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4/14/21
Artificial Intelligence: Evaluation Functions for Connect 4 and Chess

Description:

The goal of this project is to create a heuristic that will provide the statistics needed for using an adversarial min and max algorithm. Quantifying the advantage of one player over another with respect to Chess and Connect 4 has been interesting. There are multiple methodologies behind quantifying advantage with respect to Chess and Connect4.

The method chosen here for Chess evaluation is Piece Advantage. With Piece Advantage only the number of each piece is considered and not its position. The other method explored while completing this exercise is the Piece-Square Advantage method. This method considers both how many of each type of piece but also each pieces position. This approach is a more accurate of a heuristic.

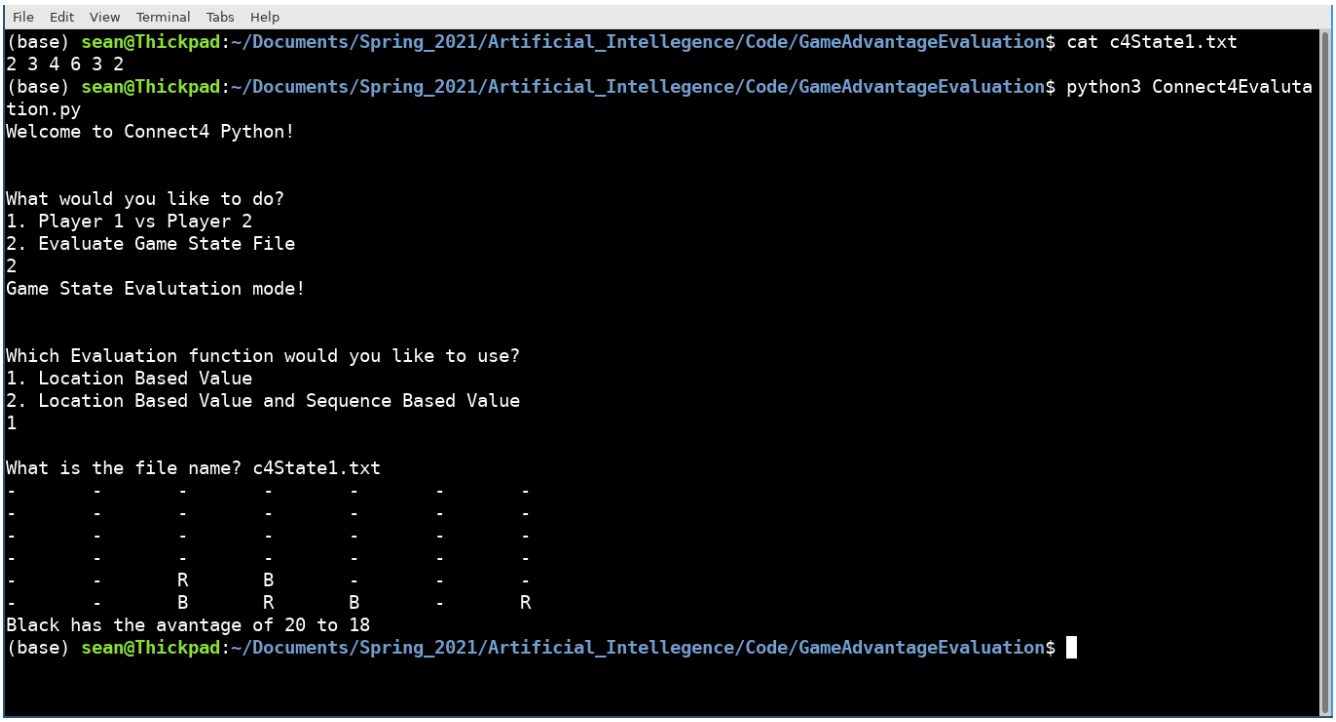
My implementation of Connect4 game state evaluation consist or two methods. The first method is a table of depicting the distribution of value associated with each cell. When called the function will traverse the current state of the game board and searched for player pieces. If a player's piece is detected its position(row and column) will be used as the index for the associated value of that cell. Once the value of the detected cell is retrieved the total for the corresponding player will be updated. The second method of evaluation consist of a combination of the first method and a piece sequence method. I created this method to quantify a given state of Connect4 based on the number of pieces a player has, compared to the other, in a row, column, or diagonal. If a player has more than the other in a sequence then the number of pieces in the sequence will be added to the players total score. If the two players have the same number of pieces in a sequence then no value will be attributed to either player.

Connect4Evaluation.py

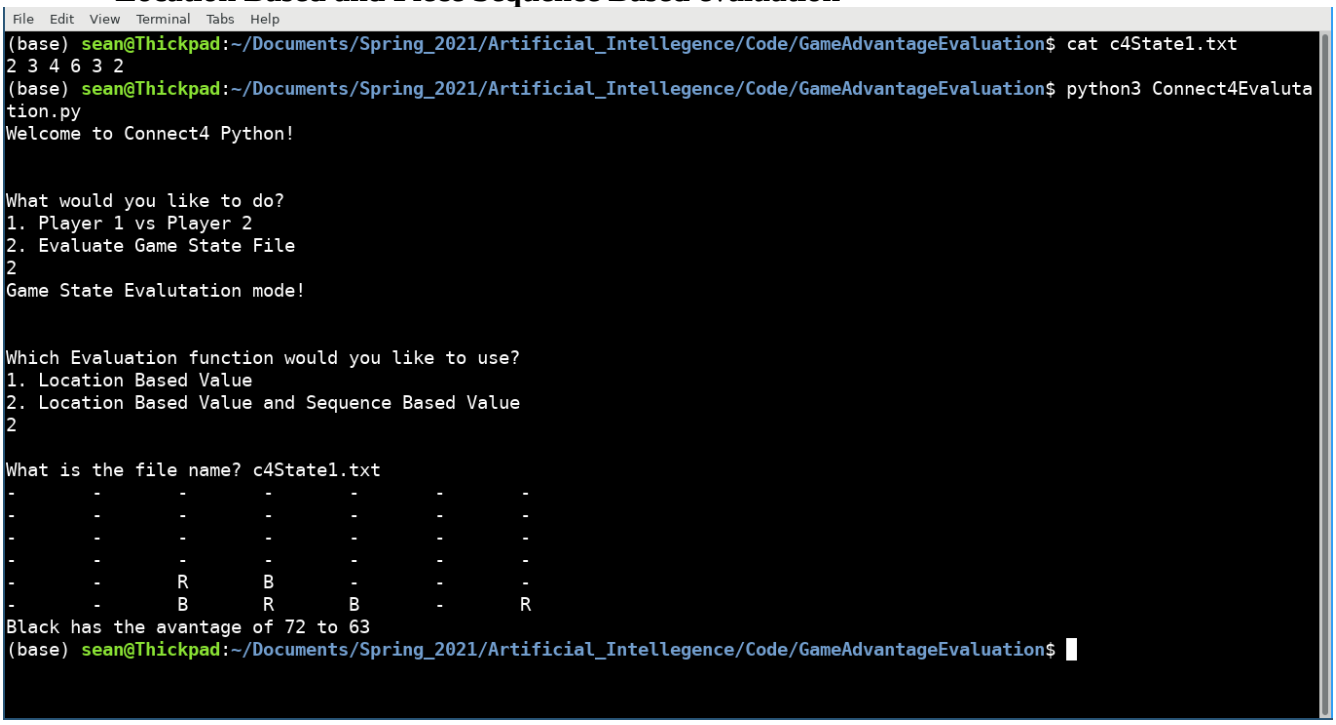
My implementation of Connect4 Evaluation allows for both live play evaluation and game state file evaluation. With live players after each turn the evaluation function will run and print the current advantage. With game state files the program will interpret the file, then perform the moves specified by the file, and finally evaluate which player has the advantage.

Game State File Evaluation:

Location Based Evaluation



Location Based and Piece Sequence Based evaluation



Player vs Player Evaluation

Location Based Evaluation

```
File  Edit  View  Terminal  Tabs  Help
(base) sean@Thickpad:~/Documents/Spring_2021/Artificial_Intellegence/Code/GameAdvantageEvaluation$ python3 Connect4Evaluta
tion.py
Welcome to Connect4 Python!


What would you like to do?
1. Player 1 vs Player 2
2. Evaluate Game State File
1
Player vs Player mode!

Which Evaluation function would you like to use?
1. Location Based Value
2. Location Based Value and Sequence Based Value
1
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -

Player 1's Turn
Enter a Column 0
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
B       -       -       -       -       -       -
Black has the avantage of 3 to 0
```

```
File  Edit  View  Terminal  Tabs  Help
Player 2's Turn
Enter a Column 6
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
B       -       -       -       -       -       R
Neither player has the advantage

Player 1's Turn
Enter a Column 1
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
B       B       -       -       -       -       R
Black has the avantage of 7 to 3

Player 2's Turn
Enter a Column 4
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
B       B       -       -       R       -       R
Red has the avantage of 8 to 7

Player 1's Turn
```

```
File  Edit  View  Terminal  Tabs  Help
Player 1's Turn
Enter a Column 3
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
B       B       -       B       R       -       R
Black has the avantage of 14 to 8

Player 2's Turn
Enter a Column 2
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
B       B       R       B       R       -       R
Black has the avantage of 14 to 13

Player 1's Turn
Enter a Column 0
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
B       -       -       -       -       -       -
B       B       R       B       R       -       R
Black has the avantage of 18 to 13

Player 2's Turn
```

```
File  Edit  View  Terminal  Tabs  Help

Player 2's Turn
Enter a Column 6
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
B       -       -       -       -       -       R
B       B       R       B       R       -       R
Black has the avantage of 18 to 17

Player 1's Turn
Enter a Column 0
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
B       -       -       -       -       -       -
B       -       -       -       -       -       R
B       B       R       B       R       -       R
Black has the avantage of 23 to 17

Player 2's Turn
Enter a Column 0
-       -       -       -       -       -       -
-       -       -       -       -       -       -
R       -       -       -       -       -       -
B       -       -       -       -       -       -
B       -       -       -       -       -       R
B       B       R       B       R       -       R
Black has the avantage of 23 to 22
```

```
File  Edit  View  Terminal  Tabs  Help

Player 1's Turn
Enter a Column 1
-       -       -       -       -       -       -
-       -       -       -       -       -       -
R       -       -       -       -       -       B
B       B       -       -       -       -       R
B       B       -       -       R       -       R
B       B       R       B       R       -       R
Black has the avantage of 42 to 35

Player 2's Turn
Enter a Column 3
-       -       -       -       -       -       -
-       -       -       -       -       -       -
R       -       -       -       -       -       B
B       B       -       -       -       -       R
B       B       -       R       R       -       R
B       B       R       B       R       -       R
Red has the avantage of 45 to 42

Player 1's Turn
Enter a Column 1
-       -       -       -       -       -       -
-       -       -       -       -       -       -
R       B       -       -       -       -       B
B       B       -       -       -       -       R
B       B       -       R       R       -       R
B       B       R       B       R       -       R
Black has the avantage of 50 to 45
Black has won
```

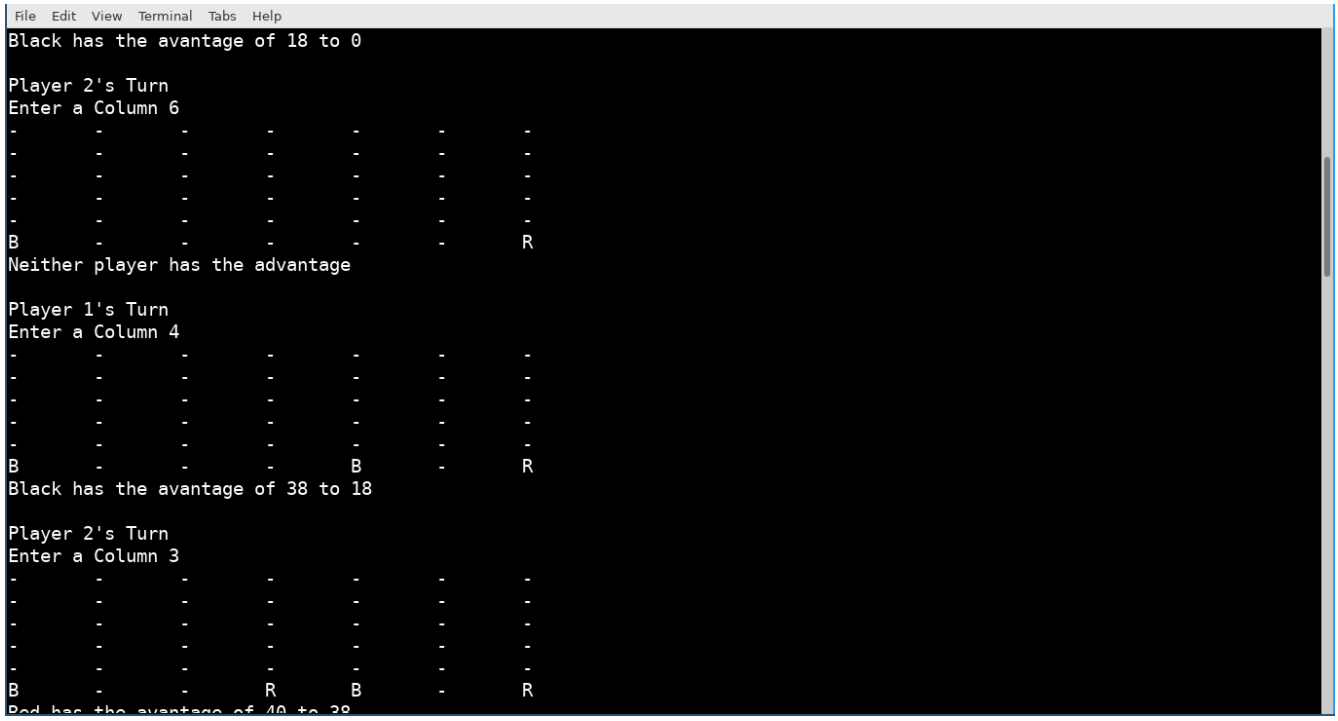
Location Based and Piece Sequence Based evaluation

```
File  Edit  View  Terminal  Tabs  Help
(base) sean@Thickpad:~/Documents/Spring_2021/Artificial_Intellegence/Code/GameAdvantageEvaluation$ python3 Connect4Evaluta
tion.py
Welcome to Connect4 Python!


What would you like to do?
1. Player 1 vs Player 2
2. Evaluate Game State File
1
Player vs Player mode!

Which Evaluation function would you like to use?
1. Location Based Value
2. Location Based Value and Sequence Based Value
2
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -

Player 1's Turn
Enter a Column 0
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
B       -       -       -       -       -       -
Black has the avantage of 18 to 0
```

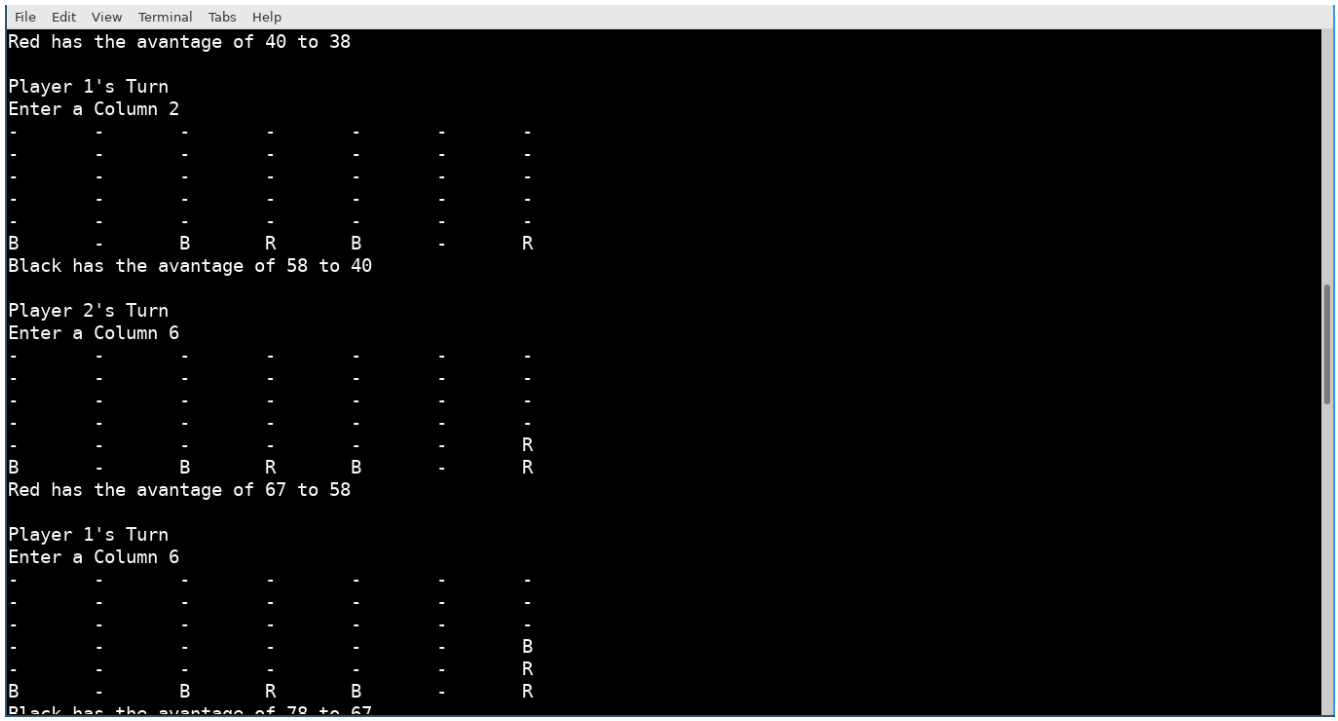


```
File  Edit  View  Terminal  Tabs  Help
Black has the avantage of 18 to 0

Player 2's Turn
Enter a Column 6
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
B       -       -       -       -       -       R
Neither player has the advantage

Player 1's Turn
Enter a Column 4
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
B       -       -       -       B       -       R
Black has the avantage of 38 to 18

Player 2's Turn
Enter a Column 3
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
B       -       -       R       B       -       R
Red has the avantage of 40 to 38
```

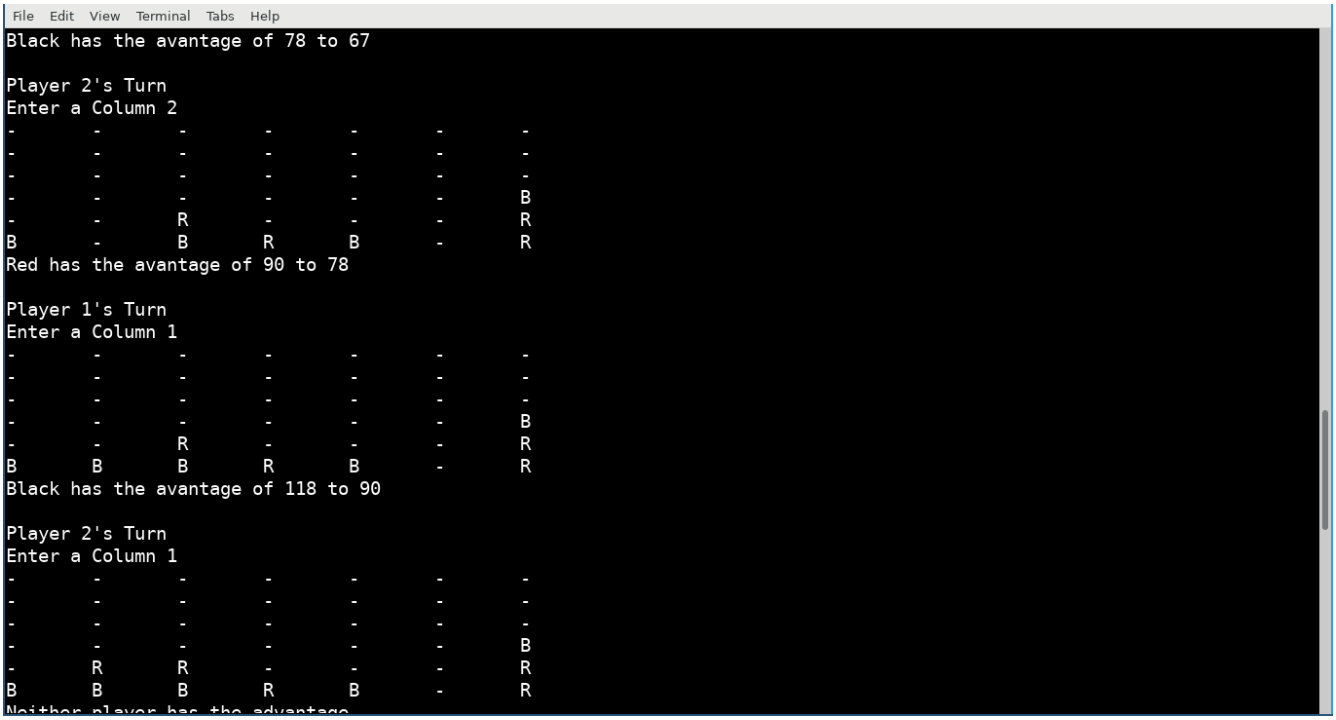


```
File  Edit  View  Terminal  Tabs  Help
Red has the avantage of 40 to 38

Player 1's Turn
Enter a Column 2
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
B       -       B       R       B       -       R
Black has the avantage of 58 to 40

Player 2's Turn
Enter a Column 6
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       R
B       -       B       R       B       -       R
Red has the avantage of 67 to 58

Player 1's Turn
Enter a Column 6
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       B
-       -       -       -       -       -       R
B       -       B       R       B       -       R
Black has the avantage of 78 to 67
```

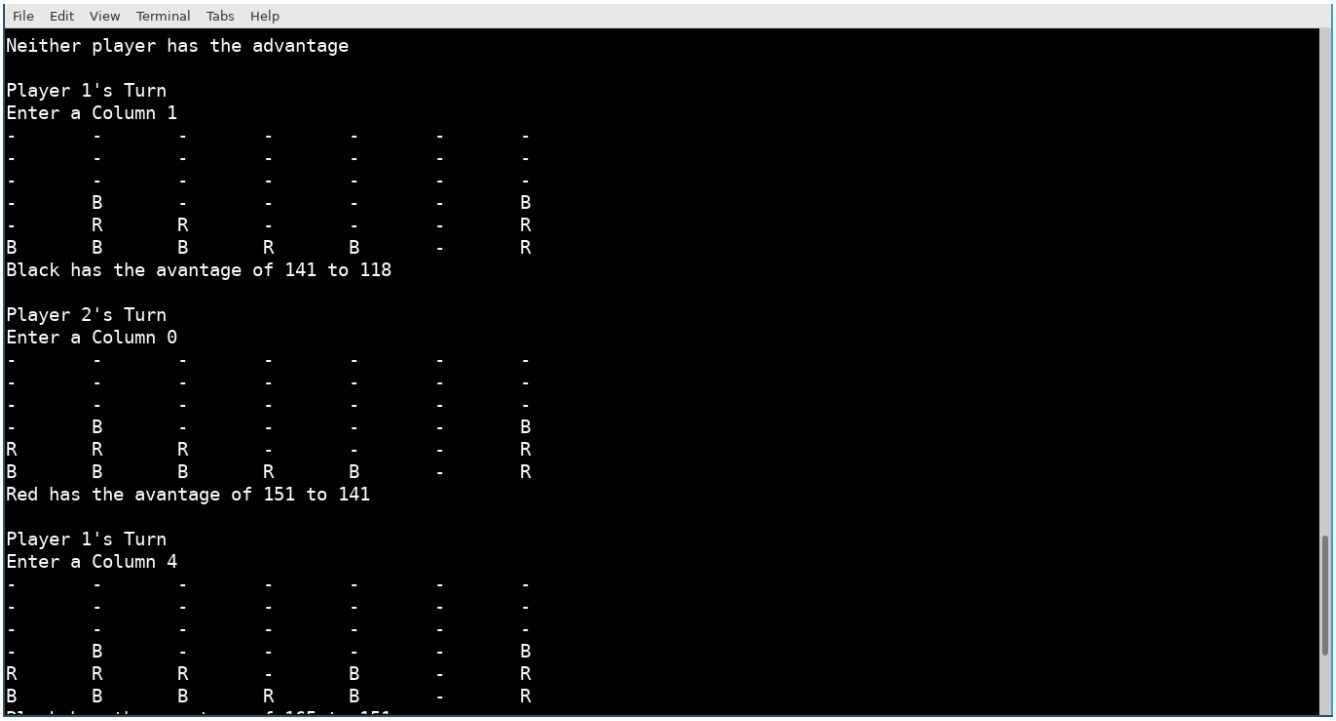


```
File  Edit  View  Terminal  Tabs  Help
Black has the avantage of 78 to 67

Player 2's Turn
Enter a Column 2
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       B
-       -       R       -       -       -       R
B       -       B       R       B       -       R
Red has the avantage of 90 to 78

Player 1's Turn
Enter a Column 1
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       B
-       -       R       -       -       -       R
B       B       B       R       B       -       R
Black has the avantage of 118 to 90

Player 2's Turn
Enter a Column 1
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       B
-       R       R       -       -       -       R
B       B       B       R       B       -       R
Neither player has the advantage
```

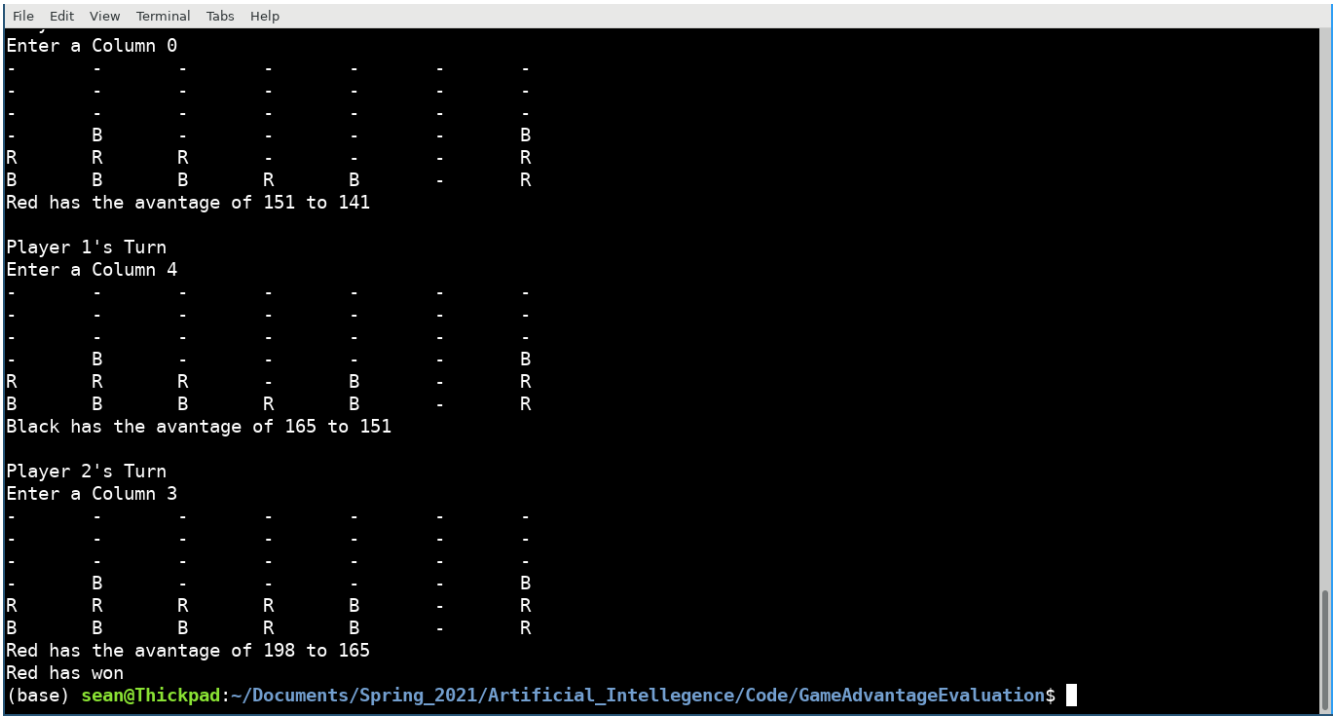


```
File  Edit  View  Terminal  Tabs  Help
Neither player has the advantage

Player 1's Turn
Enter a Column 1
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       B       -       -       -       -       B
-       R       R       -       -       -       R
B       B       B       R       B       -       R
Black has the avantage of 141 to 118

Player 2's Turn
Enter a Column 0
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       B       -       -       -       -       B
R       R       R       -       -       -       R
B       B       B       R       B       -       R
Red has the avantage of 151 to 141

Player 1's Turn
Enter a Column 4
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       -       -       -       -       -       -
-       B       -       -       -       -       B
R       R       R       -       B       -       R
B       B       B       R       B       -       R
```



Chess Evaluation

My implementation of a chess heuristic evaluation function is simple. It only allows for pre-configured game state files to be evaluated. The game state file is specified as a command line argument. Once the program opens the file it will count the number of each piece per each player. Then based on the evaluation table it will report which player has the piece advantage.