

CS60073: Advanced Machine Learning

Programming Assignment 2

Deadline: November 1, 2023 Submit a single program and a pdf write-up over email to me, with the title “Advanced Machine Learning Assignment 2”. Marks: 10

The Ising spin model is used to represent magnetic behavior of atoms in a lattice. The magnetic spin of an atom is represented by a random variable x_i which takes on a value ± 1 . The joint probability of a state for d atoms ($x = \{x_1, x_2, \dots, x_d\}$) is given by the distribution

$$p(x) = \frac{1}{Z} e^{\mu(x_1 x_2 + x_2 x_3 + \dots + x_{d-1} x_d)},$$

where Z is a constant and μ is a parameter. Assume, $d = 10$ and $\mu = 2$. Total magnetization polarity of the lattice is given by the expression $M = \frac{1}{d}(x_1 + x_2 + \dots + x_d)$.

(i) Use Gibbs sampling to approximate the above distribution. Each sample represents a magnetization state of the lattice. Plot the variation of total magnetization M of the individual samples obtained at each epoch over the iterations. Also, plot the histogram of the final approximated distribution.

(ii) Use Metropolis-Hastings sampling to approximate the above distribution. Plot the variation of total magnetization M over the iterations. Also, plot the histogram of the final approximated distribution. Consider the proposal distribution to be a Gaussian. Study the effect of variance of the Gaussian on the convergence of the sampler.