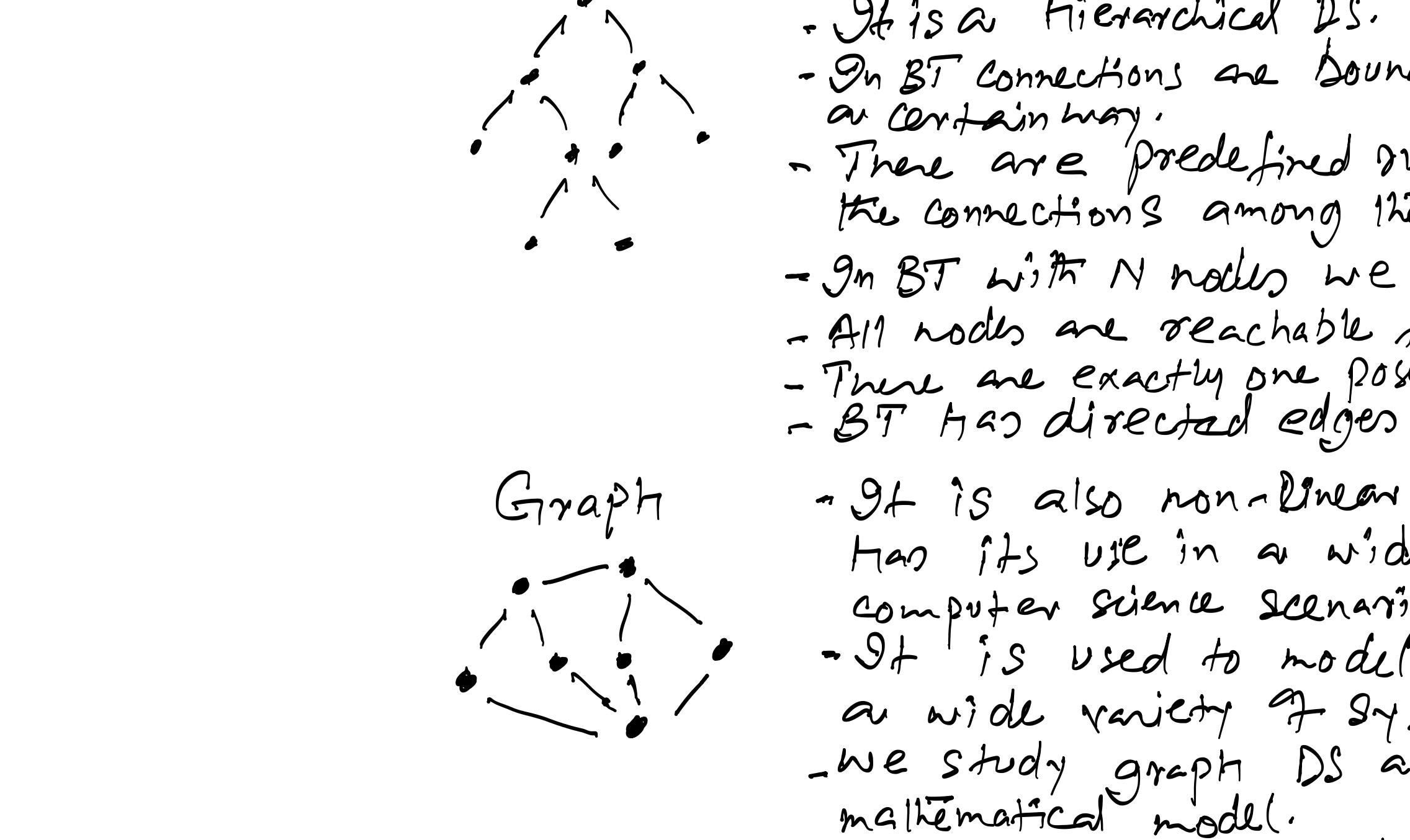
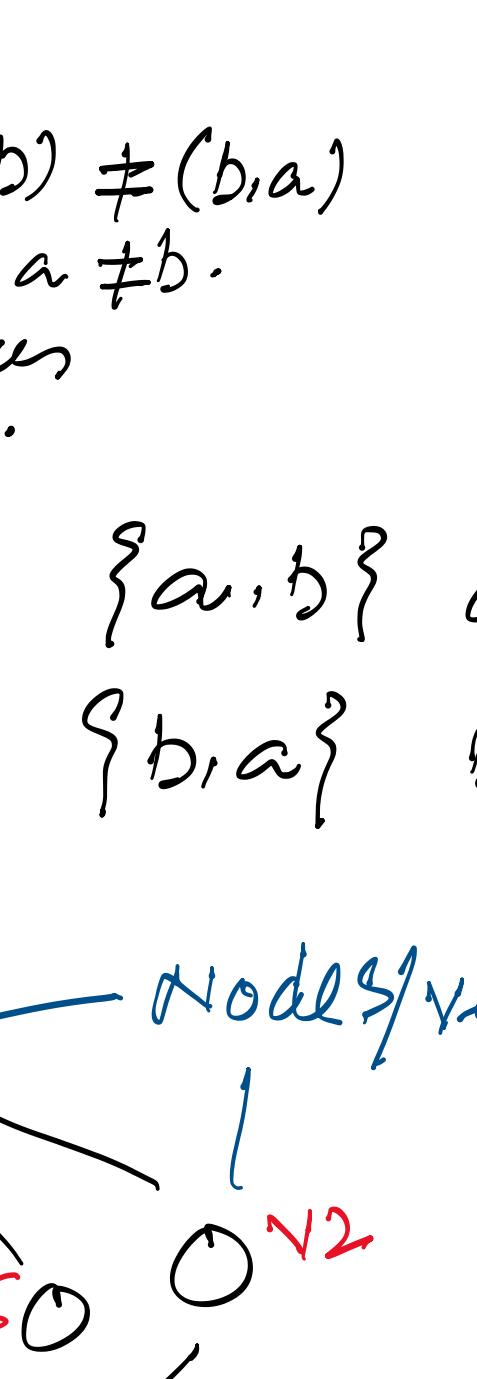


- Data Structures are ways to organise and manage data. There are linear and non-linear DS for different kinds of data.
- Graphs are used to record relationships between things.

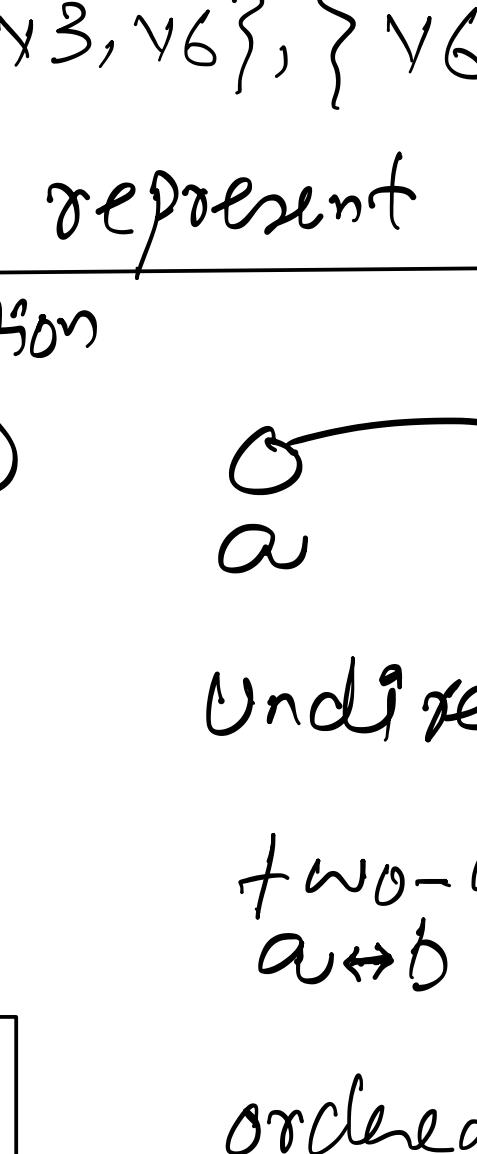


In Linear DS, data is arranged in linear or sequential manner.

Non-Linear DS:



- It is a hierarchical DS.
- In BT connections are bound to be in a certain way.
- There are predefined rules defining the connections among the nodes.
- In BT with N nodes we have $N-1$ edges.
- All nodes are reachable from root node.
- There are exactly one possible path to a node.
- BT has directed edges.



- It is also non-linear DS that has its use in a wide number of computer science scenarios.
- It is used to model and represent a wide variety of systems.
- We study graph DS as logical or mathematical model.
- Later implementation will be discussed.
- There are no rules in graphs for defining connections among the nodes.
- A graph contains a set of nodes and a set of edges and edges can be connecting nodes in any possible way.
- Graph as a concept is studied extensively in mathematics.
- In computer science we study of implement same concept of maths.
- The study of graph is often referred to as "graph theory".

In pure maths terms we define graph as:

"A graph G is an ordered pair $\{V, E\}$ where V is a set N of vertices and E is a set E of edges."

$$G = (V, E)$$

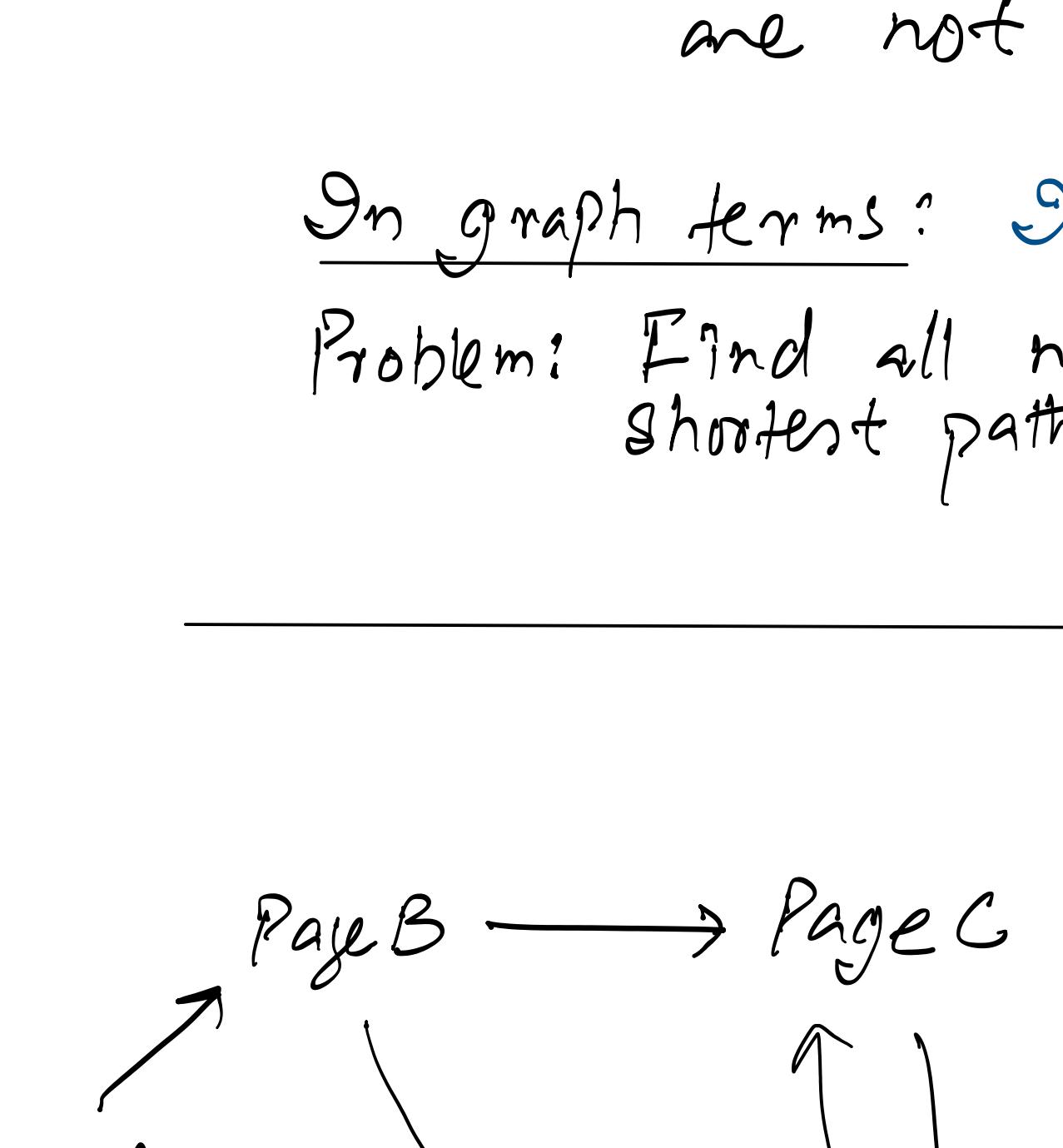
Ordered pair: $(a,b) \neq (b,a)$ if $a \neq b$.

V is set of vertices

E is set of edges.

Unordered pair: $\{a,b\}$ order is not important.

$\{a,b\} = \{b,a\}$ because order doesn't matter.

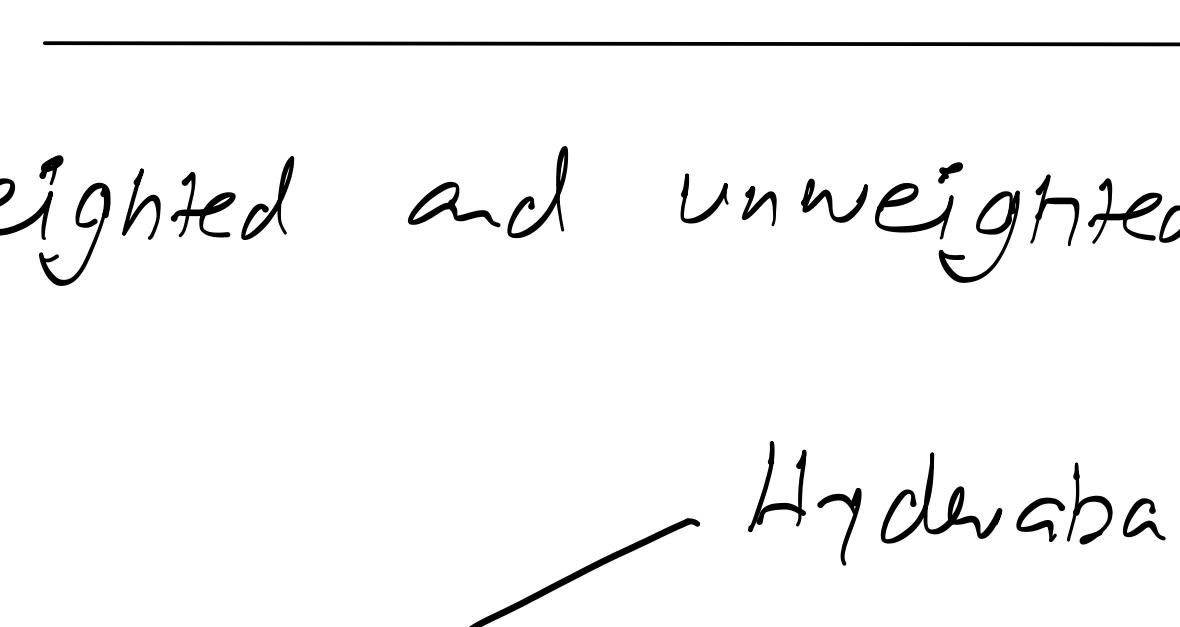


- Every vertex must have a name.
- 7 vertices
- 9 edges.

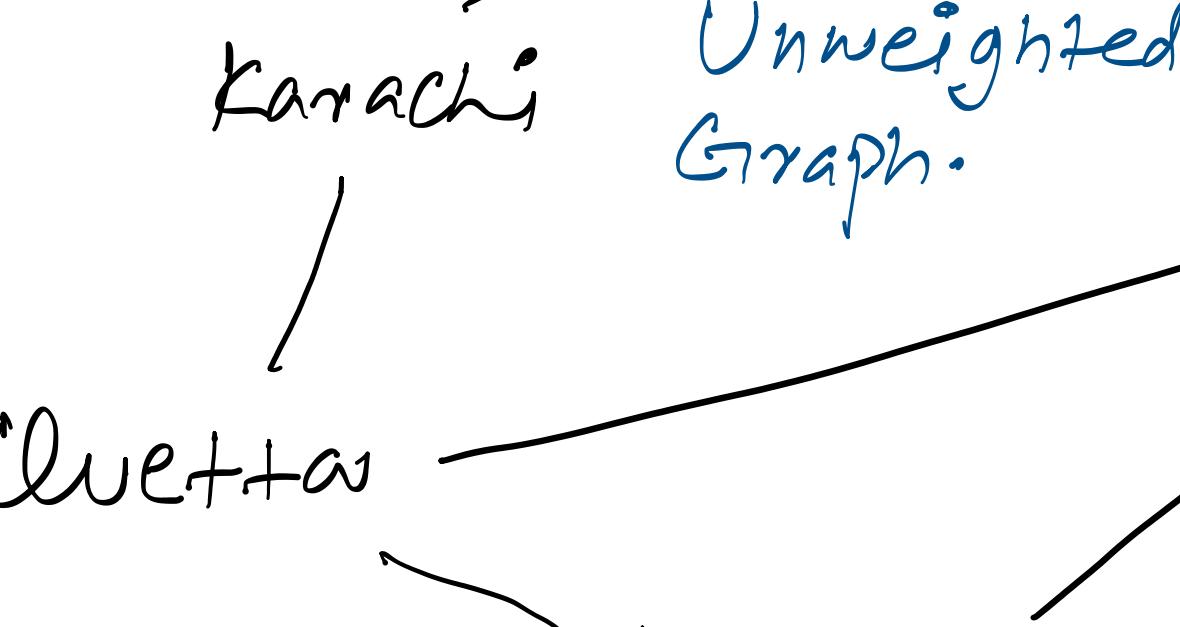
$$V = \{v_1, v_2, v_3, v_4, v_5, v_6, v_7\} \quad \text{Set of vertices for the graph above.}$$

$$E = \{ \{v_1, v_3\}, \{v_1, v_2\}, \{v_1, v_4\}, \{v_1, v_5\}, \{v_3, v_4\}, \{v_3, v_6\}, \{v_6, v_7\}, \{v_4, v_7\}, \{v_5, v_7\}, \{v_2, v_4\} \}$$

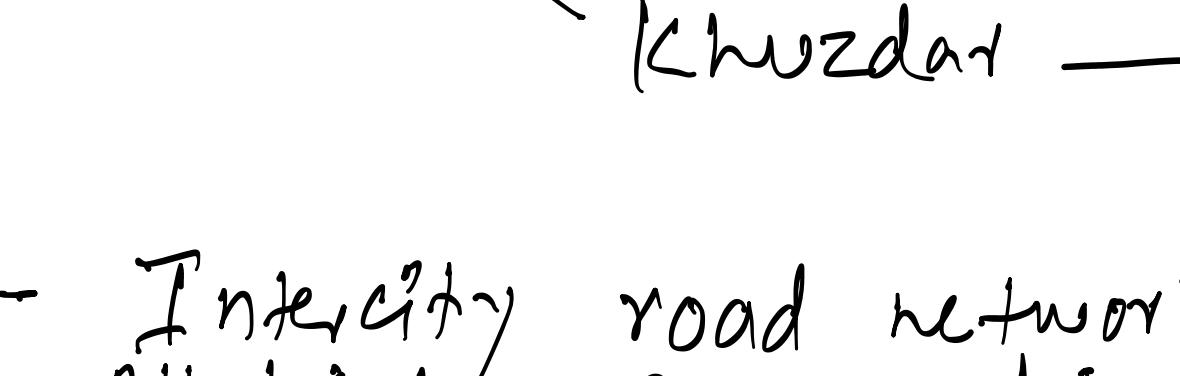
How to represent an edge? - An edge is uniquely identified by its two end points.



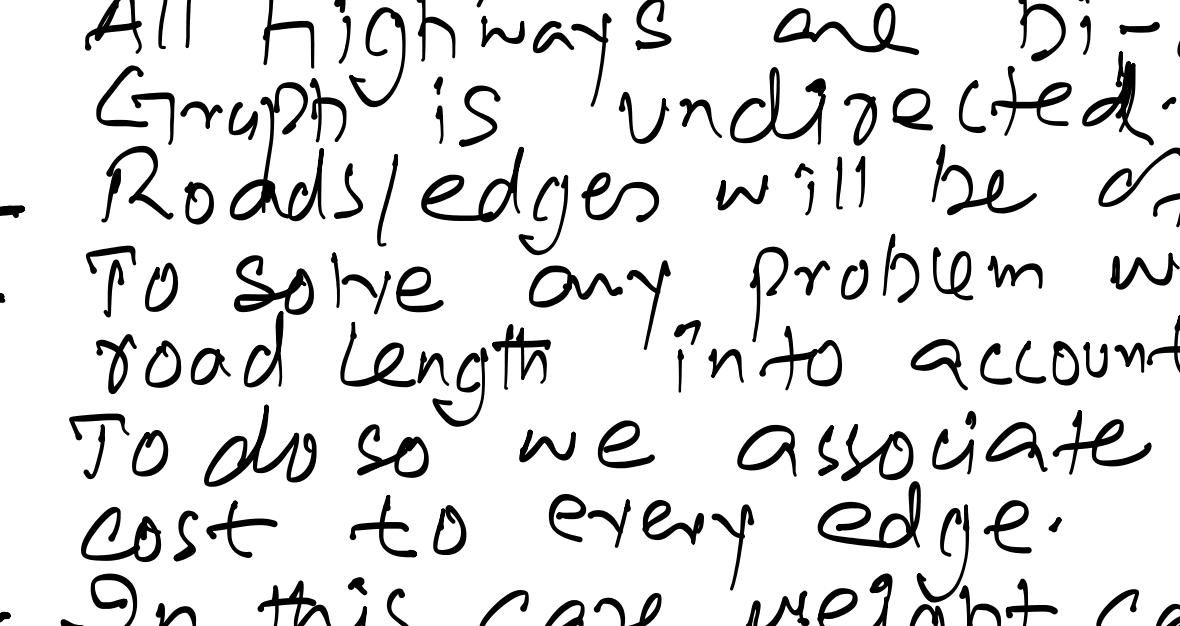
- Edges can be of two types; directed and undirected.



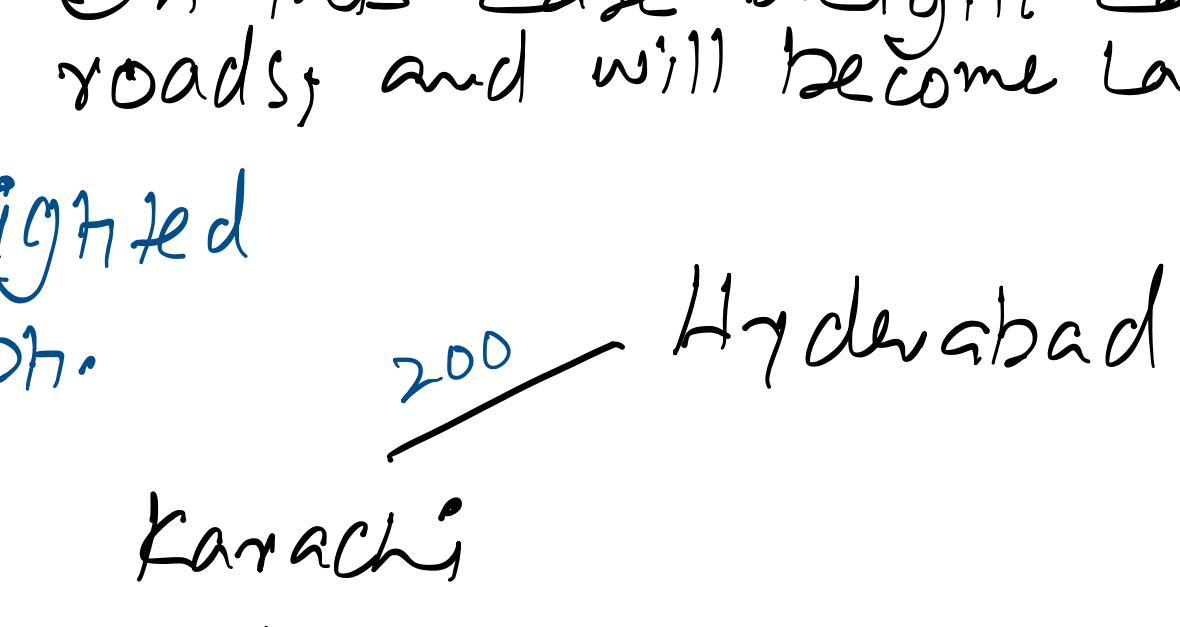
- Typically in a graph all edges can be directed or undirected.



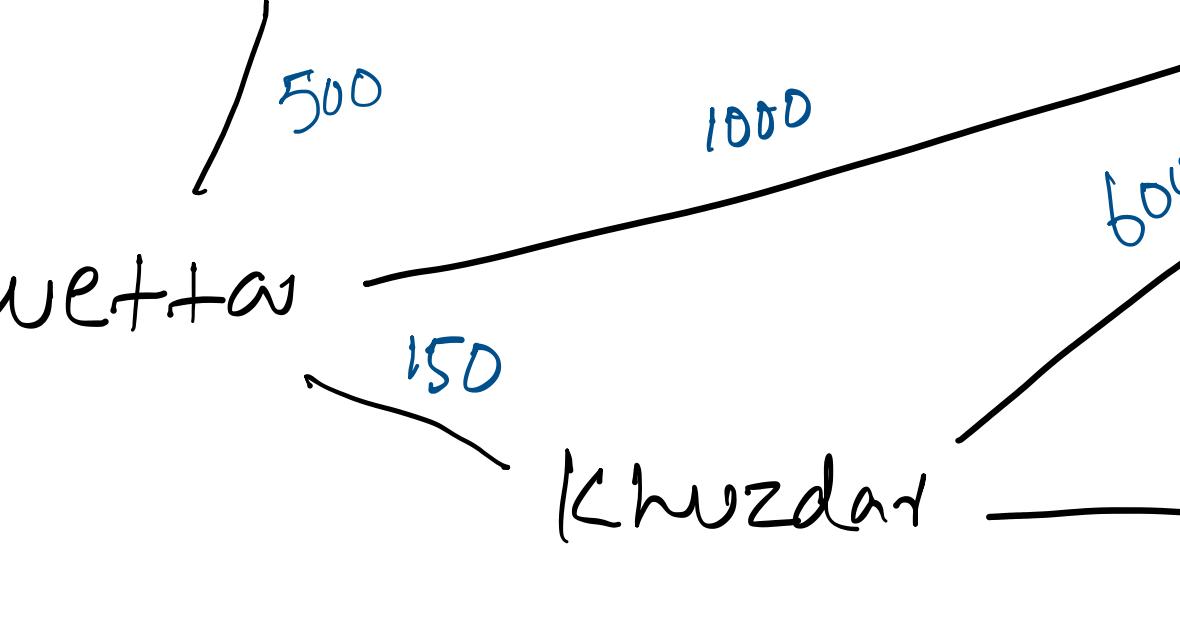
- We study graph with all the edges either directed or undirected but not both.



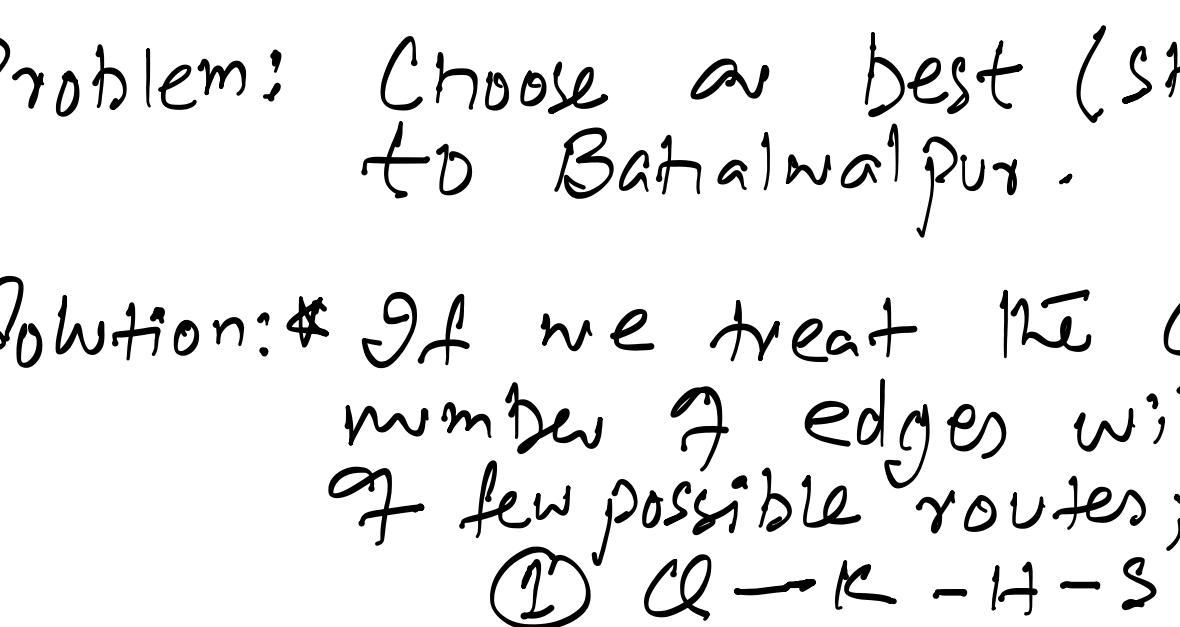
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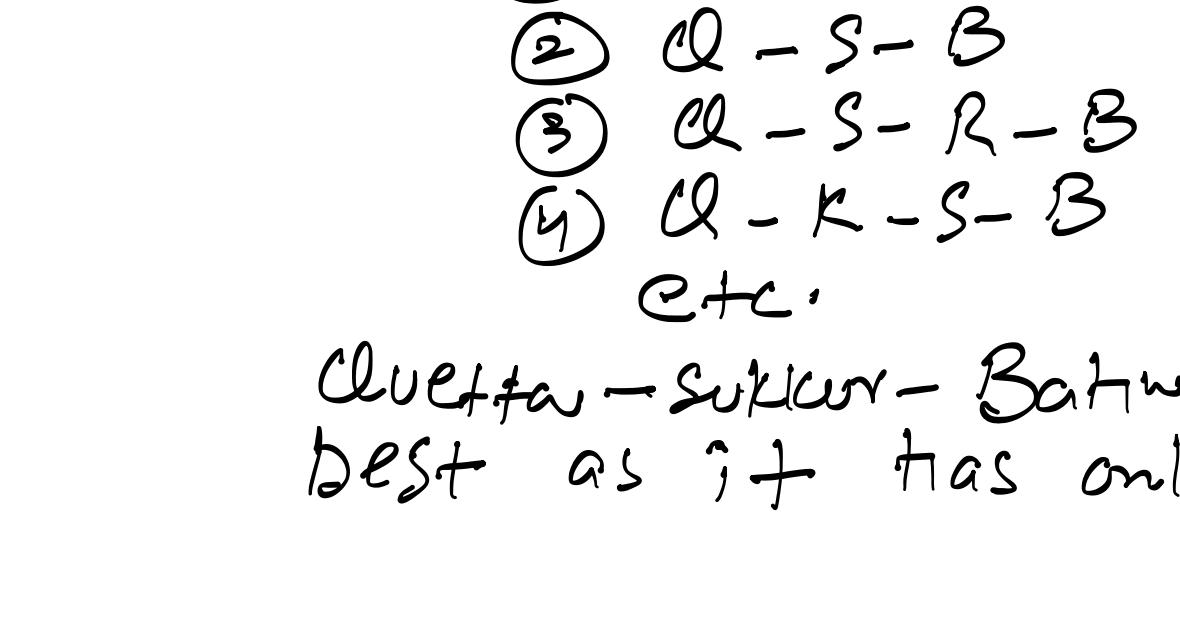
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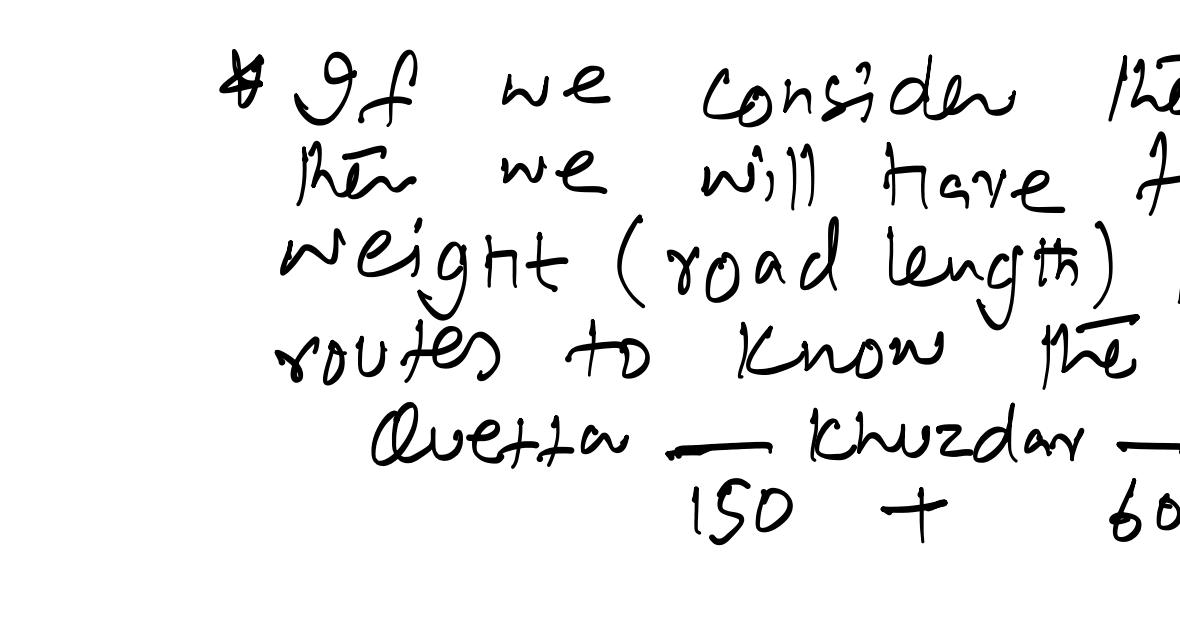
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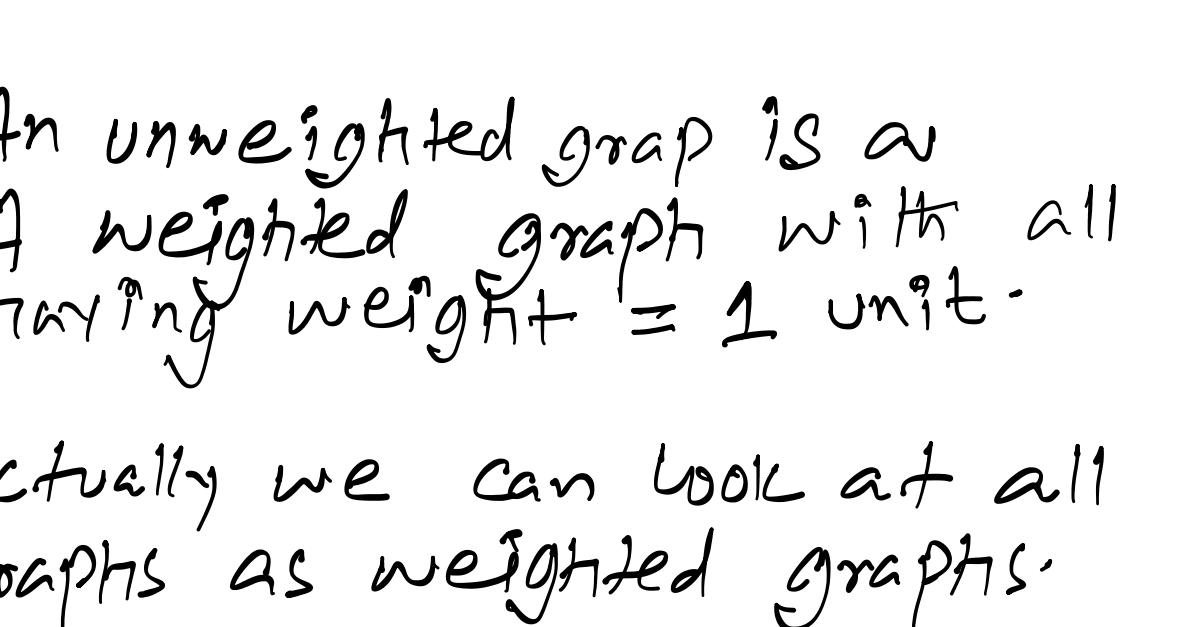
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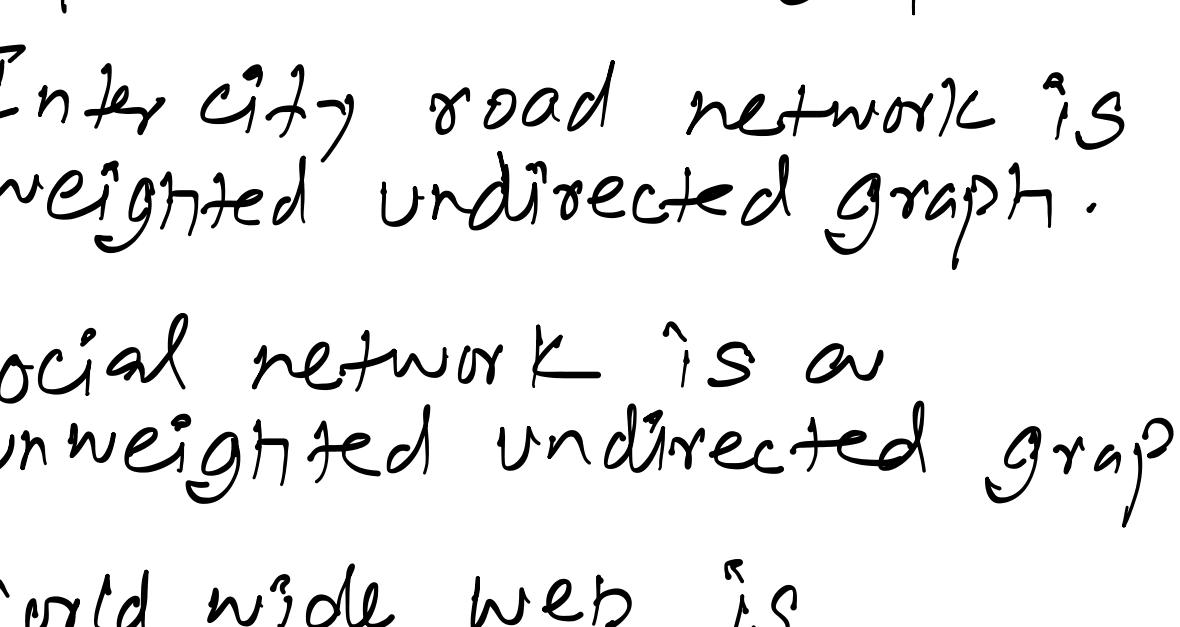
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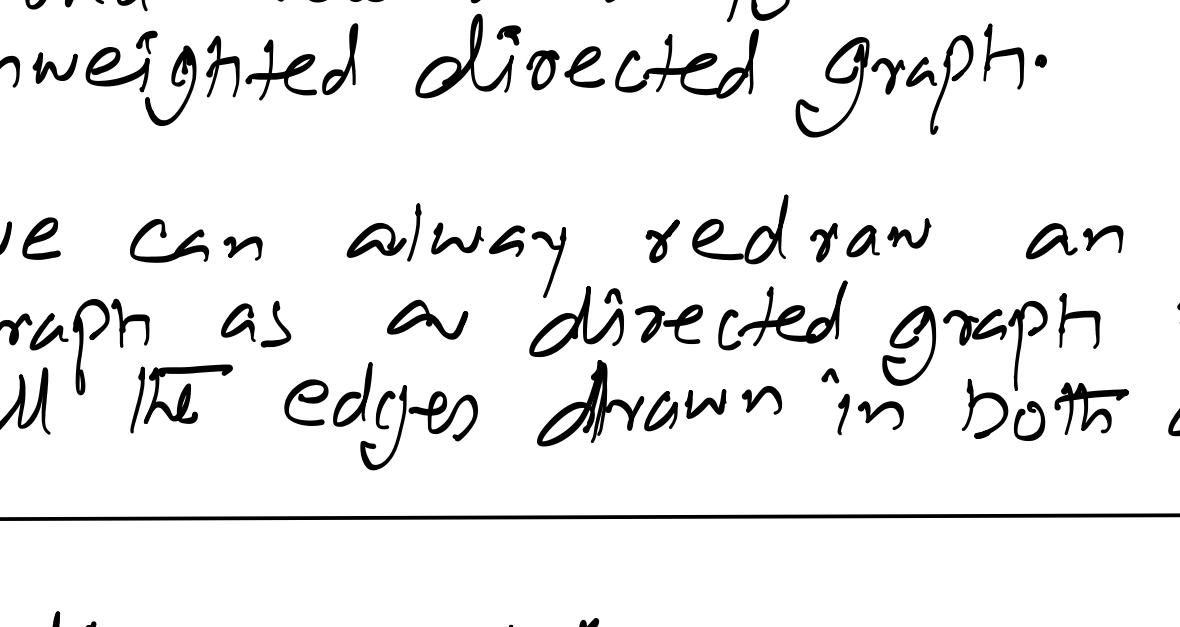
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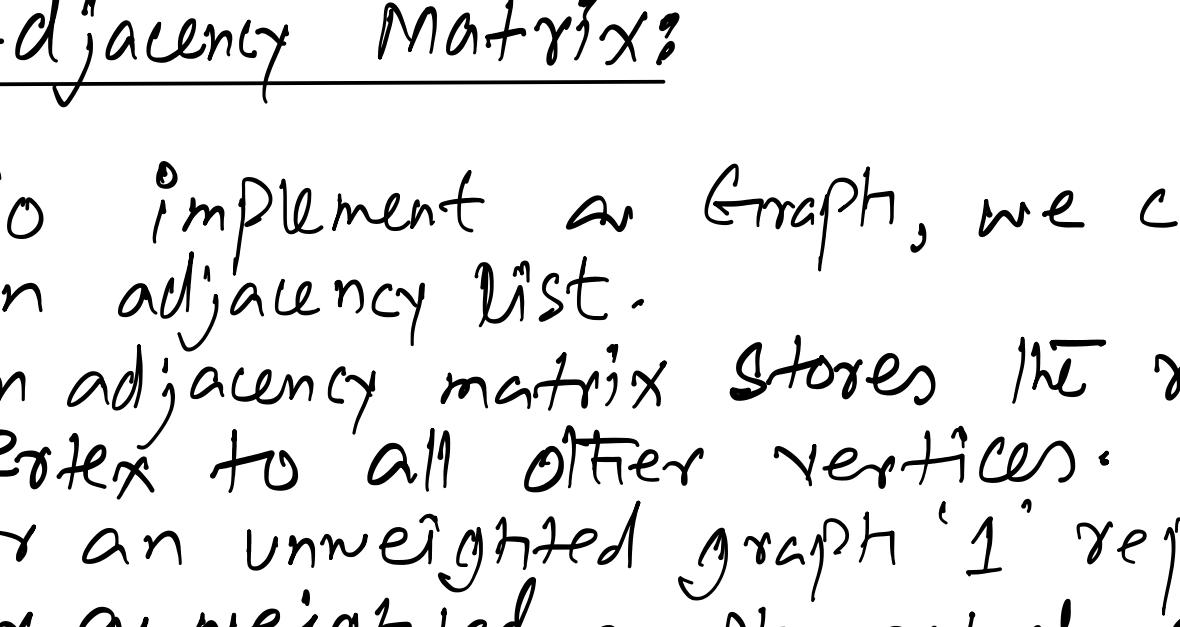
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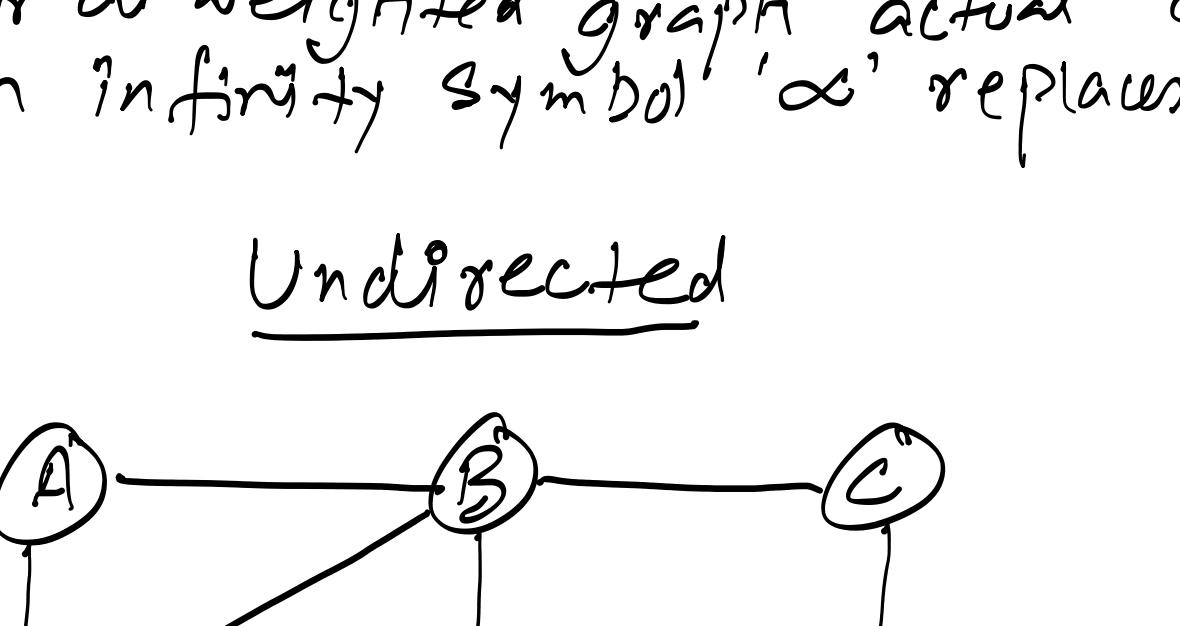
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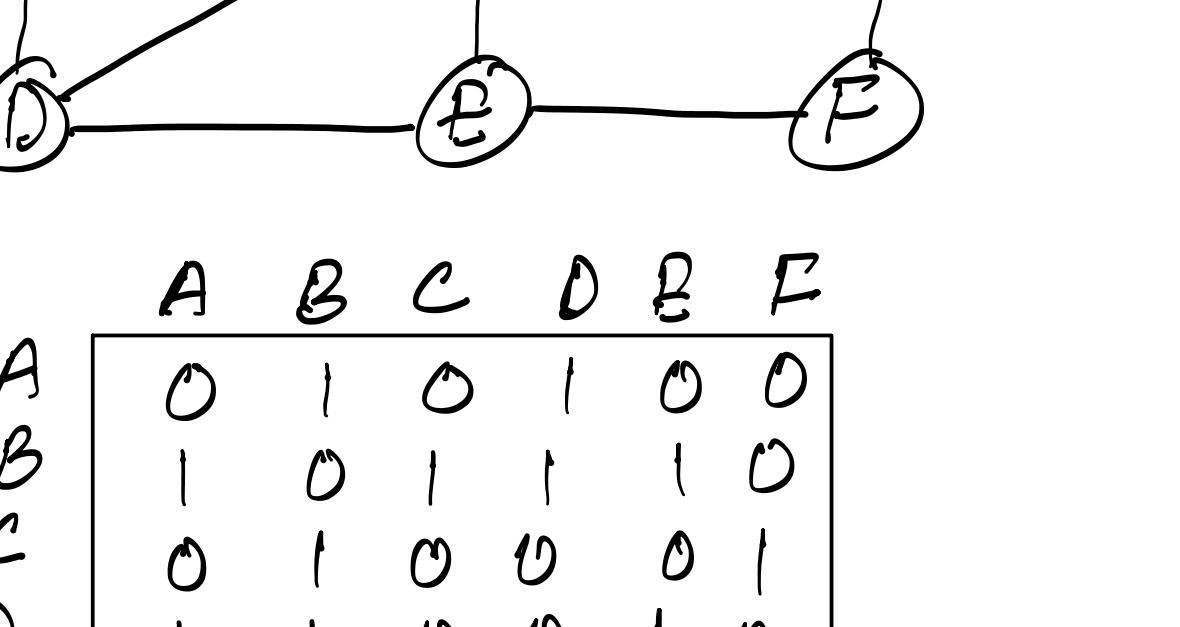
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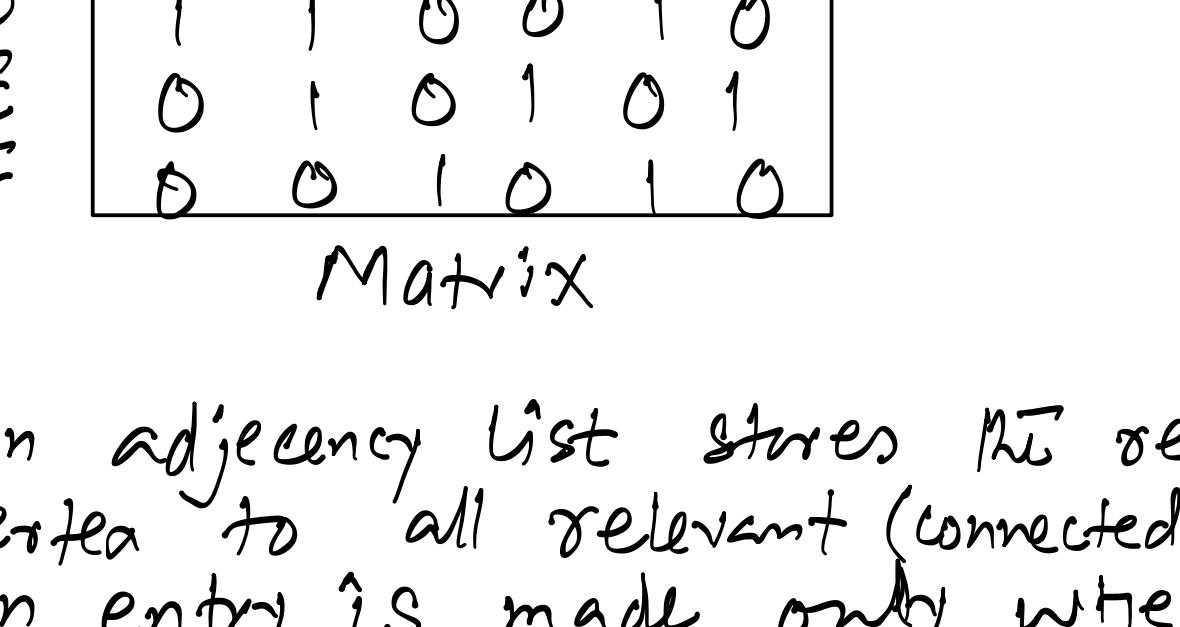
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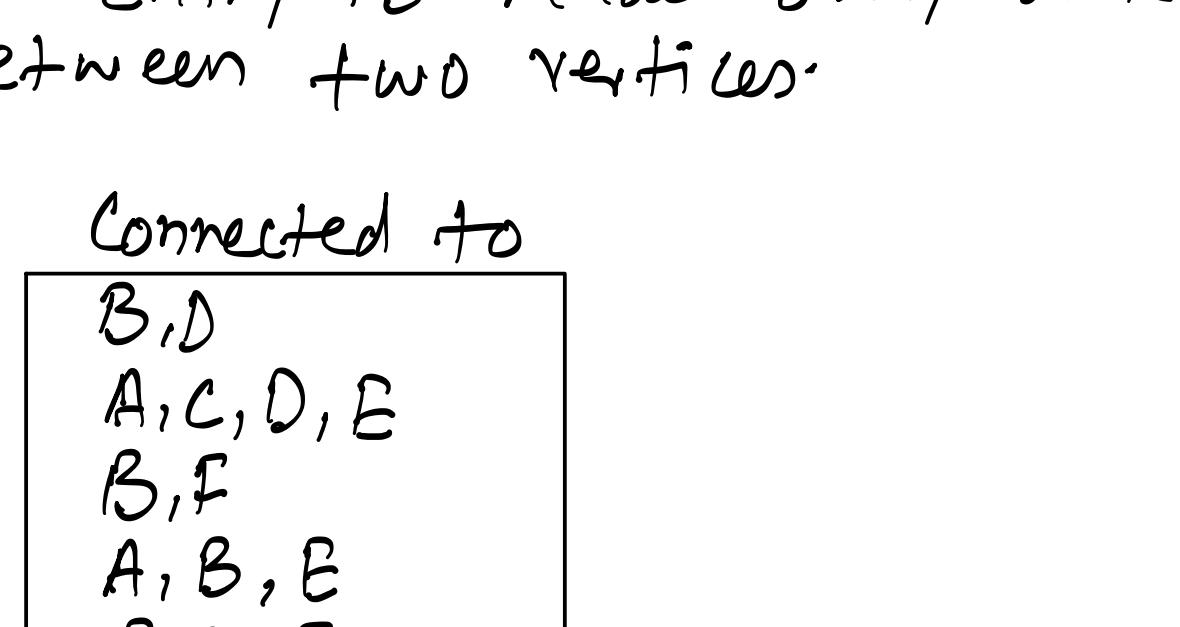
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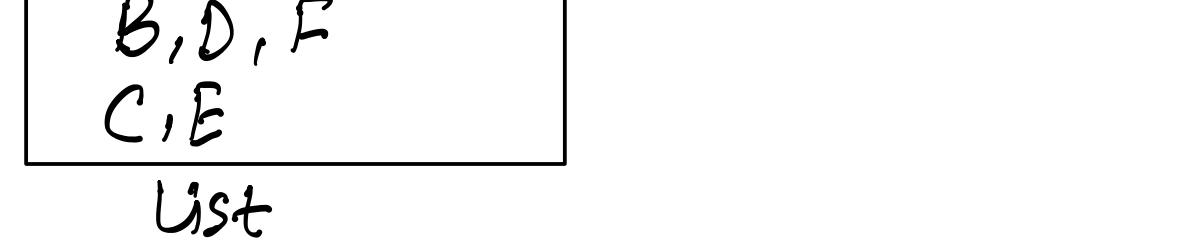
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