An Investigation of Markov Chain Monte Carlo Methods

Introduction

Initial Parameters

The Metropolis-Hastings algorithm with internal step-size parameter δ was used to generate both normal ($\mu = 0$) and exponential distributions for various values of σ and λ , respectively.



References

I. Sachs, S. Sen, J. C. Sexton; Elements of Statistical Mechanics...; Cambridge University Press, Cambridge; 1st ed.; 2006. S. M. Ross; Simulaton; Academic Press, Cambridge; 5th ed.; 2013. A. D. Sokal; Monte Carlo Methods in Statistical Mechanics...; Cargèse Summer School Lecture Series; 1996.

In this project, I simulated physical models using Markov chains, explored the correlation between the initial parameters of a Markov chain



The sufficiently time to thermalise and the integrated correlation time for each set of parameters were calculated for both distributions.



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generator and its accuracy, and employed variance reduction techniques in high-dimension Monte Carlo integration.

Variance Reduction

using Monte Carlo By integration to compute various low and high dimensional integrals, it was found that the use of variables control is favourable over the use of antithetic variables for high dimensions, however both methods result in a similar convergence for lower dimensions.



Ising Model

A 2-d 64x64 Ising model nearest-neighbour with interactions (g = 1, -1) was simulated various tor temperatures using both the Metropolis-Hastings and heat bath algorithms, both of which resulted in very similar estimates for magnetisation, 🗉 🚥 energy, and spin correlation.



