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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 player1 and 0 for player 2's move.

Initial State

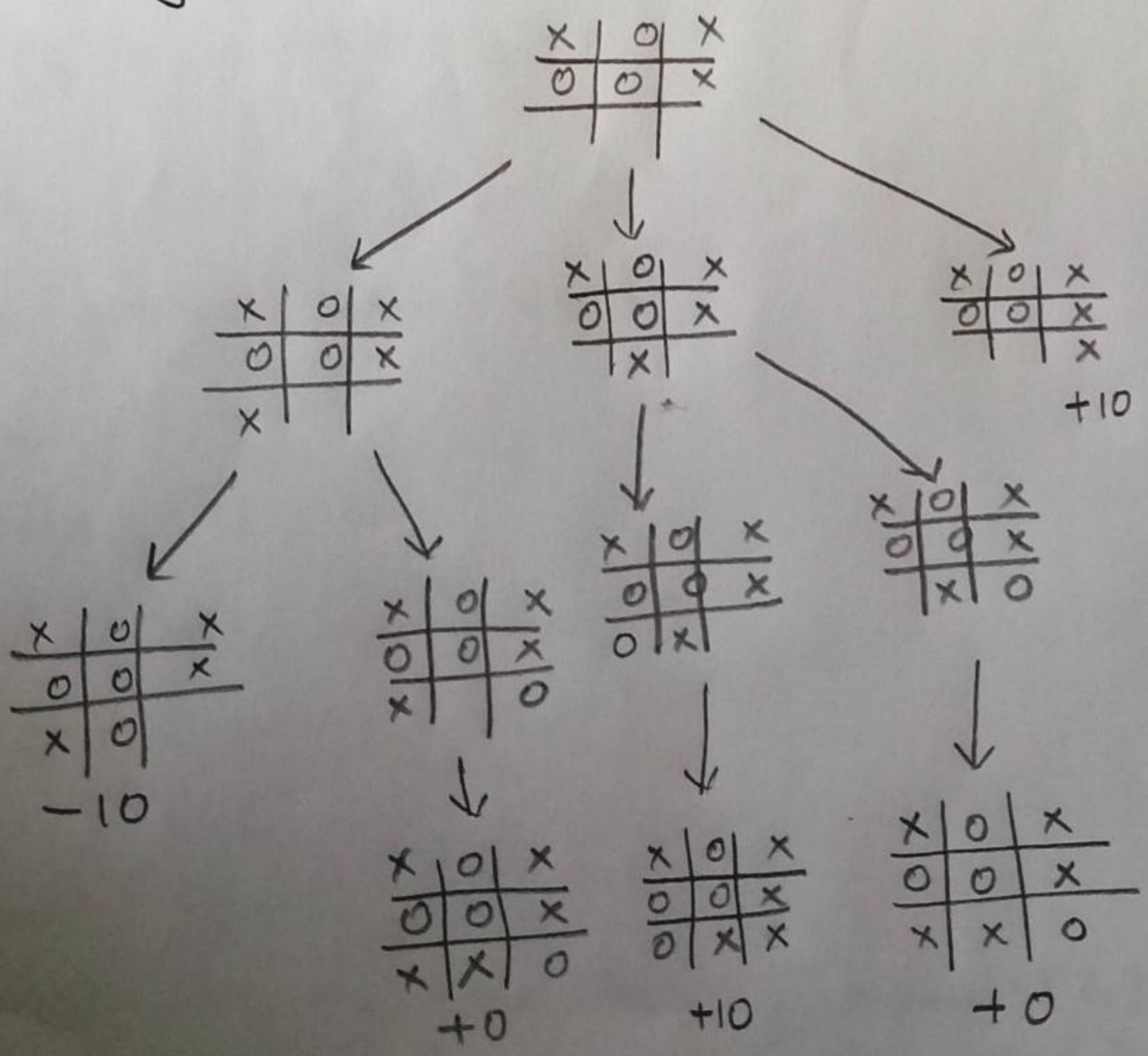
X	0	X
0	0	X
-	-	-

Final State

X	0	X
0	0	X
0	X	X

+10

Problem Solving:



If player 1 plays [2,2], then he will win the game.

The value of this move is +10.

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EXPERIMENT NO: 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:

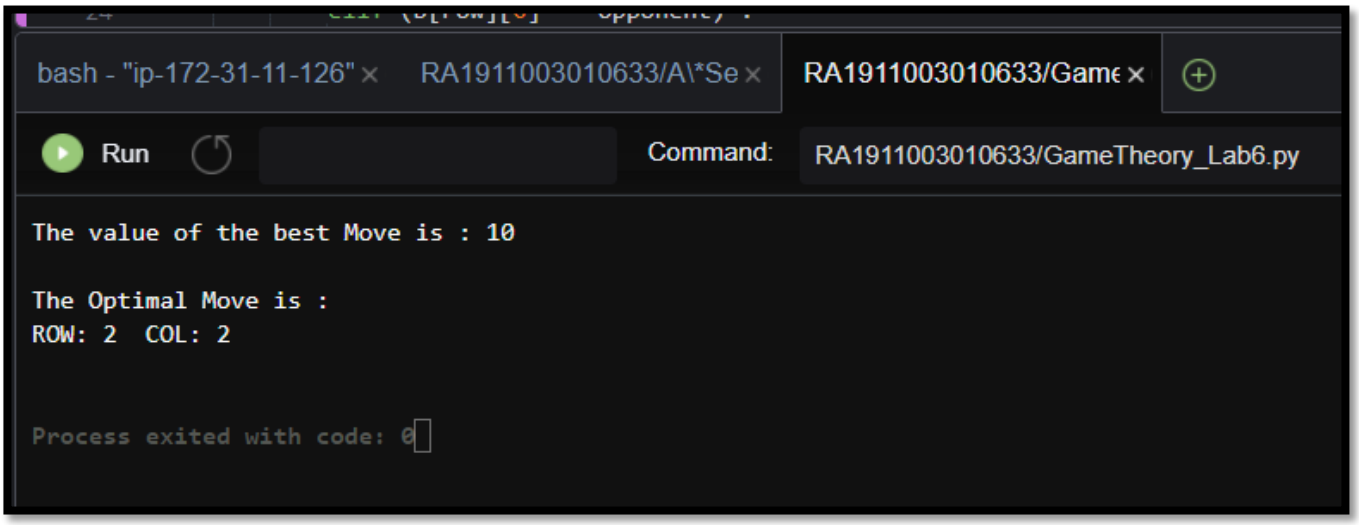
```
# Python3 program to find the next optimal move for a player
player, opponent = 'x', 'o'

# 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.