

# Analysis of heuristics for a special variant of the isolation board game

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## Synopsis

I tried a lot of ideas, played pen and paper games, searched for patterns - and the following strategies turned out to perform best.

### Custom Score: Looking ahead and blocking during end game

My first and best strategy takes the current legal moves and expands each of them by applying all valid move directions to it. The resulting list is then filtered by checking if these are legal moves. The same is done with the opponent moves, so I get two counts of look ahead moves  $L_{own}$  and  $L_{opp}$ .

Then I calculate the moves that would block the opponent's moves and do the same for the moves that would block the player using  $L_{opp}$ , so I get two more counts of blocking moves  $B_{own}$  and  $B_{opp}$ .

Because blocking does makes sense especially during the end game, I calculate a board occupation factor  $O_b$ .

The score value  $S_b$  of the current board is then calculated like this:

$$S_b = (L_{own} - L_{opp} + O_b(B_{own} - B_{opp})) \quad (1)$$

### Custom Score 2: Counting legal moves and blocking during the end game

Like the improved base heuristic I simply count the players and the opponents moves and get two counts  $M_{own}$  and  $M_{opp}$ . Then I calculate the moves that would block the opponent's moves and get  $B_{own}$ . And like before, because blocking does makes sense especially during the end game, I calculate a board occupation factor  $O_b$ .

The score value  $S_{b_2}$  of the current board is then calculated like this:

$$S_{b_2} = (M_{own} - M_{opp} + O_b B_{own}) \quad (2)$$

### Custom Score 3: Counting legal moves and moving towards the center during end game

Like before I count the players and the opponents moves and get two counts  $M_{own}$  and  $M_{opp}$ . Then I take the player position and calculate the distance to the center  $C_{own}$ . I do the same for the opponent and get  $C_{opp}$ . When I played pen and paper games I found out, that it is better to occupy the edge position during the beginning of the game and the center during end game. So I calculate the board occupation factor  $O_b$  and take that into account.

The score value  $S_{b_3}$  of the current board is then calculated like this:

$$S_{b_3} = (M_{own} - M_{opp} + \frac{1}{O_b}(C_{own} - C_{opp})) \quad (3)$$

## Results

Table 1 shows the results of the first tournament with 5 games against each opponent. The results of *AB Custom* and *AB Custom 3* are very similar.

#	Opponent	AB Improved		AB Custom		AB Custom 2		AB Custom 3	
		Won	Lost	Won	Lost	Won	Lost	Won	Lost
1	Random	7	3	9	1	9	1	9	1
2	MM Open	6	4	7	3	5	5	7	3
3	MM Center	9	1	8	2	9	1	10	0
4	MM Improved	8	2	6	4	6	4	7	3
5	AB Open	5	5	5	5	5	5	6	4
6	AB Center	5	5	7	3	6	4	5	5
7	AB Improved	6	4	6	4	6	4	4	6
Win Rate:		65.7%		68.6%		65.7%		68.6%	

Table 1: Tournament with 5 games against each opponent

So I ran another tournament with 10 games against each opponent. Table 2 shows the results

#	Opponent	AB Improved		AB Custom		AB Custom 2		AB Custom 3	
		Won	Lost	Won	Lost	Won	Lost	Won	Lost
1	Random	13	7	18	2	18	2	15	5
2	MM Open	13	7	13	7	11	9	13	7
3	MM Center	15	5	17	3	18	2	15	5
4	MM Improved	15	5	13	7	14	6	16	4
5	AB Open	11	9	13	7	10	10	11	9
6	AB Center	11	9	13	7	12	8	15	5
7	AB Improved	8	12	12	8	7	13	11	9
Win Rate:		61.4%		70.7%		64.3%		68.6%	

Table 2: Tournament with 10 games against each opponent

## Conclusion

I decided to go with the *Looking ahead and blocking during end game* because it is the most sophisticated heuristic and also show slightly better results than the other two.

In general - instead of guessing a good heuristic, today the score evaluation function could also be a deep neural network that learns from game plays against the basic heuristics and different versions of itself in a re-inforced manner.