P342 - Computational Lab Project

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Random walk in 2 Dimension

The random walk problem in two dimensions is the study of the motion of an object with a fixed step size, taken to be unit length and completely random direction in the x-y plane. The problem was solved using polar coordinates (r,θ) by keeping $r = 1$ and varying θ randomly from 0 to 2π. The (r,θ) coordinate was then converted to (x,y). It was assumed that each walk began at the origin.

At the end of each walk the final radial displacement was calculated. Using the data from 100 such walks of fixed number of steps, the RMS value of radial displacement was calculated, along with average x and y displacement.

Theoritically, we expect

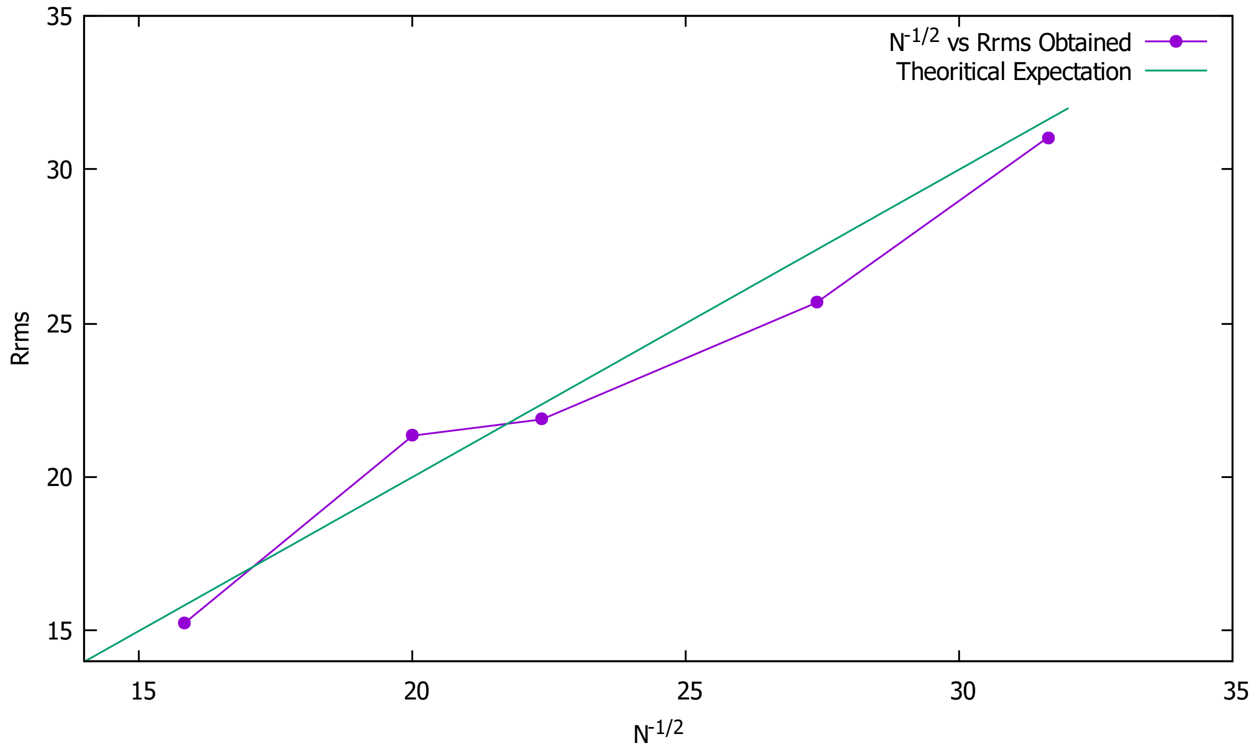
$$R_{rms} = \sqrt{N}$$

where, N is the number of steps.

Graphically, we expect a straight line at 45°. We observe that our data obtained is very similar to the theoritical expectation.

We could expect to see greater integration into the theoritical plot if we increase our sample size.

Fig 1. $\sqrt{N}$ vs Rrms, Sample size : 100 Random Walks



Monte Carlo Method for finding Ellipsoid Volume

The problem requires us to find the volume of an ellipsoid of dimensions $a = 1.0cm$, $b = 1.5cm$ and $c = 2.0cm$ using the Monte Carlo Method.

Random values of (x, y, z) were generated in range $-1 \leq x \leq 1$, $-1.5 \leq y \leq 1.5$ and $-2 \leq z \leq 2$, forming a cuboid of dimensions $2 * 1.0 \times 2 * 1.5 \times 2 * 3.0$. The number of points lying inside the ellipsoid are counted, i.e., points satisfying the equation :

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} \leq 1$$

In the limit of total number of points $N_{total} \to \infty$, they fill up essentially the entire cuboiod volume, and the points inside the ellipsoid fill up the ellipsoid volume. Thus, the ratio of the number of points gives us the ratio of the volumes, i.e.,

$$\frac{N_{ellipsoid}}{N_{total}} = \frac{V_{ellipsoid}}{V_{cuboid}}$$

Thus, we get the volume of ellipsoid as,

$$V_{ellipsoid} = \frac{N_{ellipsoid}}{N_{total}} \times (2a * 2b * 2c)$$

Theoritically, we know :

$$V_{ellipsoid} = \frac{4}{3}\pi abc = 12.56637061cm^3$$

We observe that as the value of N_{total} increases, volume obtained comes closer to the theoritical data.

Fig 2. Ellipsoid Plot for N=40000

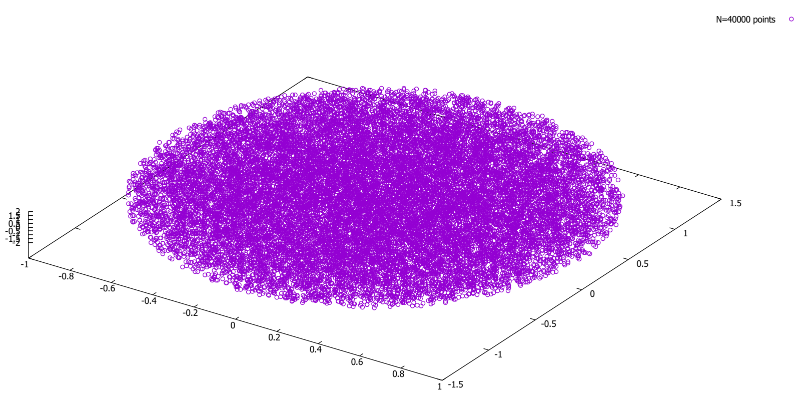


Fig 3. N vs Volume obtained