Piecewise-deterministic Monte Carlo with discontinuities

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Abstract

Markov chain Monte Carlo methods are a standard tool for sampling from intractable distributions, and hence approximating expectations of test functions. In brief, they operate by constructing a Markov chain which leaves the desired distribution invariant, and using sufficiently long trajectories as proxies for i.i.d. samples. Essentially all well-known algorithms are constructed to be reversible with respect to the target distribution. Reversibility is known to inhibit mixing by introducing diffusive, backtracking behaviour that results in the chain repeatedly exploring the same neighbourhood of the state space. The past few years have seen the development of the first practical, non-reversible MCMC methods, which avoid diffusive behaviour. However, their construction relies on a number of regularity properties, including a connected state space and a target distribution with a differentiable density. I will show how analogous algorithms can be constructed on state spaces featuring discrete values or boundaries, and for target distributions with discontinuous densities. The resulting method produces substantial efficiency gains for the Kingman coalescent: a model of latent ancestral trees in population genetics which features continuous branch lengths and discrete tree topologies, and for which reversible MCMC methods are known to scale poorly.

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