Isolation Game: Heuristic Analysis

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1 Evaluation Functions

Three types of heuristics were developed as part of the project requirement. These were used to analyze the performance of the agent in different game simulations in the tournament. These were then compared with the ID_Improved agent to draw conclusions about their effectiveness. The following are the descriptions of the heuristics analyzed in this project:

1.1 Heuristic I

This is a simple difference between the number of moves of the active player versus the overlapped moves of both players. The idea behind this heuristic is, as the game nears the end, the player would like to minimize the overlapped squares as much as possible by blocking the opponent, while maximizing their moves. This also assumes that as there are less empty spaces between the two players, there is high possibility that the game could come to an end.

1.2 Heuristic II

This heuristic takes the distance between the two players and minimizes it. I used manhattan distance method to calculate the distance between the two squares (as they can move in L-shaped fashion, and this way of measuring is close to approximating that). The idea behind this heuristic is, typically the distance between the players gets smaller towards the end of the game. An adversarial agent would try to block the moves of the opponent, and will be actively trying to get closer to them as the result. The following equation describes this heuristic.

$$\frac{m_a - m_o}{1 + d}$$

where m_a refers to the number of moves of the active player, m_o refers to the number of moves of the opponent, and d refers to the manhattan distance between their locations. I used $1 + d$ in the denominator for a safer margin, in the case if distance gets close to zero.

1.3 Heuristic III

The third heuristic is a slight improvement of the second heuristic. It is the same as the second, except that, in this case, I included the number of blank squares in the equation. This is because, in the second heuristic, the players could start at the locations nearby each other, and it would not capture the end-game in that instance. By including the number of empty squares, it makes sure that the end-game is near when the empty squares are lower. The equation of this heuristic is given below.

$$\frac{m_a - m_o}{1 + m_e + d}$$

Here, m_e refers to the number of empty squares or blank squares in the board.

2 Results of Tournament Simulations

These three heuristics are run for 50 game simulations by setting a seed in random (in order to compare) with the ID_improved heuristic. As the first measure, the average percentage of wins is compared for these four agents: ID_improved, Evaluation Function I, Evaluation Function II, and Evaluation Function III. Figure 1 shows the boxplot of these wins for the 50 simulation runs.

The boxplot shows that, on an average, the performances of heuristic I and II are worse than the ID_improved agent, whereas heuristic III is performing better than ID_improved. However, the variation of the third heuristic is higher than the ID_improved agent. The average win percentage of each agent is tabulated in Table 1.

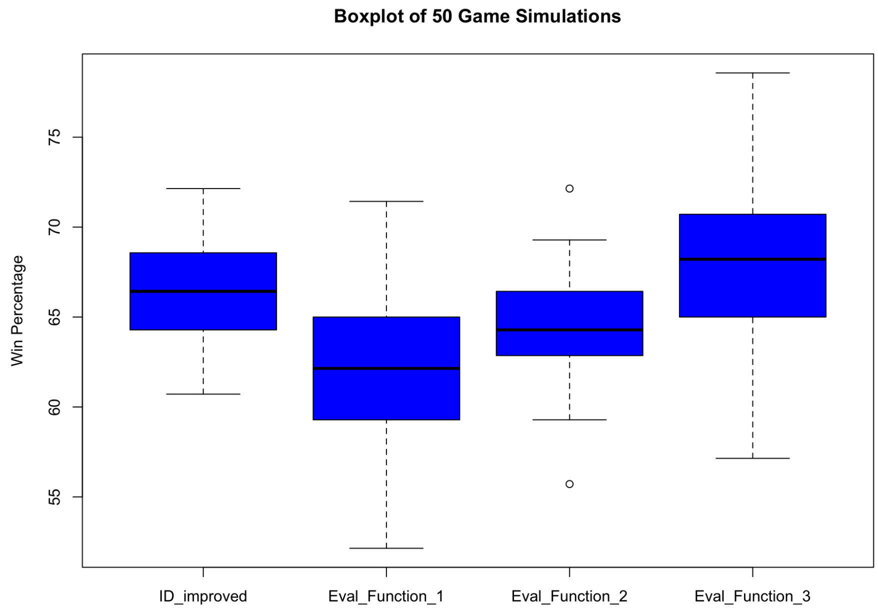

Figure 1: Boxplot of Wins (%) for 50 Tournament Simulations)

Table 1: Average Win Percentage Value of Agents

Agent	Average Win Percentage
ID_Improved	66.44%
Heuristic I	61.93%
Heuristic II	64.17%
Heuristic III	67.84%

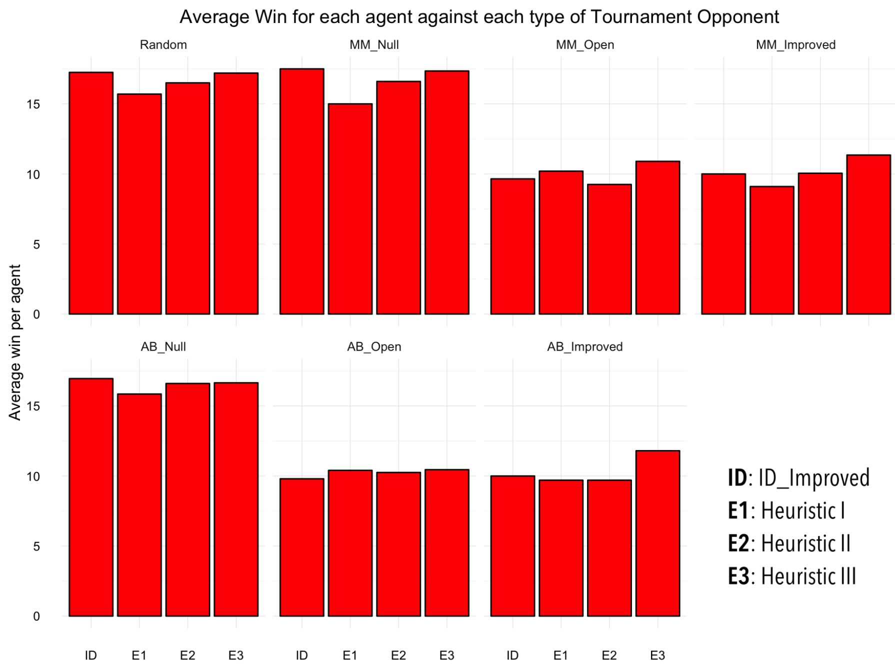

Figure 2: Average win of agents against different types of tournament agents in 50 game simulations)

Secondly, the performance of these agents are compared with different types of agents they played against in the tournament, namely, Random, MM_Null, MM_Open, MM_Improved, AB_Null, AB_Open, AB_improved (where MM refers to Minimax and AB refers to alpha-beta pruning methods). For the same 50 game simulations, the average wins of the agents among 20 runs against the different types of tournament agents were plotted. Figure 2 shows the average wins for each agent in consideration.

Here, we can observe that almost all the three heuristics (as well as ID_improved agent) fare decently well against random, MM_null and AB_null agents. However, they find it challenging to win against other agents, especially against AB_improved and MM_improved agents. We can find that heuristic III performs better than ID_improved against AB_improved agent, and this is one of the reasons the average win percentage is higher than ID_improved.