AIND Project 2: Isolation Game Agent / Josef Schodl / 09/2017

Heuristic Analysis

Heuristic descriptions

There are three custom evaluation heuristic functions competing against the AB_Improved agent:

- **Heuristic 1 – 'AB_Custom'**
  This heuristic function returns the difference between the current players possible moves and the opponent moves multiplied by a factor that is calculated based on the ratio of remaining blank spaces and maximum blank spaces, in order to set higher priority to the opening move, resulting in potential advantage in the end game.

- **Heuristic 2 – 'AB_Custom2'**
  This modified Heuristic 1 also returns the difference between the current players possible moves and the opponent moves, but with higher weighted opponent moves as they are multiplied by 2 and multiplied by the square of the distance from the center for the current player position. This way the distance from the board affects the result as a centered position usually offers a higher number of possible moves later on.

- **Heuristic 3 – 'AB_Custom3'**
  This heuristic returns the difference of the possible moves and increases priority of moves to the center of the board. Beyond that, the potential next moves are also considered. Though this results in higher numbers of calculations, this seems still more efficient than increasing depth.

Set of test runs

A set of three tournaments shows the following results:

Match #	Opponent	AB_Improved		AB_Custom		AB_Custom_2		AB_Custom_3	
		Won	Lost	Won	Lost	Won	Lost	Won	Lost
1	Random	9	1	7	3	10	0	8	2
2	MM_Open	5	5	6	4	4	6	9	1
3	MM_Center	9	1	10	0	7	3	9	1
4	MM_Improved	8	2	5	5	5	5	8	2
5	AB_Open	5	5	4	6	5	5	6	4
6	AB_Center	5	5	3	7	6	4	5	5
7	AB_Improved	5	5	4	6	5	5	7	3
	Win Rate:	65.7%		55.7%		60.0%		74.3%	

Match #	Opponent	AB_Improved		AB_Custom		AB_Custom_2		AB_Custom_3	
		Won	Lost	Won	Lost	Won	Lost	Won	Lost
1	Random	10	0	9	1	8	2	9	1
2	MM_Open	5	5	6	4	6	4	5	5
3	MM_Center	8	2	10	0	9	1	9	1
4	MM_Improved	6	4	5	5	7	3	8	2
5	AB_Open	3	7	6	4	5	5	6	4
6	AB_Center	6	4	5	5	5	5	5	5
7	AB_Improved	5	5	3	7	5	5	5	5
	Win Rate:	61.4%		62.9%		64.3%		67.1%	

Match #	Opponent	AB_Improved		AB_Custom		AB_Custom_2		AB_Custom_3	
		Won	Lost	Won	Lost	Won	Lost	Won	Lost
1	Random	8	2	9	1	8	2	10	0
2	MM_Open	4	6	5	5	7	3	7	3
3	MM_Center	8	2	9	1	9	1	9	1
4	MM_Improved	4	6	5	5	6	4	7	3
5	AB_Open	5	5	5	5	5	5	5	5
6	AB_Center	4	6	4	6	6	4	6	4
7	AB_Improved	5	5	4	6	6	4	4	6
	Win Rate:	54.3%		58.6%		67.1%		68.6%	

Recommendation of heuristic

The results of the test tournaments are showing best results for Heuristic 3 – AB_Custom3 and is therefore the best recommendation out of the three tested ones. The decision is taken for the following reasons:

- AB_Custom3 is more intensive calculations and therefore takes more CPU time per iteration, hence depth reached is lower in the available time, but considering potential future moves obviously pays off with better quality in results.
- Though AB_Custom3 is more complex in calculations than the other versions it is still based on simple calculations that can be performed in acceptable time on any CPU, and therefore obviously still goes deep enough to not worsen results due to too shallow depth.
- In test game tournament results AB_Custom3 outperforms all other versions of heuristics in all test runs, from 1.5% to 8.6% which is quite significant.
- Even more significant is the result comparison with AB_Improved, which is from 5.7% to 14.3% in the test runs.