Evaluation Heuristics

The purpose of the game is being the last player to play a legal move, so a good heuristic tries to maximize the number of valid moves available to play. It is also very important to try to minimize the opponent's number of available moves, so that the opponent has always less moves than our AI. A good heuristic that combines the previous ones has been shown previously in the course:

$$\# \textit{ of player's available moves} - \# \textit{ of opponent's available moves}$$

This heuristic works alright, nevertheless it assumes that the number of available moves for both the player and opponent are equally important. It could be the case that prioritizing the opponent's number of available moves could give better results, so I decided to test the `custom_score` function with different variations of the following formula:

$$\# \textit{ of player's available moves} - \alpha \times \# \textit{ of opponent's available moves}$$

Where α is a parameter that was varied to find the best results. It is important to mention that if the score being evaluated is a leaf node, it returns infinite if the player wins and minus infinite if the opponent wins.

The following table shows the win rates after trying the new score function for different values:

α	Student %
1	56.43
1.5	67.14
2	67.86
2.5	61.43
3	58.57

As seen, the linear combination of the $\# \textit{ of opponent's available moves}$ for which my `custom_score` function wins the most is when $\alpha = 2$. It is about 11.5% better than the original heuristic where $\alpha = 1$. This means that the AI plays better if $\# \textit{ of opponent's available moves}$ score doubly as wrong.

Supporting files

```
**************************
   Evaluating: Student
**************************

Playing Matches:
----------
  Match 1:    Student    vs    Random      Result: 17 to 3
  Match 2:    Student    vs    MM_Null     Result: 10 to 10
  Match 3:    Student    vs    MM_Open     Result: 8 to 12
  Match 4:    Student    vs MM_Improved    Result: 6 to 14
  Match 5:    Student    vs    AB_Null     Result: 13 to 7
  Match 6:    Student    vs    AB_Open     Result: 14 to 6
  Match 7:    Student    vs AB_Improved    Result: 11 to 9


Results:
----------
Student            56.43%
```

Image 1. Results Alpha equals 1.

```
**************************
   Evaluating: Student
**************************

Playing Matches:
----------
  Match 1:    Student    vs    Random      Result: 19 to 1
  Match 2:    Student    vs    MM_Null     Result: 17 to 3
  Match 3:    Student    vs    MM_Open     Result: 12 to 8
  Match 4:    Student    vs MM_Improved    Result: 12 to 8
  Match 5:    Student    vs    AB_Null     Result: 11 to 9
  Match 6:    Student    vs    AB_Open     Result: 9 to 11
  Match 7:    Student    vs AB_Improved    Result: 14 to 6


Results:
----------
Student            67.14%
```

Image 2. Results Alpha equals 1,5.

```
*************************
   Evaluating: Student
*************************

Playing Matches:
----------
  Match 1:   Student   vs   Random      Result: 20 to 0
  Match 2:   Student   vs   MM_Null     Result: 14 to 6
  Match 3:   Student   vs   MM_Open     Result: 10 to 10
  Match 4:   Student   vs MM_Improved   Result: 8 to 12
  Match 5:   Student   vs   AB_Null     Result: 16 to 4
  Match 6:   Student   vs   AB_Open     Result: 12 to 8
  Match 7:   Student   vs AB_Improved   Result: 15 to 5


Results:
----------
Student             67.86%
```

Image 3. Results Alpha equals 2.

```
*************************
   Evaluating: Student
*************************

Playing Matches:
----------
  Match 1:   Student   vs   Random      Result: 18 to 2
  Match 2:   Student   vs   MM_Null     Result: 14 to 6
  Match 3:   Student   vs   MM_Open     Result: 7 to 13
  Match 4:   Student   vs MM_Improved   Result: 13 to 7
  Match 5:   Student   vs   AB_Null     Result: 10 to 10
  Match 6:   Student   vs   AB_Open     Result: 13 to 7
  Match 7:   Student   vs AB_Improved   Result: 11 to 9


Results:
----------
Student             61.43%
```

Image 4. Results Alpha equals 2,5.

```
*************************
   Evaluating: Student
*************************

Playing Matches:
----------
  Match 1:   Student   vs   Random      Result: 14 to 6
  Match 2:   Student   vs   MM_Null     Result: 16 to 4
  Match 3:   Student   vs   MM_Open     Result: 6 to 14
  Match 4:   Student   vs MM_Improved   Result: 8 to 12
  Match 5:   Student   vs   AB_Null     Result: 14 to 6
  Match 6:   Student   vs   AB_Open     Result: 10 to 10
  Match 7:   Student   vs AB_Improved   Result: 14 to 6


Results:
----------
Student            58.57%
```

Image 5. Results alpha equals 3