Homework 4

Different ways of calculating the value of π

1. The value of π can be calculated by plotting random points on a graph in the range $S = (-1,\ 1) \times (-1,\ 1)$ and checking whether they are within the unit circle S. Remember that the unit circle has a radius $r = 1$ and area $A_{circle} = \pi r^2 = \pi$. The area of the square is $A_{square} = 2 \times 2$. Therefore the probability that any random point $P_{x,y}$ in S is within the circle C is:

$$P(P_{x,y} \in C \mid P_{x,y} \in S) = \frac{A_{circle}}{A_{square}} = \frac{\pi}{4}$$

This function reads as such: *The probability that a point $P_{x,y}$ is within the circle C given that it is within the area of the square S is equal to the ratio of the areas of C and S.* If we can calculate this probability P then we can invert this equation to find the value of π:

$$\pi = 4P$$

In order to estimate the value of P and consequently the value of π, we can start by randomly generating a list of N points in S, and checking how many are within the circle C (N_C). The estimated probability then becomes:

$$P = \frac{N_C}{N}$$

which increases in accuracy as the number of sample points N increases. Use the package NumPy (Numerical Python) to generate points in the range $(-1,\ 1) \times (-1,\ 1)$ and check whether they are in the circle. Remember that a point $P_{x,y} = (x,\ y)$ will be in a circle of radius r when:

$$x^2 + y^2 \leq r^2$$

Note: In order to do this problem, you will need to install both `numpy` and `matplotlib`. You can install both of these packages from the command line via:

```
pip install numpy
pip install matplotlib
```