Heuristic Function

Ren Silva renato s silva@hotmail.com +61 408 060504

I tested my agent in a Macbook Air 13" - so not a very powerful CPU. My searches were always running out of time and returning sub-optimal moves. I guess it is a great way to test an algorithm.

I ended up choosing: Number of My Moves minus Number of Opponent's Moves.

These were my attempts to select the heuristic function:

Number of My Moves

My first attempt of a heuristic function was to use *Number of my moves*. This was the function that was used in class for most examples, and a great starting point.

The result was that my agent was slightly worse than 'ID Improved' agent, as shown below:

Playing Matches:

```
Match 1: ID_Improved vs
                                    Result: 16 to 4
                          Random
Match 2: ID Improved vs
                          MM Null
                                    Result: 18 to 2
Match 3: ID_Improved vs
                          MM Open
                                    Result: 12 to 8
Match 4: ID Improved vs MM Improved Result: 13 to 7
Match 5: ID_Improved vs
                                    Result: 19 to 1
                          AB Null
Match 6: ID_Improved vs
                          AB_Open
                                    Result: 9 to 11
Match 7: ID_Improved vs AB_Improved Result: 11 to 9
```

Results:

ID_Improved 70.00%

Evaluating: Student

Playing Matches:

Match 1: Student Random Result: 18 to 2 ٧S Result: 18 to 2 Match 2: Student MM Null ٧S MM Open Result: 9 to 11 Match 3: Student ٧S Match 4: Student vs MM_Improved Result: 10 to 10 Result: 17 to 3 Match 5: AB Null Student ٧S Result: 12 to 8 Match 6: Student ٧S AB Open Match 7: Student vs AB_Improved Result: 10 to 10

Results:

Student 67.14%

Number of My Moves minus Number of Opponent's Moves

I then changed it to "Number of my moves" minus "Number of Opponent's moves". This has led to significant improvement of my agent, as shown below:

Playing Matches:

```
Match 1: ID_Improved vs
                          Random
                                    Result: 16 to 4
Match 2: ID Improved vs
                          MM Null
                                    Result: 17 to 3
                                    Result: 10 to 10
Match 3: ID_Improved vs
                          MM Open
Match 4: ID_Improved vs MM_Improved Result: 7 to 13
Match 5: ID_Improved vs
                          AB_Null
                                    Result: 19 to 1
Match 6: ID Improved vs
                          AB Open
                                    Result: 9 to 11
Match 7: ID_Improved vs AB_Improved Result: 13 to 7
```

Results:

ID Improved 65.00%

Playing Matches:

```
Match 1: Student vs Random Result: 18 to 2
Match 2: Student vs MM_Null Result: 19 to 1
Match 3: Student vs MM_Open Result: 15 to 5
```

tournament.py:100: UserWarning: One or more agents lost a match this round due to timeout. The get_move() function must return before time_left() reaches 0 ms. You will need to leave some time for the function to return, and may need to increase this margin to avoid timeouts during tournament play.

warnings.warn(TIMEOUT_WARNING)

```
Student
                    vs MM Improved Result: 14 to 6
Match 4:
Match 5:
           Student
                          AB Null
                                    Result: 17 to 3
                     ٧S
Match 6:
           Student
                          AB_Open
                                    Result: 16 to 4
                     ٧S
Match 7:
                     vs AB Improved Result: 13 to 7
           Student
```

Results:

Student 80.00%

Even though I have gained some significant improvement, my agent ran out of time in one of the matches, without returning a move. I went back to the code and found out why - and fixed it.

Number of My Moves minus 2 x Number of Opponent's Moves

I then went and weighted the opponent's moves more, like it was suggested in class.

The improvement was not significant, as I expected.

Playing Matches:

```
Match 1: ID_Improved vs
                         Random
                                   Result: 18 to 2
                         MM Null
                                   Result: 19 to 1
Match 2: ID Improved vs
                         MM_0pen
                                   Result: 11 to 9
Match 3: ID_Improved vs
Match 4: ID_Improved vs MM_Improved Result: 13 to 7
                                   Result: 17 to 3
Match 5: ID_Improved vs
                         AB_Null
Match 6: ID Improved vs
                         AB Open
                                   Result: 8 to 12
Match 7: ID_Improved vs AB_Improved Result: 13 to 7
```

Results:

ID_Improved 70.71%

Evaluating: Student

Playing Matches:

| Match | 1: | Student | VS | Random | Result: | 15 | tο | 5 |
|-------|----|---------|----|-------------|---------|----|----|---|
| Match | | | | | Result: | | | |
| Match | | | | MM_Open | | | | |
| Match | | | | MM Improved | | | | |
| Match | | | | AB Null | | | | |
| Match | | | | AB_Open | | | | |
| | | | | | | | | |
| Match | /: | Student | ٧S | AB_Improved | Result: | 14 | το | О |

Results:

Student 71.43%

This could have been just some random variation, so I tried again:

Playing Matches:

Match 1: ID_Improved vs Random Result: 18 to 2

```
Match 2: ID_Improved vs MM_Null Result: 18 to 2 Match 3: ID_Improved vs MM_Open Result: 13 to 7 Match 4: ID_Improved vs MM_Improved Result: 11 to 9 Match 5: ID_Improved vs AB_Null Result: 19 to 1 Match 6: ID_Improved vs AB_Open Result: 13 to 7 Match 7: ID Improved vs AB Improved Result: 13 to 7
```

Results:

ID_Improved 75.00%

Playing Matches:

```
Match 1:
                                    Result: 17 to 3
                          Random
           Student
                     ٧S
                                    Result: 20 to 0
Match 2:
           Student
                          MM_Null
                     ٧S
Match 3:
           Student
                          MM Open
                                    Result: 15 to 5
                     ٧S
                     vs MM Improved Result: 11 to 9
Match 4:
           Student
Match 5:
           Student
                          AB_Null
                                    Result: 18 to 2
                     ٧S
Match 6:
           Student
                     ٧S
                          AB Open
                                    Result: 12 to 8
Match 7:
                     vs AB_Improved Result: 8 to 12
           Student
```

Results:

Student 72.14%

So, this is definitely not the best heuristic function.

(Back to) Number of My Moves minus Number of Opponent's Moves

So, I went back to option 2, as it appears to be better.

Indeed, my agent's best game occurs when it is focused in winning at the same time that it tries to stop the opponent from wining.

Playing Matches:

```
Result: 18 to 2
Match 1: ID Improved vs
                          Random
Match 2: ID_Improved vs
                          MM Null
                                    Result: 17 to 3
Match 3: ID_Improved vs
                          MM Open
                                    Result: 11 to 9
Match 4: ID_Improved vs MM_Improved Result: 10 to 10
Match 5: ID_Improved vs
                          AB_Null
                                    Result: 20 to 0
Match 6: ID Improved vs
                          AB Open
                                    Result: 14 to 6
Match 7: ID_Improved vs AB_Improved Result: 15 to 5
```

Results:

ID_Improved 75.00%

Playing Matches:

Result: 19 to 1 Match 1: Student ٧S Random Result: 19 to 1 Match 2: MM Null Student ٧S MM_Open Match 3: Student ٧S Result: 16 to 4 Match 4: Student vs MM_Improved Result: 13 to 7 Result: 16 to 4 Match 5: AB Null Student ٧S AB Open Result: 17 to 3 Match 6: Student ٧S

Results:

Match 7:

Student 79.29%

Student

2 x Number of My Moves minus Number of Opponent's Moves

vs AB Improved Result: 11 to 9

And, in, one last attempt, I tried to weigh "my moves" (multiplying to by 2).

Playing Matches:

Match 1: ID_Improved vs Random Result: 17 to 3
Match 2: ID_Improved vs MM_Null Result: 18 to 2
Match 3: ID_Improved vs MM_Open Result: 10 to 10
Match 4: ID_Improved vs MM_Improved Result: 14 to 6
Match 5: ID_Improved vs AB_Null Result: 15 to 5

Match 6: ID_Improved vs AB_Open Result: 12 to 8 Match 7: ID Improved vs AB Improved Result: 14 to 6

Results:

ID_Improved 71.43%

Playing Matches:

tournament.py:100: UserWarning: One or more agents lost a match this round due to timeout. The get_move() function must return before time_left() reaches 0 ms. You will need to leave some time for the

function to return, and may need to increase this margin to avoid timeouts during tournament play.

warnings.warn(TIMEOUT_WARNING)

```
Student
                                     Result: 18 to 2
Match 1:
                           Random
                     ٧S
                                     Result: 16 to 4
Match 2:
           Student
                     ٧S
                           MM Null
Match 3:
           Student
                           MM Open
                                     Result: 11 to 9
                     ٧S
                     vs MM_Improved Result: 14 to 6
Match 4:
           Student
                                     Result: 18 to 2
Match 5:
           Student
                     ٧S
                           AB Null
                           AB_Open
                                     Result: 10 to 10
Match 6:
           Student
                     ٧S
Match 7:
           Student
                     vs AB_Improved Result: 10 to 10
```

Results:

Student 69.29%

The result was disappointing. I tried once more:

Evaluating: ID_Improved

Playing Matches:

```
Match 1: ID_Improved vs
                                    Result: 19 to 1
                          Random
Match 2: ID_Improved vs
                          MM_Null
                                    Result: 18 to 2
Match 3: ID Improved vs
                          MM_Open
                                    Result: 11 to 9
Match 4: ID_Improved vs MM_Improved Result: 12 to 8
                                    Result: 19 to 1
Match 5: ID_Improved vs
                          AB_Null
Match 6: ID Improved vs
                          AB Open
                                    Result: 10 to 10
Match 7: ID_Improved vs AB_Improved Result: 12 to 8
```

Results:

ID_Improved 72.14%

Evaluating: Student

Playing Matches:

```
Match 1:
                                     Result: 18 to 2
           Student
                           Random
                      ٧S
                           MM_Null
                                     Result: 16 to 4
Match 2:
           Student
                     ٧S
Match 3:
           Student
                           MM_Open
                                     Result: 12 to 8
                     ٧S
Match 4:
           Student
                     vs MM Improved Result: 12 to 8
                                     Result: 18 to 2
Match 5:
           Student
                           AB Null
                     ٧S
Match 6:
                           AB Open
                                     Result: 13 to 7
           Student
                      ٧S
Match 7:
                      vs AB_Improved Result: 11 to 9
           Student
```

Results:

Student 71.43%

The result was still disappointing. I went back to option 2:

(Back to) Number of My Moves minus Number of Opponent's Moves

Playing Matches:

```
Result: 14 to 6
Match 1: ID_Improved vs
                          Random
Match 2: ID_Improved vs
                          MM Null
                                    Result: 18 to 2
Match 3: ID_Improved vs
                          MM_Open
                                    Result: 14 to 6
Match 4: ID_Improved vs MM_Improved Result: 8 to 12
Match 5: ID_Improved vs
                          AB_Null
                                    Result: 14 to 6
                                    Result: 14 to 6
Match 6: ID_Improved vs
                          AB Open
Match 7: ID_Improved vs AB_Improved Result: 13 to 7
```

Results:

ID_Improved 67.86%

Playing Matches:

```
Result: 17 to 3
Match 1:
          Student
                   ٧S
                         Random
                         MM_Null
                                  Result: 18 to 2
Match 2:
          Student
                    ٧S
                         MM Open
                                  Result: 16 to 4
Match 3:
          Student
                    ٧S
Match 4:
          Student
                    vs MM Improved Result: 13 to 7
Match 5:
                         AB_Null
                                  Result: 19 to 1
          Student
                    ٧S
                                  Result: 16 to 4
Match 6:
          Student
                    ٧S
                         AB Open
Match 7:
          Student
                    vs AB_Improved Result: 10 to 10
```

Results:

Student 77.86%

(aind) Rens-MacBook-Air:AIND-Isolation Ren\$

So, I chose: Number of My Moves minus Number of Opponent's Moves.