



Heuristic Analysis

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Evaluating Different Heuristic Functions:

The project requires analyzing three different heuristics in order to evaluate the functions.

Comparing the three heuristics, the following results appeared:

1. *custom_score_2*: this function gets the number of the available moves for each player and returns the value accordingly.
2. *custom_score_3*: this function's main concern is to stay as much as possible towards the middle of the board to increase the chance of winning.
3. *custom_score*: this function combines *custom_score_2* with a modification when reaching the end of the game as two more functions were created to help.

After testing the three heuristic functions, the *custom_score* function is the one recommended heuristic. This heuristic is chosen for three main reasons:

1. The win rate of *custom_score* compared to the other two heuristic functions is higher while being tested against different opponents. Also, the complexity of the function is significantly less than *custom_score_2* and *custom_score_3* so the time taken by the agent to play is less as will be mentioned in *point 2*.
2. *custom_score* makes it faster for the agent to decide on the move to be chosen faster before the time limit ends, so it gives higher performance.
3. It uses two additional functions in order to help returning the tree faster to the heuristic function in the end of the game and it prunes the unnecessary nodes so the performance is higher and faster as well.



Comparing the above heuristics, the performance is as follows:

```
This script evaluates the performance of the custom_score evaluation
function against a baseline agent using alpha-beta search and iterative
deepening (ID) called 'AB_Improved'. The three 'AB_Custom' agents use
ID and alpha-beta search with the custom_score functions defined in
game_agent.py.
```

```
*****
      Playing Matches
*****
```

Match #	Opponent	AB_Improved		AB_Custom		AB_Custom_2		AB_Custom_3	
		Won	Lost	Won	Lost	Won	Lost	Won	Lost
1	Random	10	0	9	1	10	0	10	0
2	MM_Open	7	3	9	1	7	3	9	1
3	MM_Center	8	2	8	2	9	1	9	1
4	MM_Improved	7	3	9	1	8	2	6	4
5	AB_Open	5	5	8	2	7	3	5	5
6	AB_Center	5	5	6	4	5	5	5	5
7	AB_Improved	7	3	5	5	7	3	7	3

```
Win Rate:      70.0%      77.1%      75.7%      72.9%
```