Heuristic Analysis Report

Name: Khaw Huai Yu
Matric Number: 17077098/1

SYNOPSIS

The project aims at developing an adversarial search agent to play the game "Isolation". This project report focusses on the heuristics to be used in A* Search for minimax and alphabeta pruning.
Isolation is a deterministic, two-player game of perfect information in which the players alternate turns moving a single piece from one cell to another on a board. Whenever either player occupies a cell, that cell becomes blocked for the remainder of the game. The first player with no remaining legal moves loses, and the opponent is declared the winner.
This project uses a version of Isolation where each agent is restricted to L-shaped movements (like a knight in chess) on a rectangular grid (like a chess or checkerboard). The agents can move to any open cell on the board that is 2-rows and 1-column or 2-columns and 1-row away from their current position on the board. Movements are blocked at the edges of the board (the board does not wrap around), however, the player can "jump" blocked or occupied spaces (just like a knight in chess).
Additionally, agents will have a fixed time limit each turn to search for the best move and respond. If the time limit expires during a player's turn, that player forfeits the match, and the opponent wins. These rules are implemented in the isolation.Board class provided in the repository

CUSTOM HEURISTICS

In the beginning of the game, the heuristic is based on the logic that it should grab the centre of the board than the opponents using Euclidean method.

$$euclidean\ player = (game\ centre\ x - player\ location\ x)^2 + (game\ centre\ y - player\ location\ y)^2$$

$$euclidean\ opponent = (game\ centre\ x - opponent\ location\ x)^2 + (game\ centre\ y - opponent\ location\ y)^2$$

$$euclidean\ player - euclidean\ opponent$$

But purely using this heuristic logic, the agent cannot perform a very good result. So, another heuristic is added into the function, the heuristic is based on the logic that the opponent should have less moves and players should have more moves.

$$[len(my\ avaibable\ move)]^2 - \beta[len(available\ opponent\ moves)]^2$$

The latter form has been implemented in the code with β chosen as 1.5 empirically

RESULTS

The number of matches is set as 10 and the time limit is 150.

Agent	Performance
ID_Improved	56.43%
Student1	60.36%
Student2	63.93%
Student3	65.00%
Student4	65.36%
Student5	60.71%
Student6	61.79%
Student7	62.14%
CS	69.64%

The custom CS heuristics perform the highest performance among other agents

APPENDICES

****
Evaluating: ID_Improved
****

Playing Matches:

Match 1: ID_Improved vs Random Result: 36 to 4
Match 2: ID_Improved vs MM_Null Result: 28 to 12
Match 3: ID_Improved vs MM_Open Result: 14 to 26
Match 4: ID_Improved vs MM_Improved Result: 13 to 27
Match 5: ID_Improved vs AB_Null Result: 27 to 13
Match 6: ID_Improved vs AB_Open Result: 21 to 19
Match 7: ID_Improved vs AB_Improved Result: 19 to 21

Results:

ID_Improved 56.43%

****
Evaluating: Student1
****

Playing Matches:

Match 1: Student1 vs Random Result: 34 to 6
Match 2: Student1 vs MM_Null Result: 33 to 7
Match 3: Student1 vs MM_Open Result: 16 to 24
Match 4: Student1 vs MM_Improved Result: 17 to 23
Match 5: Student1 vs AB_Null Result: 29 to 11
Match 6: Student1 vs AB_Open Result: 21 to 19
Match 7: Student1 vs AB_Improved Result: 19 to 21

Results:

Student1 60.36%

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**************************
Evaluating: Student2
**************************

Playing Matches:
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Match 1: Student2 vs Random             Result: 38 to 2
Match 2: Student2 vs MM_Null            Result: 33 to 7
Match 3: Student2 vs MM_Open            Result: 19 to 21
Match 4: Student2 vs MM_Improved        Result: 19 to 21
Match 5: Student2 vs AB_Null            Result: 30 to 10
Match 6: Student2 vs AB_Open            Result: 22 to 18
Match 7: Student2 vs AB_Improved        Result: 18 to 22

Results:
----------
Student2        63.93%

**************************
Evaluating: Student3
**************************

Playing Matches:
----------
Match 1: Student3 vs Random             Result: 35 to 5
Match 2: Student3 vs MM_Null            Result: 35 to 5
Match 3: Student3 vs MM_Open            Result: 23 to 17
Match 4: Student3 vs MM_Improved        Result: 19 to 21
Match 5: Student3 vs AB_Null            Result: 27 to 13
Match 6: Student3 vs AB_Open            Result: 22 to 18
Match 7: Student3 vs AB_Improved        Result: 21 to 19

Results:
----------
Student3        65.00%
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**************************
Evaluating: Student4
**************************

Playing Matches:
----------
Match 1: Student4 vs Random            Result: 37 to 3
Match 2: Student4 vs MM_Null           Result: 31 to 9
Match 3: Student4 vs MM_Open           Result: 18 to 22
Match 4: Student4 vs MM_Improved       Result: 18 to 22
Match 5: Student4 vs AB_Null           Result: 30 to 10
Match 6: Student4 vs AB_Open           Result: 28 to 12
Match 7: Student4 vs AB_Improved       Result: 21 to 19

Results:
----------
Student4        65.36%


**************************
Evaluating: Student5
**************************

Playing Matches:
----------
Match 1: Student5 vs Random            Result: 36 to 4
Match 2: Student5 vs MM_Null           Result: 33 to 7
Match 3: Student5 vs MM_Open           Result: 14 to 26
Match 4: Student5 vs MM_Improved       Result: 15 to 25
Match 5: Student5 vs AB_Null           Result: 26 to 14
Match 6: Student5 vs AB_Open           Result: 20 to 20
Match 7: Student5 vs AB_Improved       Result: 26 to 14

Results:
----------
Student5        60.71%
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**************************
Evaluating: Student6
**************************

Playing Matches:
----------
Match 1: Student6 vs Random             Result: 37 to 3
Match 2: Student6 vs MM_Null            Result: 33 to 7
Match 3: Student6 vs MM_Open            Result: 15 to 25
Match 4: Student6 vs MM_Improved        Result: 17 to 23
Match 5: Student6 vs AB_Null            Result: 29 to 11
Match 6: Student6 vs AB_Open            Result: 20 to 20
Match 7: Student6 vs AB_Improved        Result: 22 to 18

Results:
----------
Student6        61.79%


**************************
Evaluating: Student7
**************************

Playing Matches:
----------
Match 1: Student7 vs Random             Result: 36 to 4
Match 2: Student7 vs MM_Null            Result: 35 to 5
Match 3: Student7 vs MM_Open            Result: 15 to 25
Match 4: Student7 vs MM_Improved        Result: 14 to 26
Match 5: Student7 vs AB_Null            Result: 28 to 12
Match 6: Student7 vs AB_Open            Result: 21 to 19
Match 7: Student7 vs AB_Improved        Result: 25 to 15

Results:
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Student7        62.14%
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**************************
Evaluating: CS
**************************

Playing Matches:
----------
Match 1: CS vs Random            Result: 37 to 3
Match 2: CS vs MM_Null           Result: 33 to 7
Match 3: CS vs MM_Open           Result: 28 to 12
Match 4: CS vs MM_Improved       Result: 19 to 21
Match 5: CS vs AB_Null           Result: 34 to 6
Match 6: CS vs AB_Open           Result: 24 to 16
Match 7: CS vs AB_Improved       Result: 20 to 20

Results:
----------
CS      69.64%
```