




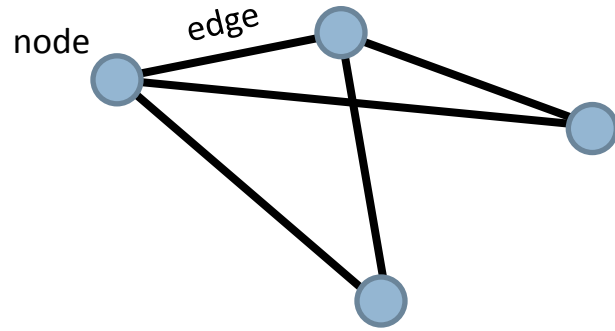
Graphs and Networks

John C. Hart

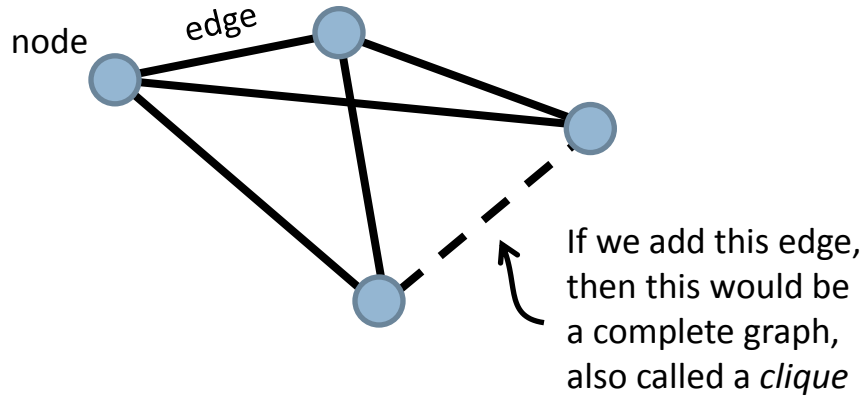
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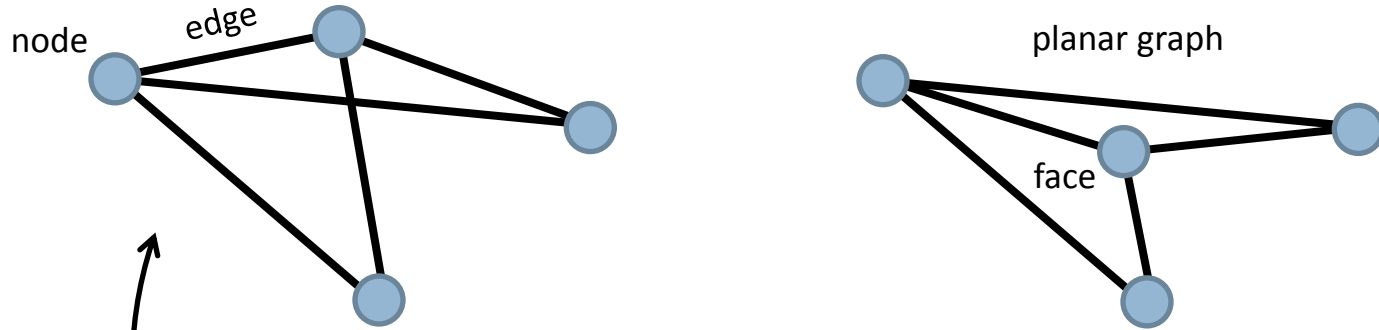
Graphs



Graphs



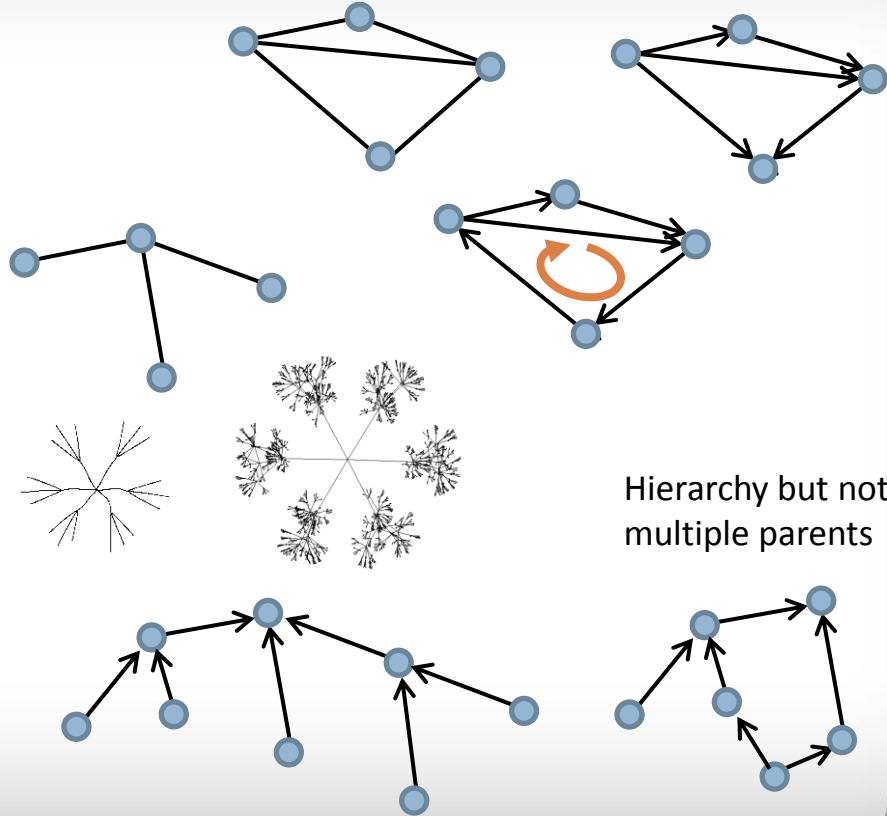
Graphs



The left graph and the right graph are *isomorphic*, two different *embeddings* of the same relationship. Together, then they form a single *disconnected* graph with two *connected components*

Directed Graphs and Hierarchies

- Directed v. undirected
- Cyclic v. acyclic
- Tree
 - minimally connected
 - n nodes, $n-1$ edges
 - Single parent node can have multiple child nodes (siblings)
- Hierarchy
 - acyclic directed graph
 - root node

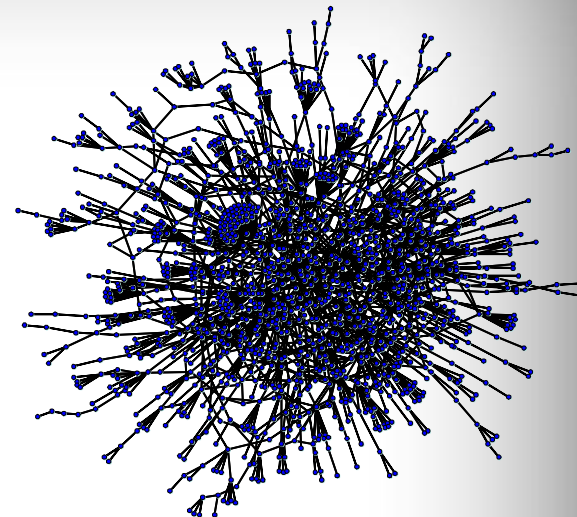
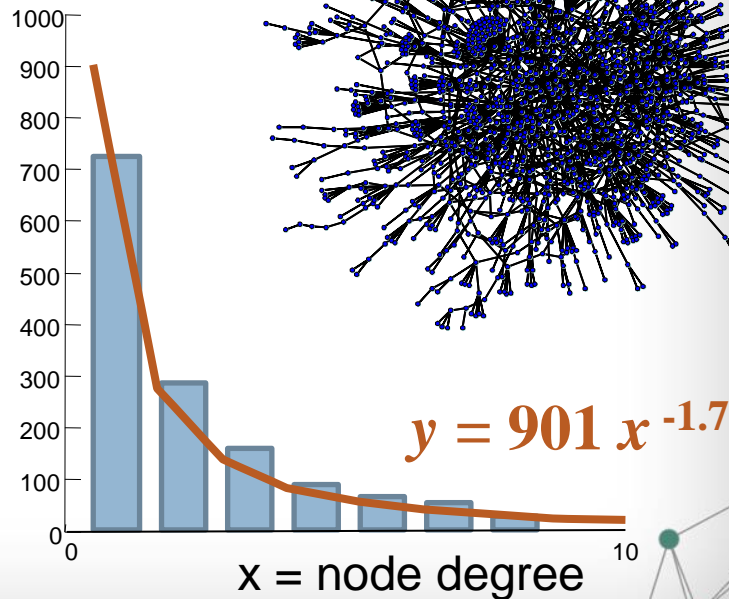


Node Degree

1,458 yeast proteins
1,948 interactions

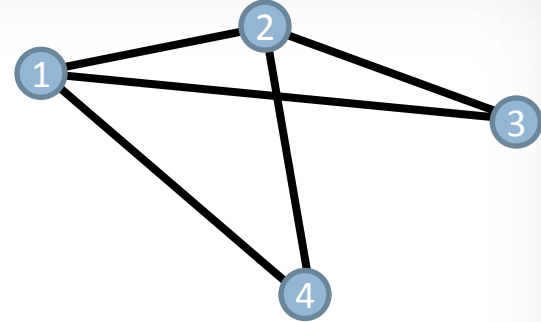
- Degree of a node = number of edges
 - Directed graph nodes have an in-degree and an out-degree
- Social networks
 - Many low degree nodes and fewer high degree nodes
 - Also called logarithmic, power-law or scale-free graphs

y = nodes
w/deg. x



Adjacency Matrix

- Matrix representation of a graph
- Square matrix
 - # of rows & columns = # of nodes
- Row i column j set to one if edge connects node i to node j, otherwise zero
- Symmetric, unless directed graph
- Can also use weighted edges
- Diagonal can represent edge between a node and itself



$$A = \begin{bmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 \end{bmatrix}$$

...this node

One if this node
is connected to...

