

Heuristics analysis for isolation game

Against the **Improved** heuristic function, we developed 3 alternative heuristic functions with the bellow formulas:

Formula 1: $\#my_moves * \#my_2nd_moves - \#opp_moves * \#opp_2nd_moves$

A variation of the Improved score. It calculates the difference of the number of moves weighted with the number of the next level moves.

Formula 2: $5 * \#my_moves - \#opp_moves$

A naive variation of the Improved score. It weights the number of the players moves with the factor 5. The factor was tuned with grid searching the formula $x * \#my_moves - y * \#opp_moves$.

Formula 3: $\#my_moves - game_state_factor * \#my_corner_moves - (\#opp_moves - game_state_factor * \#opp_corner_moves)$

Gives penalty to moves that are in the four corners of the board. The penalty is increasing while the game is running as it is worse to be in the corner in the late game.

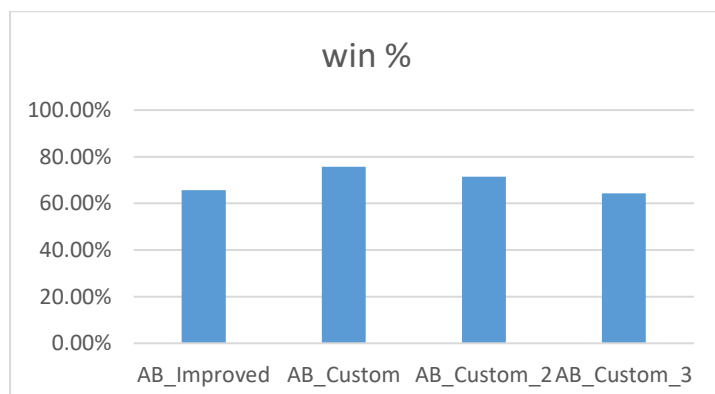
The above heuristics were implemented as custom_score, custom_score_2, custom_score_3 respectively in the game_agent.py module.

The algorithms were tested through the tournament.py module on a Win 10 Dell i7 2.7GHz, 16GB RAM, with results shown in the following grid and chart

Table 1 heuristic scores

Opponent	AB_Improved		AB_Custom		AB_Custom_2		AB_Custom_3	
	Won	Lost	Won	Lost	Won	Lost	Won	Lost
Random	9	1	9	1	10	0	10	0
MM_Open	5	5	9	1	7	3	5	5
MM_Center	9	1	9	1	10	0	9	1
MM_Improved	8	2	8	2	9	1	6	4
AB_Open	4	6	6	4	5	5	6	4
AB_Center	6	4	6	4	4	6	5	5
AB_Improved	5	5	6	4	5	5	4	6
Win Rate	65.70%		75.70%		71.40%		64.30%	
Std Deviation	2.070		1.51		2.545		2.225	

Table 2 Heuristic scores



Heuristics Evaluation/Comparison

The Formula 1 performs better. All the heuristics are quite simple to implement. The Formulas 2 and 3 need one level of iteration to complete calculations, the Formula 1 needs 2 levels of iteration. So, it is more time consuming.

So, I pick the Formula 1 which has the best winning score despite its time complexity. It also has much more stability than the alternatives: winning the Minimax players with 90% and the 60% of the AlphaBeta players with the same ratio (and its winning score has the less standard deviation).

Table 3Heuristic comparison

	Winning score	Time to complete	Ease of implementation	Stability/STDV
formula 1	75.70%	2 level iteration	Simple	1.510
formula 2	71.40%	1 level iteration	very simple	2.545
formula 3	64.30%	1 level iteration	little complex	2.225

*As alternative and in case of less capable hardware I could pick the formula 2 which has also quite good winning score but lesser time complexity.