

Artificial Intelligence Nanodegree – Project 2 Heuristic Analysis

I tested three custom heuristics for this project. The three custom heuristics are:

Custom Heuristic 1

Aggressive Improved Score Heuristic: This heuristic is similar to the improved score heuristic provided, except that the number of opponent moves(Num_Opp_Moves) is weighted more heavily than the number of own moves(Num_Own_Moves). The heuristic function is given as follow:

$$value = Num_Own_Moves - 2 * Num_Opp_Moves$$

Custom Heuristic 2

Euclidean Distance From Center and Opponent: In this heuristic, we assume that moves closer to the middle of the board are better than moves further from the middle of the board. In addition, we assume that it is better to be further away from the opponent. The heuristic function is given as follow:

$$value = -dist_{center} + dist_{opp}$$

where $dist_{center}$ is the Euclidean distance of the player from the center of the board and $dist_{opp}$ is the Euclidean distance of the player from the opponent.

Custom Heuristic 3

Combination of Heuristic 2 and Improved Score Heuristic: This heuristic uses a weighted combination of the improved score heuristic and heuristic 2. At the start of the game, heuristic 2 is weighted more heavily, whereas at the end of the game, improved score heuristic is weighted more heavily. The heuristic function is given below:

$$value = \alpha(-dist_{center} + dist_{opp}) + (1 - \alpha)(Num_Own_Moves - Num_Opp_Moves)$$

where α is the % of spaces on the board that is still blank. At the start of the game $\alpha = 1$, whereas by the end of the game α goes to 0.

I ran 100 matches using tournament.py and the winning rate in % of ID improved and the three heuristics are shown in the table below. The highlighted box in each column represents the top performing heuristic against the opponent for that column.

	Random	MM Null	MM Open	MM Improved	AB Null	AB Open	AB Improved	Overall Average
ID Improved	85.5	76.25	65.5	65.75	67.25	59.75	58.5	68.36
Custom Heuristic 1	85.25	80.75	65	63.25	71.5	65.5	59.25	70.07
Custom Heuristic 2	84.75	76.75	63	61	77	58	57	68.21
Custom Heuristic 3	88.5	79.75	68	63.5	74.75	66.75	61.25	71.79

From the data in the table, we can see that Custom Heuristic 1 outperforms ID_Improved by 1.7% on average. This suggests that giving a stronger weight to the number of opponent moves is beneficial for the agent. Interestingly, I tested a heuristic that gives the number of own moves a heavier weight and that heuristic performed worse than ID_Improved.

Custom Heuristic 2 actually performs slightly worse than ID_Improved. However, when heuristic 2 is combined with the improved score heuristic as in custom heuristic 3, it actually performed the best out of all the heuristics tested, outperforming ID_Improved by 3.4% on average.

I believe that custom heuristic 3 is the best option out of all the heuristics tested since it performs the best on average. In addition, this heuristic appears to be the most robust as it demonstrates strong performances across all player types. Out of the 4 heuristics compared in the table, it performs the best against 4 opponent types, and second best against the other 3 opponent types. Finally, in game playing, a good early game strategy is likely to be different from a good late game strategy. Custom heuristic 3 is the only heuristic out of the four that adapts its strategy for different stages of the game.