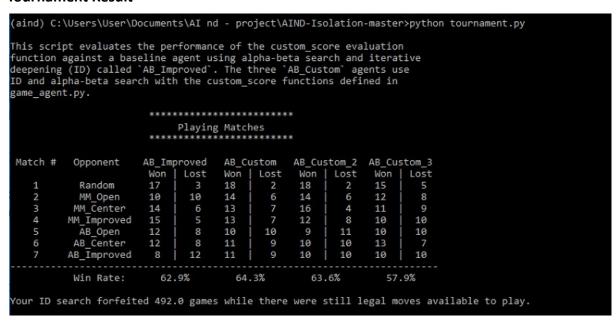# Heuristic Analysis – Isolation game

In this project, I have implemented alpha-beta search with iterative deepening with various evaluation functions as below:

Description

1. AB_Custom: *(own_moves - opp_moves) + (opp_distance - own_distance)*
   This score is to linearly combine the 'improved_score' and 'AB_Custom_3' described as below. The score will consider both maximizing own moves and blocking opponent's moves with the positional advantage, which is defined as the distance from centre of the board.

2. AB_Custom_2: *own_moves - 2 * opp_moves*
   Modifying the 'improved_score', this score is the difference between number of my moves and two times opponent's moves, which will lead to more focus on blocking opponent's moves.

3. AB_Custom_3: *opp_distance - own_distance*
   Modifying the 'centre_score', this score is the difference between the distance of my position away from the centre and that of opponent's position. This is to encourage my moves should be as nearest as possible to the centre and chase opponent's moves as far as possible from the centre.

Tournament Result

```
(aind) C:\Users\User\Documents\AI nd - project\AIND-Isolation-master>python tournament.py

This script evaluates the performance of the custom_score evaluation
function against a baseline agent using alpha-beta search and iterative
deepening (ID) called `AB_Improved`. The three `AB_Custom` agents use
ID and alpha-beta search with the custom_score functions defined in
game_agent.py.

                    ***************************
                         Playing Matches
                    ***************************

Match #   Opponent     AB_Improved    AB_Custom    AB_Custom_2   AB_Custom_3
                      Won | Lost    Won | Lost    Won | Lost    Won | Lost
   1       Random      17  |  3      18  |  2      18  |  2      15  |  5
   2       MM_Open     10  | 10      14  |  6      14  |  6      12  |  8
   3       MM_Center   14  |  6      13  |  7      16  |  4      11  |  9
   4       MM_Improved 15  |  5      13  |  7      12  |  8      10  | 10
   5       AB_Open     12  |  8      10  | 10       9  | 11      10  | 10
   6       AB_Center   12  |  8      11  |  9      10  | 10      13  |  7
   7       AB_Improved  8  | 12      11  |  9      10  | 10      10  | 10
-------------------------------------------------------------------------
        Win Rate:      62.9%         64.3%         63.6%         57.9%

Your ID search forfeited 492.0 games while there were still legal moves available to play.
```

Conclusion & Recommendation

Comparing to baseline model 'AB_Improved', only 'AB_Custom' and 'AB_Custom_2' can have higher winning rate marginally (64.3% and 63.6% vs. 62.9%). However, if we look into details, 'AB_Custom' can deliver more stable performance without losing to any opponent when comparing to 'AB_Custom_2'. For example, 'AB_Custom_2' can keep higher winning rate when facing minimax players (MM), but its performance deteriorates when facing alphabeta players. In terms of consistency, I would recommend the 'AB_Custom' model.

Actually, position is a key factor on winning isolation game, especially in early stages. This is inspired by my experience on playing against my friends, which act as human heuristics. That's why adding positional advantage into consideration can improve the result. However, just considering distance from centre cannot accurately define what positional advantage is. In some conditions in which moving to centre is not feasible, the game agent could move into unfavorable position.