# Analysis of the Heuristics

Following heuristics were chosen and implemented

- **H1** (AB_Custom): *# of player's moves – 2 x # of opponent's moves*
- **H2** (AB_Custom_2): *The square of the distance between the player and the opponent, calculated as*
  *y_i, x_i = game.get_player_location(i) , where i is either the player or the opponent*
  *score = (y_pl - y_opp)2 + (x_pl - x_opp)2*

- **H3** (AB_Custom_3): Center score of the player (Square of the distance of the player's location from the center of the board.
  *w, h = game.width / 2., game.height / 2.*
  *y, x = game.get_player_location(player)*
  *score = (h - y)2 + (w - x)2*

The results of the tournament with these heuristics are as follows:

*Table 1 Results of the Tournament*

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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     8  |   2    10  |   0
    2       MM_Open      7  |   3     7  |   3    10  |   0     8  |   2
    3      MM_Center     7  |   3    10  |   0     8  |   2    10  |   0
    4     MM_Improved    6  |   4     7  |   3     8  |   2     6  |   4
    5       AB_Open      5  |   5     6  |   4     6  |   4     5  |   5
    6      AB_Center     7  |   3     4  |   6     3  |   7     6  |   4
    7     AB_Improved    4  |   6     5  |   5     8  |   2     4  |   6
--------------------------------------------------------------------------
           Win Rate:      65.7%        70.0%        72.9%        70.0%
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As it can be seen **H1** performed quite well, as it aggressively tries to minimize opponent's available moves (hence the factor 2). In fact, **H1** is very similar to AB_Improved, but is more aggressive because of the factor 2. Hence compared to AB_Improved, **H1** has been slightly yet not significantly more successful against the other opponents.

On the other hand, **H1** vs. AB_Improved provided mixed results. In certain cases, both were equally successful (5-5), in certain cases **H1** had more wins, in certain cases, AB_Improved.

One can also observe that **H2** performs quite well against AB_Improved. This is probably due to the fact that it is actually a simpler heuristic than AB_Improved (and **H1**), which allows the search to go deeper.

Table 1 shows **H3** does not perform well against AB_Improved. As it is same heuristic with AB_Center, the expectation would have been 50%-50% with AB_Center. Although they are close, **H3** is slightly better.

Overall, **H2** seems to be the best heuristic, as it

1) performs better on average and
2) performs better against AB_Improved, as it allows a deeper search