EXP : 6 (Minimax algo)

Aim : Implementation of Minimax algorithm for an application.

Problem Formulation :

Consider a board having nine elements vector where each element will contain '-' for blank, X for indicating the move of player 1 and 0 for player 2's move.

Initial state

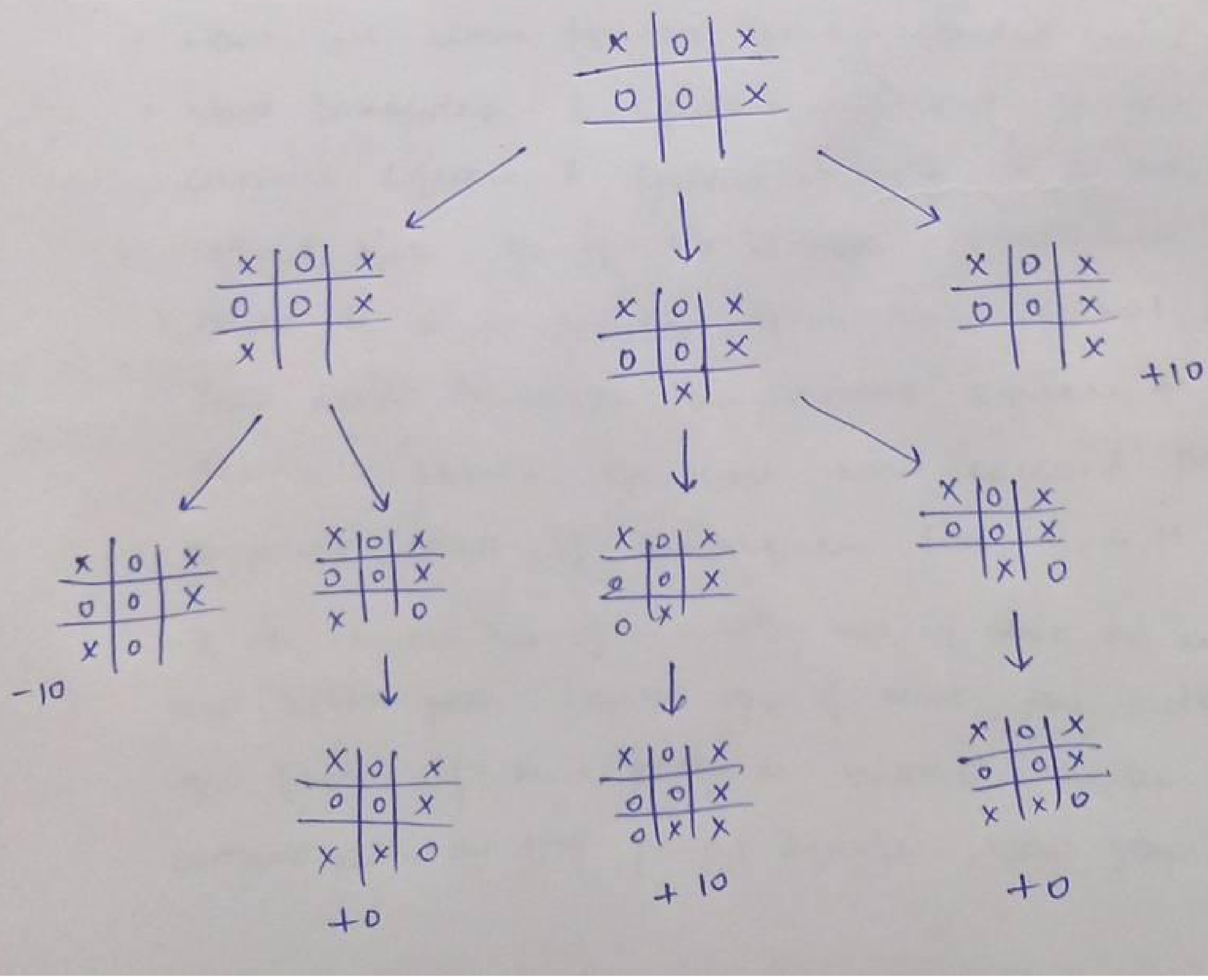
X	0	X
0	0	X
-	-	-

Final state

X	0	X
0	0	X
0	X	X

+10

Problem Solving



Algorithm :

1. Start
2. Construct the whole game tree.
3. Evaluate the scores for leaves using the evaluation function.
4. Back-up scores from leaves to root, considering the player type:
   - For max player, select the child with maximum score.
   - For min player, select the child with minimum score.
5. At the root node, choose the node with max value and perform the corresponding move.
6. Stop.

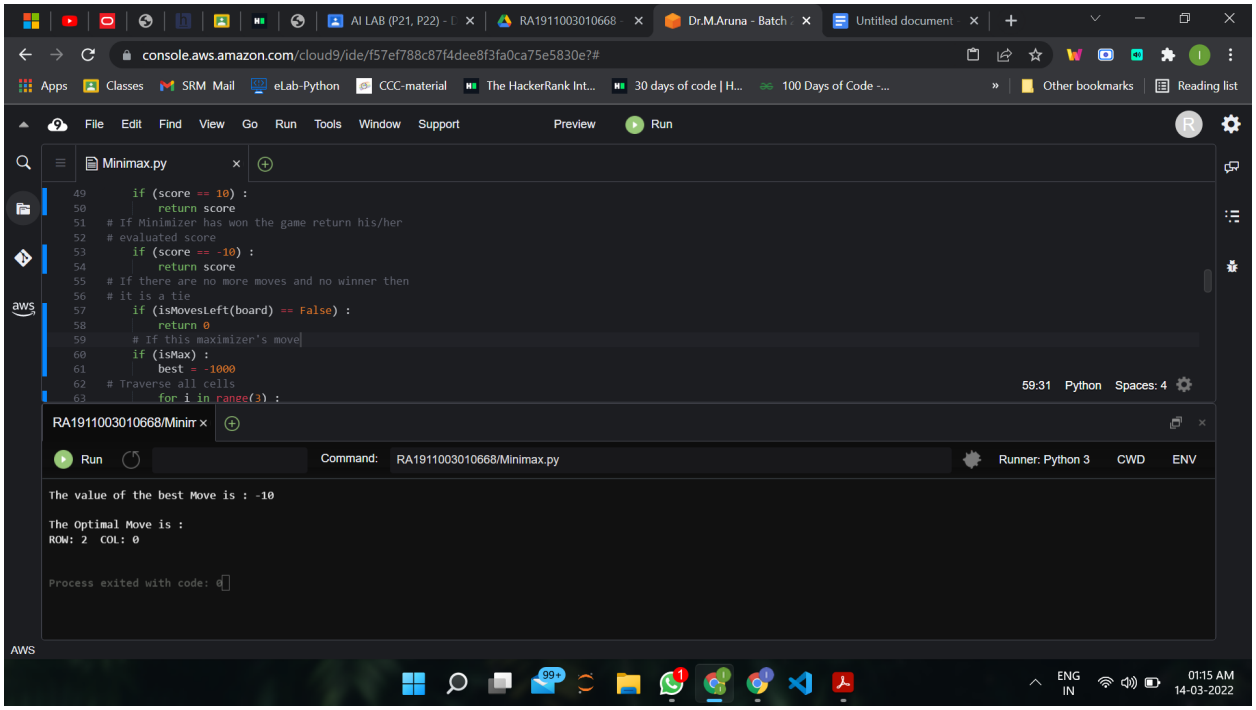
CODE:

```
# Python3 program to find the next optimal move for a player
player, opponent = 'x', 'o'
# This function returns true if there are moves
# remaining on the board. It returns false if
# there are no moves left to play.
def isMovesLeft(board) :
    for i in range(3) :
        for j in range(3) :
            if (board[i][j] == '_'):
                return True
    return False
# This is the evaluation function as discussed
# in the previous article ( http://goo.gl/sJgv68 )
def evaluate(b) :
# Checking for Rows for X or O victory.
    for row in range(3) :
        if (b[row][0] == b[row][1] and b[row][1] == b[row][2]) :
            if (b[row][0] == player) :
                return 10
            elif (b[row][0] == opponent) :
                return -10
# Checking for Columns for X or O victory.
    for col in range(3) :
        if (b[0][col] == b[1][col] and b[1][col] == b[2][col]) :
            if (b[0][col] == player) :
                return 10
        elif (b[0][col] == opponent) :
            return -10
# Checking for Diagonals for X or O victory.
    if (b[0][0] == b[1][1] and b[1][1] == b[2][2]) :
        if (b[0][0] == player) :
            return 10
        elif (b[0][0] == opponent) :
            return -10
    if (b[0][2] == b[1][1] and b[1][1] == b[2][0]) :
        if (b[0][2] == player) :
            return 10
        elif (b[0][2] == opponent) :
            return -10
# Else if none of them have won then return 0
    return 0
# This is the minimax function. It considers all
```

```
# the possible ways the game can go and returns
# the value of the board
def minimax(board, depth, isMax) :
    score = evaluate(board)
# If Maximizer has won the game return his/her
# evaluated score
    if (score == 10) :
        return score
# If Minimizer has won the game return his/her
# evaluated score
    if (score == -10) :
        return score
# If there are no more moves and no winner then
# it is a tie
    if (isMovesLeft(board) == False) :
        return 0
    # If this maximizer's move
    if (isMax) :
        best = -1000
# Traverse all cells
        for i in range(3) :
            for j in range(3) :
# Check if cell is empty
                if (board[i][j]=='_') :
# Make the move
                    board[i][j] = player
# Call minimax recursively and choose
# the maximum value
                    best = max( best, minimax(board,depth + 1,not isMax) )
# Undo the move
                    board[i][j] = '_'
            return best
# If this minimizer's move
        else :
            best = 1000
# Traverse all cells
            for i in range(3) :
                for j in range(3) :
# Check if cell is empty
                    if (board[i][j] == '_') :
# Make the move
                        board[i][j] = opponent
# Call minimax recursively and choose
# the minimum value
```

```
                    best = min(best, minimax(board, depth + 1, not isMax))
# Undo the move
                    board[i][j] = '_'
            return best
# This will return the best possible move for the player
def findBestMove(board) :
    bestVal = -1000
    bestMove = (-1, -1)
# Traverse all cells, evaluate minimax function for
# all empty cells. And return the cell with optimal
# value.
    for i in range(3) :
        for j in range(3) :
# Check if cell is empty
            if (board[i][j] == '_') :
# Make the move
                board[i][j] = player
# compute evaluation function for this
# move.
                moveVal = minimax(board, 0, False)
# Undo the move
                board[i][j] = '_'
# If the value of the current move is
# more than the best value, then update
# best/
                if (moveVal > bestVal) :
                    bestMove = (i, j)
                    bestVal = moveVal
    print("The value of the best Move is :", bestVal)
    print()
    return bestMove
# Driver code
board = [
[ 'x', 'o', 'x' ],
[ 'o', 'o', 'x' ],
[ '_', '_', '_' ]
]
bestMove = findBestMove(board)

print("The Optimal Move is :")
print("ROW:", bestMove[0], " COL:", bestMove[1])
```


console.aws.amazon.com/cloud9/ide/f57ef788c87f4dee8f3fa0ca75e5830e?#
Minimax.py
49 if (score == 10) :
50 return score
51 # If Minimizer has won the game return his/her
52 # evaluated score
53 if (score == -10) :
54 return score
55 # If there are no more moves and no winner then
56 # it is a tie
57 if (isMovesLeft(board) == False) :
58 return 0
59 # If this maximizer's move
60 if (isMax) :
61 best = -1000
62 # Traverse all cells
63 for i in range(3) :
59:31 Python Spaces: 4
RA1911003010668/Minim
Run
Command: RA1911003010668/Minimax.py
Runner: Python 3 CWD ENV
The value of the best Move is : -10
The Optimal Move is :
ROW: 2 COL: 0
Process exited with code: 0
AWS
ENG
IN
01:15 AM
14-03-2022