Graphs

10 November 2020
[Review Lab 9]
Chemical bonds
Facebook helps you connect and share with the people in your life.
What's in common

Each of these structures consists of

a collection of objects and

links between those objects.

**Goal**: Find a general framework for describing these objects and their properties.
A *graph* is a mathematical structure for representing relationships between entities.
A graph consists of a set of **nodes** (or **vertices**) connected by **edges** (or **arcs**).
A graph consists of a set of **nodes** (or **vertices**) connected by **edges** (or **arcs**).
A graph consists of a set of nodes (or vertices) connected by edges (or arcs).
Some graphs are *directed*. 
Some graphs are **undirected**.
Every undirected graph can also be represented as a directed graph, albeit with twice the edges.
How can we represent a graph?
For the (more realistic) rumor mill domain, we had

```
(define-struct gossip [who next])
;; A Gossip is a
;; (make-gossip Image [List-of Gossip])
```

The general version for an $n$-ary tree is:

```
(define-struct node [id children])
;; A Tree is a (make-node String [List-of Tree])
```

Graphs are a lot like trees. Can we do the same thing?
(define-struct vertex [name neighbors])

;; A Graph is (make-vertex String [List-of Graph])
(define-struct vertex [name neighbors])
;; A Graph is (make-vertex String [List-of Graph])

This breaks horribly if there are cycles in the graph.

(make-vertex "🐱"
  (list (make-vertex "🦦"
    (list (make-vertex "🐱" ... ...) ...) ...) ...) ...)
Better plan:

```
(define-struct vertex [name neighbors])
;; A Vertex is
;;   (make-vertex String [List-of String])
;; A Graph is [List-of Vertex]
```

This is called an “adjacency list” representation.
Example: London Underground
This isn't a complete model. We could keep adding directional edges – and, in fact, all of the stations that are connected would eventually have edges going both ways.
Acknowledgments

This lecture incorporates material from:

Keith Schwarz, Stanford
Laney Strange, Northeastern