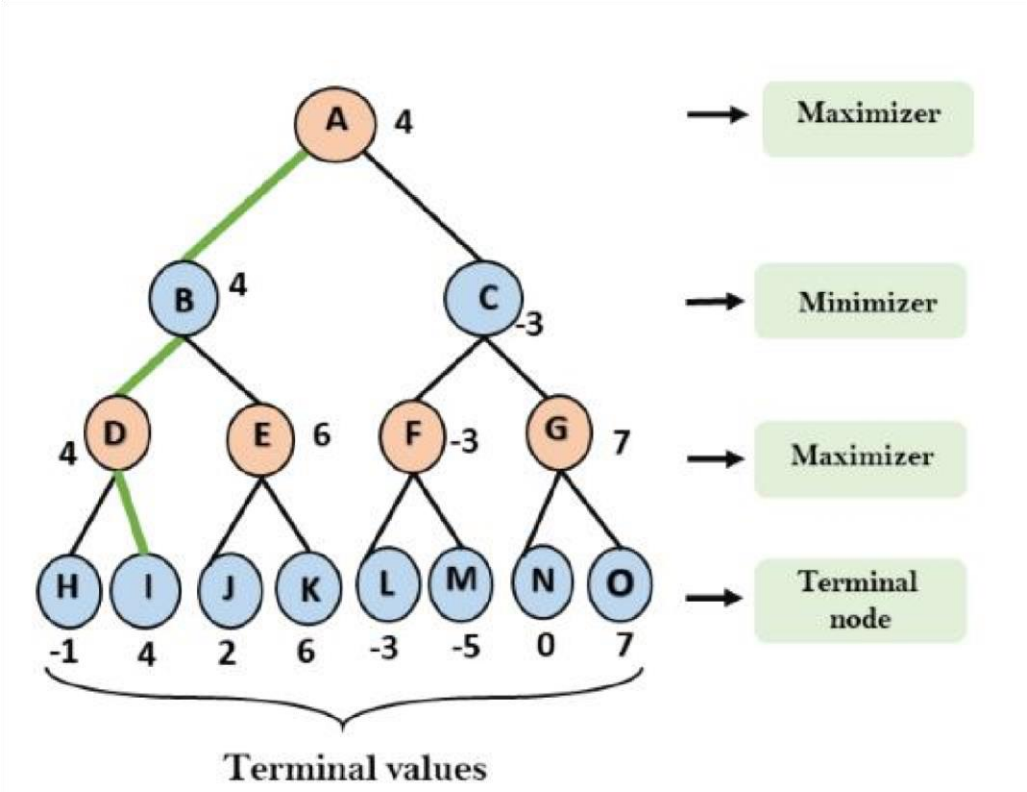
EX.NO: 4

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.

SOURCE CODE :

```
from math import inf as infinity
from random import choice
import platform import time
from os import system
HUMAN = -1 COMP
= +1
board = [
    [0, 0, 0],
    [0, 0, 0],
    [0, 0, 0],
]
def evaluate(state):    if
wins(state, COMP):
score = +1      elif wins(state,
HUMAN):         score = -1
else:         score = 0
return score


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]],
    ]
    if [player, player, player] in win_state:         return True
else:             return False def game_over(state): return
wins(state, HUMAN) or wins(state, COMP)
def empty_cells(state):
    cells = []     for x, row in
enumerate(state):         for y, cell in
enumerate(row):             if cell ==
0:
                cells.append([x, y])
```

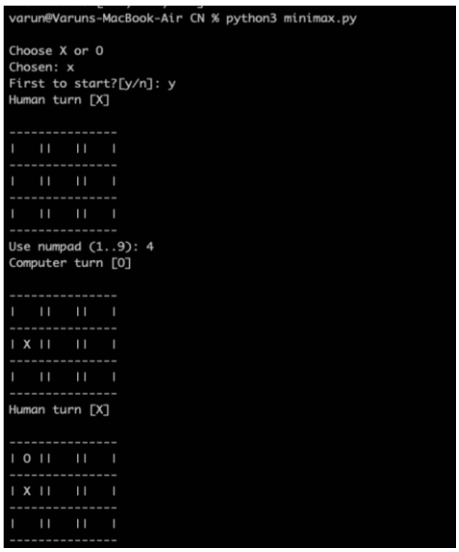
```
  return cells def
valid_move(x, y):

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

    if    valid_move(x,    y):
board[x][y]     =     player
return True     else:
        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  # max value          else:
            if score[2] < best[2]:
best = score  # min value

    return best


def clean():

    os_name = platform.system().lower()
if 'windows' in os_name:
        system('cls')
else:
        system('clear')
```

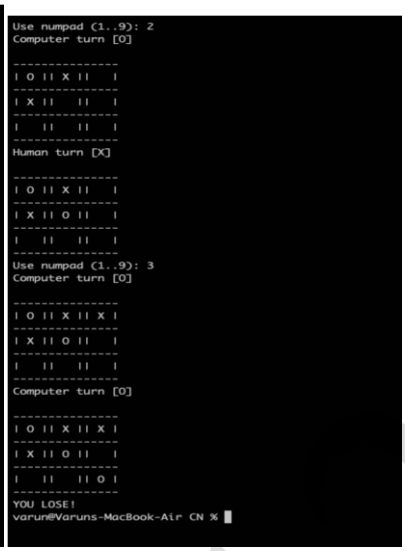
```
def render(state, c_choice, h_choice):


   chars = {         -1:
h_choice,
       +1: c_choice,
       0: ' '
}
   str_line = '---------------'

   print('\n' + str_line)
for row in state:
for cell in row:
           symbol = chars[cell]
print(f'| {symbol} |', end='')
print('\n' + str_line)


def ai_turn(c_choice, h_choice):

   depth = len(empty_cells(board))
if depth == 0 or game_over(board):
       return

   clean()
   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]

   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
```

```
   # Dictionary of valid moves
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],
   }

   clean()
   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():

   clean()     h_choice = ''
# X or O     c_choice = ''
# X or O
   first = ''  # if human is the first

   # Human chooses X or O to play     while
h_choice != 'O' and h_choice != 'X':        try:
          print('')
          h_choice = input('Choose X or O\nChosen: ').upper()
except (EOFError, KeyboardInterrupt):
          print('Bye')           exit()
except (KeyError, ValueError):
          print('Bad choice')

   # Setting computer's choice
if h_choice == 'X':
c_choice = 'O'     else:
```

```
        c_choice = 'X'

    # Human may starts first
    clean()     while first != 'Y' and
first != 'N':         try:
            first = input('First to start?[y/n]: ').upper()
except (EOFError, KeyboardInterrupt):
print('Bye')            exit()        except (KeyError,
ValueError):
            print('Bad choice')

    # Main loop of this game      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):
        clean()
        print(f'Human turn [{h_choice}]')
render(board,     c_choice,     h_choice)
print('YOU WIN!')       elif wins(board,
COMP):
        clean()
        print(f'Computer turn [{c_choice}]')
render(board,       c_choice,       h_choice)
print('YOU LOSE!')     else:
        clean()
        render(board, c_choice, h_choice)
print('DRAW!')

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

OUTPUT:





RESULT : Thus the above python code is executed successfully and output is verified.