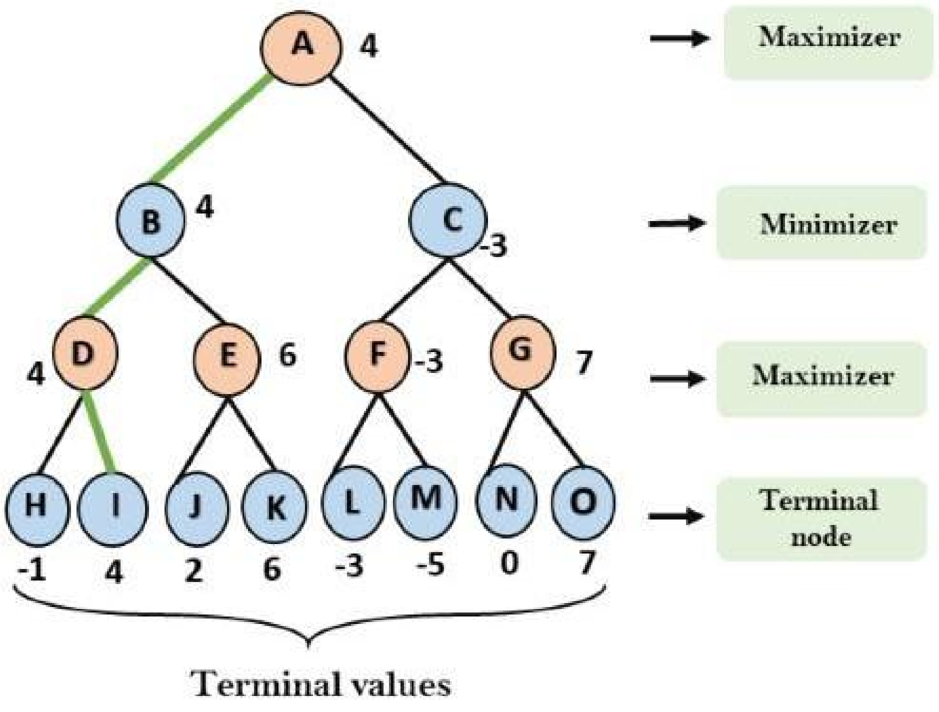
EX.NO: 05

MINIMAX ALGORITHM

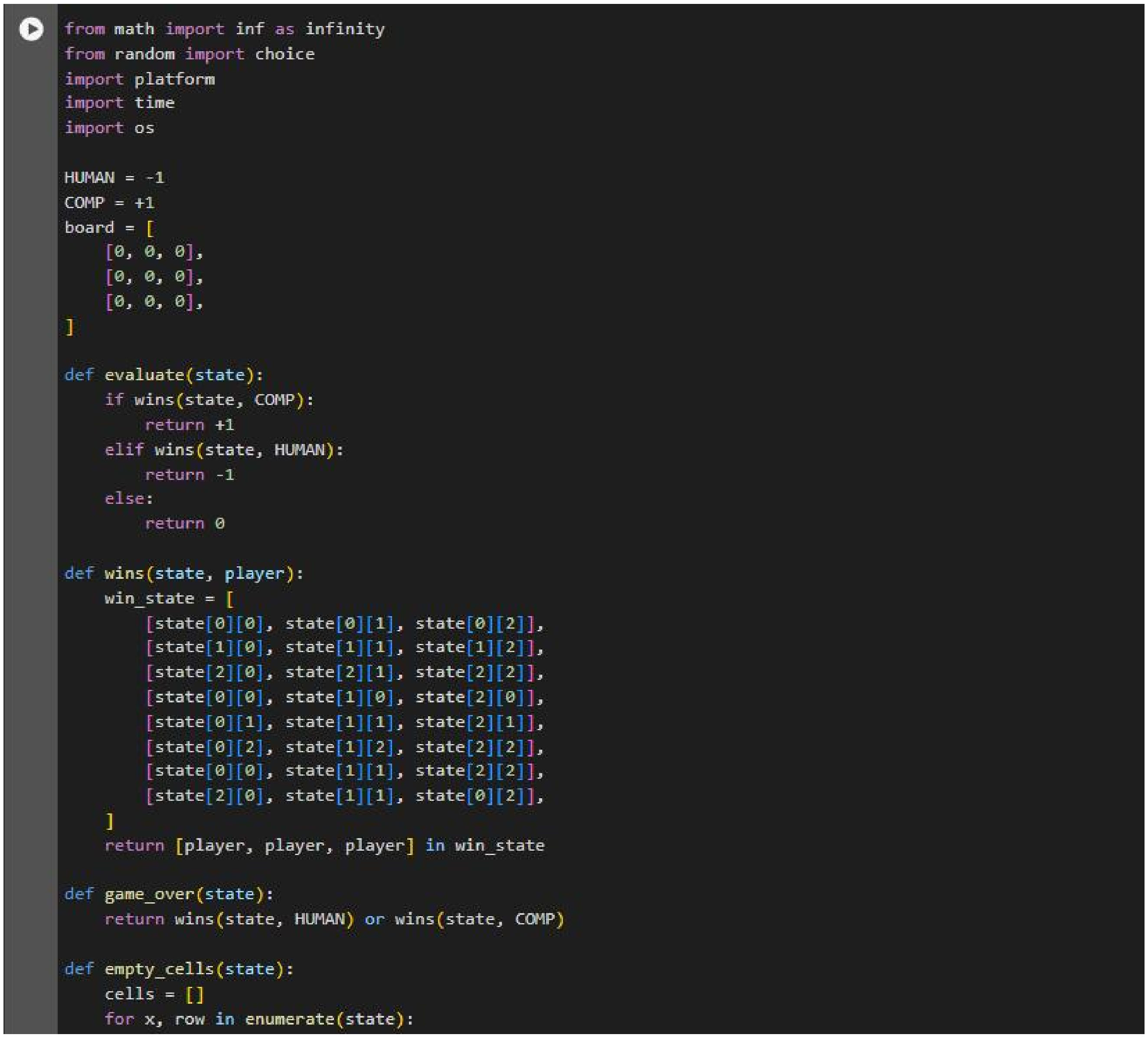
- A simple example can be used to explain how the minimax algorithm works. We've included an example of a game-tree below, which represents a two-player game.
- There are two players in this scenario, one named Maximizer and the other named Minimizer.
- Maximizer will strive for the highest possible score, while Minimizer will strive for the lowest possible score.
- Because this algorithm uses DFS, we must go all the way through the leaves to reach the terminal nodes in this game-tree.
- The terminal values are given at the terminal node, so we'll compare them and retrace the tree till we reach the original state.



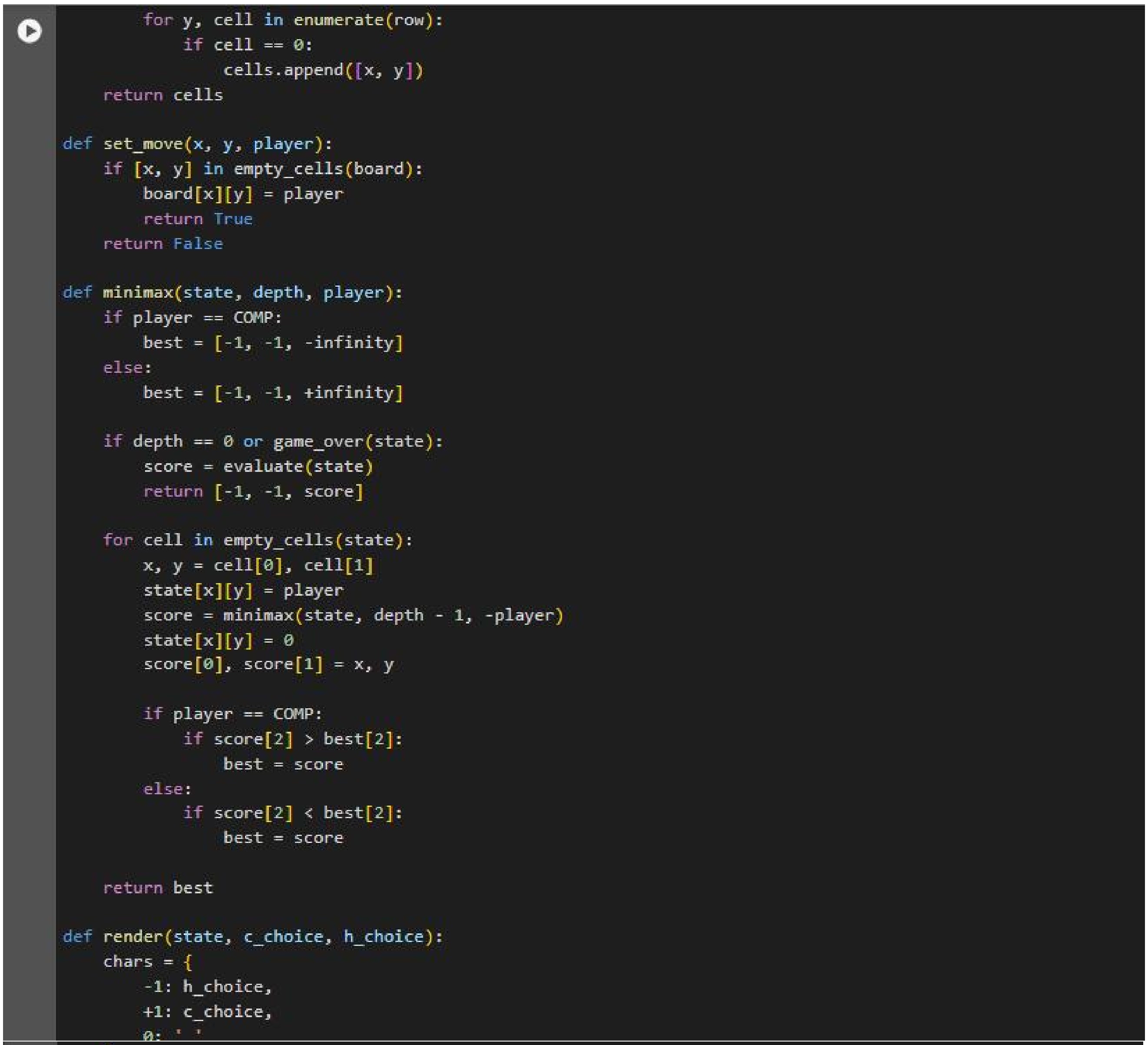
AIM :

To implement MINIMAX Algorithm problem using Python.

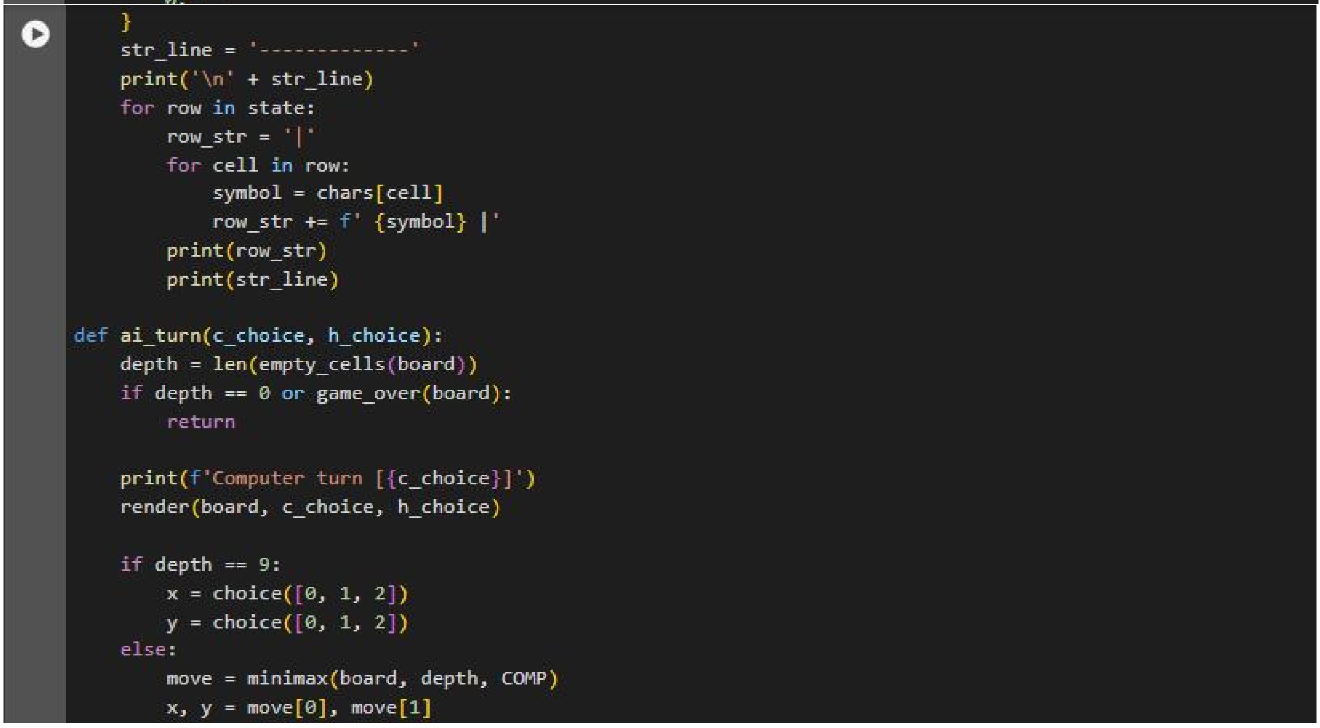
CODE :



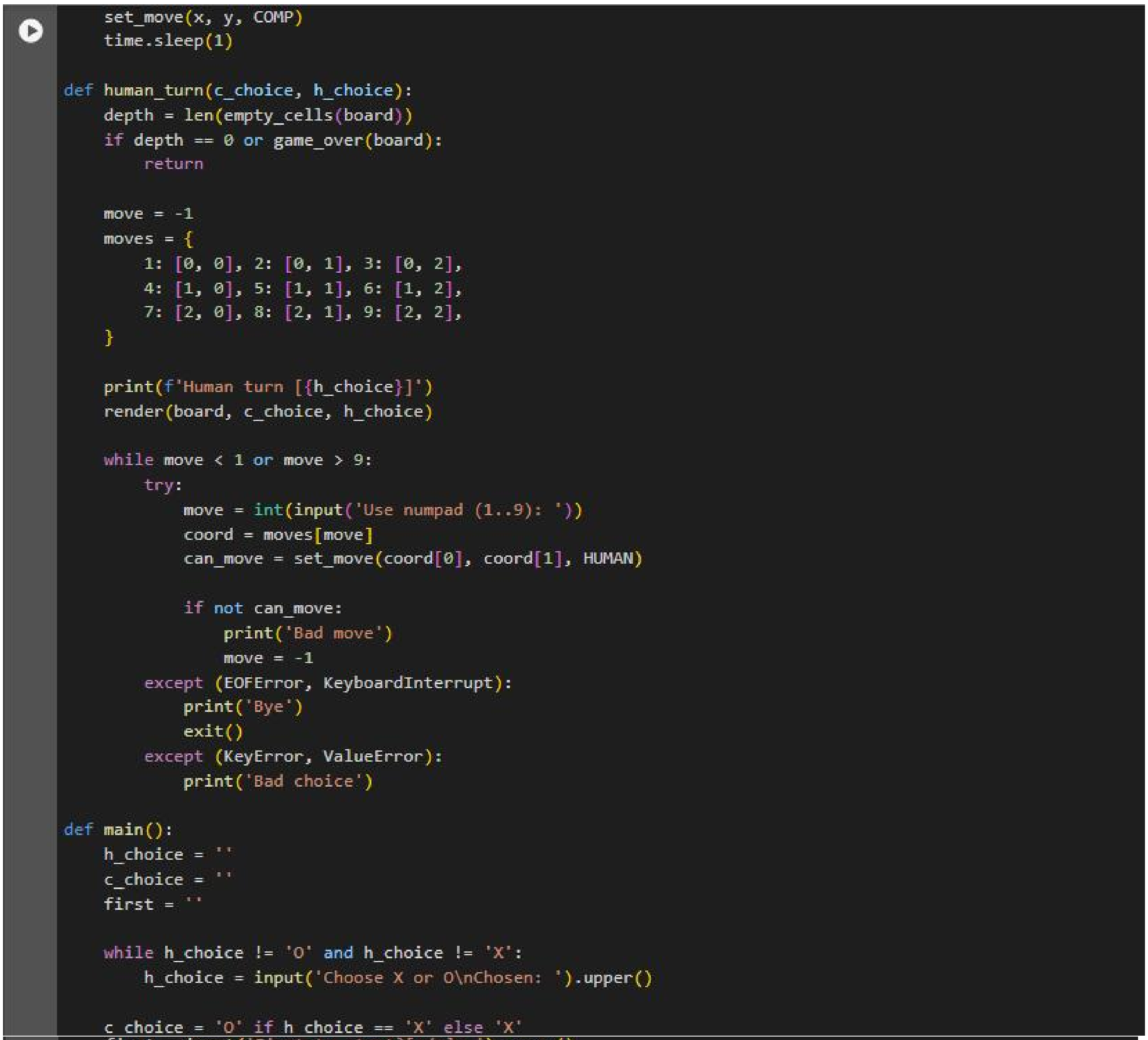
```python
from math import inf as infinity
from random import choice
import platform
import time
import os

HUMAN = -1
COMP = +1
board = [
    [0, 0, 0],
    [0, 0, 0],
    [0, 0, 0],
]

def evaluate(state):
    if wins(state, COMP):
        return +1
    elif wins(state, HUMAN):
        return -1
    else:
        return 0

def wins(state, player):
    win_state = [
        [state[0][0], state[0][1], state[0][2]],
        [state[1][0], state[1][1], state[1][2]],
        [state[2][0], state[2][1], state[2][2]],
        [state[0][0], state[1][0], state[2][0]],
        [state[0][1], state[1][1], state[2][1]],
        [state[0][2], state[1][2], state[2][2]],
        [state[0][0], state[1][1], state[2][2]],
        [state[2][0], state[1][1], state[0][2]],
    ]
    return [player, player, player] in win_state

def game_over(state):
    return wins(state, HUMAN) or wins(state, COMP)

def empty_cells(state):
    cells = []
    for x, row in enumerate(state):
```



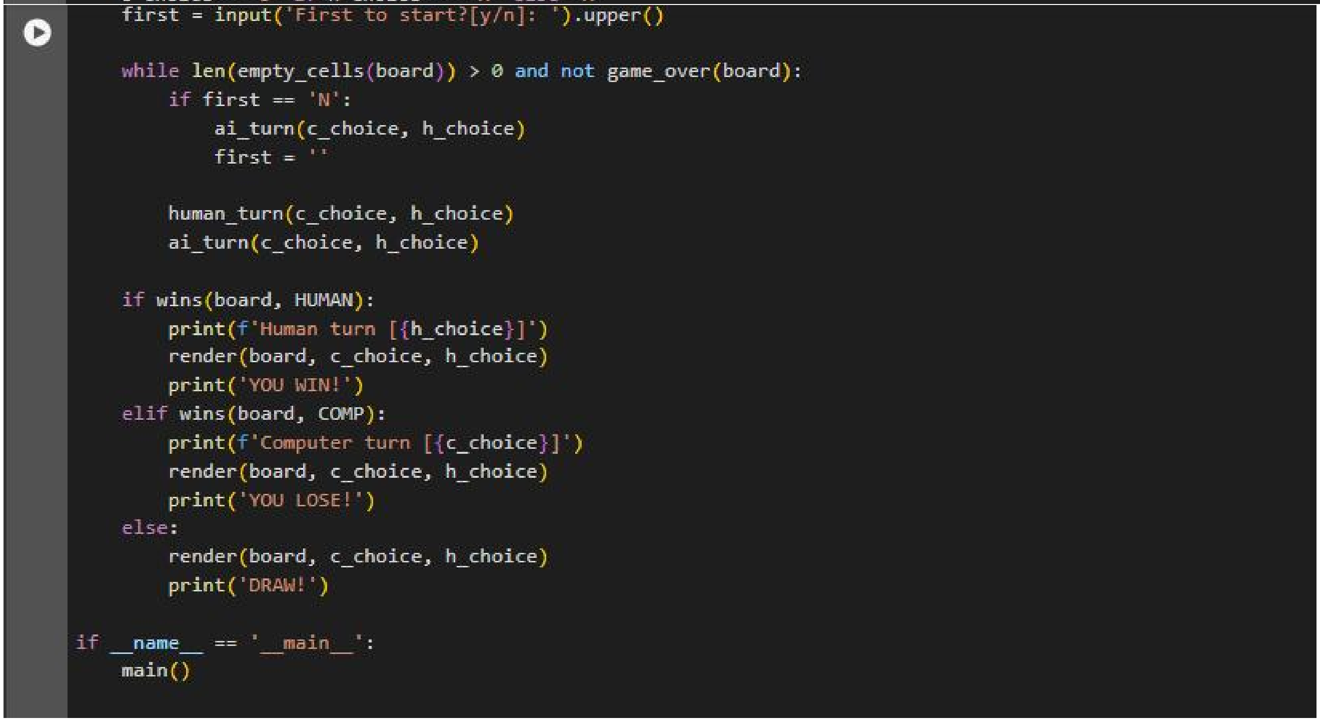
```python
        for y, cell in enumerate(row):
            if cell == 0:
                cells.append([x, y])
    return cells

def set_move(x, y, player):
    if [x, y] in empty_cells(board):
        board[x][y] = player
        return True
    return False

def minimax(state, depth, player):
    if player == COMP:
        best = [-1, -1, -infinity]
    else:
        best = [-1, -1, +infinity]

    if depth == 0 or game_over(state):
        score = evaluate(state)
        return [-1, -1, score]

    for cell in empty_cells(state):
        x, y = cell[0], cell[1]
        state[x][y] = player
        score = minimax(state, depth - 1, -player)
        state[x][y] = 0
        score[0], score[1] = x, y

        if player == COMP:
            if score[2] > best[2]:
                best = score
        else:
            if score[2] < best[2]:
                best = score

    return best

def render(state, c_choice, h_choice):
    chars = {
        -1: h_choice,
        +1: c_choice,
        0: ' '
```



```python
    }
    str_line = '-------------'
    print('\n' + str_line)
    for row in state:
        row_str = '|'
        for cell in row:
            symbol = chars[cell]
            row_str += f' {symbol} |'
        print(row_str)
        print(str_line)

def ai_turn(c_choice, h_choice):
    depth = len(empty_cells(board))
    if depth == 0 or game_over(board):
        return

    print(f'Computer turn [{c_choice}]')
    render(board, c_choice, h_choice)

    if depth == 9:
        x = choice([0, 1, 2])
        y = choice([0, 1, 2])
    else:
        move = minimax(board, depth, COMP)
        x, y = move[0], move[1]
```

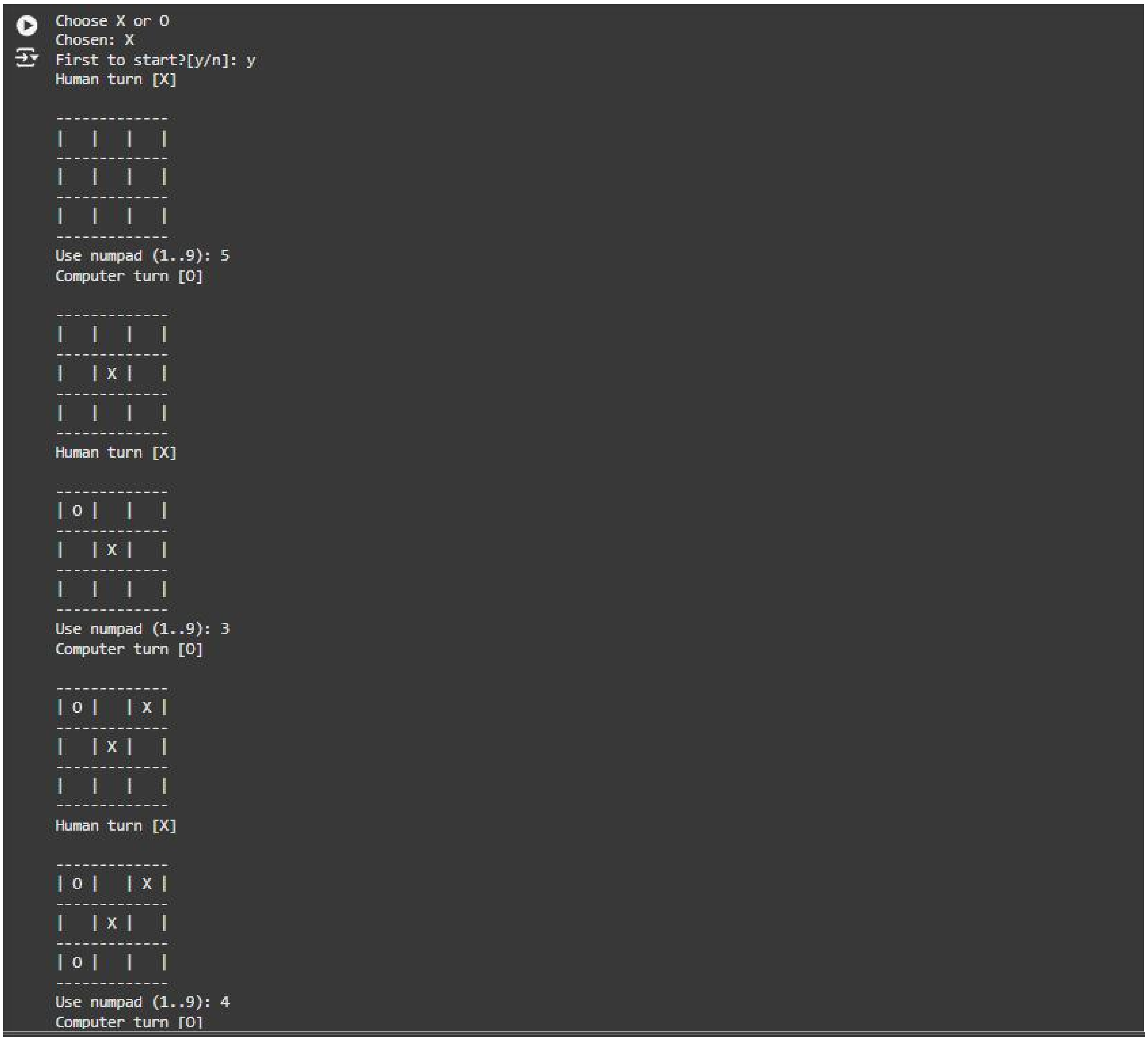


```python
    set_move(x, y, COMP)
    time.sleep(1)

def human_turn(c_choice, h_choice):
    depth = len(empty_cells(board))
    if depth == 0 or game_over(board):
        return

    move = -1
    moves = {
        1: [0, 0], 2: [0, 1], 3: [0, 2],
        4: [1, 0], 5: [1, 1], 6: [1, 2],
        7: [2, 0], 8: [2, 1], 9: [2, 2],
    }

    print(f'Human turn [{h_choice}]')
    render(board, c_choice, h_choice)

    while move < 1 or move > 9:
        try:
            move = int(input('Use numpad (1..9): '))
            coord = moves[move]
            can_move = set_move(coord[0], coord[1], HUMAN)

            if not can_move:
                print('Bad move')
                move = -1
        except (EOFError, KeyboardInterrupt):
            print('Bye')
            exit()
        except (KeyError, ValueError):
            print('Bad choice')

def main():
    h_choice = ''
    c_choice = ''
    first = ''

    while h_choice != 'O' and h_choice != 'X':
        h_choice = input('Choose X or O\nChosen: ').upper()

    c_choice = 'O' if h_choice == 'X' else 'X'
```

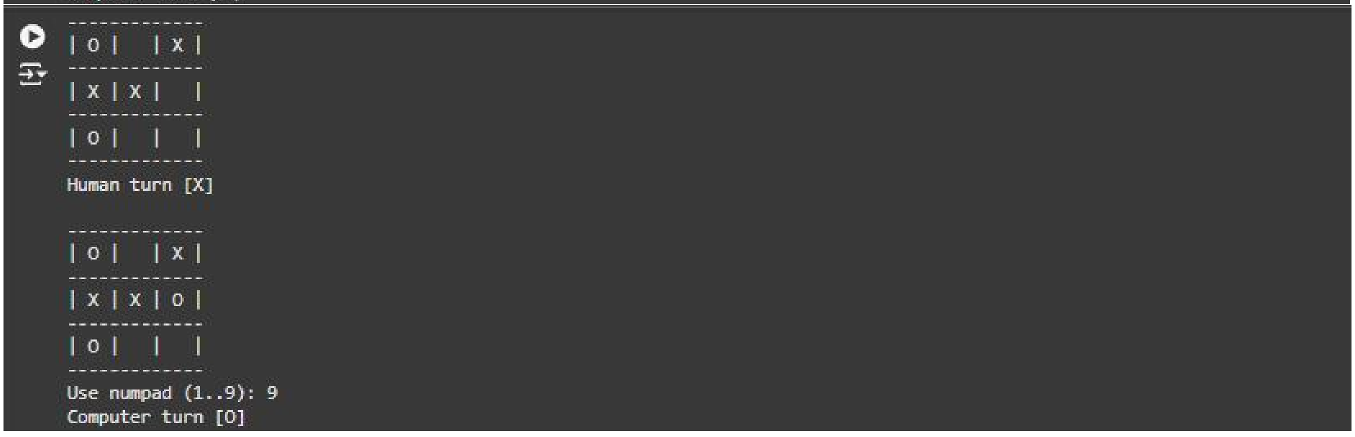


```python
    first = input('First to start?[y/n]: ').upper()

    while len(empty_cells(board)) > 0 and not game_over(board):
        if first == 'N':
            ai_turn(c_choice, h_choice)
            first = ''

        human_turn(c_choice, h_choice)
        ai_turn(c_choice, h_choice)

    if wins(board, HUMAN):
        print(f'Human turn [{h_choice}]')
        render(board, c_choice, h_choice)
        print('YOU WIN!')
    elif wins(board, COMP):
        print(f'Computer turn [{c_choice}]')
        render(board, c_choice, h_choice)
        print('YOU LOSE!')
    else:
        render(board, c_choice, h_choice)
        print('DRAW!')

if __name__ == '__main__':
    main()
```

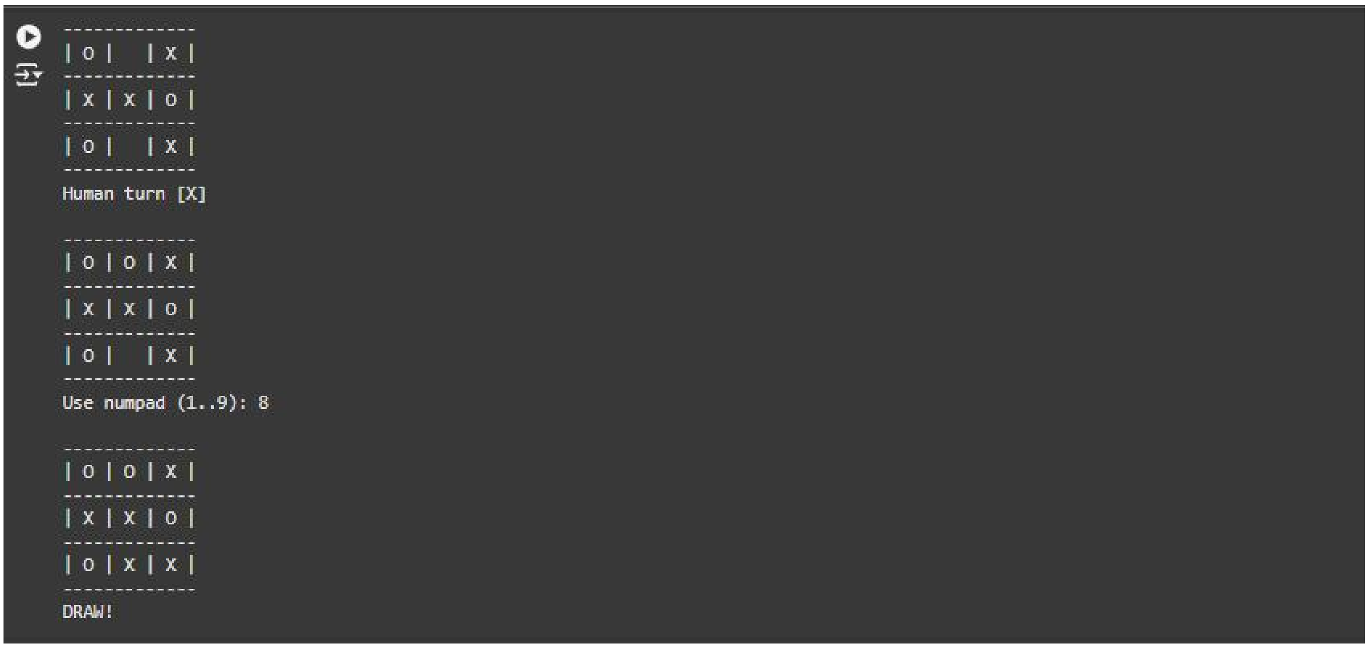
OUTPUT :



```
Choose X or O
Chosen: X
First to start?[y/n]: y
Human turn [X]

-------------
|   |   |   |
-------------
|   |   |   |
-------------
|   |   |   |
-------------
Use numpad (1..9): 5
Computer turn [O]

-------------
|   |   |   |
-------------
|   | X |   |
-------------
|   |   |   |
-------------
Human turn [X]

-------------
| O |   |   |
-------------
|   | X |   |
-------------
|   |   |   |
-------------
Use numpad (1..9): 3
Computer turn [O]

-------------
| O |   | X |
-------------
|   | X |   |
-------------
|   |   |   |
-------------
Human turn [X]

-------------
| O |   | X |
-------------
|   | X |   |
-------------
| O |   |   |
-------------
Use numpad (1..9): 4
Computer turn [O]
```



```
-------------
| O |   | X |
-------------
| X | X |   |
-------------
| O |   |   |
-------------
Human turn [X]

-------------
| O |   | X |
-------------
| X | X | O |
-------------
| O |   |   |
-------------
Use numpad (1..9): 9
Computer turn [O]
```



```
-------------
| O |   | X |
-------------
| X | X | O |
-------------
| O |   | X |
-------------
Human turn [X]

-------------
| O | O | X |
-------------
| X | X | O |
-------------
| O |   | X |
-------------
Use numpad (1..9): 8

-------------
| O | O | X |
-------------
| X | X | O |
-------------
| O | X | X |
-------------
DRAW!
```

RESULT :

Thus, the implementing of MINMAX Algorithm is successfully executed and the output is verified.