

## Isolation Game Heuristic Analysis

*by Daniel Legorreta*

For this project, I experimented with 4 heuristic.

1. Manhattan Distance or City Block Distance.
2. Percentage of Board Fill + Near Board Limits.
3. Forecast of Move.
4. Forecast of Move + Penalization Present Position + Penalization of Legal Moves.

Previously, I tested others heuristics:

- Penalization Present Position
- Penalization of Legal Moves

These were combined in the heuristic 4.

In summary, the heuristic from 1 to 3 do the following:

- **Manhattan Distance or City Block Distance:** It is implemented in the Manhattan Distance from player position to center board, it is similar to the function “center\_score” of script sample\_player.
- **Percentage of Board Fill + Near Board Limits:** It is estimated the percentage of quadrants missing by movement and they are penalized by the nearness of the border in the board.
- **Forecast of Move:** For each legal movement the future scenario is estimated and for each of them is added the number of possible legal movements.
- The last heuristic, I will explain its definition.

The heuristic chosen is **Forecast Move + Actual Position + Penalization in Legal Position** represents 3 aspects:

1. Number of possible future Legal Movements
2. Penalty for actual position
3. Penalty of the legal movements by quadrant.

The point 2 and 3 depend on number possible movements for each quadrant, the next table present the number of the possible movements:

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 a: Possible movements in each quadrant.*

The above table shows the number possible movements, the center is the area with greatest number

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possible movements and the border is the least amount. The future possible movements are chosen by the function:

**agent\_score**

**for move in Legal\_Movements:**

**game\_future=game.forecast\_move(move)**

**agent\_score=agent\_score+len(game\_future.legal\_movements(player))**

The penalty of the legal movements by quadrant are done by this loop:

**agent\_moves= all legal movements**

**for move in agent\_moves:**

**if Near\_to\_Limits(move,Center):**

**Local\_agent\_score+=10**

**elif Near\_to\_Limits(move,Values\_six):**

**Local\_agent\_score+=7**

**elif Near\_to\_Limits(move,Values\_four):**

**Local\_agent\_score+=5**

**elif Near\_to\_Limits(move,Values\_three):**

**Local\_agent\_score-=5**

**elif Near\_to\_Limits(move,Corner):**

**Local\_agent\_score-=10**

It is rewarded the nearness of the center and penalized the nearness with the border. The results of the 4 tournaments were:

Opponent	AB_Improved		Manhattan Distance		Heuristic 3		Heuristic 4	
	Won	Lost	Won	Lost	Won	Lost	Won	Lost
Random	32	8	35	5	34	6	32	8
MM_Open	27	13	22	18	20	20	29	11
MM_Center	33	7	33	7	31	9	34	6
MM_Improved	22	18	18	22	22	18	22	18
AB_Open	24	16	20	20	28	12	24	16
AB_Center	15	25	19	21	20	20	25	15
AB_Improved	22	18	22	18	19	21	23	17

Table b: Results of the 4 tournaments, 10 games each.

Opponent	AB_Improved	Manhattan Distance	Heuristic 3	Heuristic 4
Random	0.8	0.875	0.85	0.8
MM_Open	0.675	0.55	0.5	0.725
MM_Center	0.825	0.825	0.775	0.85
MM_Improved	0.55	0.45	0.55	0.55
AB_Open	0.6	0.5	0.7	0.6
AB_Center	0.375	0.475	0.5	0.625
AB_Improved	0.55	0.55	0.475	0.575
Total	0.625	0.6035714286	0.6214285714	0.675

Table c: Percentage of game won

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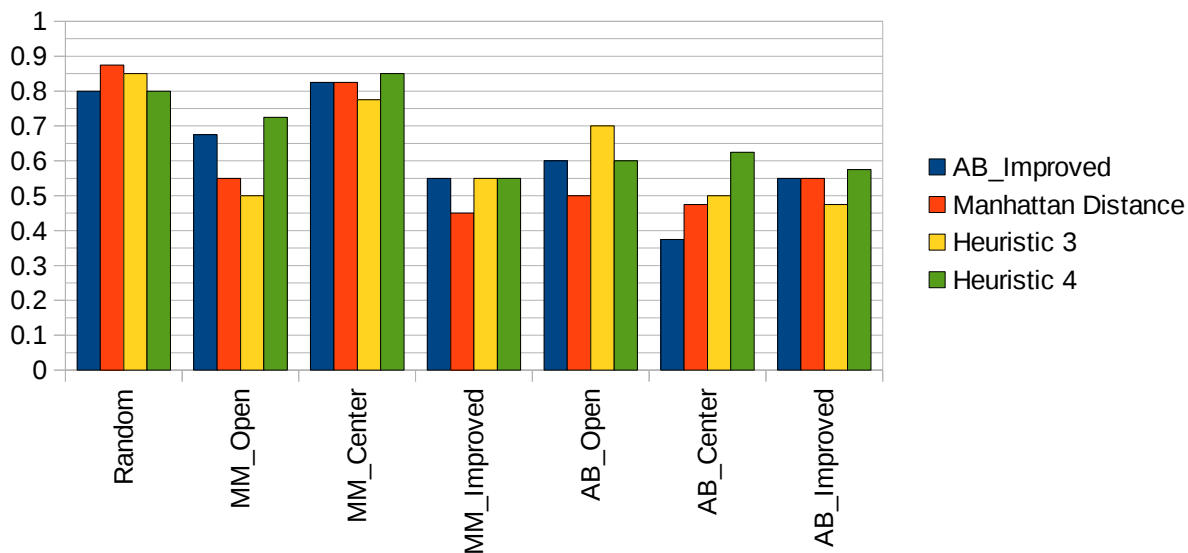


Table d: The bar represent the percentage of the games won.

The heuristic 4 won in percentage almost all games versus all opponents, it were the best heuristic almost against all opponents. This observe with the bar of colour green.

The global percentage for heuristic 4 is **68%**. The next table show the values for every heuristics.

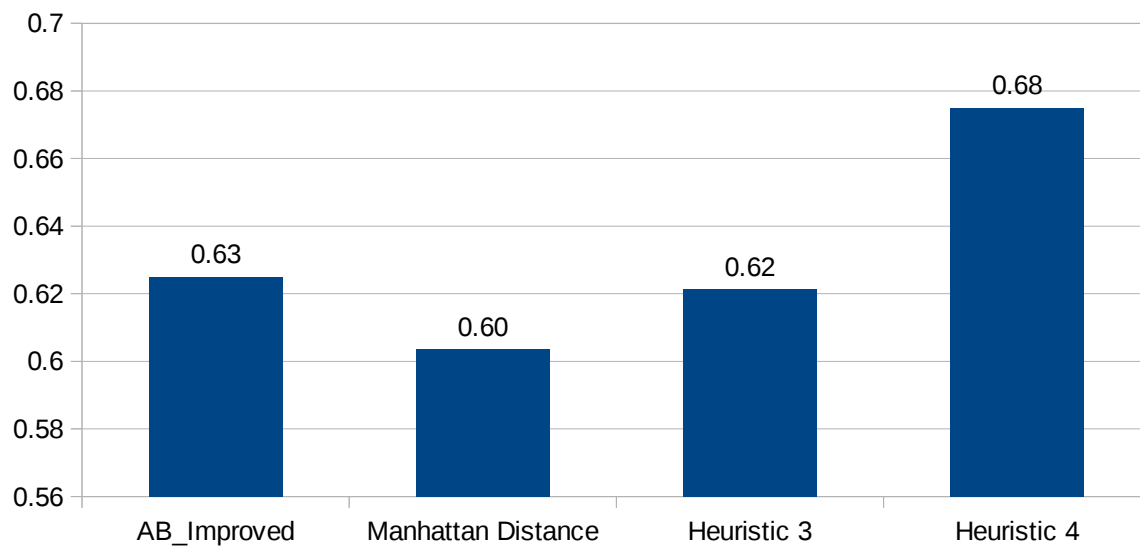


Table e: Global Percentage

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### ***Brief analysis on the evaluation function and some recommendations.***

As mentioned earlier, the heuristic 4 is a extension of the heuristic 3. This heuristic considers three aspects: number of possible future legal movements, penalty for actual position, and penalty of the legal movements by quadrant.

I thought that the win possibility is related with the greater number of available movements, while our opponent has fewer movements. The heuristic choice considered the distribution of the possible movements in three moments and amount the movements.

The heuristic “number of possible future legal movements” or heuristic 3, allows, in some way, to consider an advance in the play. Its efficient in the games were good, the general percentage the won games is 62% and it only has problems with AB\_Improved.

By adding the penalties for the position, it makes the evaluation function more complex but allows to favor certain zones of the board that allow to have more possible movements and penalize others. Furthermore, considering 3 game moments (as mentioned earlier). Adding this contributed a further 6% on efficiently rating in triumphs. The general percentage in the won games is the 68%.

On the other hand, this heuristic has a minimum 55% percentage of triumphs, compared to 47% that has the heuristic 3. Considering the data in table b and considering as baseline the results of AB\_improved, we have the behavior of the Heuristics 3 and 4 is as follows:

It is observed in red color, against the opponent that the heuristics have less wins than AB\_improved. It is also observed that heuristics 4 behaves well or better against any opponent, which can not do heuristics 3.

Opponent	Heuristic 3	Heuristic 4
	Won	Won
Random	2	0
MM_Open	-7	2
MM_Center	-2	1
MM_Improved	0	0
AB_Open	4	0
AB_Center	5	10
AB_Improved	-3	1

My recommendation is to think of trying to answer the question "what probability do I have to win according to my position", but considering that the probability of winning is related to the possibility of having more moves available. So asking the question "what does it depend on to have as many moves as possible" implies that the position, the nature of the board and the moments considered to evaluate are important.

The heuristic 3 consider a part and the heuristic “distance Manhattan” considers the effects of the position, but not of the nature of the board. With heuristic 4, I combined the important aspects to win according to the question I began with.