Ay190 – Worksheet 7
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Date: February 1, 2014

1 Monte Carlo Methods

1.1 Measuring π with MC Experiment

First we implement an MC experiment to calculate the value of π. Scatter points randomly on the square defined by $(-0.5, -0.5)$ and $(0.5, 0.5)$ and if $x^2 + y^2 < \frac{1}{4}$ then the point is inside the circle. We can use the fraction of points inside as the area and from that determine the value of π.

First we use numpy's random module with a seed of 1. We can see 1 that the method does seem to converge but not very quickly and has a great amount of noise. When we sqitch to use the SystemRandom a function which uses the operating system to provide random numbers. This may be more random and therefore better. However, we can see that in 2 that this method does have a lot of noise and doesn't seem to converge as well as numpy's random did.

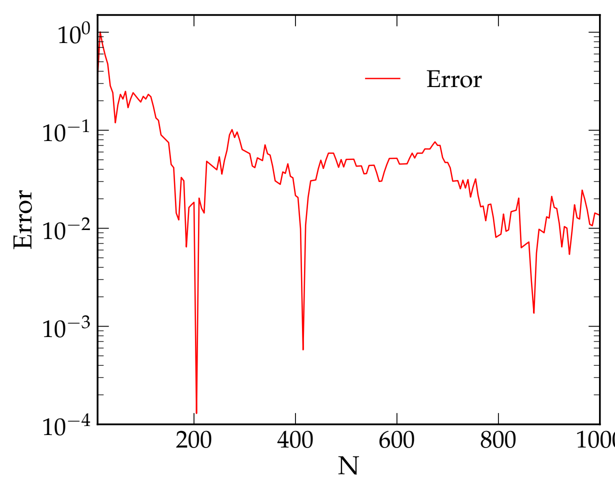

Figure 1: Convergance of Pi by MC experimental methods using numpy random.

1.2 The Birthday Paradox

Running multiple simulations, in 3 we do 5000 trials, of groups of people with various size. We can estimate the probability that at least two of them will share a birthday. We find that it is when there are 23 people that there is a 50% chance that two people will share a birthday.

1.3 Integration

We can use MC integration to evaluate integrals of monotonic functions over a region. We've estimated the integral for the function $f(x) = x^2 + 1$. The errors are shown in 4. To reduce noise in the image we average many trials to get the average error. We can see that this method does

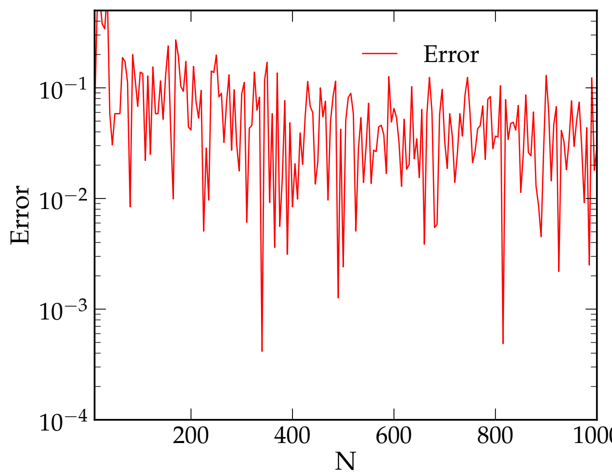

Figure 2: Convergance of Pi by MC experimental methods using OS generated random numbers.

converge to the correct result. However, for this simple function a method of direct, instead of random, estimation would be less computationally expensive.

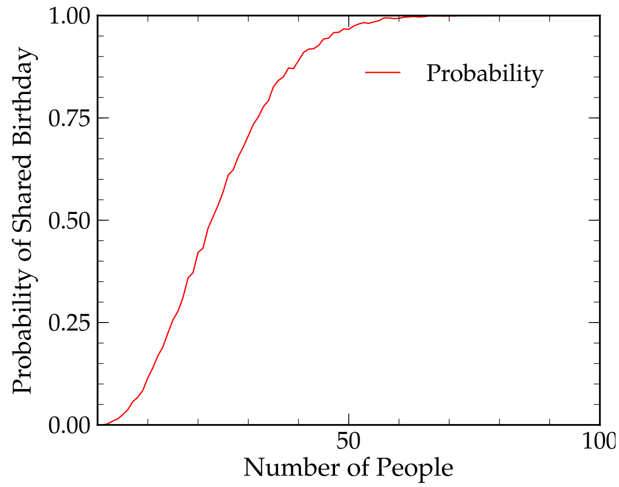

Figure 3: The probability that at least two people out of N share a birthday. Assuming birthdays are uniformly distributed.

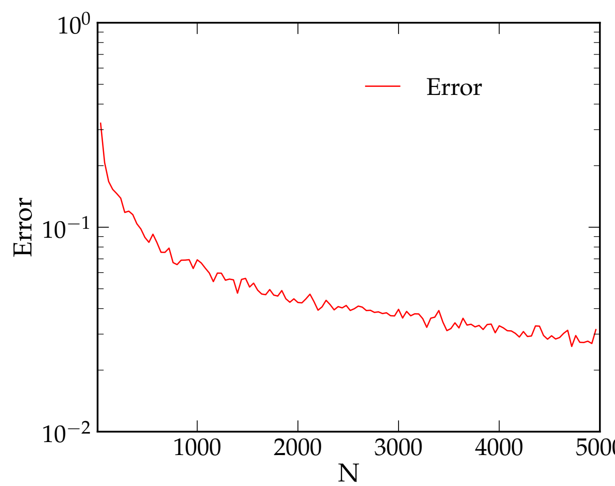

Figure 4: The average error from the true value for a given number of points.