

Unbiased Markov chain quasi-Monte Carlo for Gibbs samplers

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In statistical analysis, Monte Carlo (MC) stands as a classical numerical integration method. When encountering challenging sample problem, Markov chain Monte Carlo (MCMC) is a commonly employed method. However, the MCMC estimator is biased after a fixed number of iterations. Unbiased MCMC, an advancement achieved through coupling techniques, addresses this bias issue in MCMC. However, its variance retains the traditional $O(N^{-1/2})$ convergence rate. Quasi-Monte Carlo (QMC), known for its high order of convergence, is an alternative of MC. By incorporating the idea of QMC into MCMC, Markov chain quasi-Monte Carlo (MCQMC) effectively reduces the variance of MCMC, especially in Gibbs samplers. This work presents a novel approach that integrates unbiased MCMC with MCQMC, called as an unbiased MCQMC method. This method renders unbiased estimators while improving the rate of convergence significantly. Numerical experiments demonstrate that the unbiased MCQMC method yields a substantial reduction in variance compared to unbiased MCMC in several Gibbs sampling problems. Particularly, unbiased MCQMC achieves convergence rates of approximately $O(N^{-1})$ in moderate dimensions.