Assignment 8 Project P342

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Q(1)

*Approach:-*A random walk in a $2-D$ plane has an equally probable step in all direction in plane. To demonstrate this process, I started walk at the origin by choosing a random direction $(0 \leq \theta \leq 2\pi)$ for each step of walk. Then increase the values of Δx and Δy by values $r\cos\theta$ and $r\sin\theta$ and updated after each step for N steps. After completed N steps of walk, I have calculated R from Δx and Δy. With the same value of N, I have done for each set having 100 different random walk and calculated R_{rms} from each set. I have done for $N = 250, 500, 750, 1000, 1250$ steps and calculated radial distance R, R_{rms} and average displacement in the x and y directions for each set.

*Result:-*As the walks are random, the root-mean-square distance averaged over many walks should theoretically agree with the given relation $R_{rms} = \sqrt{N}, \Delta x = \Delta y = 0$. For each set of the random walk, I got $\Delta x \approx \Delta y \approx 0$ which was expected. Also for each set of random walk $R_{rms} \approx \sqrt{N}$ and from plotting between R_{rms} vs $\sqrt{N}$ I got the slope = 1.15($\approx$ 1), which shows my simulation agrees with mathematical result.

Q(2)

Approach:- I have calculated the volume of ellipsoid(V_e) which is enclosed cubical volume(V_c) by using Monte Carlo method. Suppose I randomly throw the points inside the cuboid it will either inside the ellipsoid(N_e) or cuboid(N). The probability that point lies inside the ellipsoid is V_e/V_c. If we draw points for large number of times fraction of points inside the ellipsoid to total will converge to V_e/V_c. So for volume of ellipsoid($a = 1.0, b = 1.5, c = 2.0$), we have to enclose it by $(2a, 2b, 2c)$ size cuboid then calculate the volume for 10 different trials by using relation given as $V_e \approx \left(\frac{V_c}{N} \times \sum N_e\right)$.

Result:- In the output, I got almost same values of volume(≈ 12.56) with the theoretical value for different trials. For large N it converges to its theoretical volume as shown in plot between V_e vs N. Fractional error volume will decrease with N by $\frac{1}{\sqrt{N}}$ as shown in plot. So one can find the exact volume by $N \to \infty$.