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FOREWORD

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Stochastic simulation is a powerful modeling tool for analyzing complex systems because it allows one to accurately describe a system through the use of logically complex and often non-algebraic variables and constraints. It has been widely used in many application areas, including transportation, manufacturing, telecommunication, supply chain management, smart grid, buildings, healthcare and finance. While it has been widely used in many industrial applications, it still functions mainly as an evaluation tool. In many real-world applications, however, we would also like to use simulation to find the best design option. This problem is known as simulation optimization, and it includes two main challenges: using simulation efficiently to identify the best among a set of design alternatives, and effectively exploring or searching the design space to find promising designs.

The primary objective of this special issue of the *IIE Transactions* is to reflect some recent developments in simulation optimization techniques and how they are applied to solve many different problems appearing in practice. Eight papers have been selected for publication in this special issue.

The first paper by Xu and Nelson proposes a simulation optimization method that combines the nested partitions method and the stochastic branch-and-bound method. It takes advantage of the partitioning structure of stochastic branch-and-bound and estimate the bounds based on the performance of sampled solutions. The proposed method then uses the improved bounds to guide solution sampling for better performance. A convergence proof is provided, and the performance of this algorithm is compared with other algorithms on three test problems: the Miller and Shaw problem, a bowl problem with flexible dimensions, and the buffer allocation problem.

The paper by Luo and Lim considers a constrained simulation optimization problem over a discrete set. The main challenge of the problem is that the feasibility of a solution cannot be known for certain, due to the noisy measurements of the constraints. To address this issue, the paper proposes a new method that converts the constrained optimization problem into an unconstrained optimization problem by finding a saddle point of the Lagrangian function. The authors then apply stochastic approximation to the Lagrangian function to search for the saddle point. The proposed method is shown to converge to the optimal solution almost surely under some conditions when the number of iterations grows. The effectiveness of the proposed method is demonstrated in inventory control problems, and staffing problems in call centers and emergency rooms.

The paper by Hu, Hong and Zhang considers joint chance constrained programs (JCCPs), which are an important class of optimization problems, and whose solutions often require sampling from a simulation. JCCPs are often non-convex and non-smooth, and thus are generally challenging to solve. In this paper, based on the epsilon-approximation method the authors proposed earlier, they propose a smoothing approximation (logarithm-sum-exponential smoothing technique) to handle non-smooth JCCPs that cannot be handled by the epsilon-approximation. This smoothing method is then used together with Monte Carlo samples, obtained via simulation

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or from historical data, to approximate the original nonsmooth chance-constrained problem by a deterministic problem. This deterministic problem is then solved using a sequential convex approximation method. In addition, the authors propose optimizing over parameters in their algorithm, to balance its accuracy with its numerical efficiency. The authors have also studied the convergence of the proposed approximation method.

The paper by Jia, Zhou and Chen considers the optimal computing budget allocation (OCBA) problem when the complexity of designs is a major concern in addition to performance of the designs. The aim of the study is to determine how to allocate simulation runs to different designs to maximize the chance of selecting m simple best designs. Based on lower bounds for the probabilities of correct selection, the authors derived asymptotically optimal computing budget allocation rules. The effectiveness of the rule is then demonstrated using some benchmark examples and a smoke detection problem in wireless sensor networks.

In the paper by Yücesan, the author demonstrates how the analysis of innovation contests can be cast in the statistical Ranking and Selection (R&S) framework. He then proposes using OCBA to improve the screening process in innovation contests. Numerical examples show the inefficiency and inaccuracy of traditional screening methods used in innovation contests, such as round robin, knock-out and serial contest. Further numerical examples show that OCBA can improve the screening process of innovation contests in both efficiency and accuracy.

Motivated by the problems faced in complex ocean liner bunker fuel management problem, the paper by Quan, Yin, Ng and Lee proposes a two-stage sequential framework for the optimization of stochastic simulations with heterogeneous variances under computer budget constraints. The proposed two-stage framework is based on the Kriging model. It incorporates optimal computing budget allocation techniques and the expected improvement function to drive and improve the estimation of the global optimum. Empirical results indicate that it is effective in obtaining optimal solutions and is shown to be more efficient than existing metamodel based techniques. In addition, it gives promising results for the ocean liner bunker fuel management problem.

The paper by Yang, Allen, Fry and Kelton considers the problem of allocating limited resources to several subsystems. In contrast with the majority of existing literature, the objective is not to find an allocation scheme that optimizes the performance of all systems, but instead is to minimize the inequality among subsystems. This objective is motivated by public service applications. For many complex systems, the performance of an allocation scheme needs to be evaluated by simulation. The paper shows how an algorithm can be implemented for this special type of simulation-optimization problem. If the individual performance measures are observed without noise, sufficient conditions are stated for determining whether the returned allocation scheme is a globally optimal solution. In the case of noisy observations, probabilistic guarantees on indifference-zone performance are given. The algorithm is compared to benchmark algorithms on a factorial-experiment. Finally, the authors apply the proposed algorithm to a case study of allocating voting machines to election precincts in Franklin County, Ohio.

In the paper by Löhndorf and Minner, the authors propose some simulation optimization methods to solve the stochastic economic lot scheduling problem (SELSP). In particular, they compare approximate dynamic programming (ADP) with a global search for parameters of simple control policies. For ADP, two value function approximation schemes are used. In numerical examples, they show that ADP works well for small problems, but is outperformed by global policy search when the problem size increases. They also find that the fixed cycle policy provides more reliable results.

Guest Editors:
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