Physics 441/PCSE 503 Assignment 4

Due Date: Wednesday, November 8, 2023

1. In the Dungeons and Dragons game, there are a couple of central  
   features that are important to the game. One of these that dice  
   with different numbers of sides are used to determine the outcome  
   of certain events.

For example, a 20-sided die is used to determine  
if an attack is successful. If the number rolled is greater than  
or equal to the armor class of the target, the attack is successful.

Another feature of the game is that there are situations where a  
player must roll the die multiple times and take the highest value.

1. Write a Python function that rolls a die with *num\_sides* sides a total of *num\_rolls* times. The function should plot a histogram of all of the rolls and should return the average roll value.
2. Use this function to simulate rolling a 20-sided die 1000000 times, plot a histogram of the results, and calculate the average roll value. Is the average roll value what you would expect? Comment on the shape of the histogram.
3. Write a Python function that rolls and n-sided die a total of m times, and returns the MAXIMUM value rolled.
4. Simulate rolling a 20-sided die, where one rolls the die TWICE, and takes the maximum of the two rolls. Plot a histogram of the results of doing this 1000000. Does the shape of the histogram make sense?
5. Beginning with the zombie\_apocalypse.ipynb notebook in the Week7/PredatorPreyModel folder, add the ability to adjust all of the parameters of the model (Pi, delta, beta, alpha, zeta) as was done in pandemic.ipynb. Search for a set of parameters that would give the best chance for defeating the zombie apocalypse. What can you conclude from this? What should we focus on, in terms of defeating the army of the dead?
6. Beginning with the bikeshare\_final.ipynb notebook in the Week7and8 folder, create a bikeshare system that models THREE locations (rather than just two). Assuming the locations are called A, B, and C, use the following parameters: total number of bikes = 100, p\_AB = 0.3, p\_BA=0.2, p\_AC = 0.4, p\_CA=0.1, p\_BC=0.35, p\_CB=0.15. Try to determine the optimum initial configuration of the 100 bikes between the three locations such that the number of unsatisfied customers will be minimized over a three-hour period of bike sharing.

As a suggestion, try some configurations in steps of 10 bikes for the initial configuration, for example, try A = 10, B = 30, C = 60, and compare that to A = 10, B = 60, C = 30. This may help you understand where the optimum configuration might be located in the (A,B,C) space.