**Homework #3**

**Due Friday, March 5, 2021, 11:59pm**

**Problem 3.1**

This problem is based on an old TV show called “Let’s Make a Deal”. The stage of that show had 3 doors numbered “1”, “2”, and “3”. Behind one of the doors was a valuable prize, the other two contained weird, smaller gifts. The contestant would choose one of the doors, say “2”, but it would not be opened yet. The host would then open one of the *other* doors that *always* had a gag gift behind it (say, door “1” for our example). He would then ask the contestant if he or she wanted to stay with door “2”, or change their selection to door “3”.

The problem is to determine which action – keep or change – gives the contestant the greater probability of selecting the door with the real prize. The task is to write a simulation code that will play a large number of games on the computer, (a) *always* switching doors, (b) *never* switching doors, and record whether we won.

Calculate the respective probabilities of a win for both strategies using 10,000 simulated games.

*(Hint: first create a function that randomly generates the number of the door that contains the real prize, and the number of the door that the contestant will select. Then write a function that simulates a whole game, where the host opens the remaining door, and the contestant decides to switch or not, controlled by a parameter of the function).*

**Problem 3.2**

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 \( n_1 = \text{np.int}(r*9999) \)

2. Repeat this three more times, always using the previous number as the range of the next random integer generated: \( n_2 = \text{np.int}(r*n_1) \), etc

3. Save the \( n_4 \) values into a list, and repeat this 1000 times.

Perform the following tasks:

a) Plot the distribution of the \( n_4 \) 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 \( n_1 \).