

Heuristic Analysis: Isolation AI Agent

Summary:

Heuristics are analyzed in comparison to the 'improved score' which is own moves minus opponent moves. The chosen heuristic was the **Mobility Score with Improved Score**. Use of the mobility score consistently outperformed all of the other heuristics I choose, including the improved score. When working with the mobility score, I had to decide whether to add the mobility score to the number of moves or multiply. I decided to stick with adding since at the end of the game the mobility score could reduce to zero, meaning poor decisions made near end game.

Heuristic 1: Try to block the opponent

Take my moves and subtract twice the opponent's available moves. The goal here is to encourage blocking one of the opponent's moves.

Opponent	Improved Score	Heuristic Score
Random	18 to 2	19 to 1
Minimax Null	16 to 4	13 to 7
Minimax Open Moves	11 to 9	10 to 10
Minimax Improved Score	9 to 11	10 to 10
Alpha-Beta Null	13 to 7	14 to 6
Alpha-Beta Open Moves	13 to 7	11 to 9
Alpha-Beta Improved Score	14 to 6	9 to 11
Total Percentage	67.14%	61.43%

The maximum number of possible moves is 8 if you have just started. Any other move, the maximum possible moves is 7 since you cannot go back to the space you just vacated. By blocking an opponent's move, the space occupied by the opponent is unavailable. This could lead to making a move without a lot of future options, which I believe caused the degradation in performance. The consequence can be seen when comparing the alpha-beta open moves and alpha-beta improved score. The open moves heuristic, without consideration to opponent moves, outperformed the opponent move weighted heuristic.

Heuristic 2: Mobility Score with Improved Score

The mobility score for a position is defined as the sum of available moves to each legal move. The heuristic adds own mobility to own moves and subtracts opponent moves and mobility.

Opponent	Improved Score	Heuristic Score
Random	16 to 4	18 to 2
Minimax Null	12 to 8	17 to 3
Minimax Open Moves	9 to 11	12 to 8

Minimax Improved Score	9 to 11	11 to 9
Alpha-Beta Null	12 to 8	13 to 7
Alpha-Beta Open Moves	13 to 7	15 to 5
Alpha-Beta Improved Score	10 to 10	15 to 5
Total	57.86%	72.14%

The heuristic outperforms the improved score because there is some assessment to the quality of the moves, not just the number of moves. My concern was the heuristic is equivalent to peaking ahead at the next depth for number of moves, this is not true since the function only considers the current state of the board.

Heuristic 3: Moves Matrix

In an attempt to information from a heuristic about how many sequential moves a player may have, I created a matrix twice the size of the game board. This matrix was filled with the number of moves it takes the center square to get to any particular square. Since the game board is smaller for every state, I can take a sub-matrix based on the player's position. From there I can take the submatrix based on my position, minus the sub-matrix based on the opponent position, then do a multiplication based on board state to replace all values where the position isn't available with zero. The sum of the final matrix should show which opponent is 'closer' to all remaining squares. Lower values would indicate an advantage.

Opponent	Improved Score	Heuristic Score
Random	18 to 2	18 to 2
Minimax Null	15 to 5	16 to 4
Minimax Open Moves	12 to 8	12 to 8
Minimax Improved Score	12 to 8	10 to 10
Alpha-Beta Null	13 to 7	13 to 7
Alpha-Beta Open Moves	12 to 8	12 to 8
Alpha-Beta Improved Score	10 to 10	12 to 8
Total	65.71%	66.43%

The heuristic performance was not very impressive, considering the effort to set it up. A valuable move would be cutting off your opponent's chain, or being in a position to take out an opponent chain of moves before they arrive to a certain location. If you are able to get to that position before the opponent, their sequential chain of moves has been cut off. This heuristic is taking into account squares that are not significant to the opponent or the player. The heuristic is on the right track to being useful, but probably needs to only consider squares in my legal moves or the opponent's moves.