

Isolation game heuristic analysis

Heuristics

For the Isolation game agent project by [Artificial Intelligence Engineer Nanodegree](#) I have experimented with following heuristics (score calculations):

- [AB_Custom] Number of moves for player and his opponent from the current position. The more moves one player has, the better his chances to win. Let's call it a **basic** heuristic.
- [AB_Custom_2] **Basic** heuristic plus a number of next moves that points to the **same position on the board** for a player and his opponent. The idea – a player can move onto position that his opponent could reach too. Consequently a player reduces the number of moves of his opponent. I added this improvement with a weight, which I found in an empirical way.
- [AB_Custom_3] **Basis** heuristic plus **positional advantage**. Positional advantage in my case is a **Manhattan distance** from the current position to the center of the board. I added this improvement with a weight, which I found in an empirical way.

Experiments

I ran a tournament to check, which of the heuristics performs better, and to see, whether one of those could beat AB_Improved agent. To get a better statistic I ran a tournament 3 times.

Results

First run

Match #	Opponent	AB_Improved		AB_Custom		AB_Custom_2		AB_Custom_3	
		W	L	W	L	W	L	W	L
1	Random	9	1	10	0	8	2	9	1
2	MM_Open	5	5	8	2	8	2	8	2
3	MM_Center	8	2	8	2	8	2	10	0
4	MM_Improved	4	6	4	6	4	6	5	5
5	AB_Open	6	4	5	5	7	3	5	5
6	AB_Center	8	2	7	3	6	4	5	5
7	AB_Improved	4	6	5	5	4	6	4	6
Win Rate		62.9%		67.1%		64.3%		65.7%	

Playing Matches

Match #	Opponent	AB_Improved		AB_Custom		AB_Custom_2		AB_Custom_3	
		Won	Lost	Won	Lost	Won	Lost	Won	Lost
1	Random	9	1	10	0	8	2	9	1
2	MM_Open	5	5	8	2	8	2	8	2
3	MM_Center	8	2	8	2	8	2	10	0
4	MM_Improved	4	6	4	6	4	6	5	5
5	AB_Open	6	4	5	5	7	3	5	5
6	AB_Center	8	2	7	3	6	4	5	5
7	AB_Improved	4	6	5	5	4	6	4	6
Win Rate:		62.9%		67.1%		64.3%		65.7%	

Your ID search forfeited 164.0 games while there were still legal moves available to play.

Second run

Match #	Opponent	AB_Improved		AB_Custom		AB_Custom_2		AB_Custom_3	
		W	L	W	L	W	L	W	L
1	Random	8	2	6	4	7	3	9	1
2	MM_Open	7	3	4	6	6	4	8	2
3	MM_Center	7	3	8	2	10	0	9	1
4	MM_Improved	7	3	6	4	5	5	6	4
5	AB_Open	7	3	3	7	6	4	3	7
6	AB_Center	4	6	5	5	8	2	5	5
7	AB_Improved	5	5	3	7	7	3	7	3
Win Rate		64.3%		50.0%		70.0%		67.1%	

 Playing Matches

Match #	Opponent	AB_Improved		AB_Custom		AB_Custom_2		AB_Custom_3	
		Won	Lost	Won	Lost	Won	Lost	Won	Lost
1	Random	8	2	6	4	7	3	9	1
2	MM_Open	7	3	4	6	6	4	8	2
3	MM_Center	7	3	8	2	10	0	9	1
4	MM_Improved	7	3	6	4	5	5	6	4
5	AB_Open	7	3	3	7	6	4	3	7
6	AB_Center	4	6	5	5	8	2	5	5
7	AB_Improved	5	5	3	7	7	3	7	3

Win Rate:		64.3%		50.0%		70.0%		67.1%	

Your ID search forfeited 167.0 games while there were still legal moves available to play.

Third run

Match #	Opponent	AB_Improved		AB_Custom		AB_Custom_2		AB_Custom_3	
		W	L	W	L	W	L	W	L
1	Random	10	0	7	3	8	2	7	3
2	MM_Open	9	1	7	3	8	2	7	3
3	MM_Center	7	3	8	2	10	0	7	3
4	MM_Improved	7	3	5	5	7	3	6	4
5	AB_Open	4	6	5	5	6	4	5	5
6	AB_Center	5	5	7	3	6	4	8	2
7	AB_Improved	5	5	5	5	3	7	5	5
Win Rate		67.1%		62.9%		68.6%		64.3%	

 Playing Matches

Match #	Opponent	AB_Improved		AB_Custom		AB_Custom_2		AB_Custom_3	
		Won	Lost	Won	Lost	Won	Lost	Won	Lost
1	Random	10	0	7	3	8	2	7	3
2	MM_Open	9	1	7	3	8	2	7	3
3	MM_Center	7	3	8	2	10	0	7	3
4	MM_Improved	7	3	5	5	7	3	6	4
5	AB_Open	4	6	5	5	6	4	5	5
6	AB_Center	5	5	7	3	6	4	8	2
7	AB_Improved	5	5	5	5	3	7	5	5
Win Rate:		67.1%		62.9%		68.6%		64.3%	

Your ID search forfeited 160.0 games while there were still legal moves available to play.

Resume

I would recommend to use **AB_Custom_2** heuristic because of the following factors:

- It translates the reduction of possible opponent moves into advantage of the game agent.
- Because of that we reduce the search space for future moves too, which allows us to go deeper in a search tree in the same amount of time.
- Among 3 runs, its average winning rate was always greater than ones, achieved by AB_Improved heuristic.

AB_Custom_2 adds sophistication and required more computations. Though this works in a our case with 7x7 board and L-shape moves better than other introduced heuristics, I suppose, this brings significant disadvantage in more complex games.