

Your solutions should include your source codes (without *.exe files), results, and discussions, all in a gzipped tar file. Please send your homework from your NTU email account to twchiu@phys.ntu.edu.tw before 24:00 of the due date.

1. Random walk on a two-dimensional square lattice

Write a C/C++ program to study the random walk problem on a two dimensional lattice. At each site of the lattice, the probability of the particle moving to any neighboring site is equal to 1/4. Use Monte Carlo simulation to find out the mean distance $\langle d \rangle$ the particle travelled versus the number of steps N it has taken. To obtain a reliable answer, it is necessary to perform many Monte Carlo simulations, each with a different path. Plot the mean distance the particle travelled versus the number of steps it has taken. For large N , can you make a statement about the functional relationship between $\langle d \rangle$ and N ?

2. Monte Carlo integration in 10 dimensions

Write a C/C++ program to perform the Monte Carlo integration of the 10 dimensional integral

$$I = \int_0^1 dx_1 \cdots \int_0^1 dx_{10} \frac{1}{1 + x_1^2 + \cdots + x_{10}^2}$$

using the following algorithms:

- (a) Simple sampling.
- (b) Rejection method.
- (c) Importance sampling with Metropolis algorithm.

In each case, compute the mean and the standard deviation versus the number of samplings, $N = 2^n$, $n = 1, 2, \dots, 16$ respectively. Discuss your results of all cases.