Heuristic Analysis Report

Name: Tan Chun Shui

Matric Number: 17110581/1

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%
```

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

Playing Matches:
----------
  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%
```

```
**************************
  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%
```

```
**************************
  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:
----------
Student7          62.14%
```

```
**************************
    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%
```