

Heuristic Analysis for Isolation AI Agent

Several heuristics have been tried for this project. The best ones are described below.

Heuristic 01

```
player_moves/len(game.get_blank_spaces())
```

This heuristic is similar to the “Open” heuristics, but the division of the player moves by the number of blank spaces left, highly increased the performance of this heuristic.

Heuristic 02

```
return 100 * player_moves/len(game.get_blank_spaces()) - num_positions_filled(game, player)
```

This heuristics will make the agent prefer positions away from the borders and away from positions already occupied in the row and column of the position being evaluated, also giving priority for positions where the player has more moves.

Heuristic 03

```
return - opponent_moves/blank - num_positions_filled(game, player) + player_moves/blank
```

This heuristic was created to try to increase the accuracy of heuristics 02, but it was approximately 1% worst than heuristic 01.

Heuristic 04

```
return 100 * player_moves/len(game.get_blank_spaces()) + 3 *  
(game.get_player_location(player) in game.get_legal_moves(game.get_opponent(player)))
```

This heuristics will give priority to positions where the player has more moves and is a position that is achievable but the other player, trying to block his possible movements.

Performance of Agents

For the evaluation of the heuristics, it was been done 33 experiments, using as parameters:

- 5 matches against each opponent
- 150ms of time limit

The results are summarized in the Table 1 and Table 2. From the results, the heuristic AB_Custom was the one with the best absolute winning rate, winning 68.84% of the games, while the second best heuristics, won 67.33% of the games. The determination of the best heuristics, cannot be done by selecting the algorithm with more winnings alone. The mean and standard deviation of the matches from each experiment must also be considered. From Table 2, the mean and standard deviation of AB_Custom is 6.88 and 1.1, respectively, while the AB_Improved has a mean of 6.73 and standard deviation of 1.07.

	AB_Improved		AB_Open		AB_Custom		AB_Custom_2		AB_Custom_3		AB_Custom_4	
	Won	Lost	Won	Lost	Won	Lost	Won	Lost	Won	Lost	Won	Lost
Random	291	39	290	40	307	23	286	44	291	39	283	47
MM_Open	254	76	250	80	265	65	240	90	243	87	245	85
MM_Center	275	55	278	52	286	44	272	58	290	40	286	44
MM_Custom	235	95	213	117	249	81	212	118	222	108	211	119
MM_Custom_2	252	78	256	74	261	69	242	88	242	88	253	77
MM_Improved	235	95	228	102	251	79	208	122	215	115	227	103
AB_Open	187	143	156	174	181	149	163	167	136	194	142	188
AB_Center	193	137	176	154	188	142	171	159	149	181	143	187
AB_Custom	175	155	155	175	170	160	149	181	130	200	128	202
AB_Custom_2	190	140	176	154	178	152	164	166	154	176	142	188
AB_Improved	157	173	134	196	163	167	143	187	124	206	119	211
Total	2444	1186	2312	1318	2499	1131	2250	1380	2196	1434	2179	1451
Win Percentage	67.33%		63.69%		68.84%		61.98%		60.50%		60.03%	

Table 1. Absolute results from experiments

	AB_Improved		AB_Open		AB_Custom		AB_Custom_2		AB_Custom_3		AB_Custom_4	
	μ	σ	μ	σ	μ	σ	μ	σ	μ	σ	μ	σ
Random	8.82	0.94	8.79	0.91	9.30	0.83	8.67	1.15	8.82	0.90	8.58	1.05
MM_Open	7.70	0.97	7.58	1.18	8.03	1.11	7.27	1.16	7.36	1.20	7.42	1.21
MM_Center	8.33	0.84	8.42	1.07	8.67	1.20	8.24	1.02	8.79	0.73	8.67	0.91
MM_Custom	7.12	1.15	6.45	1.54	7.55	1.21	6.42	1.23	6.73	1.40	6.39	1.28
MM_Custom_2	7.64	0.98	7.76	1.07	7.91	0.96	7.33	1.15	7.33	1.34	7.67	1.09
MM_Improved	7.12	1.25	6.91	1.08	7.61	1.13	6.30	1.40	6.52	1.28	6.88	1.17
AB_Open	5.67	1.34	4.73	1.11	5.48	1.02	4.94	1.15	4.12	1.34	4.30	1.22
AB_Center	5.85	1.23	5.33	1.01	5.70	1.36	5.18	1.14	4.52	1.02	4.33	1.51
AB_Custom	5.30	1.11	4.70	1.14	5.15	1.10	4.52	1.02	3.94	1.23	3.88	0.98
AB_Custom_2	5.76	1.10	5.33	1.20	5.39	1.30	4.97	1.17	4.67	1.12	4.30	1.27
AB_Improved	4.76	0.82	4.06	1.04	4.94	0.89	4.33	1.01	3.76	1.18	3.61	1.10
Mean	6.73	1.07	6.37	1.12	6.88	1.10	6.20	1.14	6.05	1.16	6.00	1.16

Table 2. General statistics from experiments.

From the results, AB_Custom is slightly better than AB_Improved, but not by a large margin. The computational expense of calculating AB_Improved and AB_Custom are approximately the same, with AB_Custom also slightly better. For these reasons the AB_Custom heuristic is the recommend one.