Heuristic Analysis

From 3 respects, **common moves of the plyer and opponent**, **the distance from the center of all possible moves for the player** and **aggression of the player to the opponent**, I created 3 strategies to evaluate the game state. The 3 heuristic evaluation functions derived from lecture of "Evaluating Evaluation Functions" in "Advanced Game playing" which formed "number my move - number opponent move", and I will analysis respectively as follows:

The 1st heuristic strategy **"common moves"** consider the intersection of the future legal moves between player and opponent. The more common moves will be result in the less avaliable free moves for the player, in other words, the less common moves will give the player as many options as possible open. For my player, this is a passive or defensive way to win more open space.

The 2nd heuristic strategy **"distance form center "** idea comes from Malcolm Haynes, a student form a previous class in the video lecture, which can be simply summarize as one word "occupy the centeral board, you will win". In the scorce function, I measured the all future legal moves distance from the centeral board to judge the probability of winning of my player. For my player, this is also a passive way to acquire more open space.

The 3rd heuristic stragey **"aggression"** was inspired by the lecture "Evaluating Evaluation Functions" that gives the more weight to the number of the opponent moves. I modified it to when the game is close to end(the blanck space is less and less) and the weight gets to more and more. For my player, this is a positive or offense way to reduce the opponent space.

After defined 3 heuristic strategies, I fistly ran them trough "python tournament.py" respectively in 3 "custom_score" functions. But I found the results of serveral experiments were not stable and sometimes forfeited. In my opinion, this was because the number of matches and timeout were less, so I changed **"timeout = 15"** and **"NUM_MATCHES = 10"** to fix these problems. At the same time, I mixed the 2nd and 3rd strateges in the 1st "custom_score" function to compare with the single stratey. The final forms are as follows:

- AB_Custom = **"distance form center "**+ **"aggression"**
- AB_Custom_2 = **"common moves"**
- AB_Custom_3 = **"aggression"**

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**************************
    Playing Matches
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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	19	1	20	0
2	MM_Open	15	5	15	5	15	5	13	7
3	MM_Center	18	2	18	2	18	2	18	2
4	MM_Improved	14	6	13	7	13	7	14	6
5	AB_Open	13	7	12	8	9	11	11	9
6	AB_Center	13	7	13	7	10	10	12	8
7	AB_Improved	9	11	12	8	12	8	11	9
	Win Rate:	70.7%		72.1%		68.6%		70.7%	

From the above "Win Rate", we can find the mixed strategy porfomed optimal heuristic then I ran the tournament a couple of times and the results are stable and no forfeits. This result is logical and in accordance with my prejudement and I think it could be the best score function of the 3 implemented because:

- 1. The mixed strage consier the both passive and positive way for player.
  2. The 2nd **"distance form center "** weighed all the possible future moves.
  3. The 3rd **"aggression"** might boost the efficiency in ID and alpha-beta search.