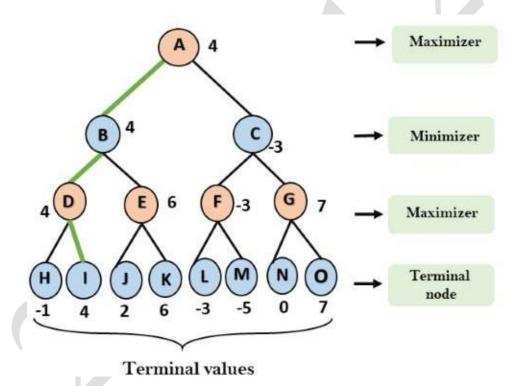
EX.NO: 5

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 = \prod
  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:

```
      VaruneWaruns-MacBook-Air CN % python3 minimax.py
      Use numpad (1..9): 2

      Choose X or 0
      Computer turn [0]

      Chosen: X
      1 0 11 X 11 1

      First to start?[y/n]: y
      I X II II I

      Human turn [X]
      I X II II I

      I II II I
      Human turn [X]

      I II II I
      I X II II I

      Use numpad (1..9): 4
      I II II I

      Computer turn [0]
      Use numpad (1..9): 3

      Computer turn [0]
      Computer turn [0]

      I II II I
      I X II O II I

      I II II I
      I X II O II I

      I II II I
      I X II O II I

      I II II I
      I X II O II I

      I O II X II X I
      I X II O II I

      I O II X II X I
      I X II O II I

      I I II II I
      I X II O II I

      I I II II I
      I X II O II I

      I I II II I
      I X II O II I

      I X II I II I
      I X II O II I

      I X II I II I
      I X II O II I

      I X II I II I
      I X II O II I

      I X II I II I
      I X II O II I

      I X II I II I
      I X II O II I

      I X II I II I
      I X II I II I

      I X II I II I
      I X II I II I</t
```

RESULT:

Thus the python code is implemented successfully and the output is verified.