Physics 441/PCSE 503 Assignment 5

Due Date: Tuesday, November 21, 2023

1. In this question, we will consider some extensions to the **Frogger game simulation** that we studied in class.
2. Consider the case where the frog can jump both forwards and backwards. That is, at any moment, the frog can jump to any other lily pad, or all the way across the stream, or all the way back to the starting point (with equal probability of jumping to any new position. Calculate the average number of jumps taken as a function of the number of lily pads. Explain the result that you see, either through comparison with the forward-jump-only rule result, or with a theoretical prediction for this new rule set, or both.
3. Consider the case where the frog can only jump forward, but now the probability of jumping to some lily pad (or all the way across the stream) is inversely proportional to the length of the jump.

You will need to calculate a discrete probability distribution for each jump that is properly normalized. For example, if there are ten lily pads, and the frog is on lily pad six, then she has five possible jump locations: lily pads 7, 8, 9, 10, and across the stream (11)). You will need to calculate a discrete probability distribution for these five possible jump locations where the probabilities are inversely proportional to the jump distance AND is properly normalized.

Compare the results of the plot of expected number of jumps as a function of the number of lily pads to the original case studied in class, and comment on the results. Do you expect to see a larger number of jumps, on average, or a smaller number of jumps, on average, compared to the original version studied in class.

Bonus: You will win my eternal admiration if you can come up with a “theory” that describes this new distribution! Hint: think about how, in the original example, we found a way to calculate the theory prediction recursively.

1. Snakes and Ladders, again!
2. Implement in the snakes and ladders Markov Chain prediction (100 squares) the often adopted rule that in order to “win’ the game, that you have to land EXACTLY on the final square (i.e. if you roll a number that is larger than the required number to land on the final square, you remain where you are). These curves (Probability vs. N\_rolls) for the “no snakes and ladders” and “with snakes and ladders” cases will represent a sort of “theory” that we can compare an actual simulation to.
3. Write an actual simulation of a single-player snakes and ladders game, for the cases of “no snakes and ladders” and “with snakes and ladders”, and then compare to the Markov Chain predictions from part (a). The idea here is that you just start on square zero, and roll a six-sided fair die, and move the appropriate number of squares, and keep rolling until you reach square 100 (exactly). You will have to think carefully about how you handle the situation where you land on either a “ladder” or “snake” square.
4. Once you get parts a) and b) working, implement and TWO-PLAYER version of the game. The final metric in this part of the problem should be the average number of rolls to win the game (for the winning player). Compare the results to the single-player version.