AIND Heuristic Analysis

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Heuristic 1: Alternating Offensive-Defensive Strategy

This heuristic combines the strategies present in heuristic 2 and 3, alternating between an aggressive and a defensive policy. Assuming the maximum number of available blank spaces is 36, the heuristic adopts an aggressive policy until it exactly half the amount of cells, or 18, remain free. At this point, the algorithm switches strategy to a defensive heuristic.

$$\textbf{if } moves \geq 18: \; H_{off} \quad \textbf{else:} \quad H_{def}$$

Heuristic 2: Minimize Opponent Player Moves

The following heuristic is a naive implementation that operates on the difference between the tube roof moves available to the main player and the opponent. There is no bias, this simply is a baseline to optimize the next two heuristics.

$$H_{off} = 2 * L_{main} - L_{opp}$$

Heuristic 3: Maximize Main Player Moves

This heuristic uses an alpha factor of 2 to maximize the main player's number of moves, and simply subtracts the difference.

$$H_{def} = L_{main} - 2 * L_{opp}$$

Heuristic Performance Summary

Opponent	AB_Improved		AB_Heuristic1		AB_Heuristic2		AB_Heuristic3	
	Won	Lost	Won	Lost	Won	Lost	Won	Lost
Random	10	0	8	2	8	2	9	1
MM_Open	7	3	7	3	7	3	5	5
MM_Center	8	2	8	2	6	4	8	2
MM_Improved	7	3	7	3	7	3	5	5
AB_Open	4	6	6	4	5	5	3	7
AB_Center	8	2	7	3	6	4	4	6
AB_Improved	5	5	6	4	6	4	6	4
Win Rate	70.0%		70.0%		64.3%		57.1%	

The three implemented naive heuristics demonstrate a win rate equal to, or less than the AB_improved game agent. While the AB_improved algorithm demonstrated a win rate of 70%, heuristics 1, 2, and 3 respectively possessed an average win rate of 70.0%, 64.3%, and 57.1%. All four heuristics demonstrated the highest win rate, or best performance, against a **random** opponent. The AB_Heuristic1 possessed the second best performance against an MM_Center opponent, with a win rate of 80%, or 8 Win and 2 Losses. The AB_Heuristic1 performed worst against the AB_Improved and AB_Open opponents, with win rates of of 60%, only slightly better than chance. The AB_Heuristic2 demonstrated the second-best win rate against MM_Open and MM_Improved opponent, with a 70% win rate, or 7 Win, 3 Loss record, respectively. The AB_Heuristic2 performed worst against AB_Open with a win rate of only 50%. AB_Heuristic3 displayed a second best win rate against MM_center, with an 80% win rate, or 8 Wins to 2 Losses. AB_Heuristic3 performed worst against AB_open, with only 3 Wins and 7 Losses.

Additional Analysis

Overall, it appears that the three implemented heuristics all perform worse against AB_open, implying that a heuristic based on a differential between the number of moves available to the main and opponent player has little influence or impact on the outcome against an AB_open agent. The best performing heuristic was AB_Improved, with an overall tie between Heuristic 1 and 2. The data suggest that the third heuristic, maximizing the main player's moves yields the worst win rate.

However, the second best heuristic that demonstrated a tied win rate to the AB_Improved algorithm was AB_Heuristic1, with an equivalent win rate of 70%. This heuristic invokes a more flexible strategy, in which the heuristic first utilizes an aggressive heuristic that seeks to maximize the main player's moves while over half of the blank spaces on the board are unoccupied (18 out of 36, on a 6x6 board. After the number of unvisited spaces drops below half, the strategy switches to a defensive policy. This yields performance that is superior to a completely aggressive or defensive policy, which we observe in heuristics 2 and 3.

This may be due to a faulty assumption between the number of moves a player uses and optimal strategy. Perhaps an optimal strategy actually exists with *less* moves, rather than more. In such a case, it is therefore unsurprising that maximizing the number of the main player's moves would yield worse performance. As a precaution, the tied performance of the top two heuristics may be due to the specific test suite, so further test runs should be executed to determine the heuristic with the highest win rate averaged over many tournaments.