the distance between two probability distributions.

The papers of Rysz et al. and Yezerska, Butenko, and Boginski both deal with optimization problems on graphs under uncertain structure. The coherent risk measures and CVaR are employed, respectively, to capture the uncertainty.

The rest of the papers consider concrete applications. The paper of Chapman and Mitchell studies humanitarian logistics with emphasis on fairness and uses CVaR to capture the disparity of the associated cost. The paper of Merzifonluoglu and Uzgoren uses CVaR for determining the best strategy for photovoltaic installation. The paper of Faturechi et al. provides interesting mathematical models for supporting the design of shelters and exits in building. Finally, the paper of Perera, Buckley, and Long studies central bank policy based on jump diffusion process.

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