ADT — abstract data type

collection of behaviors exhibited by a group of data structures

examples

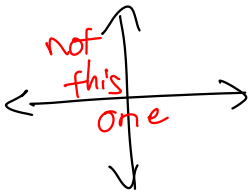
dictionary — BSTs, AVL, hashtables

OrderedCollection, stacks, queues

lists

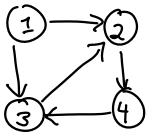
priority queues

graph

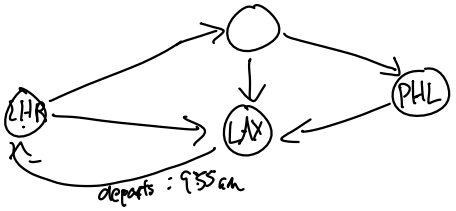


A graph is collection of vertices and edges. $\langle V, E \rangle$

$V = \{1, 2\}$
$E = \{\langle 1,2 \rangle\}$

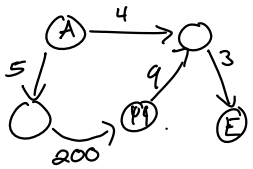


$V = \{1,2,3,4,5\}$
$E = \{\langle 1,3 \rangle, \langle 1,2 \rangle, \langle 3,2 \rangle, \langle 2,4 \rangle, \langle 4,3 \rangle\}$



vertices: airports
edge: flight

graphs that associate extra information with edges are labeled



vertices: intersections
edges: piece of road

how do we know which vertices are gas stations?

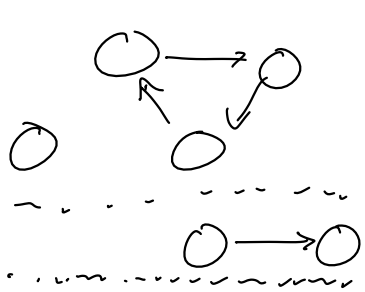
graphs that associate costs w/ edges are called weighted

A graph is a pair $\langle V, E \rangle$ where V is a set of vertices and E is a set of edges. An edge is $\langle V, L, W, V \rangle$.

(source, label, weight, destination)

Social network

directed

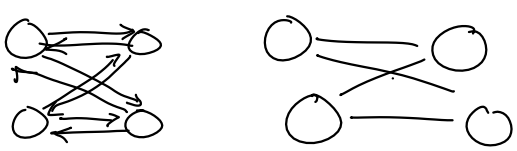


vertex = person
edge = likes

A path is a list of edges s.t. each edge's destination is the next edge's source.

$[\langle 1,2 \rangle, \langle 2,3 \rangle] \checkmark$
$[\langle 1,2 \rangle, \langle 3,4 \rangle] \times$

A graph s.t. all vertices have a path to all other vertices is connected.



undirected

An undirected graph $\langle V, E \rangle$ is a graph where, for every edge $\langle v_1, v_2 \rangle \in E$, $\langle v_2, v_1 \rangle \in E$.

A graph which would be connected if it were undirected is weakly connected.

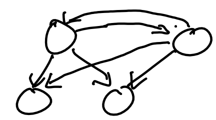
Isolated vertex: a vertex s.t. no edge has that vertex as source or destination.

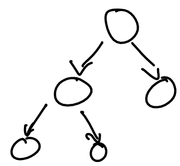
Consider a graph w/ no isolated vertices. Weakly connected?

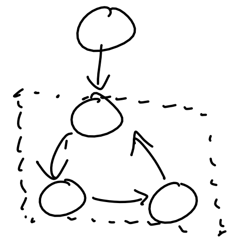
Is a tree a graph? Yes.

What properties?

- weakly connected
- directed
- unlabeled
- unweighted
- at most 1 vertex has in-degree 0; all others have in-degree 1







The <u>in-degree</u> of a vertex is the # of edges which have that vertex as the destination.

The <u>out-degree</u> - - - - - - - - - - - - - - - - source.

<u>Degree</u> = in-degree + out-degree

A <u>cycle</u> is a path that starts and ends at the same vertex.

DAG — directed acyclic graph

All trees have $|V|-1$ edges (except empty tree).

Every edge contributes 1 to a single vertex in-degree.

Graphs are good for describing relationships.