PHYS 404 and 690-03
Worksheet

Classical Monte Carlo

Exercise 1:

We will calculate the integral of a Gaussian by two different methods:

A. Analytic method

Calculate the following integral analytically:

$$G = \int_{-\infty}^{+\infty} e^{-\frac{1}{2}x^2}\, dx =$$

What is its numerical value?

G =

Make a sketch of the integrand of G over the interval [-5,+5]:

B. Monte Carlo numerical integration

Use Excel to calculate the integral G numerically with the Monte Carlo method and provide a estimate of the error on your numerical result.

A few tips:
i. Make a column for the sample number
ii. Make a column for producing a random variable over the appropriate interval.
iii. The RAND() function outputs a uniformly distributed random number over the interval [0,1].
iv. Make a column for the value of the function G for each random sample.
v. The AVERAGE() function will calculates the arithmetic average of a block of cells.
vi. The STDEVP() function computes the standard deviation of a block of cells.
vii. Make sure that you use a large number of samples (i.e. N~10,000).

$G_{\text{Monte Carlo}} =$

Run your simulation a few times. Does your Monte Carlo result and error for the integral agree with the analytic result?

Exercise 2:

Count of Buffon's needle: the original Monte Carlo simulation.

One can show that the probability for a needle of length L to intercept a line on a floor which has a parallel line tiling with spacing L is $P=2/\pi$.

In other words, $\langle \text{int}\,ercept \rangle_N = \frac{2}{\pi} \pm \frac{\sigma}{\sqrt{N}}$

Make a "needle" with the materials given to you by the instructor that has the same length as the side of the floor tiles.

Take 20 samples (more is better) of data using the floor tiles and report your results to the instructor.