Simulation Report: **Monte Carlo Estimation of π (pi)**

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Executive summary

This simulation report, authored by Dikshant Madai on October 4, 2023, explores the estimation of π (pi) using the Monte Carlo method. This statistical technique relies on random sampling to tackle complex mathematical problems. In this simulation, random (x, y) coordinates are generated within a unit square, and the ratio of points falling within a quarter-circle inscribed in the square is used to estimate π.

The primary parameter, N (number of generated coordinates), determines the accuracy of the π estimation, with larger N values providing more precise approximations. The simulation involves generating random points, checking if they fall within the quarter-circle, and applying the formula $\pi \approx 4 * (\text{inside\_circle} / N)$ to estimate π.

Results from the simulation demonstrate that as N increases, the estimated value of π approaches the true value (approximately 3.14159265359). This underscores the Monte Carlo method's effectiveness in mathematical estimation through random sampling, offering practical applications in solving complex mathematical problems.

In conclusion, this simulation serves as a compelling example of how the Monte Carlo method can be employed to estimate mathematical constants like π. It emphasizes the method's accuracy improvement with larger sample sizes, highlighting its versatility in approximating constants and solving mathematical challenges using random sampling techniques.

Contents

1. Introduction

The purpose of this simulation is to estimate the value of π (pi) using the Monte Carlo method. The Monte Carlo method is a statistical technique that relies on random sampling to solve complex mathematical problems. In this simulation, we generate random points within a unit square and use the ratio of points falling within a quarter-circle inscribed in the square to estimate π.4

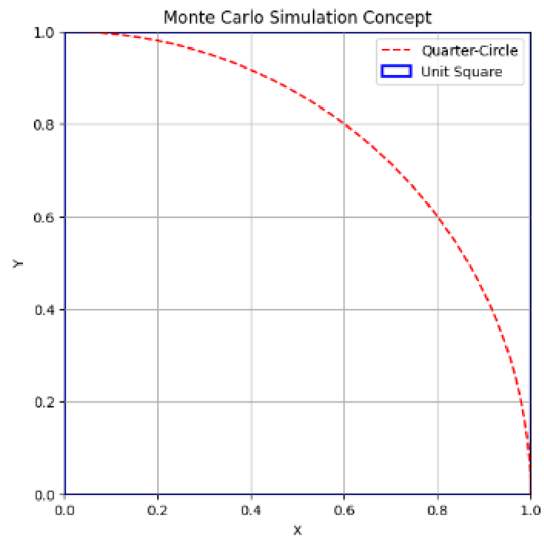

Fig: Monté Carlo simulation quarter-circle

2. Simulation Design and Parameters

The primary parameter in this simulation is N, which represents the number of random (x, y) coordinates generated within the unit square. The value of N determines the accuracy of our estimation. A larger value of N generally results in a more accurate estimation.

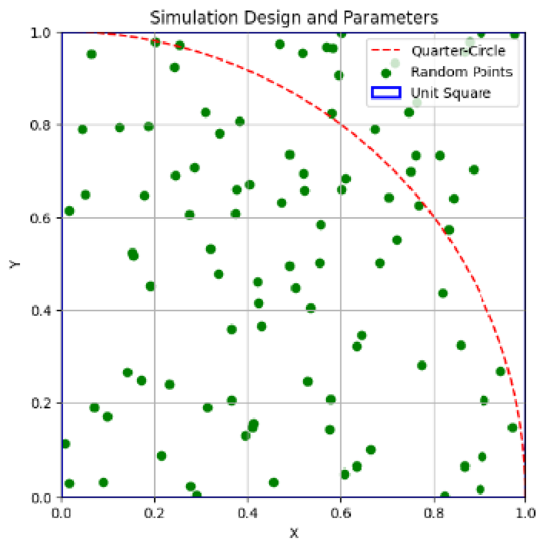

Fig: Depicts the unit square and the quarter-circel

3. Description of the Monte Carlo Simulation Process

We start by defining a unit square with side length 1 and a quarter-circle inscribed within it.

The simulation generates N random (x, y) coordinates within the unit square, where $0 \leq x \leq 1$ and $0 \leq y \leq 1$.

For each generated point, we check whether it falls within the quarter-circle by using the equation $x^2 + y^2 \leq 1$.

We count the number of points that fall within the quarter-circle (inside_circle).

We estimate π using the formula: π ≈ 4 * (inside_circle / N).

Presentation of the π (pi) Estimate and the Formula Used

The estimated value of π is presented as the output of the simulation. The formula used to estimate π is:

π ≈ 4 * (inside_circle / N)

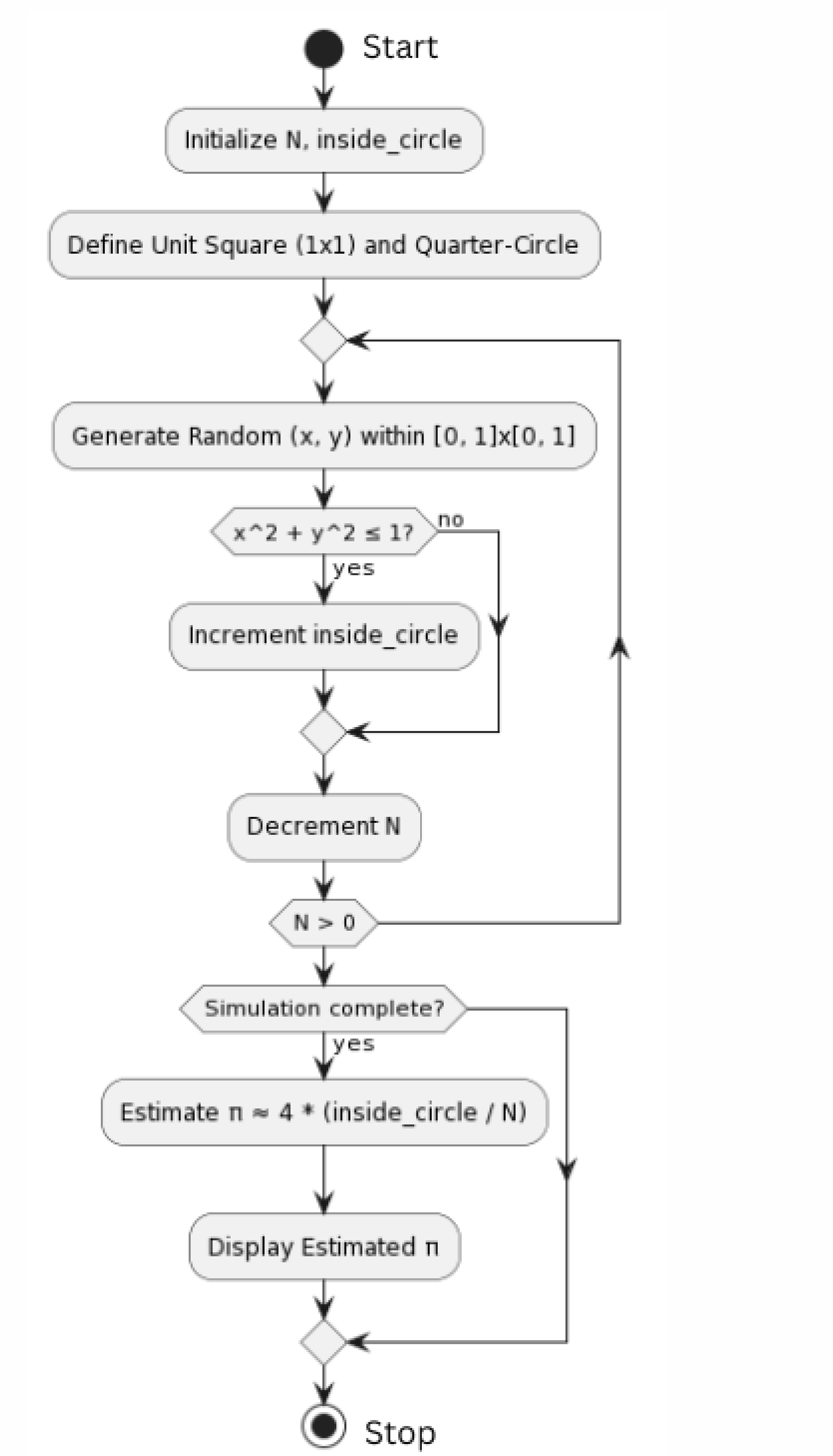

Figure: ***Monte Carlo Simulation Process*** *on Flow chart*

4. Conclusion

After running the Monte Carlo simulation with various values of N, we have obtained the following estimated values of π:

For N = 1,000: $\pi \approx 3.176$

For N = 10,000: $\pi \approx 3.1344$

For N = 100,000: $\pi \approx 3.14256$

For N = 1,000,000: $\pi \approx 3.14136$

As we can observe, as the value of N increases, the estimated value of π becomes closer to the true value of π (approximately 3.14159265359). The accuracy of the estimation improves with a larger sample size. Therefore, the Monte Carlo method provides a practical way to estimate π and other mathematical constants by relying on random sampling techniques.

So n, the Monte Carlo simulation successfully estimated π using random points within a unit square. The accuracy of the estimation improved as the number of generated points (N) increased, demonstrating the effectiveness of the Monte Carlo method for solving mathematical problems.