Heuristic Analysis

The book “Artificial Intelligence: A Modern Approach” gives three tips to build an evaluation function. They are:

1. The evaluation function should order the terminal states in the same way as the true utility function.
2. The computation must not take too long.
3. The evaluation function should be strongly correlated with the actual chances of winning for the terminal states.

So, looking at the Isolation game context, we have to use something to measure the utility of the given state that should be simple and fast. The basic way to evaluate a state is using the quantity of the available moves. The available moves are somehow connected to the position on the board. The center of the board we have 8 available moves. As we get close to the wall we have less options. And finally, the corners are the worst position.

Evaluation Function 1

The function was given by:

$$f = 3 * sum(weights\ of\ own\ moves) - sum(weights\ of\ the\ opponent\ moves)$$

The weights is defined on the following table.

2	3	4	4	4	3	2
3	4	6	6	6	4	3
4	6	8	8	8	6	4
4	6	8	8	8	6	4
4	6	8	8	8	6	4
3	4	6	6	6	4	3
2	3	4	4	4	3	2

Table 1 - Board weights

This is a weighted linear function. This approach is similar to the “Custom Score 3”, however this one uses weights that gives some positional information about the board.

Evaluation Function 2

The function was given by:

$$f = own\_moves - 3 * opponent\_moves$$

This function works in an offensive way. It will be chasing the opponent trying to minimize his available spaces.
Blindly chasing the opponent isn't a good strategy, since the agent takes less consideration about own available moves.

Evaluation Function 3

The function was given by:

$$f = 3 * own\_moves - opponent\_moves$$

This function works in a defensive way. It will be moving in order to maximize its own available moves.

Results

I ran the tournament 5 times, so:

- the Evaluation Function was able to achieve over 70% winning rate on all tournaments compared to the "AB_Improved" that achieved on 4 tournaments;
- the Evaluation Function 2 seems to perform better than the Evaluation Function 3, since the perform was better in 4 tournaments.

It seems that working exclusively on a defensive strategy is better than working exclusively on an offensive way. And adding more information about the board, the agent might slightly perform better.

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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     9  |   1     9  |   1    10  |   0
    2        MM_Open      6  |   4     9  |   1     5  |   5     6  |   4
    3       MM_Center     8  |   2    10  |   0    10  |   0     7  |   3
    4     MM_Improved     9  |   1     7  |   3     6  |   4     6  |   4
    5        AB_Open      6  |   4     6  |   4     5  |   5     5  |   5
    6       AB_Center     7  |   3     6  |   4     5  |   5     6  |   4
    7     AB_Improved     6  |   4     3  |   7     4  |   6     5  |   5
--------------------------------------------------------------------------
           Win Rate:      74.3%        71.4%        62.9%        64.3%
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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	9	1	10	0	10	0	10	0
2	MM_Open	6	4	8	2	9	1	9	1
3	MM_Center	10	0	8	2	9	1	10	0
4	MM_Improved	8	2	6	4	6	4	6	4
5	AB_Open	5	5	7	3	6	4	5	5
6	AB_Center	7	3	5	5	4	6	7	3
7	AB_Improved	5	5	6	4	5	5	5	5
	Win Rate:	71.4%		71.4%		70.0%		74.3%	

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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	9	1	9	1	8	2
2	MM_Open	8	2	7	3	6	4	10	0
3	MM_Center	6	4	9	1	6	4	9	1
4	MM_Improved	8	2	8	2	6	4	6	4
5	AB_Open	4	6	6	4	5	5	4	6
6	AB_Center	5	5	6	4	8	2	4	6
7	AB_Improved	4	6	7	3	6	4	4	6
	Win Rate:	64.3%		74.3%		65.7%		64.3%	

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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	9	1	10	0	9	1	7	3
2	MM_Open	8	2	9	1	7	3	8	2
3	MM_Center	8	2	7	3	8	2	8	2
4	MM_Improved	8	2	8	2	6	4	8	2
5	AB_Open	5	5	5	5	4	6	6	4
6	AB_Center	7	3	6	4	5	5	7	3
7	AB_Improved	6	4	6	4	5	5	4	6
	Win Rate:	72.9%		72.9%		62.9%		68.6%	

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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	9	1	10	0	10	0	10	0
2	MM_Open	9	1	9	1	8	2	9	1
3	MM_Center	10	0	8	2	8	2	8	2
4	MM_Improved	5	5	7	3	8	2	8	2
5	AB_Open	5	5	6	4	7	3	5	5
6	AB_Center	6	4	8	2	4	6	7	3
7	AB_Improved	5	5	4	6	5	5	6	4
	Win Rate:	70.0%		74.3%		71.4%		75.7%	