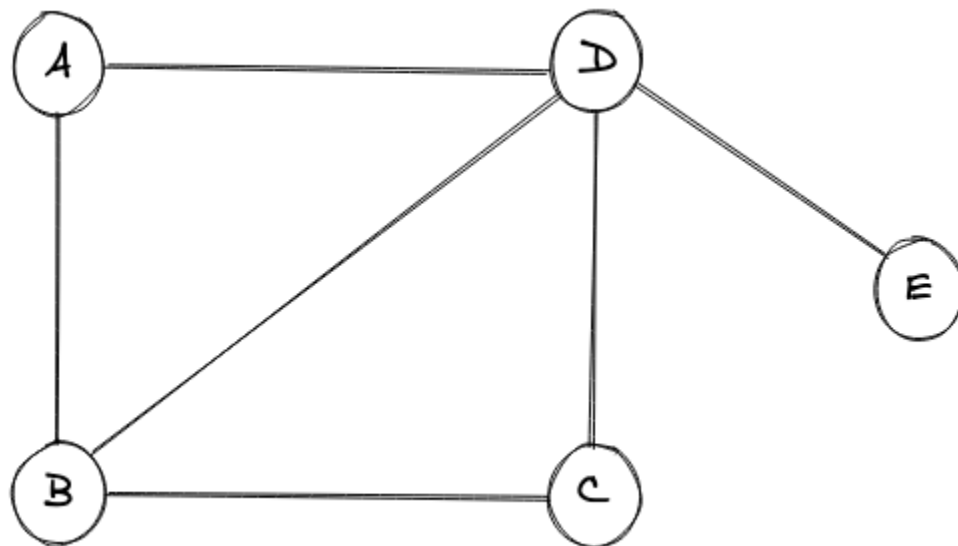# Introduction to Graphs

A **graph is an advanced data structure** that is used to organize items in an **interconnected network**. Each item in a graph is known as a **node**(or **vertex**) and these nodes are connected by **edges**.

In the figure below, we have a simple graph where there are five nodes in total and six edges.


The nodes in any graph can be referred to as **entities** and the edges that connect different nodes define the **relationships between these entities**. In the above graph we have a set of nodes **{V} = {A, B, C, D, E}** and a set of edges, **{E} = {A-B, A-D, B-C, B-D, C-D, D-E}** respectively.

Real-World Example

A very good example of graphs is a **network of socially connected people**, connected by a simple connection which is whether they know each other or not.

Consider the figure below, where a pictorial representation of a social network is shown, in which there are five people in total.
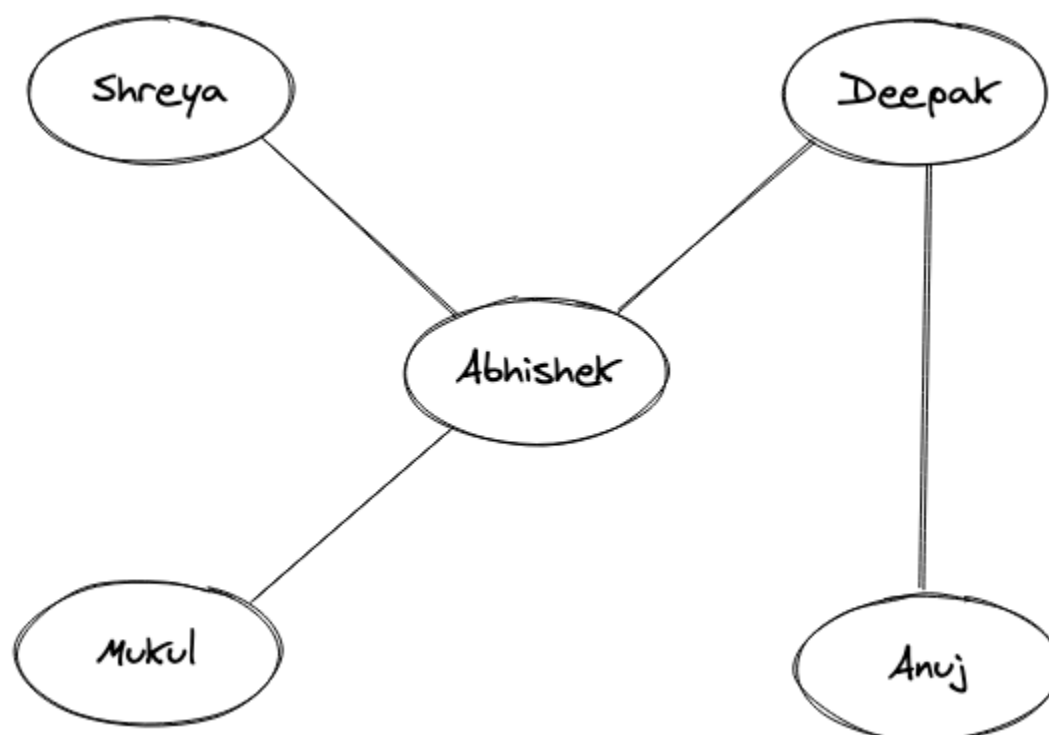
A line in the above representation between two people mean that they know each other. If there's no line in between the names, then they simply don't know each other. The names here are equivalent to the nodes of a graph and the lines that define the relationship of "knowing each other" is simply the equivalent of an edge of a graph. It should also be noted that the relationship of knowing each other goes both ways like "Abhishek" knows "Mukul" and "Mukul" knows "Abhishek".

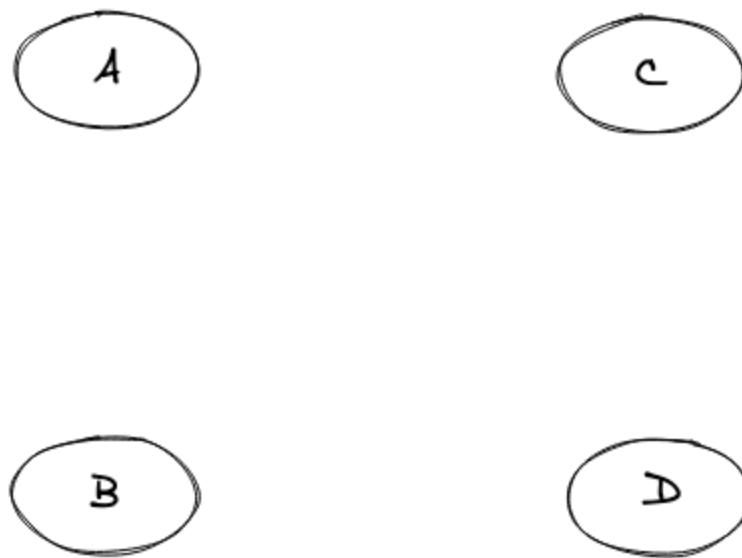The social network depicted above is nothing but a graph.

Types of Graphs

Let's cover various different types of graphs.

1. Null Graphs

A graph is said to be null if there are no edges in that graph.

A pictorial representation of the null graph is given below:

2. Undirected Graphs

If we take a look at the pictorial representation that we had in the Real-world example above, we can clearly see that different nodes are connected by a link (i.e. edge) and that edge doesn't have any kind of direction associated with it. For example, the edge between "Anuj" and "Deepak" is bi-directional and hence the relationship between them is two ways, which turns out to be that "Anuj" knows "Deepak" and "Deepak" also knows about "Anuj". These types of graphs where the relation is bi-directional or there is not a single direction, are known as Undirected graphs.

A pictorial representation of another undirected graph is given below:
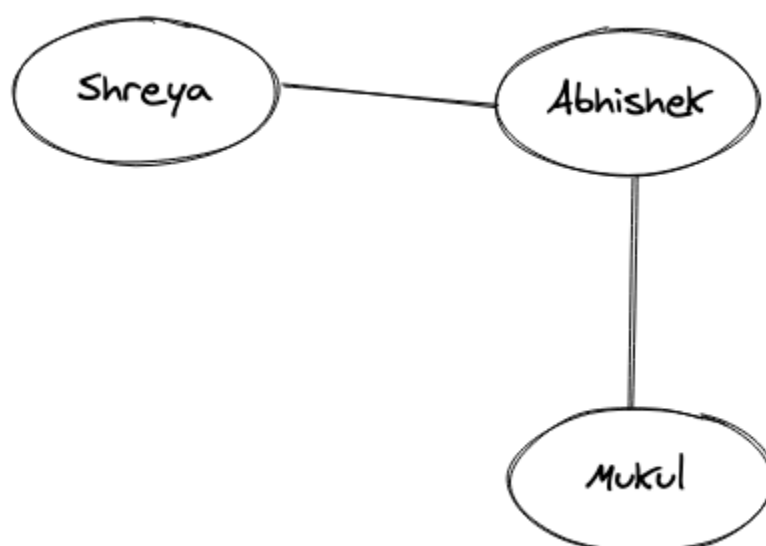
3. Directed Graphs

What if the relation between the two people is something like, "Shreya" know "Abhishek" but "Abhishek" doesn't know "Shreya". This type of relationship is one-way, and it does include a direction. The edges with arrows basically denote the direction of the relationship and such graphs are known as directed graphs.

A pictorial representation of the graph is given below:
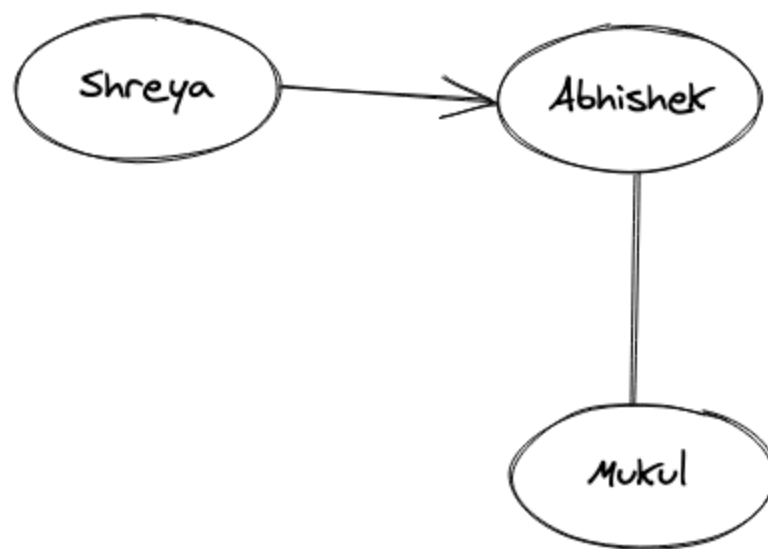
It can also be noted that the edge from "Shreya" to "Abhishek" is an outgoing edge for "Shreya" and an incoming edge for "Abhishek".

4. Cyclic Graph

A graph that contains at least one node that traverses back to itself is known as a cyclic graph. In simple words, a graph should have at least one cycle formation for it to be called a cyclic graph.

A pictorial representation of a cyclic graph is given below:
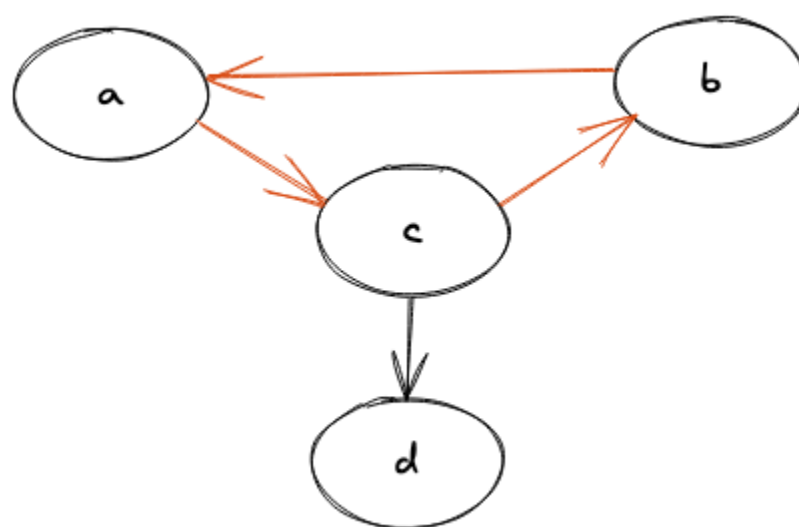
It can be easily seen that there exists a cycle between the nodes (a, b, c) and hence it is a cyclic graph.

5. Acyclic Graph

A graph where there's no way we can start from one node and can traverse back to the same one, or simply doesn't have a single cycle is known as an acyclic graph.

A pictorial representation of an acyclic graph is given below:
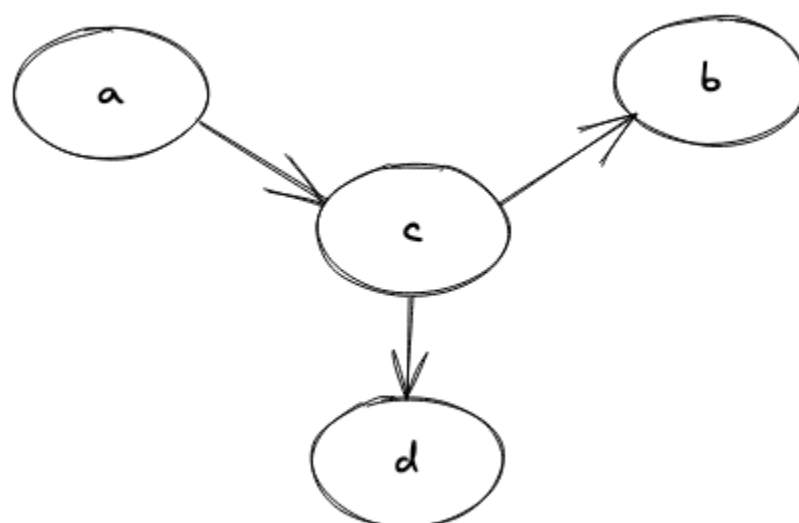
6. Weighted Graph

When the edge in a graph has some weight associated with it, we call that graph as a weighted graph. The weight is generally a number that could mean anything, totally dependent on the relationship between the nodes of that graph.

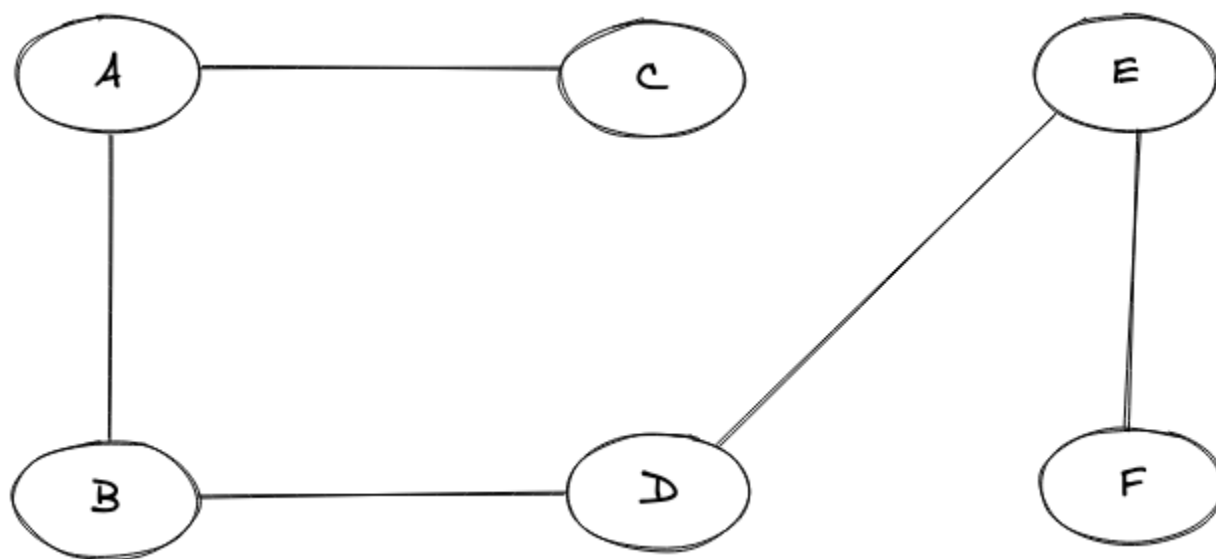A pictorial representation of the weighted graph is given below:
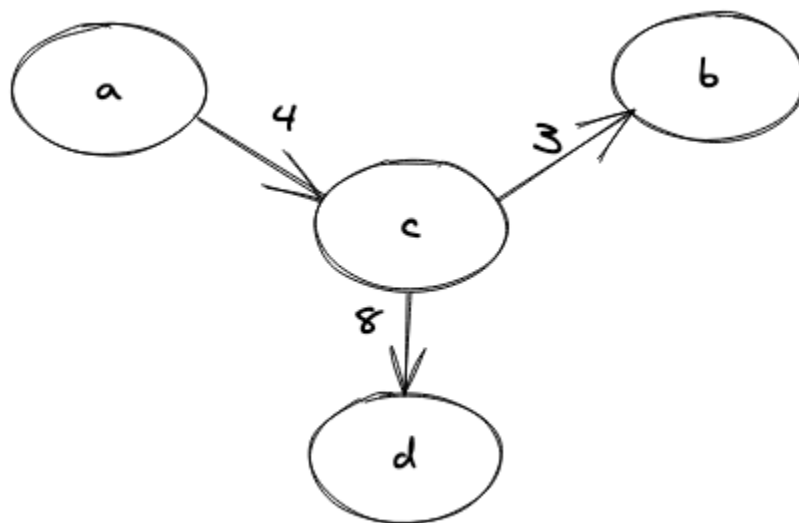
It can also be noted that if any graph doesn't have any weight associated with it, we simply call it an unweighted graph.

7. Connected Graph

A graph where we have a path between every two nodes of the graph is known as a connected graph. A path here means that we are able to traverse from a node "A" to say any node "B". In simple terms, we can say that if we start from one node of the graph we will always be able to traverse to all the other nodes of the graph from that node, hence the connectivity.
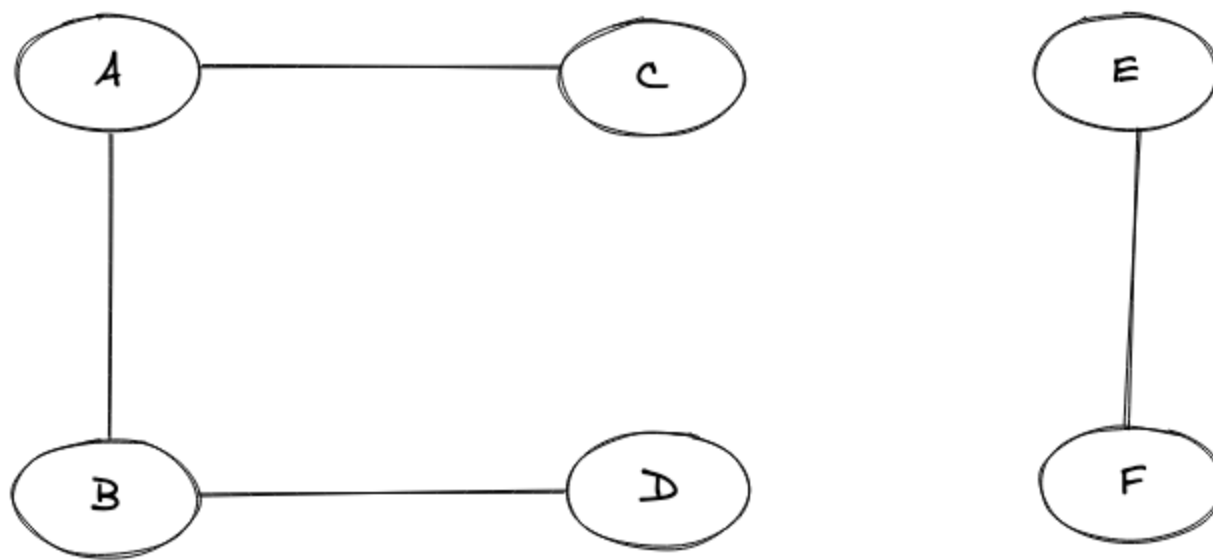
A pictorial representation of the connected graph is given below:

8. Disconnected Graph

A graph that is not connected is simply known as a disconnected graph. In a disconnected graph, we will not be able to find a path from between every two nodes of the graph.
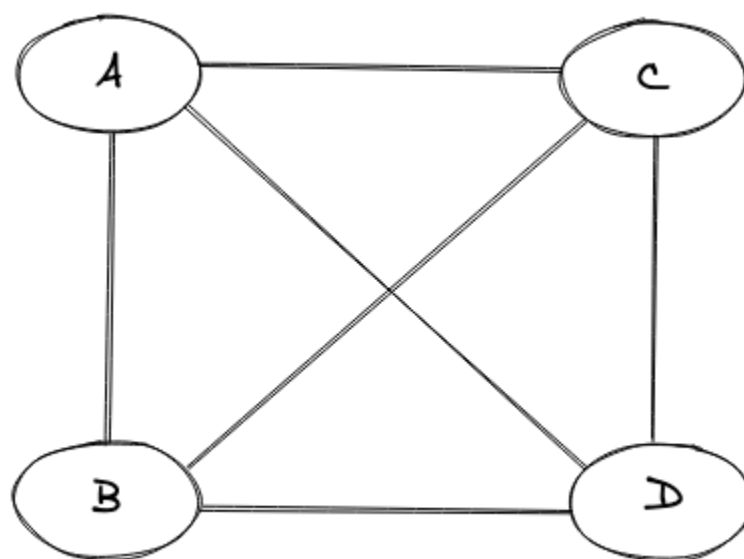
A pictorial representation of the disconnected graph is given below:

9. Complete Graph

A graph is said to be a complete graph if there exists an edge for every pair of vertices(nodes) of that graph.
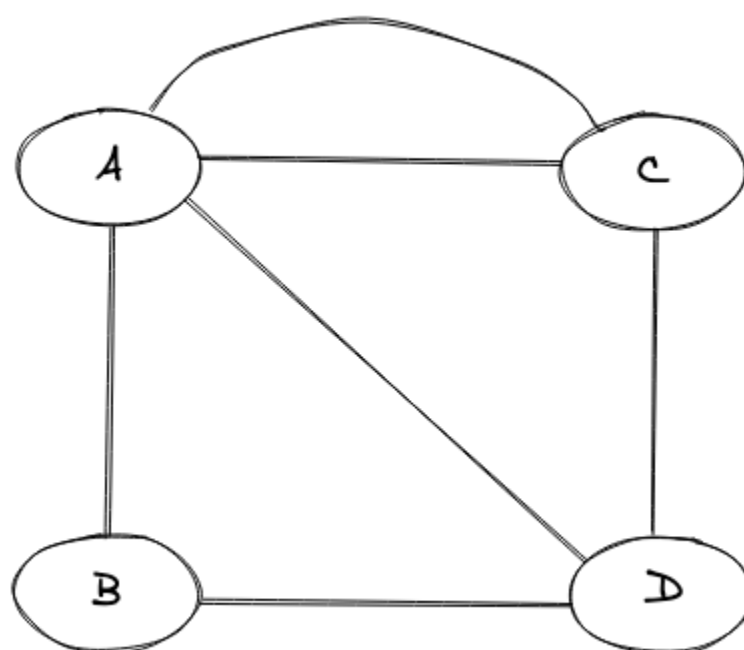
A pictorial representation of the complete graph is given below:

10. Multigraph

A graph is said to be a multigraph if there exist two or more than two edges between any pair of nodes in the graph.

A pictorial representation of the multigraph is given below:

Commonly Used Graph Terminologies

- **Path** - A sequence of alternating nodes and edges such that each of the successive nodes are connected by the edge.

- **Cycle** - A path where the starting and the ending node is the same.
- **Simple Path** - A path where we do not encounter a vertex again.
- **Bridge** - An edge whose removal will simply make the graph disconnected.
- **Forest** - A forest is a graph without cycles.
- **Tree** - A connected graph that doesn't have any cycles.
- **Degree** - The degree in a graph is the number of edges that are incident on a particular node.
- **Neighbour** - We say vertex "A" and "B" are neighbours if there exists an edge between them.

Conclusions

- We learned about what a graph is with a help of an undirected graph between different people.
- We learned how many types of graphs are there in total.
- We learned about the common terminologies that we use while talking about graphs and their subparts.