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Antithetic sampling for sequential Monte Carlo methods with application to state-space models

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Abstract In this paper, we cast the idea of antithetic sampling, widely used in standard Monte Carlo simulation, into the framework of sequential Monte Carlo methods. We propose a version of the standard auxiliary particle filter where the particles are mutated blockwise in such a way that all particles within each block are, first, offspring of a common ancestor and, second, negatively correlated conditionally on this ancestor. By deriving and examining the weak limit of a central limit theorem describing the convergence of the algorithm, we conclude that the asymptotic variance of the produced Monte Carlo estimates can be straightforwardly decreased by means of antithetic techniques when the particle filter is close to fully adapted, which involves approximation of the so-called optimal proposal kernel. As an illustration, we apply the method to optimal filtering in state-space models.

Keywords Antithetic sampling · Central limit theorem · Optimal filtering · Optimal kernel · Particle filter · State-space models

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