APMA 3100 – Probability
Section 003 – McMillan
Coding Project 1

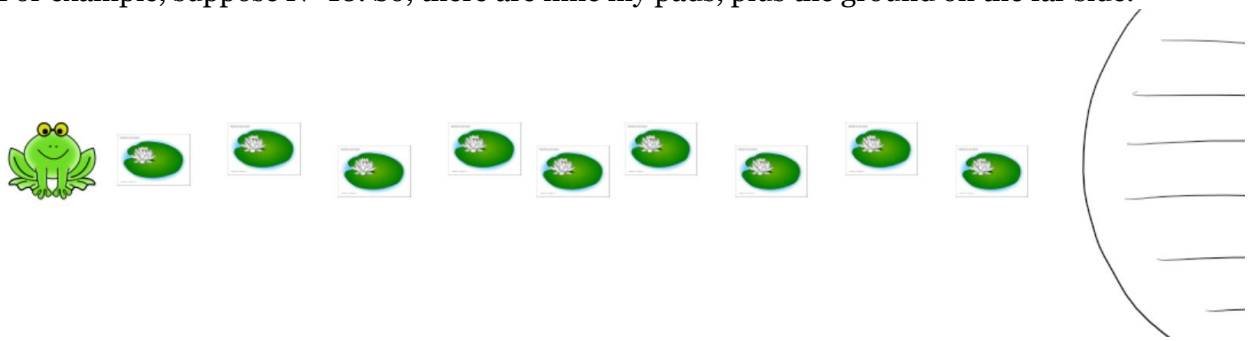
Report Due Date: 9/22/2025, 11:59pm, in Gradescope

In this project, you will implement a computer simulation of a frog-hopping game involving an element of randomness. This simulation will allow you to discover and study empirically the probability distribution of a random variable. You will run the simulation a large number of times, using computer-generated randomness, and study the distribution of outcome data.

Scenario

A frog wants to get to the other side of a pond. There are N-1 lily pads that stretch across the pond for the frog to jump onto. So, if the frog hopped onto each lily pad one at a time, it would take exactly N hops (counting the last hop when the frog lands on solid ground). However, the frog can take larger hops, so it won't necessarily take all N hops. On each hop, the frog will randomly select one of the landing spots that are still in front of it. (A "landing spot" includes the lily pads as well as the ground on the far side of the pond.) This random selection is made with equal probability for all possible landing spots in front of the frog.

For example, suppose N=10. So, there are nine lily pads, plus the ground on the far side.



For the first hop, the frog randomly chooses a number from 1 to 10, with equal probability. Suppose that it chooses 6. Then the frog jumps to the sixth lily pad. Now there are four spots left, so the frog randomly chooses a number between 1 and 4 with equal probability. Suppose it chooses 1. So now the frog is on the seventh lily pad and there are three spots left. The frog chooses a random number between 1 and 3. Suppose it selects 3 and then lands on the ground on the far side of the pond. In this outcome, the frog took 3 total hops to complete the journey.

Individual outcomes in the sample space are completed journeys. Let X be a random variable counting the number of hops it takes the frog to complete its journey. Your task in this project is to create a computer simulation of the scenario and use it to answer questions about the random variable X.

Project Tasks

1) Create a computer simulation of the scenario that can be used to empirically approximate the answers to the following questions. You may write your code in the language and environment of your choice.
   a) When N=10, what is the probability that it takes exactly three jumps?
   b) When N=8, estimate the full PMF of the number X of jumps. In other words, what are all the possible values of X, and what are all the corresponding probabilities?
   c) When N=20, what is the expected number of jumps?
   d) How does the expected value change as N increases?

2) Your report must contain at least the following elements:
   - a pasted copy of your code
   - your numerical estimate for the answer to question (a)
   - a table with your estimated PMF for question (b)
   - your numerical estimate for the answer to question (c)
   - a table of values for your estimates for $E[X]$ for N=1,2,3,…,100,
     AND a plot of these results with N as your horizontal axis and $E[X]$ as your vertical axis.

Your report should explain how your simulation runs, and it should explain what you did to produce and extract the requested data.

Rules

1. You will work with your Small Group team and submit one report per team.
2. Every team member must be prepared to discuss and explain any part of the final submitted code and be able to run the code and reproduce the results without assistance.
3. After submission, teams will complete a peer-assessment form that may justify differences in individual team-member grades.
4. **You may not collaborate with anyone else or use any external resources** other than looking up coding documentation as needed. You may ask the instructor for guidance.
5. **You may not use any AI/ML tools.**
6. Your report should be written with professional English and have a clear structure.
7. The last item of the report must be the honor pledge below, and each team member must sign their name under the honor pledge. (Digital signature is allowed.)
   "I have neither given nor received aid on this project, except from authorized sources."

Rubric

Project reports will be graded with the following rubric out of 100:

35 – Correctness of simulation (includes correctness of code)
30 – PMF values and expected values
20 – Clarity of explanations, figures, tables
10 – Explanatory comments on code (should be brief and precise)
5 – Professional standards (formatting, figures, English)