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Rare Event Sampling by Extended Ensemble MCMC

Yukito Iba

The Institute of Statistical Mathematics
* iba@ism.ac.jp

Markov Chain Monte Carlo algorithm (MCMC) is introduced in physics in 1950s and established as a useful tool in statistical science in 1990s. Sampling of Gibbs distributions in statistical physics and sampling of posterior distributions in Bayesian statistics are now two of the major applications of MCMC.

MCMC is, however, a general strategy for sampling multivariate distributions with unknown normalization constants and in principle can be applied to any other problems where we want to sample "rare events" or "large deviations" which are contained in the tails of underlying measure.

In this talk, we discuss some examples of such applications, hopefully new and/or of current interest, that is,

- Sampling from the tails of the distribution of bit error rate of error-correcting codes.
- Sampling from the distribution of extreme eigenvalues of random matrices.
- Sampling of network structures which optimize entrainment of oscillators on them.
- Sampling of initial conditions of a chaotic dynamical system which realize trajectories of "atypical" properties.

Most of the above-mentioned problems lead to highly multimodal distributions to be sampled by MCMC, and a key for attacking these problems is the way to facilitate mixing of Markov chain in the presence of multimodality.

Here we show that the use of methods known as Extended Ensemble MCMCs is quite effective for speeding up the convergence of MCMC in multimodal problems arising in our applications.