Micro Teaching Presentation
on
Minimum Spanning Tree

By
Dr. Gopal Chandra Jana
Assistant Professor
School of Computer Science Engineering
Date: 17/12/2024

Aim of the Session: Introduction to **Minimum-cost Spanning Tree (MST)** with **undirected connected weighted graph** and **Finding the Minimum-cost Spanning Tree Using Prim's Algorithm**.

Learning Outcomes:

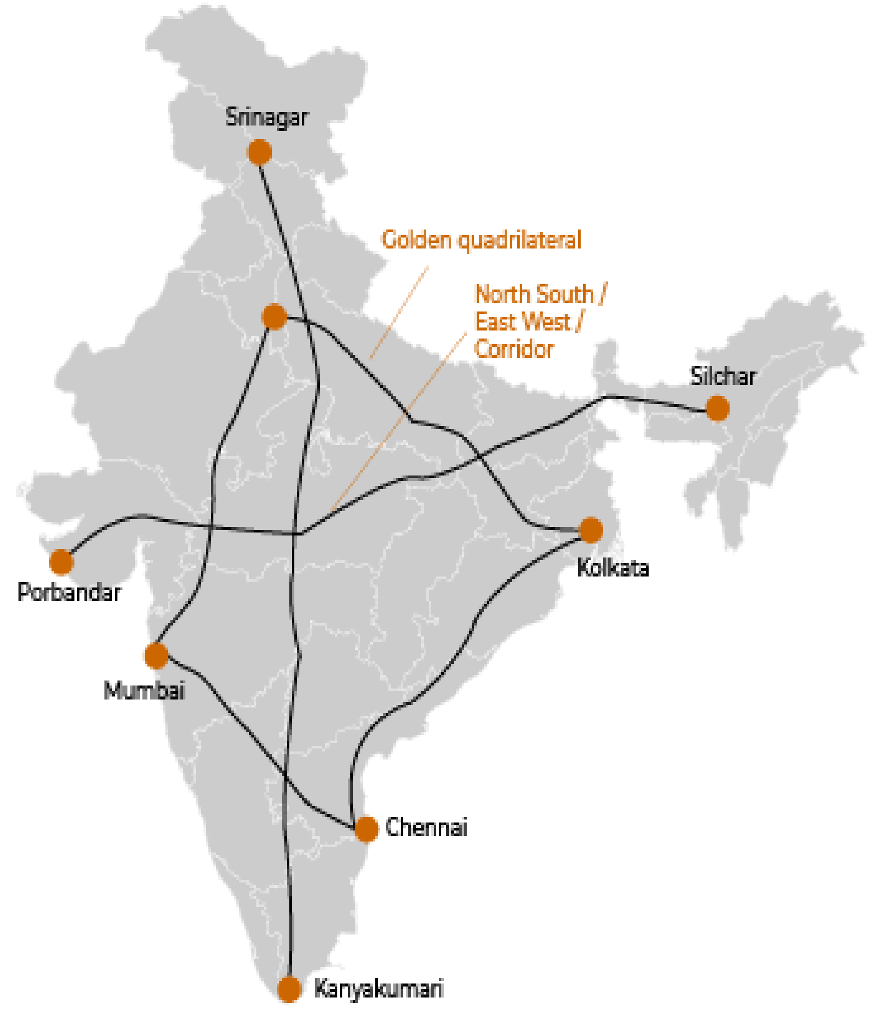
By the end of this lesson, you should be able to:

1. Compute all possible spanning trees and the Minimum Spanning Tree (MST) for a given undirected, connected, and weighted graph.

2. Apply and evaluate Prim's algorithm to find a given graph's Minimum Spanning Tree (MST), optimizing connectivity with minimal cost.

3. Evaluate the relevance of the Minimum Spanning Tree (MST), Prim's algorithm, in solving real-world problems involved in cost-effective design.

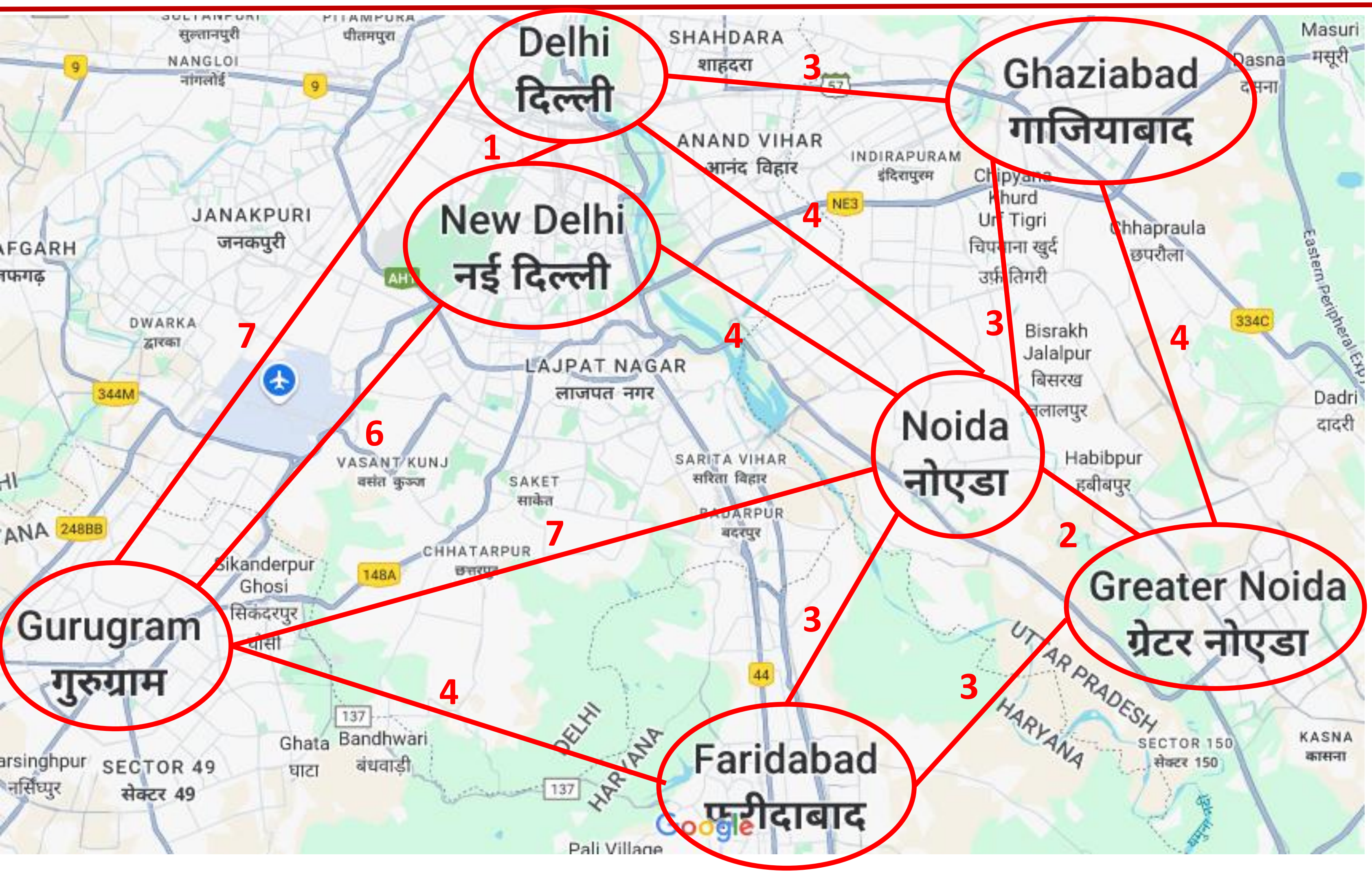
G-SCALE (Galgotias Student-Centered Active Learning Ecosystem)



Faculty Name: Dr. Gopal Chandra Jana

Session on: Minimum Spanning Tree (MST)

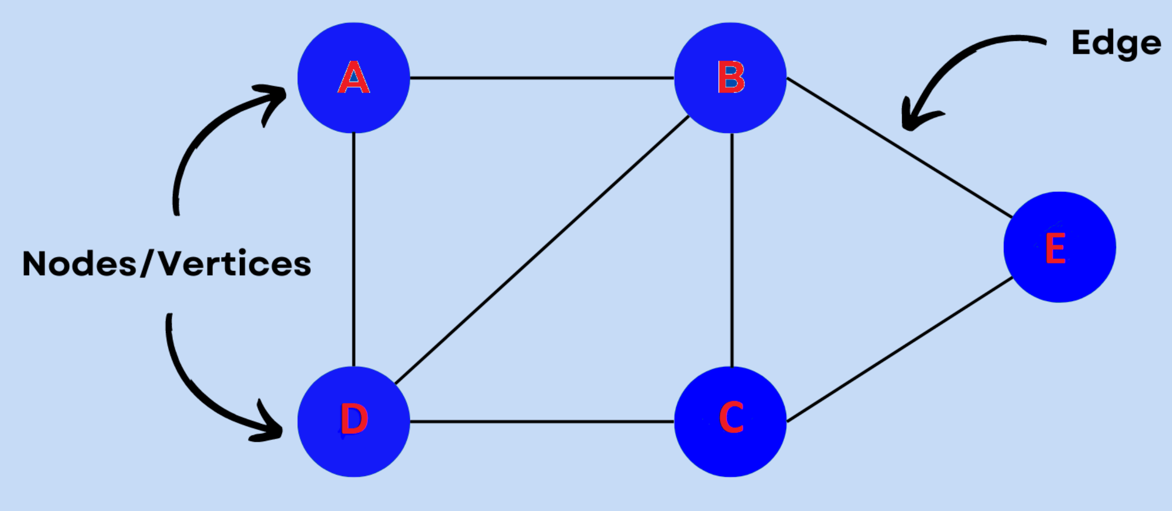

Delhi
दिल्ली
New Delhi
नई दिल्ली
Ghaziabad
गाजियाबाद
Noida
नोएडा
Greater Noida
ग्रेटर नोएडा
Gurugram
गुरुग्राम
Faridabad
फ़रीदाबाद
SHAHDARA
ANAND VIHAR
INDIRAPURAM
JANAKPURI
DWARKA
LAJPAT NAGAR
VASANT KUNJ
SAKET
SARITA VIHAR
BADARPUR
CHHATARPUR
UTTAR PRADESH
HARYANA
SECTOR 150
SECTOR 49
KASNA
Dadri
Masuri
Dasna
Chhapraula
Habibpur
Bisrakh Jalalpur
Sikanderpur Ghosi
Ghata
Bandhwari
Pali Village

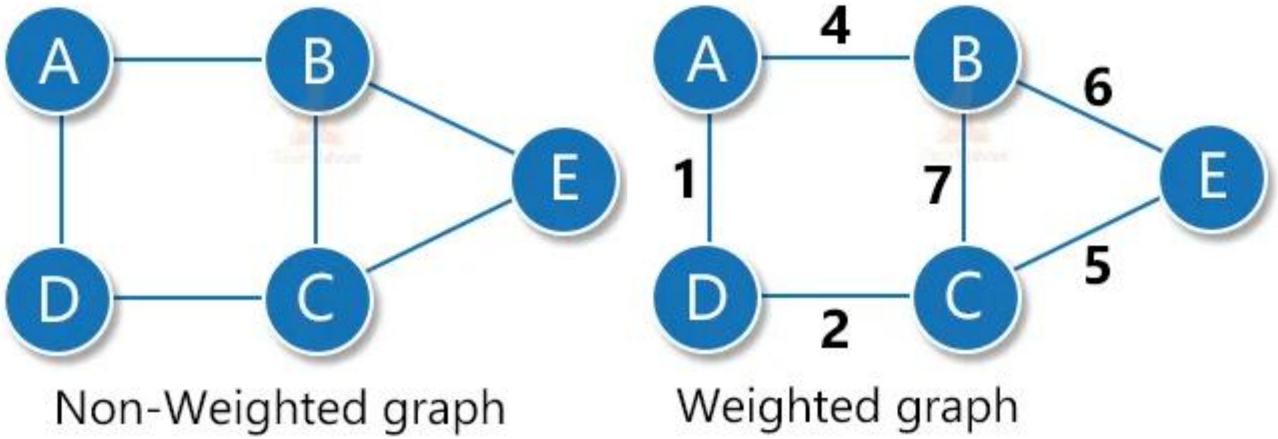


Scenario: Designing a Road Network

Imagine planning a highway system to connect seven major Indian cities. **To minimize construction costs, the goal is to determine the minimum total distance of roads required to connect all cities without creating redundant routes.**

-> Each city is represented as a node.
-> The possible roads between cities are represented as weighted edges, where the weight corresponds to the road length or construction cost.





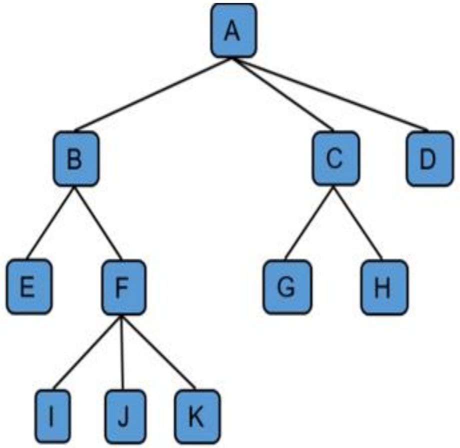
Logical Representation of Graph Data Structure

Graph => G={V, E}

*Can have cycles

Tree => T={Nodes, Edges}

*have no cycles



Logical Representation of Tree Data Structure

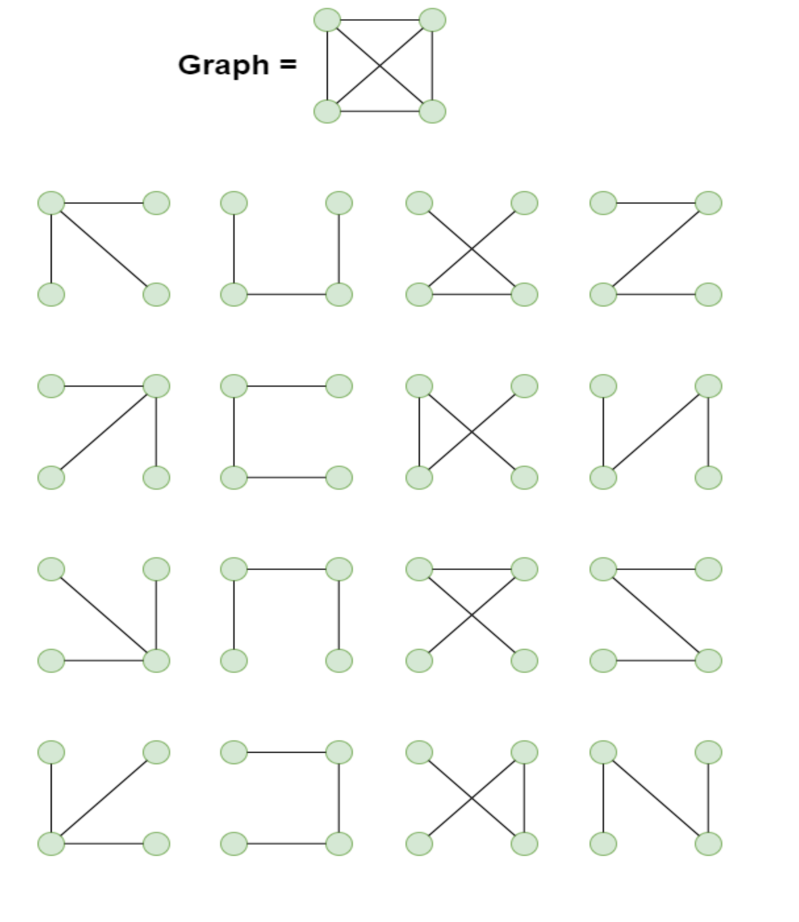
Minimum Cost Spanning Tree (MST)

What is a Spanning Tree?

A spanning tree is a subset of Graph G, such that **all the vertices are connected using the minimum possible number of edges**.

Hence, a spanning tree does not have cycles, and a graph may have more than one spanning tree.

It states that the number of spanning trees in a complete graph with **N vertices** is **N^N-2** .
For example: **N=4**, then maximum number of spanning tree possible = **4^4-2 = 16** (shown in the above image).

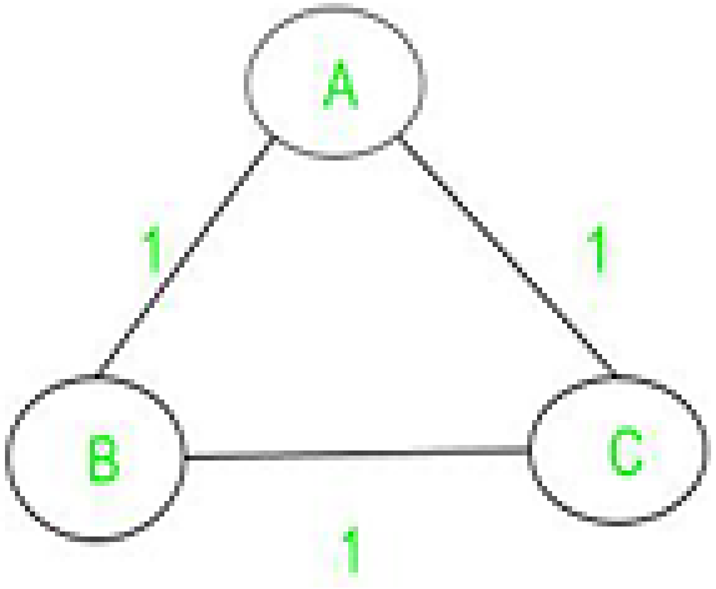


All Possible Spanning Trees of the Graph

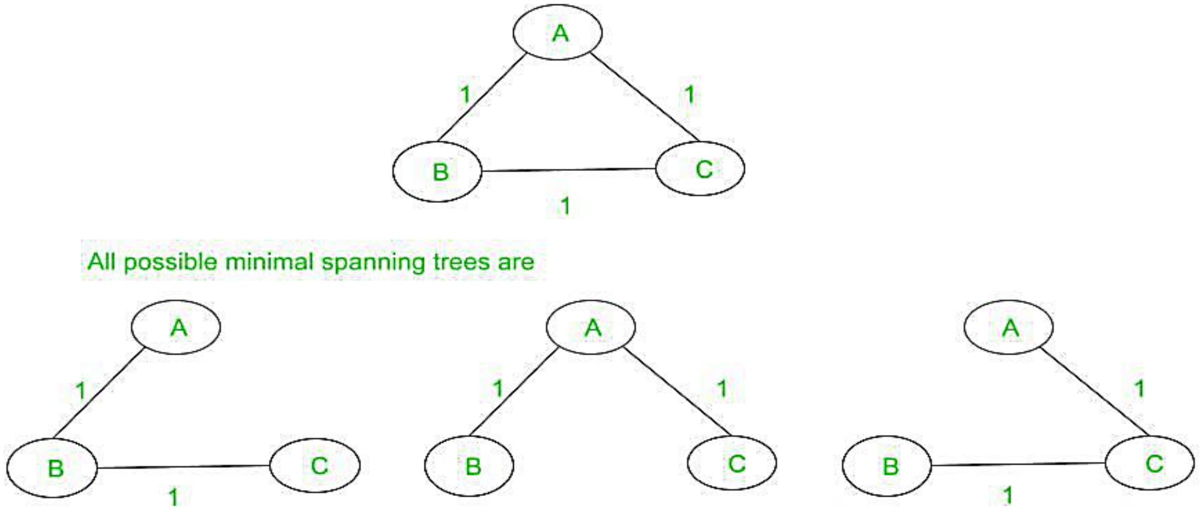
Activity-1: Compute the number of possible spanning trees from the given graph.

1. Go to wooclap.com
2. Enter the event code in the top banner

Event code
NOXTDQ

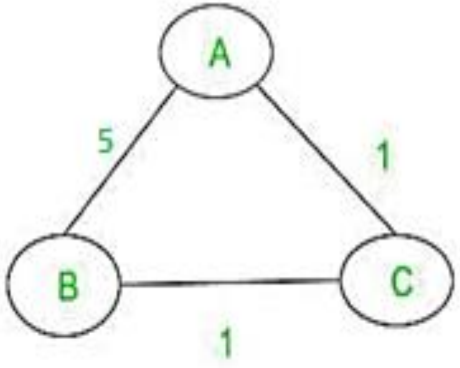


Answer for Activity 1: The number of possible spanning trees is **3**.

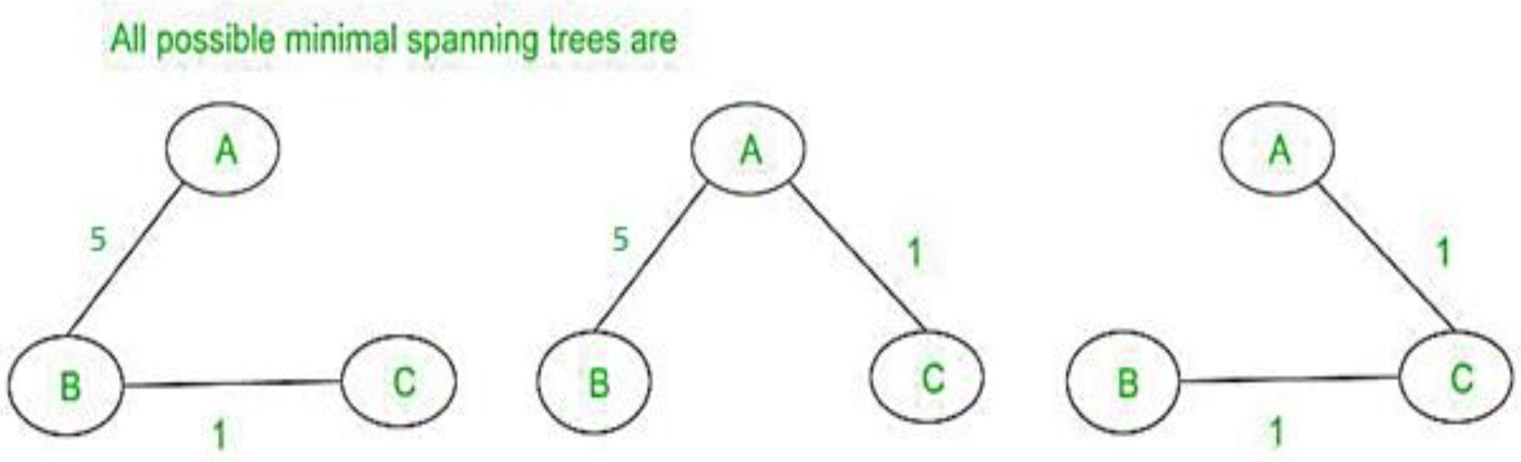


Each of the spanning trees has the same weight equal to 2.

Minimum Cost Spanning Tree (MST)



Considering the edges (A, C) and (C, B), we will have a minimum cost-spanning Tree for the given graph.

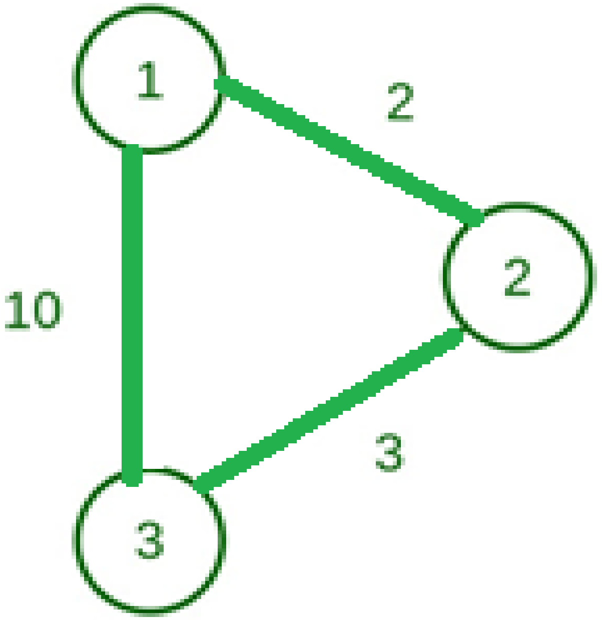


Cost = 6

Cost = 6

Cost = 2

Activity 2: Compute the minimum-cost spanning trees from the given graph.

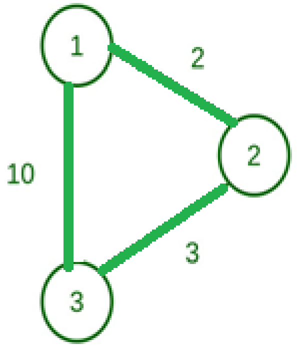


1 Go to wooclap.com

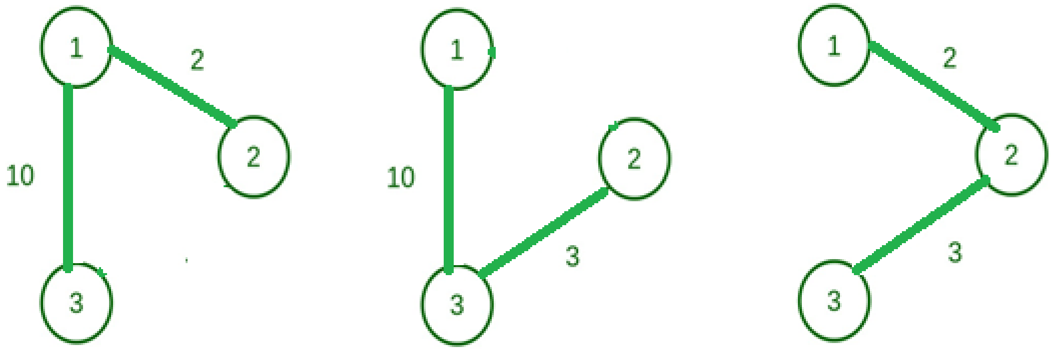
2 Enter the event code in the top banner

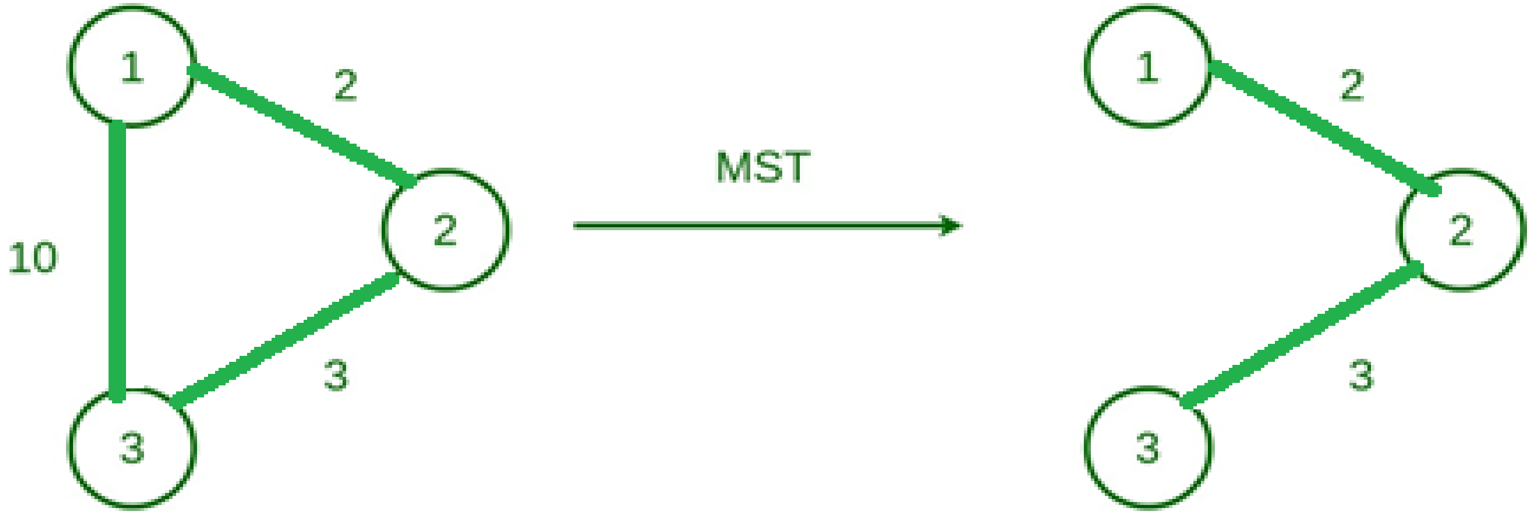
Event code
NOXTDQ

Answer for Activity 2:



Possible Spanning => Trees





What will be the computing approach when the graph size is large (i.e., input data size is large) ?

Prim's Algorithm for Minimum Spanning Tree (MST):

How does Prim's Algorithm Work?

The working of Prim's algorithm can be described by using the following steps:

Step 1: *Determine an arbitrary vertex as the starting vertex of the MST.*

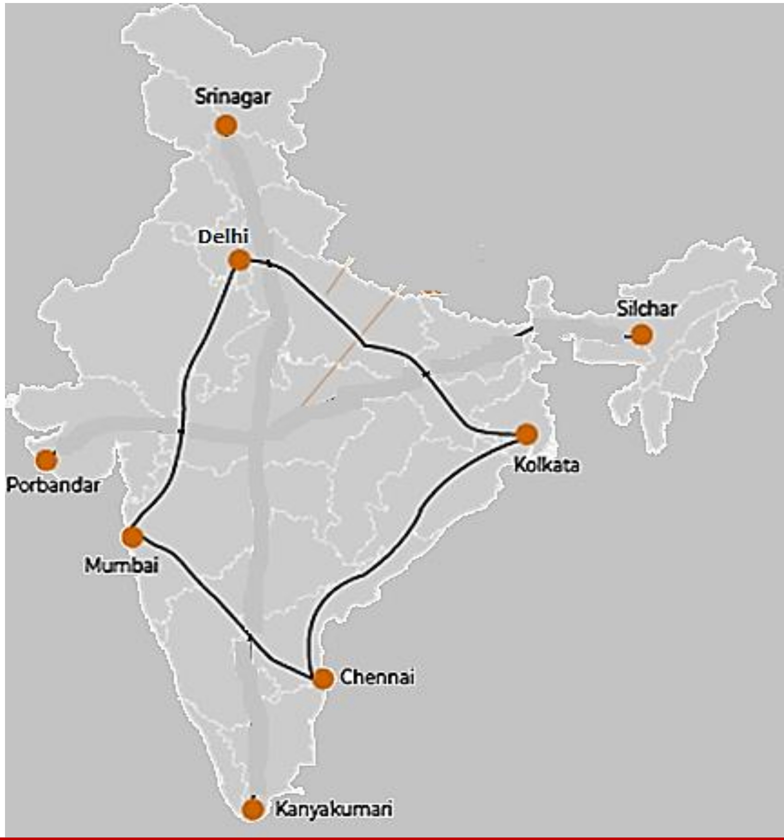
Step 2: *Follow steps 3 to 5 till there are vertices that are not included in the MST (known as fringe vertex).*

Step 3: *Find edges connecting any tree vertex with the fringe vertices.*

Step 4: *Find the minimum among these edges.*

Step 5: *Add the chosen edge to the MST if it does not form any cycle.*

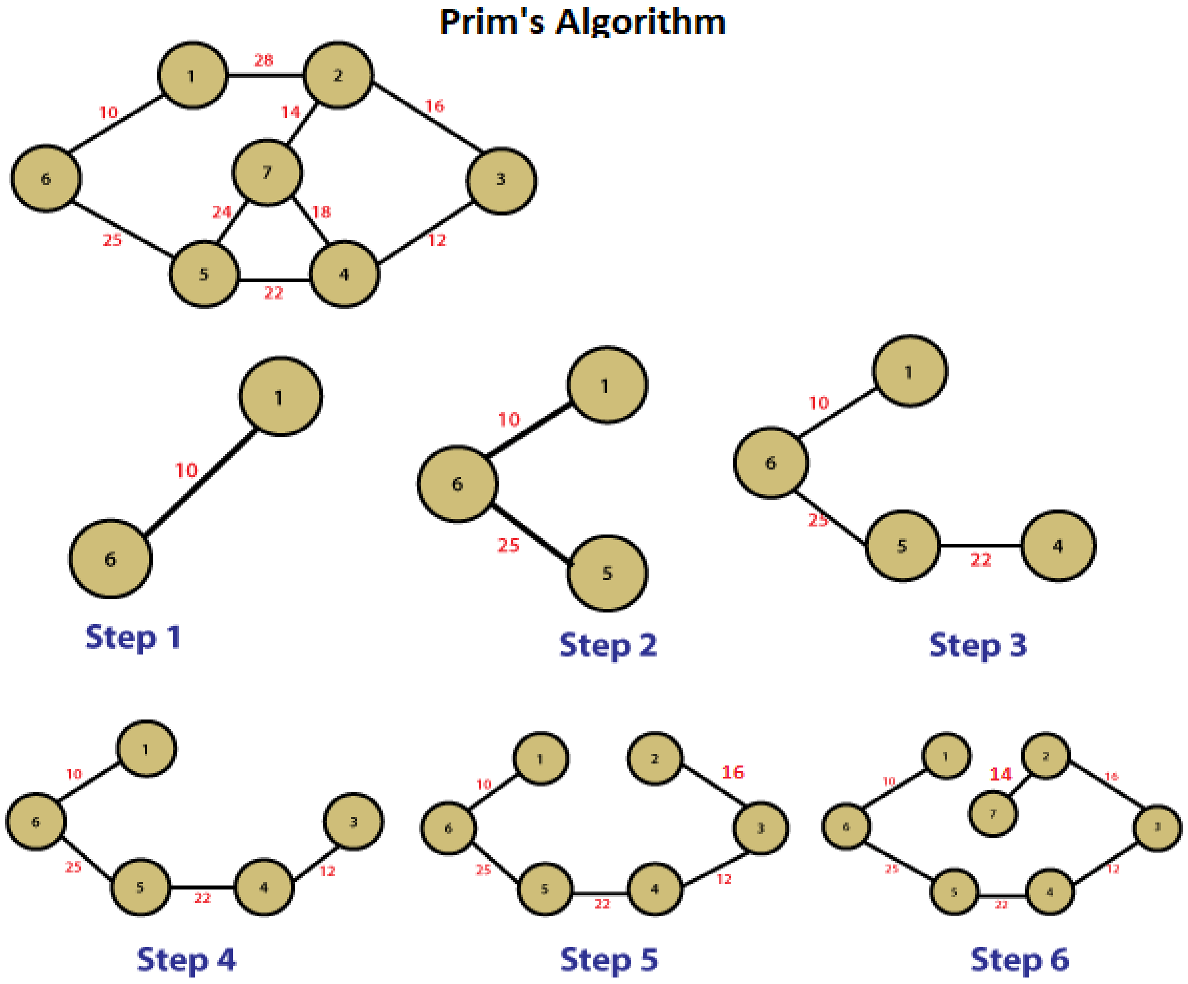
Step 6: *Return the MST and exit*



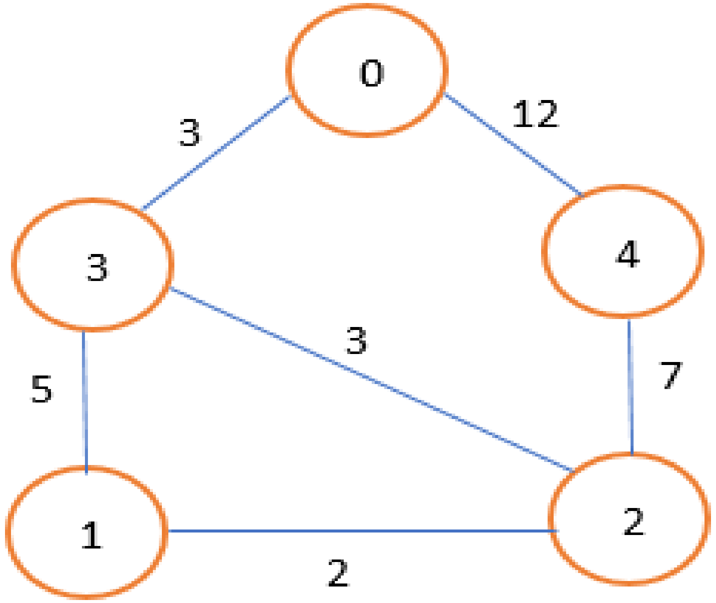
1. Select **Start Vertex**, for eg. 1
2. Find **all edges connected** with the start vertex and remaining vertex.
3. Consider the minimum edge in the MST if it is **not forming a cycle**.

(1,6), (6,5), (5,4), (4,3), (3,2), and (2,7)

total cost= 99



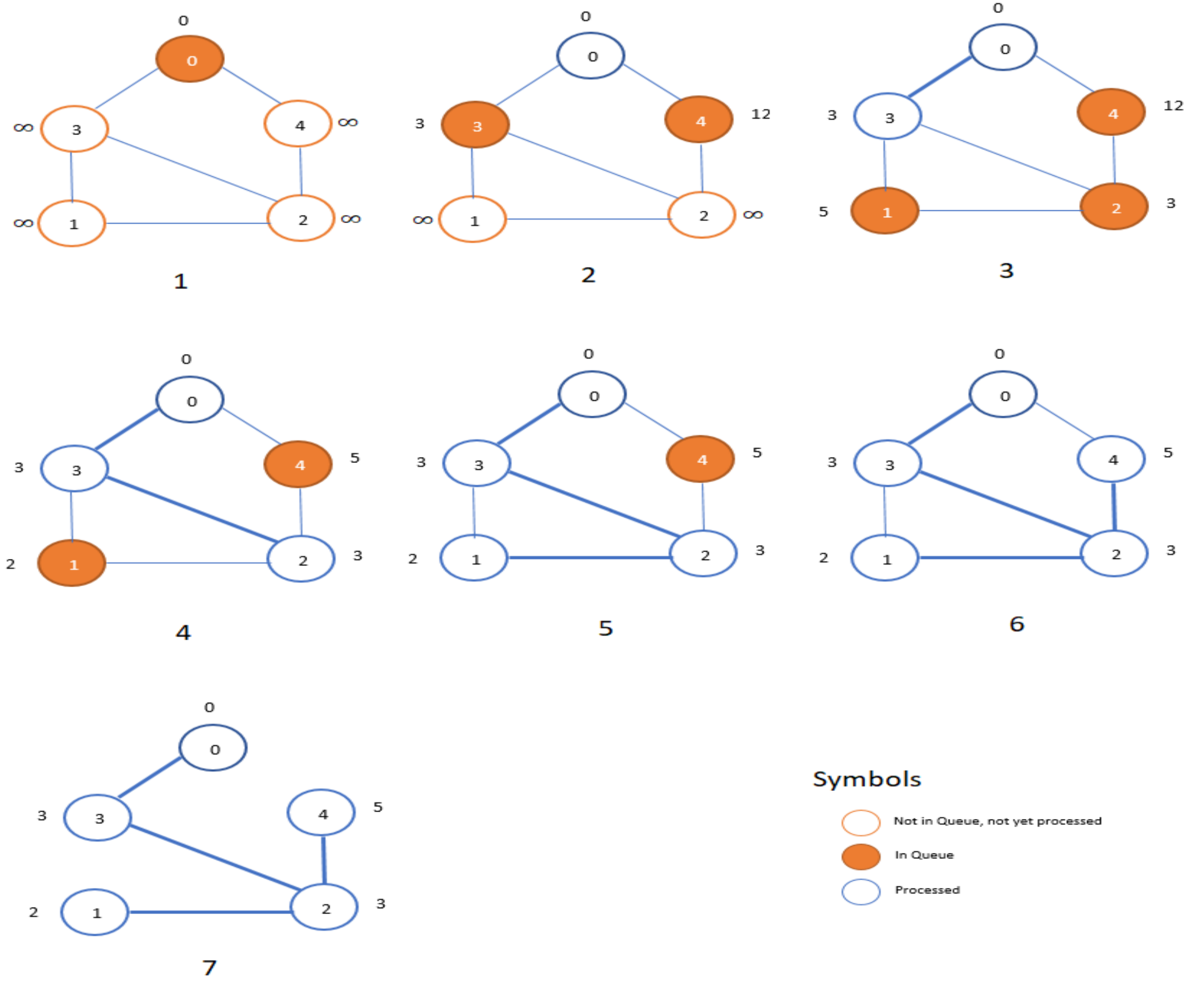
Activity 3: Apply the Prims Algorithm and evaluate the minimum spanning tree (MST) for the given graph.



1. Go to wooclap.com
2. Enter the event code in the top banner

Event code
NOXTDQ

Answer for activity 3:

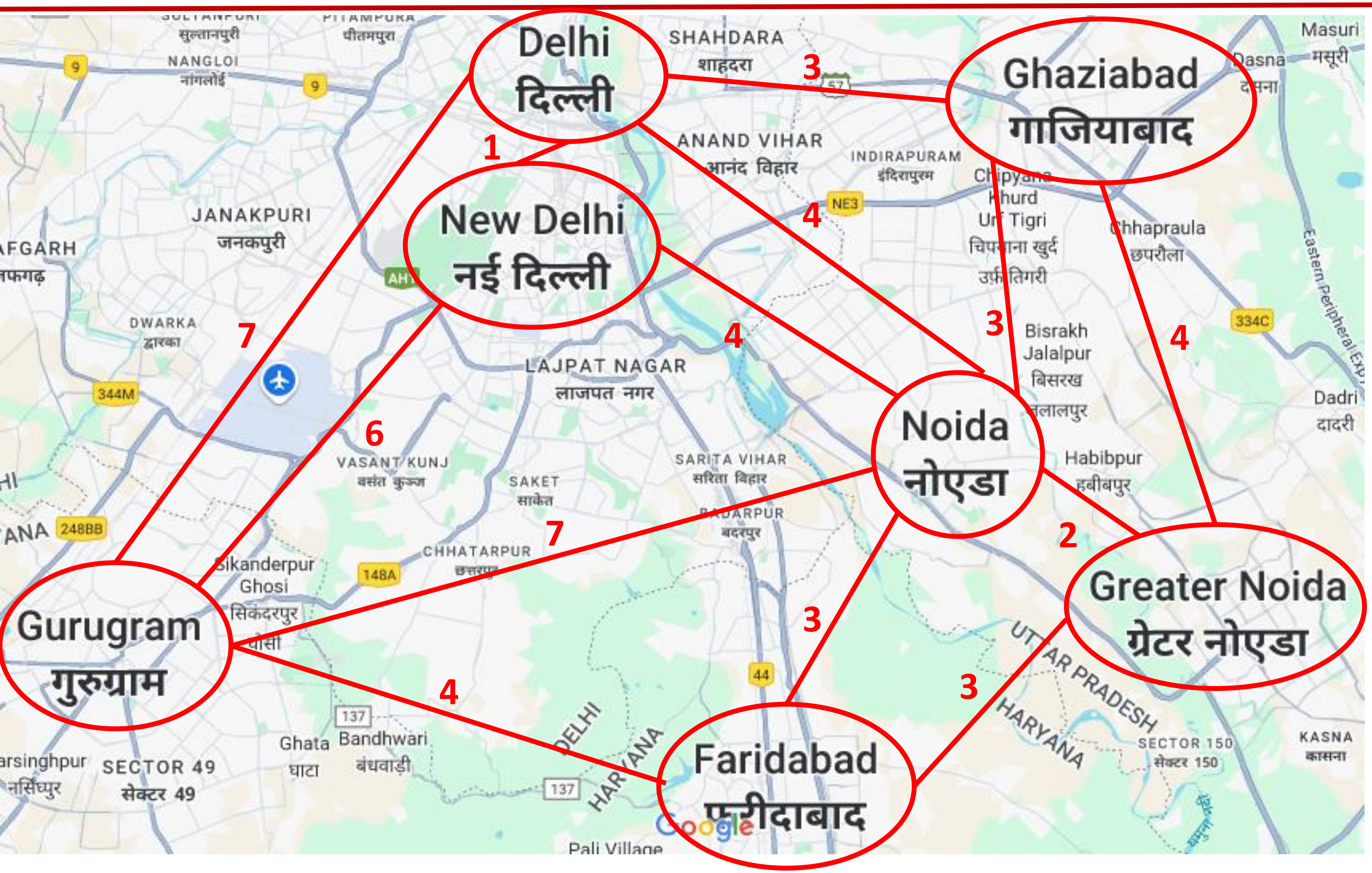


Real-Life Applications of MST:

Road Networks: Planning highways to minimize construction costs.

Telecommunications: Laying out cable networks between cities.

Electrical Grids: Connecting power substations.



Take Home Assignment:

Scenario: Designing a Road Network

Imagine planning a highway system to connect seven major Indian cities. To minimize construction costs, the goal is to determine the minimum total distance of roads required to connect all cities without creating redundant routes.

-> Each city is represented as a node.
-> The possible roads between cities are represented as weighted edges, where the weight corresponds to the road length or construction cost.

Summary of the Session: **We have discussed**

- ✓ About the basics of Graph and Tree data structures
- ✓ About Spanning Tree and its computation in an activity
- ✓ About Minimum Cost Spanning Tree and its computation in an activity
- ✓ Described Prims Algorithm to evaluate the Minimum cost spanning tree and its computation in an activity.

Session Feedback is more valuable to me.

1. Go to wooclap.com
2. Enter the event code in the top banner

Event code
NOXTDQ