Guest Editorial for the TOMACS Special Issue on the Principles of Advanced Discrete Simulation (PADS)

The Principles of Advanced Discrete Simulation (PADS) special issue is based on the selected papers from the 2015 ACM SIGSIM-PADS Conference, which is the flagship conference of the ACM's Special Interest Group on Simulation and Modeling (SIGSIM). Building on the 29 years of history and the reputation for high-quality papers, the 2015 ACM SIGSIM-PADS Conference was held at the University of Westminster in London on June 15–17, 2015. The guest editors of this special issue served as the conference General Chair (Simon Taylor) and the Co-Program Chairs (Navonil Mustafee and Young-Jun Son) and were responsible for the proceedings of the conference.

The peer-review process for the special issue built on to the original reviews for the conference, wherein the submitted papers were reviewed by members of the SIGSIM-PADS International Program Committee, with most papers receiving three referee reports and follow on discussions. A total of 24 submissions were accepted and published as full papers in the proceedings [Taylor et al. 2015]. Of these, the authors of the top 12 papers selected by the guest editors together with the editor-in-chief (EIC) of TOMACS were invited to submit a substantially extended version of their work to the special issue. Prior to the review process being started, the guest editors requested the authors to prepare a document outlining changes and extensions to their original ACM SIGSIM-PADS 2015 submission, and which also took into account the reviewer comments received for the conference submission. The guest editors then considered the changes and requested clarification to the authors, if required. During the review process, the referees were sent the authors' outline plans for paper extension; the referees were requested to check that the submitted special issue paper included the extensions and revisions that were planned by the authors.

The special issue papers were peer-reviewed by a minimum of three reviewers. Most underwent two rounds of reviews, with two papers undergoing an additional review cycle. We have one paper that has undergone the Replicating Computational Results (RCR) review process [Helms et al. 2017]. The RCR review is included in this issue [Hillston 2017]. Two articles, from the original shortlist of 12, are still under review. Keeping in mind the timescales for publication, we decided, in consultation with the EIC, that those two papers will be published in a regular issue if accepted.

The special issue consists of eight articles. The focus of the first two articles is on the application area of cell biology. The article by Lin et al. [2017] reports the development of an optimistic and thread-based parallel discrete event simulator (PDES), called the *Neuron Time Warp-Multi Thread (NTW-MT)*, for stochastic simulation of chemical reactions in cells. The contribution of the article is the NTW-MT, which can be used for the simulation of reaction diffusion models of neurons. The second article is also related to cell biology, but its focus is on modeling formalisms. It contributes to the literature in domain-specific rule-based modeling languages used for representing cell biological systems. In this article by Helms et al. [2017], the authors present *ML-Rules*, which is aimed at facilitating multilevel M&S of such systems using formal semantics and rule-based algorithms. The RCR review by Jane Hillston [2017] recommended that *ML-Rules* software is given a badging of *Available* and *Reusable* as the “artifact is documented, consistent, complete, exercisable and reusable.”

The following three special issue articles are on optimistic PDES. The article by Pellegrini and Quaqlia [2017] is on improving the performance of PDES platforms that rely on the Time Warp synchronization protocol. Towards this, they implement a *fine-grain time-sharing Time Warp architecture*, which makes systematic use of event preemption in order to dynamically reassign CPU time to higher-priority events/tasks. The authors use the PHOLD benchmark and real-world models for experimental evaluation; the results show that their proposed approach leads to the reduction of the incidence of causality errors, especially when running simulations with higher degrees of parallelism. The article by Davide et al. [2017] presents a new approach to the rollback operation that is critical to the Time Warp synchronization protocol. While previous works have mostly focused on checkpointing or reverse computing-based solutions, the authors of this article make a novel contribution by proposing an entirely different technique that relies on the runtime generation of *undo code blocks*. Further, the new technique can be combined with the classical checkpointing technique. The final article on the theme of optimistic PDES is by Gonsiorowski et al. [2017]. The focus of their work is on the simulation of gate-level circuit models that are automatically generated using an existing PDES framework and a parser system that relies on standardized gate libraries. The automatically generated model is tested by evaluating the performance of a simulation of a full-scale processor model consisting of nearly 6 million Logical Processes (LPs). The authors conclude that the automatically generated model is a more accurate model of the actual hardware.

The next article is the extended version of the original 2015 ACM SIGSIM-PADS paper [Liu et al. 2015] that won the Best Paper Award at the conference. In this article, Liu et al. [2017] present a parallel simulation toolkit called *FatTreeSim* for M&S of fat-tree network topologies. Based on two existing PDES, *FatTreeSim* supports the design and evaluation of the next-generation large-scale data center and high-performance computing environments. It also aids in the design and performance optimization of the applications running on these systems.

The following two papers are on agent-based simulation. The article by Xu et al. [2017] is on large-scale agent-based simulation of traffic networks. They present a novel *heuristics-based approach* to relax the synchronization of parallel agent-based road simulations. The contribution to literature are the heuristics that improve the efficiency of synchronization by relaxing it without affecting simulation results statistically. The final article of the special issue is on *cloning strategies for agent-based simulation*. Li et al. [2017] present the top-down and the bottom-up cloning strategies, conduct experiments, and analyze the effectiveness of the two strategies.

Preparations for the special issue began soon after the 3rd ACM SIGSIM-PADS Conference, and it has taken almost 2 years for the articles to be ready for publication. A rigorous peer-review process has ensured that the selected papers represent not only the cutting edge of research in the PADS community, but also that they provide future research direction and will, in time, contribute toward shaping the intellectual foundations of our discipline. The realization of the special issue was made possible through the contributions of numerous reviewers, and we would like to thank them all! We are grateful for their time in preparing detailed referee reports and working to the timelines of the special issue.

REFERENCES

- C. Davide, P. Alessandro, and Q. Francesco. 2017. Transparently mixing undo logs and software reversibility for state recovery in optimistic PDES. *ACM Transactions on Modeling and Computer Simulation* 27, 2, 1–26.
- E. Gonsiorowski, J. Lapre, and C. Christopher. 2017. Automatic model generation for gate-level circuit PDES with reverse computation. *ACM Transactions on Modeling and Computer Simulation* 27, 2, 1–23.

- T. Helms, T. Warnke, C. Maus, and A. Uhrmacher. 2017. Semantics and efficient simulation algorithms of an expressive multi-level modeling language. *ACM Transactions on Modeling and Computer Simulation* 27, 2, 1–25.
- J. Hillston. 2017. RCR report - semantics and efficient simulation algorithms for an expressive multi-level. *ACM Transactions on Modeling and Computer Simulation* 27, 2, 1–3.
- X. Li, W. Cai, and S. Turner. Cloning agent-based simulation. *ACM Transactions on Modeling and Computer Simulation* 27, 2, 1–24.
- Z. Lin, C. Tropper, R. McDougal, M. Patoary, W. Lytton, and Y. Yiping. 2017. Multi-threaded stochastic pdes for reactions and diffusions in neurons. *ACM Transactions on Modeling and Computer Simulation* 27, 2, 1–27.
- N. Liu, A. Haider, D. Jin, and X. H. Sun. 2017. Modeling and simulation of extreme-scale fat-tree networks for HPC systems and data centers. *ACM Transactions on Modeling and Computer Simulation* 27, 2, 1–23.
- N. Liu, A. Haider, X. H. Sun, and D. Jin. 2015. FatTreeSim: Modeling large-scale fat-tree networks for HPC systems and data centers using parallel and discrete event simulation. In *Proceedings of the 3rd ACM SIGSIM Conference on Principles of Advanced Discrete Simulation*. ACM, New York, 199–210.
- A. Pellegrini and F. Quaqlia. 2017. A fine-grain time-sharing time warp system. *ACM Transactions on Modeling and Computer Simulation* 27, 2, 1–25.
- S. J. E. Taylor, N. Mustafee, and Y. Son. (Eds.). 2015. *Proceedings of the 2015 ACM SIGSIM Conference on Principles of Advanced Discrete Simulation (ACM SIGSIM PADS)*. ACM, New York.
- Y. Xu, W. Cai, H. Aydt, M. Lees, and D. Zehe. 2017. Relaxing synchronization in parallel agent-based road traffic simulation. *ACM Transactions on Modeling and Computer Simulation* 27, 2, 1–24.

Navonil Mustafee, PhD
 Business School
 University of Exeter
 Streatham Court, Rennes Drive, Exeter EX4 4PU
 n.mustafee@exeter.ac.uk
<https://sites.google.com/site/navonilmustafee/>

Young-Jun Son, PhD
 Department of Systems and Industrial Engineering
 University of Arizona, Tucson, AZ 85721-0020
 son@sie.arizona.edu
<http://www.sie.arizona.edu/faculty/son>

Simon J. E. Taylor, PhD
 Department of Computer Science
 Brunel University London
 Kingston Lane, Uxbridge, Middlesex UB8 3PH
 simon.taylor@brunel.ac.uk
<http://www.brunel.ac.uk/people/simon-taylor>

Guest Editors