Analyzing Markov chains using Kronecker products

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Kronecker products are used to define the underlying Markov chain (MC) in various modeling formalisms, including compositional Markovian models, hierarchical Markovian models, and stochastic process algebras. Although the Kronecker representation does not provide a solution to the storage problem of state probability vectors associated with the model, it enables the storage of the underlying state transition matrix compactly, thereby facilitating the analysis of multi-dimensional models that are an order of magnitude larger than those that can be analyzed with conventional sparse matrix techniques on the same platform due to memory limitations. In the Kronecker based approach, the generator matrix underlying the MC is represented using Kronecker products of smaller matrices and is never explicitly generated. The implementation of transient and steady–state solvers rests on this compact Kronecker representation, thanks to the existence of an efficient vector–Kronecker product multiplication algorithm known as the shuffle algorithm. Here, we take a vector–matrix approach and discuss recent results related to the analysis of MCs based on Kronecker products independently from modeling formalisms.