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Artificial Intelligence Lab

Lab-6

Aim:- Implementation of minimax algorithm for an application.

Problem Formulation

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

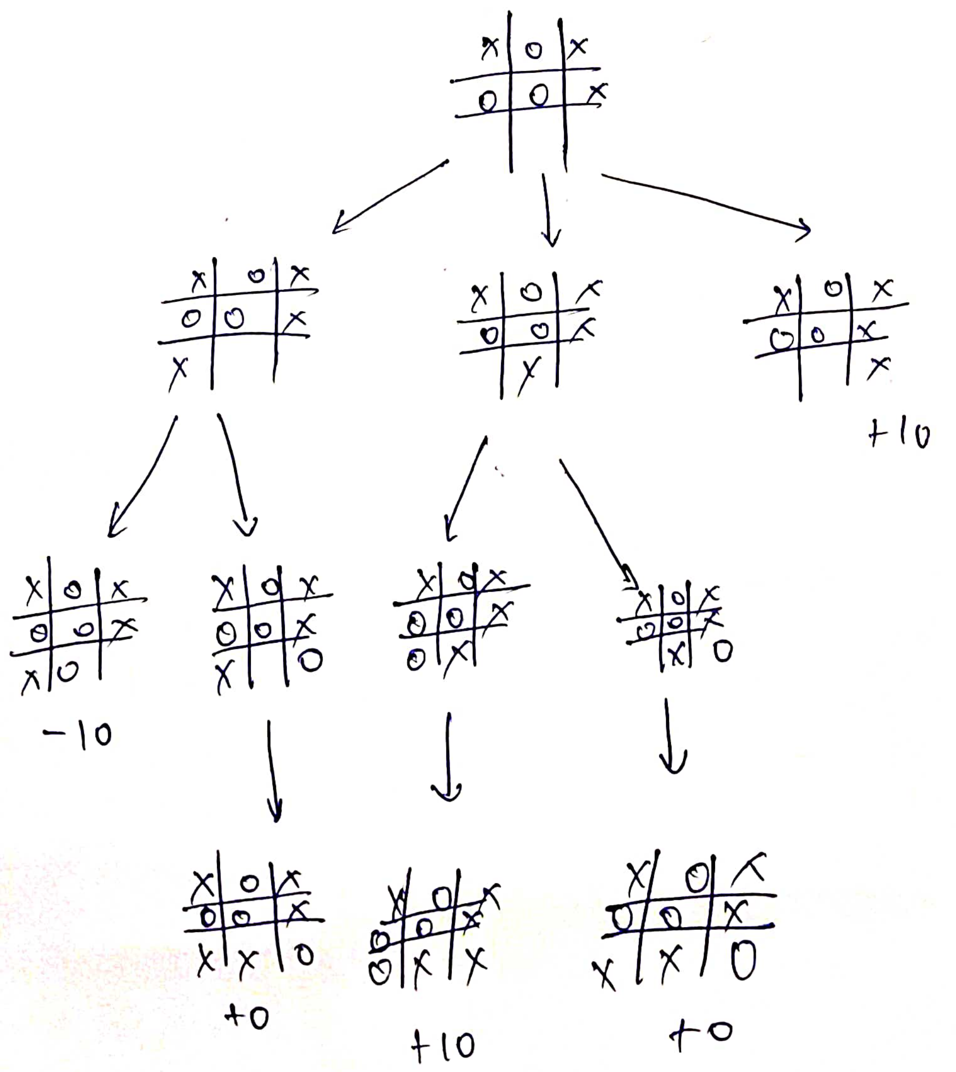
Initial State

X	O	X
O	O	X
-	-	-

Final State

X	O	X
O	O	X
O	X	X

+10



if player 1 plays [2, 2], then ~~the~~ he will win the game. The value of this move is +10

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AI LAB 6

Implementation of minimax algorithm for an application

Algorithm:

Step-1: Start

Step-2: Construct the complete game tree

Step-3: Evaluate scores for leaves using the evaluation function

Step-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

Step-5: At the root node, choose the node with max value and perform

the corresponding move

Step-6: Stop

Source 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) :
```

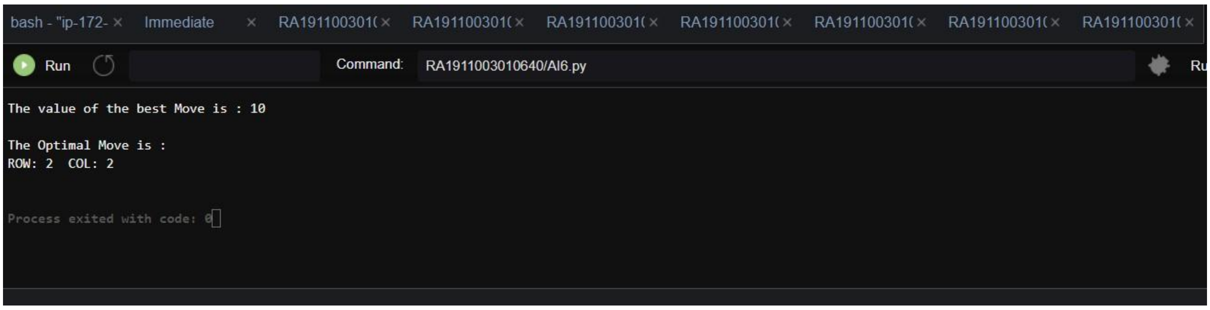
```
                return -10

        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



Result:

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