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Artificial Intelligence
Lab - 6

Aim : Implementation of minimax algo

MINIMAX ALGORITHM

Algorithm :

1. Start
2. Construct the complete game tree Stop
3. Evaluate 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 the maximum score
    - For min player, select the child with the minimum score
5. At the root node, choose the node with max value and perform the corresponding move
6. Stop

Code :

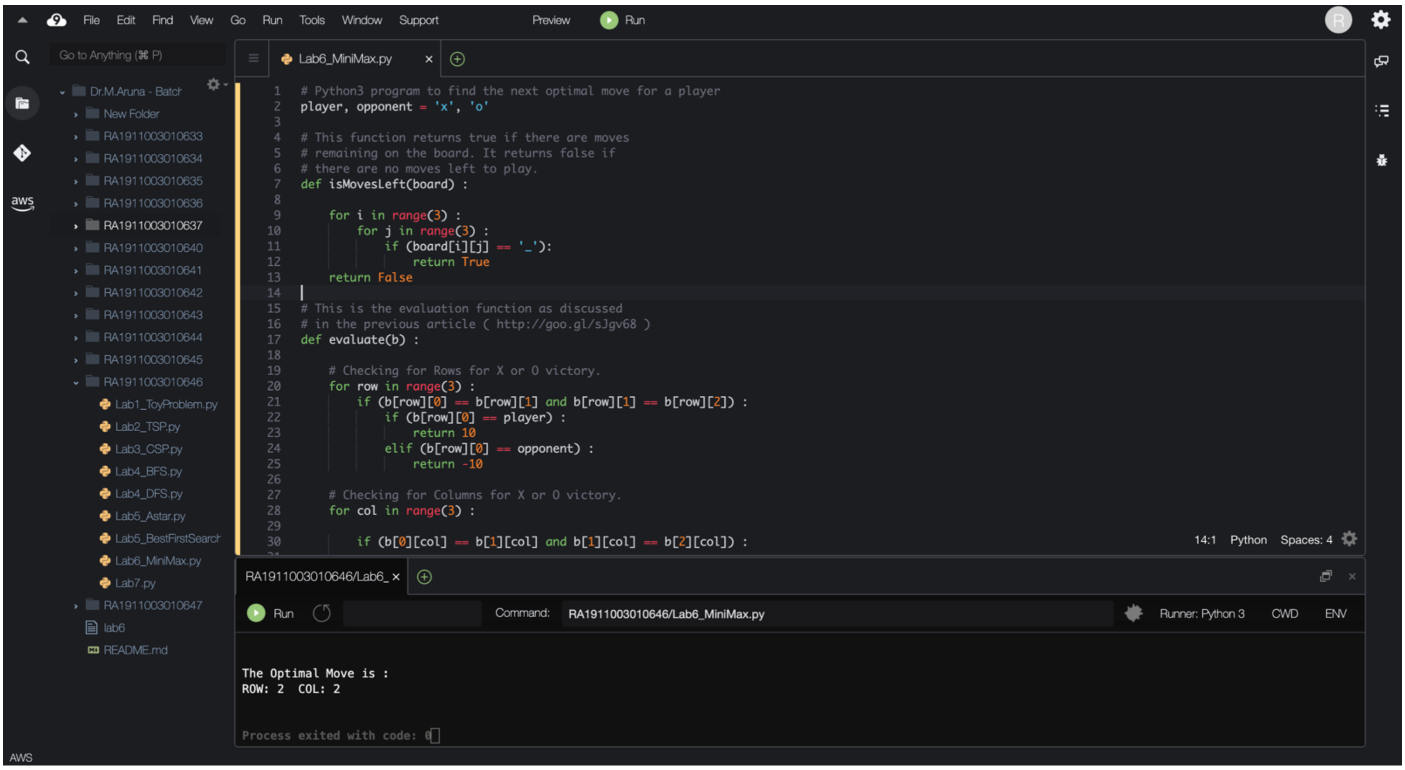
```
# Python3 program to find the next optimal move for a player
player, opponent = 'x', 'o'

# 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])
```

Output :



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Aim: Implementation of minimax algo for an application

Problem formulation

Consider a board using nine element vector where each element will ~~number~~ contain '–' for blank, X for indicating the move of player 1 & O for player 2's move.

Initial State

X	O	X
O	O	X
–	–	–

Final State

X	O	X	
O	O	X	
O	X	X	+10

Problem Solving