CUSTOM HEURISTICS IN KNIGHT'S MOVE ISOLATION

INTRODUCTION

A good heuristic score is an important factor of the minimax strategy for picking optimal game moves. The heuristic show provide an estimate of the value of a move when the search is cut off before reaching a terminal node.

The baseline for comparison will be the performance of the ID_Improved agent. This agent delivers a strong performance, winning over 75% of the matches in the tournament.

```
Match 1: ID_Improved vs   Random        Result: 372 to 28
Match 2: ID_Improved vs   MM_Null       Result: 341 to 59
Match 3: ID_Improved vs   MM_Open       Result: 288 to 112
Match 4: ID_Improved vs MM_Improved     Result: 261 to 139
Match 5: ID_Improved vs   AB_Null       Result: 313 to 87
Match 6: ID_Improved vs   AB_Open       Result: 273 to 127
Match 7: ID_Improved vs AB_Improved     Result: 257 to 143
----------
ID_Improved      75.18%
```

CUSTOM HEURISTIC 1

For the first custom heuristic, we will experiment with a score that tries to reduce the number of open moves available to the opponent. This will attempt to reward moves that limit the opponent's options. For this heuristic we will not consider any factors related to the player agent and instead focus only on the opponent. This should provide an interesting contrast to the player-centric open moves strategy.

There are several ways to score the opponent's position based on open moves, but we will simply use the inverse of the number of open moves, with a smoothing factor to ensure that the score is still well defined when the opponent has run out of moves.

$$1 / (1 + opponent\_open\_moves)$$

```
Match 1:  Student  vs  Random        Result: 358 to 42
Match 2:  Student  vs  MM_Null       Result: 339 to 61
Match 3:  Student  vs  MM_Open       Result: 264 to 136
Match 4:  Student  vs MM_Improved    Result: 266 to 134
Match 5:  Student  vs  AB_Null       Result: 314 to 86
Match 6:  Student  vs  AB_Open       Result: 267 to 133
Match 7:  Student  vs AB_Improved    Result: 255 to 145
----------
Student       73.68%
```

This heuristic performed slightly worse than the ID_Improved agent. Interestingly, while it performed similarly against the "improved" heuristic, it suffered more losses against the weaker "open" heuristic.

CUSTOM HEURISTIC 2

For the second custom heuristic, we return to considering the player's number of open moves but add in another factor to consider the opponent's open moves. By using the same term as we

used in the first heuristic, we guarantee that this factor lies within the range of 0 to 1. Effectively, then, this is analogous to the player open moves heuristic but where ties are broken by positions that minimize the number of opponent moves.

$$player\_open\_moves + 1 / (1 + opponent\_open\_moves)$$

```
Match 1:  Student  vs  Random          Result: 372 to 28
Match 2:  Student  vs  MM_Null         Result: 335 to 65
Match 3:  Student  vs  MM_Open         Result: 300 to 100
Match 4:  Student  vs MM_Improved      Result: 273 to 127
Match 5:  Student  vs  AB_Null `       Result: 325 to 75
Match 6:  Student  vs  AB_Open         Result: 267 to 133
Match 7:  Student  vs AB_Improved      Result: 270 to 130
----------
Student         76.50%
```

This heuristic was able to slightly outperform the ID_Improved agent. It was particularly effective against the "open" heuristic. This makes sense, as its use of opponent information to decide between otherwise equivalent open moves would let it prefer moves that restricted its opponent.

CUSTOM HEURISTIC 3

For the final custom heuristic, we will once again consider the number of open moves for both player and opponent. This time, however, we will combine the factors by taking the ratio of player open moves to opponent open moves. Like the improved heuristic developed in the classroom, this score will force the player to balance keeping itself open with trying to fence in the opponent. By using a ratio instead of a difference, however, the player may make different decisions about how to trade off between the two factors.

$$player\_open\_moves / (1 + opponent\_open\_moves)$$

```
Match 1:  Student  vs  Random          Result: 371 to 29
Match 2:  Student  vs  MM_Null         Result: 341 to 59
Match 3:  Student  vs  MM_Open         Result: 284 to 116
Match 4:  Student  vs MM_Improved      Result: 274 to 126
Match 5:  Student  vs  AB_Null         Result: 319 to 81
Match 6:  Student  vs  AB_Open         Result: 279 to 121
Match 7:  Student  vs AB_Improved      Result: 262 to 138
----------
Student         76.07%
```

This heuristic also performed extremely well, but didn't quite reach the effectiveness of the second heuristic.

CONCLUSION

For this project, we will select the second heuristic. Not only did it perform well against the "improved" heuristic used by the ID_Improved agent, but it also performed very strongly against the "open" heuristic as well. Hopefully this will make it a more robust contender against agents using a wider variety of strategies.