Artificial Intelligence (01CE1702)
Lab Manual 24-25

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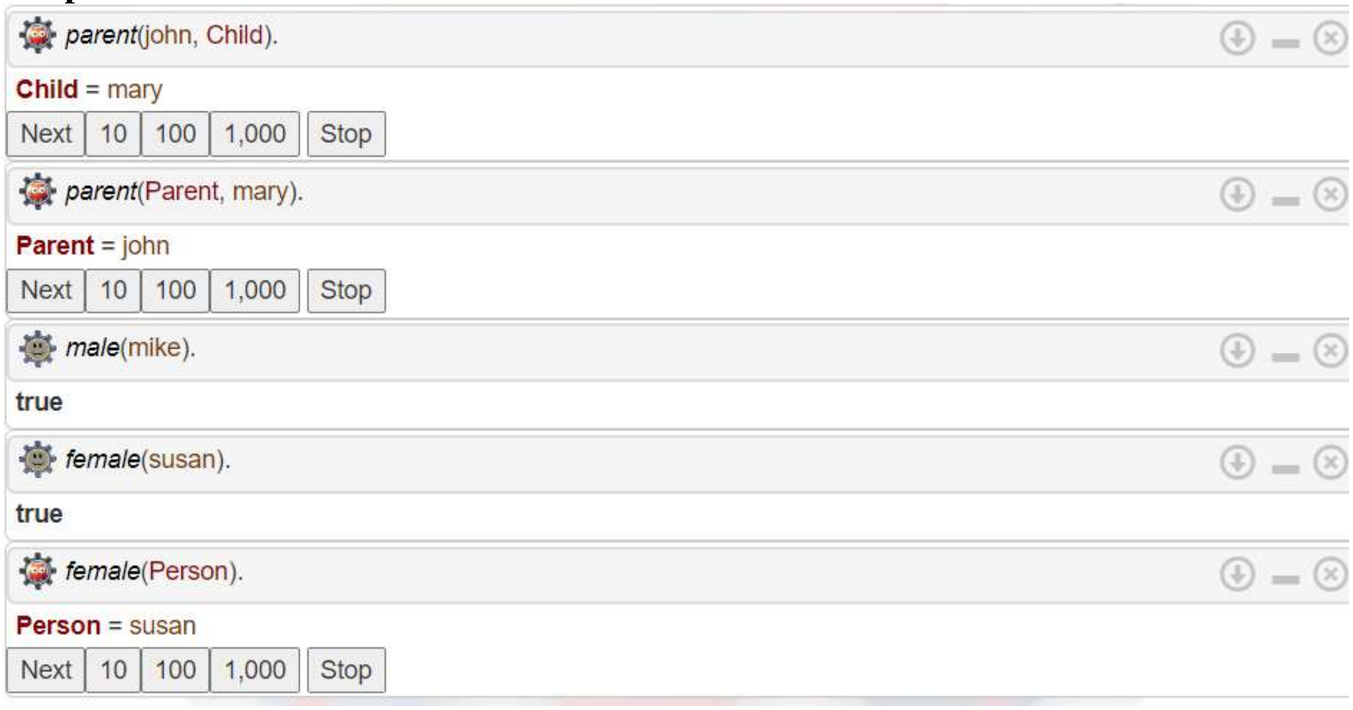
Lab	Program	Signature	Marks
1.	Write a prolog Program to understand the concept of facts and queries.		
2.	Write a prolog program to implement the following: a. Factorial of a given number b. Fibonacci of a given number		
3	Write a Prolog program to perform the following operations of the list, i) To display the element of the given list, ii) To check given element is in the list or not, iii) To print the last element of the list, Iv) To print the sum of the elements of the given list.		
4.	Implement a Family Tree and define the following predicates: 1)parent(X,Y) 2) Father(X,Y) 3) Mother(X,Y) 4) Sister(X,Y) 5)Brother(X,Y) 6)Grandfather(X,Y) 7)Grandmother(X,Y)		
5.	Assume given a set of facts of the form father(name1,name2) (name1 is the father of name2) Define a predicate cousin(X,Y) which holds iff X and Y are cousins. Define a predicate grandson(X,Y) which holds iff X is a grandson of Y. Define a predicate descendent(X,Y) which holds iff X is a descendent of Y. Define a predicate grandparent(X,Y) which holds iff X is a grandparent of Y. Consider the following genealogical tree: father(a,b). father(a,c). father(b,d). father(b,e). father(c,f). Say which answers, and in which order, are generated by your definitions for the following queries in Prolog: ?- cousin(X,Y). ?- grandson(X,Y). ?- descendent(X,Y). ?-grandparent(X,Y).		
6.	Write a program to solve Tower of Hanoi problem		
7.	Write a program to implement BFS for Water Jug problem/ 8 Puzzle problem or any AI search problem		
8.	Write a program to implement DFS for Water Jug problem/ 8 Puzzle problem or any AI search problem		
9.	Write a program to implement Single Player Game (Using Heuristic Function)		
10	Write a program to Implement A* Algorithm.		
11.	Implement the Mini Max algorithm for game playing		
12.	Write a program to solve N-Queens problem		
13	Develop an NLP application		
14	Implement Library for visual representations of text data		

Practical 1 : Write a prolog Program to understand the concept of facts and queries.

Program:

```
parent(john, mary).
parent(john, mike).
parent(susan, mary).
parent(susan, mike).
parent(mary, sophia).
parent(mary, james).
parent(paul, sophia).
parent(paul, james).

male(john).
male(mike).
male(paul).
male(james).

female(susan).
female(mary).
female(sophia).
```

Output :


```
parent(john, Child).
Child = mary

parent(Parent, mary).
Parent = john

male(mike).
true

female(susan).
true

female(Person).
Person = susan
```

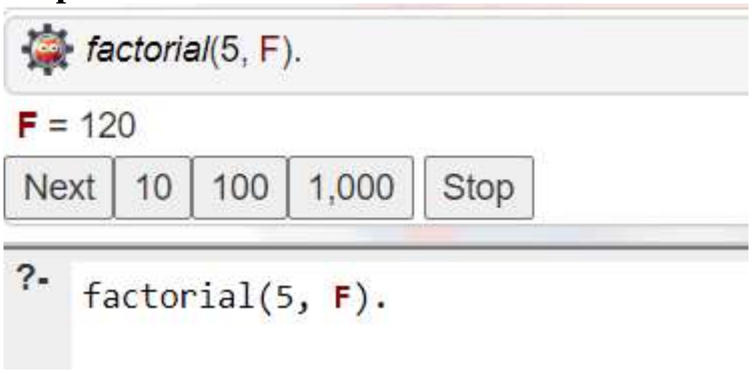
Practical 2 : Write a prolog program to implement the following:
a.Factorial of a given number
b.Fibonacci of a given number

program:

a) Factorial of a given number

```
factorial(0, 1).
factorial(N, F) :-
N > 0,
N1 is N - 1,
factorial(N1, F1),
F is N * F1.
```

output :

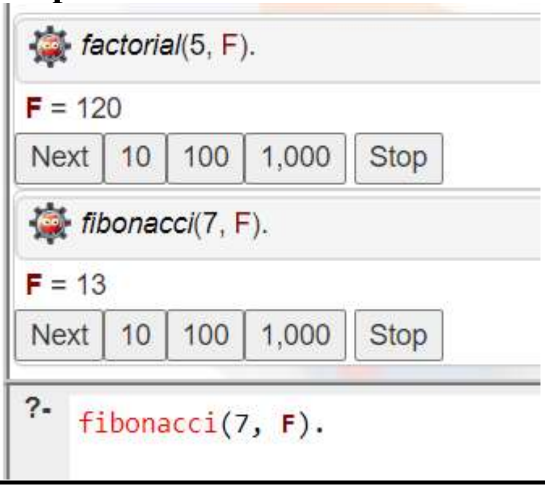


```
factorial(5, F).
F = 120
Next 10 100 1,000 Stop
?- factorial(5, F).
```

b) Fibonacci of a given number

```
fibonacci(0, 0).
fibonacci(1, 1).
fibonacci(N, F) :-
  N > 1,
  N1 is N - 1,
  N2 is N - 2,
fibonacci(N1, F1),
fibonacci(N2, F2),
F is F1 + F2.
```

output :



```
factorial(5, F).
F = 120
Next 10 100 1,000 Stop
fibonacci(7, F).
F = 13
Next 10 100 1,000 Stop
?- fibonacci(7, F).
```

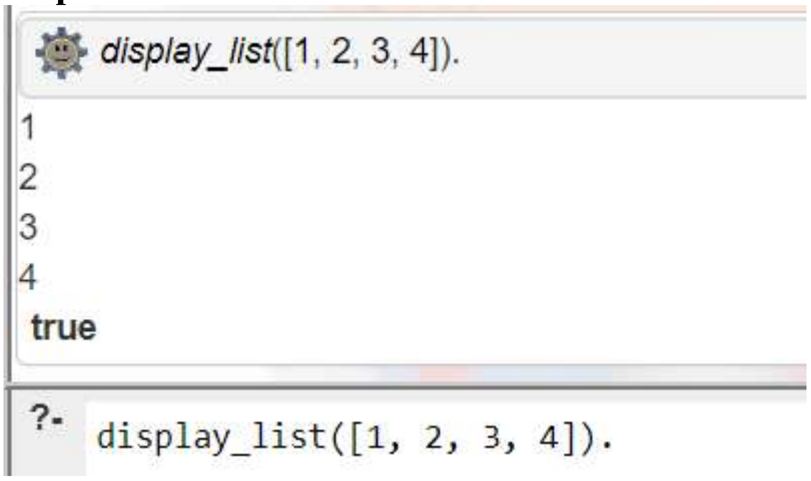
Practical 3 : Write a Prolog program to perform the following operations of the list,
i) To display the element of the given list,
ii) To check given element is in the list or not,
iii) To print the last element of the list,
Iv) To print the sum of the elements of the given list.

Program:

i) To display the element of the given list

```
display_list([]).
display_list([H|T]) :-
   write(H), nl,
   display_list(T).
```

output:

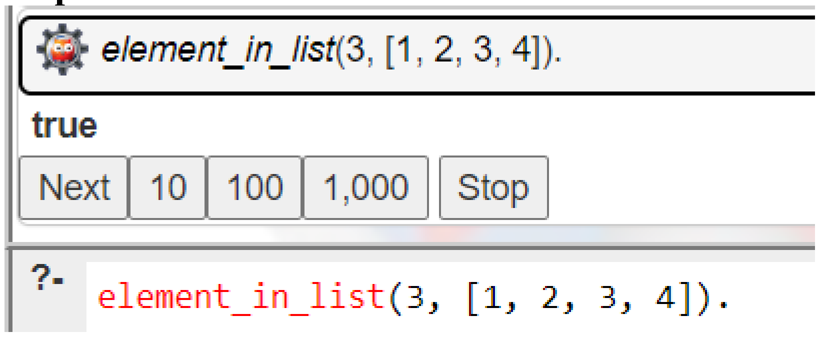


```
display_list([1, 2, 3, 4]).
1
2
3
4
true

?- display_list([1, 2, 3, 4]).
```

ii) To check given element is in the list or not

```
element_in_list(X, [X|_]).
element_in_list(X, [_|T]) :-
   element_in_list(X, T).
```

output:

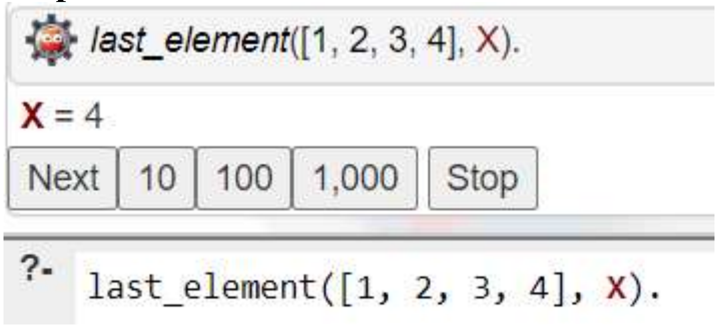


```
element_in_list(3, [1, 2, 3, 4]).
true
Next 10 100 1,000 Stop

?- element_in_list(3, [1, 2, 3, 4]).
```

iii) To print the last element of the list

```
last_element([X], X).
last_element([_|T], X) :-
   last_element(T, X).
```

output:

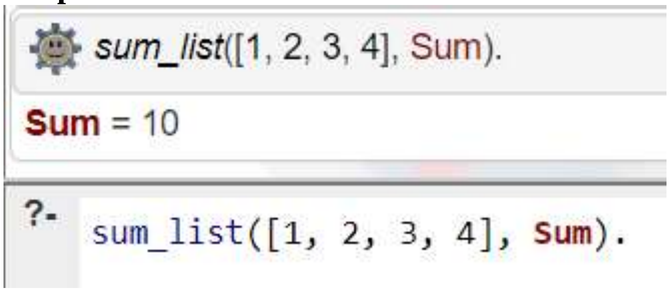


```
last_element([1, 2, 3, 4], X).
X = 4
Next 10 100 1,000 Stop
?- last_element([1, 2, 3, 4], X).
```

iv) To print the sum of the elements of the given list.

```
sum_list([], 0).
sum_list([H|T], Sum) :-
   sum_list(T, TempSum),
   Sum is H + TempSum.
```

Output:



```
sum_list([1, 2, 3, 4], Sum).
Sum = 10
?- sum_list([1, 2, 3, 4], Sum).
```

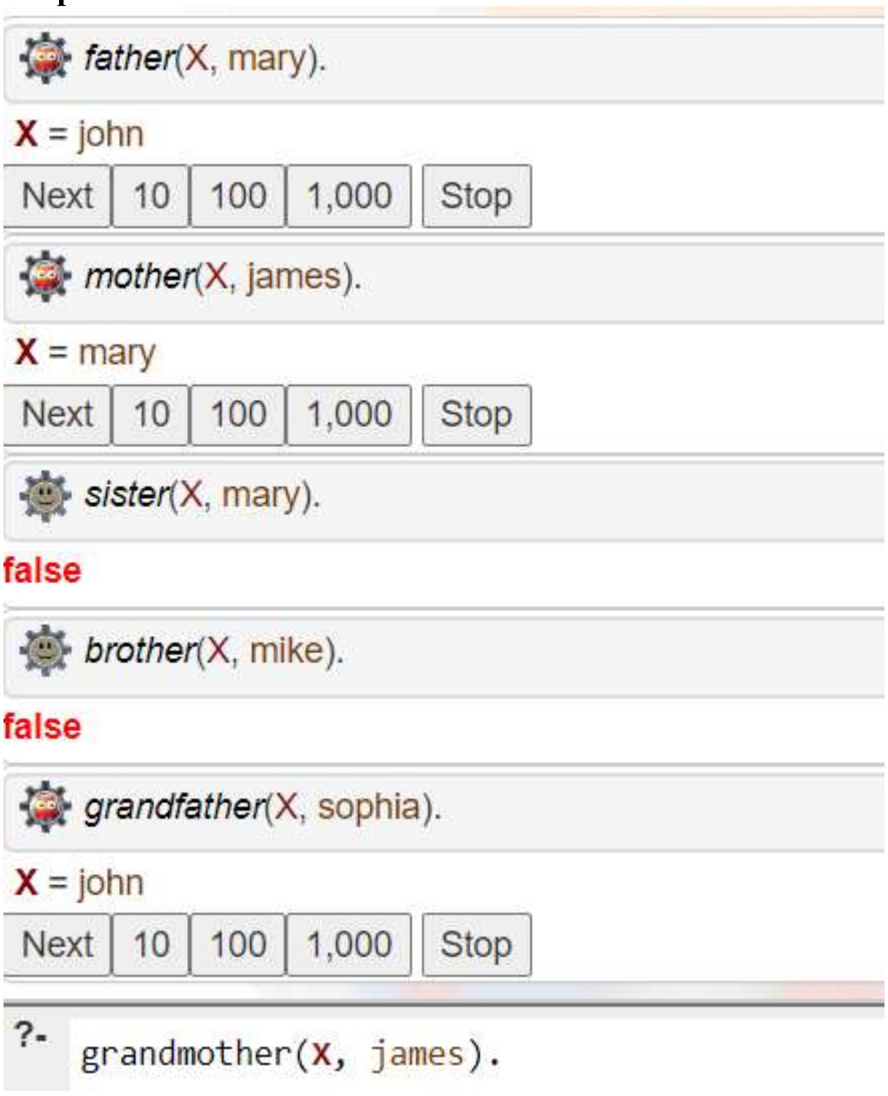
Practical 4: Implement a Family Tree and define the following predicates:

1)parent(X,Y)
2)Father(X,Y)
3)Mother(X,Y)
4)Sister(X,Y)
5)Brother(X,Y)
6)Grandfather(X,Y)
7)Grandmother(X,Y)

Program:

```
parent(john, mary).
parent(john, mike).

parent(susan, mary).
parent(susan, mike).

parent(mary, sophia).
parent(mary, james).

parent(paul, sophia).
parent(paul, james).

male(john).
male(mike).

male(paul).
male(james).

female(susan).
female(mary).

female(sophia).

father(X, Y) :- parent(X, Y), male(X).
mother(X, Y) :- parent(X, Y), female(X).

sister(X, Y) :- parent(Z, X), parent(Z, Y), female(X), X \= Y.
brother(X, Y) :- parent(Z, X), parent(Z, Y), male(X), X \= Y.

grandfather(X, Y) :- parent(X, Z), parent(Z, Y), male(X).
grandmother(X, Y) :- parent(X, Z), parent(Z, Y), female(X).
```

Output:



```
father(X, mary).
X = john
Next 10 100 1,000 Stop

mother(X, james).
X = mary
Next 10 100 1,000 Stop

sister(X, mary).
false

brother(X, mike).
false

grandfather(X, sophia).
X = john
Next 10 100 1,000 Stop

?- grandmother(X, james).
```

Practical 5: Assume given a set of facts of the form father(name1,name2) (name1 is the father of name2)
Define a predicate cousin(X,Y) which holds iff X and Y are cousins. Define a predicate grandson(X,Y) which holds iff X is a grandson of Y.
Define a predicate descendent(X,Y) which holds iff X is a descendent of Y. Define a predicate grandparent(X,Y) which holds iff X is a grandparent of Y.

Consider the following genealogical tree:

```
father(a,b).
father(a,c).
father(b,d).
father(b,e).
father(c,f).
```

Say which answers, and in which order, are generated by your definitions for the following queries in Prolog:

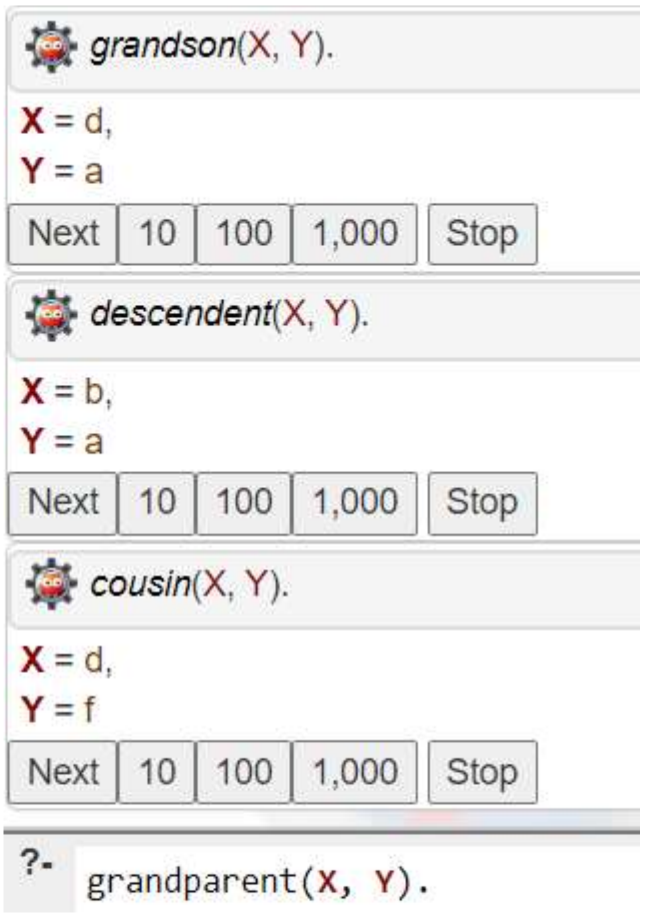
```
?- cousin(X,Y).
?- grandson(X,Y).
?- descendent(X,Y).
?-grandparent(X,Y).
```

Program:

```
father(a, b).
father(a, c).

father(b, d).
father(b, e).

father(c, f).

cousin(X, Y) :-
   father(P1, X),
   father(P2, Y),

   father(GP, P1),
   father(GP, P2),
   P1 \= P2.

grandson(X, Y) :-
   father(Y, P),
   father(P, X).

descendent(X, Y) :-
   father(Y, X).
```

```
descendent(X, Y) :-
   father(Y, Z),
   descendent(X, Z).

grandparent(X, Y) :-
   father(X, P),
   father(P, Y).
```

Outout:



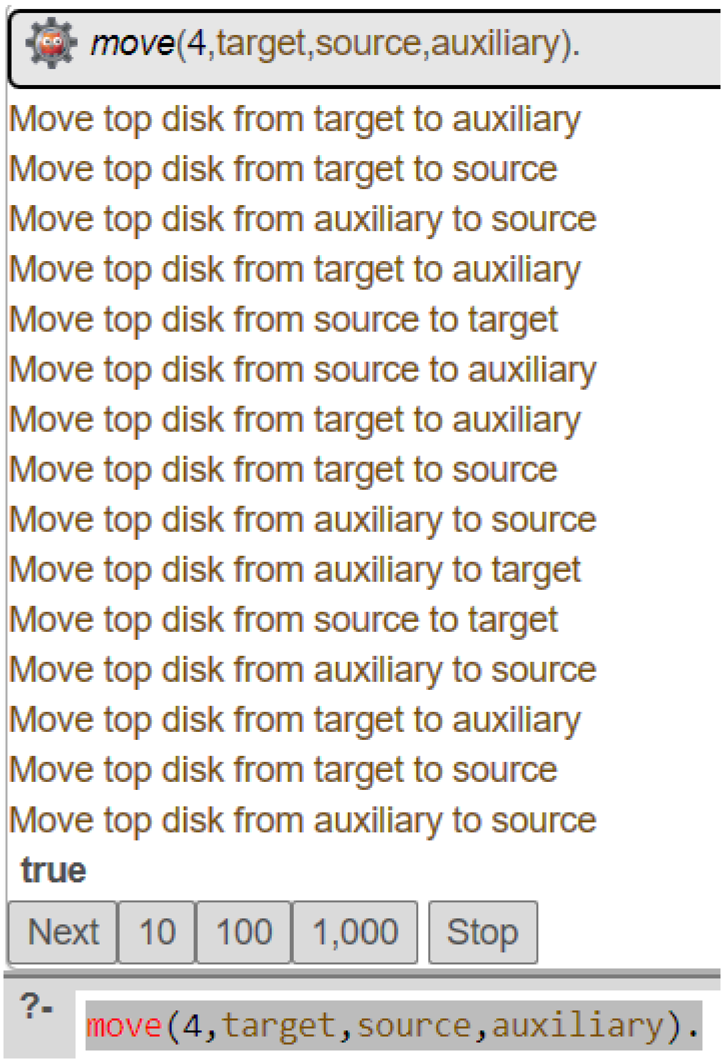
```
grandson(X, Y).
X = d,
Y = a

descendent(X, Y).
X = b,
Y = a

cousin(X, Y).
X = d,
Y = f

?- grandparent(X, Y).
```

Practical 6 : Write a program to solve Tower of Hanoi problem

Program:

```
move(1, X, Y, _) :-
   write('Move top disk from '), write(X), write(' to '), write(Y), nl.

move(N, X, Y, Z) :-
   N > 1,
   M is N - 1,
   move(M, X, Z, Y),  % Move N-1 disks from Source to Auxiliary using Target as
auxiliary
   move(1, X, Y, _),  % Move the remaining disk from Source to Target
   move(M, Z, Y, X).  % Move the N-1 disks from Auxiliary to Target using Source as
auxiliary
```

Output:



```
move(4,target,source,auxiliary).

Move top disk from target to auxiliary
Move top disk from target to source
Move top disk from auxiliary to source
Move top disk from target to auxiliary
Move top disk from source to target
Move top disk from source to auxiliary
Move top disk from target to auxiliary
Move top disk from target to source
Move top disk from auxiliary to source
Move top disk from auxiliary to target
Move top disk from source to target
Move top disk from auxiliary to source
Move top disk from target to auxiliary
Move top disk from target to source
Move top disk from auxiliary to source
true

?- move(4,target,source,auxiliary).
```

Practical 7 : Water jug problem using BFS

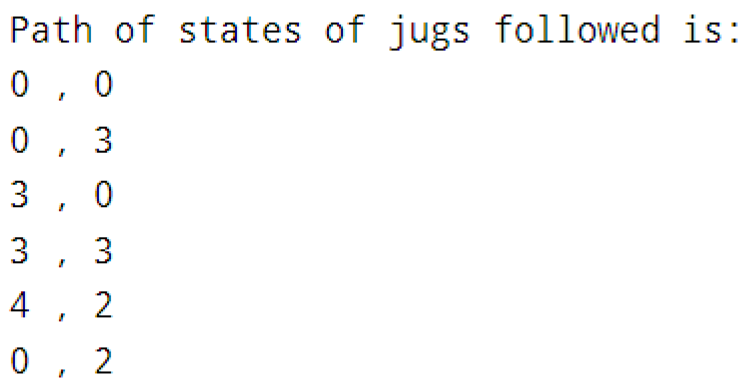
Program:

```
import java.util.*;

class Pair {
    int j1, j2;
    List<Pair> path;

    Pair(int j1, int j2) {
        this.j1 = j1;
        this.j2 = j2;
        path = new ArrayList<>();
    }

    Pair(int j1, int j2, List<Pair> _path) {
        this.j1 = j1;
        this.j2 = j2;
        path = new ArrayList<>(_path);
        path.add(new Pair(this.j1, this.j2));
    }
}

public class WaterJugProblem {
    public static void main(String[] args) throws java.lang.Exception {
        int jug1 = 4;
        int jug2 = 3;
        int target = 2;

        getPathIfPossible(jug1, jug2, target);
    }

    private static void getPathIfPossible(int jug1, int jug2, int target) {
        boolean[][] visited = new boolean[jug1 + 1][jug2 + 1];
        Queue<Pair> queue = new LinkedList<>();

        // Initial State: Both Jugs are empty so, initialise j1 j2 as 0 and put it in the path list
        Pair initialState = new Pair(0, 0);
        initialState.path.add(new Pair(0, 0));
        queue.offer(initialState);

        while (!queue.isEmpty()) {
            Pair curr = queue.poll();

            // Skip already visited states and overflowing water states
            if (curr.j1 > jug1 || curr.j2 > jug2 || visited[curr.j1][curr.j2]) {
                continue;
            }

            // Mark current jugs state as visited
```

```
visited[curr.j1][curr.j2] = true;

// Check if current state has already reached the target amount of water or not
if (curr.j1 == target || curr.j2 == target) {
   if (curr.j1 == target) {
      // If in our current state, jug1 holds the required amount of water, then we
      // empty the jug2 and push it into our path.
      curr.path.add(new Pair(curr.j1, 0));
   } else {
      // else, If in our current state, jug2 holds the required amount of water,
      // then we empty the jug1 and push it into our path.
      curr.path.add(new Pair(0, curr.j2));
   }

   int n = curr.path.size();
   System.out.println("Path of states of jugs followed is:");
   for (int i = 0; i < n; i++)
      System.out.println(curr.path.get(i).j1 + " , " + curr.path.get(i).j2);

   return;
}

// If we have not yet found the target, then we
// have three cases left:
// I. Fill the jug and Empty the other
// II. Fill the jug and let the other remain untouched
// III. Empty the jug and let the other remain untouched
// IV. Transfer amounts from one jug to another

// I. Fill the jug and Empty the other
queue.offer(new Pair(jug1, 0, curr.path));
queue.offer(new Pair(0, jug2, curr.path));

// II. Fill the jug and let the other remain untouched
queue.offer(new Pair(jug1, curr.j2, curr.path));
queue.offer(new Pair(curr.j1, jug2, curr.path));

// III. Empty the jug and let the other remain untouched
queue.offer(new Pair(0, curr.j2, curr.path));
queue.offer(new Pair(curr.j1, 0, curr.path));

// IV. Transfer water from one to another until one jug becomes empty or until
// one jug becomes full in this process

// Transferring water form jug1 to jug2
int emptyJug = jug2 - curr.j2;
int amountTransferred = Math.min(curr.j1, emptyJug);
int j2 = curr.j2 + amountTransferred;
int j1 = curr.j1 - amountTransferred;
queue.offer(new Pair(j1, j2, curr.path));
```

```
            // Transferring water form jug2 to jug1
            emptyJug = jug1 - curr.j1;
            amountTransferred = Math.min(curr.j2, emptyJug);
            j2 = curr.j2 - amountTransferred;
            j1 = curr.j1 + amountTransferred;
            queue.offer(new Pair(j1, j2, curr.path));
        }

        System.out.println("Not Possible to obtain target");
    }
}
```

Output:



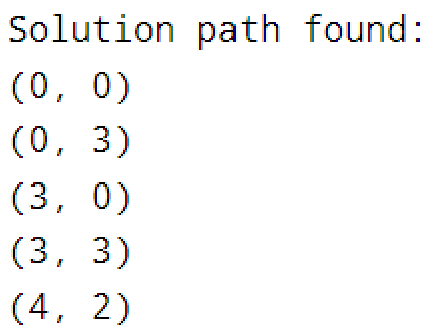
```
Path of states of jugs followed is:
0 , 0
0 , 3
3 , 0
3 , 3
4 , 2
0 , 2
```

Practical 8 : Write a program to implement DFS for Water Jug problem/ 8 Puzzle problem or any AI search problem

Program:

```
def is_goal(state, target):
    return target in state

def get_successors(state, capacities):
    successors = []
    jug1, jug2 = state
    max1, max2 = capacities

    # Fill Jug1
    if jug1 < max1:
        successors.append((max1, jug2))
    # Fill Jug2
    if jug2 < max2:
        successors.append((jug1, max2))
    # Empty Jug1
    if jug1 > 0:
        successors.append((0, jug2))
    # Empty Jug2
    if jug2 > 0:
        successors.append((jug1, 0))
    # Pour Jug1 to Jug2
    if jug1 > 0 and jug2 < max2:
        pour_amount = min(jug1, max2 - jug2)
        successors.append((jug1 - pour_amount, jug2 + pour_amount))
    # Pour Jug2 to Jug1
    if jug2 > 0 and jug1 < max1:
        pour_amount = min(jug2, max1 - jug1)
        successors.append((jug1 + pour_amount, jug2 - pour_amount))

    return successors

def dfs_water_jug(start, capacities, target):
    stack = [start]
    visited = set()
    parent_map = {}

    while stack:
        state = stack.pop()

        if state in visited:
            continue

        visited.add(state)
        if is_goal(state, target):
            path = []
            while state:
                path.append(state)
                state = parent_map.get(state)
            return path[::-1]

        for successor in get_successors(state, capacities):
            if successor not in visited:
                stack.append(successor)
                parent_map[successor] = state

    return None

# Example usage
start_state = (0, 0)  # Both jugs are empty initially
jug_capacities = (4, 3)  # Capacity of jug1 is 4 liters, jug2 is 3 liters
target = 2  # The goal is to measure exactly 2 liters

solution_path = dfs_water_jug(start_state, jug_capacities, target)

if solution_path:
    print("Solution path found:")
    for state in solution_path:
        print(state)
else:
    print("No solution found.")
```

Output:



```
Solution path found:
(0, 0)
(0, 3)
(3, 0)
(3, 3)
(4, 2)
```

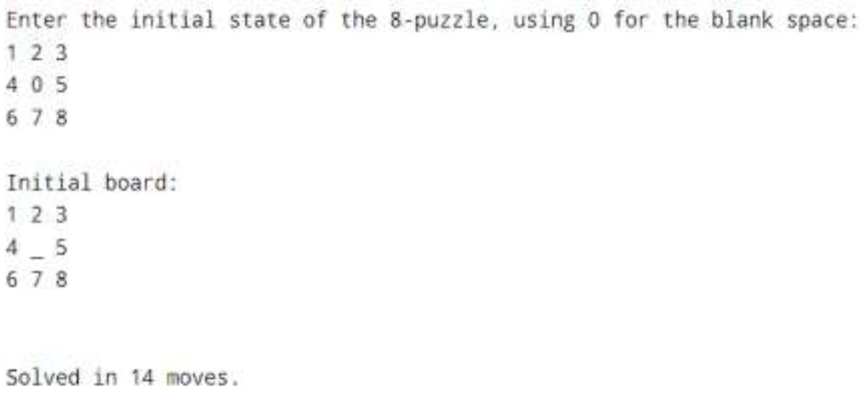
Practical 9 : Write a program to implement Single Player Game (Using Heuristic Function)

Program:

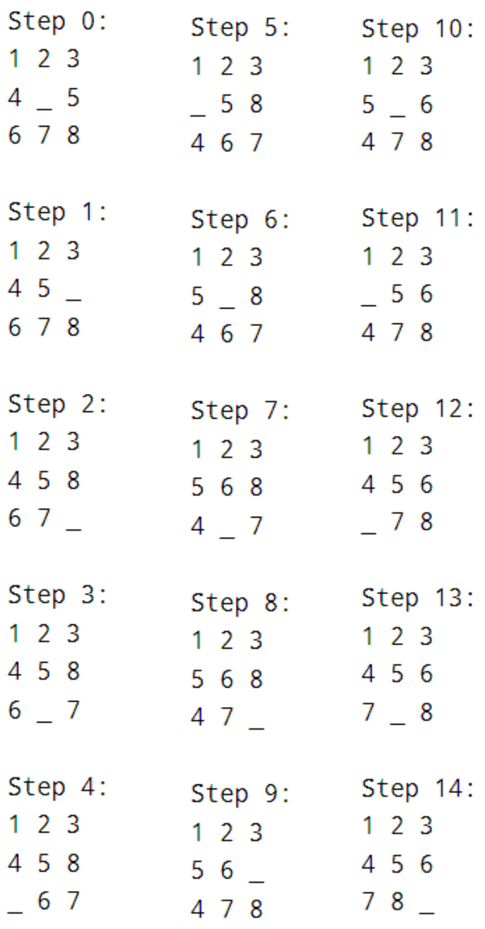
```
import heapq

class PuzzleState:
    def __init__(self, board, moves=0, previous=None):
        self.board = board
        self.moves = moves
        self.previous = previous
        self.blank_pos = self.find_blank()

    def find_blank(self):
        for i in range(3):
            for j in range(3):
                if self.board[i][j] == 0:
                    return (i, j)

    def __lt__(self, other):
        return self.priority() < other.priority()

    def priority(self):
        return self.moves + self.manhattan_distance()

    def manhattan_distance(self):
        distance = 0
        for i in range(3):
            for j in range(3):
                if self.board[i][j] != 0:
                    x, y = divmod(self.board[i][j] - 1, 3)
                    distance += abs(x - i) + abs(y - j)
        return distance

    def is_goal(self):
        goal = [[1, 2, 3], [4, 5, 6], [7, 8, 0]]
        return self.board == goal

    def generate_successors(self):
        successors = []
        x, y = self.blank_pos
        directions = [(-1, 0), (1, 0), (0, -1), (0, 1)]
        for dx, dy in directions:
            new_x, new_y = x + dx, y + dy
            if 0 <= new_x < 3 and 0 <= new_y < 3:
                new_board = [row[:] for row in self.board]
                new_board[x][y], new_board[new_x][new_y] = new_board[new_x][new_y],
new_board[x][y]
```

```
            successors.append(PuzzleState(new_board, self.moves + 1, self))
        return successors

def print_board(board):
    for row in board:
        print(" ".join(str(num) if num != 0 else "_" for num in row))
    print()

def a_star_search(initial_board):
    start_state = PuzzleState(initial_board)
    open_set = []

    heapq.heappush(open_set, start_state)
    closed_set = set()

    while open_set:
        current_state = heapq.heappop(open_set)

        if current_state.is_goal():
            return current_state

        closed_set.add(tuple(map(tuple, current_state.board)))

        for successor in current_state.generate_successors():
            if tuple(map(tuple, successor.board)) not in closed_set:
                heapq.heappush(open_set, successor)

    return None

def reconstruct_path(state):
    path = []
    while state:
        path.append(state.board)
        state = state.previous
    return path[::-1]

def main():
    print("Enter the initial state of the 8-puzzle, using 0 for the blank space:")
    initial_board = []
    for _ in range(3):
        row = list(map(int, input().split()))
        initial_board.append(row)

    print("\nInitial board:")
    print_board(initial_board)

    solution = a_star_search(initial_board)
    if solution:
        path = reconstruct_path(solution)
        print(f"\nSolved in {len(path) - 1} moves.\n")
        for i, step in enumerate(path):
            print(f"Step {i}:")
            print_board(step)
    else:
        print("No solution found.")

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

Output :



```
Enter the initial state of the 8-puzzle, using 0 for the blank space:
1 2 3
4 0 5
6 7 8

Initial board:
1 2 3
4 _ 5
6 7 8


Solved in 14 moves.
```



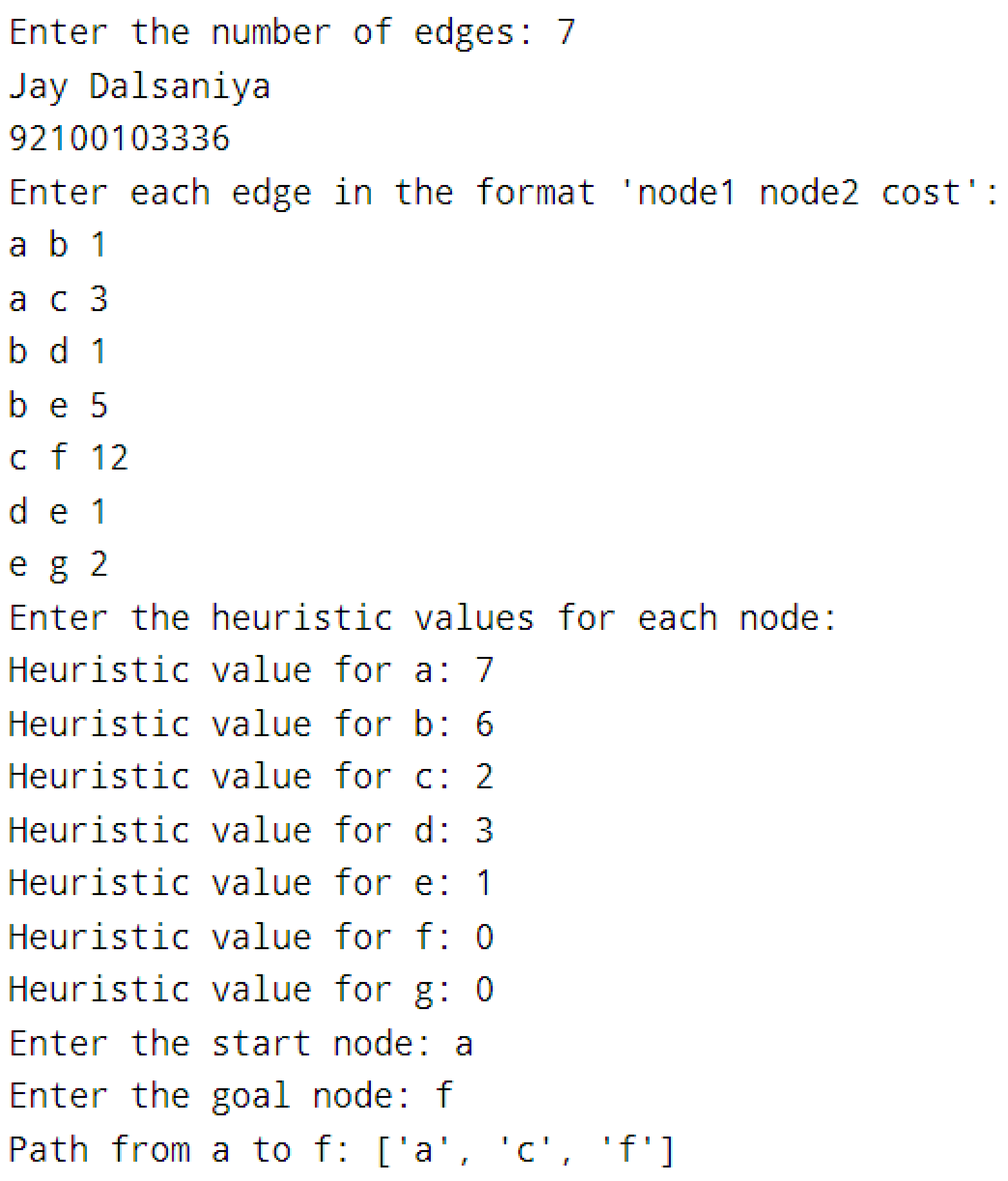
```
Step 0:     Step 5:     Step 10:
1 2 3       1 2 3       1 2 3
4 _ 5       _ 5 8       5 _ 6
6 7 8       4 6 7       4 7 8

Step 1:     Step 6:     Step 11:
1 2 3       1 2 3       1 2 3
4 5 _       5 _ 8       _ 5 6
6 7 8       4 6 7       4 7 8

Step 2:     Step 7:     Step 12:
1 2 3       1 2 3       1 2 3
4 5 8       5 6 8       4 5 6
6 7 _       4 _ 7       _ 7 8

Step 3:     Step 8:     Step 13:
1 2 3       1 2 3       1 2 3
4 5 8       5 6 8       4 5 6
6 _ 7       4 7 _       7 _ 8

Step 4:     Step 9:     Step 14:
1 2 3       1 2 3       1 2 3
4 5 8       5 6 _       4 5 6
_ 6 7       4 7 8       7 8 _
```

Practical 10 : Write a program to Implement A* Algorithm.

Program:

```
import heapq

class Node:
    def __init__(self, name, parent=None, g=0, h=0):
        self.name = name
        self.parent = parent
        self.g = g  # Cost from start to node
        self.h = h  # Heuristic estimate of cost from node to goal
        self.f = g + h  # Total cost

    def __lt__(self, other):
        return self.f < other.f

def a_star_search(start, goal, graph, heuristic):
    open_list = []
    closed_list = set()

    start_node = Node(start, None, 0, heuristic[start])
    goal_node = Node(goal, None)

    heapq.heappush(open_list, start_node)

    while open_list:
        current_node = heapq.heappop(open_list)

        if current_node.name == goal:
            path = []
            while current_node:
                path.append(current_node.name)
                current_node = current_node.parent
            return path[::-1]  # Return reversed path

        closed_list.add(current_node.name)

        for neighbor, cost in graph[current_node.name].items():
            if neighbor in closed_list:
                continue

            g = current_node.g + cost
            h = heuristic[neighbor]
            neighbor_node = Node(neighbor, current_node, g, h)

            if add_to_open(open_list, neighbor_node):
                heapq.heappush(open_list, neighbor_node)
    return None  # Return None if no path is found

def add_to_open(open_list, neighbor_node):
    for node in open_list:
        if neighbor_node.name == node.name and neighbor_node.f >= node.f:
            return False
    return True

def main():
    # Input the graph
    graph = {}
    num_edges = int(input("Enter the number of edges: "))
    print("Jay Dalsaniya")
    print("92100103336")
    print("Enter each edge in the format 'node1 node2 cost':")
    for _ in range(num_edges):
        node1, node2, cost = input().split()
        cost = int(cost)
        if node1 not in graph:
            graph[node1] = {}
        if node2 not in graph:
            graph[node2] = {}
        graph[node1][node2] = cost
        graph[node2][node1] = cost  # Assuming undirected graph

    # Input the heuristic values
    heuristic = {}
    print("Enter the heuristic values for each node:")
    for node in graph:
        h_value = int(input(f"Heuristic value for {node}: "))
        heuristic[node] = h_value

    # Input the start and goal nodes
    start = input("Enter the start node: ")
    goal = input("Enter the goal node: ")

    # Perform A* search
    path = a_star_search(start, goal, graph, heuristic)

    # Output the result
    if path:
        print(f"Path from {start} to {goal}: {path}")
    else:
        print(f"No path found from {start} to {goal}.")

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

Output :



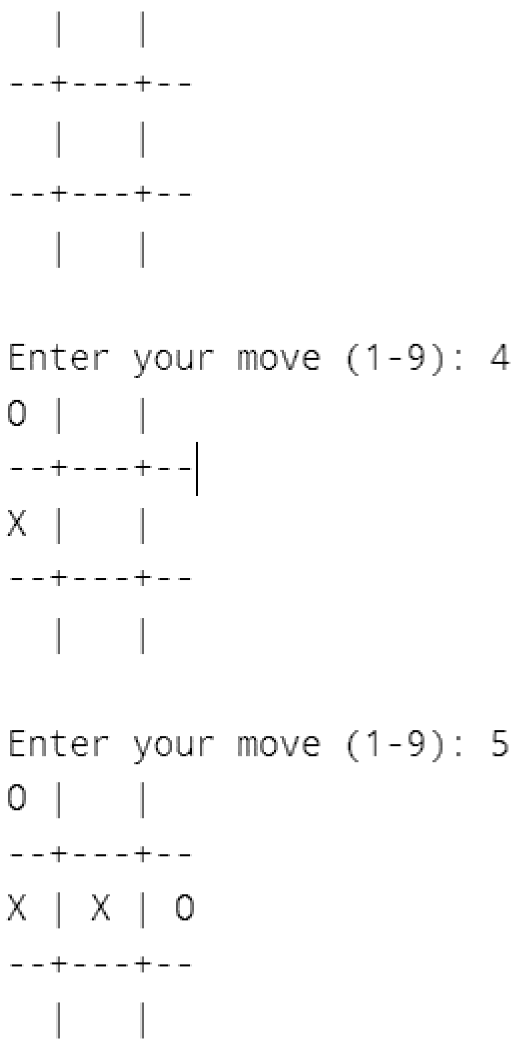
```
Enter the number of edges: 7
Jay Dalsaniya
92100103336
Enter each edge in the format 'node1 node2 cost':
a b 1
a c 3
b d 1
b e 5
c f 12
d e 1
e g 2
Enter the heuristic values for each node:
Heuristic value for a: 7
Heuristic value for b: 6
Heuristic value for c: 2
Heuristic value for d: 3
Heuristic value for e: 1
Heuristic value for f: 0
Heuristic value for g: 0
Enter the start node: a
Enter the goal node: f
Path from a to f: ['a', 'c', 'f']
```

Practical 11 : Implement the Mini Max algorithm for game playing

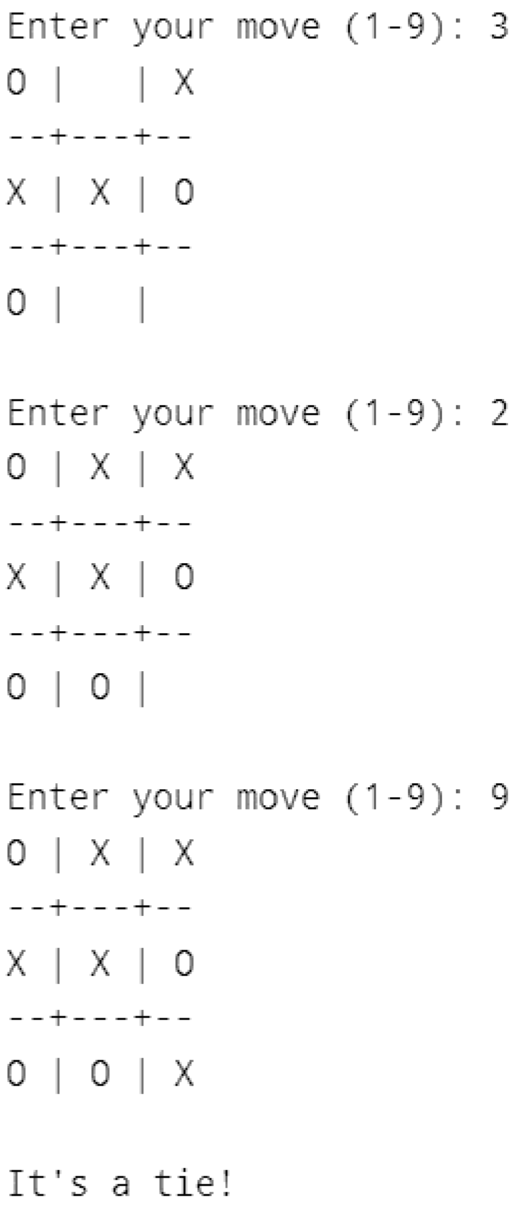
Program:

```
import math

# Display board
def display_board(board):
    for i in range(0, 9, 3):
        print(f"{board[i]} | {board[i+1]} | {board[i+2]}")
        if i < 6:
            print("--+---+--")
    print()

# Check winner
def check_winner(board, player):
    win_conditions = [(0, 1, 2), (3, 4, 5), (6, 7, 8),
                      (0, 3, 6), (1, 4, 7), (2, 5, 8),
                      (0, 4, 8), (2, 4, 6)]
    for condition in win_conditions:
        if board[condition[0]] == player and board[condition[1]] == player and board[condition[2]]
== player:
            return True
    return False

# Minimax algorithm
def minimax(board, is_max):
    if check_winner(board, 'O'):
        return 10
    if check_winner(board, 'X'):
        return -10
    if ' ' not in board:
        return 0

    best_score = -math.inf if is_max else math.inf
    for i in range(9):
        if board[i] == ' ':
            board[i] = 'O' if is_max else 'X'
            score = minimax(board, not is_max)
            board[i] = ' '
            best_score = max(best_score, score) if is_max else min(best_score, score)
    return best_score

# AI move
def ai_move(board):
    best_move = -1
    best_score = -math.inf
    for i in range(9):
        if board[i] == ' ':
            board[i] = 'O'
            score = minimax(board, False)
            board[i] = ' '
            if score > best_score:
                best_score = score
                best_move = i
    if best_move != -1:
        board[best_move] = 'O'

# Player move
def player_move(board):
    move = -1
    while move not in range(1, 10) or board[move-1] != ' ':
        try:
            move = int(input("Enter your move (1-9): "))
        except ValueError:
            pass
    board[move-1] = 'X'

# Game loop
def play_game():
    board = [' '] * 9
    while True:
        display_board(board)
        if check_winner(board, 'X'):
            print("You win!")
            break
        if check_winner(board, 'O'):
            print("AI wins!")
            break
        if ' ' not in board:
            print("It's a tie!")
            break

        player_move(board)
        if ' ' in board:
            ai_move(board)

if __name__ == "__main__":
    play_game()
```

Output :



```
  |   |
--+---+--
  |   |
--+---+--
  |   |

Enter your move (1-9): 4
O |   |
--+---+--
X |   |
--+---+--
  |   |

Enter your move (1-9): 5
O |   |
--+---+--
X | X | O
--+---+--
  |   |
```



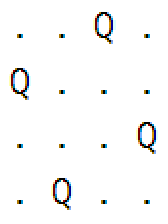
```
Enter your move (1-9): 3
O |   | X
--+---+--
X | X | O
--+---+--
O |   |

Enter your move (1-9): 2
O | X | X
--+---+--
X | X | O
--+---+--
O | O |

Enter your move (1-9): 9
O | X | X
--+---+--
X | X | O
--+---+--
O | O | X

It's a tie!
```

Practical 12 : Write a program to solve N-Queens problem

Program:

```
# N is the size of the chessboard (N x N)
N = 4

# Function to print the solution
def printSolution(board):
    for i in range(N):
        for j in range(N):
            if board[i][j] == 1:
                print("Q", end=" ")
            else:
                print(".", end=" ")
        print()

# Function to check if a queen can be placed on board[row][col]
def isSafe(board, row, col):
    # Check the current row on the left side
    for i in range(col):
        if board[row][i] == 1:
            return False

    # Check upper diagonal on the left side
    for i, j in zip(range(row, -1, -1), range(col, -1, -1)):
        if board[i][j] == 1:
            return False

    # Check lower diagonal on the left side
    for i, j in zip(range(row, N, 1), range(col, -1, -1)):
        if board[i][j] == 1:
            return False

    return True

# Recursive utility function to solve the N-Queens problem
def solveNQUtil(board, col):
    # Base case: If all queens are placed, return True
    if col >= N:
        return True

    # Try placing the queen in each row of the current column
    for i in range(N):
        if isSafe(board, i, col):
            # Place the queen
            board[i][col] = 1

            # Recur to place the rest of the queens
            if solveNQUtil(board, col + 1):
                return True

            # If placing the queen does not lead to a solution, backtrack
            board[i][col] = 0

    # If the queen cannot be placed in any row in this column, return False
    return False

# Function to solve the N-Queens problem using backtracking
def solveNQ():
    # Initialize the board with all 0's (empty board)
    board = [[0 for _ in range(N)] for _ in range(N)]

    if not solveNQUtil(board, 0):
        print("Solution does not exist")
        return False

    printSolution(board)
    return True

# Driver Code
if __name__ == '__main__':
    solveNQ()
```

Output:



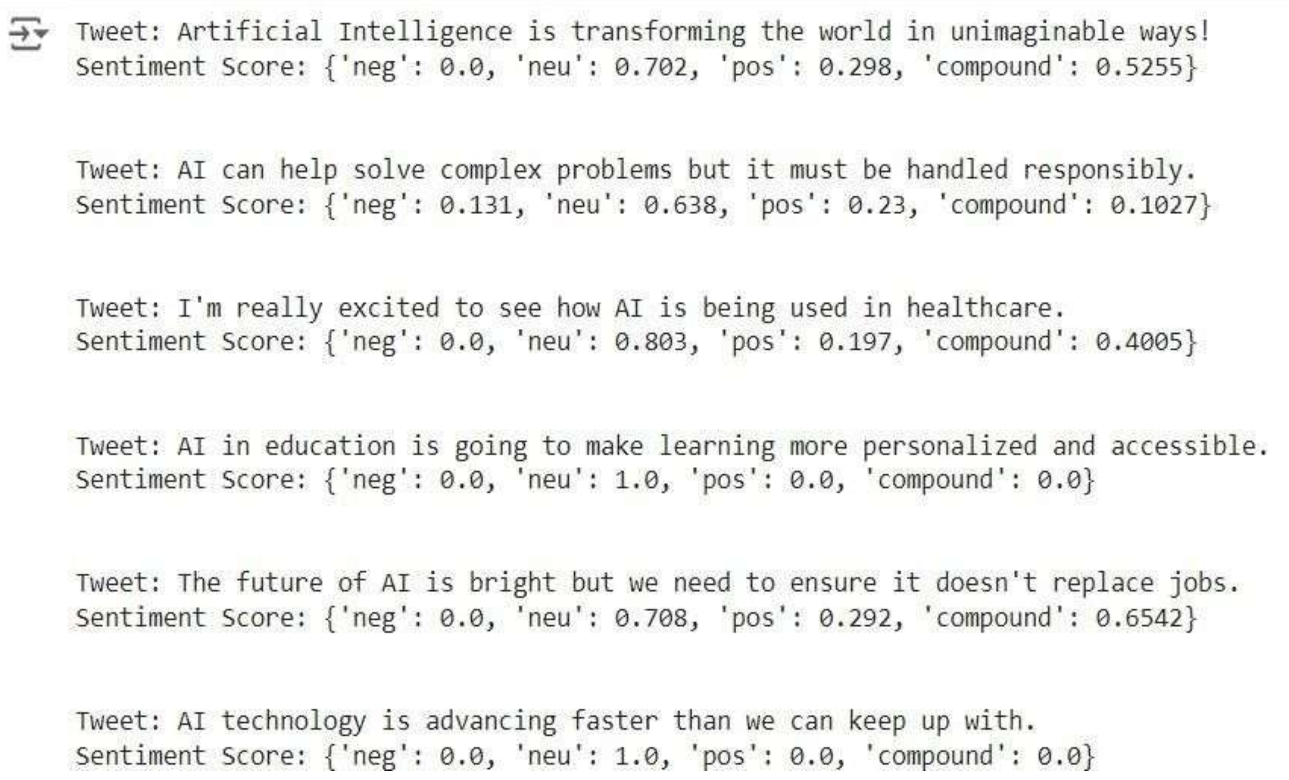
```
. . Q .
Q . . .
. . . Q
. Q . .
```

Practical 13 : Develop an NLP application

Program:

```
from nltk.sentiment.vader import SentimentIntensityAnalyzer import nltk sia =

SentimentIntensityAnalyzer()

# Tweets about AI
tweets = [
    "Artificial Intelligence is transforming the world in unimaginable ways!",

    "AI can help solve complex problems but it must be handled responsibly.",

    "I'm really excited to see how AI is being used in healthcare.",

    "AI in education is going to make learning more personalized and accessible.",

    "The future of AI is bright but we need to ensure it doesn't replace
    jobs.",
    "AI technology is advancing faster than we can keep up with."
]

def analyze_sentiment(tweets): for

tweet in tweets: print(f"Tweet:

{tweet}") score =

sia.polarity_scores(tweet)

print(f"Sentiment Score: {score}")

        print("\n")

analyze_sentiment(tweets)
```

Output:



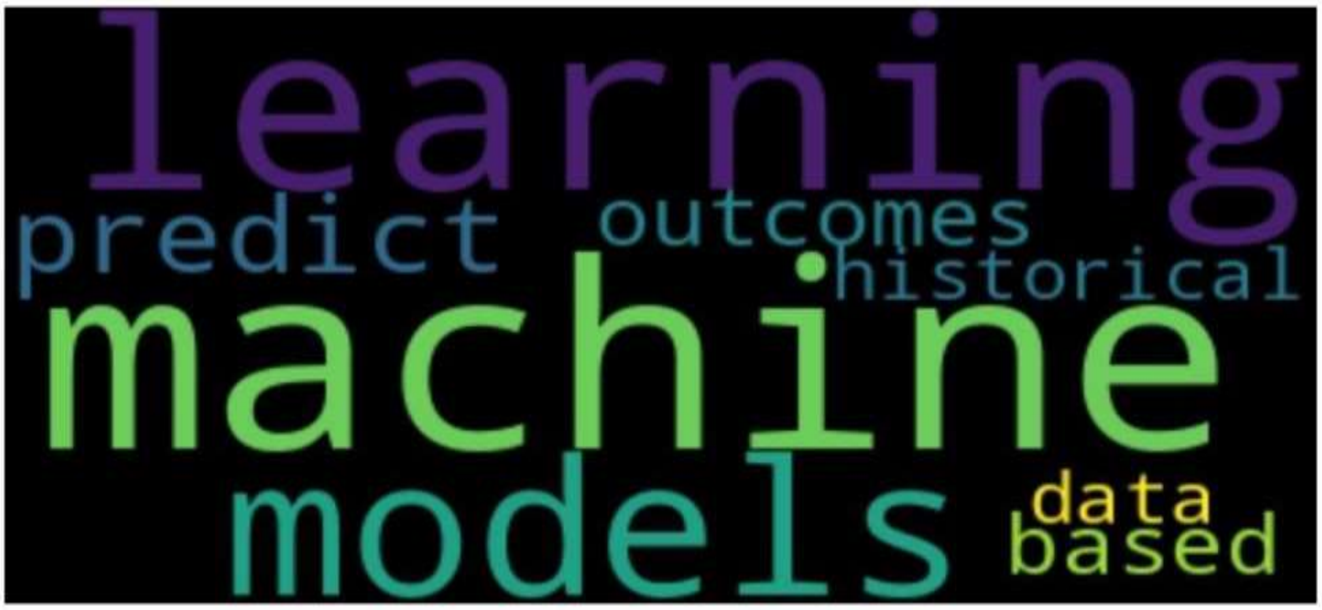
```
Tweet: Artificial Intelligence is transforming the world in unimaginable ways!
Sentiment Score: {'neg': 0.0, 'neu': 0.702, 'pos': 0.298, 'compound': 0.5255}


Tweet: AI can help solve complex problems but it must be handled responsibly.
Sentiment Score: {'neg': 0.131, 'neu': 0.638, 'pos': 0.23, 'compound': 0.1027}


Tweet: I'm really excited to see how AI is being used in healthcare.
Sentiment Score: {'neg': 0.0, 'neu': 0.803, 'pos': 0.197, 'compound': 0.4005}


Tweet: AI in education is going to make learning more personalized and accessible.
Sentiment Score: {'neg': 0.0, 'neu': 1.0, 'pos': 0.0, 'compound': 0.0}


Tweet: The future of AI is bright but we need to ensure it doesn't replace jobs.
Sentiment Score: {'neg': 0.0, 'neu': 0.708, 'pos': 0.292, 'compound': 0.6542}


Tweet: AI technology is advancing faster than we can keep up with.
Sentiment Score: {'neg': 0.0, 'neu': 1.0, 'pos': 0.0, 'compound': 0.0}
```

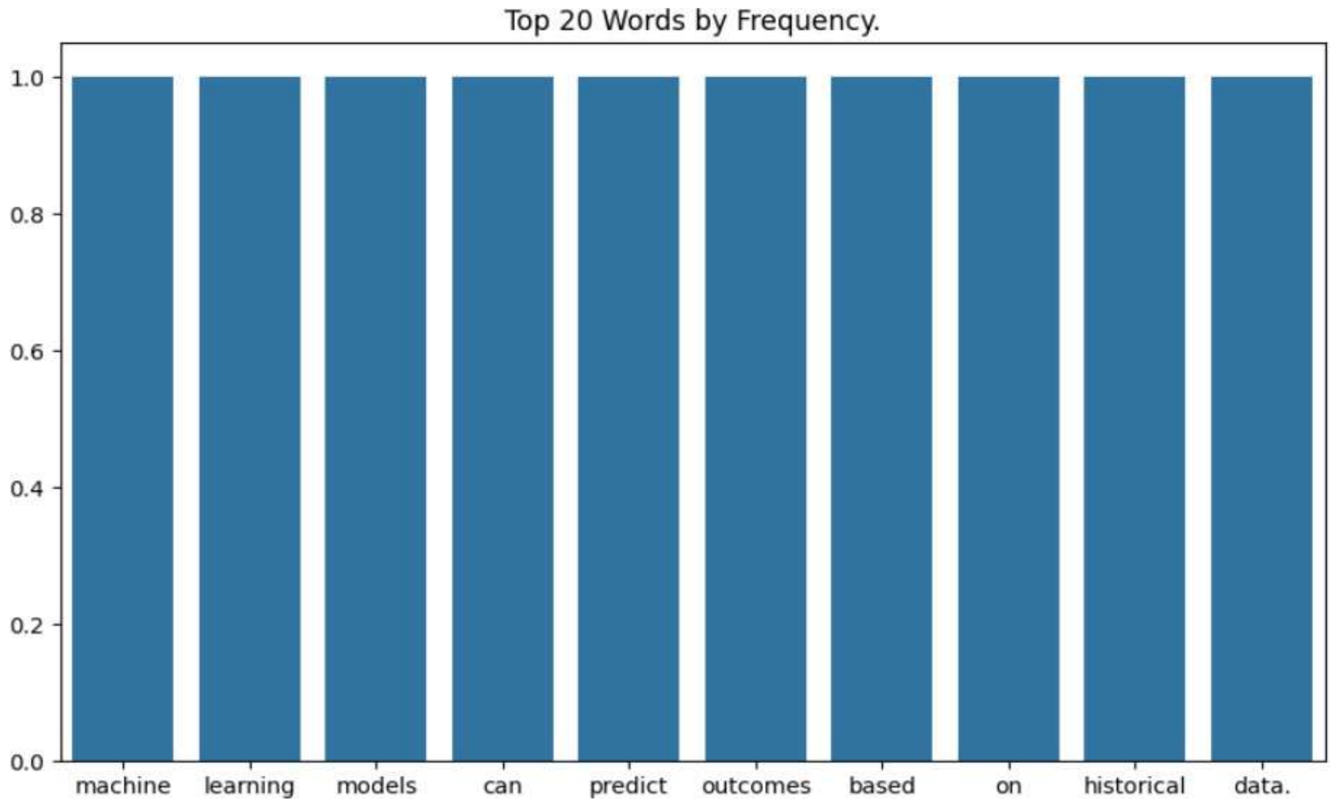
Practical 14 : Implement Library for visual representations of text data

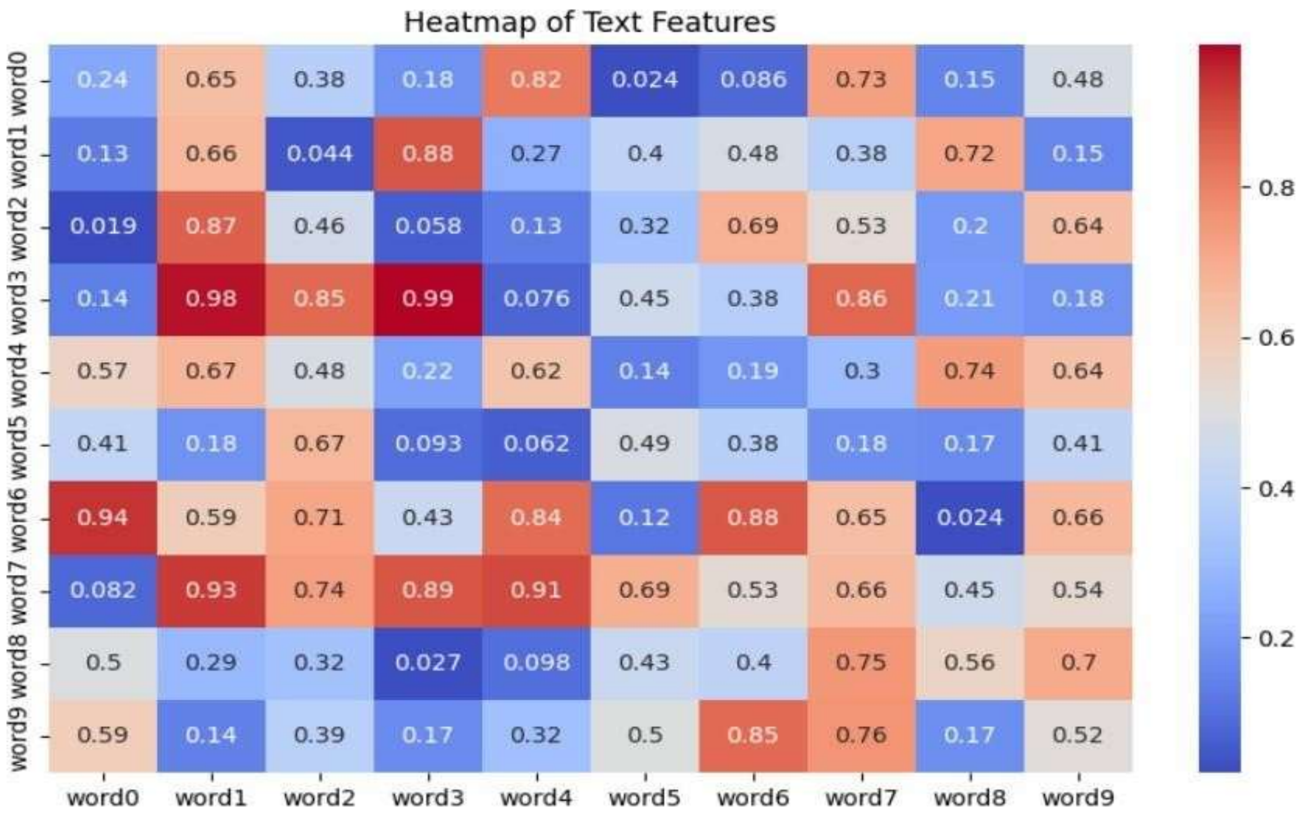
Program:

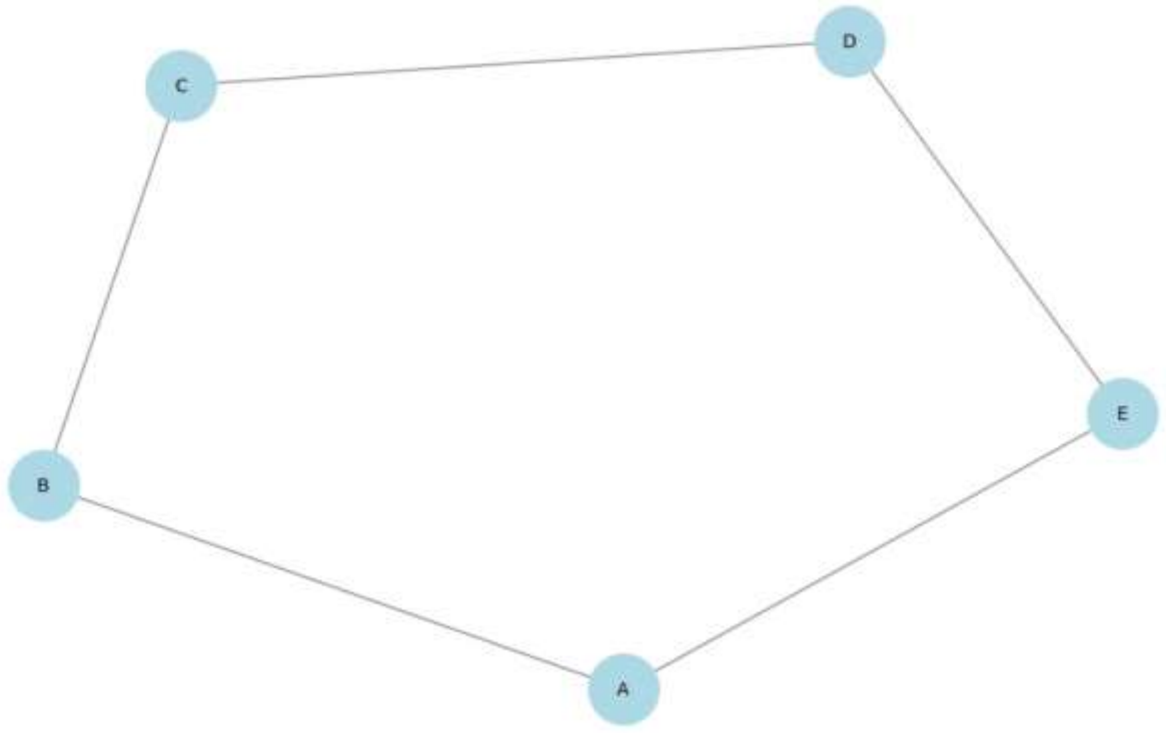
```
  import matplotlib.pyplot as plt
  import seaborn as sns
  from wordcloud import
  WordCloud import networkx as
  nx from collections import
  Counter import numpy as np
  from sklearn.decomposition import PCA
  #import pyLDAvis
  #import
  pyLDAvis.sklearn

  def plot_wordcloud(text,max_words=100,colormap='viridis'):
  wordcloud=WordCloud(max_words=max_words,colormap=colormap,background_color='white').gen
  erat e(text)
    plt.figure(figsize=(10,5))
    plt.imshow(wordcloud,interpolation='bili
    near') plt.axis('off') plt.show()
def
  plot_barchart(text,top_n=20
  ): words=text.split()
  word_counts=Counter(word
  s)
    most_common=word_counts.most_common(top_n)
    labels,values=zip(*most_common)
    plt.figure(figsize=(10,6))
    sns.barplot(x=labels,y=values)
    plt.title(f"Top {top_n} Words by Frequency.")
    plt.show()

  def plot_heatmap(data_matrix,x_labels,y_labels):
    plt.figure(figsize=(10,6))
    sns.heatmap(data_matrix,annot=True,cmap='coolwarm',xticklabels=x_labels,yticklabels=y_la
    bels) plt.title("Heatmap of Text Features") plt.show()
def
  plot_graph(edges)
  :
    G=nx.Graph()
    G.add_edges_from(edges)
    plt.figure(figsize=(10,6))
    pos=nx.spring_layout(G)
    nx.draw(G,pos,with_labels=True,node_color='
    lightblue',edge_color='gray',node_size=1500,f
    ont_size=10
)
  plt.show()

def plot_scatterplot(embeddings,labels=None):
  pca=PCA(n_components=2)
  reduced_embeddings=pca.fit_transform(embeddings)
  plt.figure(figsize=(10,6))
  plt.scatter(reduced_embeddings[:,0],reduced_embeddings[:,1]
  ,s=50) plt.xlabel("Principal Component 1") plt.ylabel("Principal
  Component 2") plt.title("PCA projection of text embeddings.")
  plt.show()

if__name___== "_main__": text = "machine learning models can predict
  outcomes based on historical data." plot_wordcloud(text)
  plot_barchart(text) data=np.random.rand(10,10)
  plot_heatmap(data,x_labels=[f'word{i}'for i in range(10)],y_labels=[f'word{i}'for i in
  range(10)]) edges=[('A','B'),('B','C'),('C','D'),('D','E'),('E','A')] plot_graph(edges)
  embeddings=np.random.rand(100,100)
  plot_scatterplot(embeddings)
```

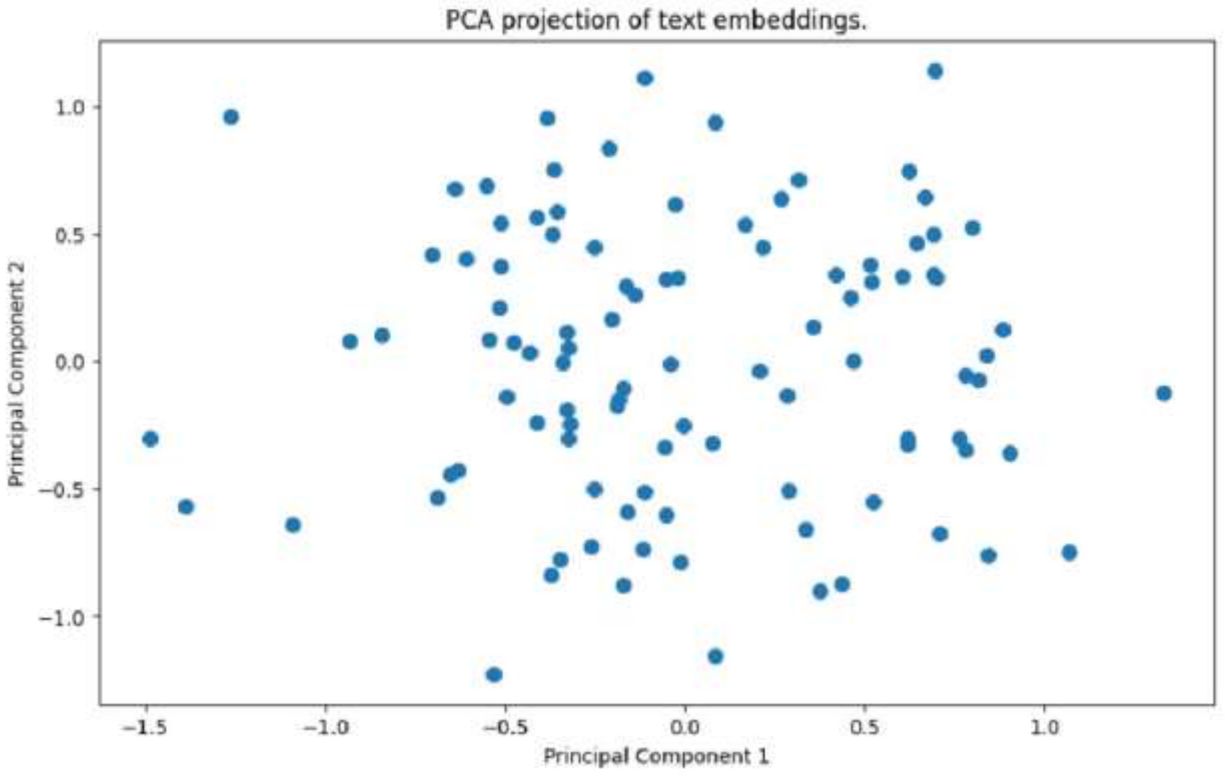
Output:




Top 20 Words by Frequency.
1.0
0.8
0.6
0.4
0.2
0.0
machine
learning
models
can
predict
outcomes
based
on
historical
data.


Heatmap of Text Features
word0 0.24 0.65 0.38 0.18 0.82 0.024 0.086 0.73 0.15 0.48
word1 0.13 0.66 0.044 0.88 0.27 0.4 0.48 0.38 0.72 0.15
word2 0.019 0.87 0.46 0.058 0.13 0.32 0.69 0.53 0.2 0.64
word3 0.14 0.98 0.85 0.99 0.076 0.45 0.38 0.86 0.21 0.18
word4 0.57 0.67 0.48 0.22 0.62 0.14 0.19 0.3 0.74 0.64
word5 0.41 0.18 0.67 0.093 0.062 0.49 0.38 0.18 0.17 0.41
word6 0.94 0.59 0.71 0.43 0.84 0.12 0.88 0.65 0.024 0.66
word7 0.082 0.93 0.74 0.89 0.91 0.69 0.53 0.66 0.45 0.54
word8 0.5 0.29 0.32 0.027 0.098 0.43 0.4 0.75 0.56 0.7
word9 0.59 0.14 0.39 0.17 0.32 0.5 0.85 0.76 0.17 0.52
word0 word1 word2 word3 word4 word5 word6 word7 word8 word9
0.8
0.6
0.4
0.2


A
B
C
D
E


PCA projection of text embeddings.
Principal Component 1
Principal Component 2
−1.5
−1.0
−0.5
0.0
0.5
1.0