

Heuristic Analysis

There are five custom evaluation heuristic functions being analyzed in the tournament script.

AB_Improved (benchmark): number of player's legal moves – number of opponent's legal moves

AB_Custom : Manhattan distance between player and opponent + square of number of player's legal moves – number of opponent's legal moves

AB_Custom_2: Manhattan distance between player and opponent

AB_Custom_3: 15 - Manhattan distance between player and opponent

AB_Custom_4: square of number of player's legal moves – number of opponent's legal moves

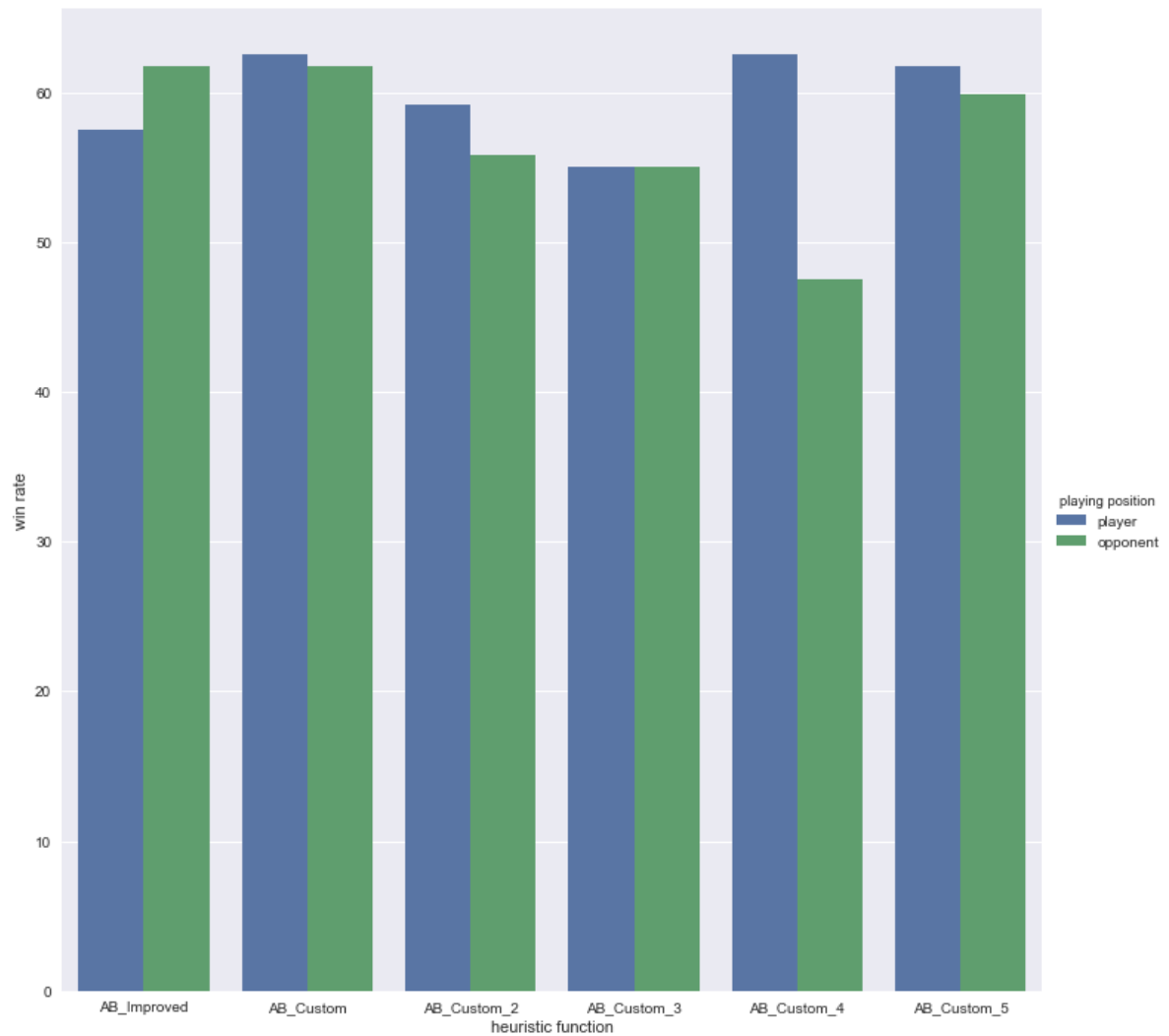
AB_Custom_5: Manhattan distance between player and opponent + number of player's legal moves – number of opponent's legal moves

Each player played 20 matches against his opponents and below is a summary of the result:

Match #	Opponent	AB_Improved		AB_Custom		AB_Custom_2		AB_Custom_3		AB_Custom_4		AB_Custom_5	
		Won	Lost	Won	Lost	Won	Lost	Won	Lost	Won	Lost	Won	Lost
1	Random	15	5	13	7	16	4	17	3	17	3	18	2
2	MM_Open	12	8	16	4	13	7	12	8	8	12	15	5
3	MM_Center	15	5	16	4	17	3	16	4	13	7	15	5
4	MM_Improved	13	7	11	9	14	6	9	11	12	8	12	8
5	AB_Open	9	11	13	7	10	10	10	10	12	8	11	9
6	AB_Center	13	7	14	6	10	10	11	9	7	13	9	11
7	AB_Improved	13	7	10	10	13	7	10	10	11	9	10	10
8	AB_Custom	9	11	11	9	10	10	8	12	7	13	10	10
9	AB_Custom_2	13	7	11	9	9	11	13	7	13	7	10	10
10	AB_Custom_3	13	7	14	6	10	10	8	12	11	9	12	8
11	AB_Custom_4	9	11	9	11	6	14	8	12	11	9	14	6
12	AB_Custom_5	9	11	11	9	10	10	10	10	10	10	10	10
Win Rate:		59.60%		62.10%		57.50%		55.00%		55.00%		60.80%	

AB_Custom and AB_Custom_5 performs better than the benchmark while the rest were underperforming. It gives the intuition that combining different heuristic functions is likely to give better results. AB_Custom_2 performed better than AB_Custom_3 which indicates staying away from opponent is likely to be a better strategy. Although AB_Custom_4 performs worse than the benchmark, it greatly enhanced the performance when combining with AB_Custom_2 to form AB_Custom. However, AB_Custom_5 (which is AB_Custom_2 + benchmark) only performed slightly better than the benchmark. It looks like more effort to maintain maximum moves available (passive strategy) instead of more effort to reduce opponent's legal moves (active strategy) while trying to stay away from opponents is a better choice for playing this game.

To examine the impact of playing position, results of 10 matches for our agents playing player position and the other 10 matches for playing opponent position were extracted and shown below.



AB_Custom and AB_Custom_4 have very consistent win rate for either playing player position or opponent position while others show discrepancies which means they have bias towards their playing position.

Besides, it is interesting to see how deep the agent can search with different heuristic functions. For each function, 1st and 2nd move was set randomly for the board and then each agent searched the third move for 5000 times to find the respective average depth. Results are shown below.

heuristic function	depth searched for 3rd move
AB_Improved	6
AB_Custom	6
AB_Custom_2	7
AB_Custom_3	7
AB_Custom_4	6
AB_Custom_5	6

AB_Custom_2 and AB_Custom_3 got the deepest depth. However, they got the worst performance in the tournament while others had one depth less but had better performance. This indicates that AB_Custom_2 and AB_Custom_3 are suffering more on horizon effect.

I would recommend to use AB_Custom as evaluation function as it had the highest winning rate in the tournament. Besides, it had consistent performance regardless of playing position. Last but not least, it suffers less on horizon effect comparing to others.