```python
#1. Recursive Dfs. Read the undirected unweighted graph from a .csv file.
import csv
from collections import defaultdict

def read_graph_from_csv(filename):
    graph = defaultdict(list)
    with open(filename, 'r') as file:
        reader = csv.reader(file)
        next(reader)  # Skip header (source,destination)
        for source, destination in reader:
            graph[source].append(destination)
            graph[destination].append(source)  #coz it's undirected
    return graph

def dfs_recursive(graph, node, visited):
    if node not in visited:
        print(node, end=" ")
        visited.add(node)
        for neighbor in graph[node]:
            dfs_recursive(graph, neighbor, visited)

if __name__ == "__main__":
    filename = 'graph.csv'
    graph = read_graph_from_csv(filename)
    print("Graph adjacency list:")
    for node, neighbors in graph.items():
        print(f"{node}: {neighbors}")

    print("\nDFS traversal starting from 'A':")
    visited = set()
    dfs_recursive(graph, 'A', visited)
```

```
Graph adjacency list:
A: ['B', 'C']
B: ['A', 'D']
C: ['A', 'E']
D: ['B', 'E']
E: ['C', 'D']

DFS traversal starting from 'A':
A B D E C
```

```python
#2. Implement Non-Recursive Df Read the undirected unweighted graph from user.
from collections import defaultdict

def read_graph_from_user():
    graph = defaultdict(list)
    num_edges = int(input("Enter the number of edges: "))
```

```python
    print("Enter each edge in the format: source destination")
    for _ in range(num_edges):
        u, v = input().split()
        graph[u].append(v)
        graph[v].append(u)  # Since it's undirected
    return graph

def dfs_iterative(graph, start_node):
    visited = set()
    stack = [start_node]

    while stack:
        node = stack.pop()
        if node not in visited:
            print(node, end=" ")
            visited.add(node)
            # Add neighbors to stack
            for neighbor in reversed(graph[node]):  # reverse for
consistent ordering
                if neighbor not in visited:
                    stack.append(neighbor)

# Example usage
if __name__ == "__main__":
    graph = read_graph_from_user()
    print("\nGraph adjacency list:")
    for node, neighbors in graph.items():
        print(f"{node}: {neighbors}")

    start = input("\nEnter the starting node for DFS: ")
    print("\nDFS traversal (iterative):")
    dfs_iterative(graph, start)
```

```
Enter the number of edges: 5
Enter each edge in the format: source destination
a b
b c
c d
d e
e a

Graph adjacency list:
a: ['b', 'e']
b: ['a', 'c']
c: ['b', 'd']
d: ['c', 'e']
e: ['d', 'a']

Enter the starting node for DFS: d
```

```
DFS traversal (iterative):
d c b a e
```

```python
#3. Implement Bfs Algorithm. Read the undirected unweighted graph from user.
from collections import defaultdict, deque

def read_graph_from_user():
    graph = defaultdict(list)
    num_edges = int(input("Enter the number of edges: "))

    print("Enter each edge in the format: source destination")
    for _ in range(num_edges):
        u, v = input().split()
        graph[u].append(v)
        graph[v].append(u)  # Undirected graph
    return graph

def bfs(graph, start_node):
    visited = set()
    queue = deque([start_node])

    while queue:
        node = queue.popleft()
        if node not in visited:
            print(node, end=" ")
            visited.add(node)
            for neighbor in graph[node]:
                if neighbor not in visited:
                    queue.append(neighbor)

# Example usage
if __name__ == "__main__":
    graph = read_graph_from_user()

    print("\nGraph adjacency list:")
    for node, neighbors in graph.items():
        print(f"{node}: {neighbors}")

    start = input("\nEnter the starting node for BFS: ")
    print("\nBFS traversal:")
    bfs(graph, start)
```

```
Enter the number of edges: 5
Enter each edge in the format: source destination
a c
c e
e d
d b
```

```
b c

Graph adjacency list:
a: ['c']
c: ['a', 'e', 'b']
e: ['c', 'd']
d: ['e', 'b']
b: ['d', 'c']

Enter the starting node for BFS: c

BFS traversal:
c a e b d
```

```
#4. Implement Bfs. Read the directed unweighted graph and the
heuristic values from user.
from collections import defaultdict
import heapq

def read_graph_and_heuristics():
    graph = defaultdict(list)
    heuristic = {}

    num_edges = int(input("Enter number of edges: "))
    print("Enter each edge as: source destination")
    for _ in range(num_edges):
        u, v = input().split()
        graph[u].append(v)  # Directed graph

    num_nodes = int(input("Enter number of nodes to input heuristic
values: "))
    print("Enter each node and its heuristic value (e.g., A 5):")
    for _ in range(num_nodes):
        node, h = input().split()
        heuristic[node] = int(h)

    return graph, heuristic

def best_first_search(graph, heuristic, start, goal):
    visited = set()
    priority_queue = []
    heapq.heappush(priority_queue, (heuristic[start], start))

    while priority_queue:
        h_value, current = heapq.heappop(priority_queue)
        if current not in visited:
            print(current, end=" ")
            visited.add(current)

            if current == goal:
```

```
                print("\nGoal reached!")
                return

            for neighbor in graph[current]:
                if neighbor not in visited:
                    heapq.heappush(priority_queue,
(heuristic[neighbor], neighbor))

    print("\nGoal not reachable.")

# Example usage
if __name__ == "__main__":
    graph, heuristic = read_graph_and_heuristics()

    print("\nGraph adjacency list:")
    for node, neighbors in graph.items():
        print(f"{node}: {neighbors}")

    start = input("\nEnter the starting node: ")
    goal = input("Enter the goal node: ")

    print("\nBest First Search traversal:")
    best_first_search(graph, heuristic, start, goal)
```

```
Enter number of edges: 5
Enter each edge as: source destination
a b
b d
d a
c b
c e
Enter number of nodes to input heuristic values: 5
Enter each node and its heuristic value (e.g., A 5):
a 2
b 6
c 7
d 1
e 4

Graph adjacency list:
a: ['b']
b: ['d']
d: ['a']
c: ['b', 'e']

Enter the starting node: b
Enter the goal node: e

Best First Search traversal:
```

```
b d a
Goal not reachable.

#5. Implement Bfs. Read the undirected weighted graph and the
heuristic values from user.

import heapq
from collections import defaultdict

def read_graph_and_heuristic():
    graph = defaultdict(list)
    heuristic = {}

    n = int(input("Enter number of edges: "))
    print("Enter edges in format: node1 node2 weight")
    for _ in range(n):
        u, v, w = input().split()
        w = int(w)
        graph[u].append((v, w))
        graph[v].append((u, w))  # Undirected

    m = int(input("Enter number of nodes for heuristic values: "))
    print("Enter node and heuristic value:")
    for _ in range(m):
        node, h = input().split()
        heuristic[node] = int(h)

    return graph, heuristic

def best_first_search(graph, heuristic, start, goal):
    visited = set()
    queue = []
    heapq.heappush(queue, (heuristic[start], start))

    while queue:
        _, node = heapq.heappop(queue)
        if node not in visited:
            print(node, end=" ")
            visited.add(node)

            if node == goal:
                print("\nGoal Reached!")
                return

            for neighbor, _ in graph[node]:
                if neighbor not in visited:
                    heapq.heappush(queue, (heuristic[neighbor],
neighbor))

if __name__ == "__main__":
```

```
    graph, heuristic = read_graph_and_heuristic()
    start = input("\nEnter start node: ")
    goal = input("Enter goal node: ")

    print("\nBest First Search Path:")
    best_first_search(graph, heuristic, start, goal)
```

```
Enter number of edges: 6
Enter edges in format: node1 node2 weight
a b 5
b d 6
d e 7
e b 1
c d 4
a e 5
Enter number of nodes for heuristic values: 5
Enter node and heuristic value:
a 1
b 2
d 4
e 5
c 7

Enter start node: a
Enter goal node: d

Best First Search Path:
a b d
Goal Reached!
```

```
#6. Bfs Read the undirected unweighted graph and the heuristic values
from user.
def read_graph_and_heuristic_unweighted():
    graph = defaultdict(list)
    heuristic = {}

    n = int(input("Enter number of edges: "))
    print("Enter edges in format: node1 node2")
    for _ in range(n):
        u, v = input().split()
        graph[u].append((v, 1))
        graph[v].append((u, 1))

    m = int(input("Enter number of nodes for heuristic values: "))
    print("Enter node and heuristic value:")
    for _ in range(m):
        node, h = input().split()
        heuristic[node] = int(h)

    return graph, heuristic
```

```python
def best_first_search(graph, heuristic, start, goal):
    visited = set()
    queue = []
    heapq.heappush(queue, (heuristic[start], start))

    while queue:
        _, node = heapq.heappop(queue)
        if node not in visited:
            print(node, end=" ")
            visited.add(node)

            if node == goal:
                print("\nGoal Reached!")
                return

            for neighbor, _ in graph[node]:
                if neighbor not in visited:
                    heapq.heappush(queue, (heuristic[neighbor],
neighbor))

if __name__ == "__main__":
    graph, heuristic = read_graph_and_heuristic_unweighted()
    start = input("\nEnter start node: ")
    goal = input("Enter goal node: ")

    print("\nBest First Search Path:")
    best_first_search(graph, heuristic, start, goal)
```

```
Enter number of edges: 4
Enter edges in format: node1 node2
a b
b c
c a
d b
Enter number of nodes for heuristic values: 4
Enter node and heuristic value:
a 1
b 2
c 3
d 4

Enter start node: a
Enter goal node: c

Best First Search Path:
a b c
Goal Reached!
```

```
#7. Implement Bfs Read the directed weighted graph and the heuristic
values from user.
def read_directed_graph_and_heuristic():
    graph = defaultdict(list)
    heuristic = {}

    n = int(input("Enter number of edges: "))
    print("Enter edges in format: node1 node2 weight")
    for _ in range(n):
        u, v, w = input().split()
        w = int(w)
        graph[u].append((v, w))  # Directed only

    m = int(input("Enter number of nodes for heuristic values: "))
    print("Enter node and heuristic value:")
    for _ in range(m):
        node, h = input().split()
        heuristic[node] = int(h)

    return graph, heuristic

def best_first_search(graph, heuristic, start, goal):
    visited = set()
    queue = []
    # Check if start node is in heuristic
    if start not in heuristic:
        print(f"Starting node '{start}' not found in heuristic
values.")
        return

    heapq.heappush(queue, (heuristic[start], start))

    while queue:
        _, node = heapq.heappop(queue)
        if node not in visited:
            print(node, end=" ")
            visited.add(node)

            if node == goal:
                print("\nGoal Reached!")
                return

            for neighbor, _ in graph[node]:
                if neighbor not in visited:
                    if neighbor in heuristic:
                        heapq.heappush(queue, (heuristic[neighbor],
neighbor))
                    else:
                        print(f"Heuristic value for node '{neighbor}'
not found. Skipping.")
```

```
    print("\nGoal not reachable.")

if __name__ == "__main__":
    graph, heuristic = read_directed_graph_and_heuristic()
    start = input("\nEnter start node: ")
    goal = input("Enter goal node: ")

    print("\nBest First Search Path:")
    best_first_search(graph, heuristic, start, goal)
```

```
Enter number of edges: 5
Enter edges in format: node1 node2 weight
a b 5
c d 4
e a 2
a d 7
d c 3
Enter number of nodes for heuristic values: 2
Enter node and heuristic value:
a 5
b 5

Enter start node: a
Enter goal node: d

Best First Search Path:
a Heuristic value for node 'd' not found. Skipping.
b
Goal not reachable.
```

```
#8. Implement A* algorithm. Read directed weighted graph and heuristic
values from a .csv file.
import pandas as pd
import heapq

def a_star_algorithm(edges_file, heuristic_file):
    # Read edges and heuristic from CSV files
    edges_df = pd.read_csv(edges_file)
    heuristic_df = pd.read_csv(heuristic_file)

    # Create graph
    graph = {}
    for _, row in edges_df.iterrows():
        graph.setdefault(row['source'],
[]).append((row['destination'], row['weight']))

    # Create heuristic dictionary
    heuristics = dict(zip(heuristic_df['node'],
heuristic_df['heuristic']))
```

```
    # Take user input
    start_node = input("Enter the Start Node: ").strip().upper()
    goal_node = input("Enter the Goal Node: ").strip().upper()

    # A* search
    open_set = []
    heapq.heappush(open_set, (heuristics[start_node], 0, start_node,
[start_node]))
    visited = set()

    while open_set:
        est_total_cost, cost_so_far, current_node, path =
heapq.heappop(open_set)

        if current_node == goal_node:
            print(f"Path found: {' -> '.join(path)} with total cost
{cost_so_far}")
            return

        if current_node in visited:
            continue
        visited.add(current_node)

        for neighbor, weight in graph.get(current_node, []):
            if neighbor not in visited:
                total_cost = cost_so_far + weight
                est_cost = total_cost + heuristics.get(neighbor,
float('inf'))
                heapq.heappush(open_set, (est_cost, total_cost,
neighbor, path + [neighbor]))

    print("No path found.")

# Correct path
edges_file = '/content/edges.csv'
heuristic_file = '/content/heuristic.csv'

# Call A* function
a_star_algorithm(edges_file, heuristic_file)
```

```
Enter the Start Node: a
Enter the Goal Node: d
Path found: A -> B -> D with total cost 3
```

```
#9. Implement A* algorithm. Read directed weighted graph and heuristic
values from user
import heapq

def best_first_search():
    # Taking input
    n = int(input("Enter number of edges: "))
```

```
    graph = {}

    print("Enter edges in format: source destination weight")
    for _ in range(n):
        src, dest, weight = input().split()
        weight = int(weight)
        if src not in graph:
            graph[src] = []
        graph[src].append((dest, weight))

    # Taking heuristics
    heuristics = {}
    m = int(input("Enter number of nodes for heuristics: "))
    print("Enter heuristics in format: node heuristic_value")
    for _ in range(m):
        node, h = input().split()
        # Convert node to uppercase to maintain consistency
        node = node.strip().upper()
        heuristics[node] = int(h)

    # Start and goal
    start = input("Enter start node: ").strip().upper()
    goal = input("Enter goal node: ").strip().upper()

    # Best First Search
    open_set = []
    heapq.heappush(open_set, (heuristics[start], start, [start]))
    visited = set()

    while open_set:
        h_val, current, path = heapq.heappop(open_set)

        if current == goal:
            print(f"Path found: {' -> '.join(path)}")
            return

        if current in visited:
            continue
        visited.add(current)

        for neighbor, _ in graph.get(current, []):
            if neighbor not in visited:
                heapq.heappush(open_set, (heuristics.get(neighbor,
float('inf')), neighbor, path + [neighbor]))

    print("No path found.")

# Run the Best First Search function
best_first_search()
```

```
Enter number of edges: 3
Enter edges in format: source destination weight
a b 3
b c 1
c a 5
Enter number of nodes for heuristics: 3
Enter heuristics in format: node heuristic_value
a 1
b 2
c 3
Enter start node: a
Enter goal node: c
No path found.
```

```
#10. Implement A* algorithm. Read undirected weighted graph and
heuristic values from a .csv file.
import heapq
import pandas as pd

def a_star_algorithm(edges_file, heuristic_file):
    try:
        # Load and clean graph edges
        edges_df = pd.read_csv(edges_file)
        edges_df.columns = edges_df.columns.str.strip()  # Strip extra
spaces in column names
        expected_cols = {'source', 'destination', 'weight'}

        if not expected_cols.issubset(edges_df.columns):
            print(f"Error: edges.csv must have columns:
{expected_cols}")
            return

        graph = {}
        for _, row in edges_df.iterrows():
            # Clean data by stripping extra spaces from the values
            src, dest, weight = str(row['source']).strip().upper(),
str(row['destination']).strip().upper(), row['weight']
            graph.setdefault(src, []).append((dest, weight))
            graph.setdefault(dest, []).append((src, weight))  # For
undirected graph

        # Load and clean heuristic values
        heuristic_df = pd.read_csv(heuristic_file)
        heuristic_df.columns = heuristic_df.columns.str.strip()  #
Strip extra spaces in column names
        if not {'node', 'heuristic'}.issubset(heuristic_df.columns):
            print(f"Error: heuristic.csv must have columns: 'Node' and
'Heuristic'")
            return
```

```
        heuristics = dict((str(row['node']).strip().upper(),
row['heuristic']) for _, row in heuristic_df.iterrows())

        # Get start and goal nodes from user input
        start = input("Enter Start Node: ").strip().upper()
        goal = input("Enter Goal Node: ").strip().upper()

        # Ensure start and goal nodes exist in the graph
        if start not in graph or goal not in graph:
            print("Start or Goal node not present in the graph!")
            return

        # Initialize open set for A* search
        open_set = []
        heapq.heappush(open_set, (heuristics[start], 0, start,
[start]))  # (f_score, g_score, current_node, path)
        visited = set()

        while open_set:
            f_score, g_score, current, path = heapq.heappop(open_set)

            # Check if we've reached the goal
            if current == goal:
                print(f"\nPath found: {' -> '.join(path)}")
                print(f"Total cost: {g_score}")
                return

            # Skip visited nodes
            if current in visited:
                continue
            visited.add(current)

            # Explore neighbors
            for neighbor, cost in graph.get(current, []):
                if neighbor not in visited:
                    new_g = g_score + cost
                    new_f = new_g + heuristics.get(neighbor,
float('inf'))
                    heapq.heappush(open_set, (new_f, new_g, neighbor,
path + [neighbor]))

        print("\nNo path found between the given nodes.")

    except FileNotFoundError as e:
        print(f"Error: {e}")
    except Exception as e:
        print(f"An unexpected error occurred: {e}")

# --- RUN ---
a_star_algorithm('edges.csv', 'heuristic.csv')
```

```
Enter Start Node: a
Enter Goal Node: e

Path found: A -> C -> E
Total cost: 5
```

```
#11. Implement A* algorithm. Read undirected weighted graph and
heuristic values from user.
import heapq

def a_star_algorithm():
    # Read the graph from user input
    graph = {}
    num_edges = int(input("Enter the number of edges: "))

    for _ in range(num_edges):
        edge = input("Enter edge (source, destination, weight):
").split()
        src, dest, weight = edge[0].strip().upper(),
edge[1].strip().upper(), int(edge[2].strip())
        graph.setdefault(src, []).append((dest, weight))
        graph.setdefault(dest, []).append((src, weight))  # For
undirected graph

    # Read the heuristic values from user input
    heuristics = {}
    num_nodes = int(input("Enter the number of nodes for heuristic
values: "))

    for _ in range(num_nodes):
        node, heuristic = input("Enter node and heuristic value (node,
heuristic): ").split()
        heuristics[node.strip().upper()] = int(heuristic.strip())

    # Get start and goal nodes from user input
    start = input("Enter Start Node: ").strip().upper()
    goal = input("Enter Goal Node: ").strip().upper()

    # Ensure start and goal nodes exist in the graph
    if start not in graph or goal not in graph:
        print("Start or Goal node not present in the graph!")
        return

    # Initialize open set for A* search
    open_set = []
    heapq.heappush(open_set, (heuristics[start], 0, start, [start]))
# (f_score, g_score, current_node, path)
    visited = set()

    while open_set:
```

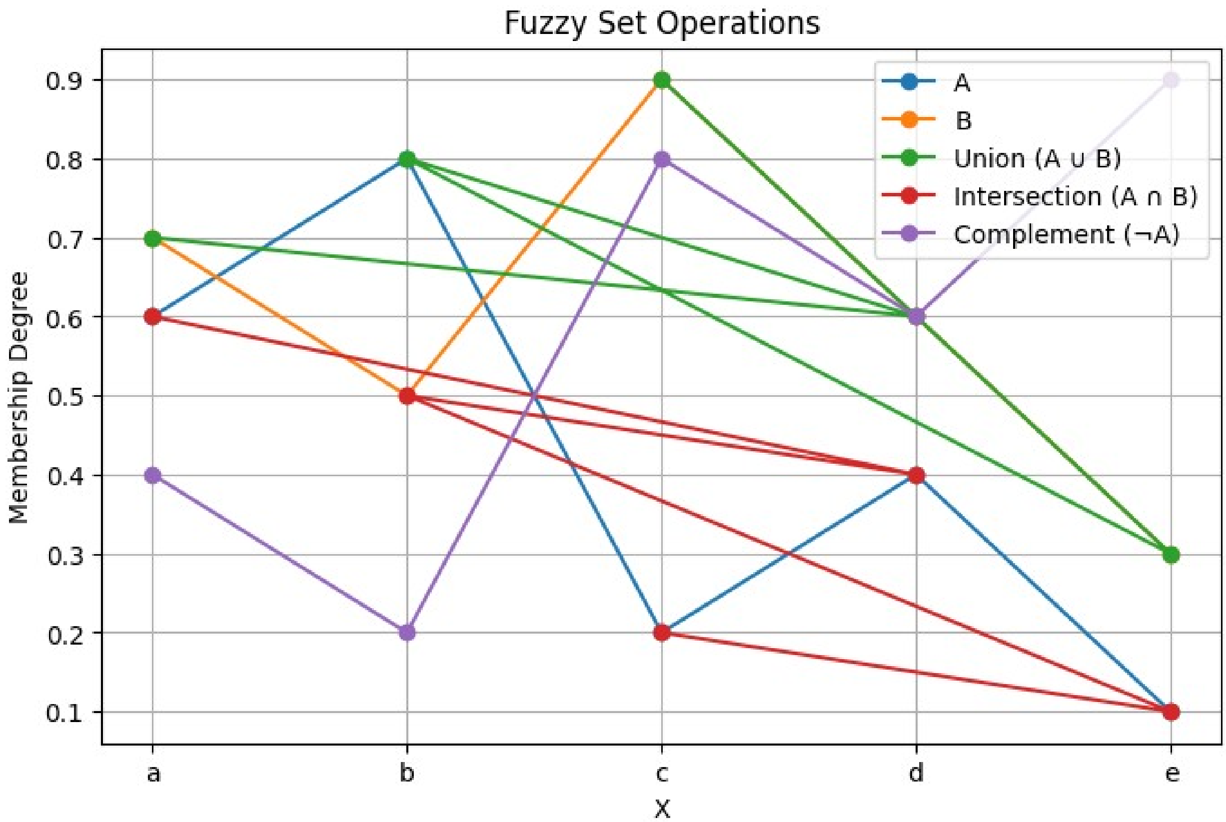
```
        f_score, g_score, current, path = heapq.heappop(open_set)

        # Check if we've reached the goal
        if current == goal:
            print(f"\nPath found: {' -> '.join(path)}")
            print(f"Total cost: {g_score}")
            return

        # Skip visited nodes
        if current in visited:
            continue
        visited.add(current)

        # Explore neighbors
        for neighbor, cost in graph.get(current, []):
            if neighbor not in visited:
                new_g = g_score + cost
                new_f = new_g + heuristics.get(neighbor, float('inf'))
                heapq.heappush(open_set, (new_f, new_g, neighbor, path
+ [neighbor]))

    print("\nNo path found between the given nodes.")

a_star_algorithm()
```

```
Enter the number of edges: 3
Enter edge (source, destination, weight): a b 3
Enter edge (source, destination, weight): b c 4
Enter edge (source, destination, weight): c a 4
Enter the number of nodes for heuristic values: 3
Enter node and heuristic value (node, heuristic): a 4
Enter node and heuristic value (node, heuristic): b 5
Enter node and heuristic value (node, heuristic): c 6
Enter Start Node: a
Enter Goal Node: c

Path found: A -> C
Total cost: 4
```

```
#12. Implement Fuzzy set operations – union, intersection and
complement. Demonstrate these operations with 3 fuzzy sets.
import matplotlib.pyplot as plt

# Function to calculate union of fuzzy sets
def fuzzy_union(set_a, set_b):
    return {x: max(set_a.get(x, 0), set_b.get(x, 0)) for x in
set_a.keys() | set_b.keys()}

# Function to calculate intersection of fuzzy sets
def fuzzy_intersection(set_a, set_b):
```

```
    return {x: min(set_a.get(x, 0), set_b.get(x, 0)) for x in
set_a.keys() | set_b.keys()}

# Function to calculate complement of a fuzzy set
def fuzzy_complement(set_a):
    return {x: 1 - membership for x, membership in set_a.items()}

# Function to plot fuzzy sets for visualization
def plot_fuzzy_sets(fuzzy_sets, title="Fuzzy Sets"):
    plt.figure(figsize=(8, 5))
    for label, fuzzy_set in fuzzy_sets.items():
        plt.plot(list(fuzzy_set.keys()), list(fuzzy_set.values()),
label=label, marker='o')

    plt.xlabel('X')
    plt.ylabel('Membership Degree')
    plt.title(title)
    plt.legend()
    plt.grid(True)
    plt.show()

# Example fuzzy sets
A = {'a': 0.6, 'b': 0.8, 'c': 0.2, 'd': 0.4, 'e': 0.1}
B = {'a': 0.7, 'b': 0.5, 'c': 0.9, 'd': 0.6, 'e': 0.3}
C = {'a': 0.3, 'b': 0.4, 'c': 0.8, 'd': 0.5, 'e': 0.6}

# Perform fuzzy set operations
union_ab = fuzzy_union(A, B)
intersection_ab = fuzzy_intersection(A, B)
complement_a = fuzzy_complement(A)

# Display results
print("Union of A and B:", union_ab)
print("Intersection of A and B:", intersection_ab)
print("Complement of A:", complement_a)

# Visualize the fuzzy sets and operations
plot_fuzzy_sets({
    'A': A,
    'B': B,
    'Union (A ∪ B)': union_ab,
    'Intersection (A ∩ B)': intersection_ab,
    'Complement (¬A)': complement_a
}, "Fuzzy Set Operations")
```

```
Union of A and B: {'a': 0.7, 'd': 0.6, 'b': 0.8, 'e': 0.3, 'c': 0.9}
Intersection of A and B: {'a': 0.6, 'd': 0.4, 'b': 0.5, 'e': 0.1, 'c':
0.2}
Complement of A: {'a': 0.4, 'b': 0.19999999999999996, 'c': 0.8, 'd':
0.6, 'e': 0.9}
```

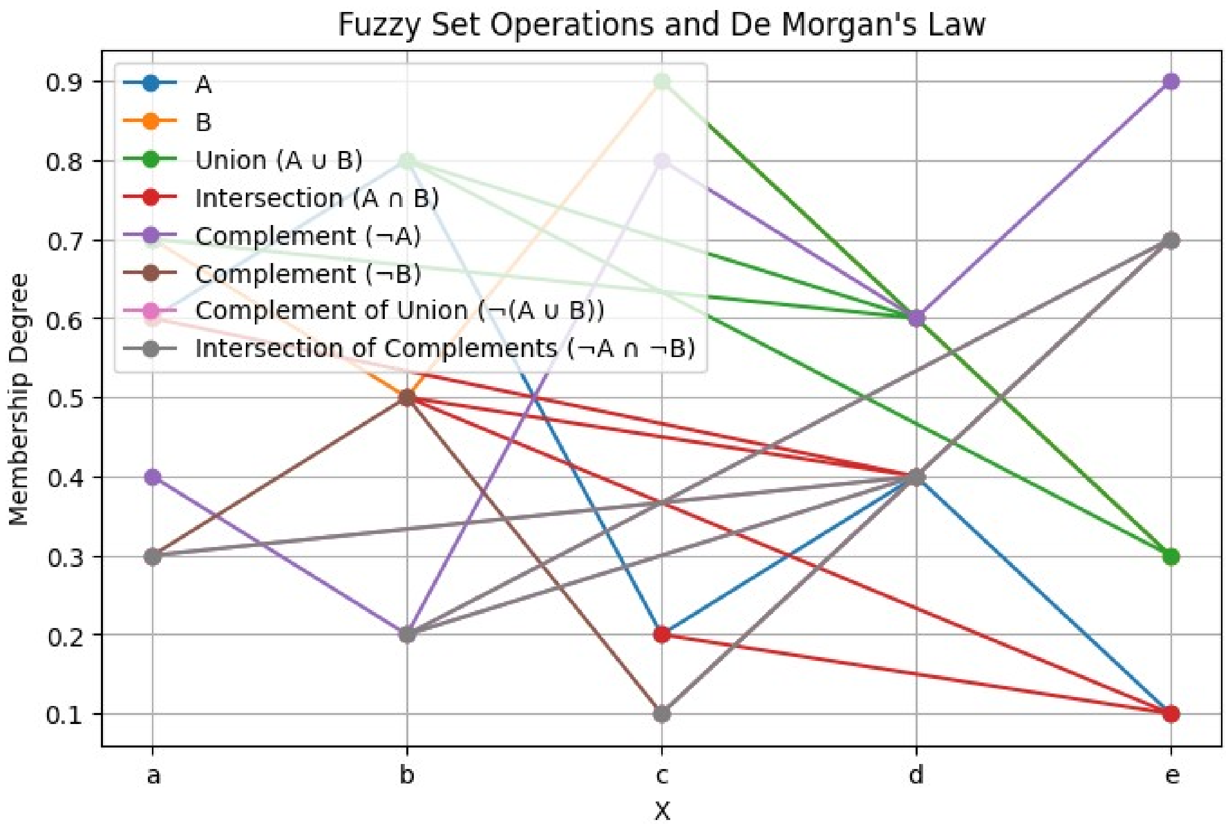



```
#13. Implement Fuzzy set operations – union, intersection and
complement. Demonstrate De Morgan’s Law ( Complement of Union) with 2
fuzzy sets.
import matplotlib.pyplot as plt

# Function to calculate union of fuzzy sets
def fuzzy_union(set_a, set_b):
    return {x: max(set_a.get(x, 0), set_b.get(x, 0)) for x in
set_a.keys() | set_b.keys()}

# Function to calculate intersection of fuzzy sets
def fuzzy_intersection(set_a, set_b):
    return {x: min(set_a.get(x, 0), set_b.get(x, 0)) for x in
set_a.keys() | set_b.keys()}

# Function to calculate complement of a fuzzy set
def fuzzy_complement(set_a):
    return {x: 1 - membership for x, membership in set_a.items()}

# Function to plot fuzzy sets for visualization
def plot_fuzzy_sets(fuzzy_sets, title="Fuzzy Sets"):
    plt.figure(figsize=(8, 5))
    for label, fuzzy_set in fuzzy_sets.items():
        plt.plot(list(fuzzy_set.keys()), list(fuzzy_set.values()),
```

```
label=label, marker='o')

    plt.xlabel('X')
    plt.ylabel('Membership Degree')
    plt.title(title)
    plt.legend()
    plt.grid(True)
    plt.show()

# Example fuzzy sets
A = {'a': 0.6, 'b': 0.8, 'c': 0.2, 'd': 0.4, 'e': 0.1}
B = {'a': 0.7, 'b': 0.5, 'c': 0.9, 'd': 0.6, 'e': 0.3}

# Perform fuzzy set operations
union_ab = fuzzy_union(A, B)
intersection_ab = fuzzy_intersection(A, B)
complement_a = fuzzy_complement(A)
complement_b = fuzzy_complement(B)

# De Morgan's Law demonstration: Complement of Union = Complement of A
∩ Complement of B
complement_union_ab = fuzzy_complement(union_ab)
intersection_complement_ab = fuzzy_intersection(complement_a,
complement_b)

# Display results
print("Union of A and B:", union_ab)
print("Intersection of A and B:", intersection_ab)
print("Complement of A:", complement_a)
print("Complement of B:", complement_b)
print("Complement of Union (¬(A ∪ B)):", complement_union_ab)
print("Intersection of Complements (¬A ∩ ¬B):",
intersection_complement_ab)

# Verify De Morgan's Law
print("\nDe Morgan's Law Verification:")
if complement_union_ab == intersection_complement_ab:
    print("De Morgan's Law holds: ¬(A ∪ B) == (¬A ∩ ¬B)")
else:
    print("De Morgan's Law does not hold.")

# Visualize the fuzzy sets and operations
plot_fuzzy_sets({
    'A': A,
    'B': B,
    'Union (A ∪ B)': union_ab,
    'Intersection (A ∩ B)': intersection_ab,
    'Complement (¬A)': complement_a,
    'Complement (¬B)': complement_b,
    'Complement of Union (¬(A ∪ B))': complement_union_ab,
```

```
    'Intersection of Complements (¬A ∩ ¬B)':
intersection_complement_ab
}, "Fuzzy Set Operations and De Morgan's Law")
```

```
Union of A and B: {'a': 0.7, 'd': 0.6, 'b': 0.8, 'e': 0.3, 'c': 0.9}
Intersection of A and B: {'a': 0.6, 'd': 0.4, 'b': 0.5, 'e': 0.1, 'c':
0.2}
Complement of A: {'a': 0.4, 'b': 0.19999999999999996, 'c': 0.8, 'd':
0.6, 'e': 0.9}
Complement of B: {'a': 0.30000000000000004, 'b': 0.5, 'c':
0.09999999999999998, 'd': 0.4, 'e': 0.7}
Complement of Union (¬(A ∪ B)): {'a': 0.30000000000000004, 'd': 0.4,
'b': 0.19999999999999996, 'e': 0.7, 'c': 0.09999999999999998}
Intersection of Complements (¬A ∩ ¬B): {'a': 0.30000000000000004, 'd':
0.4, 'b': 0.19999999999999996, 'e': 0.7, 'c': 0.09999999999999998}

De Morgan's Law Verification:
De Morgan's Law holds: ¬(A ∪ B) == (¬A ∩ ¬B)
```

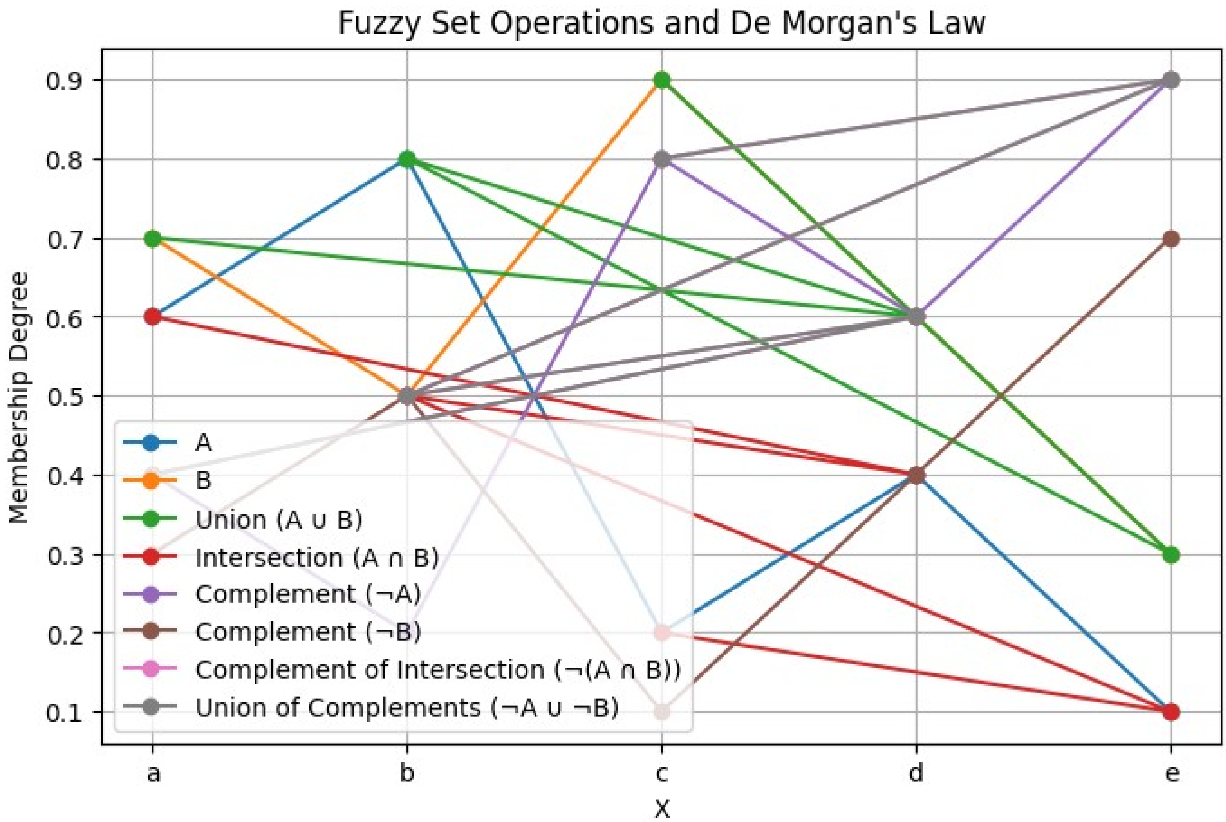



```
#14. Implement Fuzzy set operations– union, intersection and
complement. Demonstrate De Morgan’s Law (Complement of
Intersection)with 2 fuzzy sets.
import matplotlib.pyplot as plt
```

```python
# Function to calculate union of fuzzy sets
def fuzzy_union(set_a, set_b):
    return {x: max(set_a.get(x, 0), set_b.get(x, 0)) for x in
set_a.keys() | set_b.keys()}

# Function to calculate intersection of fuzzy sets
def fuzzy_intersection(set_a, set_b):
    return {x: min(set_a.get(x, 0), set_b.get(x, 0)) for x in
set_a.keys() | set_b.keys()}

# Function to calculate complement of a fuzzy set
def fuzzy_complement(set_a):
    return {x: 1 - membership for x, membership in set_a.items()}

# Function to plot fuzzy sets for visualization
def plot_fuzzy_sets(fuzzy_sets, title="Fuzzy Sets"):
    plt.figure(figsize=(8, 5))
    for label, fuzzy_set in fuzzy_sets.items():
        plt.plot(list(fuzzy_set.keys()), list(fuzzy_set.values()),
label=label, marker='o')

    plt.xlabel('X')
    plt.ylabel('Membership Degree')
    plt.title(title)
    plt.legend()
    plt.grid(True)
    plt.show()

# Example fuzzy sets
A = {'a': 0.6, 'b': 0.8, 'c': 0.2, 'd': 0.4, 'e': 0.1}
B = {'a': 0.7, 'b': 0.5, 'c': 0.9, 'd': 0.6, 'e': 0.3}

# Perform fuzzy set operations
union_ab = fuzzy_union(A, B)
intersection_ab = fuzzy_intersection(A, B)
complement_a = fuzzy_complement(A)
complement_b = fuzzy_complement(B)

# De Morgan's Law demonstration: Complement of Intersection =
Complement of A ∪ Complement of B
complement_intersection_ab = fuzzy_complement(intersection_ab)
union_complement_ab = fuzzy_union(complement_a, complement_b)

# Display results
print("Union of A and B:", union_ab)
print("Intersection of A and B:", intersection_ab)
print("Complement of A:", complement_a)
print("Complement of B:", complement_b)
print("Complement of Intersection (¬(A ∩ B)):",
complement_intersection_ab)
```

```python
print("Union of Complements (¬A ∪ ¬B):", union_complement_ab)

# Verify De Morgan's Law
print("\nDe Morgan's Law Verification:")
if complement_intersection_ab == union_complement_ab:
    print("De Morgan's Law holds: ¬(A ∩ B) == (¬A ∪ ¬B)")
else:
    print("De Morgan's Law does not hold.")

# Visualize the fuzzy sets and operations
plot_fuzzy_sets({
    'A': A,
    'B': B,
    'Union (A ∪ B)': union_ab,
    'Intersection (A ∩ B)': intersection_ab,
    'Complement (¬A)': complement_a,
    'Complement (¬B)': complement_b,
    'Complement of Intersection (¬(A ∩ B))':
complement_intersection_ab,
    'Union of Complements (¬A ∪ ¬B)': union_complement_ab
}, "Fuzzy Set Operations and De Morgan's Law")
```

```
Union of A and B: {'a': 0.7, 'd': 0.6, 'b': 0.8, 'e': 0.3, 'c': 0.9}
Intersection of A and B: {'a': 0.6, 'd': 0.4, 'b': 0.5, 'e': 0.1, 'c':
0.2}
Complement of A: {'a': 0.4, 'b': 0.19999999999999996, 'c': 0.8, 'd':
0.6, 'e': 0.9}
Complement of B: {'a': 0.30000000000000004, 'b': 0.5, 'c':
0.09999999999999998, 'd': 0.4, 'e': 0.7}
Complement of Intersection (¬(A ∩ B)): {'a': 0.4, 'd': 0.6, 'b': 0.5,
'e': 0.9, 'c': 0.8}
Union of Complements (¬A ∪ ¬B): {'a': 0.4, 'd': 0.6, 'b': 0.5, 'e':
0.9, 'c': 0.8}

De Morgan's Law Verification:
De Morgan's Law holds: ¬(A ∩ B) == (¬A ∪ ¬B)
```




```python
#15. Nim Game using Min-Max Algorithm

def nim_minmax(piles, turn):
    # Base case: if all piles are empty
    if all(pile == 0 for pile in piles):
        if turn == 'computer':
            return False
        else:
            return True

    if turn == 'computer':
        for i in range(len(piles)):
            for remove in range(1, piles[i]+1):
                new_piles = piles.copy()
                new_piles[i] -= remove
                if nim_minmax(new_piles, 'user'):
                    return True
        return False
    else:
        for i in range(len(piles)):
            for remove in range(1, piles[i]+1):
                new_piles = piles.copy()
                new_piles[i] -= remove
                if not nim_minmax(new_piles, 'computer'):
```

```
                    return False
        return True

def computer_move(piles):
    for i in range(len(piles)):
        for remove in range(1, piles[i]+1):
            new_piles = piles.copy()
            new_piles[i] -= remove
            if nim_minmax(new_piles, 'user'):
                print(f"Computer removes {remove} from pile {i+1}")
                piles[i] -= remove
                return
    # Otherwise random move
    for i in range(len(piles)):
        if piles[i] > 0:
            print(f"Computer removes 1 from pile {i+1}")
            piles[i] -= 1
            return

def nim_game():
    piles = list(map(int, input("Enter initial piles separated by
space: ").split()))
    turn = 'user'

    while any(pile > 0 for pile in piles):
        print("Current Piles:", piles)
        if turn == 'user':
            pile_index = int(input("Choose pile (1,2,3...): ")) - 1
            remove = int(input(f"How many to remove from pile
{pile_index+1}: "))
            if 0 <= pile_index < len(piles) and 1 <= remove <=
piles[pile_index]:
                piles[pile_index] -= remove
                turn = 'computer'
            else:
                print("Invalid move, try again!")
        else:
            computer_move(piles)
            turn = 'user'

    if turn == 'computer':
        print("Congratulations! You win!")
    else:
        print("Computer wins!")

# Start game
nim_game()
```

```
Enter initial piles separated by space: 4
Current Piles: [4]
```

```
Choose pile (1,2,3...): 1
How many to remove from pile 1: 2
Current Piles: [2]
Computer removes 2 from pile 1
Computer wins!

#16: Modified Nim Game where Computer loses or draws (bad strategy)

def is_terminal(piles):
    return all(pile == 0 for pile in piles)

def minimax(piles, turn):
    if is_terminal(piles):
        if turn == 'computer':
            return 1  # User wins
        else:
            return -1  # Computer wins (should be avoided)

    if turn == 'user':
        max_eval = -float('inf')
        for i in range(len(piles)):
            for remove in range(1, piles[i]+1):
                new_piles = piles.copy()
                new_piles[i] -= remove
                eval = minimax(new_piles, 'computer')
                max_eval = max(max_eval, eval)
        return max_eval
    else:  # Computer's turn
        min_eval = float('inf')
        for i in range(len(piles)):
            for remove in range(1, piles[i]+1):
                new_piles = piles.copy()
                new_piles[i] -= remove
                eval = minimax(new_piles, 'user')
                min_eval = min(min_eval, eval)
        return min_eval

def computer_move(piles):
    best_move = None
    best_value = float('inf')  # Computer tries to maximize user's
winning chances

    for i in range(len(piles)):
        for remove in range(1, piles[i]+1):
            new_piles = piles.copy()
            new_piles[i] -= remove
            move_value = minimax(new_piles, 'user')
            if move_value < best_value:
                best_value = move_value
                best_move = (i, remove)
```

```python
    if best_move:
        pile_index, remove = best_move
        print(f"Computer removes {remove} from pile {pile_index+1}")
        piles[pile_index] -= remove

def nim_game_computer_loses():
    piles = list(map(int, input("Enter initial piles separated by space: ").split()))
    turn = 'user'

    while any(pile > 0 for pile in piles):
        print("Current Piles:", piles)
        if turn == 'user':
            pile_index = int(input("Choose pile (1,2,3...): ")) - 1
            remove = int(input(f"How many to remove from pile {pile_index+1}: "))
            if 0 <= pile_index < len(piles) and 1 <= remove <= piles[pile_index]:
                piles[pile_index] -= remove
                turn = 'computer'
            else:
                print("Invalid move, try again!")
        else:
            computer_move(piles)
            turn = 'user'

    if turn == 'computer':
        print("Congratulations! You win!")
    else:
        print("Computer wins!")

# Start corrected Nim Game
nim_game_computer_loses()
```

```
Enter initial piles separated by space: 3
Current Piles: [3]
Choose pile (1,2,3...): 1
How many to remove from pile 1: 2
Current Piles: [1]
Computer removes 1 from pile 1
Computer wins!
```

```python
#17: Simple MLP with random weights (N inputs, 2 hidden layers, 1 output)

import numpy as np

def simple_mlp(N):
    # Random weight initialization
```

```
    input_layer = np.random.randint(0, 2, N)
    hidden1 = np.random.rand(N, 5)  # First hidden layer with 5 
neurons
    hidden2 = np.random.rand(5, 3)  # Second hidden layer with 3 
neurons
    output_layer = np.random.rand(3, 1)  # Output neuron

    bias1 = np.random.rand(5)
    bias2 = np.random.rand(3)
    bias_out = np.random.rand(1)

    print("Input Layer:", input_layer)
    print("Hidden Layer 1 weights:\n", hidden1)
    print("Hidden Layer 2 weights:\n", hidden2)
    print("Output Layer weights:\n", output_layer)
    print("Biases Hidden1:", bias1)
    print("Biases Hidden2:", bias2)
    print("Bias Output:", bias_out)

simple_mlp(int(input("Enter number of binary inputs N: ")))


Enter number of binary inputs N: 5
Input Layer: [1 1 0 1 0]
Hidden Layer 1 weights:
 [[0.67918865 0.53265386 0.22199662 0.2319215  0.17923496]
 [0.56093198 0.08294417 0.35619519 0.3005264  0.70324272]
 [0.69061265 0.31066721 0.77101091 0.9332458  0.43633444]
 [0.50739286 0.62905229 0.43016016 0.69460454 0.89672172]
 [0.32283473 0.54078247 0.58723179 0.68748564 0.1449001 ]]
Hidden Layer 2 weights:
 [[0.71215739 0.37719736 0.72238744]
 [0.53026622 0.01204923 0.76475184]
 [0.33541128 0.591893   0.26305616]
 [0.76800792 0.08506511 0.36665168]
 [0.37385874 0.13382513 0.27024746]]
Output Layer weights:
 [[0.21773044]
 [0.53538901]
 [0.72658449]]
Biases Hidden1: [0.28701185 0.9863212  0.68086411 0.96462637
0.71667904]
Biases Hidden2: [0.89504967 0.89412531 0.08073415]
Bias Output: [0.79063544]

#18. Implement a simple Multi-Layer Perceptron with 4 binary inputs, 
one hidden layer and two binary outputs. Display the final weight 
matrices, bias
#values and the number of steps. Note that random values are assigned 
to weight matrices and bias in each step.
```

```python
import numpy as np

# Sigmoid activation function
def sigmoid(x):
    return 1 / (1 + np.exp(-x))

# Derivative of sigmoid function
def sigmoid_derivative(x):
    return x * (1 - x)

# MLP implementation
def simple_mlp_4inputs():
    # Set number of inputs, hidden layer neurons, and outputs
    input_size = 4
    hidden_size = 5
    output_size = 2

    # Random initialization of input data (4 binary inputs)
    inputs = np.random.randint(0, 2, (1, input_size))  # 1 sample, 4
binary inputs

    # Random weight initialization for hidden layer and output layer
    weights_input_hidden = np.random.rand(input_size, hidden_size)
    weights_hidden_output = np.random.rand(hidden_size, output_size)

    # Random bias initialization
    bias_hidden = np.random.rand(1, hidden_size)
    bias_output = np.random.rand(1, output_size)

    # Display initial random values
    print("Initial random input data:", inputs)
    print("Initial weights for input-hidden layer:\n",
weights_input_hidden)
    print("Initial weights for hidden-output layer:\n",
weights_hidden_output)
    print("Initial biases for hidden layer:", bias_hidden)
    print("Initial biases for output layer:", bias_output)

    # Forward pass
    hidden_input = np.dot(inputs, weights_input_hidden) + bias_hidden
# Weighted sum for hidden layer
    hidden_output = sigmoid(hidden_input)  # Apply sigmoid activation

    output_input = np.dot(hidden_output, weights_hidden_output) +
bias_output  # Weighted sum for output layer
    output = sigmoid(output_input)  # Apply sigmoid activation

    # Display final results
    print("Hidden layer output after activation:\n", hidden_output)
```

```
    print("Output layer output after activation:\n", output)

# Run the simple MLP with 4 binary inputs, one hidden layer, and 2
binary outputs
simple_mlp_4inputs()

#19: MLP with Backpropagation and Sigmoid

import numpy as np

def sigmoid(x):
    return 1 / (1 + np.exp(-x))

def sigmoid_derivative(x):
    return x * (1 - x)

def mlp_sigmoid(X, y, epochs=10000, learning_rate=0.5):
    np.random.seed(1)
    hidden_weights = np.random.rand(X.shape[1], 4)
    output_weights = np.random.rand(4, 1)

    hidden_bias = np.random.rand(1, 4)
    output_bias = np.random.rand(1, 1)

    for _ in range(epochs):
        hidden_layer_input = np.dot(X, hidden_weights) + hidden_bias
        hidden_layer_output = sigmoid(hidden_layer_input)

        output_layer_input = np.dot(hidden_layer_output,
output_weights) + output_bias
        predicted_output = sigmoid(output_layer_input)

        error = y - predicted_output
        d_predicted_output = error *
sigmoid_derivative(predicted_output)

        error_hidden_layer = d_predicted_output.dot(output_weights.T)
        d_hidden_layer = error_hidden_layer *
sigmoid_derivative(hidden_layer_output)

        output_weights +=
hidden_layer_output.T.dot(d_predicted_output) * learning_rate
        output_bias += np.sum(d_predicted_output, axis=0,
keepdims=True) * learning_rate
        hidden_weights += X.T.dot(d_hidden_layer) * learning_rate
        hidden_bias += np.sum(d_hidden_layer, axis=0, keepdims=True) *
learning_rate

    print("Final hidden weights:", hidden_weights)
    print("Final output weights:", output_weights)
    print("Final hidden biases:", hidden_bias)
```

```
    print("Final output biases:", output_bias)

X = np.array([[0,0], [0,1], [1,0], [1,1]])
y = np.array([[0], [1], [1], [0]])

mlp_sigmoid(X, y)

Final hidden weights: [[ 3.16040446  2.09595821  2.48105925
6.74771973]
 [ 3.71642527 -1.08434045  3.15093112  6.44603707]]
Final output weights: [[-6.96144027]
 [-2.89650915]
 [-5.66207991]
 [10.76730372]]
Final hidden biases: [[-5.37009401  1.13754151 -4.44623543 -
2.91262015]]
Final output biases: [[-2.3178838]]

#20: MLP with Backpropagation and ReLU

import numpy as np

def relu(x):
    return np.maximum(0, x)

def relu_derivative(x):
    return np.where(x > 0, 1, 0)

def mlp_relu(X, y, epochs=10000, learning_rate=0.01):
    np.random.seed(2)
    hidden_weights = np.random.rand(X.shape[1], 4)
    output_weights = np.random.rand(4, 1)

    hidden_bias = np.random.rand(1, 4)
    output_bias = np.random.rand(1, 1)

    for _ in range(epochs):
        hidden_layer_input = np.dot(X, hidden_weights) + hidden_bias
        hidden_layer_output = relu(hidden_layer_input)

        output_layer_input = np.dot(hidden_layer_output,
output_weights) + output_bias
        predicted_output = relu(output_layer_input)

        error = y - predicted_output
        d_predicted_output = error * relu_derivative(predicted_output)

        error_hidden_layer = d_predicted_output.dot(output_weights.T)
        d_hidden_layer = error_hidden_layer *
relu_derivative(hidden_layer_output)
```

```
        output_weights +=
hidden_layer_output.T.dot(d_predicted_output) * learning_rate
        output_bias += np.sum(d_predicted_output, axis=0,
keepdims=True) * learning_rate
        hidden_weights += X.T.dot(d_hidden_layer) * learning_rate
        hidden_bias += np.sum(d_hidden_layer, axis=0, keepdims=True) *
learning_rate

    print("Final hidden weights:", hidden_weights)
    print("Final output weights:", output_weights)
    print("Final hidden biases:", hidden_bias)
    print("Final output biases:", output_bias)

X = np.array([[0,0], [0,1], [1,0], [1,1]])
y = np.array([[0], [1], [1], [0]])

mlp_relu(X, y)
```

```
Final hidden weights: [[ 0.40456434 -0.02631716  0.22623762
0.39695446]
 [ 0.36115211  0.30834531  0.1381827   0.53649435]]
Final output weights: [[-0.08021039]
 [ 0.09015251]
 [ 0.27385746]
 [-0.0683555 ]]
Final hidden biases: [[0.05773956 0.45684572 0.02572638 0.66790618]]
Final output biases: [[0.50205522]]
```

```
#21: MLP with Backpropagation and Tanh Activation

import numpy as np

def tanh(x):
    return np.tanh(x)

def tanh_derivative(x):
    return 1 - np.square(x)

def mlp_tanh(X, y, epochs=10000, learning_rate=0.01):
    np.random.seed(3)
    hidden_weights = np.random.rand(X.shape[1], 4)
    output_weights = np.random.rand(4, 1)

    hidden_bias = np.random.rand(1, 4)
    output_bias = np.random.rand(1, 1)

    for _ in range(epochs):
        hidden_layer_input = np.dot(X, hidden_weights) + hidden_bias
        hidden_layer_output = tanh(hidden_layer_input)

        output_layer_input = np.dot(hidden_layer_output,
```

```
output_weights) + output_bias
        predicted_output = tanh(output_layer_input)

        error = y - predicted_output
        d_predicted_output = error * tanh_derivative(predicted_output)

        error_hidden_layer = d_predicted_output.dot(output_weights.T)
        d_hidden_layer = error_hidden_layer *
tanh_derivative(hidden_layer_output)

        output_weights +=
hidden_layer_output.T.dot(d_predicted_output) * learning_rate
        output_bias += np.sum(d_predicted_output, axis=0,
keepdims=True) * learning_rate
        hidden_weights += X.T.dot(d_hidden_layer) * learning_rate
        hidden_bias += np.sum(d_hidden_layer, axis=0, keepdims=True) *
learning_rate

    print("Final hidden weights:", hidden_weights)
    print("Final output weights:", output_weights)
    print("Final hidden biases:", hidden_bias)
    print("Final output biases:", output_bias)

X = np.array([[0,0], [0,1], [1,0], [1,1]])
y = np.array([[0], [1], [1], [0]])

mlp_tanh(X, y)
```

```
Final hidden weights: [[0.4654151  2.19335943 1.01569505 0.57152559]
 [0.87460147 2.15612849 0.99990659 0.3810431 ]]
Final output weights: [[-0.38675746]
 [ 2.17554998]
 [-2.23688389]
 [-0.38871873]]
Final hidden biases: [[ 0.64292158 -0.64032751 -1.46787821
0.73162679]]
Final output biases: [[-0.31797082]]
```

```
#22. Write a program to read a text file with at least 30 sentences
and 200 words and perform the following tasks in the given sequence.
#a. Text cleaning by removing punctuation/special characters, numbers
and extra white spaces. Use regular expression for the same.
#b. Convert text to lowercase
#c. Tokenization
#d. Remove stop words
#e. Correct misspelled words
import re
import nltk
from nltk.corpus import stopwords
from textblob import TextBlob
```

```python
# Download necessary NLTK data
nltk.download('punkt')
nltk.download('stopwords')
nltk.download('punkt_tab') # Download the punkt_tab resource

# Step 1: Read the file
with open('sample_text.txt', 'r') as file:
    text = file.read()

# Step 2: Text Cleaning - Remove punctuation, special characters,
numbers, extra spaces
text = re.sub(r'[^a-zA-Z\s]', '', text)  # Keep only letters and
spaces
text = re.sub(r'\s+', ' ', text).strip()  # Replace multiple spaces
with single space

# Step 3: Convert to lowercase
text = text.lower()

# Step 4: Tokenization
tokens = nltk.word_tokenize(text)

# Step 5: Remove stopwords
stop_words = set(stopwords.words('english'))
filtered_tokens = [word for word in tokens if word not in stop_words]

# Step 6: Correct misspelled words
corrected_tokens = []
for word in filtered_tokens:
    blob = TextBlob(word)
    corrected_word = str(blob.correct())
    corrected_tokens.append(corrected_word)

# Final output
print("Cleaned and Processed Tokens:\n")
print(corrected_tokens)
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
[nltk_data] Downloading package punkt_tab to /root/nltk_data...
[nltk_data]   Unzipping tokenizers/punkt_tab.zip.

Cleaned and Processed Tokens:

['upon', 'time', 'village', 'far', 'away', 'lived', 'curious',
'young', 'boy', 'every', 'morning', 'would', 'wander', 'woods',
'looking', 'adventure', 'birds', 'chirped', 'melodious', 'air',
'smelled', 'fresh', 'sweet', 'one', 'day', 'found', 'old', 'dusty',
```

```
'map', 'buried', 'beneath', 'tree', 'map', 'promised', 'treasures',
'beyond', 'imagination', 'eagerly', 'shared', 'discovery', 'friends',
'together', 'decided', 'follow', 'map', 'journey', 'easy', 'rivers',
'crossed', 'hills', 'climbed', 'sometimes', 'got', 'lost', 'retract',
'steps', 'one', 'afternoon', 'started', 'raining', 'heavily',
'soaked', 'tired', 'sought', 'shelter', 'large', 'oak', 'tree', 'old',
'man', 'approached', 'warned', 'dangers', 'lay', 'ahead', 'however',
'spirit', 'unbreakable', 'thanked', 'continued', 'dawn', 'stumbled',
'upon', 'hidden', 'cave', 'inside', 'found', 'ancient', 'artifacts',
'glittering', 'jewels', 'joy', 'knew', 'bounds', 'realized', 'real',
'treasure', 'adventure', 'friendships', 'grown', 'stronger', 'years',
'later', 'still', 'spoke', 'adventure', 'fond', 'memories', 'lessons',
'learned', 'stayed', 'forever', 'trust', 'courage', 'perseverance',
'true', 'rewards', 'end', 'village', 'celebrated', 'bravery', 'grand',
'feast', 'songs', 'sung', 'tales', 'told', 'child', 'dreamed',
'future', 'adventures', 'time', 'passed', 'story', 'brave',
'children', 'remained', 'fetched', 'villages', 'history', 'told',
'around', 'fires', 'inspiring', 'many', 'generations', 'courage',
'kindness', 'curiosity', 'values', 'passed']
```

```python
#23. Write a program to read a text file with at least 30 sentences
and 200 words and perform the following tasks in the given sequence.
#a. Text cleaning by removing punctuation/special characters, numbers
and extra white spaces. Use regular expression for the same.
#b. Convert text to lowercase
#c. Stemming and Lemmatization
#d. Create a list of 3 consecutive words after lemmatization
import re
import nltk
from nltk.stem import PorterStemmer, WordNetLemmatizer
from nltk.corpus import stopwords

# Download necessary NLTK data
nltk.download('punkt')
nltk.download('wordnet')
nltk.download('omw-1.4')  # WordNet corpus for lemmatizer
nltk.download('stopwords')

# Step 1: Read the file
with open('sample_text.txt', 'r') as file:
    text = file.read()

# Step 2: Text Cleaning
text = re.sub(r'[^a-zA-Z\s]', '', text)  # Keep only letters and
spaces
text = re.sub(r'\s+', ' ', text).strip()  # Remove extra white spaces

# Step 3: Convert to lowercase
text = text.lower()
```

```
# Step 4: Tokenization
tokens = nltk.word_tokenize(text)

# Step 5: Stemming
stemmer = PorterStemmer()
stemmed_tokens = [stemmer.stem(word) for word in tokens]

# Step 6: Lemmatization
lemmatizer = WordNetLemmatizer()
lemmatized_tokens = [lemmatizer.lemmatize(word) for word in
stemmed_tokens]

# Step 7: Create list of 3 consecutive words (triplets)
triplets = []
for i in range(len(lemmatized_tokens) - 2):
    triplet = (lemmatized_tokens[i], lemmatized_tokens[i+1],
lemmatized_tokens[i+2])
    triplets.append(triplet)

# Final Output
print("Sample of triplets:\n")
for t in triplets[:10]:  # Print first 10 triplets as a sample
    print(t)
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
[nltk_data] Downloading package wordnet to /root/nltk_data...
[nltk_data] Downloading package omw-1.4 to /root/nltk_data...
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!

Sample of triplets:

('onc', 'upon', 'a')
('upon', 'a', 'time')
('a', 'time', 'in')
('time', 'in', 'a')
('in', 'a', 'villag')
('a', 'villag', 'far')
('villag', 'far', 'away')
('far', 'away', 'live')
('away', 'live', 'a')
('live', 'a', 'curiou')
```

```
#24.Write a program to read a 3 text files on any technical concept
with at least 20 sentences and 150 words. Implement one-hot encoding.
import re
from sklearn.preprocessing import MultiLabelBinarizer

# Step 1: Read the files
file_paths = ['machine_learning.txt', 'cloud_computing.txt',
```

```
'blockchain.txt']
documents = []

for path in file_paths:
    with open(path, 'r') as file:
        text = file.read()
        text = re.sub(r'[^a-zA-Z\s]', '', text)  # Remove
punctuations/special chars
        text = text.lower()
        documents.append(text)

# Step 2: Tokenize each document into words
tokenized_docs = [doc.split() for doc in documents]

# Step 3: Create vocabulary (all unique words)
vocabulary = sorted(set(word for doc in tokenized_docs for word in
doc))

print("Vocabulary size:", len(vocabulary))

# Step 4: One-hot encode using MultiLabelBinarizer
mlb = MultiLabelBinarizer(classes=vocabulary)
one_hot_encoded = mlb.fit_transform(tokenized_docs)

# Step 5: Display one-hot encoded vectors
for idx, vec in enumerate(one_hot_encoded):
    print(f"\nOne-Hot Encoding for Document {idx+1}:")
    print(vec)
```

```
Vocabulary size: 284

One-Hot Encoding for Document 1:
[1 0 1 1 1 0 0 1 0 0 1 1 1 0 1 0 1 1 1 1 0 0 0 1 1 0 1 0 0 0 0 0 0 0 0
1 0
 0 0 1 1 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 1 1 0 0 0 1 0 1 0 1 1 0 1 1
1 0
 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 1 1 0 0 0 1 1 0 1 1 1 0 0 0 1 0 1
1 1
 0 0 1 0 0 1 0 0 0 0 0 1 0 0 0 1 0 1 1 0 1 0 0 0 1 0 0 1 1 1 1 1 1 0 1
1 0
 1 1 0 1 1 0 0 1 1 0 0 0 0 1 0 0 1 1 0 1 1 0 0 1 1 0 0 1 1 1 0 0 0 0 0
0 0
 1 0 0 0 1 0 0 1 1 1 1 0 0 0 0 1 0 0 0 0 1 0 0 0 1 1 1 0 0 0 0 0 1 0 0
0 0
 0 0 0 0 0 0 1 0 0 0 0 1 0 1 0 0 0 1 0 0 1 1 1 0 1 1 1 0 1 1 0 1 0 0 1
0 0
 0 1 0 1 0 0 1 1 1 0 0 1 0 0 1 0 0 1 0 1 1 1 1 0 0]

One-Hot Encoding for Document 2:
[1 1 0 0 0 1 0 0 1 1 0 0 1 0 0 1 1 0 0 0 0 1 1 1 0 1 0 0 0 0 0 0 0 0 1
```

```
1 0
 1 0 0 0 1 1 0 1 0 1 1 0 0 0 1 0 0 1 1 0 0 0 1 0 0 0 1 1 0 0 0 0 1 0 0
0 0
 1 0 1 0 1 1 1 0 1 1 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
0 0
 1 0 0 0 0 0 1 0 1 0 1 0 0 1 1 0 0 0 0 0 1 0 0 0 0 1 1 0 1 0 1 0 0 1 0
0 0
 0 1 0 1 1 1 1 0 1 0 0 1 0 0 1 0 0 1 0 0 1 1 0 0 0 0 0 0 1 1 1 0 1 1 1
1 1
 0 1 1 1 0 1 1 0 0 0 0 0 1 1 1 0 0 1 1 1 0 1 0 1 0 0 0 0 0 1 0 0 0 0 1
1 1
 1 1 1 0 0 1 0 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 0 0 0 0 0 1 0 0 1 0 0 1 1
0 0
 1 0 0 0 1 1 0 0 0 1 0 1 1 0 0 1 1 0 1 1 0 0 0 0 1]

One-Hot Encoding for Document 3:
[1 0 0 1 0 0 1 0 0 0 0 0 1 1 1 0 1 0 0 0 1 0 0 0 0 0 0 1 1 1 1 1 1 1 0
0 1
 0 1 1 0 0 0 1 0 1 0 0 1 1 1 1 1 1 0 0 1 1 0 0 1 1 1 1 0 0 1 0 0 0 0 0
1 1
 0 1 0 1 0 0 0 1 0 0 1 0 0 1 0 1 1 1 0 0 1 1 1 0 0 1 0 0 0 1 1 0 0 1 0
0 0
 0 1 0 1 1 0 0 1 0 1 0 0 1 0 0 0 1 1 0 1 0 1 1 1 0 0 0 0 1 0 1 0 0 0 0
0 1
 0 1 1 0 0 0 1 0 0 1 1 0 1 0 0 1 0 0 1 0 0 0 1 0 0 1 1 0 1 1 0 1 0 0 0
0 0
 0 0 0 0 0 0 1 1 0 0 0 1 0 0 1 0 1 0 0 1 0 0 1 0 0 0 0 1 1 0 1 1 0 1 0
0 0
 0 1 0 1 1 1 0 1 0 0 0 0 0 0 0 1 1 0 1 0 0 0 0 1 0 0 0 1 0 0 1 0 1 0 1
1 1
 0 0 1 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 1 0]

#25. Write a program to read a 3 text files on a movie review with at
least 20 sentences and 150 words. Implement bag of words.
from sklearn.feature_extraction.text import CountVectorizer
import re

# Step 1: Read the files
file_paths = ['machine_learning.txt', 'blockchain.txt',
'cloud_computing.txt']
documents = []

for path in file_paths:
    with open(path, 'r') as file:
        text = file.read()
        # Basic cleaning
        text = re.sub(r'[^a-zA-Z\s]', '', text)  # Remove punctuation
and numbers
        text = text.lower()
        documents.append(text)
```

```
# Step 2: Create Bag of Words Model
vectorizer = CountVectorizer()
X = vectorizer.fit_transform(documents)

# Step 3: Display
print("Vocabulary:")
print(vectorizer.get_feature_names_out())

print("\nBag of Words Matrix (Each row = Document, Each column = Word
frequency):")
print(X.toarray())

Vocabulary:
['access' 'accuracy' 'across' 'address' 'advantages' 'agreements'
 'algorithms' 'allows' 'amazon' 'among' 'analyze' 'and' 'application'
 'applications' 'architectures' 'are' 'artificial' 'as' 'assess'
 'automatic' 'availability' 'azure' 'based' 'becomes' 'behind' 'being'
 'beyond' 'bitcoin' 'block' 'blockchain' 'blockchains' 'blocks'
'built'
 'businesses' 'can' 'cases' 'categorized' 'chain' 'challenges'
'cleaning'
 'cloud' 'clouds' 'composed' 'compute' 'computers' 'computing'
'concerns'
 'consensus' 'consumption' 'containing' 'continues' 'contracts'
'corda'
 'core' 'cost' 'costs' 'creating' 'crossvalidation' 'crucial'
 'cryptocurrencies' 'cryptographic' 'dapps' 'data' 'databases' 'deals'
 'decentralized' 'decision' 'deep' 'demand' 'detection' 'developers'
 'developing' 'different' 'disaster' 'distributed' 'down' 'each' 'ec'
 'economical' 'edge' 'efficiency' 'eliminates' 'emerging' 'enable'
 'enables' 'encryption' 'energy' 'engineering' 'ensures'
'enterprisegrade'
 'ethereum' 'evaluation' 'even' 'evolve' 'examples' 'execution'
 'experience' 'explicitly' 'exploring' 'feature' 'feedback' 'field'
 'finance' 'first' 'flexibility' 'focuses' 'for' 'fraud' 'from'
'fscore'
 'google' 'governments' 'grow' 'hashes' 'healthcare' 'help' 'high'
 'however' 'hybrid' 'hyperledger' 'iaas' 'image' 'immutability'
 'implement' 'important' 'improve' 'improves' 'in' 'include'
'increases'
 'industries' 'innovations' 'institutions' 'integrity' 'intelligence'
 'internet' 'into' 'involves' 'is' 'issues' 'it' 'labeled' 'layers'
 'leading' 'learn' 'learning' 'ledger' 'libraries' 'like' 'linked'
 'machine' 'machines' 'main' 'maintain' 'major' 'make' 'management'
'many'
 'measures' 'mechanisms' 'metrics' 'microsoft' 'mining' 'model'
'models'
 'modern' 'more' 'multiple' 'need' 'network' 'networks' 'neural' 'new'
 'nfts' 'normalizing' 'of' 'on' 'ondemand' 'one' 'optimization' 'or'
```

```
 'organizations' 'other' 'over' 'overfitting' 'own' 'paas'
'payasyougo'
 'performance' 'physical' 'platform' 'popular' 'precision'
'predictions'
 'preprocessing' 'previous' 'pricing' 'privacy' 'private' 'programmed'
 'proof' 'providers' 'provides' 'public' 'pytorch' 'quickly' 'rapidly'
 'rds' 'recall' 'recognition' 'recommendation' 'recordkeeping'
'records'
 'recovery' 'reduces' 'refers' 'reinforcement' 'remain' 'resources'
'run'
 'saas' 'scalability' 'scale' 'sectors' 'securely' 'security'
'selection'
 'serve' 'serverless' 'servers' 'services' 'signals' 'significant'
 'significantly' 'single' 'smart' 'solutions' 'specialized' 'stake'
 'storage' 'subset' 'such' 'supervised' 'supply' 'support' 'systems'
 'techniques' 'technology' 'tensorflow' 'that' 'the' 'these' 'this'
 'three' 'to' 'tokenization' 'transactions' 'transform' 'transforming'
 'transparency' 'trees' 'trends' 'types' 'underfitting' 'unlabeled'
 'unsupervised' 'up' 'use' 'used' 'using' 'validating' 'vector'
'virtual'
 'virtualization' 'vital' 'web' 'widely' 'with' 'within' 'without'
'work'
 'worldwide']

Bag of Words Matrix (Each row = Document, Each column = Word
frequency):
[[ 0  1  1  1  0  0  1  0  0  1  1  9  0  1  0  4  1  2  1  0  0  0  1
1
   0  1  0  0  0  0  0  0  0  0  1  0  0  0  1  1  0  0  0  0  0  0  0
0
   0  0  1  0  0  0  0  0  0  1  1  0  0  0  6  0  1  0  1  1  0  1  1
1
   0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  1  0  0  0  1  1  0  0
0
   1  1  0  2  1  1  0  0  0  1  0  1  1  1  0  0  1  0  0  1  0  0  0
0
   0  1  0  0  0  2  0  1  1  0  1  0  0  0  1  0  0  3  4  1  3  1  1
0
   1 10  0  1  2  0  6  1  0  0  1  1  0  0  0  0  1  0  0  2  1  0  1
1
   0  0  2  2  0  0  1  1  2  0  0  0  0  0  0  0  1  0  0  0  2  0  0
1
   1  1  1  0  0  0  0  1  0  0  0  0  1  0  0  0  1  1  1  0  0  0  0
0
   1  0  0  0  0  0  0  0  0  0  1  0  0  0  0  1  0  1  0  0  0  1  0
0
   1  1  1  0  1  2  1  0  1  1  0  1  0  0  3  0  0  0  1  0  1  0  0
1
   1  1  0  0  2  0  0  1  0  0  1  0  1  2  1  1  0  0]
```

```
 [ 0  0  2  0  0  1  0  0  0  0  0 10  1  1  0  3  0  0  0  1  0  0  0
0
   0  0  1  1  1  8  1  2  1  0  0  1  0  1  1  0  0  0  1  0  1  0  0
1
   1  1  1  1  1  0  0  1  1  0  0  1  1  1  1  0  0  2  0  0  0  0  0
1
   1  0  1  0  1  0  0  0  1  0  0  1  0  0  1  0  1  1  1  0  0  1  1
1
   0  0  1  0  0  0  1  1  0  0  2  0  0  0  0  1  0  1  1  0  0  1  0
1
   0  0  1  0  0  0  1  1  0  1  0  1  1  1  0  0  0  0  6  0  1  0  0
0
   0  0  1  0  1  1  0  0  0  1  0  0  1  1  0  1  0  0  1  0  0  1  0
0
   0  1  0  0  1  1  0  6  1  0  1  0  0  0  0  0  0  0  0  0  0  0  1
1
   0  0  0  1  0  0  1  0  2  0  0  1  0  0  1  0  0  0  0  1  1  0  1
1
   0  1  0  0  0  1  0  1  1  1  0  1  0  0  0  0  0  0  0  1  1  0  1
0
   0  0  0  1  0  0  0  3  0  0  4  0  1  0  3  1  2  0  0  1  0  0  0
0
   0  0  0  1  1  1  1  0  0  0  0  0  0  0  0  0  1  0]
 [ 1  0  0  0  1  0  0  1  1  0  0 10  0  0  1  7  0  0  0  0  1  1  1
0
   1  0  0  0  0  0  0  0  0  1  1  0  1  0  0  0 10  1  0  1  0  8  1
0
   0  0  1  0  0  1  1  0  0  0  1  0  0  0  1  1  0  0  0  0  1  0  0
0
   0  1  0  1  0  1  1  1  0  1  1  0  0  1  0  0  1  0  0  0  0  0  0
0
   0  0  0  0  0  0  0  0  1  0  1  0  0  0  1  0  0  0  0  0  1  0  1
0
   1  0  0  1  1  0  0  0  0  0  1  0  0  0  0  1  1  0  2  0  2  0  0
1
   0  0  0  0  3  0  1  1  1  1  0  1  0  0  1  0  0  1  0  0  1  0  0
1
   1  0  0  0  0  0  0  2  2  1  0  1  1  1  1  1  0  1  1  1  0  2  1
0
   0  0  0  0  1  1  1  0  0  2  1  1  0  1  0  1  0  0  0  0  0  1  0
0
   0  0  1  1  1  1  1  0  0  2  0  0  1  1  4  0  1  0  1  0  0  0  0
1
   0  0  0  0  0  0  0  1  0  0  4  0  0  1  4  0  0  1  0  0  0  1  1
0
   0  0  1  0  1  1  0  0  1  1  0  1  1  0  0  0  0  1]]
```

```python
#26. Write a program to read a 3 text files a tourist place with at
least 20 sentences and 150 words. Implement TF-IDF.
from sklearn.feature_extraction.text import TfidfVectorizer
```

```
import re

# Step 1: Read the files
file_paths = ['machine_learning.txt', 'blockchain.txt',
'cloud_computing.txt']
documents = []

for path in file_paths:
    with open(path, 'r') as file:
        text = file.read()
        # Basic cleaning
        text = re.sub(r'[^a-zA-Z\s]', '', text)  # Remove punctuation
and numbers
        text = text.lower()
        documents.append(text)

# Step 2: Create TF-IDF Model
vectorizer = TfidfVectorizer()
X = vectorizer.fit_transform(documents)

# Step 3: Display
print("Vocabulary:")
print(vectorizer.get_feature_names_out())

print("\nTF-IDF Matrix (Each row = Document, Each column = Word
importance):")
print(X.toarray())
```

```
Vocabulary:
['access' 'accuracy' 'across' 'address' 'advantages' 'agreements'
 'algorithms' 'allows' 'amazon' 'among' 'analyze' 'and' 'application'
 'applications' 'architectures' 'are' 'artificial' 'as' 'assess'
 'automatic' 'availability' 'azure' 'based' 'becomes' 'behind' 'being'
 'beyond' 'bitcoin' 'block' 'blockchain' 'blockchains' 'blocks'
'built'
 'businesses' 'can' 'cases' 'categorized' 'chain' 'challenges'
'cleaning'
 'cloud' 'clouds' 'composed' 'compute' 'computers' 'computing'
'concerns'
 'consensus' 'consumption' 'containing' 'continues' 'contracts'
'corda'
 'core' 'cost' 'costs' 'creating' 'crossvalidation' 'crucial'
 'cryptocurrencies' 'cryptographic' 'dapps' 'data' 'databases' 'deals'
 'decentralized' 'decision' 'deep' 'demand' 'detection' 'developers'
 'developing' 'different' 'disaster' 'distributed' 'down' 'each' 'ec'
 'economical' 'edge' 'efficiency' 'eliminates' 'emerging' 'enable'
 'enables' 'encryption' 'energy' 'engineering' 'ensures'
'enterprisegrade'
 'ethereum' 'evaluation' 'even' 'evolve' 'examples' 'execution'
 'experience' 'explicitly' 'exploring' 'feature' 'feedback' 'field'
```

```
 'finance' 'first' 'flexibility' 'focuses' 'for' 'fraud' 'from'
'fscore'
 'google' 'governments' 'grow' 'hashes' 'healthcare' 'help' 'high'
 'however' 'hybrid' 'hyperledger' 'iaas' 'image' 'immutability'
 'implement' 'important' 'improve' 'improves' 'in' 'include'
'increases'
 'industries' 'innovations' 'institutions' 'integrity' 'intelligence'
 'internet' 'into' 'involves' 'is' 'issues' 'it' 'labeled' 'layers'
 'leading' 'learn' 'learning' 'ledger' 'libraries' 'like' 'linked'
 'machine' 'machines' 'main' 'maintain' 'major' 'make' 'management'
'many'
 'measures' 'mechanisms' 'metrics' 'microsoft' 'mining' 'model'
'models'
 'modern' 'more' 'multiple' 'need' 'network' 'networks' 'neural' 'new'
 'nfts' 'normalizing' 'of' 'on' 'ondemand' 'one' 'optimization' 'or'
 'organizations' 'other' 'over' 'overfitting' 'own' 'paas'
'payasyougo'
 'performance' 'physical' 'platform' 'popular' 'precision'
'predictions'
 'preprocessing' 'previous' 'pricing' 'privacy' 'private' 'programmed'
 'proof' 'providers' 'provides' 'public' 'pytorch' 'quickly' 'rapidly'
 'rds' 'recall' 'recognition' 'recommendation' 'recordkeeping'
'records'
 'recovery' 'reduces' 'refers' 'reinforcement' 'remain' 'resources'
'run'
 'saas' 'scalability' 'scale' 'sectors' 'securely' 'security'
'selection'
 'serve' 'serverless' 'servers' 'services' 'signals' 'significant'
 'significantly' 'single' 'smart' 'solutions' 'specialized' 'stake'
 'storage' 'subset' 'such' 'supervised' 'supply' 'support' 'systems'
 'techniques' 'technology' 'tensorflow' 'that' 'the' 'these' 'this'
 'three' 'to' 'tokenization' 'transactions' 'transform' 'transforming'
 'transparency' 'trees' 'trends' 'types' 'underfitting' 'unlabeled'
 'unsupervised' 'up' 'use' 'used' 'using' 'validating' 'vector'
'virtual'
 'virtualization' 'vital' 'web' 'widely' 'with' 'within' 'without'
'work'
 'worldwide']

TF-IDF Matrix (Each row = Document, Each column = Word importance):
[[0.         0.056738   0.04315071 0.056738   0.         0.
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  0.         0.04315071 0.         0.13404151 0.056738   0.113476
  0.056738   0.         0.         0.         0.04315071 0.056738
  0.         0.056738   0.         0.         0.         0.
  0.         0.         0.         0.         0.04315071 0.
  0.         0.         0.04315071 0.056738   0.         0.
  0.         0.         0.         0.         0.         0.
  0.         0.         0.03351038 0.         0.         0.
```

```
 0.         0.         0.         0.056738   0.04315071 0.
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 0.         0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.         0.
 0.056738   0.         0.         0.056738   0.         0.
 0.         0.056738   0.056738   0.         0.         0.
 0.056738   0.056738   0.         0.113476   0.056738   0.056738
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 0.056738   0.056738   0.         0.         0.056738   0.
 0.         0.056738   0.         0.         0.         0.
 0.         0.056738   0.         0.         0.         0.113476
 0.         0.04315071 0.056738   0.         0.04315071 0.
 0.         0.         0.056738   0.         0.         0.170214
 0.13404151 0.056738   0.10053113 0.056738   0.056738   0.
 0.056738   0.56737999 0.         0.056738   0.06702075 0.
 0.25890427 0.04315071 0.         0.         0.056738   0.04315071
 0.         0.         0.         0.         0.056738   0.
 0.         0.113476   0.04315071 0.         0.056738   0.04315071
 0.         0.         0.113476   0.113476   0.         0.
 0.056738   0.03351038 0.06702075 0.         0.         0.
 0.         0.         0.         0.         0.056738   0.
 0.         0.         0.113476   0.         0.         0.04315071
 0.056738   0.056738   0.056738   0.         0.         0.
 0.         0.056738   0.         0.         0.         0.
 0.056738   0.         0.         0.         0.056738   0.056738
 0.056738   0.         0.         0.         0.         0.
 0.056738   0.         0.         0.         0.         0.
 0.         0.         0.         0.         0.056738   0.
 0.         0.         0.         0.056738   0.         0.056738
 0.         0.         0.         0.056738   0.         0.
 0.056738   0.056738   0.056738   0.         0.056738   0.113476
 0.056738   0.         0.056738   0.056738   0.         0.056738
 0.         0.         0.10053113 0.         0.         0.
 0.056738   0.         0.056738   0.         0.         0.056738
 0.056738   0.056738   0.         0.         0.06702075 0.
 0.         0.056738   0.         0.         0.056738   0.
 0.04315071 0.113476   0.056738   0.056738   0.         0.        ]
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 0.06287238 0.12574475 0.06287238 0.         0.         0.06287238
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 0.         0.06287238 0.06287238 0.04781606 0.         0.06287238
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