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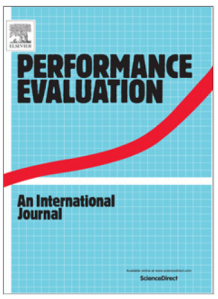

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PII: S0166-5316(17)30130-X
DOI: https://doi.org/10.1016/j.peva.2017.11.004
Reference: PEVA 1947

To appear in: *Performance Evaluation*

Received date : 31 March 2017
Revised date : 30 October 2017
Accepted date : 2 November 2017

Please cite this article as: C. Feng, J. Hillston, Accelerating simulation of Population Continuous Time Markov Chains via automatic model reduction, *Performance Evaluation* (2018), https://doi.org/10.1016/j.peva.2017.11.004

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Accelerating Simulation of Population Continuous Time Markov Chains via Automatic Model Reduction

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Abstract

We present a novel model reduction method which can significantly boost the speed of stochastic simulation of a population continuous-time Markov chain (PCTMC) model. Specifically, given a set of predefined target populations of the modellers' interest, our method exploits the coupling coefficients between population variables and transitions with respect to those target populations which are calculated based on a directed coupling graph constructed for the PCTMC. Population variables and transitions which have high coupling coefficients on the target populations are exactly simulated. However, the remaining population variables and transitions which have low coupling coefficients can either be removed or approximately simulated in the reduced model. The reduced model generated by our approach has significantly lower cost for stochastic simulation, but still retains high accuracy on the statistical properties of the target populations. The applicability and effectiveness of our method is demonstrated on two illustrative models.

Keywords: Population continuous time Markov chain; Stochastic simulation; Model Reduction

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