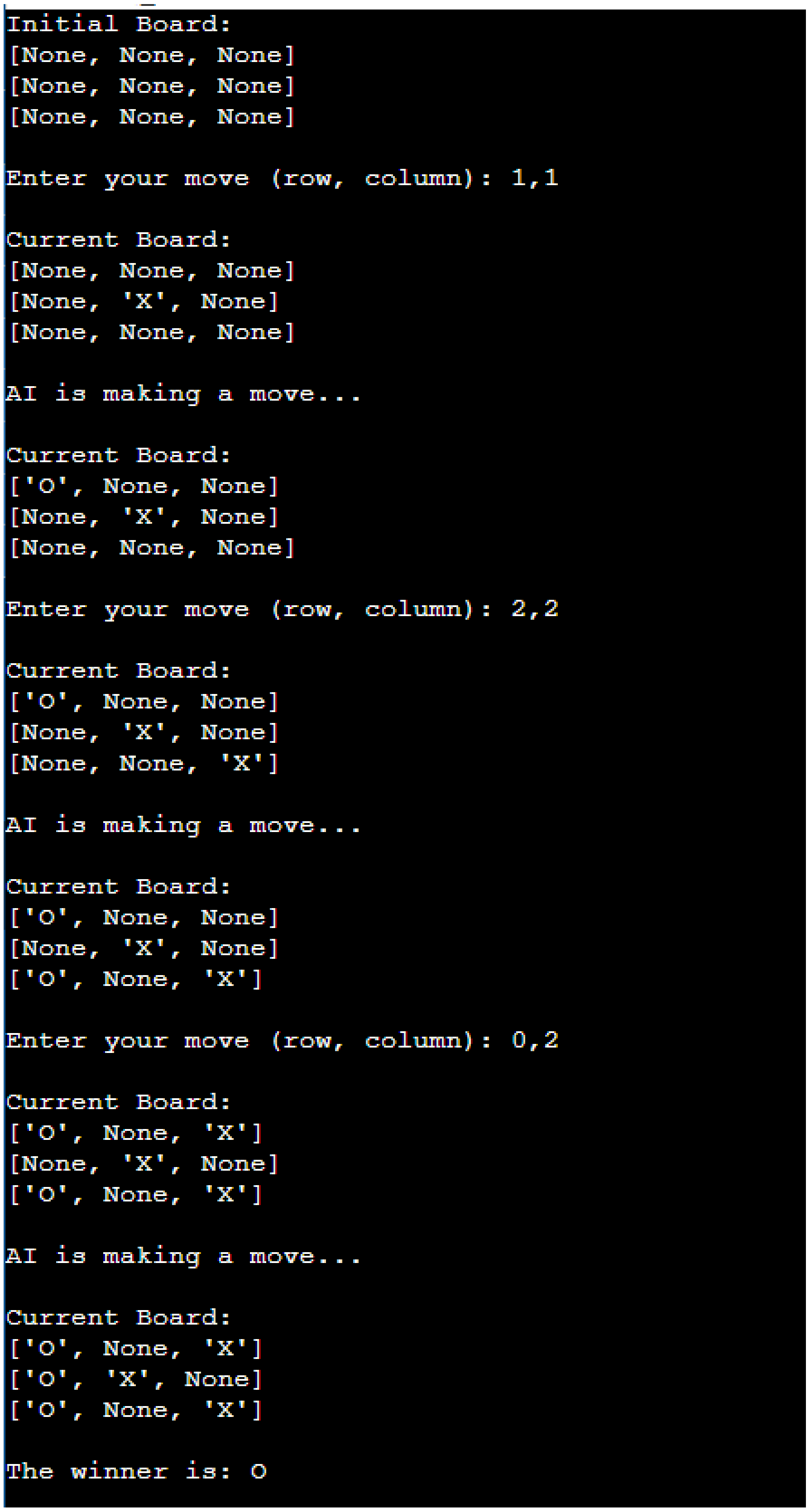
TIC-TAC-TOE

```
import math
import copy

X = "X"
O = "O"
EMPTY = None


def initial_state():
    return [[EMPTY, EMPTY, EMPTY],
            [EMPTY, EMPTY, EMPTY],
            [EMPTY, EMPTY, EMPTY]]


def player(board):
    countO = 0
    countX = 0
    for y in [0, 1, 2]:
        for x in board[y]:
            if x == "O":
                countO = countO + 1
            elif x == "X":
                countX = countX + 1
    if countO >= countX:
        return X
    elif countX > countO:
        return O


def actions(board):
    freeboxes = set()
    for i in [0, 1, 2]:
        for j in [0, 1, 2]:
            if board[i][j] == EMPTY:
                freeboxes.add((i, j))
    return freeboxes


def result(board, action):
    i = action[0]
    j = action[1]
    if type(action) == list:
        action = (i, j)
    if action in actions(board):
        if player(board) == X:
            board[i][j] = X
        elif player(board) == O:
            board[i][j] = O
    return board


def winner(board):
    if (board[0][0] == board[0][1] == board[0][2] == X or board[1][0] == board[1][1] == board[1][2]
== X or board[2][0] == board[2][1] == board[2][2] == X):
        return X
    if (board[0][0] == board[0][1] == board[0][2] == O or board[1][0] == board[1][1] == board[1][2]
== O or board[2][0] == board[2][1] == board[2][2] == O):
        return O
    for i in [0, 1, 2]:
        s2 = []
        for j in [0, 1, 2]:
            s2.append(board[j][i])
        if (s2[0] == s2[1] == s2[2]):
            return s2[0]
    strikeD = []
    for i in [0, 1, 2]:
        strikeD.append(board[i][i])
    if (strikeD[0] == strikeD[1] == strikeD[2]):
        return strikeD[0]
    if (board[0][2] == board[1][1] == board[2][0]):
        return board[0][2]
    return None


def terminal(board):
    Full = True
    for i in [0, 1, 2]:
        for j in board[i]:
            if j is None:
                Full = False
    if Full:
        return True
    if (winner(board) is not None):
        return True
    return False
```

```
def utility(board):
    if (winner(board) == X):
        return 1
    elif winner(board) == O:
        return -1
    else:
        return 0


def minimax_helper(board):
    isMaxTurn = True if player(board) == X else False
    if terminal(board):
        return utility(board)

    scores = []
    for move in actions(board):
        result(board, move)
        scores.append(minimax_helper(board))
        board[move[0]][move[1]] = EMPTY
    return max(scores) if isMaxTurn else min(scores)


def minimax(board):
    isMaxTurn = True if player(board) == X else False
    bestMove = None
    if isMaxTurn:
        bestScore = -math.inf
        for move in actions(board):
            result(board, move)
            score = minimax_helper(board)
            board[move[0]][move[1]] = EMPTY
            if (score > bestScore):
                bestScore = score
                bestMove = move
        return bestMove
    else:
        bestScore = +math.inf
        for move in actions(board):
            result(board, move)
            score = minimax_helper(board)
            board[move[0]][move[1]] = EMPTY
            if (score < bestScore):
                bestScore = score
                bestMove = move
        return bestMove


def print_board(board):
    for row in board:
        print(row)


# Example usage:
game_board = initial_state()
print("Initial Board:")
print_board(game_board)

while not terminal(game_board):
    if player(game_board) == X:
        user_input = input("\nEnter your move (row, column): ")
        row, col = map(int, user_input.split(','))
        result(game_board, (row, col))
    else:
        print("\nAI is making a move...")
        move = minimax(copy.deepcopy(game_board))
        result(game_board, move)

    print("\nCurrent Board:")
    print_board(game_board)

# Determine the winner
if winner(game_board) is not None:
    print(f"\nThe winner is: {winner(game_board)}")
else:
    print("\nIt's a tie!")
```

Output:



```
Initial Board:
[None, None, None]
[None, None, None]
[None, None, None]

Enter your move (row, column): 1,1

Current Board:
[None, None, None]
[None, 'X', None]
[None, None, None]

AI is making a move...

Current Board:
['O', None, None]
[None, 'X', None]
[None, None, None]

Enter your move (row, column): 2,2

Current Board:
['O', None, None]
[None, 'X', None]
[None, None, 'X']

AI is making a move...

Current Board:
['O', None, None]
[None, 'X', None]
['O', None, 'X']

Enter your move (row, column): 0,2

Current Board:
['O', None, 'X']
[None, 'X', None]
['O', None, 'X']

AI is making a move...

Current Board:
['O', None, 'X']
['O', 'X', None]
['O', None, 'X']

The winner is: O
```