

Evaluation Functions and Performances

1. eval_1: the difference of squares of own moves and opponent moves.
Balanced strategy which amplifies own and opponent moves exponentially. Weaker than ID_Improved.

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

Playing Matches:

Match 1: ID_Improved vs Random      Result: 20 to 0
Match 2: ID_Improved vs MM_Null     Result: 17 to 3
Match 3: ID_Improved vs MM_Open     Result: 17 to 3
Match 4: ID_Improved vs MM_Improved Result: 15 to 5
Match 5: ID_Improved vs AB_Null     Result: 17 to 3
Match 6: ID_Improved vs AB_Open     Result: 13 to 7
Match 7: ID_Improved vs AB_Improved Result: 15 to 5

Results:
ID_Improved      81.43%

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

Playing Matches:

Match 1: Student vs Random      Result: 19 to 1
Match 2: Student vs MM_Null     Result: 18 to 2
Match 3: Student vs MM_Open     Result: 12 to 8
Match 4: Student vs MM_Improved Result: 13 to 7
Match 5: Student vs AB_Null     Result: 17 to 3
Match 6: Student vs AB_Open     Result: 12 to 8
Match 7: Student vs AB_Improved Result: 13 to 7

Results:
Student          74.29%
```

2. eval_2: own moves – 2 * opponent moves
a defensive strategy. Similar performance to ID_Improved.

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

Playing Matches:

Match 1: ID_Improved vs Random      Result: 20 to 0
Match 2: ID_Improved vs MM_Null     Result: 19 to 1
Match 3: ID_Improved vs MM_Open     Result: 14 to 6
Match 4: ID_Improved vs MM_Improved Result: 16 to 4
Match 5: ID_Improved vs AB_Null     Result: 18 to 2
Match 6: ID_Improved vs AB_Open     Result: 12 to 8
Match 7: ID_Improved vs AB_Improved Result: 13 to 7

Results:
ID_Improved      80.00%

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

Playing Matches:

Match 1: Student vs Random      Result: 20 to 0
Match 2: Student vs MM_Null     Result: 18 to 2
Match 3: Student vs MM_Open     Result: 14 to 6
Match 4: Student vs MM_Improved Result: 15 to 5
Match 5: Student vs AB_Null     Result: 20 to 0
Match 6: Student vs AB_Open     Result: 13 to 7
Match 7: Student vs AB_Improved Result: 13 to 7

Results:
Student          80.71%
```

3. eval_3: own moves – opponent moves – move count

balanced strategy which prefers less game progression. A bit more performant than ID_Improved.

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

Playing Matches:

Match 1: ID_Improved vs Random      Result: 19 to 1
Match 2: ID_Improved vs MM_Null     Result: 19 to 1
Match 3: ID_Improved vs MM_Open     Result: 13 to 7
Match 4: ID_Improved vs MM_Improved Result: 17 to 3
Match 5: ID_Improved vs AB_Null     Result: 15 to 5
Match 6: ID_Improved vs AB_Open     Result: 10 to 10
Match 7: ID_Improved vs AB_Improved Result: 7 to 13

Results:
ID_Improved      71.43%

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

Playing Matches:

Match 1: Student vs Random      Result: 20 to 0
Match 2: Student vs MM_Null     Result: 18 to 2
Match 3: Student vs MM_Open     Result: 15 to 5
Match 4: Student vs MM_Improved Result: 15 to 5
Match 5: Student vs AB_Null     Result: 19 to 1
Match 6: Student vs AB_Open     Result: 11 to 9
Match 7: Student vs AB_Improved Result: 4 to 16

Results:
Student          72.86%
```

4. eval_4:

if move count few: own moves – opponent moves

else if move count middle: own moves – opponent moves – move count

else: move count high: own moves – opponent moves

hybrid strategy based on game progression. Initially balanced, then also considers game progression, but in the end returns back to pure balanced strategy. Weaker than ID_Improved.

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

Playing Matches:

Match 1: ID_Improved vs Random      Result: 19 to 1
Match 2: ID_Improved vs MM_Null     Result: 19 to 1
Match 3: ID_Improved vs MM_Open     Result: 16 to 4
Match 4: ID_Improved vs MM_Improved Result: 13 to 7
Match 5: ID_Improved vs AB_Null     Result: 17 to 3
Match 6: ID_Improved vs AB_Open     Result: 16 to 4
Match 7: ID_Improved vs AB_Improved Result: 11 to 9

Results:
ID_Improved      79.29%

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

Playing Matches:

Match 1: Student vs Random      Result: 20 to 0
Match 2: Student vs MM_Null     Result: 16 to 4
Match 3: Student vs MM_Open     Result: 12 to 8
tournament.py:100: UserWarning: One or more agents lost a
return before time_left() reaches 0 ms. You will need to le
ase this margin to avoid timeouts during tournament play.
warnings.warn(TIMEOUT_WARNING)
Match 4: Student vs MM_Improved Result: 10 to 10
Match 5: Student vs AB_Null     Result: 16 to 4
Match 6: Student vs AB_Open     Result: 9 to 11
Match 7: Student vs AB_Improved Result: 11 to 9

Results:
Student          67.14%
```

5. eval_5:

random selection, 40% own moves – opponent moves, 60% own moves – opponent moves – move count

hybrid probabilistic approach with combination of balanced and balanced with anti-progressive strategy. Weaker than ID_Improved.

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

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: 17 to 3
Match 4: ID_Improved vs MM_Improved Result: 14 to 6
Match 5: ID_Improved vs AB_Null     Result: 19 to 1
Match 6: ID_Improved vs AB_Open     Result: 12 to 8
Match 7: ID_Improved vs AB_Improved Result: 11 to 9

Results:
ID_Improved      77.86%

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

Playing Matches:

Match 1: Student vs Random      Result: 19 to 1
Match 2: Student vs MM_Null     Result: 19 to 1
Match 3: Student vs MM_Open     Result: 17 to 3
Match 4: Student vs MM_Improved Result: 13 to 7
Match 5: Student vs AB_Null     Result: 13 to 7
Match 6: Student vs AB_Open     Result: 9 to 11
Match 7: Student vs AB_Improved Result: 10 to 10

Results:
Student          71.43%
```

6. eval_6:
 - move count < 0.9 * game size: own moves – opponent moves
 - else: own moves – opponent moves – move count

hybrid strategy based on game progression. Until end of game balanced strategy. At the end anti game progression strategy. A bit weaker than ID_Improved.

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

Playing Matches:

Match 1: ID_Improved vs Random      Result: 20 to 0
Match 2: ID_Improved vs MM_Null     Result: 20 to 0
Match 3: ID_Improved vs MM_Open     Result: 17 to 3
Match 4: ID_Improved vs MM_Improved Result: 13 to 7
Match 5: ID_Improved vs AB_Null     Result: 17 to 3
Match 6: ID_Improved vs AB_Open     Result: 14 to 6
Match 7: ID_Improved vs AB_Improved Result: 13 to 7

Results:
ID_Improved      81.43%

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

Playing Matches:

Match 1: Student vs Random      Result: 19 to 1
Match 2: Student vs MM_Null     Result: 19 to 1
Match 3: Student vs MM_Open     Result: 16 to 4
Match 4: Student vs MM_Improved Result: 15 to 5
Match 5: Student vs AB_Null     Result: 19 to 1
Match 6: Student vs AB_Open     Result: 16 to 4
Match 7: Student vs AB_Improved Result: 9 to 11

Results:
Student          80.71%
```

7. eval_7:
 - if move count < 0.1 * game size: own moves
 - else if move count < 0.9 * game size: own moves – opponent moves + move count
 - else move count: own moves – opponent moves – move count

hybrid strategy. This time initially try open strategy. Until end of the game pro game progression strategy. At the end anti game progression strategy. More performant than ID_Improved.

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

Playing Matches:

Match 1: ID_Improved vs Random      Result: 19 to 1
Match 2: ID_Improved vs MM_Null     Result: 17 to 3
Match 3: ID_Improved vs MM_Open     Result: 15 to 5
Match 4: ID_Improved vs MM_Improved Result: 14 to 6
Match 5: ID_Improved vs AB_Null     Result: 18 to 2
Match 6: ID_Improved vs AB_Open     Result: 15 to 5
Match 7: ID_Improved vs AB_Improved Result: 9 to 11

Results:
ID_Improved      76.43%

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

Playing Matches:

Match 1: Student vs Random      Result: 20 to 0
Match 2: Student vs MM_Null     Result: 18 to 2
Match 3: Student vs MM_Open     Result: 16 to 4
Match 4: Student vs MM_Improved Result: 15 to 5
Match 5: Student vs AB_Null     Result: 19 to 1
Match 6: Student vs AB_Open     Result: 13 to 7
Match 7: Student vs AB_Improved Result: 16 to 4

Results:
Student          83.57%
```

8. eval_8:
 - if move count < 0.1 * game size: own moves
 - else: own moves – opponent moves + move count

hybrid strategy. Initially open, then pro game progression strategy. More performant than ID_Improved.

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

Playing Matches:

tournament.py:100: UserWarning: One or more agents lost a
return before time_left() reaches 0 ms. You will need to l
ase this margin to avoid timeouts during tournament play
warnings.warn(TIMEOUT_WARNING)
Match 1: ID_Improved vs Random      Result: 18 to 2
Match 2: ID_Improved vs MM_Null     Result: 16 to 4
Match 3: ID_Improved vs MM_Open     Result: 15 to 5
Match 4: ID_Improved vs MM_Improved Result: 15 to 5
Match 5: ID_Improved vs AB_Null     Result: 18 to 2
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      77.14%

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

Playing Matches:

Match 1: Student vs Random      Result: 20 to 0
Match 2: Student vs MM_Null     Result: 19 to 1
Match 3: Student vs MM_Open     Result: 18 to 2
Match 4: Student vs MM_Improved Result: 17 to 3
Match 5: Student vs AB_Null     Result: 17 to 3
Match 6: Student vs AB_Open     Result: 17 to 3
Match 7: Student vs AB_Improved Result: 13 to 7

Results:
Student          86.43%
```

9. eval_9: own moves – opponent moves + move count
balanced strategy with pro game progression approach. Remarkable more performant than ID_Improved.

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

Playing Matches:

Match 1: ID_Improved vs Random      Result: 18 to 2
Match 2: ID_Improved vs MM_Null     Result: 17 to 3
Match 3: ID_Improved vs MM_Open     Result: 15 to 5
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: 15 to 5
Match 7: ID_Improved vs AB_Improved Result: 12 to 8

Results:
ID_Improved      75.71%

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

Playing Matches:

Match 1: Student vs Random      Result: 20 to 0
Match 2: Student vs MM_Null     Result: 17 to 3
Match 3: Student vs MM_Open     Result: 16 to 4
Match 4: Student vs MM_Improved Result: 15 to 5
Match 5: Student vs AB_Null     Result: 20 to 0
Match 6: Student vs AB_Open     Result: 16 to 4
Match 7: Student vs AB_Improved Result: 15 to 5

Results:
Student          85.00%
```

10. occupancy * (own moves – opponent moves) + move count
balanced strategy combined with occupancy and pro game progression approach.
More performant than ID_Improved.

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

Playing Matches:

Match 1: ID_Improved vs Random      Result: 17 to 3
Match 2: ID_Improved vs MM_Null     Result: 17 to 3
Match 3: ID_Improved vs MM_Open     Result: 14 to 6
Match 4: ID_Improved vs MM_Improved Result: 12 to 8
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: 12 to 8

Results:
ID_Improved      74.29%

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

Playing Matches:

Match 1: Student vs Random      Result: 19 to 1
Match 2: Student vs MM_Null     Result: 19 to 1
Match 3: Student vs MM_Open     Result: 15 to 5
Match 4: Student vs MM_Improved Result: 17 to 3
Match 5: Student vs AB_Null     Result: 19 to 1
Match 6: Student vs AB_Open     Result: 13 to 7
Match 7: Student vs AB_Improved Result: 14 to 6

Results:
Student          82.86%
```

11. occupancy * (own moves – (2 * occupancy) * opponent moves) + move count
hybrid strategy combined with occupancy and pro game progression approach.
Adaptive offense/defense according to occupancy. Initially offensive, but then defensive approach. More performant than ID_Improved.

```

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

Playing Matches:
-----
Match 1: ID_Improved vs Random      Result: 20 to 0
tournament.py:100: UserWarning: One or more agents lost a
. The get_move() function must return before time_left() r
eave some time for the function to return, and may need to
timeouts during tournament play.
warnings.warn(TIMEOUT_WARNING)
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: 15 to 5
Match 5: ID_Improved vs AB_Null     Result: 17 to 3
Match 6: ID_Improved vs AB_Open     Result: 14 to 6
Match 7: ID_Improved vs AB_Improved Result: 10 to 10

Results:
-----
ID_Improved      76.43%

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

Playing Matches:
-----
Match 1: Student vs Random      Result: 20 to 0
Match 2: Student vs MM_Null     Result: 17 to 3
Match 3: Student vs MM_Open     Result: 16 to 4
Match 4: Student vs MM_Improved Result: 15 to 5
Match 5: Student vs AB_Null     Result: 16 to 4
Match 6: Student vs AB_Open     Result: 20 to 0
Match 7: Student vs AB_Improved Result: 14 to 6

Results:
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Student          84.29%

```

Recommendation for Evaluation Function

eval_9 is the winner of all. As seen in eval_7, 8, 9, 10 and 11 the pro game progression approaches (+ move count) are clearly more performant. Balanced strategy also performs better than aggressively offensive or defensive strategies. Random and probabilistic approaches lead to weaker results as seen in eval_4 and 5. Hybrid approaches do not necessarily always improve the results as seen in eval_5, 6 and 11.