Special Issue on Tools for Computer Performance Modelling and Reliability Analysis

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This special issue offers an up-to-date overview on software tools for computer performance modelling and reliability analysis that are currently developed by research groups in academia. Because of the ever increasing complexity of computer systems, researchers have developed throughout the years many analytical and simulative approaches to evaluate performance and reliability of real-world systems. However, the mathematical skills required to understand some of these results are often a barrier for their widespread adoption as a part of practitioners tend to perceive research results on modeling as too complex to be useful in their problems. Software tools represent a notable exception to this barrier, as they tend to hide most of the mathematical details of the modeling or analytical technique. Further, the learning curve of users can be made faster by distributing examples or graphical interfaces with context-sensitive hints.

Although software tools represent an effective way to convey modeling research result into practical applications, we feel that more should be done in advertising to the general public what tools are available and how they differ in terms of functionalities and modeling approaches used. For example, we are not aware of any web page listing the available academic performance and reliability tools. Therefore, the chances of a tool of becoming popular seems to be left either to the individual action of the authors or to the popularity of the web platform on which the tool is distributed (e.g., Sourceforge). The eleven invited papers in this special issue try to help in this direction by reviewing the general characteristics of some popular tools for performance and reliability analysis. Each paper presents a general description of tool features together with a discussion on upcoming extensions. Table 1 overviews the main features of the tools presented in this special issue.

	GreatSPN	JMT	Möbius+Traviando	OPEDo	PEPA Eclipse Plugin	PIPE2	PRISM	QPME	SHARPE	SMART	TANGRAM-II
Fault Trees			*						*		
Markov Chains	*								*	*	*
Queueing Networks		*		*				*	*		*
Stoch. Activ. Networks			*								
Prob. Model Checking							*				
Stoch. Petri Nets	*		*			*			*	*	
Stoch. Process Algebra			*		*						
Composite/Hier. Models		*	*					*	*		*
Approximate Analytical		*	*	*			*		*	*	*
Exact Analytical	*	*	*	*	*	*	*		*	*	*
Transient Analysis	*		*			*	*		*	*	*
GUI/Graphical Eval.	*	*	*	*	*	*	*	*	*		*
Numerical Optimization				*							
Simulation	*	*	*		*	*	*	*		*	*
Workload Analysis		*									*

Table 1: Main features of tools presented in the special issue

GreatSPN is presented in the first paper of the special issue, titled "The GreatSPN Tool: Recent Enhancements" authored by Soheib Baarir, Marco Beccuti, Davide Cerotti, Massimiliano De Pierro, Susanna Donatelli, and Giuliana Franceschinis. The tool is specifically tailored to the solution of Generalized Stochastic Petri Nets (GSPNs) and Stochastic Well-Formed Nets (SWNs) and can perform a variety of evaluations such as structural analyses, state-space analysis, simulation, Markov chain generation.

Java Modelling Tools (JMT) is a suite of applications for queueing network analysis and workload characterization. The tool is presented in the paper "JMT Performance Engineering Tools for System Modeling" authored by Marco Bertoli, Giuliano Casale, and Giuseppe Serazzi. JMT supports product-form and non-product-form networks, what-if analysis, wizard-based user interaction, and a module for workload characterization from measured traces.

The Möbius framework, presented in the paper "Performance and Dependability Modeling with Möbius" by Shravan Gaonkar, Ken Keefe, Eric Rozier, William H. Sanders, Ruth Lamprecht, and Peter Kemper, is a multi-paradigm environment that allows the specification of composite performance and reliability models based on different formalisms such as stochastic activity networks (SANs), fault trees, and the PEPA stochastic process algebra. Möbius simulation traces can be exported in XML to the Traviando visualization tool for model validation and statistical analysis.

OPEDo is a software tool for the numerical optimization of performance or dependability metrics in discrete event systems. The application is described in the paper "OPEDo: A Tool for the Optimization of Performance and Dependability Models", by Markus Arns, Peter Buchholz, and Dennis Müller. OPEDo implements local, global, and hybrid search methods which iteratively evaluate the response surface seeking for the optimum. OPEDo considers the underlying model as black-box, thus it supports the interfacing to external applications for model specification and evaluation.

PEPA Eclipse Plug-in, presented in the paper "The PEPA Eclipse Plugin" by Mirco Tribastone, Adam Duguid, and Stephen Gilmore, supports the definition of stochastic process algebra models based on the Performance Evaluation Process Algebra (PEPA) language.

The tool runs inside the open source Eclipse workspace and supports seamless upgrade to newer version through via the Eclipse interface. PEPA Eclipse Plug-in is centered around the Pepato library for static, Markovian, and ODE analysis of PEPA models by means of numerical and simulative methods.

The paper "PIPE2: A Tool for the Performance Evaluation of Generalised Stochastic Petri Nets" by Nicholas J. Dingle, William J. Knottenbelt, and Tamas Suto describes the PIPE2 tool for analysis of Generalized Stochastic Petri Nets (GSPNs). The application supports structural and performance analysis modules for evaluation of GSPNs. PIPE2 integrates an original formalism for graphical specification of performance queries and adopts a client-server software architecture that allows for parallel or distributed model analysis.

The PRISM tool presented in "PRISM: Probabilistic Model Checking for Performance and Reliability Analysis" by Marta Kwiatkowska, Gethin Norman, and David Parker, is an open-source probabilistic model checker that supports Markov chains, Markov decision processes, and reward models. PRISM integrates a native language for textual modeling and allows for the efficient validation of model properties based on a temporal logic approach. The implemented evaluation techniques include discrete-event simulation, numerical and graph-theoretical model-checking algorithms, and symbolic techniques based on binary decision diagrams (BDD) model representations.

The QPME tool described in "QPME A Performance Modeling Tool Based on Queueing Petri Nets" by Samuel Kounev and Christofer Dutz supports the specification of performance models based on the Queueing Petri Nets (QPNs) formalism, which allows the specification of queueing places within stochastic Petri nets. The tool allows the evaluation of QPNs by Monte carlo simulations and has native support for colored tokens, incidence functions, and several performance data collection modes. QPME is integrated with the Eclipse Rich Content Platform through the QPE color editor which allows graphical specification of model structure.

SHARPE is a tool for semi-symbolic analysis of fault trees, reliability block diagrams, acyclic series-parallel graphs, acyclic and cyclic Markov and semi-Markov models, GSPNs, and closed product-form queueing networks. In "SHARPE at the Age of Twenty Two" by Kishor S. Trivedi and Robin Sahner describe the development of the tool as well as advanced features such as exact model decomposition, exponomial distributions and their practical application to real-world availability models.

The SMART tool presented in "Advanced features in SMART: the Stochastic Model checking Analyzer for Reliability and Timing" by Gianfranco Ciardo, Andrew S. Miner, and Min Wan, is a software package for model-checking and for numerical and simulative evaluation of stochastic models which are an extended form of Petri nets. SMART integrates advanced features for compact representation of large scale models based on different types of decision diagrams which can be evaluated either exactly or approximately. The tool also integrates a simulation module and CTL model checking capabilities.

TANGRAM-II, described in the paper "The TANGRAM-II Integrated Modeling Environment for Computer Systems and Networks" by Edmundo de Souza e Silva, Daniel R. Figueiredo, and Rosa M.M. Lẽao, is a comprehensive suite of tools for system modeling and traffic measurement. The analytical solution engine supports both Markovian and non-Markovian models; the simulation engine can also evaluate generic fluid-models such as fluid Generalized Processor Sharing (GPS) and FIFO queues. TANGRAM-II also integrates native support for specification of Hybrid Markov Models and a network measurement engine that can obtain unicast and multicast measurements.

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