

## Assignment – 13

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### Task 1:

#### Dijkstra's Shortest Path Finder:

Code Dijkstra's algorithm to find the shortest path from a start node to every other node in a weighted graph with positive weights.

#### Program:

```
import java.util.*;

public class DijkstraAlgorithm {
    private static final int INF = Integer.MAX_VALUE;
    public static void main(String[] args) {
        int[][] graph = {
            { 0, 4, 0, 8, 0},
            { 4, 0, 8, 11, 0},
            { 0, 8, 7, 0, 4},
            { 0, 7, 0, 9, 14},
            { 0, 0, 0, 9, 10}};
        dijkstras(graph, 0);
    }

    public static void dijkstras(int[][] graph, int src) {
        int v = graph.length;
        int[] dij = new int[v];
        boolean[] visited = new boolean[v];
        Arrays.fill(dij, INF);
        dij[src] = 0;
        for (int count = 0; count < v - 1; count++) {
            int u = minDistance(dij, visited);
            visited[u] = true;
            for (int j = 0; j < v; j++) {
                if (!visited[j] && graph[u][j] != 0 &&
                    dij[u] != INF && dij[u] + graph[u][j] <
                    dij[j]) {
                    dij[j] = dij[u] + graph[u][j];
                }
            }
        }
        printResult(dij);
    }

    public static int minDistance(int[] dij, boolean[] visited) {
        int min = INF;
        int minindex = -1;
        for (int v = 0; v < dij.length; v++) {
            if (!visited[v] && dij[v] <= min) {
                min = dij[v];
                minindex = v;
            }
        }
    }
}
```

```

        }
        return minindex;
    }

    public static void printResult(int[] dij) {
        System.out.println("vertex \t distance from source: ");
        for (int i = 0; i < dij.length; i++) {
            System.out.println(i + "\t" + dij[i]);
        }
    }
}

```

### Output:

```

vertex      distance from source:
0          0
1          4
2         12
3          8
4         16

```

## Task 2:

### Kruskal's Algorithm for MST:

Implement Kruskal's algorithm to find the minimum spanning tree of a given connected, undirected graph with non-negative edge weights.

### Program:

```

import java.util.Arrays;
import java.util.LinkedList;

class Edge implements Comparable<Edge>{
    int src,dest, weight;
    public Edge(int src, int dest, int weight) {
        super();
        this.src = src;
        this.dest = dest;
        this.weight = weight;
    }
    @Override
    public int compareTo(Edge e1) {
        return this.weight-e1.weight;
    }
}

public class KruskalsAlgorithm {
    private int vertex;
    private LinkedList<Edge> edges;
    public KruskalsAlgorithm(int v) {
        vertex=v;
        edges=new LinkedList<>();
    }
}

```

```

public void addEdges(int src,int dest,int weight) {
    Edge edge=new Edge(src, dest, weight);
    edges.add(edge);
}

private int find(int[] parent, int i) {
    if(parent[i] != i && parent[i] != -1)
        parent[i]=find(parent, parent[i]);
    return parent[i] == -1 ? i : parent[i];
}

private void union(int[] parent, int x,int y) {
    int xset=find(parent, x);
    int yset=find(parent, x);
    parent[xset]=yset;
}

public void kruskalMST() {
    Edge[] resultEdges=new Edge[vertex];
    int e=0;
    int i=0;
    edges.sort(null);
    int[] parent=new int[vertex];
    Arrays.fill(parent, -1);
    while(e<vertex-1) {
        Edge next=edges.get(i++);
        int x=find(parent, next.src);
        int y=find(parent, next.dest);
        if(x != y) {
            resultEdges[e++]=next;
            union(parent, x, y);
        }
    }
    System.out.println("Minimal Spanning Tree: ");
    int totalWeight=0;
    for(i=0;i<e;i++) {
        System.out.println(resultEdges[i].src+
                           " - "+resultEdges[i].dest+": "
                           +resultEdges[i].weight);
        totalWeight +=resultEdges[i].weight;
    }
    System.out.println("Total weight: "+totalWeight);
}

public static void main(String[] args) {
    int v=4;
    KruskalsAlgorithm graph=new KruskalsAlgorithm(v);
    graph.addEdges(0, 1, 8);
    graph.addEdges(0, 2, 7);
    graph.addEdges(0, 3, 5);
    graph.addEdges(1, 3, 10);
    graph.addEdges(2, 3, 4);
    graph.kruskalMST();
}
}

```

**Output:**

Minimal Spanning Tree:

2 - 3: 4

0 - 3: 5

0 - 2: 7

Total weight: 16

**Task 3:****Union-Find for Cycle Detection:**

Write a Union-Find data structure with path compression. Use this data structure to detect a cycle in an undirected graph.

**Program:**

```
public class UnionFind {
    private int[] parent;
    private int[] rank;
    public UnionFind(int n) {
        parent = new int[n];
        rank = new int[n];
        for (int i = 0; i < n; i++) {
            parent[i] = i;
            rank[i] = 0;
        }
    }

    public int find(int x) {
        if (parent[x] != x) {
            parent[x] = find(parent[x]);
        }
        return parent[x];
    }

    public void union(int x, int y) {
        int rootx = find(x);
        int rooty = find(y);
        if (rootx == rooty)
            return;
        if (rank[rootx] < rank[rooty]) {
            parent[rootx] = rooty;
        } else if (rank[rootx] > rank[rooty]) {
            parent[rooty] = rootx;
        } else {
            parent[rooty] = rootx;
            rank[rooty]++;
        }
    }
}
```

```

public class UnionFindAlgorithm {
    public static boolean hasCycle(int[][] edges,int n) {
        UnionFind uf=new UnionFind(n);
        for(int[] edge:edges) {
            int u=edge[0];
            int v=edge[1];
            int rootu=uf.find(u);
            int rootv=uf.find(v);
            if(rootu == rootv) {
                return true;
            }
            uf.union(rootu, rootv);
        }
        return false;
    }

    public static void main(String[] args) {
        int[][] edges= {
            {0,1},
            {1,2},
            {2,3},
            {3,0}};

        int n=4;
        boolean cycle=hasCycle(edges, n);
        if(cycle) {
            System.out.println("Cycle detected!");
        }
        else {
            System.out.println("Cycle not detected.");
        }
    }
}

```

**Output:**

Cycle detected!