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.
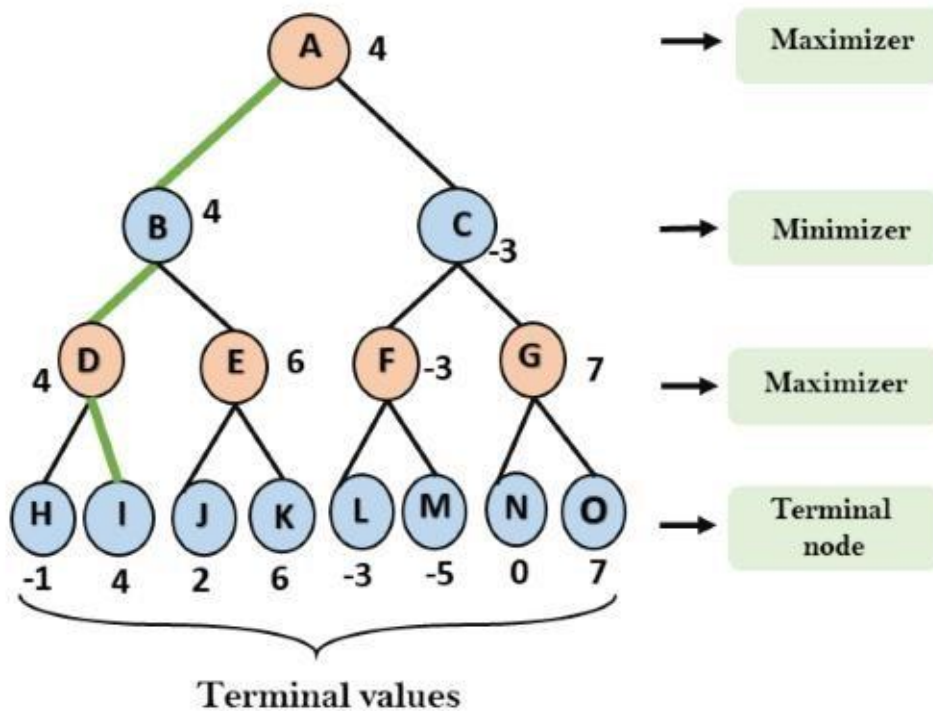
AIM :

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
```

```python
                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:
```

```python
        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):
```

```python
    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):
```

```python
        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.**

S M SANJAY