

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:

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

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 “AB_Improved”, however this one uses weights that gives some positional information about the board.

Evaluation Function 2

The function was given by:

$$f = 3 * \text{own_moves} - \text{opponent_moves}$$

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

Evaluation Function 3

The function was given by:

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    if move_count >= 12
         $f = -2 * \text{opponent\_moves}$ 
    else
 $f = 2 * (\text{own\_moves} - \text{common\_moves}) + \text{common\_moves} - 3 * (\text{opponent\_moves} - \text{common\_moves})$ 

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While working on the evaluation functions, I noticed that following a single strategy doesn't work. So, I tried to mix up the strategies.

This function works somehow offensive and defensive in the beginning of the game and after 12 moves, it will move more aggressively.

Results

I ran the tournament 6 times, so:

- the "AB_Custom" was able to achieve over 70% winning rate on 5 of 6 tournaments compared to the "AB_Improved" that achieved only on 2 tournaments;
- the "AB_Custom_2" seems to perform better than the "AB_Custom_3", since the perform was better in 4 of 6 tournaments.

Even though AB_Custom performed better than AB_Improved, I still would recommend the AB_Improved because:

- AB_Improved goes deeper because it performs simple operations allowing it to go deeper.
- AB_Custom might performs better than AB_Improved because it might go as deep as the AB_Improved, however defining a weight table isn't an easy task and changing the board size would require a redefinition of the weight table.

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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	6	4	9	1	9	1	10	0
2	MM_Open	6	4	8	2	6	4	7	3
3	MM_Center	8	2	9	1	7	3	8	2
4	MM_Improved	5	5	9	1	8	2	9	1
5	AB_Open	5	5	6	4	5	5	5	5
6	AB_Center	5	5	6	4	6	4	5	5
7	AB_Improved	7	3	6	4	5	5	6	4
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Win Rate:		60.0%		75.7%		65.7%		71.4%	

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

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	10	0	10	0	9	1
2	MM_Open	7	3	7	3	8	2	8	2
3	MM_Center	8	2	10	0	8	2	9	1
4	MM_Improved	7	3	9	1	5	5	3	7
5	AB_Open	5	5	5	5	6	4	5	5
6	AB_Center	7	3	8	2	6	4	7	3
7	AB_Improved	4	6	2	8	5	5	4	6
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Win Rate:		68.6%		72.9%		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	9	1	10	0	10	0	8	2
2	MM_Open	10	0	8	2	7	3	7	3
3	MM_Center	9	1	10	0	8	2	9	1
4	MM_Improved	8	2	8	2	7	3	8	2
5	AB_Open	4	6	6	4	8	2	6	4
6	AB_Center	6	4	6	4	6	4	5	5
7	AB_Improved	5	5	5	5	6	4	7	3
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Win Rate:		72.9%		75.7%		74.3%		71.4%	

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	8	2	10	0	8	2
2	MM_Open	8	2	5	5	7	3	7	3
3	MM_Center	10	0	9	1	9	1	8	2
4	MM_Improved	5	5	9	1	6	4	7	3
5	AB_Open	4	6	6	4	4	6	4	6
6	AB_Center	5	5	5	5	6	4	5	5
7	AB_Improved	7	3	4	6	5	5	3	7
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Win Rate:		68.6%		65.7%		67.1%		60.0%	

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	9	1	10	0	9	1
2	MM_Open	9	1	8	2	6	4	7	3
3	MM_Center	8	2	8	2	10	0	9	1
4	MM_Improved	7	3	10	0	8	2	8	2
5	AB_Open	7	3	3	7	7	3	5	5
6	AB_Center	6	4	5	5	6	4	6	4
7	AB_Improved	5	5	6	4	5	5	3	7
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Win Rate:		74.3%		70.0%		74.3%		67.1%	