# Heuristic Results

| Match # | Opponent | AB_Improved | AB_Custom | AB_Custom_2 | AB_Custom_3 |
|---|---|---|---|---|---|
| | | Won \| Lost | Won \| Lost | Won \| Lost | Won \| Lost |
| **1** | **Random** | 161 \| 39 | 170 \| 30 | 147 \| 53 | 168 \| 32 |
| **2** | **MM_Open** | 134 \| 66 | 117 \| 83 | 114 \| 86 | 127 \| 73 |
| **3** | **MM_Center** | 150 \| 50 | 136 \| 64 | 148 \| 52 | 153 \| 47 |
| **4** | **MM_Improved** | 122 \| 78 | 111 \| 89 | 125 \| 75 | 121 \| 79 |
| **5** | **AB_Open** | 109 \| 91 | 101 \| 99 | 105 \| 95 | 106 \| 94 |
| **6** | **AB_Center** | 110 \| 90 | 100 \| 100 | 105 \| 95 | 102 \| 98 |
| **7** | **AB_Improved** | 88 \| 112 | 96 \| 104 | 92 \| 108 | 90 \| 110 |
| **Win Rate** | | 62.4% | 59.4% | 59.7% | 61.9% |

In evaluating the different heuristics, the number of matches was set to 100, and the time limit was left at the default value of 150. AB_Improved performed the best, and AB_Custom_3 performed nearly as well as AB_Improved. Conversely, AB_Custom and AB_Custom_2 didn't perform quite as well as AB_Improved and AB_Custom_3, but did perform similarly to each other and almost as well as the Improved/Custom_3 heuristics.

A possible reason for the fact the Improved/Custom_3 heuristics have similar results and Custom/Custom_2 have similar results could be that heuristics that use an absolute value of the number of moves (e.g. the total number of the player's available moves) are superior to heuristics that use a ratio (e.g. player's moves / total moves). AB_Improved and AB_Custom_3 are similar in that AB_Improved is the net total of the player's possible moves minus the opponent's possible moves, whereas AB_Custom_3 minimizes the number of the opponent's moves by returning the negative of the total number of the opponent's moves for a given game state (the inverse of AB_Open). Likewise, AB_Custom and AB_Custom_2 are both similar in that they give a value that is a ratio. AB_Custom is the ratio of the number of the player's possible moves compared to the total number of moves on the board, and AB_Custom_2 returns the negative value of the ratio of the number of opponents moves compared to the total number of moves on the board (it is the inverse of AB_Custom).

The recommended custom heuristic in this case is **AB_Custom_3**, for the following reasons:

1. At 61.9%, it has the highest win rate among all of the custom heuristics.
2. It best predicts the outcome of the game. The object of the game is to eliminate the opponent's available moves, not maximize one's own available moves. While maximizing one's own moves may be highly correlating with winning, minimizing the opponent's move more accurately reflects the object of the game.
3. It allows the game tree to be searched more deeply. Because the calculation of the AB_Custom_3 heuristic is simpler than the other custom heuristics, it can be completed faster. This allows it to search to a further depth in the game tree.