Editorial for the SI: Optimization of Discrete Event Dynamic Systems

Yorai Wardi · Edwin Chong

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Abstract We consider it a great privilege to introduce this special two-issue series on Optimization of Discrete Event Dynamic Systems. Optimization has played a central role in the research discipline of discrete event dynamic systems since its inception, and has been the focus of many papers published in this journal since its creation. Driven by applications in several areas such as manufacturing, transportation, and telecommunications, the optimization problem has been addressed by our research community with particular emphases on theory, computation, and simulation. The purpose of this special issue is to bring together papers representing diverse problems of current interest, and to expose and highlight state-of-the-art ideas, techniques, and algorithms that have been developed for their solution.

The papers comprising this collection represent the following problem areas within the discipline of DEDS optimization: (1) Deterministic large-scale optimization, (2) stochastic large-scale optimization, (3) optimal timing control of DEDS, (4) optimal control of switched-mode, hybrid dynamical systems, and (5) sample-path sensitivity estimation and IPA. The following paragraphs briefly summarize the contributions.

The paper *Time-Optimal Coordination of Flexible Manufacturing Systems Using Deterministic Finite Automata and Mixed Integer Linear Programming*, by A. Kobetski and M. Fabian, concerns the problem of optimizing performance in production systems while maintaining structural properties such as collision and

Y. Wardi (✉)

School of Electrical and Computer Engineering, Georgia Institute of Technology,
Atlanta, GA 30332-0250, USA
e-mail: yorai.wardi@ece.gatech.edu

E. Chong (✉)

Department of Electrical and Computer Engineering, Colorado State University,
1373 Campus Delivery, Fort Collins, CO 80523-1373, USA
e-mail: Edwin.Chong@ColoState.Edu

deadlock avoidance. The paper combines techniques from finite automata and mixed-integer programming, and uses the special structure of the problem to develop computationally-efficient algorithmic techniques.

The paper *Ordinal Optimization and Quantification of Heuristic Designs*, by Z. Shen, Y.C. Ho, and Q.C. Zhao, addresses large-scale optimal design problems. It develops an algorithmic approach that is based on ordering the designs according to a ruler which is constructed by ordinal-optimization techniques. Analysis and simulation experiments demonstrate that the proposed framework yields computationally efficient algorithms for large-scale problems that outperform existing techniques.

The paper *Optimal Node Visitation in Acyclic Stochastic Digraphs with Multi-threaded Traversals and Internal Visitation Requirements*, by T. Bountourelis and S.A. Reveliotis, concerns the optimal routing-policy problem in acyclic stochastic digraphs, where it is desired to minimize the expected number of graph traversals subject to the constraint that each leaf node must be visited a given number of times. The problem is NP-hard, and the paper proposes a suboptimal policy that is computationally tractable and asymptotically optimal.

Partially Observable Markov Decision Process Approximations for Adaptive Sensing, by E.K.P. Chong, C. Kreucher, and A.O. Hero, addresses the problem of managing sensor resources to achieve a sensing task. The problem is subjected to the “curse of dimensionality” and an optimal solution is generally computationally intractable. The paper overcomes this difficulty by formulating the problem in the framework of partially observable Markov decision processes, and developing effective, scalable approximation techniques for its solution.

The paper *Optimal control of production processes with variable execution times*, by D. Giglio, R. Minciardi, S. Saccone, and S. Siri, addresses the problem of optimal timing control in production systems. The performance measure is comprised of time-related cost functions such as earliness and tardiness of parts and products, and the control variables consist of idle times of parts and cycle times of the machines. The paper applies optimal-control techniques to investigate the special structure of the problem and to derive the optimal control in a closed-loop feedback form.

On-line Optimal Control of a Class of Discrete Event systems with Real-Time Constraints, by J. Mao and C.G. Cassandras, considers an optimal control problem defined on a class of stochastic DEDS, subject to hard state constraints. The constraints are not known a priori and become available as the state evolves, and therefore the problem has to be solved in real time. The paper develops a technique that combines sample-path optimization with adaptive estimation of the probability law underlying the solution, and it demonstrates its efficacy in real-time scenarios and its advantages over existing techniques for the considered class of problems.

The paper *On an Optimization Problem for a class of Impulsive Hybrid Systems*, by S. A. Attia, V. Azhmyakov, and J. Raisch, considers an optimal control problem defined on hybrid dynamical systems with state discontinuities at the times of mode switching. The objective is to minimize a cost functional defined on the state trajectory, and the control variable consists of the mode-switching times and the associated jumps in the state. The paper derives necessary optimality conditions and proposes a convergent algorithm for the optimal control problem.

Timing Control of Switched Systems with Applications to Robotic Marionettes, by P. Martin and M. Egerstedt, presents experimental results of optimally controlling the schedule of motion primitives of autonomous robotic marionettes to optimize

their movement. A compiler optimizes the schedule using a framework for optimal control of hybrid dynamical systems recently developed by the authors.

The paper *A Perturbation Analysis Approach to Phantom Estimators for Waiting Times in the G/G/1 Queue*, by B. Heidergott, T. Farenhorat-Yuan, and F. Vasquez-Abad, proposes a new performance-sensitivity estimator for the GI/G/1 queue, based on the technique of weak differentiation. Combined with perturbation-analysis propagation rules, it has a smaller variance than the established IPA estimator.

Infinitesimal Perturbation Analysis in Networks of Stochastic Flow Models: General Framework and Case Study of Tandem Networks with Flow Control, by Y. Wardi and G.F. Riley, presents a unified approach to IPA in the setting of fluid queueing networks. The approach consists of an iterative procedure for computing the sample gradients of various performance functions by linearizing the state trajectory and the timing of discrete events, and is demonstrated on a network with flow control and signal delays.

As the guest editors we wish to thank the authors for their contributions, the reviewers for their assistance, and the editorial office for its support. We also thank the Editor-in-Chief, Professor Xiren Cao, for including our papers in this special collection and for handling the review of our papers in a separate process.

Yorai Wardi and Edwin Chong,
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