Comparison of heuristic methods applied to Isolation

April 18, 2017

1 Methods

1.1 Number available moves

The simplest of methods available is the number of moves available to the player in the current state. This is a simple metric and does not capture a complete state of the board, not taking into account the relative state of the opponent.

1.2 Area based heuristic

This is a more complex method, working out the number of empty positions around the current player, the downside of this method is that is is relatively expensive.

1.3 Axis of movement based heuristic

Similar to the number of available moves this method attempts to get more granular detail of the game state by taking into account the directions of movement available to the player. Two methods were implemented for this the first returning the product of the movement along each direction the second from the formula:

$$\frac{\text{num\_axis\_available}}{8} \times \text{num\_moves\_available} \tag{1}$$

1.4 Adversarial implementation

The above heuristics do not take into account adequately the opponent state. When minimax takes this into account this is relatively more expensive as the bulk of computational expense is is in the last layer of the explored space. The solution is to lazily factor in the opponent by applying the same heuristic to the opponent, multiplied by an arbitrary priority coefficient (this is to emphasize/deemphasize the opponents state on the board), as if it were the opponent turn.

2 Results (adversarial results only)

NB: all coefficient multiplier for all methods was 2, except for axis_movement_adversarial where it was set to 4

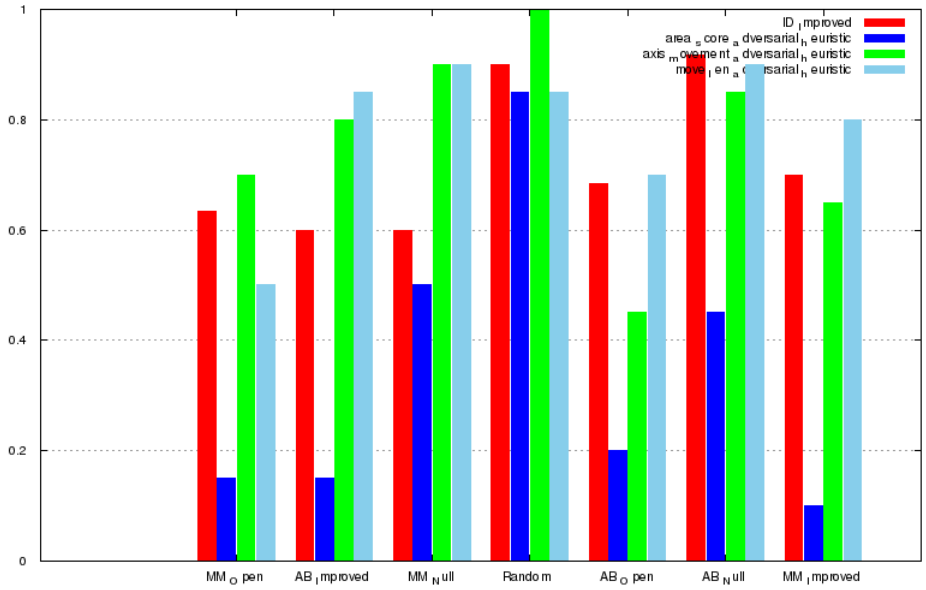

Figure 1: win ratio per heuristic per opponent heuristic

3 Discussion

Interestingly the axis based movement, number available moves and the given id improved appear to suit different opponents more favorably. While the axis based heuristic outperforms the random opponent, it is at a disadvantage against id improved around half the time, with the number available moves heuristic displaying the most consistency.

Initially the area based heuristic was thought to be promising but its dismal performance is likely due to two main factors, it is computationally expensive and only captures valuable information later in the game. Initially there will only be a single cluster of empty space and any move within this heuristic will not reflect whether a move is good or bad except at points where sections of the board can be cut off.

The axis based heuristic is not able to consistently beat id improved with an overall score of 76.4% vs 78.57%. The most likely explanation is that the fundamental assumption on which it is based – maximizing movement in all axis is flawed. This makes sense as this would cause the agent to try to stay as central to the board as possible ignoring potentially superior moves around the edge of the board. This would cause it to improperly predict opponent moves as well as choose non optimal moves itself.

4 Conclusion

The best heuristic to use is the number of moves available to the agent taking less the scaled number of opponent moves, this is because it consistently performs well though is not the best choice for all situations. It abstractly captures the fundamental concept of the game, from a high level allowing minimax/iterative deepening to do the heavy bulk of the work. It is likely not the best strategy, different stages of the game may require different strategies. In fact an obvious improvement might be to make the opponent priority coefficient scale with game turn, as this may become more or less relevant as the game progresses.