

Heuristic Analysis

For the heuristic analysis we will evaluate 3 heuristics in the custom_scores and comment about the ID_Improved.

Three heuristics

The heuristics are:

Difference between number of player's movements minus number of opponent's movements – Heuristic 1

Here it is the code:

```
return (float(len(game.get_legal_moves(player))) -  
len(game.get_legal_moves(game.get_opponent(player))))
```

This is the simplest heuristic we analysed. The results were 66.71% student against 66.25% ID_Improved. In the end evaluating this heuristic against the ID_Improved, they are really calculating the same thing.

The difference in performance is due to the Student code to be faster being able to evaluate deeper positions.

Average difference between number of player's movements minus number of opponent's movements for one move ahead – Heuristic 2

Code:

```
score = 0  
  
for move in game.get_legal_moves(player):  
    game_copy = game.forecast_move(move)  
    score += float(len(game_copy.get_legal_moves(player))) -  
len(game_copy.get_legal_moves(game.get_opponent(player)))  
  
division = (len(game.get_legal_moves(player)) if len(game.get_legal_moves(player)) !=  
0 else 0.001)  
  
return score / division
```

The performance here was 67.21% Student and 67.96% ID_Improved. When we go one movement ahead we are seeing more into the future than the ID_Improved but since we are spending more time the result is approximately the same.

Average difference between number of player's movements minus number of opponent's movements for two moves ahead – Heuristic 3

Code:

```

score = 0

division = 0

for move in game.get_legal_moves(player):

    game_copy = game.forecast_move(move)

    for second_move in game_copy.get_legal_moves(game.get_opponent(player)):

        game_second_copy = game_copy.forecast_move(second_move)

        score += (

            float(len(game_second_copy.get_legal_moves(player))) -

            len(game_second_copy.get_legal_moves(game.get_opponent(player))))

        division += 1

division = (division if division != 0 else 0.001)

return score / division

```

The performance here was 58.82% Student and 67.00% ID_Improved. When we increased the code the time to run it became too high, in the end we couldn't perform better than ID_Improved. We lost too much time performing the custom_score and were not seeing deeper enough in the end.

Table with runs

Heuristic 1		Heuristic 2		Heuristic 3	
ID_Improved	Student	ID_Improved	Student	ID_Improved	Student
65.71	62.86	68.57	65.00	67.14	58.57
66.43	65.00	64.29	65.00	69.29	57.14
68.57	60.00	69.29	70.00	70.00	59.29
62.86	71.43	71.43	65.00	64.29	62.14
65.00	65.71	64.29	61.43	71.43	56.43
63.57	70.00	68.57	65.71	67.86	56.43
60.00	62.86	67.86	67.14	70.71	63.57
67.14	67.14	66.43	62.86	67.14	62.86
68.57	67.86	77.14	71.43	70.00	62.14
63.57	67.14	70.00	68.57	61.43	55.71
61.43	71.43	69.29	70.71	61.43	60.71
67.86	71.43	60.71	67.14	72.14	60.00
69.29	68.57	70.71	65.71	72.86	57.86
73.57	68.57	69.29	69.29	67.14	55.71
70.00	64.29	66.43	69.29	66.43	59.29
67.86	62.14	67.86	68.57	65.00	55.00
62.86	74.29	65.00	67.14	67.14	59.29

62.86	61.43	64.29	65.00	62.86	60.71
66.43	70.00	68.57	75.71	55.71	61.43
71.43	62.14	69.29	63.57	70.00	52.14

Conclusion

In the end the heuristic choosen is the one that see one move ahead. It is similar to the ID_Improved but it is more prepared to the end of the game, when one move can be the difference between winning and losing.