Heuristic Functions Analysis

Tianwei Zhu

There are 3 heuristics to be evaluated in the tournament. They are custom_score, custom_score_2 and custom_score_3, respectively.

Custom_score calculates the distances of player's location and opponent player's location to the center point. Then perform the subtraction between them. The win rate of this function raised to 55.7%. It has low performance while playing with opponents AB_Improved and AB_Open. Notwithstanding, the performance improved when it plays with other opponents.

Custom_score_2 calculates the distances of player's location to x and y axis. Then multiply these values to get the area. The overall win rate of this heuristic is same to the rate of custom_score. The performance of this function is overall high in MM opponents and relatively low while playing with AB opponents.

Custom_score_3 calculates the sum of distances of player's location to the center point from all available legal moves. Then calculates the opponent's one and calculates the difference between both scores. This has the highest win rate among other heuristics, 58.6% to be exact. It has low performance in AB_Center. However, when it plays with all other opponents, the win rate increased accordingly.

Custom_score_3 outperformed AB_Improved in almost all opponents except AB_Open, where AB_Improved won 6 and lost 4 while my heuristic won 3 lost 7. I think it is possibly due to the high computational cost of custom_score_3 that had led the heuristic to choose less optimal moves.

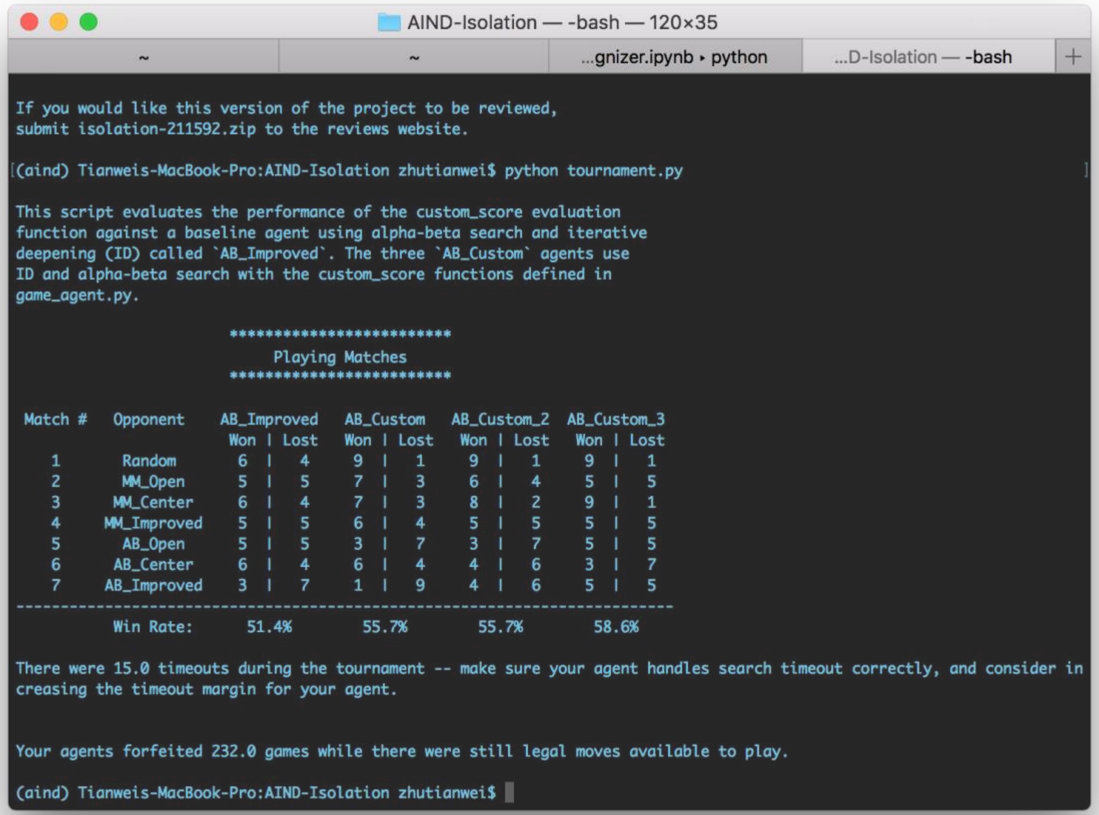
I would use custom_score_3 as it has the highest win rate, 58.6% to be exact. The second reason is that it consistently wins the opponent or is in deuce in 6 games and it only loses 1 game with AB_Center, with 3 versus 7. The third reason is that it calculates the sum of distances of all legal moves to the center, which makes the heuristic more accurate if only calculate one but at the same time this will also increases the computational cost. So bigger is the value of custom_score_3, better it predicts the final outcome of the game.

The remaining problem is its low performance in AB_Center. Once this issue is solved, the overall performance of this heuristic will also increase.

Win rate of different heiristics:

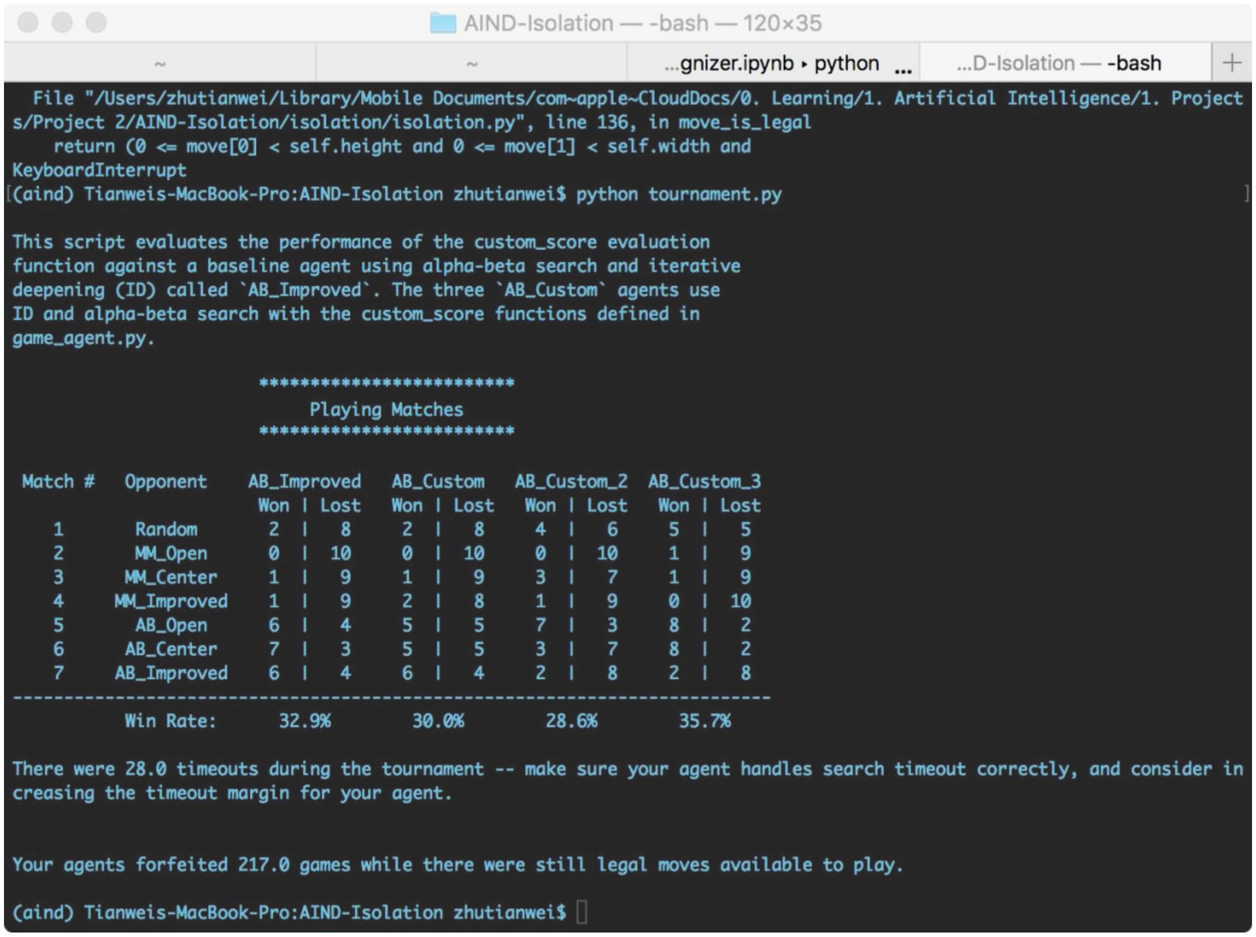
Heuristics	Custom_score	Custom_score_2	Custom_score_3
Win rate	55.7%	55.7%	58.6%

Results of analysis:



```
If you would like this version of the project to be reviewed,
submit isolation-211592.zip to the reviews website.

(aind) Tianweis-MacBook-Pro:AIND-Isolation zhutianwei$ 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       6  |  4      9  |  1      9  |  1      9  |  1
    2       MM_Open      5  |  5      7  |  3      6  |  4      5  |  5
    3      MM_Center     6  |  4      7  |  3      8  |  2      9  |  1
    4     MM_Improved    5  |  5      6  |  4      5  |  5      5  |  5
    5       AB_Open      5  |  5      3  |  7      3  |  7      5  |  5
    6      AB_Center     6  |  4      6  |  4      4  |  6      3  |  7
    7     AB_Improved    3  |  7      1  |  9      4  |  6      5  |  5
--------------------------------------------------------------------------
           Win Rate:      51.4%        55.7%        55.7%        58.6%

There were 15.0 timeouts during the tournament -- make sure your agent handles search timeout correctly, and consider in
creasing the timeout margin for your agent.


Your agents forfeited 232.0 games while there were still legal moves available to play.

(aind) Tianweis-MacBook-Pro:AIND-Isolation zhutianwei$
```

Analysis from the first test:



AIND-Isolation — -bash — 120×35

~ | ~ | ...gnizer.ipynb ▸ python ... | ...D-Isolation — -bash

```
  File "/Users/zhutianwei/Library/Mobile Documents/com~apple~CloudDocs/0. Learning/1. Artificial Intelligence/1. Project
s/Project 2/AIND-Isolation/isolation/isolation.py", line 136, in move_is_legal
    return (0 <= move[0] < self.height and 0 <= move[1] < self.width and
KeyboardInterrupt
(aind) Tianweis-MacBook-Pro:AIND-Isolation zhutianwei$ 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       2  |   8     2  |   8     4  |   6     5  |   5
    2       MM_Open      0  |  10     0  |  10     0  |  10     1  |   9
    3      MM_Center     1  |   9     1  |   9     3  |   7     1  |   9
    4     MM_Improved    1  |   9     2  |   8     1  |   9     0  |  10
    5       AB_Open      6  |   4     5  |   5     7  |   3     8  |   2
    6      AB_Center     7  |   3     5  |   5     3  |   7     8  |   2
    7     AB_Improved    6  |   4     6  |   4     2  |   8     2  |   8
--------------------------------------------------------------------------
           Win Rate:      32.9%        30.0%        28.6%        35.7%

There were 28.0 timeouts during the tournament -- make sure your agent handles search timeout correctly, and consider in
creasing the timeout margin for your agent.


Your agents forfeited 217.0 games while there were still legal moves available to play.

(aind) Tianweis-MacBook-Pro:AIND-Isolation zhutianwei$
```