# Heuristic Descriptions

**AB_Custom_3:** This evaluation function weights available opponent moves more heavily when determining the heuristic value of a board state. To be precise, each available opponent move on a state counts for -2 units, while each available state for the agent only counts for +1. The reasoning behind this is that the opponent will have the next turn, and so the amount of available states for the agent at the time of making their move is optimistic. This weighting should prioritize more aggressive strategies that actively try to limit the mobility of the opponent.

**AB_Custom_2:** Legal moves that are not directly adjacent to the player's position in a state are weighted more heavily than those that are. The idea is that if a player has many long moves available, then they have not been cut off yet in that direction by an opponent's current position or previous move. Similarly, penalizing the player for allowing the opponent to retain long moves will encourage cutting off directions by making aggressive moves close to the opponent.

**AB_Custom:** Aspects from both other custom heuristics are combined. Opponent moves are weighted more, and the availability of non-adjacent moves are also weighted more. Because empirically both moves seemed to perform slightly better than AB_Improved, then there would likely exist a way of combining them that would not degrade the accuracy of the evaluation function in estimating the optimal move.

# Results

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                    **************************
                        Playing Matches
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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      8  |   2     9  |   1     9  |   1    10  |   0
   3      MM_Center     9  |   1    10  |   0    10  |   0    10  |   0
   4     MM_Improved    8  |   2     9  |   1     8  |   2     9  |   1
   5       AB_Open      4  |   6     7  |   3     6  |   4     3  |   7
   6      AB_Center     7  |   3     7  |   3     5  |   5     5  |   5
   7     AB_Improved    4  |   6     7  |   3     5  |   5     9  |   1
--------------------------------------------------------------------------
          Win Rate:      71.4%        84.3%        75.7%        80.0%
```

In the tournament, AB_Custom_2 and AB_Custom_3 have win rates ranging between 75-80%, while AB_Custom reaches above 80%. The 2 weaker custom heuristics outperform each other against different opponents, lending support that they contain complementary information. AB_Custom outperforms both other custom heuristics against all opponents, and defeats AB_Improved both in tournament results and head-to-head matches consistently. There is still room for improvement in tuning the balance between the ideas that AB_Custom combines from the other two heuristics.

# Recommendation

**AB_Custom** was chosen because it consistently outperforms both other custom heuristics in the tournament. It also outperforms AB_Improved both in tournament, and head-to-head results. Furthermore, it has some level of justification as being a combination of the other 2 heuristics. As they both perform reasonably well in the tournament, if they are complementary mechanisms to evaluating the state, then some combination that has even better overall performance should exist, and the results seem to support this. Finally, AB_Custom is a good choice because it contains certain parameters for how much it weights opponent moves and non-adjacent moves, and these can be tuned provided a lot of data, or to accommodate differently sized boards.