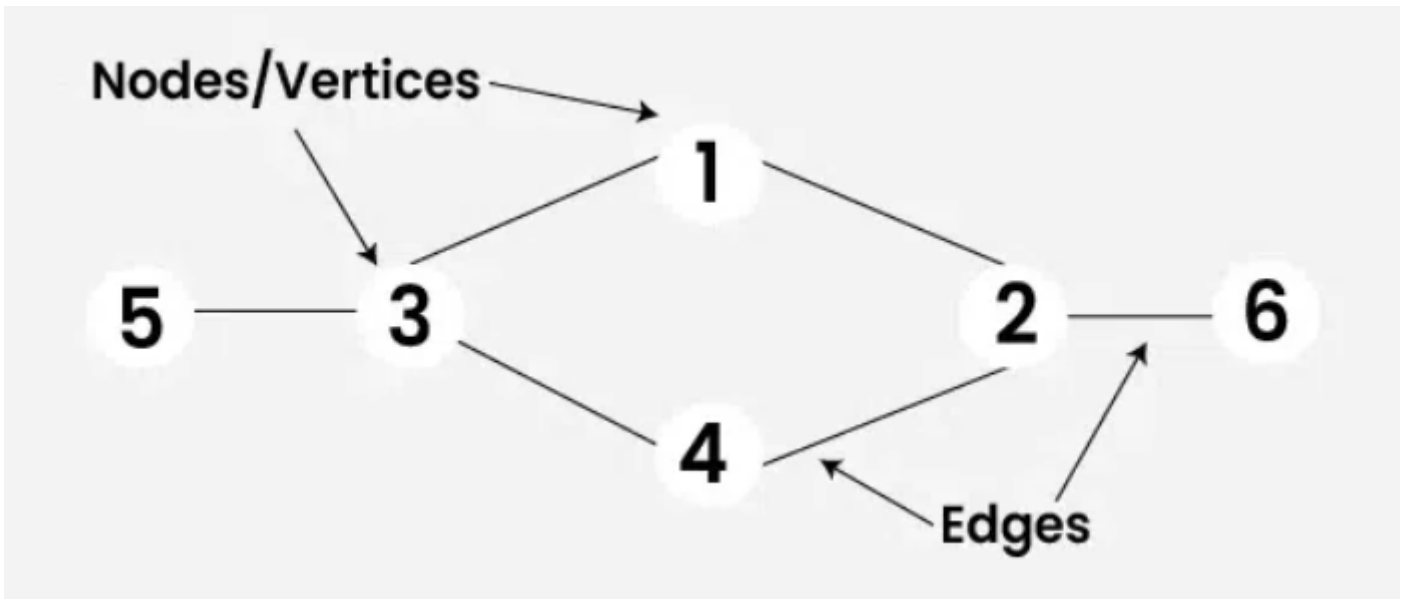


# 1. Graphs Concept



A **Graph** is a non-linear data structure consisting of **nodes** and **edges**. The nodes are formally called vertices, and the edges are lines or arcs that connect any two nodes in the graph.

Graphs are used to solve many real-world problems. They are used to represent networks, such as social networks, transportation networks (roads and cities), or computer networks.

## 1.1 Graph Terminology

- **Vertex (or Node):** The fundamental unit of the graph.
- **Edge:** A line that connects two vertices.
- **Path:** A sequence of vertices connected by edges.
- **Cycle:** A path that starts and ends at the same vertex. A graph with no cycles is acyclic.
- **Connected Graph:** An undirected graph where there is a path between any two vertices.
- **Weighted Graph:** Each edge is assigned a numerical value or "weight," often representing cost or distance.
- **Unweighted Graph:** Edges do not have weights.

## 1.2 Graph Analogy

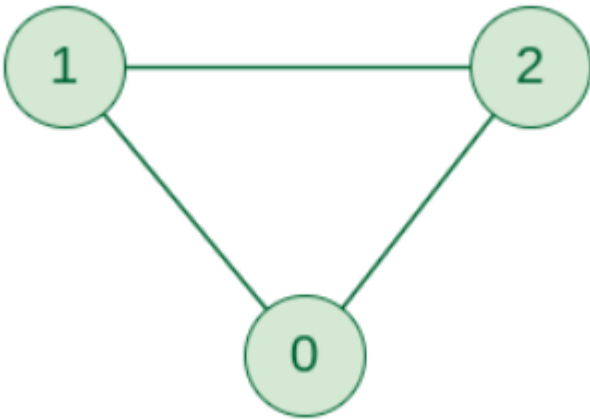
Imagine a social network like Facebook or Twitter.

- Each **person** is a **Vertex (Node)**.

- The **friendship** or **connection** between two people is an **Edge**.
- If the friendship is mutual (i.e. Facebook), it's an **undirected** graph.
- If you can "follow" someone without them following you back (i.e. Twitter), it's a **directed** graph.

## 1.3 Types of Graph

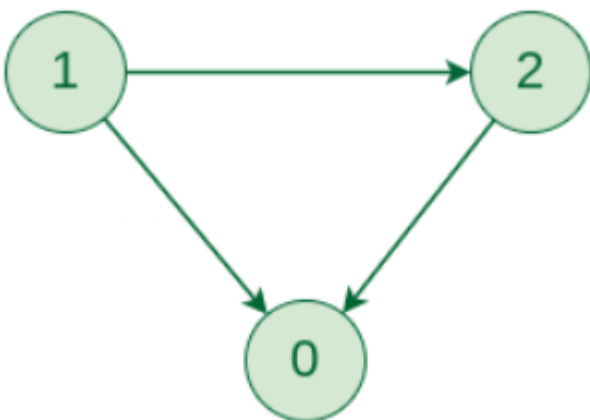
### 1.3.1 Undirected Graph



In an **Undirected Graph**, edges represent a mutual, bidirectional relationship. An edge  $(u, v)$  is identical to an edge  $(v, u)$ . There is no "direction" to the connection.

- **Analogy:** A friendship on Facebook or a two-way street. If **A** is friends with **B**, then **B** is automatically friends with **A**.
- **Degree:** The "degree" of a vertex is simply the total number of edges connected to it.

### 1.3.2 Directed Graph



In a **Directed Graph (or Digraph)**, edges are one-way streets. An edge  $(u, v)$  represents a connection from **u** to **v**, but it does not imply a connection from **v** to **u**.

- **Analogy:** Following someone on Twitter or a one-way street.  $A$  can follow  $B$  (an edge  $A \rightarrow B$ ), but  $B$  does not have to follow  $A$  back. An edge  $B \rightarrow A$  would be a separate, distinct edge.
  - **Degree:** Degree is split into two types:
    - **In-degree:** The number of edges pointing to the vertex.
    - **Out-degree:** The number of edges pointing away from the vertex.
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