ARTIFICIAL INTELLIGENCE

LAB 6

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AIM: Implementation of min-max 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 'o' for player 2's move.

initial state

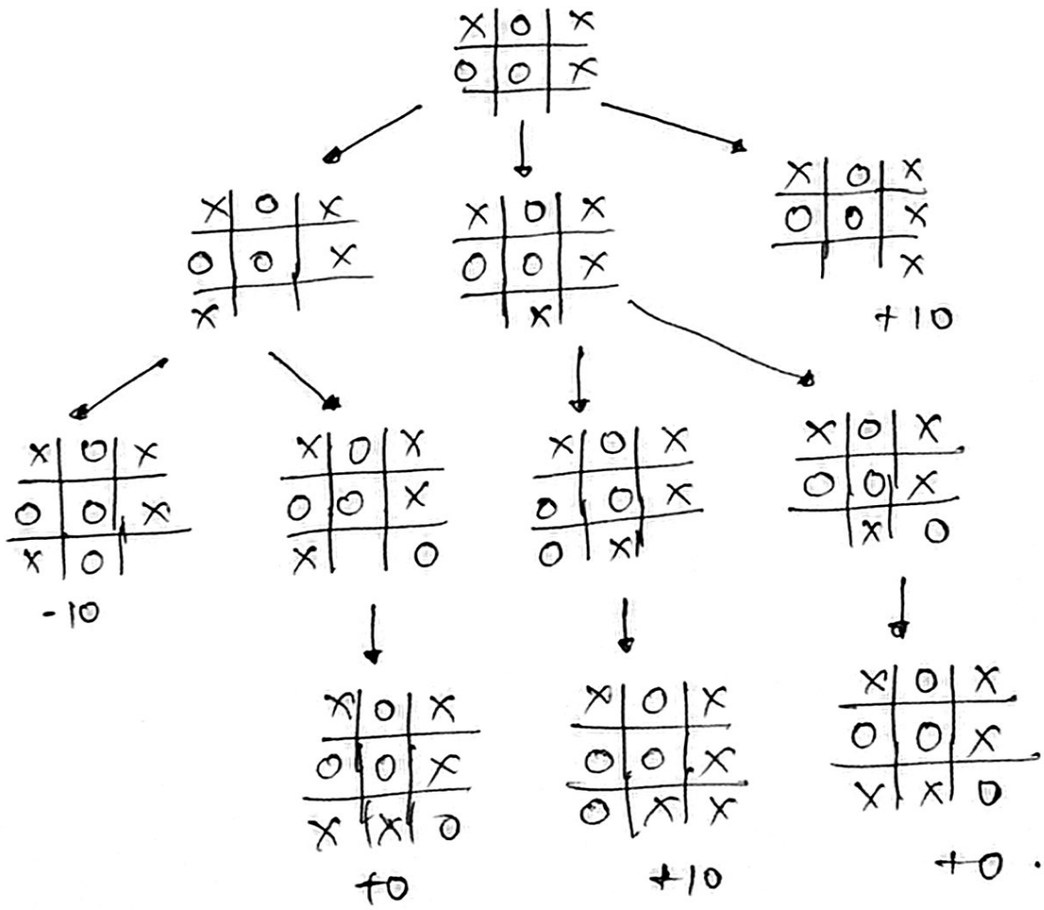
X	O	X
O	O	X
_	_	_

final state

X	O	X
O	O	X
O	X	X

+10

PROBLEM SOLVING:



ALGORITHM:

1. Start
2. Construct the complete game tree.
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

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
```

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                        best = max( best, minimax(board,
                                                  depth + 1,
                                                  not isMax)
)

                        # Undo the move
                        board[i][j] = '_'
            return best

      else :
            best = 1000

            for i in range(3) :
                  for j in range(3) :


                        if (board[i][j] == '_') :


                              board[i][j] = opponent


                              best = min(best, minimax(board, depth + 1,
not isMax))

                              board[i][j] = '_'
            return best

def findBestMove(board) :
      bestVal = -1000
      bestMove = (-1, -1)


      for i in range(3) :
            for j in range(3) :


                  if (board[i][j] == '_') :

                        board[i][j] = player

                        moveVal = minimax(board, 0, False)


                        board[i][j] = '_'
```

```
                    if (moveVal > bestVal) :
                        bestMove = (i, j)
                        bestVal = moveVal

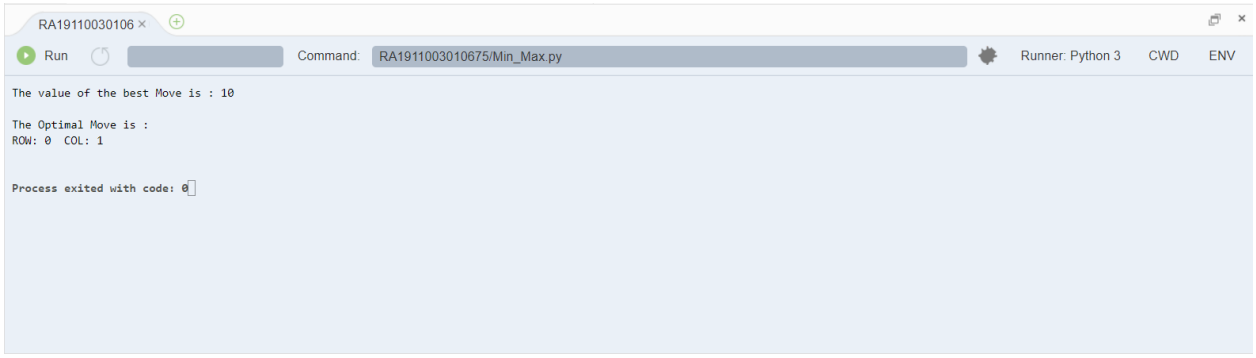
    print("The value of the best Move is :", bestVal)
    print()
    return bestMove

board = [
    [ 'o', '_', '_' ],
    [ 'o', 'x', '_' ],
    [ 'x', '_', '_' ]
]

bestMove = findBestMove(board)

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

Output:



Result:

Hence, the Implementation of minimax algorithm for TIC-TAC-TOE is done successfully