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 2016 ACM SIGSIM-PADS Conference, which is the flagship conference of the ACM's Special Interest Group on Simulation and Modeling (SIGSIM). Building on the 30 years of history and the reputation for high-quality papers, the 2016 ACM SIGSIM-PADS Conference was held in Banff, Alberta, Canada on May 15–18, 2016. The guest editors of this special issue served as the conference General Chair (Richard Fujimoto) and the Program Chair (Christopher Carothers) 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 20 submissions were accepted and published as full papers and an additional 6 submissions were accepted and published as short papers in the proceedings (Fujimoto and Carothers 2016). Of these, the authors of the top 6 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. Two of the invitees declined the invitation on the basis they were not able to produce sufficiently new results in time to meet the review schedule. Because of this, an additional paper was invited. The guest editors requested the authors to prepare a document outlining changes and extensions to their original ACM SIGSIM-PADS 2016 submission and that 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 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 undergoing an additional review cycle. The special issue consists of five articles that are summarized below.

In the first article (Stoffers et al. 2018), an *automated memoization* approach is shown to speed up simulations done as part of an overall parameter study by avoiding redundant computations. What make this approach most interesting is the support of *impure* functions such as C++ code blocks that perform complex pointers accesses to read object data values. The implementation currently uses Clang to parse C++ simulation code for memoization. In terms of performance gains, the authors report an 80 times speedup for a case study of an OFDM network simulation.

The next article (Hannon et al. 2018) presents a technique for combining the emulation and simulation as part of a smart grid planning and evaluation process. Here, the Distribution System Solver Network (DSSnet) testbed provides an efficient synchronization of time between real-time emulation events and virtual time simulation events using Linux kernel containers as well as offers improvements in scalability, fidelity, and usability necessary to provide a full featured smart grid development platform. As part of the system evaluation, virtual time system overheads, emulation overheads, and accuracy experiment results are reported along with a case study of a microgrid demand response application.

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The third article (Zhao et al. 2018) provides a new methodology for simulating pedestrian motion in high-density scenarios. Here a role-dependent data-driven approach is used to generate realistic crowd dynamics under high-population-density conditions that divides the pedestrians into one of two categories: *leader* or *follower*. Overall, this approach results in a model that better reflects the natural behavior of pedestrians in crowded areas. To validate the effectiveness and generality of the role-dependent model, two real-world datasets are used as part of the detailed analysis.

The last two articles focus on applying massively parallel optimistic simulation to efficiently model extreme-scale network and computer systems at both scale and a high degree of fidelity. In Wolfe et al. (2018), a slim fly supercomputer network topology is modeled and evaluated using both synthetic and real application traffic workloads. The slim fly network is of interest because of its low diameter, which leads to fewer packet hops and overall lower cost of construction relative to other network topology alternatives. A strong scaling performance study is conducted, and performance results are presented on a one-million node slim fly network model, which is the largest network model reported to date for this particular topology.

Because of the demise of Moore's Law scaling, alternative non-von Neumann processor designs are being considered and neuromorphic processors offer the promise of human brainlike computing for applications like image classification using only 100mW of power versus 100W of power used by conventional CPUs. In Plagge et al. (2018), *NeMo* provides a parallel simulation framework for the efficient and effective exploration the neuromorphic hardware design space. This optimistic simulation framework offers processor models with both a standard leaky, integrate, and fire (LIF) neuron model and a highly accurate representation of the IBM TrueNorth neuromorphic processor. As part of their performance study, *NeMo* executes a TrueNorth processor model with nearly 8.4 million neuromorphic cores using 2,048 IBM Blue Gene/Q supercomputer compute nodes.

Preparations for the special issue began soon after the 2016 ACM SIGSIM Conference on Principles of Advanced Discrete Simulation (PADS), and it has taken over 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 thank them all. We are grateful for their time in preparing detailed referee reports and working to the timelines of the special issue.

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