Heuristic Analysis

For the development of the heuristics for the second project, I tried to visualize what might be the most effective means of applying a weight to any given move. The improved score outlined in the videos was very basic but it did serve to effectively narrow choices to those moves which would maximize the available moves at every step while limiting those of the opponent.

Among the heuristics implemented, including AB_Improved, no method stands out as being consistently better than any of the others in terms of performance. For ease of implementation, AB_Improved may still be the best method since it requires the least amount of logic when compared to the other methods. However, the other heuristics are not that much more complicated computationally and require only a few more lines of code to implement, so the significance is not that great. The scores produced by custom_score2 and custom_score3 are similar to the improved_score in that they are linearly correlated to the number of moves forecast for the player versus those forecast for the opponent. The custom_score heuristic uses a similar methodology as the others, except the average of the diagonal distances are used. The produced score is still similar to those output by the other methods. All the heuristics operate at the same level upon each iteration of the search tree, with the score being called by the min_value and max_value functions in both Minimax and AlphaBeta.

Based on the simplicity and comparative complexity among all the heuristics implemented, I do not have a preference for any single heuristic over another. Since all the results produced were consistently within close range to one another, it does not seem that one is particularly better suited to the task of scoring this than any other, including the improved_score.

The mechanism for each heuristic is described below.

Custom_score - O(n)

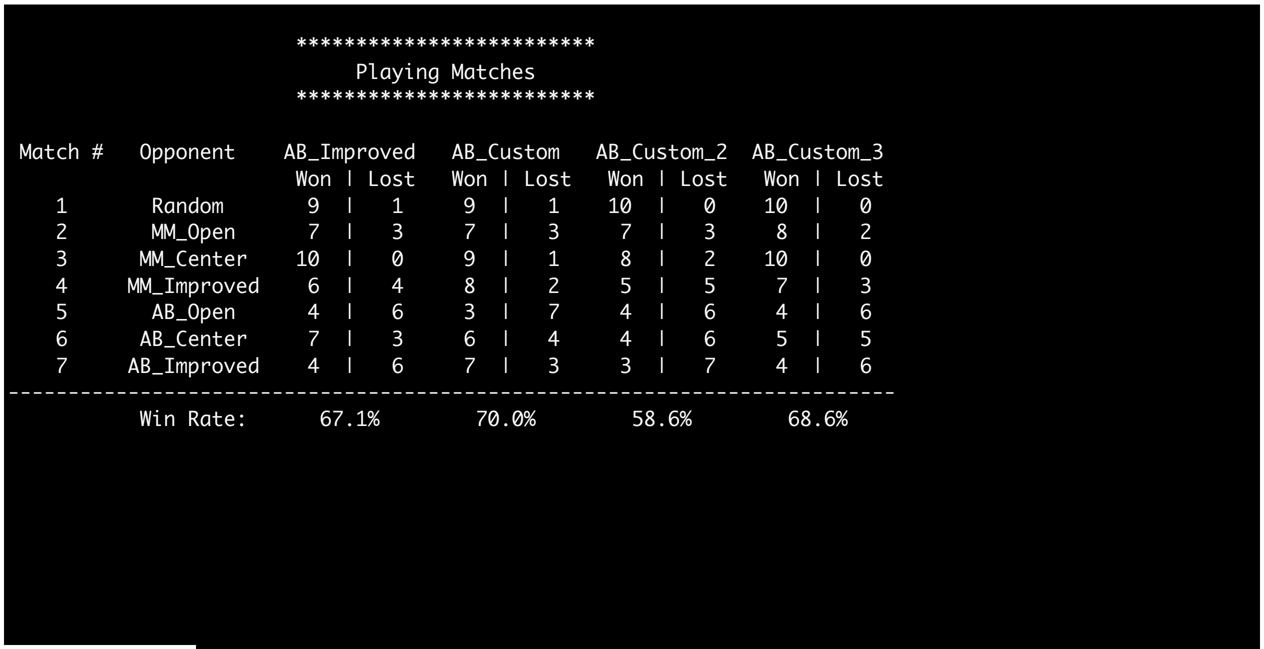
For this heuristic I took the average of the diagonal distance from forecast moves relative to the player and the opponent's current location. The difference between the two averages was then returned as the score.

Custom_score2 - O(n)

This measures the difference between the sum of the number of moves available to a player within 3 spaces of a player and the sum of the number of moves available to their opponent.

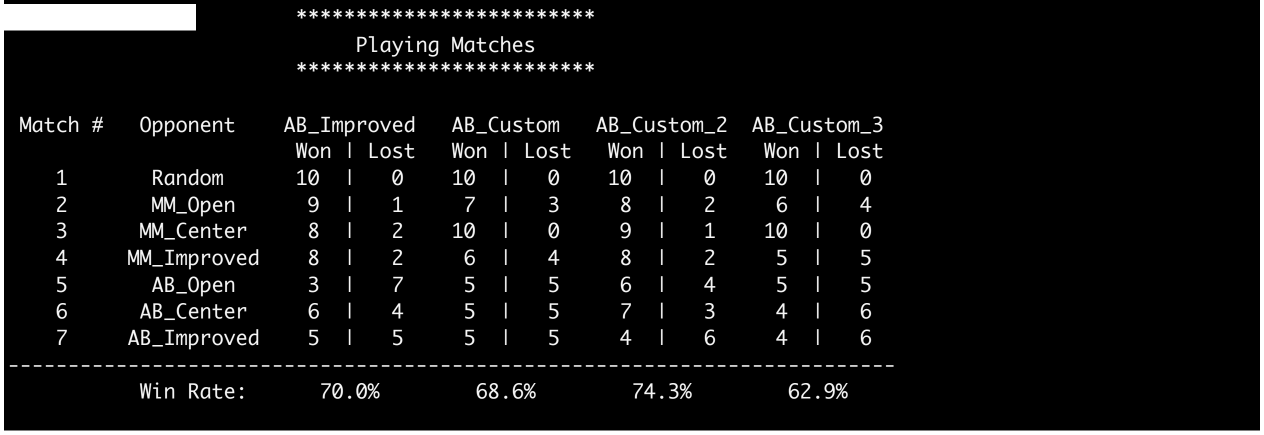
Custom_score3 – O(n)

This measures the difference between the sum of the Manhattan distances for each available move to a player relative to their opponent's location and the sum of the Manhattan distances for each available move for an opponent relative to the player's location.



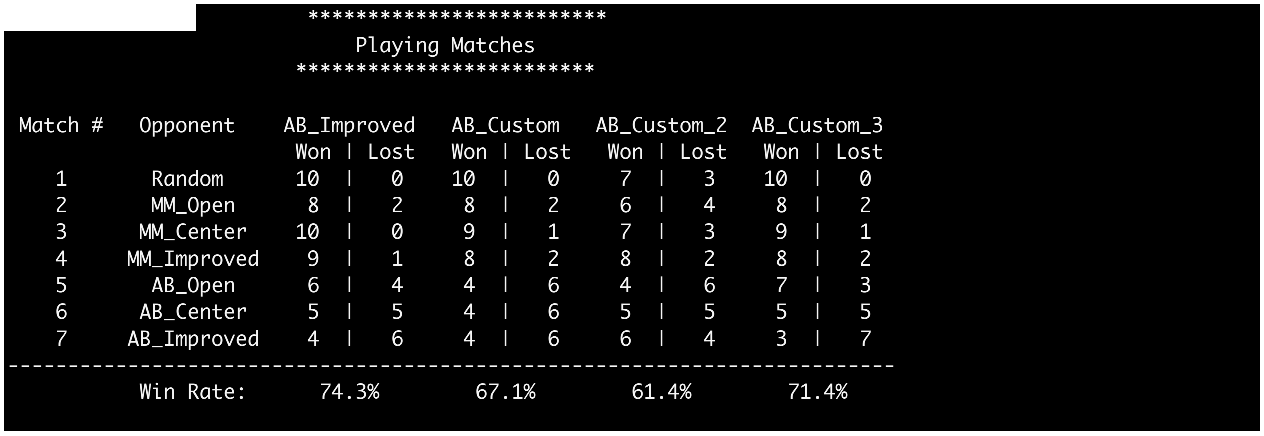
```
                         *************************
                              Playing Matches
                         *************************

 Match #   Opponent    AB_Improved   AB_Custom   AB_Custom_2  AB_Custom_3
                        Won | Lost   Won | Lost   Won | Lost   Won | Lost
    1       Random       9  |   1     9  |   1    10  |   0    10  |   0
    2       MM_Open      7  |   3     7  |   3     7  |   3     8  |   2
    3      MM_Center    10  |   0     9  |   1     8  |   2    10  |   0
    4     MM_Improved    6  |   4     8  |   2     5  |   5     7  |   3
    5       AB_Open      4  |   6     3  |   7     4  |   6     4  |   6
    6      AB_Center     7  |   3     6  |   4     4  |   6     5  |   5
    7     AB_Improved    4  |   6     7  |   3     3  |   7     4  |   6
--------------------------------------------------------------------------
           Win Rate:      67.1%        70.0%        58.6%        68.6%
```



```
                         *************************
                              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    10  |   0    10  |   0    10  |   0
    2       MM_Open      9  |   1     7  |   3     8  |   2     6  |   4
    3      MM_Center     8  |   2    10  |   0     9  |   1    10  |   0
    4     MM_Improved    8  |   2     6  |   4     8  |   2     5  |   5
    5       AB_Open      3  |   7     5  |   5     6  |   4     5  |   5
    6      AB_Center     6  |   4     5  |   5     7  |   3     4  |   6
    7     AB_Improved    5  |   5     5  |   5     4  |   6     4  |   6
--------------------------------------------------------------------------
           Win Rate:      70.0%        68.6%        74.3%        62.9%
```



```
                          *************************
                              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    10  |   0     7  |   3    10  |   0
    2       MM_Open      8  |   2     8  |   2     6  |   4     8  |   2
    3      MM_Center    10  |   0     9  |   1     7  |   3     9  |   1
    4     MM_Improved    9  |   1     8  |   2     8  |   2     8  |   2
    5       AB_Open      6  |   4     4  |   6     4  |   6     7  |   3
    6      AB_Center     5  |   5     4  |   6     5  |   5     5  |   5
    7     AB_Improved    4  |   6     4  |   6     6  |   4     3  |   7
--------------------------------------------------------------------------
           Win Rate:      74.3%        67.1%        61.4%        71.4%
```