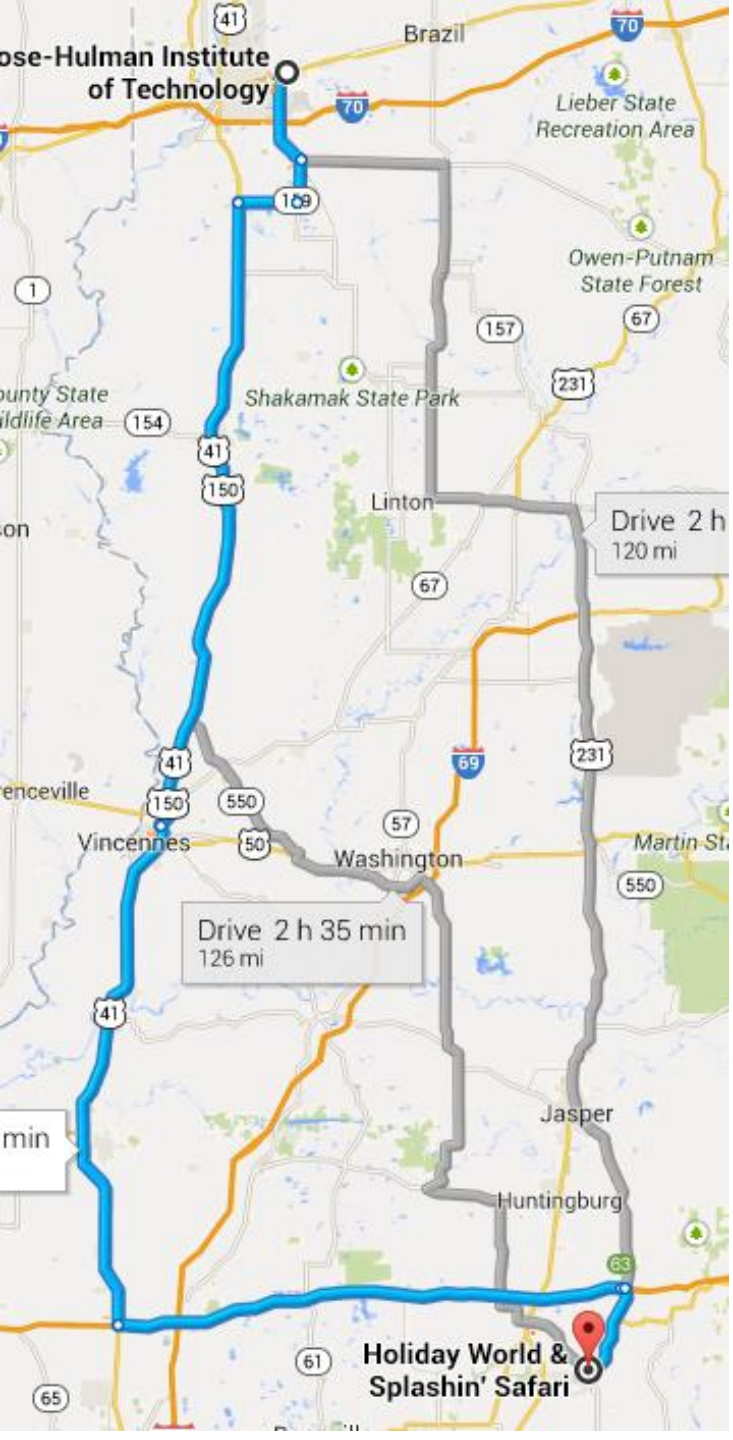
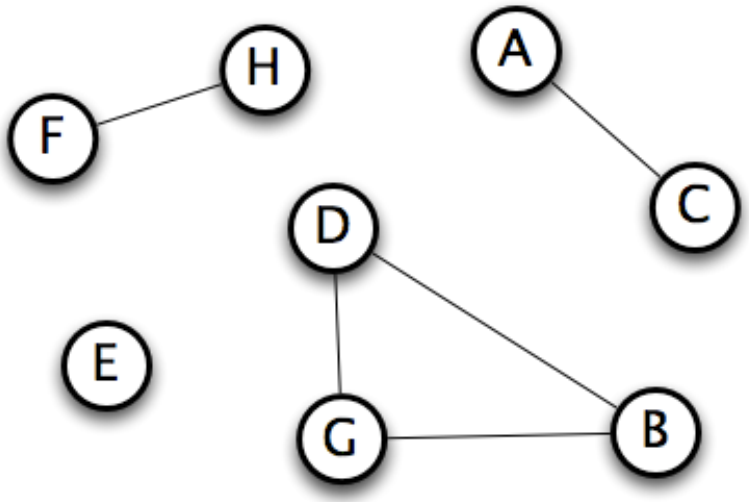




CSSE 230 Day 28

Graphs and their representations

After this lesson, you should be able to …
…explain what makes a graph different than a tree
… implement simple graph algorithms

https://www.google.com/maps/preview#!data=!1m4!1m3!1d989355!2d-87.4496039!3d38.8342589!4m26!3m17!1m5!1sRose-Hulman+Institute+of+Technology%2C+5500+Wabash+Ave%2C+Terre+Haute%2C+IN+47803!2s0x886d6e421b703737%3A0x96447680305ae1a4!3m2!3d39.482156!4d-87.322345!1m1!1sHoliday+World+%26+Splashin'+Safari%2C+Santa+Claus%2C+IN!3m8!1m3!1d245622!2d-86.923997!3d39.3256455!3m2!1i1920!2i955!4f13.1!5m2!1i3m1!1e1!7m4!1i1m3!1m1!1e1!2b1&fid=0

Graphs

Terminology
Representations
Algorithms

Example Graph

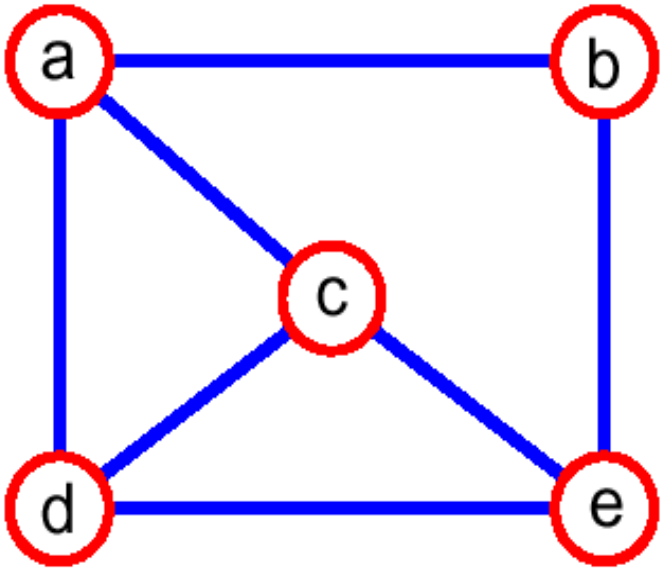
A **graph G** = (**V**,**E**) is composed of:

V: set of *vertices*

E: set of *edges* connecting the *vertices* in **V**

An **edge e** = (u,v) is a pair of vertices

Example:



V= {a,b,c,d,e}

E=
{(a,b),(a,c),(a,d),
(b,e),(c,d),(c,e),
(d,e)}

Graph Terminology

- Size? Edges or vertices?

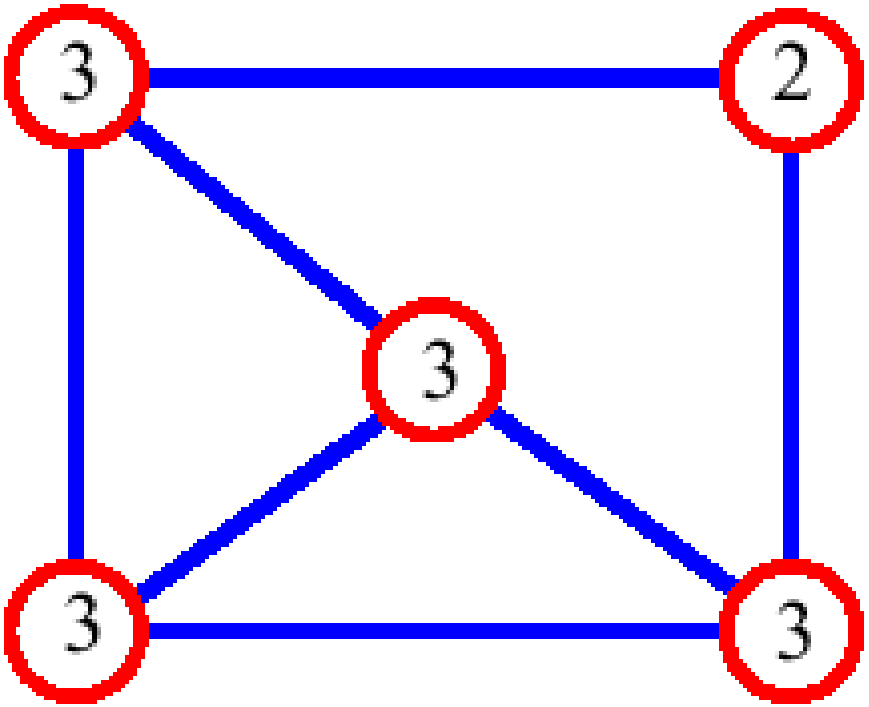
- In this class, we use
  - Size: # **V** (number of edges)

- But the runtime of graph algorithms often depend on the number of edges

Graph Terminology

also called "neighbors"

- adjacent vertices: connected by an edge
- degree (of a vertex): # of adjacent vertices

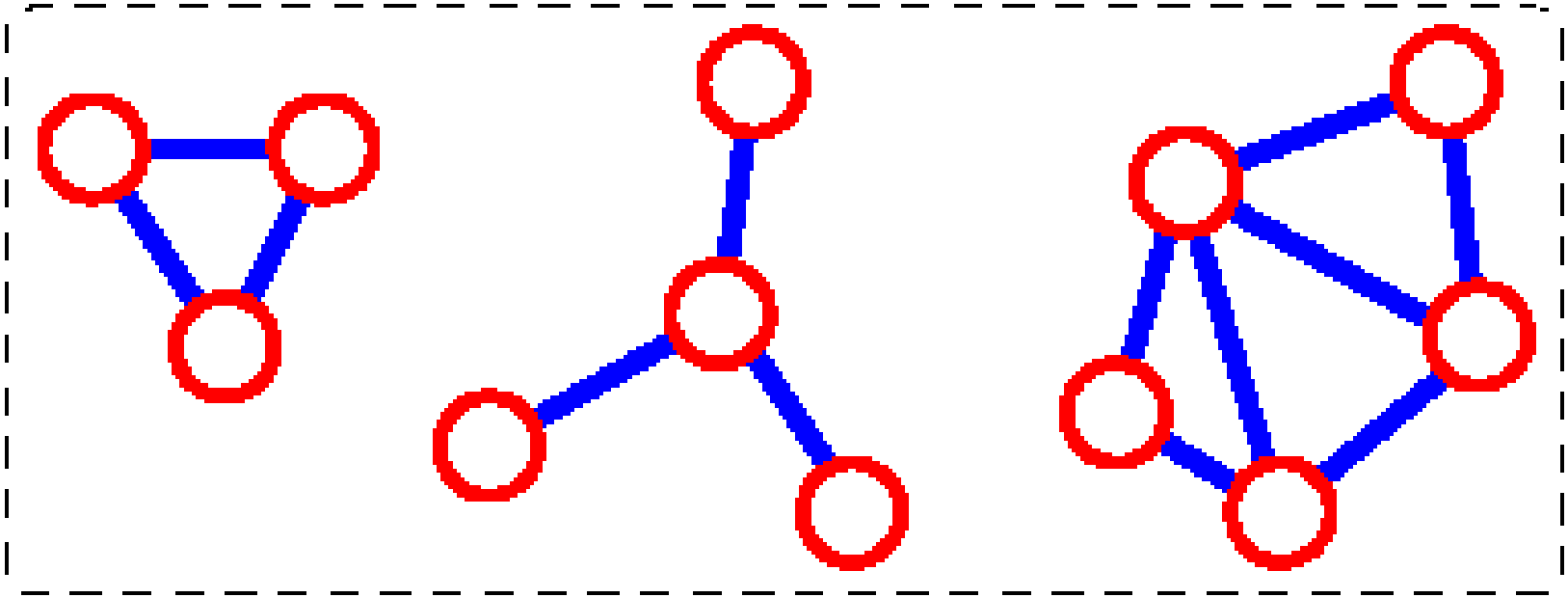


$$\sum_{v \in V} \deg(v) = 2(\#\text{ edges})$$

- Since adjacent vertices each count the adjoining edge, it will be counted twice

Continuing Graph Terminology

connected component: maximal connected subgraph. E.g., the graph below has 3 connected components.



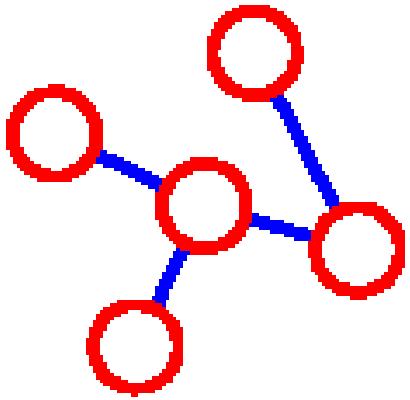
More Connectivity

n = #vertices

m = #edges

For a tree **m** = **n** - 1

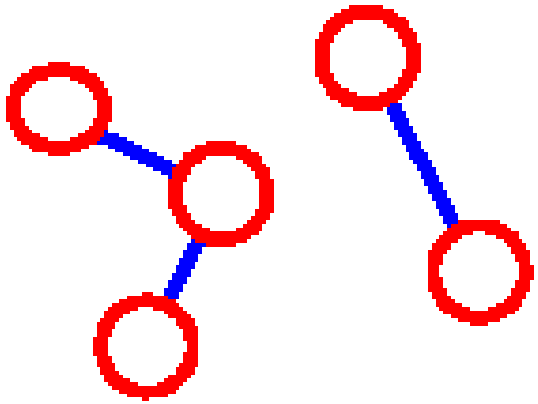
A necessary but not sufficient condition for a graph to be a tree.



n = 5

m = 4

If **m** < **n** - 1, G is not connected



n = 5

m = 3

We represent vertices using a collection of objects

- Each Vertex object contains information about itself
- Examples:
  - City name
  - IP address
  - People in a social network
- Observations about real graphs?

There are many options for representing edges of a graph

- Adjacency matrix
- Adjacency list. Each vertex stores…
  - pointers to other vertices?
  - named vertices using a HashMap<Name,Vertex>
  - An index into an array of the Vertex objects. In each case, we need a way to store the vertex collection
- Edge list

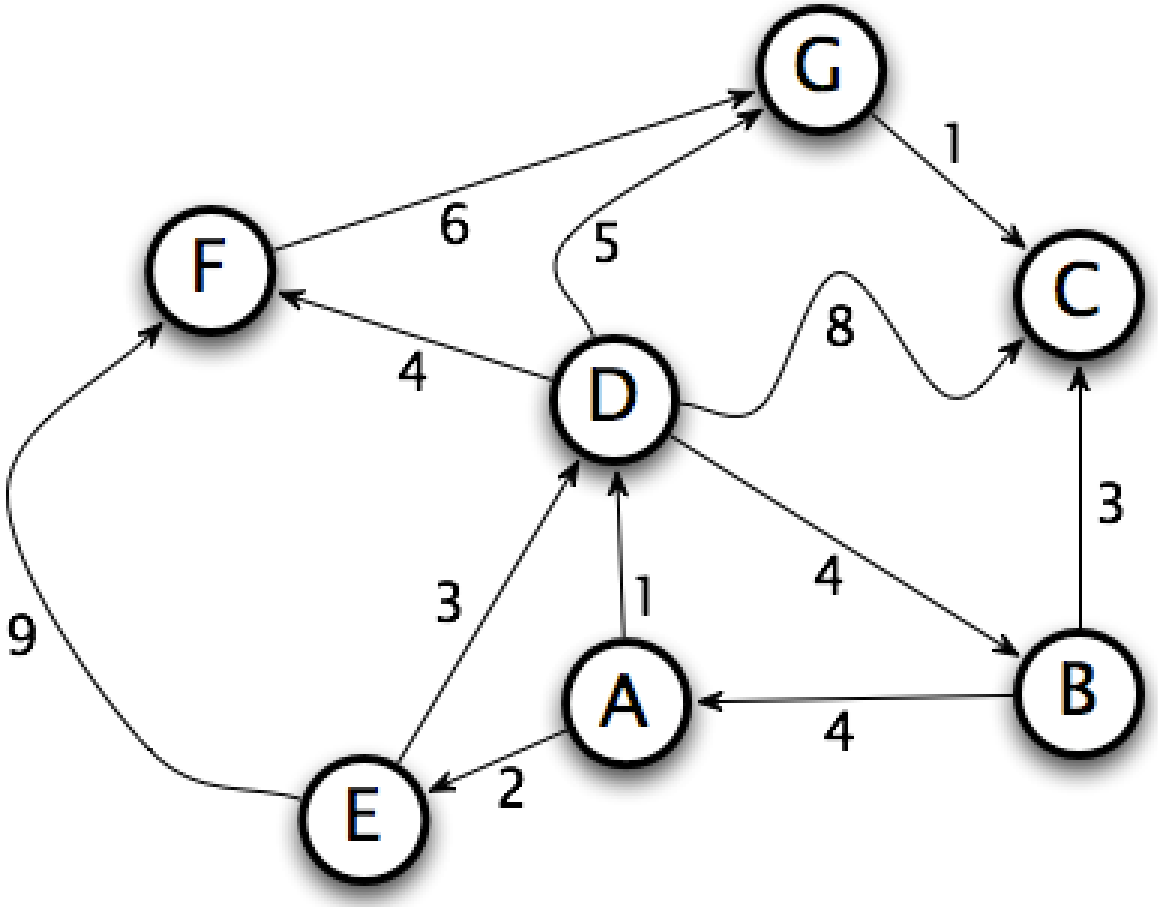
To consider:

Why not just use a triangular "matrix"?

Does a boolean adjacency matrix make sense?

Sample graph problem: Weighted Shortest Path

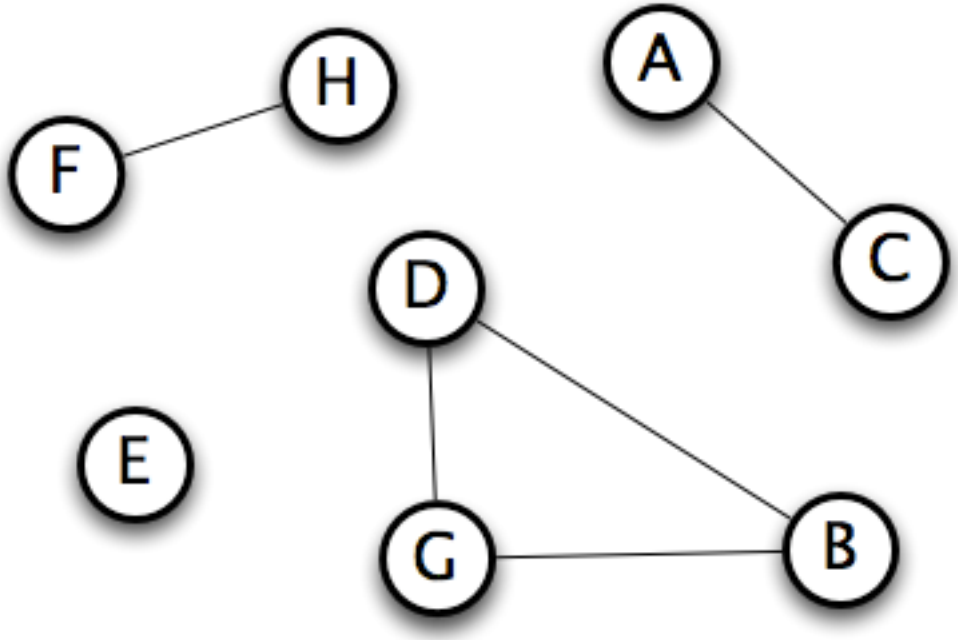
- What's the cost of the shortest path from A to each of the other nodes in the graph?



For much more on graphs, take MA/CSSE 473 or MA 477

Largest Connected Component

- What's the size of the largest connected component?



In SVN: RandomGraphs