Monte Carlo Simulation

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1. Introduction

Monte Carlo methods are a class of computational algorithms that rely on repeated random sampling to compute their results. Monte Carlo methods are often used in computer simulations of physical and mathematical systems. These methods are most suited to calculation by a computer and tend to be used when it is infeasible to compute an exact result analytically or with a deterministic algorithm. This method is also used to complement the theoretical derivations.

The Monte Carlo Method solves problems using probability. Given the probability, P, that an event will occur in certain conditions, a computer can be used to generate those conditions repeatedly. The number of times the event occurs divided by the number of times the conditions are generated should be approximately equal to P.

2. An Example for the Method (Calculation of pi)

If a circle of radius R is inscribed inside a square with side length 2R, then the area of the circle will be πR^2 and the area of the square will be $4R^2$.The ratio of the area of the circle to the area of the square will be pi/4.

This means that, if N points are picked at random inside the square, then approximately N*π/4 of these points should fall inside the circle.

This code generates random numbers in the range (-R, R) which lie inside the square. And then it checks whether the point lies inside the circle? If x and y are the coordinates of the point, it lies inside the circle if

$$x^2 + y^2 < R^2 \tag{2.1}$$

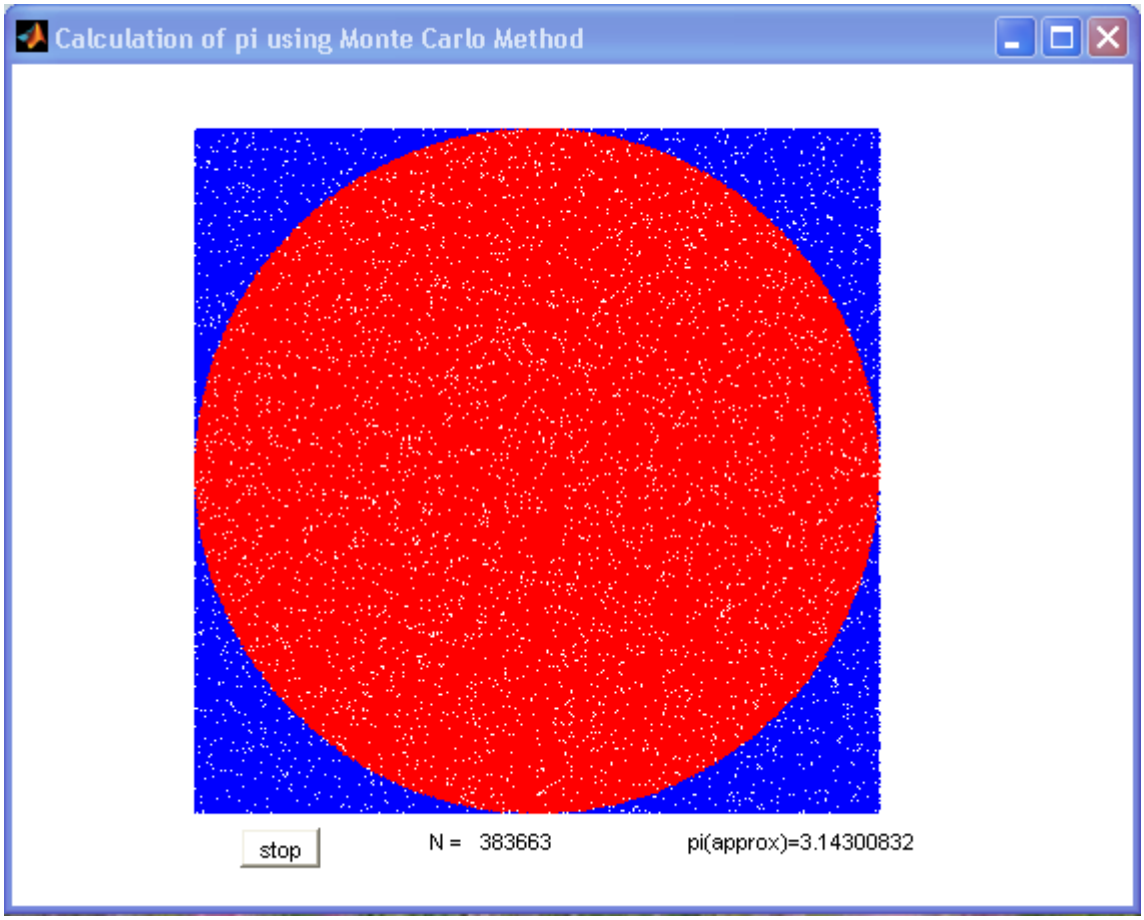
Where x and y are the coordinates of the point and R is the radius of the circle. The program keeps track and counts the number of points generated (N) so far and the number of points that lie inside the circle (M). The value of pi is then approximated as:

$$pi = 4 * \frac{M}{N} \tag{2.2}$$

Monte Carlo Method is often useful for solving problems in physics and mathematics which cannot be solved by analytical means; it is a rather slow method of calculating pi.

The code runs for ever until the stop button is toggled. It also displays the number of points generated and the value of π for every count.

A screen shot of the code is shown below:


Calculation of pi using Monte Carlo Method
stop
N = 383663
pi(approx)=3.14300832

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