IE507, Modeling and Computation Lab
Lab 03, August 23, 2016.

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Instructions: In this lab, we will use Python to simulate randomness. You are required to work on your own and submit a report on lab notebook by Thursday (Aug 25, 2016) 5:30pm. Upload all your Python files on Moodle by Thursday (Aug 25, 2016) midnight.

Exercise 1: We want to test whether the numbers generated by in-built function of Python for generating randon numbers between 0 and 1 are uniformly distributed.

1. [**R**] Write a Python function *testrand(n)* which takes as input a positive integer n. It should generated n randon numbers between 0 and 1 using the in-built function in Python. It should then plot the histogram of values seen in this set of numbers. In particular, plot the histogram for $n = 4$, $n = 10$, $n = 1000$, and $n = 1000000$. Upload these plots on Moodle. Remember to add proper labels, titles and legends etc. Is the shape of the histogram as you would expect from a uniform distribution? Explain why or why not.

2. [**R**] Suppose we want to check whether a given set of numbers (input1 on moodle) are uniformly randomly distributed. Plot the histogram of its distribution and comment whether it looks randomly uniformly distributed or not.

3. [**R**] Write another Python function testrand2(n, k) similar to the function testrand(n) above, but only plot the histogram of the the set of every kth random number generated. So if k is two, it will plot the histogram taking only the $2nd$, $4th$, $6th$, ... numbers and ignore the remaining. Is this set uniformly random for different values of k? Assume k is not too large.

4. [**R**] Let us now do the same exercise for our input file 'input1'. Write a function that takes an integer k as input and plots histograms of distribution of elements in this file when only every kth element is selected. Does the distribution look uniform?

5. [**R**] Write your conclusions about this experiment. Are the above two tests sufficient for checking randomness?

Excerxise 2: 2D-randomness.
Suppose we want to generate a set of uniformly distributed points in a two-dimensional plane, say in the rectagle $(0, 1) \times (0, 1)$.

1. [**R**] Write a Python function *twodrand(n)* which takes as input a positive integer n. It should create n pairs of random numbers (x, y) so that both x and y are uniformly randomly distributed and are independent of each other. It should then generate a scatterplot of values seen in this set of numbers. In particular, plot the histogram for $n = 100$, $n = 1000$, and $n = 1000000$. Upload the plot for $n = 1000$ on Moodle. Remember to add proper labels, titles and legends etc. Is the shape of plot as you would expect from a uniform distribution? Explain why or why not.

2. [**R**] Consider the input file 'input2' in Moodle. It loads a matrix S of size 100000×2. Suppose each row of the matrix represents a point (x, y). Check, using some simple logic, whether these points are uniformly randomly distributed or not. Explain the conclusions you make.

3. [**R**] Do the same exercise for the third input file 'input3'.