Project Goose

6th of February, 2018

Your first project is to investigate the *Royal and Most Pleasant Game of Goose*. Your project will consist of four parts.

The Game of Goose

The Royal and Most Pleasant Game of Goose is dice game played on a board with 63 spaces. Each player rolls the two six sided dice and then moves forward the sum of the two dice. The first player who lands exactly in space 63 wins. There are a few other rules.

- If a player's first throw is a six and a three go to space 26
- If a player's first throw is a four and a five go to space 53
- If a player lands on a goose, the player is moved forward by the same amount.
- If a player rolls more than 63, they count off to 63 and then move backwards with the remaining count.

The goose squares are located at spaces: 5, 9, 14, 18, 23, 27, 32, 36, 41, 45, 50, 54, and 59. There are additional hazard spaces.

- Space 6 – The Bridge – Go to space twelve
- Space 19 – The Hotel – Stay for one turn
- Space 31 – The Well – Stay for two turns
- Space 42 – The Maze – Go back to space 39
- Space 52 – The Prison – Stay for three turns
- Space 58 – Death – Go to space one

Goose was used as both a gambling and drinking game. Landing on special spaces would require the player to add money to winner's pot.

The Project

Your project consists of four parts. Your handin will be in the form of a pdf write-up written in LaTeX.

The Introduction

Explain what Markov chains are and how they apply to the game of Goose. You should use some academic references.

The Markov Chain

You will create a Markov chain to represent a single player's travels through the game of Goose. You should be able to use the Markov chain to calculate the probability of where a player will be after n moves. You will probably want to use a program like R or Mathematica. Answer the following questions (your answers should be added into the write up in a results section!):

1. How did you represent the three squares where you have to wait turns?
2. What is the fewest turns for a player to win?
3. What is the probability that a player has won on turns 2, 4, 8, 16, 32, 64, and 128?
4. Is it ever more probably that a player has won than hasn't? If so, on what turn? If not, why not?

The Simulation

You will program a simulation of the game of Goose, which does NOT use a Markov chain. Your simulation will use random numbers to simulate dice rolls. How can you find probabilities using the simulation? Answer the following questions using your simulation (your answers should be added into the write up in a results section!):

1. What is the fewest turns for a player to win?
2. What is the probability that a player has won on turns 2, 4, 8, 16, 32, 64, and 128?
3. Is it ever more probably that a player has won than hasn't? If so, on what turn? If not, why not?

Analysis

An analysis section will be added to your write up. Your analysis will utilize both your simulation and your transition matrix. You will need to answer the following questions:

1. What is the shortest path for a player to win? What algorithm did you use?
2. What is the least probable path for a winning player? What algorithm did you use?
3. What is the most probable path for a player to win? What algorithm did you use?
4. What is the longest path for a player to win? What algorithm did you use?
5. Is the transition matrix bipartite? Why or why not?
6. Can you find an Eulerian trail? If not why?
7. Compare the information you found from your simulation to the Markov chain? Are they the same? How do they differ?

All good papers have figures (graphics). You will need to produce at least two graphics and include them in your write up, the graphics should be referenced in the write up and include descriptive captions.

1. Create a graphic to display the probability of winning on each of the first 128 turns.
2. Create a graphic to display the probability of being on each space after 2, 4, 6, 8, 16, 32, 64 turns.

Finally, you should write a conclusion section which summarizes what you did.

Turn In

You will need to submit files (on canvas) for your: source code, transition matrix (csv), and paper. All work is pledged and is to be your work. You may work in groups of up to four.