Prob, Comput & Sim (ST504)

Final project

Simulation of Tic Tac Toe Report

Fall 2018

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I simulated the game of Tic Tac Toe in R to see what the proportion of wins and draws would be when both players play randomly, and when one player is playing with a strategy and when the other player is playing randomly. To do this I created the board by using a matrix that contains all of the possible winning combinations. I had to number the spots on the Tic Tac Toe board as 1-9. Then I recorded within the matrix, the sequence of numbers which indicates a win.

First, I simulate a game where both players place their marks on the board randomly. This required me to create a function that keeps track of which spot is free and which are still available. Then it was necessary to find out which player got the winning sequence. From here, I simulated this process 100 times, then 1000 times, then 10,000 times. For each simulation size I created a table of wins and draws to see if the proportions changed as the size of the simulation increases.

My original question of interest was to find out the proportion of wins, and draws for the two players when they both play randomly vs when player 2 is random but player 1 is strategic. The results of my findings for a simulation of size 10,000 when both players play randomly are as follows.

	5^{th} turn	6^{th} turn	7^{th} turn	8^{th} turn	9^{th} turn
Player 1 wins	897	0	2727	0	2252
Proportion of win	8.97%	0%	27.27%	0%	22.52%
Player 2 wins	0	889	0	1968	0
Proportion of win	0%	8.89%	0%	19.68%	0%
Draw	0	0	0	0	1267
Proportion of draw	0%	0%	0%	0%	12.67%

The interesting thing about both players playing randomly is that they both have approximately equal chance of winning (8.9) on the first possible chance but the probability of player 2 winning

on the second possible chance is about 8% less than the probability that player 1 wins. Furthermore, player 1 has an additionally chance to win that player 2 will never get. This makes it 8.69% more likely for player 1 to win. 12.67% of the time there will be a draw game when no one is employing a strategy.

Then for the next part of my project, I tried the game where player one has a strategy and player2 is playing randomly.

Here is a summary of the strategy:

1. Always start in the middle. (X is player 1 and O is player 2)

2. If player2 starts with any of the green boxes, then player1 chooses the adjacent green box Fig1

3. If player 2 chooses any of the red boxes, player 1 chooses diagonally opposite green box Fig 2.

4. Depending on the further moves, player 1 chooses strategically to develop three of his/her moves in a line and to stop player 2 from winning. Below is pictorial representation of one game:

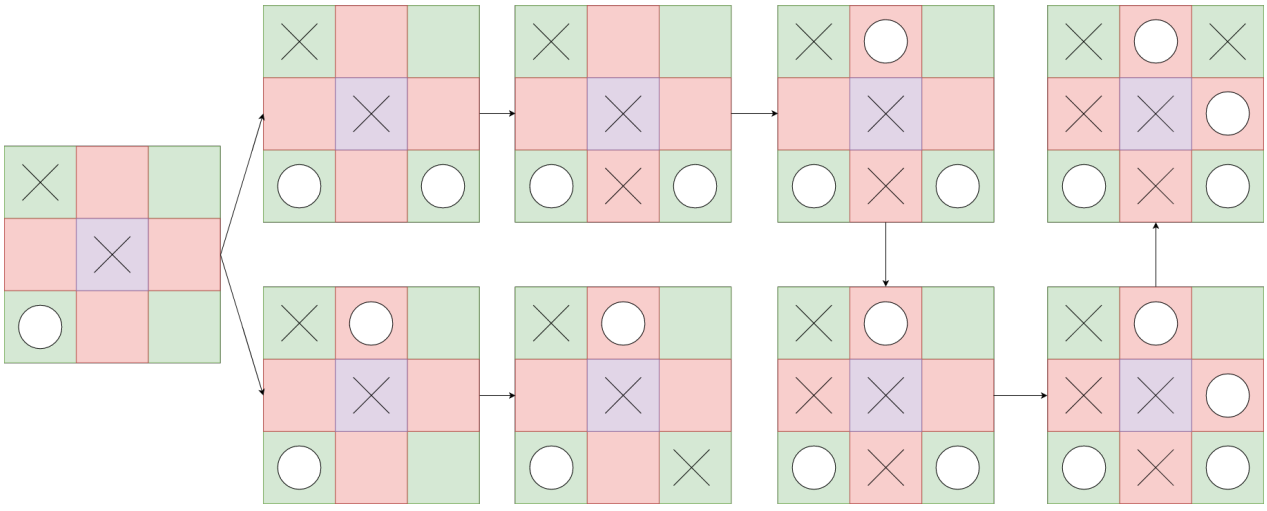

Figure (1)

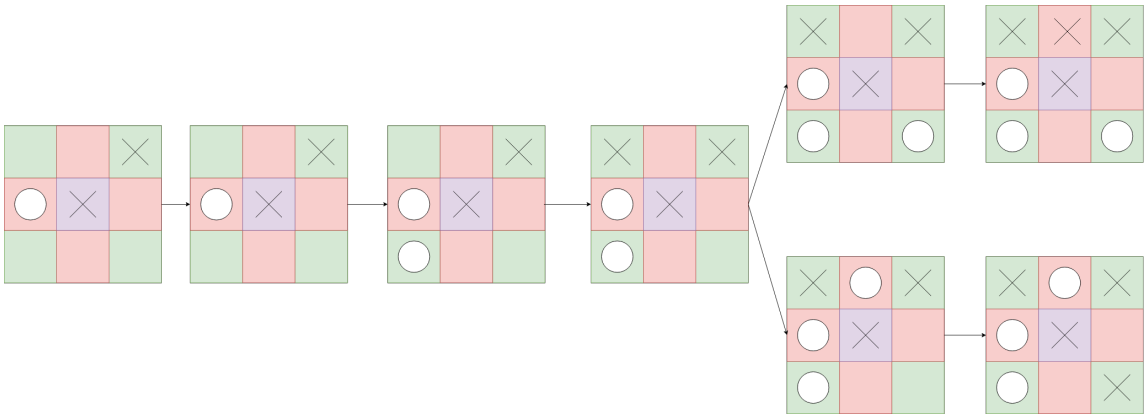

Figure (2)

The results of my 10,000 simulations for this game where player 1 has strategy and player 2 is random are as follows:

	5th turn	6th turn	7th turn	8th turn	9th turn
Player 1 wins Proportion of win	8243 82.43%	0 0%	1539 15.39%	0 0%	119 1.19%
Player 2 wins Proportion of win	0 0%	0 0%	0 0%	0 0%	0 0%
Draw Proportion of draw	0 0%	0 0%	0 0%	0 0%	99 .99 %

For the future, I could probably improve on my simulation by changing it to where the first player is random and the second player has a strategy to discover more about the effect of choosing the center spot. However, I think this might not increase the probability that player1(random) wins from the 0% wining rate since the player who plays randomly will might not have a chance of winning due to the randomness. It will be interesting if I work some simulation for the center circle which I think is part of the secret to success.