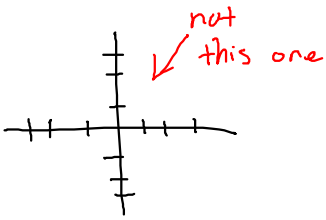
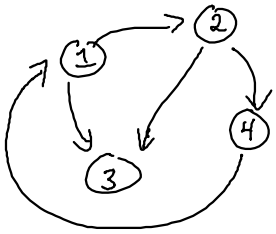
Graphs

What's an ADT?

abstract data type
describes what we ask a data structure to do but not how it works



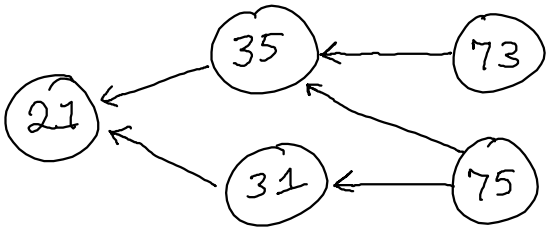


A graph G is a pair of sets V (nodes) (vertices) and E (edges).
An edge is an ordered pair of vertices.

Graphs are good at describing relationships.

$\langle \{1,2,3,4\}, \{\langle 1,2\rangle, \langle 1,3\rangle, \langle 2,3\rangle, \langle 2,4\rangle, \langle 4,1\rangle\} \rangle$

V E

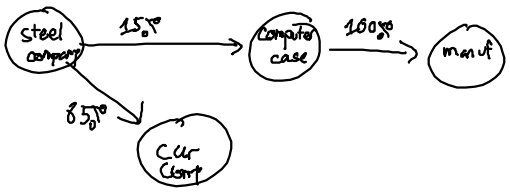


vertices: courses
edges: $\langle v_1, v_2 \rangle \Rightarrow v_1$ requires v_2

source target/destination

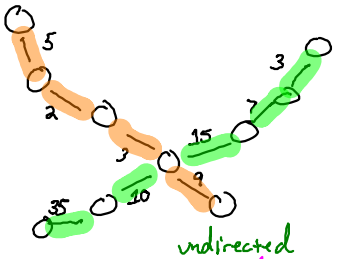
Example Graphs

Supply chain V: companies
E: provides to



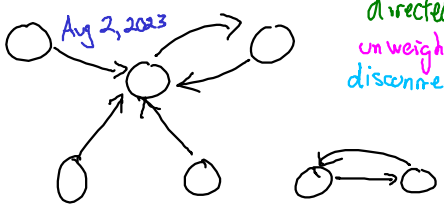
directed
weighted
disconnected

Transit V: locations (bus stop)
E: route between



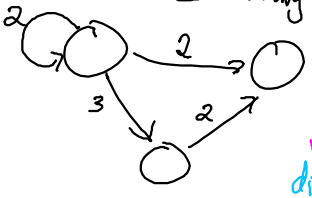
undirected
weighted
connected

Social media V: user
E: follows



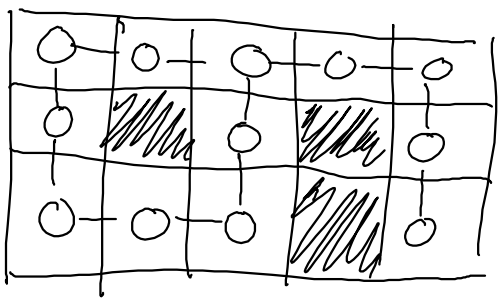
directed
unweighted
disconnected

Pokemon V: pokémon
E: strong against

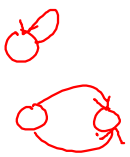


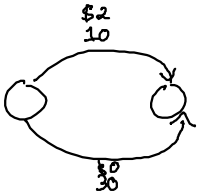
directed
weighted
disconnected

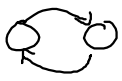
A graph is undirected if, for every edge $\langle V_1, V_2 \rangle$, it also contains the edge $\langle V_2, V_1 \rangle$.
A graph is directed if it is not undirected.
A graph is weighted if each edge is associated with a comparable (numeric) value.
A graph is labeled if edges contain additional information.
A path is a list of edges such that each edge's target is the next edge's source.
A graph is connected if, for every pair of vertices, there is a path from one to the other.
A graph is weakly connected if it would be connected were it undirected.
A graph is simple if there are no self-loops ($\langle V_1, V_1 \rangle$) and if it has at most one edge from each vertex to each other vertex.

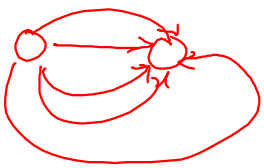


Not simple









What is the maximum number of edges in a directed simple graph?

$n(n-1)-1$