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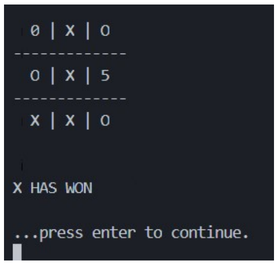
Project 1.A : TTT WITH MINIMAX

4/1/19

Analysis / Sample Outputs: “X” is COMPUTER and goes first

Game 1: HUMAN LOSS

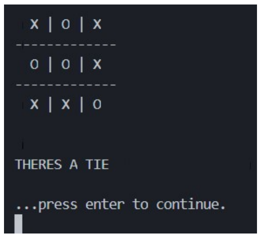


```
 0 | X | O
------------
 O | X | 5
------------
 X | X | O


X HAS WON

...press enter to continue.
```

Game 2: TIE

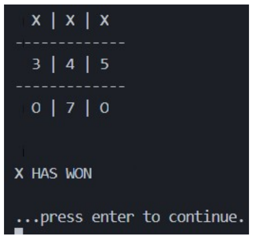


```
 X | O | X
------------
 O | O | X
------------
 X | X | O


THERES A TIE

...press enter to continue.
```

Game 3: HUMAN LOSS

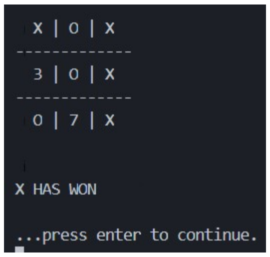


```
 X | X | X
------------
 3 | 4 | 5
------------
 O | 7 | O


X HAS WON

...press enter to continue.
```

Game 4: HUMAN LOSS

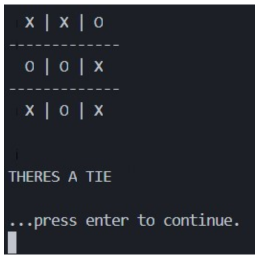


```
 X | O | X
------------
 3 | O | X
------------
 O | 7 | X


X HAS WON

...press enter to continue.
```

Game 5: TIE

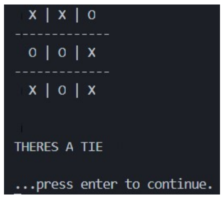


```
 X | X | O
------------
 O | O | X
------------
 X | O | X


THERES A TIE

...press enter to continue.
```

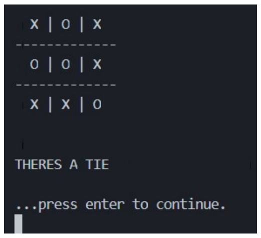
Game 6: TIE


```
 X | X | O
-------------
 O | O | X
-------------
 X | O | X


THERES A TIE

...press enter to continue.
```

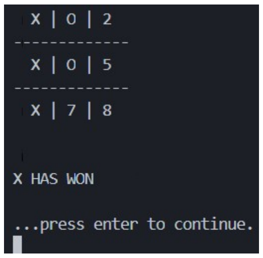
Game 7: TIE


```
 X | O | X
-------------
 O | O | X
-------------
 X | X | O


THERES A TIE

...press enter to continue.
```

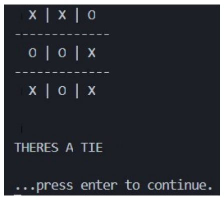
Game 8: HUMAN LOSS


```
 X | O | 2
-------------
 X | O | 5
-------------
 X | 7 | 8


X HAS WON

...press enter to continue.
```

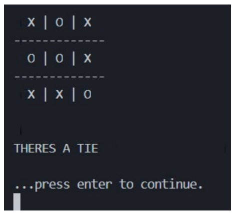
Game 9: TIE


```
 X | X | O
-------------
 O | O | X
-------------
 X | O | X


THERES A TIE

...press enter to continue.
```

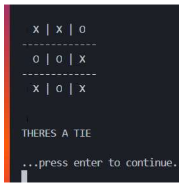
Game 10: TIE


```
 X | O | X
-------------
 O | O | X
-------------
 X | X | O


THERES A TIE

...press enter to continue.
```

MINIMAX vs MINIMAX: TIE


```
 X | X | O
-------------
 O | O | X
-------------
 X | O | X


THERES A TIE

...press enter to continue.
```

Results:

Humans vs AI (Human Wins, AI Win, TIE) -- (0, 4, 6)

- Game 3 and 8: AI obviously sees optimal path
- Game 4 and 1: Starting a corner like the AI results in loss
- Starting in middle after corner move is only move that can result in a tie

AI vs AI: always a tie

CODE

TTT GAME

```
      from os import system, name

import time

def clear():
    # for windows
    if name == 'nt':
        _ = system('cls')
    # for mac and linux(here, os.name is 'posix')
    else:
        _ = system('clear')

'''
    CLASS that defines the board and its behaviour over a tic tac toe game
'''
class TicTacToe:
    '''
    CONSTRUCTOR: defines board to use in tic tac toe games
        constructor makes empty list of 9 _.
          0 | 1 | 2
          3 | 4 | 5
          6 | 7 | 8
    '''
    def __init__(self, x, o):
        self.board = [ '_' for _ in range(9) ] # inits board of 9 '_',
        self.turns_played = 0 #9 max.
        self.winning_moves = (
[0,1,2],[3,4,5],[6,7,8],[0,3,6],[1,4,7],[2,5,8],[0,4,8],[2,4,6] )
        self.winner = None
        self.x = x #whoever is x player, real or AI
        # note : X ALWAYS GOES FIRST
        self.o = o #whoever is x player, real or AI
        self.turn = self.x #current turn

    '''
    returns TRUE if a player has won, or if there is a tie, FALSE otherwise
    self.winner is updated with either 'X' 'O' or 'TIE'
    '''
    def is_game_done(self):
        if self.num_turns()<5: #impossible to get win without 5 min moves. save
some cpu cycles
            return False
        else:
            for l in self.winning_moves:
                # print("checking " + self.player_at(l[0]) + " AND " +
self.player_at(l[1]) + " AND " + self.player_at(l[2]) )
                if (self.player_at(l[0])) == (self.player_at(l[1])) ==
(self.player_at(l[2])) and (self.player_at(l[0])) !=' ' :
                    self.winner = (self.player_at(l[0]))
                    return True
            if self.num_turns() == 9: #no one won and 9 turns made
                self.winner = 'TIE'
                return True
            return False

    '''
    returns how many valid moves have been played
    '''
    def num_turns(self):
        return int(self.turns_played)

    '''
    given position in board, return 'x', 'o', or '_'
    '''
    def player_at(self, position):
        if position > 9 or position < 0:
            return "INVALID"
        return self.board[position]


    '''
    print the contents of da board
    '''
    def display_board(self):
        s=[' ' for _ in range(9)]
        for i in range(0,9):
            if self.board[i] == ' ':
                s[i] = i
            else:
                s[i] = self.board[i]

        line1 = "  " + str(s[0]) + " | " + str(s[1]) + " | " + str(s[2])
        filler = "-------------"
        line2 = "  " + str(s[3]) + " | " + str(s[4]) + " | " + str(s[5])
        line3 = "  " + str(s[6]) + " | " + str(s[7]) + " | " + str(s[8])
        print(line1)
        print(filler)
        print(line2)
        print(filler)
        print(line3)
        print("\n")

    '''
    actually play the game!
    '''
    def play_ttt(self):

        while True:
            clear()
            self.turns_played += 1
            if self.turn is self.x:
                current_player = self.x
                char = 'X'
            else:
                current_player = self.o
                char = 'O'

            if current_player.kind == 'human':
                self.display_board()

            move = current_player.move(self.board) #get move from player,
validation is done within the current_players class
            self.board[move] = char # place move

            if self.is_game_done() is True:
                clear()
                self.display_board()
                if self.winner == "TIE":
                    print("THERES A TIE")
                else:
                    clear()
                    self.display_board()
                    print(str(self.winner) + " HAS WON")
                return True

            if self.x.kind == 'MiniMax' == self.o.kind :
                self.display_board()
                time.sleep(1.5)

            if self.turn == self.x:
                self.turn = self.o
            else:
                self.turn = self.x
```

AI CLASS:

```
import random
from Player import *

# X IS MAX (computer) O IS MINS (human)
# we will return score based off of X's position
class MiniMax(Player):
    def __init__(self, char='X'):
        self.char = char
        self.kind = 'MiniMax'
        if self.char == 'X':
            self.opponent = 'O'
        else :
            self.opponent = 'X'

    '''
    is game done given board state?
    returns (TRUE, value of state [10 win, -10 lost] ) or FALSE
    '''
    def is_terminal_state(self, board):
        winning_states = (
[0,1,2],[3,4,5],[6,7,8],[0,3,6],[1,4,7],[2,5,8],[0,4,8],[2,4,6] )
        for a,b,c in winning_states:
            if board[a]==board[b]==board[c]==self.char:
                return (True, 10) #minimax won!
            elif board[a]==board[b]==board[c]==self.opponent:
                return (True, -10) #other player won

        space_counter = 0
        for spot in board:
            if spot==' ':
                space_counter+=1

        if space_counter==0: #TIE
            return (True, 0)

        return (False, 0) # aint over yet, chiefton

    def move(self, board): #acutal MINIMAX IMPLEMENTATION
        # in order to cut down brnaching factor a bit, IF ai
        #  is going first, just choose a corner.
        if len( self.available_positions(board) ) == 9:
            return random.choice( [0,2,6,8] )
        # ON THE MINIMAX TURN, YOU WANT THE BEST (MAX) OF THE OTHER PLAYERS
TURNS(MIN)
        moves=[-10 for _ in range(9)] #move values
        for move in self.available_positions(board) : # for every child, is it a
winner? is a successor a winner? else play random
            board[int(move)] = str(self.char)
            r = (self.is_terminal_state(board))[0]
            if (self.is_terminal_state(board))[0] is True:
                return move
            board_val = self.min_value(board)
            board[move] = '█'
            moves[move] = board_val

        # try all moves where its currently a tie, if enemy places at this move,
then game over, so place a blocker
        c=0
        for i in moves:
            if i == 0 and board[c] == '█':
                board[c] = self.opponent
                res = (self.is_terminal_state(board))[1]
                if int(res) == int(-10):
                    return c
                board[c] = '█'
            c+=1

        # otherwise play random move
        return moves.index(max(moves))

        # if cant find a move there, just take a tie from here.
        #   return random.choice(self.available_positions(board))

    def max_value(self, board):
        board_done, return_value = self.is_terminal_state(board)
        if board_done: # if current board is done, return -10, 0 , 10
            return return_value

        value = -100

        for moves in self.available_positions(board):
            board[moves] = self.char
            new_value = self.min_value(board)
            if new_value > value:
                value = new_value
            board[moves] = '█'
```

```python
        return value

    def min_value(self, board):
        board_done, return_value = self.is_terminal_state(board)
        if board_done:
            return return_value

        value = 100

        for moves in self.available_positions(board):
            board[moves] = self.opponent
            new_value = self.max_value(board)
            if new_value < value:
                value = new_value
            board[moves] = ' '

        return value
```

PLAYER CLASS

```python
class Player:
    def __init__(self, char='X'):
        self.kind = 'human'
        self.char = char

    def move(self, board):
        while True: #valid move
            move = int(input('Your move? '))
            if board[move] != "X" and board[move] != "O" and move >= 0 and move
<= 9:
                return move

    def available_positions(self, board):
        return [i for i in range(0, 9) if board[i] == ' ']
```