Homework #9

Due Monday, April 18, 2022, 11:59pm

Problem 9.1.

First use the 'broken stick' model to generate a set of non-negative integer numbers with a lognormal distribution between 0 and 9999. The strategy is the following:

1. Pick a uniform random number between 0 and 1 (*r*). Use this to create an integer in the range between 0 and 9999 by `n1 = np.int(r*9999)`
2. Repeat this three more times, always using the previous number as the range of the next random integer generated: `n2 = np.int(r*n1)`, etc
3. Save the n4 values into a list, and repeat this 1000 times.

Perform the following tasks:

a) Plot the distribution of the *n4* numbers

b) Create a new list from the leading digits of the numbers, e.g. 2318 -> 2, 923 -> 9, 21->2, etc.

c) Plot the distribution of the first digits. Their distribution is non-uniform, follows the so-called Benford's Law, used to detect election fraud. Compare this to the distribution of the first digits of *n1.*

Problem 9.2

Consider the graph X with 11 nodes shown on the figure below.

1. Create the adjacency matrix A for the graph X.
2. Using the adjacency matrix, calculate the number of closed triangles on X
3. Calculate the Laplacian matrix of X and calculate its eigenvalues and eigenvectors.
4. Use the eigenvectors corresponding to the two lowest eigenvalues (different from 0) as the x,y coordinates to re-plot the graph.
5. Use an algorithmic method to determine the shortest path from node 1 to node 7.
6. Use an algorithmic solution to find the pair of nodes with the maximal shortest path (*hint: try Dijkstra's algorithm*)