



Software Tools, Techniques and Architectures for Computer Simulation

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In recent years, the complexity of computer simulations has increased steadily, and it is now common to see very complex software development for simulation studies.^{1,2} These tasks are particularly challenging in the field of computer systems and networking simulations.³⁻⁶ Although there have been numerous efforts in the field of modeling and simulation of computer systems and computer networks, there have been few opportunities for researchers to discuss and highlight the main issues they face when building new software tools, techniques and architectures for these applications.

Following the success of the first SIMUTools International Conference on Simulation Tools and Techniques (Marseille, France, March 2008), and its follow-up editions in Rome (2009) and Malaga (2010), this special issue aims at giving such an opportunity. The idea of this issue is to provide a timely reference of the current best practices and thus contribute to help the simulation community to tackle new problems and improve the current state-of-the-art techniques and tools. The first edition of SIMUTools received 114 submissions in this field out of which 33 were accepted for publication as full papers in the conference proceedings. The authors of the best of these papers and numerous other contributions in this area were submitted to this issue. After a long review process, this double-volume issue includes a number of varied topics briefly summarized hereafter, including a few extended versions of the original papers from SIMUTools, and many other interesting articles related to simulation tools and techniques.

'A Component-Based Simulator for MIPS32 Processors', by Yu Chen and Hessam Sarjoughian, introduces the use of DEVS-Suite for creating a library for simulation of computer architecture, based on MIPS32 processors. The authors compare single-cycle, multi-cycle and pipeline MIPS 32 architectures, by modeling them using their physical and functional architectures. Each component is built as a DEVS atomic/coupled component, and a simulation is automatically executed based on the DEVS-Suite environment. The authors also discuss educational activities based on their model and tools, including an interesting survey.

The paper 'A Simulation Environment for Hierarchical Process Chains Based on OMNET++', by Falko Bause, Peter Buchholz, Jan Kriege and Sebastian Vastag, introduces the use of the networking tool OMNET++ in a different application domain: process chains. The authors introduce ProC/B, a library for hierarchical modeling that can be mapped into discrete-event simulation models. The idea is to map a graphical specification model and convert it into an OMNET++ library for simulation purposes. The authors present the design of such a library, and discuss validation results of the transformation process.

The article 'Application-Level Simulation for Network Security', by Stephan Schmidt, Rainer Bye, Joël Chinnow, Karsten Bsufka, Ahmet Camtepe and Sahin Albayrak, presents the design of NeSSi, a network simulator that incorporates varied network-security models (automated attack generators, trace analysis, intrusion detection, etc.). The main goal is to allow network service providers to improve security through simulation analysis, using a library tailored specifically for security experts and network administrators. The tool allows the user to model hierarchical networks, and it provides an advanced GUI to create network topologies and varied scenarios. The models can be executed with high performance, based on a parallel

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simulation engine. The authors present interesting case studies based on the detection and prevention of computer worms, and they show different projects where this tool has been recently used.

Wolfgang E. Denzel, Jian Li, Peter Walker and Yuho Jin introduce their work entitled 'A Framework for End-to-end Simulation of High performance Computing Systems', in which they present a software tool for studying HPC systems with thousands of components and varied interconnects. The main problem they try to address is high scalability in the simulation of these systems, which is not straightforward. They used OMNET++ to build a library with focus on their applications. The tool allows them to collect traces, organize the code better, and use the graphical interfaces of this well-established environment. They introduce varied simulation results for validation purposes, including a discussion on parallelization of this environment to improve performance based on MPI middleware.

'A Network-based Simulation Architecture for Studying Epidemic Dynamics' by Chung-Yuan Huang, Yu-Shiuan Tsai and Tzai-Hung Wen introduces a network-based simulation applied to the study of epidemiology. The authors use a new architecture based on demographics, in order to be able to run advanced simulations applied to complex epidemics. Their model is based on cellular automata, and it uses spatial distribution of the entities, and their geographical scale. They show the use of their tool through an example based on the SARS and HIV epidemics, comparing the predicted simulations with the empirical data (for validation purposes).

Finally, the article 'A Methodology for Solving Logistic Optimization Problems through Simulation', by Mercedes Narciso, Miquel A. Piera and Antoni Guasch, introduces a methodology for decision-making analysis in logistics, based on simulation and optimization. The authors propose to define discrete-event models using colored Petri nets (CPN), and their application to logistic problems (which, being NP-hard, can be studied through simulation methods). The idea is to first model the system as a discrete-event model, specifying the resources needed, queues, delays, etc. The method they propose allows one to convert this model into a CPN, and do reachability analysis using standard tools. Then, an optimization algorithm is applied to the reachability tree, trying to find optimal solutions through different heuristics. They show the feasibility of their proposal through an interesting case study on job-shop operations.

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