Programming Assignment 4

Computing π with Coconuts

Suppose that the Professor on Gilligan's Island needs an approximation of π to four decimal places for his latest invention (which he hopes will impress Mary-Ann enough that she will fix him one of her fabulous banana and coconut pies), but all that he has are a basket of coconuts and a length of rope. Since Gilligan is always thwarting his rescue plans, he has a lot of time on his hands and so comes up with the following method.

Imagine that you have a unit square with bottom left corner at the origin (0, 0). On top of that square inscribe a circle with radius 1 and its center at the origin. Choose two random numbers $0 \leq x, y \leq 1$ and use them as the coordinate of a point in the square. The probability that this point falls inside the circle is π / 4.

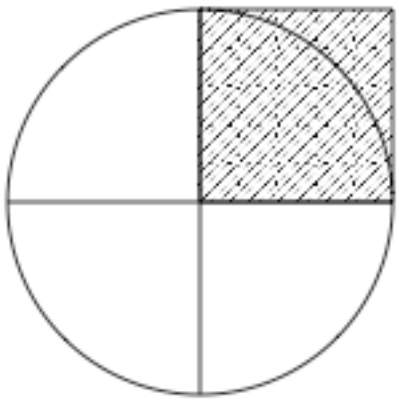

Figure 1: If the area of the square is 1, then the area of the quarter circle is π / 4.

The professor remembers enough geometric constructions from high school to use his length of rope to make a primitive compass. He uses this to draw a unit square in the sand beneath a tall palm tree. He then uses it to inscribe a circle of unit radius with its center on the bottom left corner of the square. He now has Gilligan climb the palm tree with the basket of coconuts. He has him shake the basket and scatter the nuts over the square. He has the Skipper count the nuts that fall inside the square, and also specifically those that fall in the inscribed quarter circle. The ratio of the number of nuts in the quarter circle to the total number of nuts in the square is his first approximation of π / 4.

Since he has a lot of time on his hands, and he really wants that banana and coconut pie, he convinces Gilligan and the Skipper repeat this experiment many times. He averages the results together to come up with his approximation of π.

Since you really don't have a basket of coconuts, or Gilligan and the Skipper to do your work for you, but you do have a computer, an algorithm to simulate it is in order.

A simple algorithm to estimate the value of π can be implemented by repeatedly choosing random points and checking whether they fall into the intersection of the quarter circle and the square. The fraction of points that fall into this intersection is π / 4. A point (x, y) is in the intersection of $\sqrt{x^2 + y^2} \leq 1$

What you need to do…

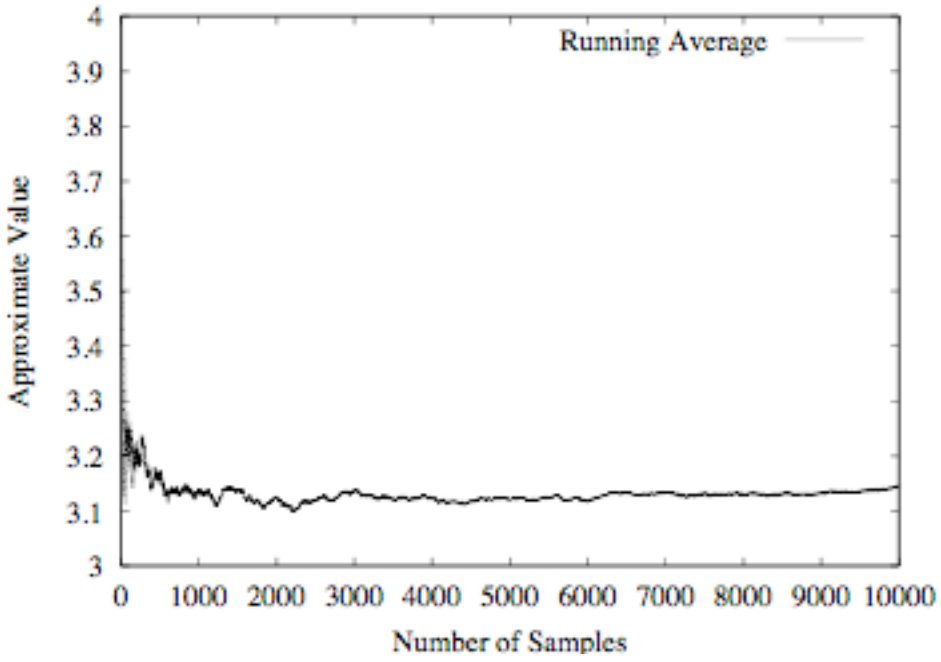

Figure 2: The figure shows the running average as the number of coconuts increases. It gets closer to π the more coconuts that get dropped.

You should write a program that asks the user for a random seed (this starts the random number generator), and then continues to drop coconuts and approximate π until four digits past the decimal point are correct.

- Get a value from the user
- Include the following function in your code to calculate a random number. To figure out where the coconut landed, you will need two random numbers.
  - double rnd(int range){return (double)((range * random()) % 1000000000) / 1000000000; }
- How do you know when you have dropped enough coconuts?
  - M_PI = 3.14159265358979323846264338327950288
  - If the absolute value of the difference between M_PI and your estimate is less than 10^{-4} then you can declare success.
- This time you will also need to include math.h and stdlib.h
- You need to submit two files: coconut.c and output.txt

If you would like points back on a previous assignment, you can also implement one other method (your choice) to compute an approximation of π using a for loop. For example, the Gregory-Leibnitz series, Viète's formula, or the particularly inefficient Wallace product are examples.

Check the Wikipedia for more information: http://en.wikipedia.org/wiki/Pi.