

## Heuristic Analysis

In my comparison I used the following heuristics:

- (1) minimize distance from the center of the board
- (2) minimize distance between players
- (3)  $\#my\_moves - 3 \#opponent\_moves$

First function promotes moves with the smallest distance from the center (score =  $1/(\text{distance from the center})$ ), the rationale behind it is that the player will always have more moves around center (not constrained by the board borders). Second heuristic assumes that the player should stay close to the opponent following the rule – ‘keep your friends close but your enemies closer’, and analyzing the chess knight like move I realized that actually this strategy could work. Third score promotes moves that limit opponent’s number of legal moves. This is a modified heuristic of AB\_Improved player’s strategy.

My agent played 100 games with each player (num\_matches =100). 100 provides much better statistics than default 5 matches per agent. The final statistics are as follows:

Tab. 1

Match	Opponent	AB_Improved	Ab_Custom	AB_Custom_2	AB_Custom_3
1	Random	78.5%	79.0%	83.5%	82.5%
2	MM_Open	72.5%	66.5%	69.0%	73.0%
3	MM_Center	90.0%	86.5%	90.0%	89.0%
4	MM_Improved	74.0%	66.5%	71.0%	72.0%
Win Rate Against MM players		<b>78.8%</b>	<b>73.2%</b>	<b>76.7%</b>	<b>78.0%</b>
5	AB_Open	56.0%	50.5%	44.5%	54.0%
6	AB_Center	53.5%	50.5%	47.0%	60.0%
7	AB_Improved	47.5%	46.0%	41.5%	52.5%
Win Rate Against AB players		<b>52.3%</b>	<b>49.0%</b>	<b>44.3%</b>	<b>55.5%</b>
Total Win Rate		<b>67.4%</b>	<b>63.6%</b>	<b>63.8%</b>	<b>69.0%</b>

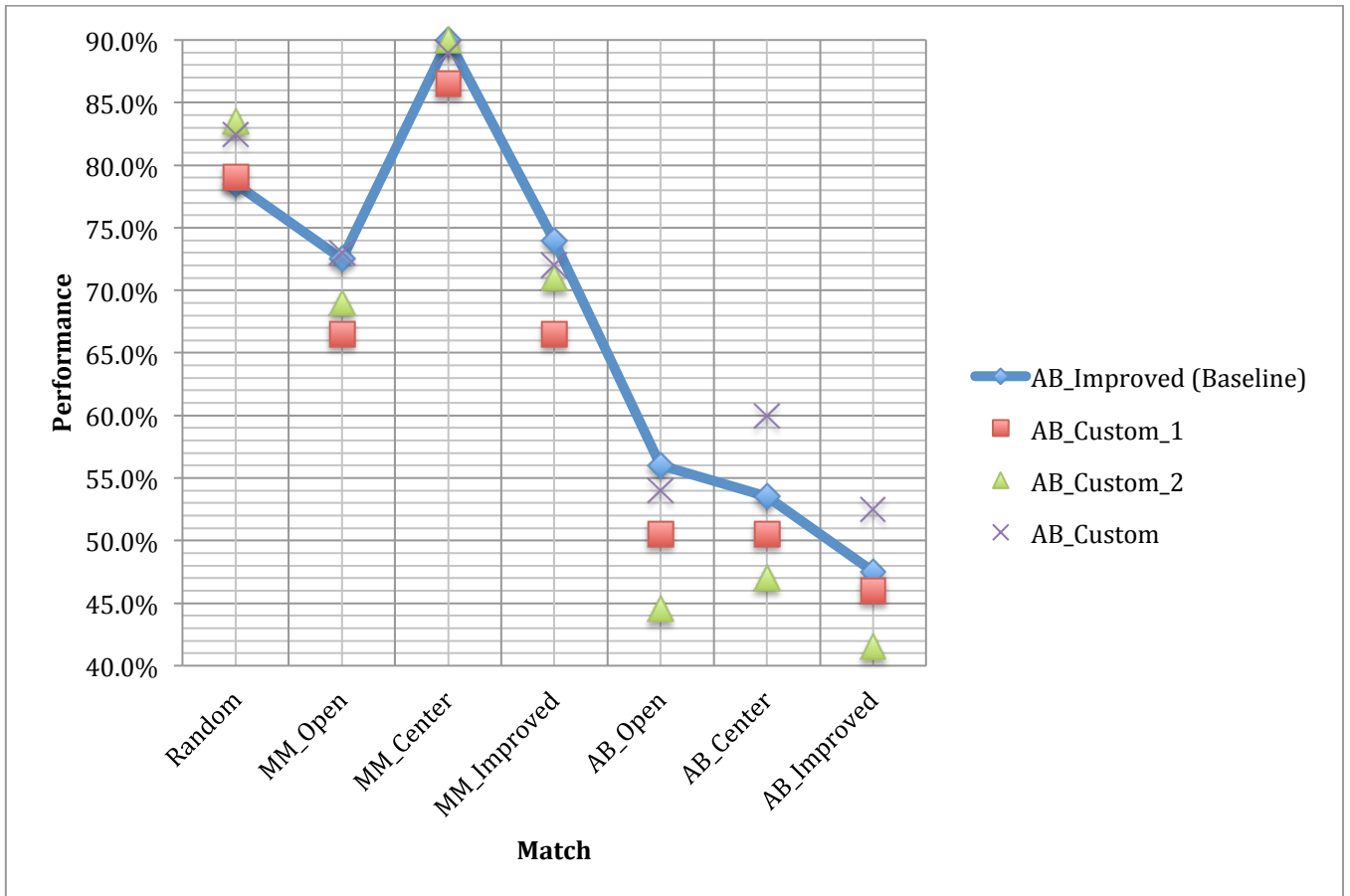
In general all three heuristics performed better than MM players (blue rows in Tab.1) however, my agent’s results are below the baseline (Fig. 1), meaning no real performance improvement (win rate >70%).

In comparison with AB opponents (green rows in Tab. 1), only the third evaluation function won more often than the opponent. Additionally its overall performance against AB agents increased around 3% in comparison with the baseline (55.5% vs. 52.3%).

Interestingly, AB\_Center opponent used the opposite strategy to the first heuristic i.e. stay close to the border. The result is close to tie, meaning that the position in respect to the center of the board doesn’t influence the result of the game significantly.

There was around 150 timeouts during the tournament, which is probably due to more complex algorithms of evaluation function 1 and 2 whose calculation of the position in relation the center or the opponent requires more time. That is another reason why the evaluation function should have relatively simple formula, so it can evaluate the score in time given for the turn.

Given the above analysis, heuristic 3 seems a good candidate for an improved evaluation function. It has a simple structure similar to the opponent's Improved Score ( $\text{my\_moves} - \# \text{opponent\_moves}$ ). However, the factor 3 before  $\# \text{opponent\_moves}$  makes our player more aggressive, trying to chase the opponent and block its moves. This strategy seems working pretty well, as the win rate against AB\_Improved increased around 5% (55.2% vs. 47.5% of the baseline). It also showed overall increase in win rate of around 1.6% (69.0% vs. 67.4% of the baseline). It has a simple structure, which allows quick calculation, and avoids timeout.



*Fig. 1. Performance per Match*