
HEURISTICS ANALYSIS

FOR AN ADVERSARIAL GAME PLAYING AGENT FOR ISOLATION

The primary three custom heuristic evaluation functions were created in `game_agent.py` namely `custom_score`, `custom_score_2`, `custom_score_3`.

Tournaments were run to evaluate the performance of the heuristic functions which is termed as ‘Student’ in `tournament.py` that plays against several opponents. The Student agent uses time-limited Iterative Deepening along with the custom heuristics.

The tournament opponents are listed below. (sample heuristics and players defined in `sample_players.py`)

- Random: An agent that randomly chooses a move each turn.
- MM_Open: MinimaxPlayer agent using the `open_move_score` heuristic with search depth 3
- MM_Center: MinimaxPlayer agent using the `center_score` heuristic with search depth 3
- MM_Improved: MinimaxPlayer agent using the `improved_score` heuristic with search depth 3
- AB_Open: AlphaBetaPlayer using iterative deepening alpha-beta search and the `open_move_score` heuristic
- AB_Center: AlphaBetaPlayer using iterative deepening alpha-beta search and the `center_score` heuristic
- AB_Improved: AlphaBetaPlayer using iterative deepening alpha-beta search and the `improved_score` heuristic

Another computer agent called “ID_Improved” that was designed by others was run before each of them on the same laptop to provide a benchmark to compare the overall performance of all match results with.

Heuristic functions:

Heuristic 1:

Returns a score equal to the difference in the number of moves available to my player and the opponent player which has a weightage of 2. The “Student custom” agent outperformed “ID_Improved”. The “Student Custom” agent performed well against Test Agents.

Match #	Opponents	ID_improved		AB_Custom	
		Win	Loss	Win	Loss
1	Random	10	0	10	0
2	MM_Open	5	5	9	1
3	MM_Center	9	1	9	1
4	MM_Improved	7	3	9	1
5	AB_Open	7	3	9	1
6	AB_Center	7	3	5	5
7	AB_Improved	6	4	6	4
	Overall	72.9%		81.4%	

Heuristic 2:

Returns a score equal to square of the distance from the centre of the board to the position of the player. The “Student” custom2 agent performed poorly as compared to “ID_Improved”. The “ID_Improved” agent performed well, even against Test Agents.

Match #	Opponents	ID_improved		AB_Custom2	
		Win	Loss	Win	Loss
1	Random	10	0	10	0
2	MM_Open	5	5	6	4
3	MM_Center	9	1	6	4
4	MM_Improved	7	3	6	4
5	AB_Open	7	3	3	7
6	AB_Center	7	3	5	5
7	AB_Improved	6	4	4	6
	Overall	72.9%		57.1%	

Heuristic 3:

Returns a score equal to the number of legal moves left for my player. The “Student custom3” agent performed poorly as compared to “ID_Improved”.The “ID_Improved” agent performed well, even against Test Agents.

Match #	Opponents	ID_improved		AB_Custom3	
		Win	Loss	Win	Loss
1	Random	10	0	10	0
2	MM_Open	5	5	7	3
3	MM_Center	9	1	6	4
4	MM_Improved	7	3	4	6
5	AB_Open	7	3	5	5
6	AB_Center	7	3	7	3
7	AB_Improved	6	4	4	6
	Overall	72.9%		61.4%	

Heuristic Recommendation

The best performing evaluation function against “ID_Improved” was Heuristic 1 with 81.4% respectively, and is therefore recommended to be used, and has been submitted in ‘custom_score ()’. The reasons justifying this recommendation are as follows:

- Least difference in the percentage between the “ID_Improved” and the “Student” for Heuristic 1. This is supported by data evidence in the column ID_Improved Performance and Student Performance in all tables.
- The “Student” performed poorly in Heuristic 2 &3 against “ID_Improved” where Test Agents using the Open Score or the Improved Score heuristics performed much better for scoring moves than only scoring with a higher weighting for available moves that were adjacent to one or two already occupied positions in horizontal or vertical sequence.