Perfect simulation using atomic regeneration with application to Sequential Monte Carlo*

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Abstract

Consider an irreducible, Harris recurrent Markov chain of transition kernel Π and invariant probability measure π. If Π satisfies a minorization condition, then the split chain allows the identification of regeneration times which may be exploited to obtain perfect samples from π. Unfortunately, many transition kernels associated with complex Markov chain Monte Carlo algorithms are analytically intractable, so establishing a minorization condition and simulating the split chain is challenging, if not impossible. For uniformly ergodic Markov chains with intractable transition kernels, we propose two efficient perfect simulation procedures of similar expected running time which are instances of the multigamma coupler and an imputation scheme. These algorithms overcome the intractability of the kernel by introducing an artificial atom and using a Bernoulli factory. We detail an application of these procedures when Π is the recently introduced iterated conditional Sequential Monte Carlo kernel. We additionally provide results on the general applicability of the methodology, and how Sequential Monte Carlo methods may be used to facilitate perfect simulation and/or unbiased estimation of expectations with respect to the stationary distribution of a non-uniformly ergodic Markov chain.

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