Heuristic Analysis

Introduction:

Three custom heuristics are implemented and analyze. The first method is a focused on maximizing the ratio between possible moves of self-player and those of opponent player. The last two methods are mutations of the "improved_score" heuristic, with different goals to achieve. Following is detailed description of the three methods.

Custom Heuristic 1:

custom_score_1 = float(self_move/(opponent_move+1))

The goal of this heuristic is to maximize the ratio between possible moves of self_player vs possible moves of opponent player. A constant +1 is added to the denominator to avoid division by zero, also to give a little more weights to the opponent players move.

Custom Heuristic 2:

*custom_score_2 = float(self_move - 5*opponent_move)*

This is a mutation of the improved_score heuristic, and the most important change here is to give opponent's possible moves more weight to encourage self_players to minimize opponent's move in an earlier stage.

Custom Heuristic 3:

*custom_score_3 = float(5*self_move - opponent_move)*

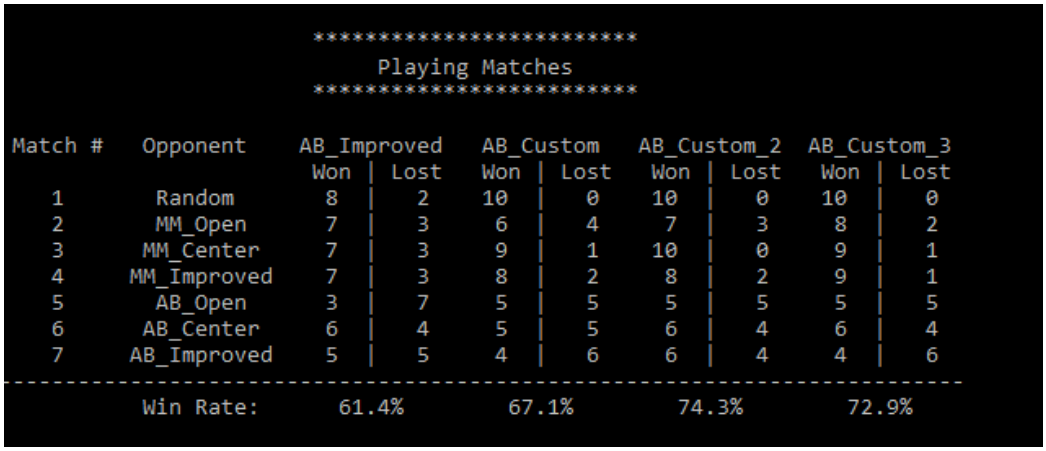
This is also a mutation of the improved_score heuristic, and the most noticeable modification here is to give self_player more weights. The goal of this method is not to minimize opponent's move but rather play defensively and passively.

Experiments:

Following are the experiment results. 3 set of different configs are used for the experiment.

Results:

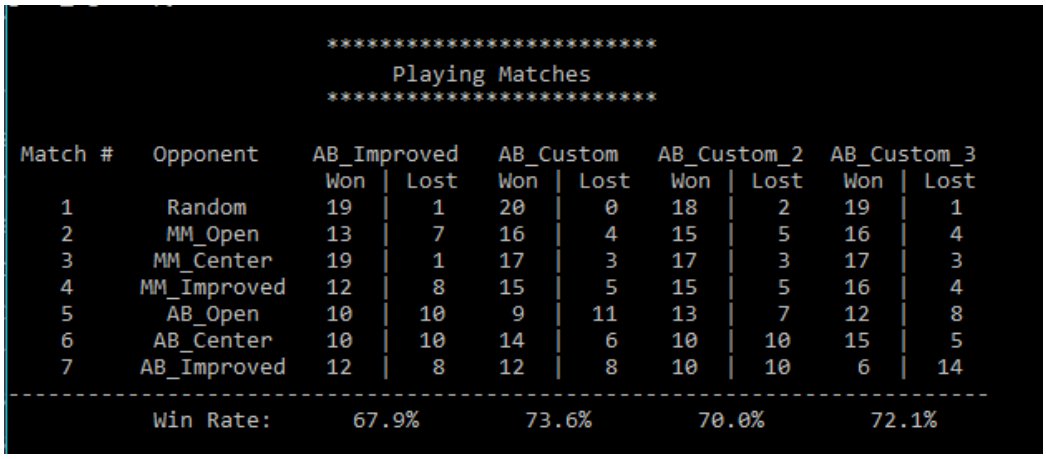
10 matches & 150 milliseconds



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

Match #   Opponent    AB_Improved   AB_Custom   AB_Custom_2  AB_Custom_3
                      Won | Lost   Won | Lost   Won | Lost   Won | Lost
   1       Random      8  |   2    10  |   0    10  |   0    10  |   0
   2       MM_Open     7  |   3     6  |   4     7  |   3     8  |   2
   3      MM_Center    7  |   3     9  |   1    10  |   0     9  |   1
   4     MM_Improved   7  |   3     8  |   2     8  |   2     9  |   1
   5       AB_Open     3  |   7     5  |   5     5  |   5     5  |   5
   6      AB_Center    6  |   4     5  |   5     6  |   4     6  |   4
   7     AB_Improved   5  |   5     4  |   6     6  |   4     4  |   6
-----------------------------------------------------------------------
          Win Rate:      61.4%        67.1%        74.3%        72.9%
```

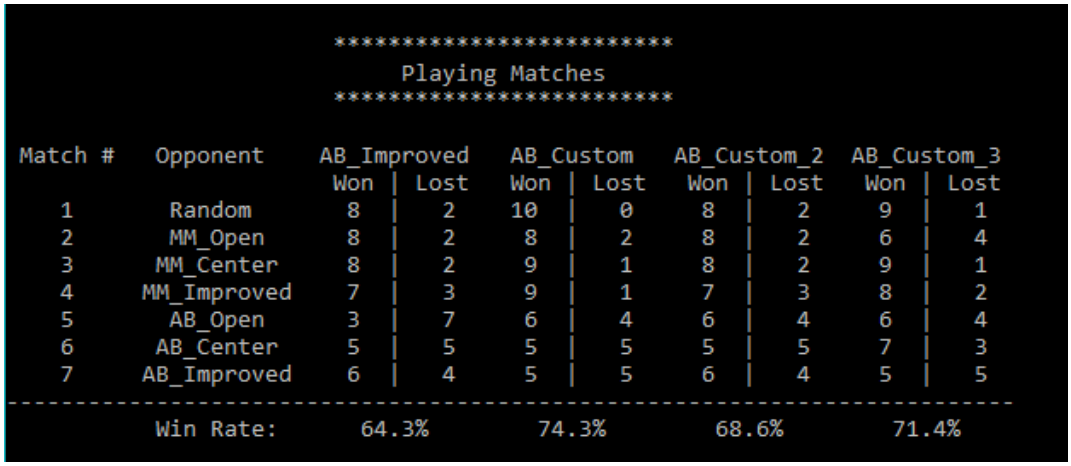
20 matches & 150 milliseconds



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

Match #   Opponent    AB_Improved   AB_Custom   AB_Custom_2  AB_Custom_3
                      Won | Lost   Won | Lost   Won | Lost   Won | Lost
   1       Random     19  |   1    20  |   0    18  |   2    19  |   1
   2       MM_Open    13  |   7    16  |   4    15  |   5    16  |   4
   3      MM_Center   19  |   1    17  |   3    17  |   3    17  |   3
   4     MM_Improved  12  |   8    15  |   5    15  |   5    16  |   4
   5       AB_Open    10  |  10     9  |  11    13  |   7    12  |   8
   6      AB_Center   10  |  10    14  |   6    10  |  10    15  |   5
   7     AB_Improved  12  |   8    12  |   8    10  |  10     6  |  14
-----------------------------------------------------------------------
          Win Rate:      67.9%        73.6%        70.0%        72.1%
```

10 matches & 50 milliseconds



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

Match #   Opponent    AB_Improved   AB_Custom   AB_Custom_2  AB_Custom_3
                      Won | Lost   Won | Lost   Won | Lost   Won | Lost
   1       Random      8  |   2    10  |   0     8  |   2     9  |   1
   2       MM_Open     8  |   2     8  |   2     8  |   2     6  |   4
   3      MM_Center    8  |   2     9  |   1     8  |   2     9  |   1
   4     MM_Improved   7  |   3     9  |   1     7  |   3     8  |   2
   5       AB_Open     3  |   7     6  |   4     6  |   4     6  |   4
   6      AB_Center    5  |   5     5  |   5     5  |   5     7  |   3
   7     AB_Improved   6  |   4     5  |   5     6  |   4     5  |   5
-----------------------------------------------------------------------
          Win Rate:      64.3%        74.3%        68.6%        71.4%
```

Recommendation:

I would recommend AB_Custom_3 heuristic among all the four heuristics tested. First of all, since the all 3 custom heuristics are variants of AB_Improved, they are almost equally computationally expensive. Second, based on the result of 3 different sets of test configs, AB_Custom_3 has a winning rate consistently higher than 70%, even with only 50 milliseconds of search time limit. Third, Ab_Custom_3 has the most consistent performance against all opponent amongs the three customed models.