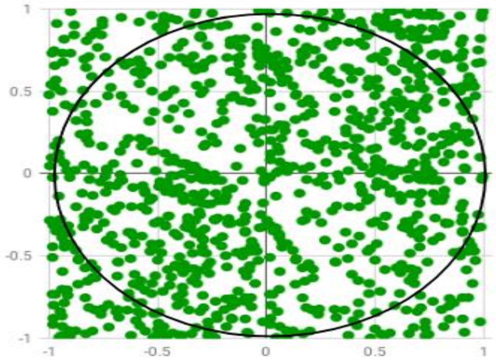
Estimating the value of Pi using Monte Carlo

Monte Carlo estimation

Monte Carlo methods are a broad class of computational algorithms that rely on repeated random sampling to obtain numerical results. One of the basic examples of getting started with the Monte Carlo algorithm is the estimation of Pi.

Estimation of Pi

The idea is to simulate random (x, y) points in a 2-D plane with domain as a square of side 1 unit. Imagine a circle inside the same domain with same diameter and inscribed into the square. We then calculate the ratio of number points that lied inside the circle and total number of generated points. Refer to the image below:




```
1. Initialize circle_points=0, square_points=0
2.  For i=0 to N do  //N is large value
3.        Generate random point x (0≤x≤1).
4.        Generate random point y (0≤y≤1).
5.        Calculate d = x*x + y*y.
6.          If d <= 1, circle_points++.
7.        square_points++.
8   pi = 4*(circle_points/square_points).
```

Random points are generated only few of which lie outside the imaginary circle We know that area of the square is 1 unit sq while that of circle is $\pi*(1/2)^2 = \pi/4$. Now for a very large number of generated points,

$$\pi/4 \quad = \text{area of circle/area of square}$$
$$= \text{number points inside circle/ number points inside square}$$

$$\text{So } \pi = 4*(\text{number points inside circle/ number points inside square})$$

The beauty of this algorithm is that we don't need any graphics or simulation to display the generated points. We simply generate random **(x, y)** pairs and then check if $x^2+y^2 \leq 1$. If yes, we increment the number of points that appears inside the circle. In randomized and simulation algorithms like Monte Carlo, the more the number of iterations, the more accurate the result is. Thus, the title is "**Estimating** the value of Pi" and not "Calculating the value of Pi".

Value of N needs be large for accurate estimation. When N is large, this calculation can be done using multithreaded program very easily.