Preface

This volume presents the set of papers accompanying the lectures of the seventh International School on Formal Methods for the Design of Computer, Communication and Software Systems (SFM).

This series of schools addresses the use of formal methods in computer science as a prominent approach to the rigorous design of computer, communication and software systems. The main aim of the SFM series is to offer a good spectrum of current research in foundations as well as applications of formal methods, which can be of help for graduate students and young researchers who intend to approach the field.

SFM 2007 was devoted to formal techniques for performance evaluation and covered several aspects of the field, including formalisms for performance modeling (Markov chains, queueing networks, stochastic Petri nets, and stochastic process algebras), equivalence checking and model checking, efficient solution techniques, and software performance engineering.

The opening paper by Stewart presents Markov chains, the fundamental performance modeling formalism in use since the early 1900s. The author outlines the events that have led to the present state of the art in the numerical approach to Markov chain performance modeling and describes current solution methods and ongoing research efforts.

The paper by Balsamo and Marin is about queueing networks, a class of stochastic models extensively applied to represent and analyze resource-sharing systems such as communication and computer systems. The authors mostly focus on product-form queueing networks, which allow one to define efficient algorithms to evaluate average performance measures.

The paper by Balbo illustrates generalized stochastic Petri nets, a modeling formalism that can be conveniently used both for the functional verification of complex models of discrete-event dynamic systems and for their performance and reliability evaluation.

The paper by Clark, Gilmore, Hillston, and Tribastone provides an introduction to stochastic process algebras and their use in performance modeling, with a focus on the PEPA formalism. The authors describe the compositional modeling capabilities of the formalism and the tools available to support Markov-chain-based analysis.

The paper by Bernardo defines and compares several Markovian behavioral equivalences with respect to a number of criteria such as their discriminating power, the exactness of the Markov-chain-level aggregations they induce, the achievement of the congruence property, the existence of sound and complete axiomatizations, the existence of logical characterizations, and the existence of efficient verification algorithms.

The paper by Kwiatkowska, Norman, and Parker presents an overview of model checking for both discrete-time and continuous-time Markov chains, which

deals with algorithms for verifying them against specifications written in probabilistic extensions of temporal logic, including quantitative properties with rewards. The authors also outline the main features supported by the probabilistic model checker PRISM.

The paper by Gribaudo and Telek summarizes the basic concepts and the potential use of Markov fluid models, together with the factors that determine the limits of their solvability and practical guidelines that can be extracted from these factors to establish the applicability of fluid models in practice.

The paper by Knottenbelt and Bradley explores an array of techniques for analyzing stochastic performance models with large state spaces. The authors concentrate on explicit techniques suitable for unstructured state spaces and show how memory and run-time requirements can be reduced using a combination of probabilistic algorithms, disk-based solution techniques, and communication-efficient parallelism based on hypergraph partitioning.

The paper by Ciardo discusses some important classes of decision diagrams and shows how they can be effectively employed to derive symbolic algorithms for the analysis of large discrete-state models. In particular, the author presents both explicit and symbolic algorithms for state-space generation, CTL model checking, and continuous-time Markov chain solution.

The paper by Smith reviews the origins of software performance engineering (SPE) and covers its fundamental elements: the data required, the software performance models, and the SPE process. The author also illustrates how to apply the modeling and analysis techniques and reports on the current status as well as the outstanding problems.

The closing paper by Woodside is about using the SPT/MARTE annotations to capture important performance features of a software design, such as platform operations, component submodel composition, state machine uses, and communication costs and delays. The author also addresses the relationship of the annotated design model to the different kinds of performance model that can be extracted.

We believe that this book offers a comprehensive view of what has been done and what is going on worldwide in the field of formal methods for performance evaluation. We wish to thank all the lecturers and all the participants for a lively and fruitful school. We also wish to thank the entire staff of the University Residential Center of Bertinoro for the organizational and administrative support. Finally, we are very grateful to BiCi – Bertinoro international Center for informatics, which kindly provided a sponsorship for this event under the Leonardo Melandri Program.

June 2007 Marco Bernardo and Jane Hillston

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