Assignment 10

QUESTION

Use N=1000 and show 3 snapshots of a 2D Random Walk

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Simulate 1000 random walks in a plane, each walk having 25 steps (steps having equal lengths =1). Let each walk start at (0,0) and each step be in a random direction. Compute the average distance from (0,0) after 4, 9, 16 and 25 steps.

QUESTION

Using the Gaussian distribution

$$P(x)=\frac{1}{\sqrt{2\pi\sigma^2}}\exp\left(\frac{-(x-\mu)^2}{2\sigma^2}\right),$$

verify that

(a) it is normalized;

(b) <x> = μ

(c) variance = σ^2

[Hints: Assume Re[s^2]>0; Use PowerExpand]

QUESTION

Using derivatives, verify that

$$\rho(x,t) = \frac{1}{\sqrt{4\pi Dt}}\exp\left(\frac{-x^2}{4Dt}\right)$$

is a solution of the diffusion equation

$$\frac{\partial\rho}{\partial t}=D\frac{\partial^2\rho}{\partial x^2}$$

QUESTION

A normal (Gaussian) distribution corresponds to a distribution of random numbers such that its mean is μ and the standard deviation is σ.

A way to generate random numbers that satisfy such distribution is by writing: RandomReal[NormalDistribution[μ,σ]].

(i) Generate a list with 2000 random numbers from a Gaussian distribution with μ=0 and σ=1. Make a histogram with this list using a command from *Mathematica*.

(ii) With the same list above, make a histogram using only do-loops. Use three different bin sizes= 0.5, 0.2, and 0.1.

(iii) For the bin size=0.2, normalize the histogram so that the area underneath is 1.
Use the data corresponding to the middle point of the bins and fit it with a Gaussian. What do you get for <x> and the variance?
What is the relative error between your fit and σ=1?
Plot both curves together: the normalized histogram and the Gaussian fit.