Model checking probabilistic systems

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This lecture will provide an introduction to the verification of CTMCs, a model that combines discrete probabilistic branching with random state residence times. CTMCs are prominent in performance and dependability evaluation, occur as semantic model of high-level modeling formalisms such as stochastic Petri nets and process algebras, and are frequently used in systems biology. We will introduce a branching-time logic on CTMCs, and explain in detail how the validity of these logical formulas can be model-checked on finite CTMCs. In order to handle large, or even infinite CTMCs, we introduce an abstraction technique that fits within the realm of three-valued abstraction methods. The key ingredients of this technique are a partitioning of the state space combined with an abstraction of transition probabilities by intervals. We will present the underlying theory of this abstraction, some examples, and indicate how such abstraction can be applied in a compositional manner. Finally, we show how CTMCs can be verified against linear real-time properties given as deterministic timed automata.

References

[1] Christel Baier, Boudewijn R. Haverkort, Holger Hermanns, and Joost-Pieter Katoen. Model-checking algorithms for continuous-time Markov chains. In *IEEE Transactions on Software Engineering*, 29(6):524541, 2003.

[2] Joost-Pieter Katoen, Daniel Klink, Martin Leucker, and Verena Wolf. Abstraction for Stochastic Systems by Erlangs Method of Stages. In *19th International Conference on Concurrency Theory (CONCUR08)*. pages 279294. Volume 5201 of LNCS. Springer, 2008.

[3] Taolue Chen, Tingting Han, Joost-Pieter Katoen, and Alexandru Mereacre. Quantitative Model Checking of Continuous-Time Markov Chains Against Timed Automata Specifications. In *IEEE Symposium on Logic in Computer Science (LICS)*. IEEE CS Press, 2009.