Heuristic Analysis

There are 4 heuristics defined in this project:
1. Simplest_aggressive
2. Maximize_winning
3. Minimize_losing
4. Weighted_combination

1. Simplest_aggressive: By this heuristic, we are trying to minimize opponent's moves. (Described in lectures) Instead of subtracting the no. of opponent moves (OM) from the main player's moves (PM) we're using a more aggressive approach. Before subtracting OM from PM, we multiply it by 2. This way, we're rewarding the states which have less and less number of OM left which in turn makes it easier for main player to win.
It can be mathematically expressed as:

len(main_player_moves) – alpha * len(opponent's moves)

As described above, the value of alpha is chosen as 2.

2. Maximize_winning: By this approach, we're trying to minimize the ratio of opponent moves to main player's moves. In short, opponent should have lesser moves as compared to main player's moves.
It can be mathematically expressed as:

len(main_player_moves) / len(opponent's moves)

3. Minimize_losing: Here. we're trying to minimize the ratio of opponent moves to main player's moves. Or no. of main player moves should be much more than no. of moves of opponent.

- len(opponent's moves) / len(main_player_moves)

4. Weighted_combination:
This can be expressed as:

alpha * maximize_winning – beta * minimize_losing

As we can see that this is much effective heuristic, since it combines both of the above heuristics.
Here alpha is 1 and beta is 1.5.

Results:

Agent	**Performance**
ID_Improved	68.14%
Student1	70.04%
Student2	66.86%
Student3	66.00%
Student4	68.36%

Result of tournament.py:

```
This script evaluates the performance of the custom heuristic function by
comparing the strength of an agent using iterative deepening (ID) search
with alpha-beta pruning against the strength rating of agents using other
heuristic functions.  The `ID_Improved` agent provides a baseline by
measuring the performance of a basic agent using Iterative Deepening and
the "improved" heuristic (from lecture) on your hardware.  The `Student`
agent then measures the performance of Iterative Deepening and the custom
heuristic against the same opponents.


*************************
 Evaluating: ID_Improved
*************************

Playing Matches:
----------
  Match 1: ID_Improved vs   Random      Result: 334 to 66
  Match 2: ID_Improved vs   MM_Null     Result: 303 to 97
  Match 3: ID_Improved vs   MM_Open     Result: 263 to 137
  Match 4: ID_Improved vs MM_Improved   Result: 252 to 148
  Match 5: ID_Improved vs   AB_Null     Result: 290 to 110
  Match 6: ID_Improved vs   AB_Open     Result: 230 to 170
  Match 7: ID_Improved vs AB_Improved   Result: 236 to 164


Results:
----------
ID_Improved         68.14%
```

```
*************************

Evaluating: Student1
*************************

Playing Matches:
----------
  Match 1:  Student1   vs   Random      Result: 339 to 61
  Match 2:  Student1   vs   MM_Null     Result: 309 to 91
  Match 3:  Student1   vs   MM_Open     Result: 265 to 135
  Match 4:  Student1   vs MM_Improved   Result: 258 to 142
  Match 5:  Student1   vs   AB_Null     Result: 294 to 106
  Match 6:  Student1   vs   AB_Open     Result: 257 to 143
  Match 7:  Student1   vs AB_Improved   Result: 239 to 161


Results:
----------
Student1            70.04%

*************************
  Evaluating: Student2
*************************

Playing Matches:
----------
  Match 1:  Student2   vs   Random      Result: 329 to 71
  Match 2:  Student2   vs   MM_Null     Result: 294 to 106
  Match 3:  Student2   vs   MM_Open     Result: 258 to 142
  Match 4:  Student2   vs MM_Improved   Result: 242 to 158
  Match 5:  Student2   vs   AB_Null     Result: 270 to 130
  Match 6:  Student2   vs   AB_Open     Result: 248 to 152
  Match 7:  Student2   vs AB_Improved   Result: 231 to 169


Results:
----------
Student2            66.86%

*************************
  Evaluating: Student3
*************************

Playing Matches:
----------
  Match 1:  Student3   vs   Random      Result: 317 to 83
  Match 2:  Student3   vs   MM_Null     Result: 297 to 103
  Match 3:  Student3   vs   MM_Open     Result: 246 to 154
```

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  Match 4:  Student3   vs MM_Improved   Result: 238 to 162
  Match 5:  Student3   vs   AB_Null     Result: 285 to 115
  Match 6:  Student3   vs   AB_Open     Result: 248 to 152
  Match 7:  Student3   vs AB_Improved   Result: 217 to 183


Results:
----------
Student3            66.00%


*************************
  Evaluating: Student4
*************************

Playing Matches:
----------
  Match 1:  Student4   vs   Random      Result: 337 to 63
  Match 2:  Student4   vs   MM_Null     Result: 299 to 101
  Match 3:  Student4   vs   MM_Open     Result: 268 to 132
  Match 4:  Student4   vs MM_Improved   Result: 242 to 158
  Match 5:  Student4   vs   AB_Null     Result: 286 to 114
  Match 6:  Student4   vs   AB_Open     Result: 253 to 147
  Match 7:  Student4   vs AB_Improved   Result: 229 to 171


Results:
----------
Student4            68.36%
```