A Statistical Analysis of Blokus

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Introduction

Blokus is a strategy game played on a 20 x 20 grid between four players. The rules state that each player must begin by placing his piece on a corner square, and each successive move he must place a piece such that it touches another of his pieces only at a corner. That is, a player cannot place a piece separately from his other placed pieces or such that the edges of any pieces are touching. The objective is to place as many individual squares on the board as possible. The player with the most squares on the board is the winner.

Several strategies are commonly used in Blokus--the two most popular being that of blocking others from your corner of the board, and of attacking others by spreading your pieces across the map.

In order to compare the effectiveness of the two strategies, as well as gain a deeper understanding of the game itself, we created a simulation of the game as well as four different AI strategies representing the two approaches described above as well as two 'neutral' or 'dumb' strategies.

Strategies

Strategy 1: Completely random
Strategy 2: Prioritize larger pieces
Strategy 3: Prioritize larger pieces, and prioritize moves closer to the center
Strategy 4: Prioritize larger pieces, and prioritize moves closer to their corner

Procedure

All four strategies are based upon the same core algorithm. At each turn, the board is analyzed to compute every possible unique move available to the player. The number of possible moves is recorded for each turn in a text file.

Strategy 1 samples uniformly from this list.

Strategy 2 removes all but the largest pieces from this list, and then samples uniformly from the list

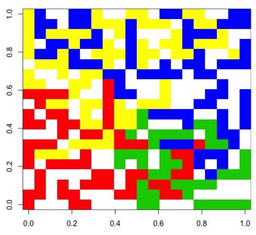
Strategies 3 and 4 remove the smallest pieces, and then assign a priority to the remaining moves according to the x,y coordinate of their placement. The algorithm then samples uniformly amongst the highest priority moves.

The result of each game, as well as the number of possible moves for each player at each turn, are stored in individual text files.

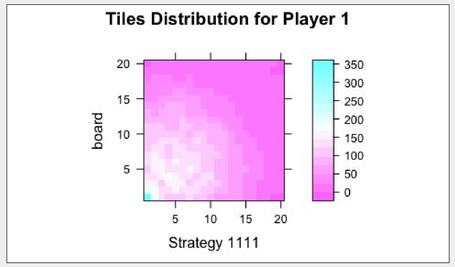
These text files were then analyzed in R.

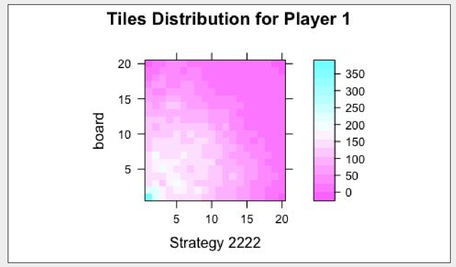
When referring to a game, "Strategy 1234" implies player 1 is using strategy 1, player 2 is using strategy 2, player 3 is using strategy 3, and player 4 is using strategy 4. Each unique game is simulated 1000 times.

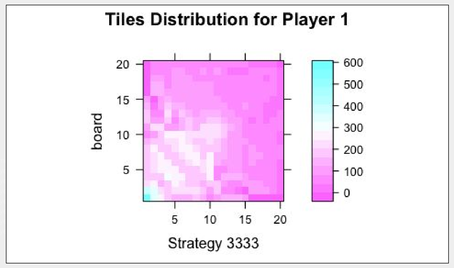
Source Code (github)

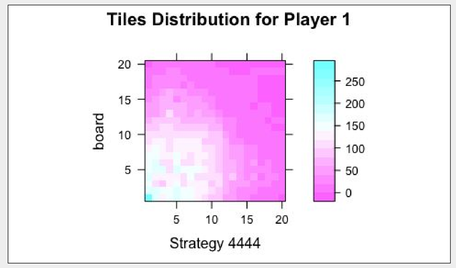


Tile Distribution and Win Rate According to Strategy



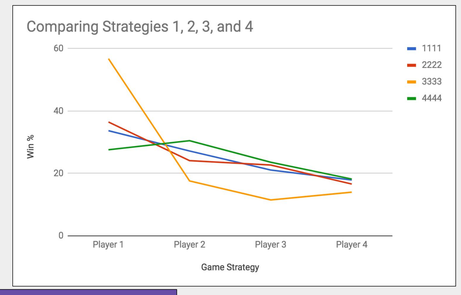






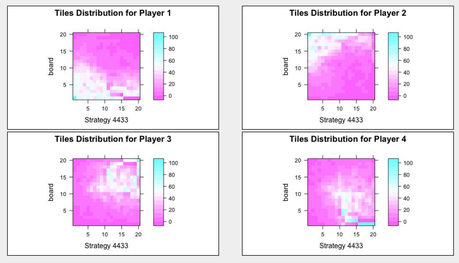
Game Strategy	Player 1	Player 2	Player 3	Player 4
1111	33.7	27.2	21.1	17.9
2222	36.5	24.1	22.7	16.6
3333	56.8	17.6	11.5	14
4444	27.6	30.5	23.6	18.2

When all players use the same strategy, there is a clear decrease in win percentage from player one to player four. Strategies 1, 2, and 4 result in a linear decrease in win percentage at a rate of ~6% per player. Strategy 3, however, results in an extremely high win percentage for player 1, suggesting that the first player to reach the center of the board has a significant advantage over the others.

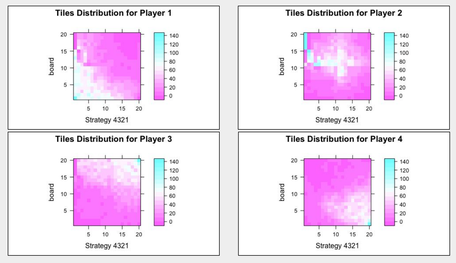


Comparing Strategies Against Each Other

Strategy 4433

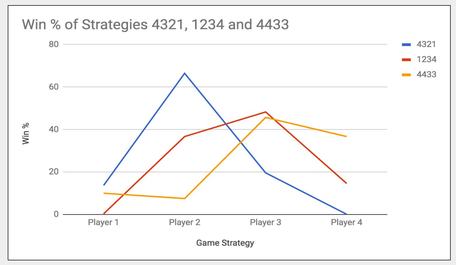


Strategy 4321

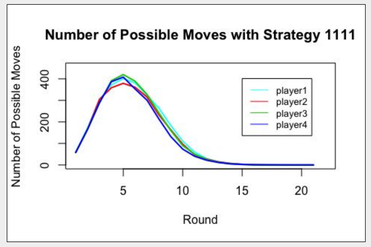


Game Strategy	Player 1	Player 2	Player 3	Player 4
4321	13.7	66.5	19.6	0.1
1234	0.3	36.7	48.3	14.6
4433	10	7.5	45.7	36.7

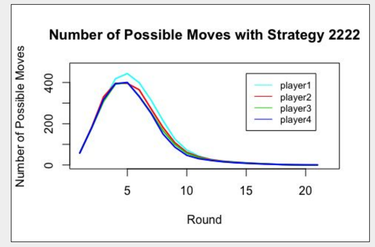
When all four strategies are compared against each other, strategy 3 is the most successful, followed by 2, then 4, and lastly 1. This implies a positive relationship between toward the center and win rate.
After averaging the win rates in 4321 and 1234, The comparative win rates are:
1: 0.2% 2: 28.2% 3: 57.4% 4: 14.2%



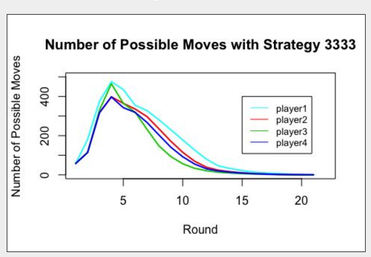
Number of Possible Moves Over Time According To Strategy



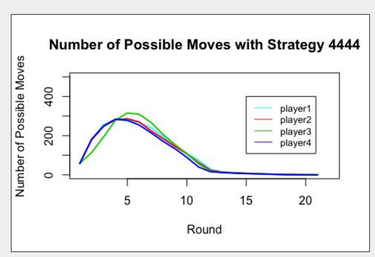
Player 1: 33%



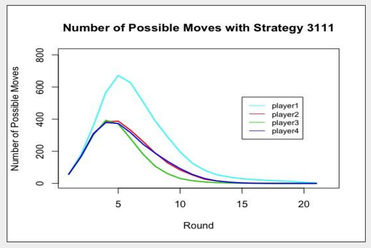
Player 1: 36%



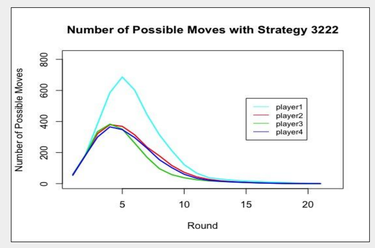
Player 1: 56%



Player 1: 33%



Player 1: 98%



Player 1: 66%

Results and Conclusion

After analyzing several thousand games of Blokus under four different strategies, it is clear that one's method of placement can drastically affect one's chance of winning. Based on our data, the most effective strategies involve placing the largest pieces first, and moving toward the center as rapidly as possible. Doing so allows the player to have a maximal amount of possible moves throughout the game, giving them an advantage.

In future studies we would like to improve strategy 4, the 'blocking' algorithm, such that it can intelligently respond to approaching opponents instead of simply prioritizing moves close to its starting corner.

Acknowledgements

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