

## Heuristic Analysis

### Evaluation heuristics

- AB\_Custom
  - Evaluation heuristic looks at the number of moves available to both the players and returns a score:  $num\_own\_moves - 2 * num\_opponent\_moves$
  - This is similar to the *improved* heuristic, but is more aggressive and imposes a higher penalty on number of opponent's moves as a result
- AB\_Custom2
  - Evaluation heuristic goes through all of player and opponent's legal moves, calculating a score:
    - i. Encouraging player's moves closer to the player's current location and discouraging far away ones
    - ii. Discouraging player's moves closer to the player's current location and encouraging far away ones
    - iii. This is based on the idea that closer moves will be easier to execute while the farther ones will be blocked by the opponent at some point
- AB\_Custom3
  - The *terminal state* can be reached due to any of these reasons: no moves available OR maximum depth was reached and search process was cut-off as a result
  - Evaluation heuristic does the following:
    - i. If moves are available for player, pick the first one and apply it
    - ii. If moves are available for opponent on the new game board, pick the first one and apply it
    - iii. Calculate score in a manner similar to the *AB\_Custom2* heuristic

## Results

Run 1:

Match #	Opponent	AB_Improved		AB_Custom		AB_Custom_2		AB_Custom_3	
		Won	Lost	Won	Lost	Won	Lost	Won	Lost
1	Random	8	2	9	1	8	2	7	3
2	MM_Open	6	4	7	3	5	5	6	4
3	MM_Center	7	3	8	2	9	1	9	1
4	MM_Improved	8	2	7	3	6	4	7	3
5	AB_Open	5	5	5	5	4	6	5	5
6	AB_Center	6	4	7	3	6	4	4	6
7	AB_Improved	4	6	3	7	4	6	5	5
Win Rate:		62.9%		65.7%		60.0%		61.4%	

As seen here, AB\_Custom performs the best at 65.7%, followed by AB\_Improved at 62.9%.

AB\_Custom3 and AB\_AB\_Custom2 trail at 61.4% and 60.0% respectively

It's also interesting that when playing against Random and MiniMax opponents, the results seem to vary more then when playing against AlphaBeta opponents.

## Recommendation

I would recommend AB\_Custom evaluation heuristic.

The intuition of heavily penalizing the number of moves left for the opponent seems to lead to a better win rate as supported by the results.

To improve further, I'd be interested in:

- Running a greater number of simulations
- Tweaking the evaluation heuristics to include looking at the position of blocked spaces

Justification:

- Better win rate as compared to the other heuristics
- Simplicity, solely looks at the number of possible moves for player and opponent
- Low complexity - considers a player's neighboring locations and if those locations are legal (not blocked, can be moved to by the piece in a L manner, etc). This ensures that the heuristic can finish within a reasonable period.
- Evaluation heuristic only looks at the current board and doesn't traverse deep, ensuring that it finishes within a reasonable period