MOTIVATION: visualize flight routes in North America
- natural representation is a graph

1. Create series of nodes (or vertices) w/ each node representing a city
   - each node is airport code
2. Connect any 2 cities (nodes) which have a flight route blw them w/ a line called an edge

* NODES (vertices) specify entities we are interested in.
* EDGES specify relationships blw entities.
Def. A graph $G = (V, E)$ is a finite set of vertices $V$, and a finite set of edges $E$, where each edge $(u, v)$ connects 2 vertices, $u$ and $v$.

1. We have $G = (V, E)$.
   - Vertices $V = \{u, v, w\}$
   - Edges $E = \{(u, v), (v, w), (w, u)\}$

2. $G = (V, E)$.
   - Vertices $V = \{a, b, c, d, e, f\}$
   - Edges $E = \{(a, c), (b, c), (b, d), (c, e), (d, f), (c, f)\}$
Types of Edges

Graph Theory

Types of edges (two types):
1. Directed edges
   - Ordered pair vertices (u,v).
   - For example, (A, B)
   - If A is a friend of B, B is not a friend of A.
   - Example: (A, B) and (B, A) are different edges.
2. Undirected edge
   - Unordered pair vertices (u,v).
   - E.g., a "network" of friends.
   - If Sam is a friend of Bob, then Bob is also a friend of Sam.
   - Example: (e) and (f) are the same edge.

Types of Graphs

0. Directed Graph
   - All edges are directed
   - Route network

@ Undirected Graph
   - All edges are undirected
   - Friend network
**Graph Theory**

**Terminology**

- **Def.** Two vertices in a graph are adjacent if there exists an edge $(u,v)$.

- **Def.** Multi-edges (or parallel edges) are edges that have the same endpoints (in an undirected graph) or the same origin and destination (in a directed graph).

- **Def.** A self-loop is an edge $(v,v)$.

- **Def.** A graph does not have parallel edges and self-loops, then it is called single.

- **Def.** A multi-graph can have multiple edges between the same two vertices and self-loops.

In this course, we deal almost exclusively with simple graphs.