

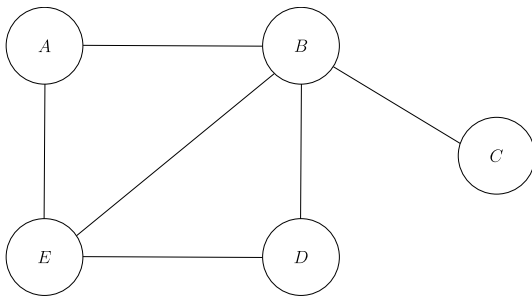
Graph Neural Networks

Introduction to Graphs

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What is a Graph?

- ❖ A **graph** is a data structure composed of two primary components: **nodes** (or **vertices**) representing entities, and **edges** (or **links**) representing relationships between these entities.
- ❖ Each node and edge in a graph may also contain **feature data**, which provides additional information:
 - ❑ In a *road network*, an edge could be characterized by its length, number of lanes, accident frequency, and speed limit. This information is stored in an **edge embedding**.
 - ❑ In a *social network*, nodes might include attributes such as names, ages, or other personal details. This information is stored in a **node embedding**.



Graph Representation

- ❖ Formally, a graph is defined by a set of N nodes and a set of E edges that connect pairs of nodes.
- ❖ A common way to represent a graph is through an **adjacency matrix**, which is an $N \times N$ matrix where the entry (i, j) is 1 if there is an edge between nodes i and j , and 0 otherwise.

	A	B	C	D	E
A	0	1	0	0	1
B	1	0	1	1	1
C	0	1	0	1	0
D	0	1	1	0	1
E	1	1	0	1	0

- ❖ Another common representation is the **incidence matrix**, an $N \times E$ matrix where entry (i, j) is 1 if node i is incident with edge j .

	$e1$	$e2$	$e3$	$e4$	$e5$	$e6$
A	1	1	0	0	0	0
B	1	0	1	1	1	0
C	0	0	0	0	1	0
D	0	0	0	1	0	1
E	0	1	1	0	0	1

Types of Graphs

- ❖ Graphs can vary based on their structure and characteristics:
 1. **Homogeneous** and **Heterogeneous** graphs
 2. **Bipartite** graphs
 3. **Cyclic** and **Acyclic** graphs
 4. **Knowledge Graphs**
 5. **Hypergraphs**