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*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 | 47.33% |
| my\_moves\_heuristic | 43.50% |
| maximise\_player\_moves | 45.83% |
| minimise\_opponent\_moves | 43.67% |
| maximise\_ratio\_of\_player\_to\_opponent\_moves | 48.33% |
| minimise\_ratio\_of\_player\_to\_opponent\_moves | 44.50% |

From the results, we can see that maximise\_ratio\_of\_player\_to\_opponent\_moves produced the best results at 48.33%. 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.

# Appendix 1

Raw heuristic test results output:

                        \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

                             Playing Matches

                        \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

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Test: AB\_Improved

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Playing Matches:

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  Match 1: AB\_Improved  vs   Random    Result: 51 to 49

  Match 2: AB\_Improved  vs   MM\_Open   Result: 45 to 55

  Match 3: AB\_Improved  vs  MM\_Center  Result: 39 to 61

  Match 4: AB\_Improved  vs MM\_Improved Result: 47 to 53

  Match 5: AB\_Improved  vs   AB\_Open   Result: 48 to 52

  Match 6: AB\_Improved  vs  AB\_Center  Result: 54 to 46

Results:

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AB\_Improved         47.33%

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Test: my\_moves\_heuristic

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Playing Matches:

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  Match 1: my\_moves\_heuristic vs   Random    Result: 53 to 47

  Match 2: my\_moves\_heuristic vs   MM\_Open   Result: 35 to 65

  Match 3: my\_moves\_heuristic vs  MM\_Center  Result: 39 to 61

  Match 4: my\_moves\_heuristic vs MM\_Improved Result: 43 to 57

  Match 5: my\_moves\_heuristic vs   AB\_Open   Result: 50 to 50

  Match 6: my\_moves\_heuristic vs  AB\_Center  Result: 41 to 59

Results:

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my\_moves\_heuristic     43.50%

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Test: maximise\_player\_moves

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Playing Matches:

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  Match 1: maximise\_player\_moves vs   Random    Result: 50 to 50

  Match 2: maximise\_player\_moves vs   MM\_Open   Result: 30 to 70

  Match 3: maximise\_player\_moves vs  MM\_Center  Result: 38 to 62

  Match 4: maximise\_player\_moves vs MM\_Improved Result: 61 to 39

  Match 5: maximise\_player\_moves vs   AB\_Open   Result: 50 to 50

  Match 6: maximise\_player\_moves vs  AB\_Center  Result: 46 to 54

Results:

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maximise\_player\_moves     45.83%

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Test: minimise\_opponent\_moves

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Playing Matches:

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  Match 1: minimise\_opponent\_moves            vs   Random    Result: 46 to 54

  Match 2: minimise\_opponent\_moves            vs   MM\_Open   Result: 41 to 59

  Match 3: minimise\_opponent\_moves            vs  MM\_Center  Result: 38 to 62

  Match 4: minimise\_opponent\_moves            vs MM\_Improved Result: 53 to 47

  Match 5: minimise\_opponent\_moves            vs   AB\_Open   Result: 40 to 60

  Match 6: minimise\_opponent\_moves            vs  AB\_Center  Result: 44 to 56

Results:

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minimise\_opponent\_moves     43.67%

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Test: maximise\_ratio\_of\_player\_to\_opponent\_moves

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Playing Matches:

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  Match 1: maximise\_ratio\_of\_player\_to\_opponent\_moves vs   Random    Result: 48 to 52

  Match 2: maximise\_ratio\_of\_player\_to\_opponent\_moves vs   MM\_Open   Result: 43 to 57

  Match 3: maximise\_ratio\_of\_player\_to\_opponent\_moves vs  MM\_Center  Result: 47 to 53

  Match 4: maximise\_ratio\_of\_player\_to\_opponent\_moves vs MM\_Improved Result: 49 to 51

  Match 5: maximise\_ratio\_of\_player\_to\_opponent\_moves vs   AB\_Open   Result: 54 to 46

  Match 6: maximise\_ratio\_of\_player\_to\_opponent\_moves vs  AB\_Center  Result: 49 to 51

Results:

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maximise\_ratio\_of\_player\_to\_opponent\_moves     48.33%

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Test: minimise\_ratio\_of\_player\_to\_opponent\_moves

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Playing Matches:

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  Match 1: minimise\_ratio\_of\_player\_to\_opponent\_moves vs   Random    Result: 44 to 56

  Match 2: minimise\_ratio\_of\_player\_to\_opponent\_moves vs   MM\_Open   Result: 41 to 59

  Match 3: minimise\_ratio\_of\_player\_to\_opponent\_moves vs  MM\_Center  Result: 34 to 66

  Match 4: minimise\_ratio\_of\_player\_to\_opponent\_moves vs MM\_Improved Result: 55 to 45

  Match 5: minimise\_ratio\_of\_player\_to\_opponent\_moves vs   AB\_Open   Result: 48 to 52

  Match 6: minimise\_ratio\_of\_player\_to\_opponent\_moves vs  AB\_Center  Result: 45 to 55

Results:

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minimise\_ratio\_of\_player\_to\_opponent\_moves     44.50%