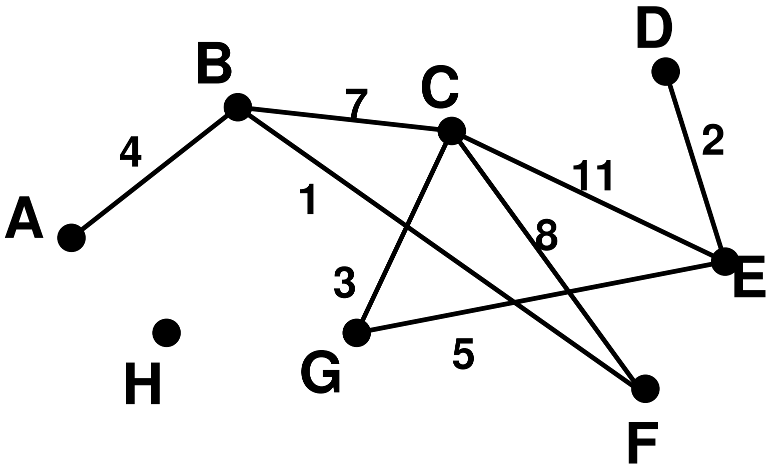
Computer Science 385
Design and Analysis of Algorithms
Siena University
Spring 2026

In-class Graph Data Structures Intro

A wide variety of information can be represented as a collection of entities and some sort of relationship between some or all pairs of those entities. This kind of data is often represented by the mathematical construct known as a *graph*, which, in the realm of computing, is often represented by a graph data structure.

Definition:

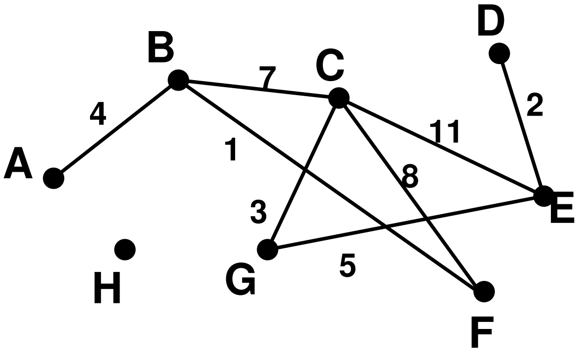
A simple example:



Here, the letters represent

and numbers are

The numbers here mean that this is a



- Two vertices are *adjacent* if

  Examples:

- A *path* is

  Example:

- A *simple path*

  Example:

- A simple path is a *cycle* if

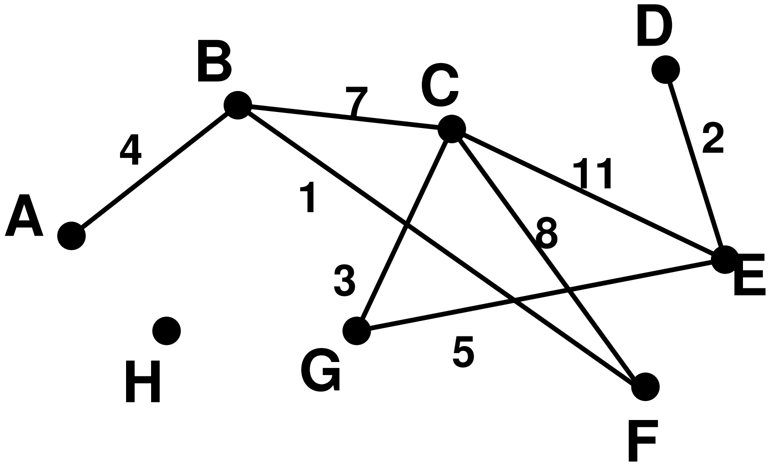
  Example:

- A graph that contains no cycles is called
- Two vertices u and v are *connected* if

- The *degree* of a vertex is

  Examples:

Let’s add some arrows to our sample graph.



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- The graph is now

  The original was

- here, we have an *out-degree* and *in-degree* for each vertex

There are two principal ways that a graph is usually represented:

1. an *adjacency matrix*, or
2. *adjacency lists*.

As a running example, we will consider an undirected graph where the vertices represent the states in the northeastern U.S.: NY, VT, NH, ME, MA, CT, and RI. An edge exists between two states if they share a common border, and we assign edge weights to represent the length of their border.

Adjacency matrix representation of NE graph

Adjacency list representation of NE graph