HEURISTIC ANALYSIS

For the Game of Isolation

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Introduction

The project aim is to develop a Game Playing Agent for the game of Isolation. The game is typically played by 2 players on a grid board like that of Chess or Checkers. The game is turn based with each player choosing a legal move on the board and blocking off the square of their last move. This square can no longer be used by either player. The winner is decided when one of the players is unable to move on the board. The player who cannot move loses, crowning the other player.

In this projects version of Isolation, players can move in an 'L' shape, like that of a Knight in chess. Players are also able to jump over blocked squares, unlike the typical game. This report considers possible scoring heuristics for this modified version of the game, and which of those produces the best result.

Custom Heuristics

My Moves Heuristic

The My Moves heuristic is calculated based on the number of moves available to the player, ignoring its opponent's available moves. It can be expressed as:

len(players legal moves)

Maximise Player Moves Heuristic

This heuristic is calculated based on maximising the number of moved available to the player, verses the number of moves available to the opponent. A value of 1.5 was chosen for X.

*X * len(players legal moves) – len(opponents legal moves)*

Minimise Opponent Moves Heuristic

This heuristic is calculated based on minimising the number of moved available to the opponent, verses the number of moves available to the player. A value of 1.5 was chosen for X.

*len(players legal moves) – X * len(opponents legal moves)*

Maximise Ratio of Player to Opponent Moves Heuristic

This heuristic calculates the ratio of available moves for the Player to the Opponent. Consideration must be taken for the possibility of the Opponents moves being equal to 0.

len(player legal moves) / len(opponent legal moves)

Minimise Ratio of Player to Opponent Moves Heuristic

This heuristic calculates the ratio of available moves for the Player to the Opponent. Consideration must be taken for the possibility of the Opponents moves being equal to 0.

- (len(opponent legal moves) / len(player legal moves))

Heuristic Performance

Below are the results of the heuristic performance test using the provided tournament.py script. The number of test games was increased to 100 to provide more accurate results. AB_Improved was used as a baseline.

Heuristic	Win %
AB_Improved	65.33%
my_moves_heuristic	62.17%
maximise_player_moves	67.17%
minimise_opponent_moves	64.50%
maximise_ratio_of_player_to_opponent_moves	64.67%
minimise_ratio_of_player_to_opponent_moves	67.67%

From the results, we can see that minimise_ratio_of_player_to_opponent_moves produced the best results at 67.67%. This heuristic was chosen as my Custom_Heuristic for the following reasons:

1. It produced the best results of all the tests, including producing a better result than the baseline AB_Improved.
2. It takes into account both the player and its opponent, giving a more accurate overview of the current game state.
3. It is only interested in the current state of the game, not requiring any additional game history to calculate.
4. The number of calculations needed to get a result is no greater than any of the other heuristics.

The raw results of this test can be found in Appendix 1.

Appendix 1

Raw heuristic test results output:

```
                        **************************
                             Playing Matches
                        **************************

************************
Test: AB_Improved
************************

Playing Matches:
----------------

  Match 1: AB_Improved vs   Random        Result: 79 to 21
  Match 2: AB_Improved vs   MM_Open       Result: 69 to 31
  Match 3: AB_Improved vs  MM_Center      Result: 78 to 22
  Match 4: AB_Improved vs MM_Improved     Result: 54 to 46
  Match 5: AB_Improved vs   AB_Open       Result: 53 to 47
  Match 6: AB_Improved vs  AB_Center      Result: 59 to 41


Results:
----------
AB_Improved         65.33%

************************
Test: my_moves_heuristic
************************

Playing Matches:
----------------

  Match 1: my_moves_heuristic vs   Random        Result: 83 to 17
  Match 2: my_moves_heuristic vs   MM_Open       Result: 64 to 36
  Match 3: my_moves_heuristic vs  MM_Center      Result: 70 to 30
  Match 4: my_moves_heuristic vs MM_Improved     Result: 57 to 43
  Match 5: my_moves_heuristic vs   AB_Open       Result: 42 to 58
  Match 6: my_moves_heuristic vs  AB_Center      Result: 57 to 43


Results:
----------
my_moves_heuristic     62.17%

************************
Test: maximise_player_moves
************************

Playing Matches:
----------------

  Match 1: maximise_player_moves vs   Random     Result: 80 to 20
  Match 2: maximise_player_moves vs   MM_Open    Result: 69 to 31
  Match 3: maximise_player_moves vs  MM_Center   Result: 76 to 24
  Match 4: maximise_player_moves vs MM_Improved  Result: 63 to 37
  Match 5: maximise_player_moves vs   AB_Open    Result: 56 to 44
  Match 6: maximise_player_moves vs  AB_Center   Result: 59 to 41


Results:
----------
maximise_player_moves     67.17%

************************
Test: minimise_opponent_moves
************************
```

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

  Match 1: minimise_opponent_moves vs   Random          Result: 82 to 18
  Match 2: minimise_opponent_moves vs   MM_Open         Result: 64 to 36
  Match 3: minimise_opponent_moves vs  MM_Center        Result: 73 to 27
  Match 4: minimise_opponent_moves vs MM_Improved       Result: 61 to 39
  Match 5: minimise_opponent_moves vs   AB_Open         Result: 53 to 47
  Match 6: minimise_opponent_moves vs  AB_Center        Result: 54 to 46


Results:
----------
minimise_opponent_moves     64.50%

*************************
Test: maximise_ratio_of_player_to_opponent_moves
*************************

Playing Matches:
----------------

  Match 1: maximise_ratio_of_player_to_opponent_moves vs   Random     Result: 83 to 17
  Match 2: maximise_ratio_of_player_to_opponent_moves vs   MM_Open    Result: 64 to 36
  Match 3: maximise_ratio_of_player_to_opponent_moves vs  MM_Center   Result: 79 to 21
  Match 4: maximise_ratio_of_player_to_opponent_moves vs MM_Improved  Result: 58 to 42
  Match 5: maximise_ratio_of_player_to_opponent_moves vs   AB_Open    Result: 52 to 48
  Match 6: maximise_ratio_of_player_to_opponent_moves vs  AB_Center   Result: 52 to 48


Results:
----------
maximise_ratio_of_player_to_opponent_moves     64.67%

*************************
Test: minimise_ratio_of_player_to_opponent_moves
*************************

Playing Matches:
----------------

  Match 1: minimise_ratio_of_player_to_opponent_moves vs   Random     Result: 84 to 16
  Match 2: minimise_ratio_of_player_to_opponent_moves vs   MM_Open    Result: 69 to 31
  Match 3: minimise_ratio_of_player_to_opponent_moves vs  MM_Center   Result: 72 to 28
  Match 4: minimise_ratio_of_player_to_opponent_moves vs MM_Improved  Result: 69 to 31
  Match 5: minimise_ratio_of_player_to_opponent_moves vs   AB_Open    Result: 57 to 43
  Match 6: minimise_ratio_of_player_to_opponent_moves vs  AB_Center   Result: 55 to 45


Results:
----------
minimise_ratio_of_player_to_opponent_moves     67.67%
```