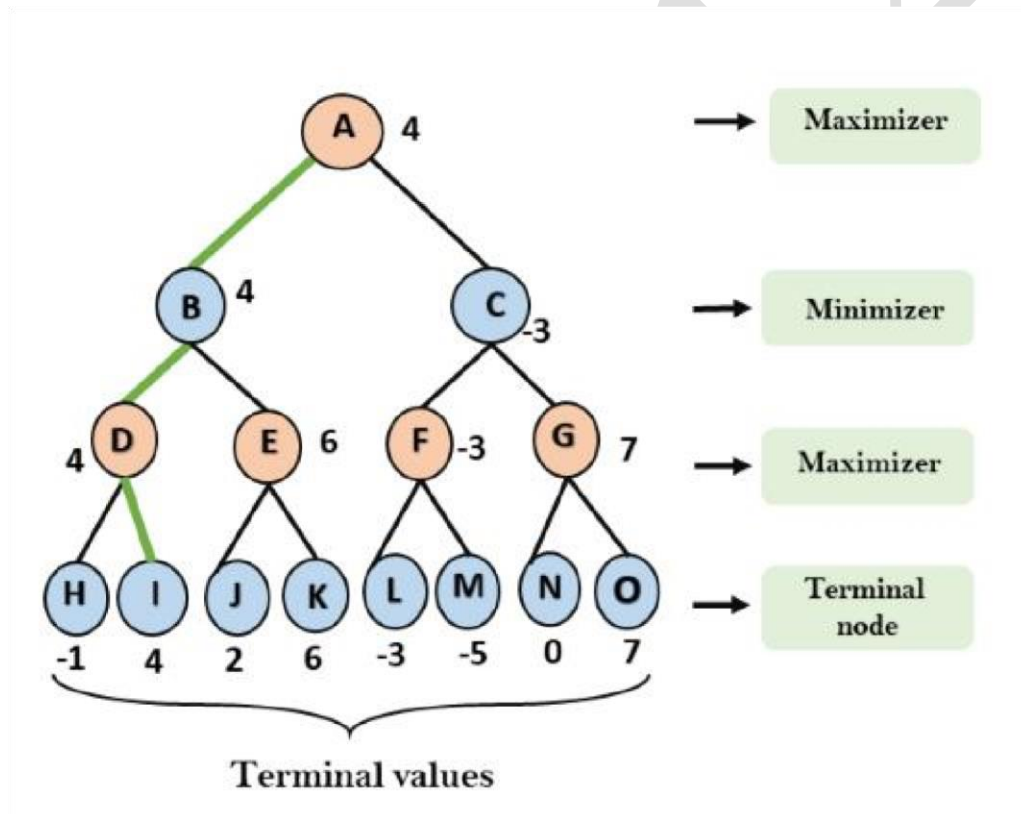


EX.NO: 4

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:

```
varun@Varuns-MacBook-Air CN % python3 minimax.py
Choose X or O
Chosen: x
First to start?[y/n]: y
Human turn [X]
-----
|  |  |  |
|  |  |  |
|  |  |  |
-----
Use numpad (1..9): 4
Computer turn [O]
-----
|  |  |  |
| X |  |  |
|  |  |  |
-----
Human turn [X]
-----
| O |  |  |
| X |  |  |
|  |  |  |
-----
Use numpad (1..9): 2
Computer turn [O]
-----
| O | X |  |
| X |  |  |
|  |  |  |
-----
Human turn [X]
-----
| O | X |  |
| X | O |  |
|  |  |  |
-----
Use numpad (1..9): 3
Computer turn [O]
-----
| O | X | X |
| X | O |  |
|  |  |  |
-----
Computer turn [O]
-----
| O | X | X |
| X | O |  |
|  |  | O |
-----
YOU LOSE!
varun@Varuns-MacBook-Air CN %
```

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