Markov chain Monte Carlo and sequential Monte Carlo methods have emerged as the two main tools to sample from high dimensional probability distributions. Although asymptotic convergence of Markov chain Monte Carlo algorithms is ensured under weak assumptions, the performance of these algorithms is unreliable when the proposal distributions that are used to explore the space are poorly chosen and/or if highly correlated variables are updated independently. We show here how it is possible to build efficient high dimensional proposal distributions by using sequential Monte Carlo methods. This allows us not only to improve over standard Markov chain Monte Carlo schemes but also to make Bayesian inference feasible for a large class of statistical models where this was not previously so.We demonstrate these algorithms on a non-linear state space model and a Lévy-driven stochastic volatility model. – andrieu 2010

The use of simulation for high-dimensional intractable computations has revolutionized applied mathematics. Designing, improving and understanding the new tools leads to (and leans on) fascinating mathematics, from representation theory through micro-local analysis. – diaconis 2009

Monte Carlo (MC) simulations are among the most powerful numerical tools to investigate very large systems. This review covers the fundamental principles of the Metropolis algorithm. Related topics like the determination of error bars and the autocorrelation time to measure how the algorithm will converge are also treated. The two dimensional Ising model and its behavior at the phase transition is then studied with a minimal implementation of the tools described herein. – Dominic 2005

This purpose of this introductory paper is threefold. First, it introduces the Monte Carlo method with emphasis on probabilistic machine learning. Second, it reviews the main building blocks of modern Markov chain Monte Carlo simulation, thereby providing and introduction to the remaining papers of this special issue. Lastly, it discusses new interesting research horizons. – andrieu 2003

Markov chain Monte Carlo using the Metropolis-Hasting algorithm is a general method for simulation of stochastic process having probability densities known up to a constant of proportionality. Despite recent advances in its theory, the practice has remained controversial. This article makes the case for basing all inference on one long run of the Markov chain and estimating the Monte Carlo error by standard nonparametric methods well-known in the time-series and operations research literature. In passing it touches on Kipnis-Varadhan central limit theorem for reverseablle Markov chains, on some new variance estimators, on judging the relative efficiency of competing Monte Carlo schemes, on methods fro constructing more rapidly mixing Markov chains and on diagnostics for Markov chain Monte Carlo. – geyer 1992

A generalization of the sampling method introduced by Metropolis et. Al (1953) is presented along with an exposition of the relevant theory, techniques of application and methods and difficulties of assessing the error in Monte Carlo estimates. Examples of the methods, including the generation of random orthogonal matrices and potential applications of methods to numerical problems arising in statistics, are discussed. – hastings 1970

A general method, suitable for fast computing machines, for investigating such properties as equations of state for substances consisting of interacting individual molecules is described. The method consists of a modified Monte Carlo integration over configuration space. Results for the two-dimensional rigid-sphere system have been obtained on the Los Alamos MANIAC and are presented here. These results are compared to the free volume equation of state and to a four-term virial coefficient expansion. – metropolis 1953