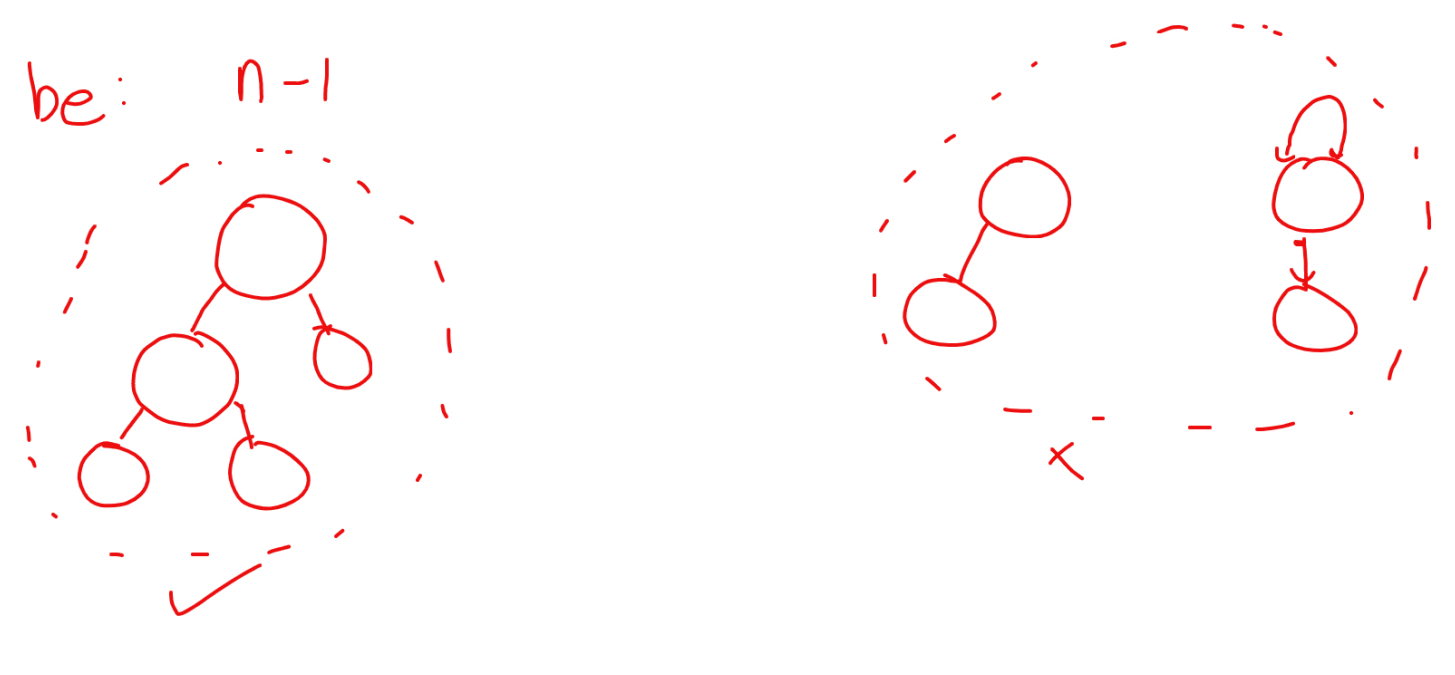
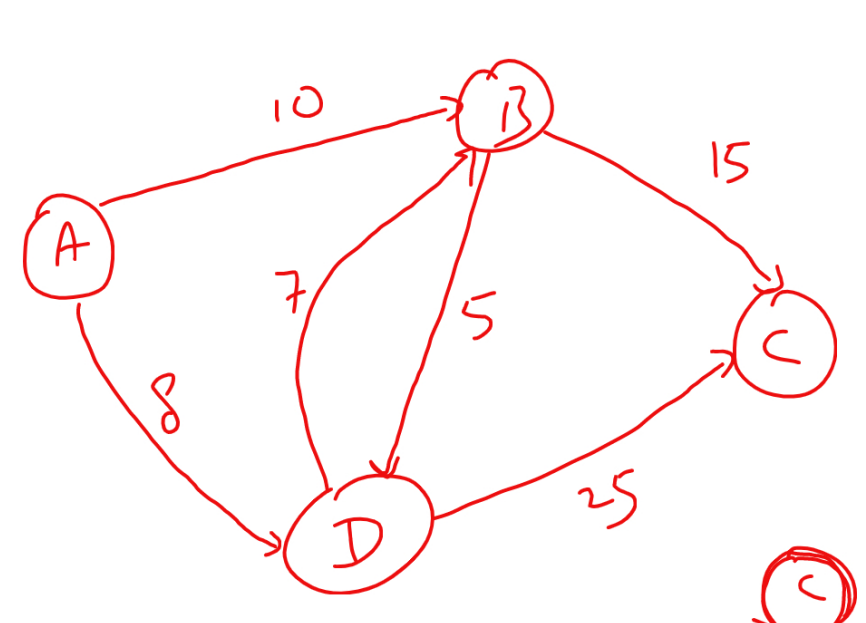
1) $k * \log(k)$
2) $(n-k) * \log(k)$
+
$\underline{n * \log(k)}$

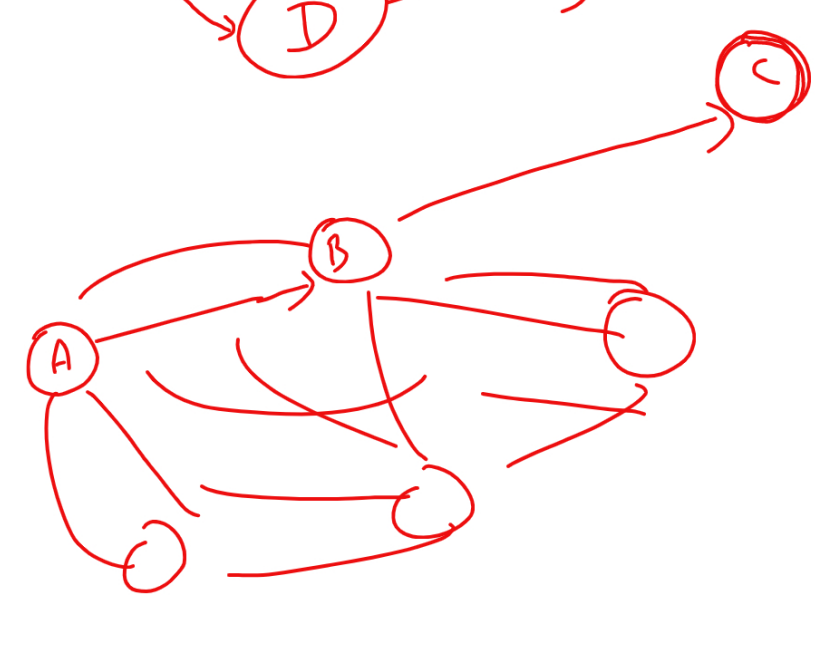
Tree is a graph where all the nodes are connected and also, it does not have a loop.

=> For a tree of size 'n', then the no. of edges will be: n-1





A → B → C : 35
A → D → C : 33
A → D → B → C : 30



---

1) Directed graph: Edge(U → V) != Edge(V → U)
2) Undirected graph: Edge(U → V) == Edge(V → U)

Categorization based upon the direction of edges

1) Weighted graph: Edges have wts. Eg. Google maps
2) Unweighted graph: Edges do not have wts. Eg. social network.

Categorization based upon the wts. of edges

---

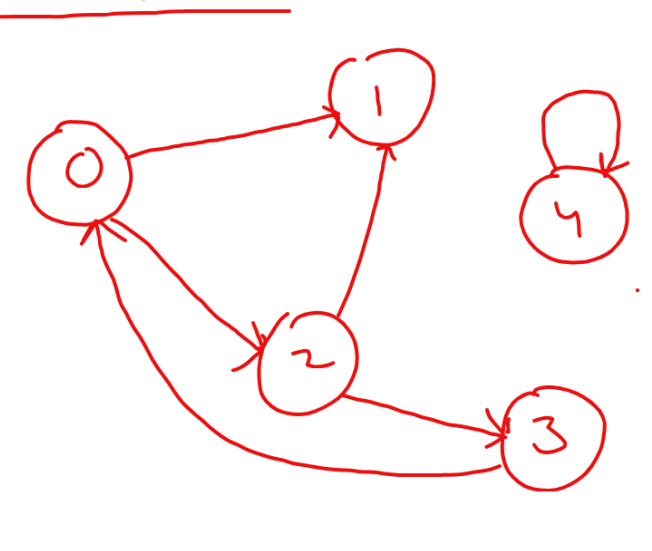
1) Directed + Weighted
2) Directed + Unweighted
3) Undirected + Weighted
4) Undirected + Unweighted

KINDS OF GRAPHS

ADJACENCY MATRIX

space = O(V²)

For directed + unweighted graphs:



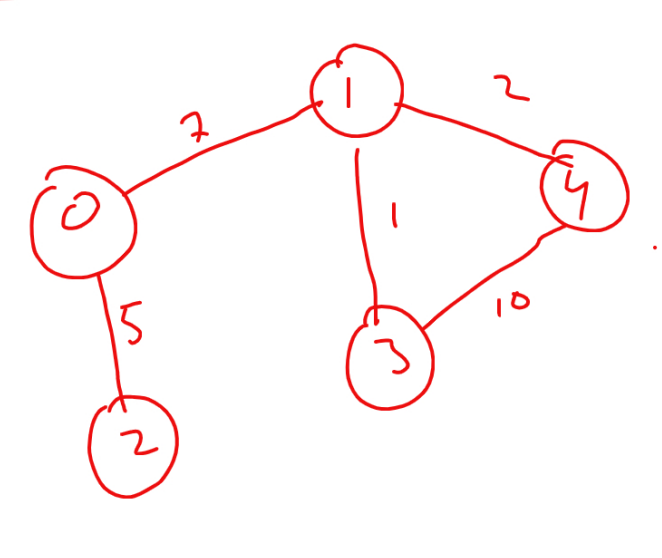
V = 5

adj[][]

$$\begin{array}{c|ccccc} & 0 & 1 & 2 & 3 & 4 \\ \hline 0 & 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 2 & 0 & 1 & 0 & 1 & 0 \\ 3 & 1 & 0 & 0 & 0 & 0 \\ 4 & 0 & 0 & 0 & 0 & 1 \end{array}$$

adj[i][j] = 1 => Edges b/w i to j (i → j)
= 0 => No edge from i to j

For undirected + weighted graphs:



V = 5

$$\begin{array}{c|ccccc} & 0 & 1 & 2 & 3 & 4 \\ \hline 0 & 0 & 7 & 5 & 0 & 0 \\ 1 & 7 & 0 & 0 & 1 & 2 \\ 2 & 5 & 0 & 0 & 0 & 0 \\ 3 & 0 & 1 & 0 & 0 & 10 \\ 4 & 0 & 2 & 0 & 10 & 0 \end{array}$$

adj[i][j] = w => a directed edge from (i → j) with wt = w.
= 0 => no edge from (i → j)

---

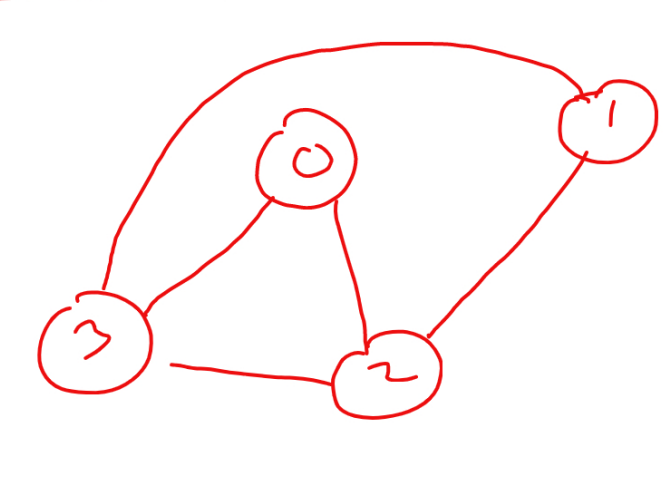
no. of vertices = 10^5 (0, 1 ---, 99999)
no. of edges = 100

$(10^5 \times 10^5) = \underline{10^{10}}$

ADJACENCY LIST

Space = O(V + E)

Undirected + Unweighted

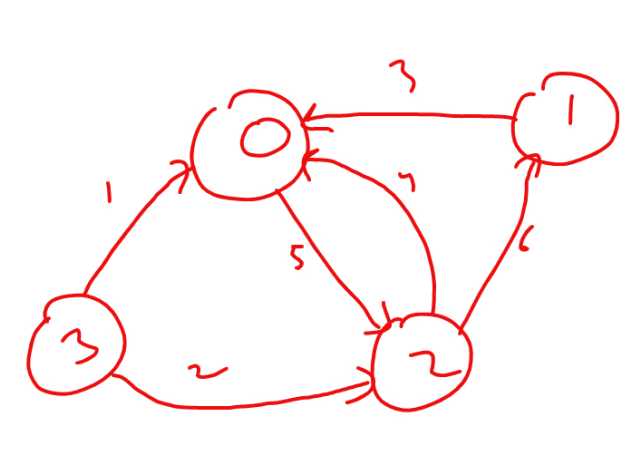


0: 2, 3
1: 2, 3
2: 0, 1, 3
3: 0, 1, 2

V = 4

At index i: we will have a list of values (j) denoting a directed edge (i → j)

Directed + weighted:



0: (2, 5)
1: (0, 3)
2: (0, 1), (1, 6)
3: (0, 1) (2, 2)

V = 4

At index i: we will have a list of pairs {j, w} denoting a directed edge (i → j) with weight = w