# ML LAB ASSIGNMENT 1

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Design and implement machine learning algorithm using least means square learning rule to play checkers game. The training experience should be generated by the program playing game with itself.

```
# for mathematical operations
import numpy as np
import time
import random
from tqdm import tqdm
# for the GUI
import pygame
# for the plot of error
import matplotlib.pyplot as plt
```

✓ 0.6s

basic libraries required for this implementation

```
class Board:
    def __init__(self):
        # Initialize the board
        self.board = np.zeros((10, 10), dtype=int)
        player1_positions = [ (6, 0), (6, 2), (6, 4), (6, 6),(6,8), (7, 1), (7, 3),
                              (7, 5), (7, 7),(7,9), (8, 0), (8, 2), (8, 4), (8, 6),
                              (8,8),(9, 1), (9, 3), (9, 5), (9, 7),(9,9)]
        player2_positions = [(0, 0), (0, 2), (0, 4), (0, 6),(0,8), (1, 1),
                              (1, 3), (1, 5), (1, 7), (1,9),(2, 0), (2, 2),
                              (2,4), (2, 6),(2,8), (3, 1), (3, 3), (3, 5), (3, 7), (3, 9)]
        for pos in player1_positions:
            self.board[pos] = 1
        for pos in player2_positions:
            self.board[pos] = 2

    def print_board(self):
        # ANSI color codes for coloured printing
        RED = '\033[91m'
        BLUE = '\033[94m'
        RESET = '\033[0m'
        for row in self.board:
            for item in row:
                if item == 1 :
                    print(RED + str(item) + RESET, end='  ')
                elif item == 2:
                    print(BLUE + str(item) + RESET, end='  ')
                elif item == 11:
                    print(RED + str(item) + RESET, end=' ')
                elif item == 22:
                    print(BLUE + str(item) + RESET, end=' ')
                else:
                    print(item, end='  ')
            print()
```

Board class with board initialization
And printing board function

```
def board_stats(self):
    # Returns the number of pieces for each player and the number of pieces that can jump for each player
    # [player, player 1 pieces, player 2 pieces, player 1 pieces that can jump, player 2 pieces that can jump, player 1 kings, player 2 kings]
    stats = [1, np.sum(self.board == 1 )+np.sum(self.board == 11), np.sum(self.board == 2 )+np.sum(self.board == 22), 0, 0, 0, 0]

    for i in range(10):
        for j in range(10):
            # how many player 2 is player 1 threathening
            if self.board[i, j] == 1:
                if i - 1 >= 0 and j - 1 >= 0:
                    if (self.board[i - 1, j - 1] == 2 or self.board[i - 1, j - 1] == 22) and i - 2 >= 0 and j - 2 >= 0 and self.board[i - 2, j - 2] == 0:
                        stats[3] += 1
                if i - 1 >= 0 and j + 1 <= 9:
                    if (self.board[i - 1, j + 1] == 2 or self.board[i - 1, j + 1] == 22) and i - 2 >= 0 and j + 2 <= 9 and self.board[i - 2, j + 2] == 0:
                        stats[3] += 1
            # how many player 1 is player 2 threathening
            elif self.board[i, j] == 2:
                if i + 1 <= 9 and j - 1 >= 0:
                    if (self.board[i + 1, j - 1] == 1 or self.board[i + 1, j - 1] == 11) and i + 2 <= 9 and j - 2 >= 0 and self.board[i + 2, j - 2] == 0:
                        stats[4] += 1
                if i + 1 <= 9 and j + 1 <= 9:
                    if (self.board[i + 1, j + 1] == 1 or self.board[i + 1, j + 1] == 11) and i + 2 <= 9 and j + 2 <= 9 and self.board[i + 2, j + 2] == 0:
                        stats[4] += 1
            # player 1 king
            elif self.board[i,j]==11:
                stats[5]+=1
                # top left
                if i - 1 >= 0 and j - 1 >= 0:
                    if (self.board[i - 1, j - 1] == 2 or self.board[i - 1, j - 1] == 22) and i - 2 >= 0 and j - 2 >= 0 and self.board[i - 2, j - 2] == 0:
                        stats[3] += 1
                # top right
                if i - 1 >= 0 and j + 1 <= 9:
                    if (self.board[i - 1, j + 1] == 2 or self.board[i - 1, j + 1] == 22) and i - 2 >= 0 and j + 2 <= 9 and self.board[i - 2, j + 2] == 0:
                        stats[3] += 1
                # bottom left
                if i + 1 <= 9 and j - 1 >= 0:
                    if (self.board[i + 1, j - 1] == 2 or self.board[i + 1, j - 1] == 22) and i + 2 <= 9 and j - 2 >= 0 and self.board[i + 2, j - 2] == 0:
                        stats[3] += 1
                # bottom right
                if i + 1 <= 9 and j + 1 <= 9:
                    if (self.board[i + 1, j + 1] == 2 or self.board[i + 1, j + 1] == 22) and i + 2 <= 9 and j + 2 <= 9 and self.board[i + 2, j + 2] == 0:
                        stats[3] += 1
```

```
            # player 2 king
            elif self.board[i,j]==22:
                stats[6]+=1
                # bottom left
                if i + 1 <= 9 and j - 1 >= 0:
                    if (self.board[i + 1, j - 1] == 1 or self.board[i + 1, j - 1] == 11) and i + 2 <= 9 and j - 2 >= 0 and self.board[i + 2, j - 2] == 0:
                        stats[4] += 1
                # bottom right
                if i + 1 <= 9 and j + 1 <= 9:
                    if (self.board[i + 1, j + 1] == 1 or self.board[i + 1, j + 1] == 11) and i + 2 <= 9 and j + 2 <= 9 and self.board[i + 2, j + 2] == 0:
                        stats[4] += 1
                # top left
                if i - 1 >= 0 and j - 1 >= 0:
                    if (self.board[i - 1, j - 1] == 1 or self.board[i - 1, j - 1] == 11) and i - 2 >= 0 and j - 2 >= 0 and self.board[i - 2, j - 2] == 0:
                        stats[4] += 1
                # top right
                if i - 1 >= 0 and j + 1 <= 9:
                    if (self.board[i - 1, j + 1] == 1 or self.board[i - 1, j + 1] == 11) and i - 2 >= 0 and j + 2 <= 9 and self.board[i - 2, j + 2] == 0:
                        stats[4] += 1
    return stats
```

STATS-> returns the xi values for the board state

```
   def get_moves(self, player):
       # Get all possible moves for a player
       normal_moves = []
       kill_moves = []
       for i in range(10):
           for j in range(10):
               if self.board[i, j] == player or self.board[i, j] == player
* 11:
                   if player == 1:
                       if self.board[i,j]==1:
                           if i - 1 >= 0 and j - 1 >= 0:
                               if (self.board[i - 1, j - 1] == 2 or
self.board[i - 1, j - 1] == 22) and i - 2 >= 0 and j - 2 >= 0 and
self.board[i - 2, j - 2] == 0:
                                   kill_moves.append([i, j, i - 1, j - 1])
                               if self.board[i - 1, j - 1] == 0:
                                   normal_moves.append([i, j, i - 1, j -
1])
                           if i - 1 >= 0 and j + 1 <= 9:
                               if (self.board[i - 1, j + 1] == 2 or
self.board[i - 1, j + 1] == 22 ) and i - 2 >= 0 and j + 2 <= 9 and
self.board[i - 2, j + 2] == 0:
                                   kill_moves.append([i, j, i - 1, j + 1])
                               if self.board[i - 1, j + 1] == 0:
                                   normal_moves.append([i, j, i - 1, j +
1])
                       elif self.board[i,j]==11:
                           # top left
                           if i - 1 >= 0 and j - 1 >= 0:
                               if (self.board[i - 1, j - 1] == 2 or
self.board[i - 1, j - 1] == 22) and i - 2 >= 0 and j - 2 >= 0 and
self.board[i - 2, j - 2] == 0:
                                   kill_moves.append([i, j, i - 1, j - 1])
                               if self.board[i - 1, j - 1] == 0:
                                   normal_moves.append([i, j, i - 1, j -
1])
                           # top right
                           if i - 1 >= 0 and j + 1 <= 9:
```

```
                            if (self.board[i - 1, j + 1] == 2 or
self.board[i - 1, j + 1] == 22) and i - 2 >= 0 and j + 2 <= 9 and
self.board[i - 2, j + 2] == 0:
                                kill_moves.append([i, j, i - 1, j + 1])
                            if self.board[i - 1, j + 1] == 0:
                                normal_moves.append([i, j, i - 1, j +
1])
                        # bottom left
                        if i + 1 <= 9 and j - 1 >= 0:
                            if (self.board[i + 1, j - 1] == 2 or
self.board[i + 1, j - 1] == 22) and i + 2 <= 9 and j - 2 >= 0 and
self.board[i + 2, j - 2] == 0:
                                kill_moves.append([i, j, i + 1, j - 1])
                            if self.board[i + 1, j - 1] == 0:
                                normal_moves.append([i, j, i + 1, j -
1])
                        # bottom right
                        if i + 1 <= 9 and j + 1 <= 9:
                            if (self.board[i + 1, j + 1] == 2 or
self.board[i + 1, j + 1] == 22) and i + 2 <= 9 and j + 2 <= 9 and
self.board[i + 2, j + 2] == 0:
                                kill_moves.append([i, j, i + 1, j + 1])
                            if self.board[i + 1, j + 1] == 0:
                                normal_moves.append([i, j, i + 1, j +
1])
                else:
                    if self.board[i,j]==2:
                        if i + 1 <= 9 and j - 1 >= 0:
                            if (self.board[i + 1, j - 1] == 1 or
self.board[i + 1, j - 1] == 11) and i + 2 <= 9 and j - 2 >= 0 and
self.board[i + 2, j - 2] == 0:
                                kill_moves.append([i, j, i + 1, j - 1])
                            if self.board[i + 1, j - 1] == 0:
                                normal_moves.append([i, j, i + 1, j -
1])
                        if i + 1 <= 9 and j + 1 <= 9:
                            if (self.board[i + 1, j + 1] == 1 or
self.board[i + 1, j + 1] == 11) and i + 2 <= 9 and j + 2 <= 9 and
self.board[i + 2, j + 2] == 0:
                                kill_moves.append([i, j, i + 1, j + 1])
```

```
                            if self.board[i + 1, j + 1] == 0:
                                normal_moves.append([i, j, i + 1, j +
1])
                    elif self.board[i,j]==22:
                        # bottom left
                        if i + 1 <= 9 and j - 1 >= 0:
                            if (self.board[i + 1, j - 1] == 1 or
self.board[i + 1, j - 1] == 11) and i + 2 <= 9 and j - 2 >= 0 and
self.board[i + 2, j - 2] == 0:
                                kill_moves.append([i, j, i + 1, j - 1])
                            if self.board[i + 1, j - 1] == 0:
                                normal_moves.append([i, j, i + 1, j -
1])
                        # bottom right
                        if i + 1 <= 9 and j + 1 <= 9:
                            if (self.board[i + 1, j + 1] == 1 or
self.board[i + 1, j + 1] == 11) and i + 2 <= 9 and j + 2 <= 9 and
self.board[i + 2, j + 2] == 0:
                                kill_moves.append([i, j, i + 1, j + 1])
                            if self.board[i + 1, j + 1] == 0:
                                normal_moves.append([i, j, i + 1, j +
1])
                        # top left
                        if i - 1 >= 0 and j - 1 >= 0:
                            if (self.board[i - 1, j - 1] == 1 or
self.board[i - 1, j - 1] == 11) and i - 2 >= 0 and j - 2 >= 0 and
self.board[i - 2, j - 2] == 0:
                                kill_moves.append([i, j, i - 1, j - 1])
                            if self.board[i - 1, j - 1] == 0:
                                normal_moves.append([i, j, i - 1, j -
1])
                        # top right
                        if i - 1 >= 0 and j + 1 <= 9:
                            if (self.board[i - 1, j + 1] == 1 or
self.board[i - 1, j + 1] == 11) and i - 2 >= 0 and j + 2 <= 9 and
self.board[i - 2, j + 2] == 0:
                                kill_moves.append([i, j, i - 1, j + 1])
                            if self.board[i - 1, j + 1] == 0:
                                normal_moves.append([i, j, i - 1, j +
1])
```

```
        if len(kill_moves)>0:
            return kill_moves
        else:
            return normal_moves
```

GETMOVES : this function returns the next move that any color piece can take based on available moves, also if any kill moves available it chooses it first

```
    #this function get's moves for human player for a specific checker
    def get_available_moves(self, player, row, col):
        # Get all possible moves for a player's piece at a specific
position
        normal_moves = []
        kill_moves = []

        if player == 1 :  # Player 1's piece or king
            if self.board[row][col] in [1, 11]:
                # Check for moves to the top-left and top-right diagonals
                if row - 1 >= 0:
                    if col - 1 >= 0 and self.board[row - 1][col - 1] == 0:
                        normal_moves.append((row - 1, col - 1))
                    elif col - 2 >= 0 and (self.board[row - 1][col - 1] ==
2 or self.board[row - 1][col - 1] == 22)  and self.board[row - 2][col - 2]
== 0:
                        kill_moves.append((row - 2, col - 2))
                if row - 1 >= 0:
                    if col + 1 < 10 and self.board[row - 1][col + 1] == 0:
                        normal_moves.append((row - 1, col + 1))
                    elif col + 2 < 10 and (self.board[row - 1][col + 1] ==
2 or self.board[row - 1][col + 1] == 22) and self.board[row - 2][col + 2]
== 0:
                        kill_moves.append((row - 2, col + 2))
                # Check for moves to the bottom-left and bottom-right
diagonals for kings
                if self.board[row][col] == 11:
                    print("here")
                    if row + 1 < 10:
                        if col - 1 >= 0 and self.board[row + 1][col - 1] ==
0:
                            normal_moves.append((row + 1, col - 1))
```

```
                    elif col - 2 >= 0 and (self.board[row + 1][col - 1]
== 2 or self.board[row + 1][col - 1] == 22) and self.board[row + 2][col -
2] == 0:
                        kill_moves.append((row + 2, col - 2))
                if row + 1 < 10:
                    if col + 1 < 10 and self.board[row + 1][col + 1] ==
0:
                        normal_moves.append((row + 1, col + 1))
                    elif col + 2 < 10 and (self.board[row + 1][col + 1]
== 2 or self.board[row + 1][col + 1] == 22) and self.board[row + 2][col +
2] == 0:
                        kill_moves.append((row + 2, col + 2))
        if kill_moves:
            return kill_moves
        else:
            return normal_moves
```

This is a small modified version of get moves function, used by the gui to show next moves for the player

```
    def check(self,player):
        # to search for any kings
        for i in range(10):
            for j in range(10):
                if self.board[i,j]==player:
                    if player==1:
                        if i==0:
                            self.board[i,j]=11
                    else:
                        if i==9:
                            self.board[i,j]=22
```

This check function updates if any piece is a king or not after every move it is called for the updation

THE MAIN LMS CODE:

```
board = Board()
board.print_board()

# Initialize weights
error = []
weights = [-0.5, 1, -1, 1, -1, 1, -1]
learning_rate = 0.1
one_wins = 0
two_wins = 0
# Play 100 games
for i in tqdm(range(100)):
   MSE = 0
   # Initialize the board
   board = Board()

   while True:
       # Get moves for player
1------------------------------------------------------------------------
---
       moves = board.get_moves(1)
       if len(moves) == 0:
           error.append(MSE)
           two_wins += 1
           # print("Player 2 wins")
           break
       # get
stats----------------------------------------------------------------------
-----------------------
       stats = board.board_stats()
       best_move = []
       best_value = -100000000
       # below value is V(cap) of x
       curr_value = weights[0] + weights[1] * stats[1] + weights[2] *
stats[2] + weights[3] * stats[3] + weights[4] * stats[4] + weights[5] *
stats[5] + weights[6] * stats[6]
       # ---------------------------------------
       # this for loop checks all possible moves and updates based on the
best move
       for move in moves:
```

```
            new_board = Board()
            new_board.board = np.copy(board.board)
            if new_board.board[move[2],move[3]]==2 or
new_board.board[move[2],move[3]]==22:

new_board.board[move[2]+(move[2]-move[0]),move[3]+(move[3]-move[1])]=board
.board[move[0],move[1]]
                new_board.board[move[2],move[3]]=0
            else:
                new_board.board[move[2], move[3]] = board.board[move[0],
move[1]]

            new_board.board[move[0], move[1]] = 0
            new_stats = new_board.board_stats()
            value = weights[0] + weights[1] * new_stats[1] + weights[2] *
new_stats[2] + weights[3] * new_stats[3] + weights[4] * new_stats[4] +
weights[5] * new_stats[5] + weights[6] * new_stats[6]

            if value > best_value:
                best_value = value
                best_move = move
        # ----------------------------------------
        # finalize the best_move in the board
        if board.board[best_move[2],best_move[3]]==2 or
board.board[best_move[2],best_move[3]]==22:

board.board[best_move[2]+(best_move[2]-best_move[0]),best_move[3]+(best_mo
ve[3]-best_move[1])]=board.board[best_move[0],best_move[1]]
                board.board[best_move[2],best_move[3]]=0
        else:
            board.board[best_move[2], best_move[3]] =
board.board[best_move[0], best_move[1]]

        board.board[best_move[0], best_move[1]] = 0

        for j in range(7):
            weights[j] += learning_rate * stats[j] * (best_value -
curr_value)
        MSE+= (best_value - curr_value)**2
        # check for any kings
```

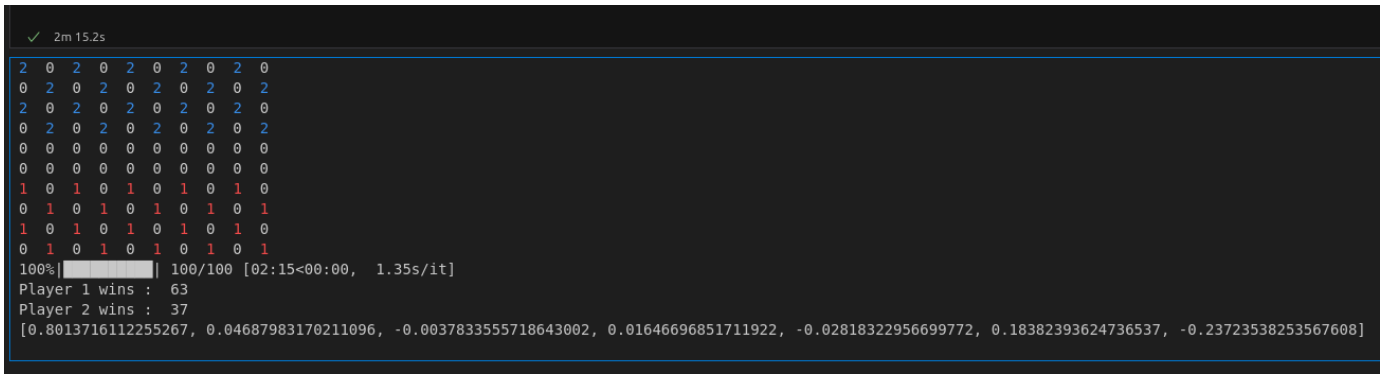
```
        board.check(1)
        # time for player
2-------------------------------------------------------------------------
------
        moves = board.get_moves(2)
        if len(moves) == 0:
            error.append(MSE)
            one_wins += 1
            # print("Player 1 wins")
            break

        stats = board.board_stats()
        best_move = []
        best_value = 100000000
        curr_value = weights[0] + weights[1] * stats[1] + weights[2] *
stats[2] + weights[3] * stats[3] + weights[4] * stats[4] + weights[5] *
stats[5] + weights[6] * stats[6]

        if random.random() < 0.5:  # Adjust the threshold as needed
        # if True:
        # Enter the loop to evaluate moves
            for move in moves:
                new_board = Board()
                new_board.board = np.copy(board.board)
                # based on jump we decide the move
                if new_board.board[move[2],move[3]]==1 or
new_board.board[move[2],move[3]]==11:

new_board.board[move[2]+(move[2]-move[0]),move[3]+(move[3]-move[1])]=board
.board[move[0],move[1]]
                    new_board.board[move[2],move[3]]=0
                else:
                    new_board.board[move[2], move[3]] =
board.board[move[0], move[1]]
                new_board.board[move[0], move[1]] = 0

                new_stats = new_board.board_stats()
                value = weights[0] + weights[1] * new_stats[1] + weights[2]
* new_stats[2] + weights[3] * new_stats[3] + weights[4] * new_stats[4] +
weights[5] * new_stats[5] + weights[6] * new_stats[6]
```

```
                if value < best_value:
                    best_value = value
                    best_move = move
        else:
            # Choose a random move from the list of moves
            best_move = random.choice(moves)
            new_board = Board()
            new_board.board = np.copy(board.board)
            if new_board.board[best_move[2],best_move[3]]==1 or
new_board.board[best_move[2],best_move[3]]==11:

new_board.board[best_move[2]+(best_move[2]-best_move[0]),best_move[3]+(bes
t_move[3]-best_move[1])]=board.board[best_move[0],best_move[1]]
                    new_board.board[best_move[2],best_move[3]]=0
            else:
                new_board.board[best_move[2], best_move[3]] =
board.board[best_move[0], best_move[1]]

            new_board.board[best_move[0], best_move[1]] = 0

            new_stats = new_board.board_stats()
            best_value = weights[0] + weights[1] * new_stats[1] +
weights[2] * new_stats[2] + weights[3] * new_stats[3] + weights[4] *
new_stats[4] + weights[5] * new_stats[5] + weights[6] * new_stats[6]

        if board.board[best_move[2],best_move[3]]==1 or
board.board[best_move[2],best_move[3]]==11:

board.board[best_move[2]+(best_move[2]-best_move[0]),best_move[3]+(best_mo
ve[3]-best_move[1])]=board.board[best_move[0],best_move[1]]
                board.board[best_move[2],best_move[3]]=0
        else:
            board.board[best_move[2], best_move[3]] =
board.board[best_move[0], best_move[1]]

        board.board[best_move[0], best_move[1]] = 0
        for j in range(7):
            weights[j] += learning_rate * stats[j] * (best_value -
curr_value)
```

```
        board.check(2)
print("Player 1 wins : ", one_wins)
print("Player 2 wins : ", two_wins)

print(weights)
```

Here we allow it to play 100 or 1000 games with itself using the LMS rule and also updating the error, weights for the xi's so that we can train it to get the best optimal move

For player 2 : this player is sub-optimal which means it has a 50% probability of choosing the optimal moves based on the weights and the rest of the time it selects any random move, this creates randomness using which player 1 can learn even better.




After training for 2 min and 15 sec it played 100 games against itself, and player 1 won 63 games whereas player 2 won 37.
Alse we can see the weights,
Npw we use these weights to play with the algorithm, ie us against the trained weights

**after 1000 games(23 minutes): [0.054537615797118105, 2.3236704114554607e-13, 4.567999037113247e-13, 6.521783448117344e-14, -6.68272507123147e-14, 8.902002357840587e-13, -1.3058832144047386e-12]**

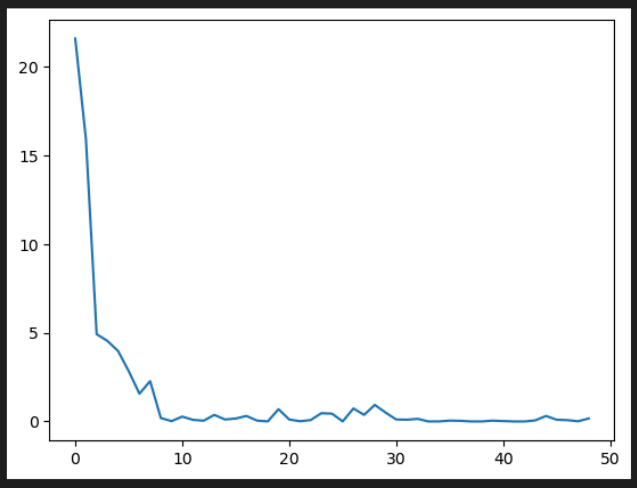
**ERROR PLOT :**

```
print(error)
plt.plot(error[1:50])
```

```
[4]
```

```
[23.515427201647206, 21.57513226208161, 15.892011419496953, 4.917651594617295, 4.54182118469171, 3.9712
```

```
[<matplotlib.lines.Line2D at 0x7fa66ede0850>]
```



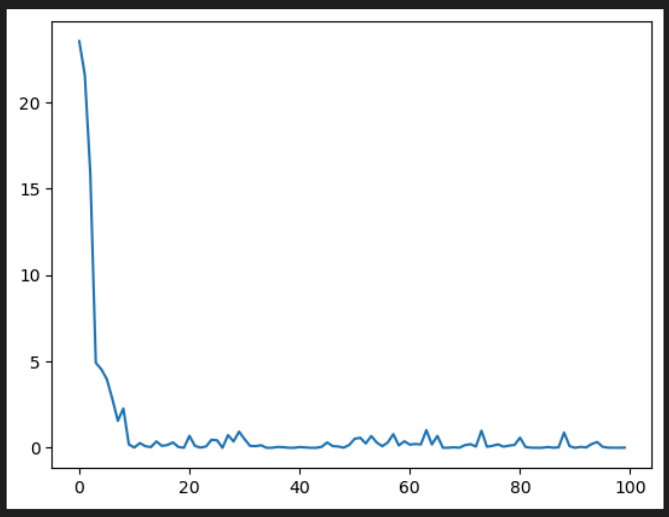

**Error plot for the first 50 entries**

```
print(error)
plt.plot(error)
```

```
[3]  ✓ 0.0s
```

```
[23.515427201647206, 21.57513226208161, 15.892011419496953, 4.917651594617295, 4.54182118469171, 3.9712
```

```
[<matplotlib.lines.Line2D at 0x7f6ca9632510>]
```




**ERROR plot against first 100 entries (100 games)**

**GUI using pygame:**

```
class CheckersGui:
    def __init__(self, board):
        # Initialize Pygame
        pygame.init()

        # Constants
        self.WIDTH, self.HEIGHT = 1000, 1000
        self.ROWS, self.COLS = 10, 10
        self.SQUARE_SIZE = self.HEIGHT // self.ROWS
        self.chance = 0

        # Colors
        self.WHITE = (245, 222, 179)
        self.BROWN = (184, 115, 51)
        self.RED = (0, 0, 0)
        self.GREEN = (255, 255, 255)
        self.BLUE = (0, 0, 255)

        # Initialize screen
        self.screen = pygame.display.set_mode((self.WIDTH, self.HEIGHT))
        pygame.display.set_caption('Checkers')

        self.board = board

    # Function to draw the board
    def draw_board(self):
        for row in range(self.ROWS):
            for col in range(row % 2, self.COLS, 2):
                pygame.draw.rect(self.screen, self.BROWN, (col *
self.SQUARE_SIZE, row * self.SQUARE_SIZE, self.SQUARE_SIZE,
self.SQUARE_SIZE))

    # Function to draw the checkers
    def draw_checkers(self):
        for row in range(self.ROWS):
            for col in range(self.COLS):
                if self.board.board[row][col] == 1:  # Player 1's checker
```

```
                    pygame.draw.circle(self.screen, self.RED, (col *
self.SQUARE_SIZE + self.SQUARE_SIZE // 2, row * self.SQUARE_SIZE +
self.SQUARE_SIZE // 2), self.SQUARE_SIZE // 3)
                elif self.board.board[row][col] == 2:  # Player 2's checker
                    pygame.draw.circle(self.screen, self.GREEN, (col *
self.SQUARE_SIZE + self.SQUARE_SIZE // 2, row * self.SQUARE_SIZE +
self.SQUARE_SIZE // 2), self.SQUARE_SIZE // 3)
                elif self.board.board[row][col] == 11:  # Player 1's king
                    pygame.draw.circle(self.screen, self.RED, (col *
self.SQUARE_SIZE + self.SQUARE_SIZE // 2, row * self.SQUARE_SIZE +
self.SQUARE_SIZE // 2), self.SQUARE_SIZE // 3)
                    pygame.draw.circle(self.screen, self.WHITE, (col *
self.SQUARE_SIZE + self.SQUARE_SIZE // 2, row * self.SQUARE_SIZE +
self.SQUARE_SIZE // 2), self.SQUARE_SIZE // 6)
                elif self.board.board[row][col] == 22:  # Player 2's king
                    pygame.draw.circle(self.screen, self.GREEN, (col *
self.SQUARE_SIZE + self.SQUARE_SIZE // 2, row * self.SQUARE_SIZE +
self.SQUARE_SIZE // 2), self.SQUARE_SIZE // 3)
                    pygame.draw.circle(self.screen, self.WHITE, (col *
self.SQUARE_SIZE + self.SQUARE_SIZE // 2, row * self.SQUARE_SIZE +
self.SQUARE_SIZE // 2), self.SQUARE_SIZE // 6)

    def update_display(self):
        self.screen.fill(self.WHITE)
        self.draw_board()
        self.draw_checkers()
        pygame.display.flip()


    #This will display the possible moves a player can play
    def display_possible_moves(self, moves):
        self.update_display()

        for move in moves:
            row, col = move
            pygame.draw.circle(self.screen, self.BLUE, (col *
self.SQUARE_SIZE + self.SQUARE_SIZE // 2, row * self.SQUARE_SIZE +
self.SQUARE_SIZE // 2), self.SQUARE_SIZE // 8)

    #This essentially makes the move on the computer's behalf
```

```
   def computer_move(self):
       # Get all possible moves for the computer
       moves = self.board.get_moves(2)
       print(moves)
       if len(moves) == 0:
           return
       else:

           stats = board.board_stats()
           best_move = []
           best_value = 100000000
           curr_value = weights[0] + weights[1] * stats[1] + weights[2] *
stats[2] + weights[3] * stats[3] + weights[4] * stats[4] + weights[5] *
stats[5] + weights[6] * stats[6]

           for move in moves:
               new_board = Board()
               new_board.board = np.copy(board.board)
               # based on jump we decide the move
               if new_board.board[move[2],move[3]]==1 or
new_board.board[move[2],move[3]]==11:

new_board.board[move[2]+(move[2]-move[0]),move[3]+(move[3]-move[1])]=board
.board[move[0],move[1]]
                   new_board.board[move[2],move[3]]=0
               else:
                   new_board.board[move[2], move[3]] =
board.board[move[0], move[1]]
               new_board.board[move[0], move[1]] = 0

               new_stats = new_board.board_stats()
               value = weights[0] + weights[1] * new_stats[1] + weights[2]
* new_stats[2] + weights[3] * new_stats[3] + weights[4] * new_stats[4] +
weights[5] * new_stats[5] + weights[6] * new_stats[6]

               if value < best_value:
                   best_value = value
                   best_move = move
```

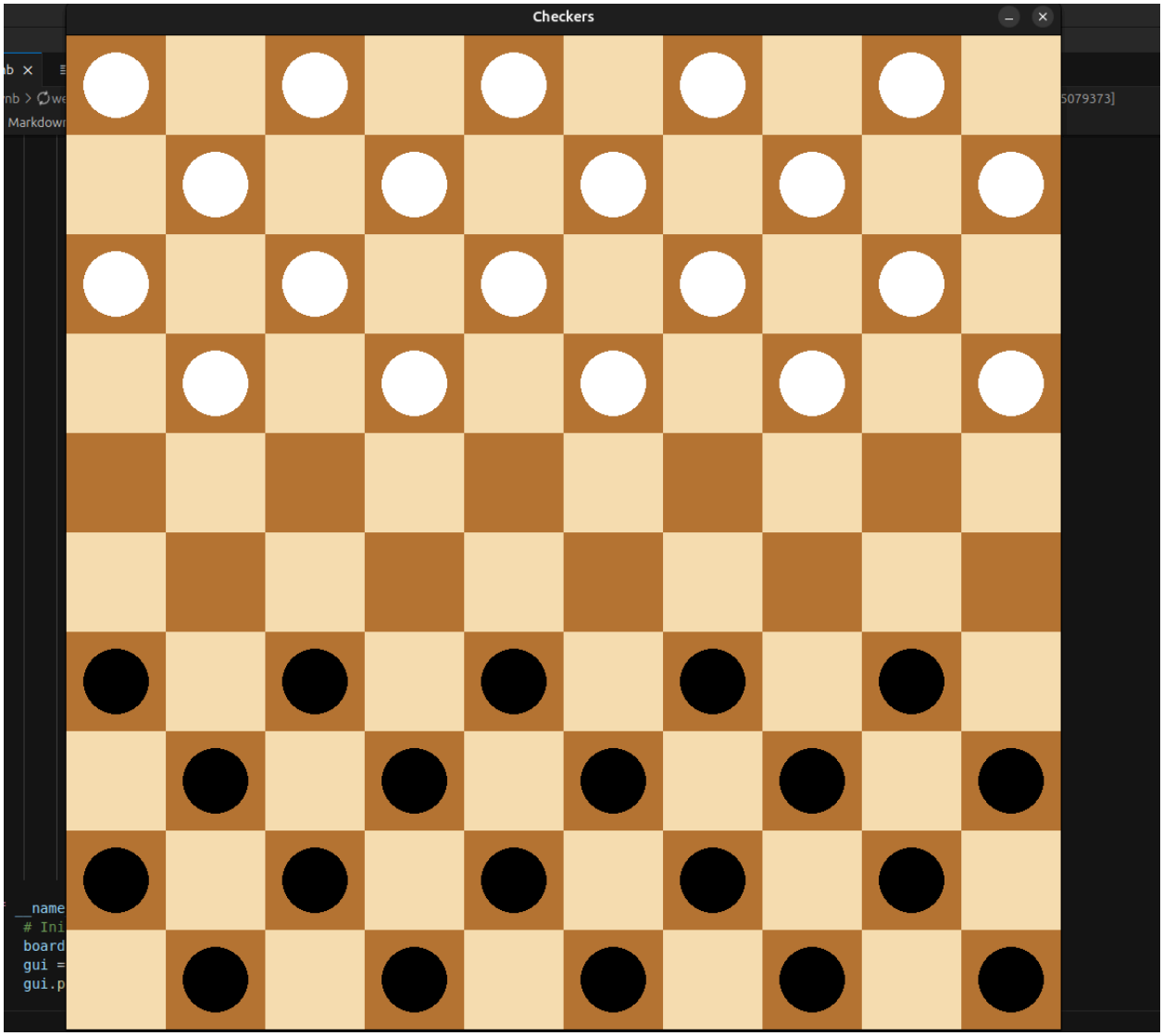
```
            if board.board[best_move[2],best_move[3]]==1 or
board.board[best_move[2],best_move[3]]==11:

board.board[best_move[2]+(best_move[2]-best_move[0]),best_move[3]+(best_mo
ve[3]-best_move[1])]=board.board[best_move[0],best_move[1]]
                    board.board[best_move[2],best_move[3]]=0
            else:
                board.board[best_move[2], best_move[3]] =
board.board[best_move[0], best_move[1]]

            board.board[best_move[0], best_move[1]] = 0

            #check for kings
            self.board.check(2)

            #now update the board
            self.update_display()

    def play(self):
        self.update_display()
        # Main game loop
        running = True

        curr_moves = []
        curr_checker = []
        flag = 0

        while running:
            for event in pygame.event.get():
                if event.type == pygame.QUIT:
                    running = False
                elif event.type == pygame.MOUSEBUTTONDOWN:
                    x, y = pygame.mouse.get_pos()
                    row = y // self.SQUARE_SIZE
                    col = x // self.SQUARE_SIZE

                    #check if the player has selected a move
                    for move in curr_moves:
                        if row == move[0] and col == move[1]:
                            #means player has selected a move
```

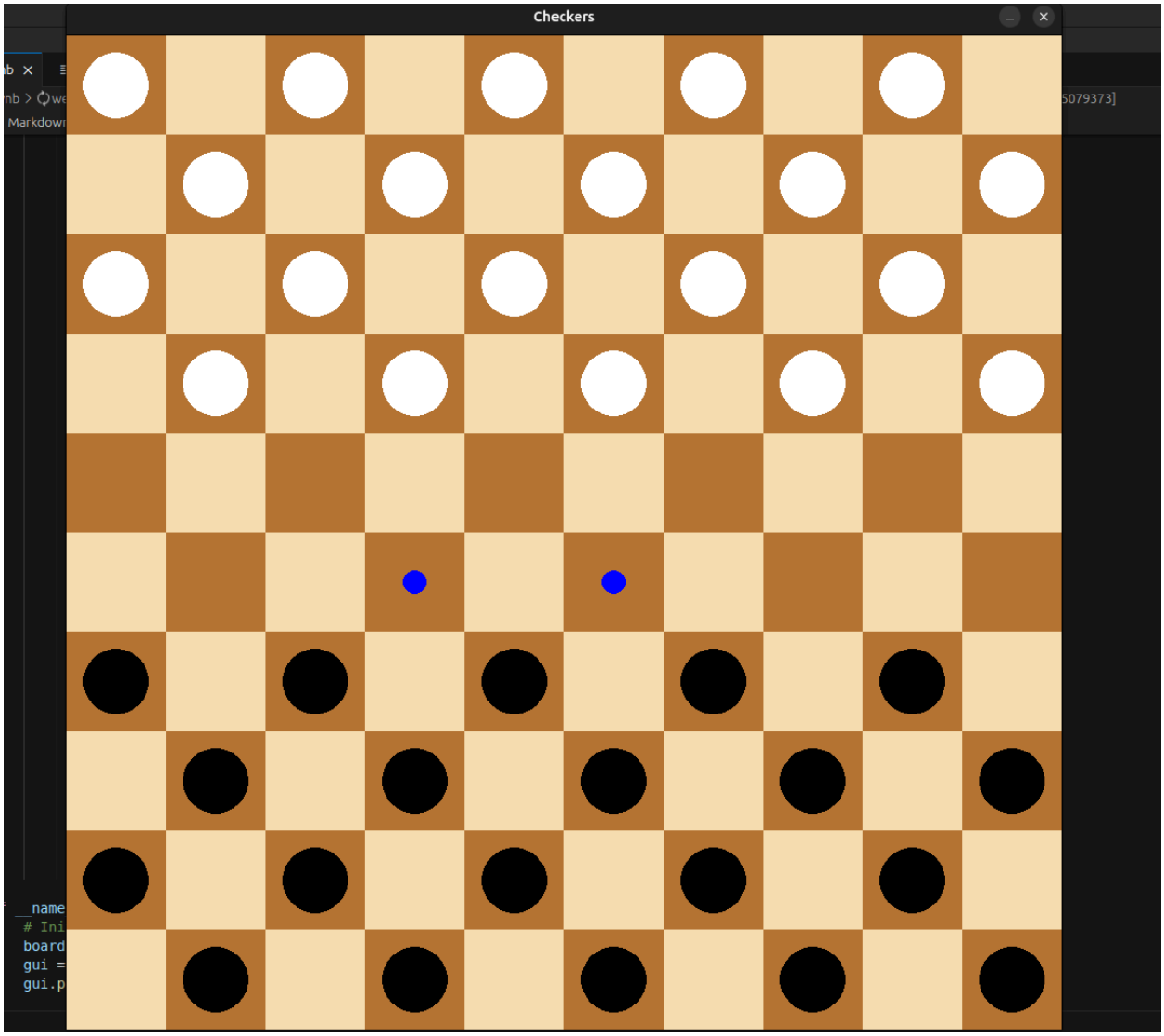
```
                            self.board.board[move[0], move[1]] =
self.board.board[curr_checker[0], curr_checker[1]]     # not directly 1,
as it could be a king # was an error here
                            self.board.board[curr_checker[0],
curr_checker[1]] = 0

                            #if in between curr pos and new pos there is an
enemy
                            if abs(curr_checker[0]-move[0])>1:

self.board.board[(curr_checker[0]+move[0])//2,
(curr_checker[1]+move[1])//2] = 0

                            #check for kings
                            self.board.check(1)

                            #update the display
                            self.update_display()

                            #reset the curr_moves and curr_checker
                            curr_moves = []
                            curr_checker = []
                            flag = 1
                            break

                    #if flag is 1, means player has made the move
                    if flag == 1:
                        flag = 0

                        #otherwise movement is too fast
                        time.sleep(1)

                        #player has made the move, now we call function for
the
                        #computer to make its move
                        self.computer_move()

                        continue

                    #we first get the possible moves
```

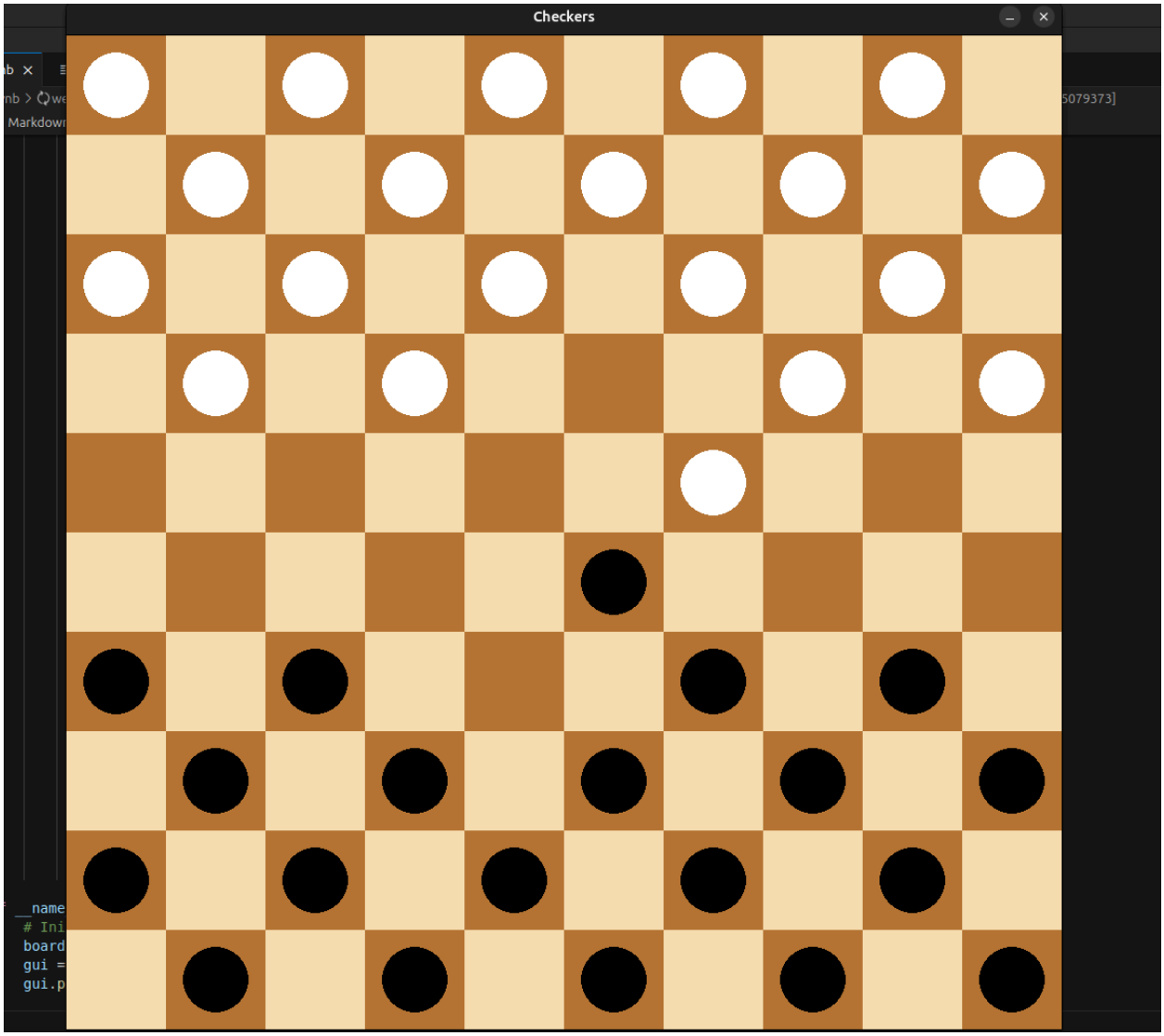
```
                    moves = self.board.get_available_moves(1,row,col)
                    print(moves)
                    curr_moves = moves
                    curr_checker = [row,col]

                    #then display the available moves
                    self.display_possible_moves(moves)
                    pygame.display.flip()

if __name__ == "__main__":
    # Initialize the board
    board = Board()
    gui = CheckersGui(board)
    gui.play()
```

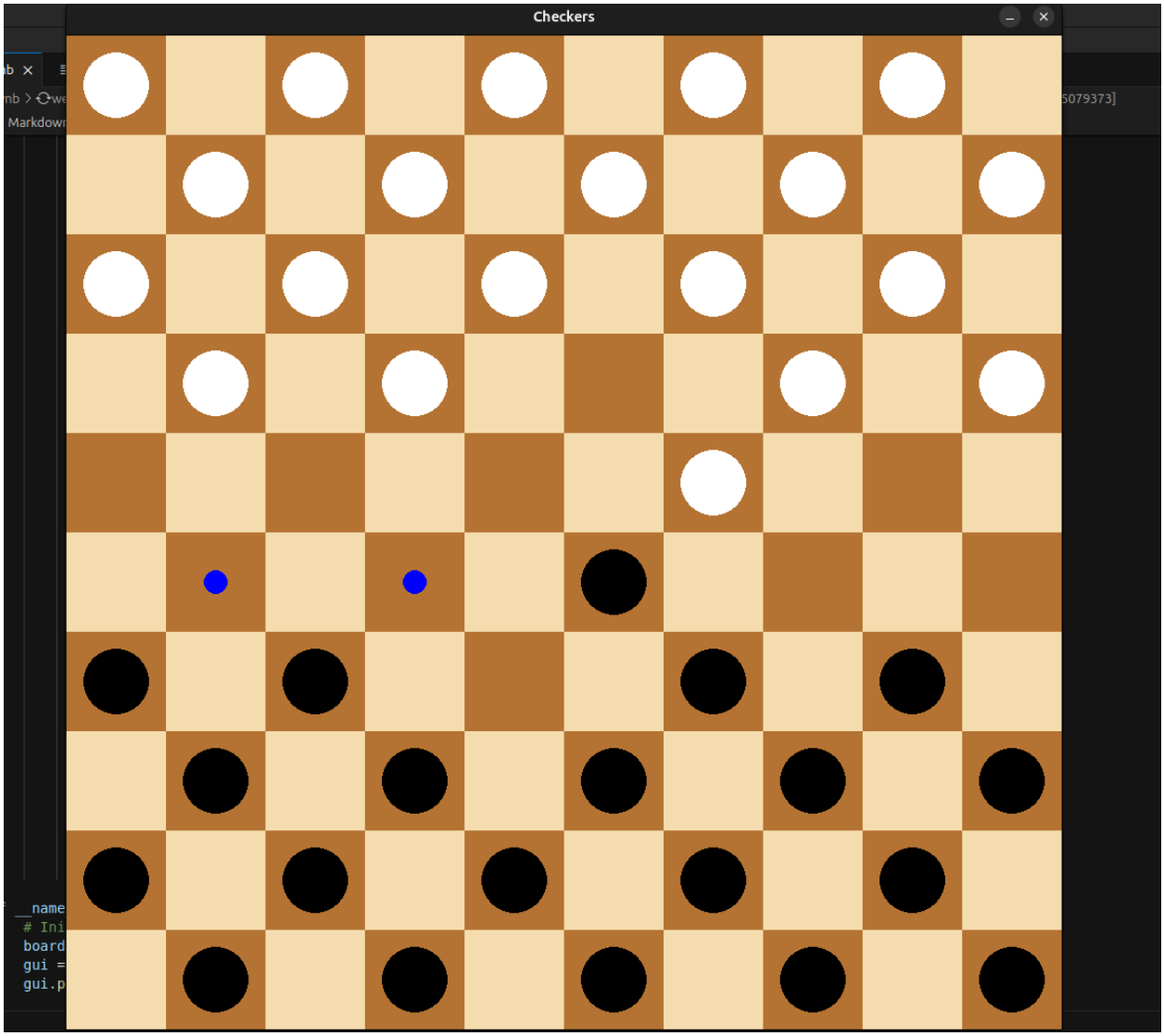
I mean this gui part is totally new for me, so used already available templates , the main thing was the lms part which was fully implemented

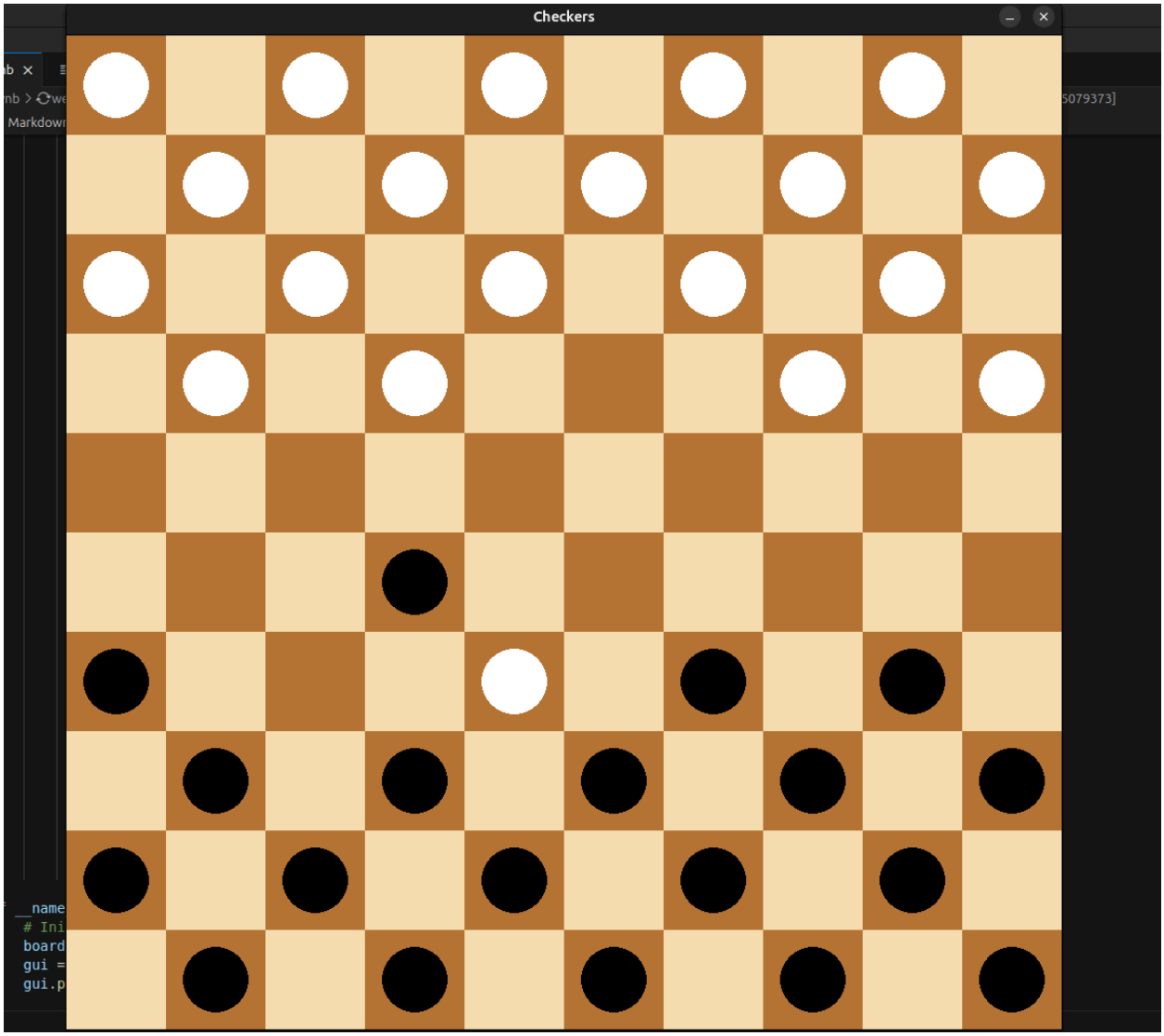
Now running the gui part:




Checkers

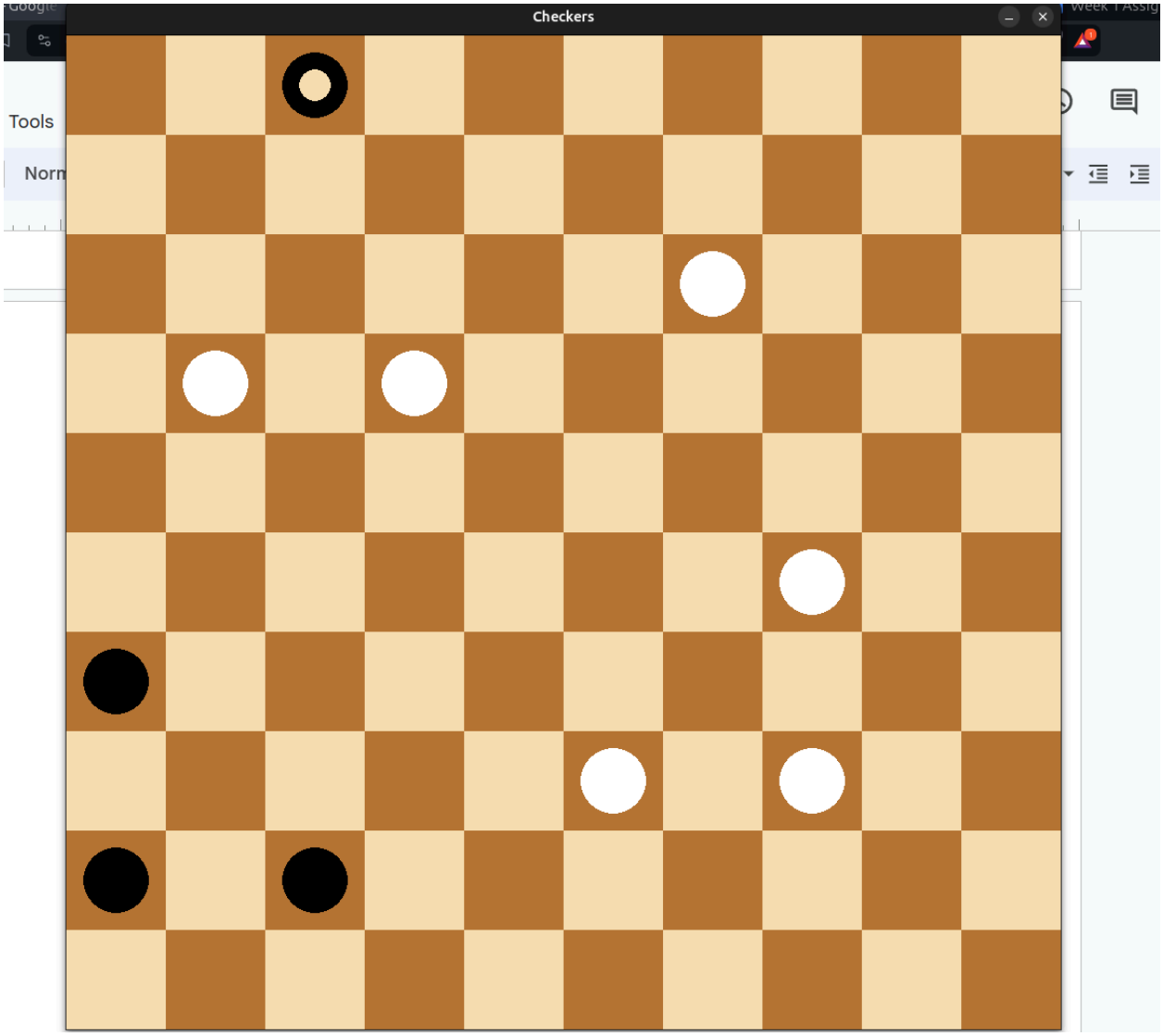

Checkers


Checkers

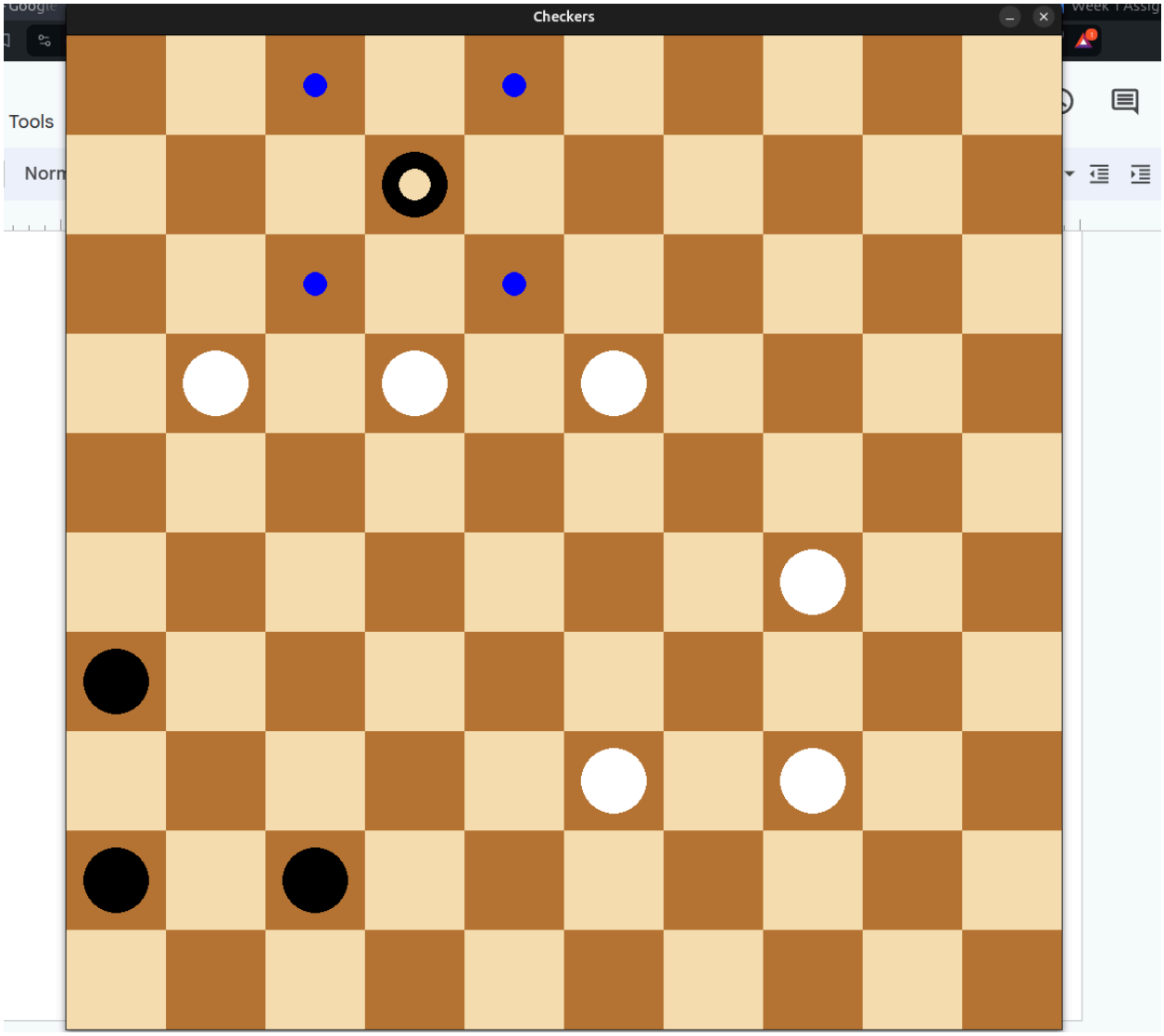



And it goes on, it selects the best moves based on the V(b) value calculated using the stats ie the xi’s and the weights and takes the moves.

THE king has also been implemented:
Ie when any piece reaches the other end it gets promoted to a king, so it shows all 4 sides of movement:




After the black piece reached the other end its shape changed,  and also it can now move in all 4 direction :


Checkers
Tools