Queueing Syst (2013) 73:341–343
DOI 10.1007/s11134-013-9350-1

Editorial foreword to special issue on Simulation of Stochastic Networks and related topics

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Published online: 13 March 2013

This special issue contains a selection of papers which are based on some of the invited lectures that were given at the workshop on Simulation of Stochastic Networks which took place on June 21–23, 2010 at the Newton Institute of Mathematical Sciences in Cambridge, UK. The workshop, which was dedicated to topics related to estimation of rare events as well as other aspects including simulation of stochastic differential equations (SDEs), and steady-state simulation, was attended by over fifty active researchers and leading experts in the fields of applied probability and stochastic simulation.

The special issue cuts across different areas at the intersection of applied probability and stochastic simulation and we believe that an important strength of the issue is that the contributions suggest interesting research avenues in their respective areas. We therefore hope that the readers will enjoy these contributions and feel enticed to venture into the topics that concern the papers in this special issue.

The first paper in this special issue, *Analysis of an interacting particle method for rare event estimation*, is authored by Yi Cai and Paul Dupuis. The paper studies a class of interacting particle systems for Monte Carlo estimation of large deviations probabilities based on finding a subsolution to a certain partial differential equation (PDE). In recent years, the subsolution approach has become one of the standard methods for constructing rare event simulation estimators with suitable optimality properties. The authors extend, at least in the context of one- dimensional problems, the subsolution approach for constructing suitable optimal estimators to a much broader class of particle methods. Surprisingly, they show that the PDE associated to interacting particle

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methods might be considerably easier to solve than that arising in other methods such as importance sampling. The authors also provide the first analysis of a general particle estimator in a regime in which the number of particles is held constant while a large deviations parameter is sent to infinity.

The second paper is due to Bahar Kaynar and Michel Mandjes. The title is *Estimation of the workload correlation in a Markov fluid queue*. This paper studies Monte Carlo estimators for the autocorrelation function of the workload process of a stationary Markov modulated queue. In this setting, the authors show, by deriving suitable bounds on rates of convergence, that the autocorrelation function decreases exponentially fast to zero. So, obtaining accurate Monte Carlo estimates of the autocorrelation function evaluated at a large time is a challenging problem similar to rare event estimation. Provable efficient Monte Carlo estimation of autocorrelation in stationary processes is a topic that has not been studied much in the literature. The authors devise a clever coupling strategy which is later shown empirically to be efficient in some cases, but not all of them. The paper provides an invitation and an opportunity to venture into the underlying statistical theory behind the design and analysis of provable optimal estimators for long-term autocorrelations.

The third paper of this special issue, *Large deviations for the empirical mean of an M/M/1 queue*, by Jose Blanchet, Peter Glynn, and Sean Meyn, was motivated by a question posed by Sean Meyn during his lecture at the workshop. The question involved the slow convergence rate of the empirical mean number in the system of an M/M/1 queue starting empty. It was conjectured in the talk by Sean Meyn that, despite the geometric ergodicity and the simplicity of the M/M/1 queue, large deviations for the upper tail of the empirical mean decrease to zero at a precise subexponential rate. This paper verifies this conjecture and exposes the limitations of large deviations theory for Markov processes. In particular, it is shown that even in the case of a process as regular as a stable M/M/1 queue, the empirical mean of basically any unbounded function of the queue length process will exhibit subexponential large deviations asymptotics that are consistent with heavy-tailed phenomena. The results of the paper provide an invitation to more investigations on this intriguing observation.

Finally, the fourth paper in this special issue relates to Monte Carlo methods for SDEs: a topic that is of great importance in virtually any area of stochastic modeling involving continuous time processes. In their paper: *The strong weak convergence of the Quasi-EA*, the authors, Stefano Peluchetti, Gareth Roberts, and Bruno Casella study a procedure that produces sample paths that are close in total variation to the those underlying the target SDE. The authors' analyses include precise estimates of convergence rates. The procedure is related to a successful exact simulation algorithm based on acceptance/rejection (so-called EA). By sequentially applying EA procedures in short time intervals the authors make the acceptance probability of the EA procedure close to unity. This suggests comparing the induced proposal probability measure obtained in this form (the Quasi-EA distribution) with that of the SDE. Natural extensions such as multidimensional diffusion processes, Levy driven SDEs, and models with constraints arising in queueing networks provide interesting environments for further investigation in connection with the ideas of this paper.

We are grateful to all the authors for their excellent contributions to this special issue. Many thanks also go to the referees for their careful and deep reviews. We are specially grateful to QUESTA's Editor in Chief Sergey Foss for his advice and patience. Finally, last but not least, our gratitude goes to the editorial managers Aiza Mae F. Policarpio, Sudha Subramanian, and all other QUESTA editorial staff, without whom this special issue would have been impossible to complete.