Introduction

2011.10.03(Mon)

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- Definition
- Why important?
- Examples of networks
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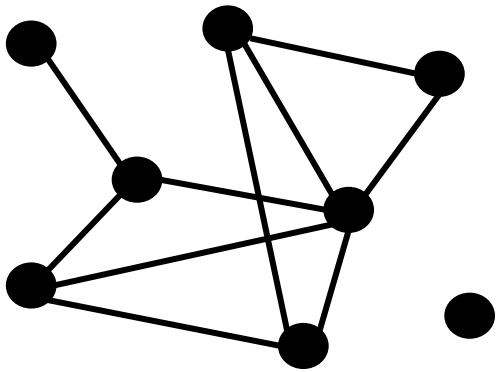
Definition

- a collection of points joined together in pairs by lines

vertices, nodes

edges

- many objects in physical, biological, and social sciences can be thought of as networks



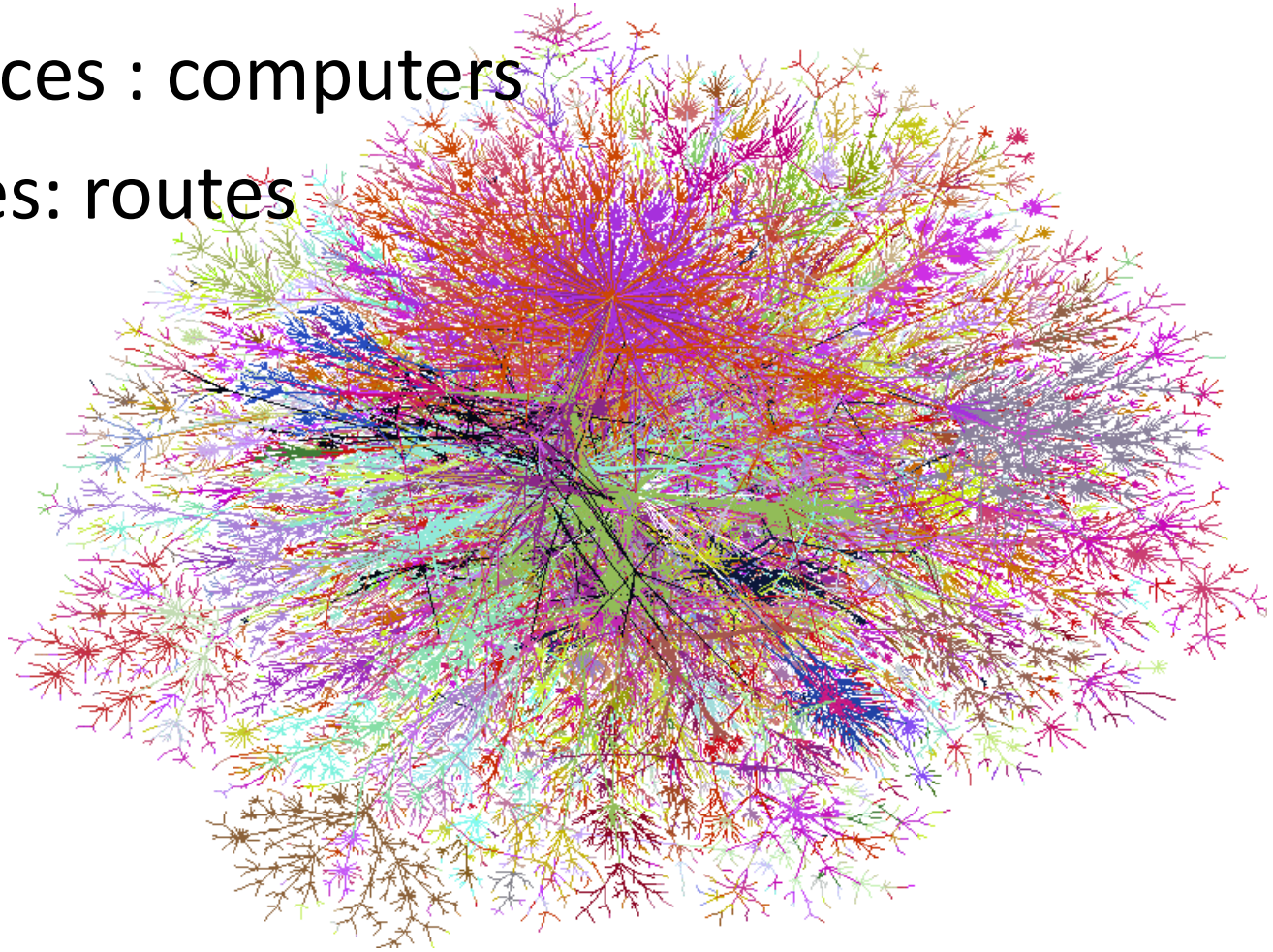
Why important?

- individual parts or components in many systems are linked together
- many aspects are worthy of study
  - the nature of individual components
    - how a computer works
  - the nature of connections or interactions
    - communication protocols on the Internet
  - the pattern of connections between components

the structure of the network

Examples- Internet

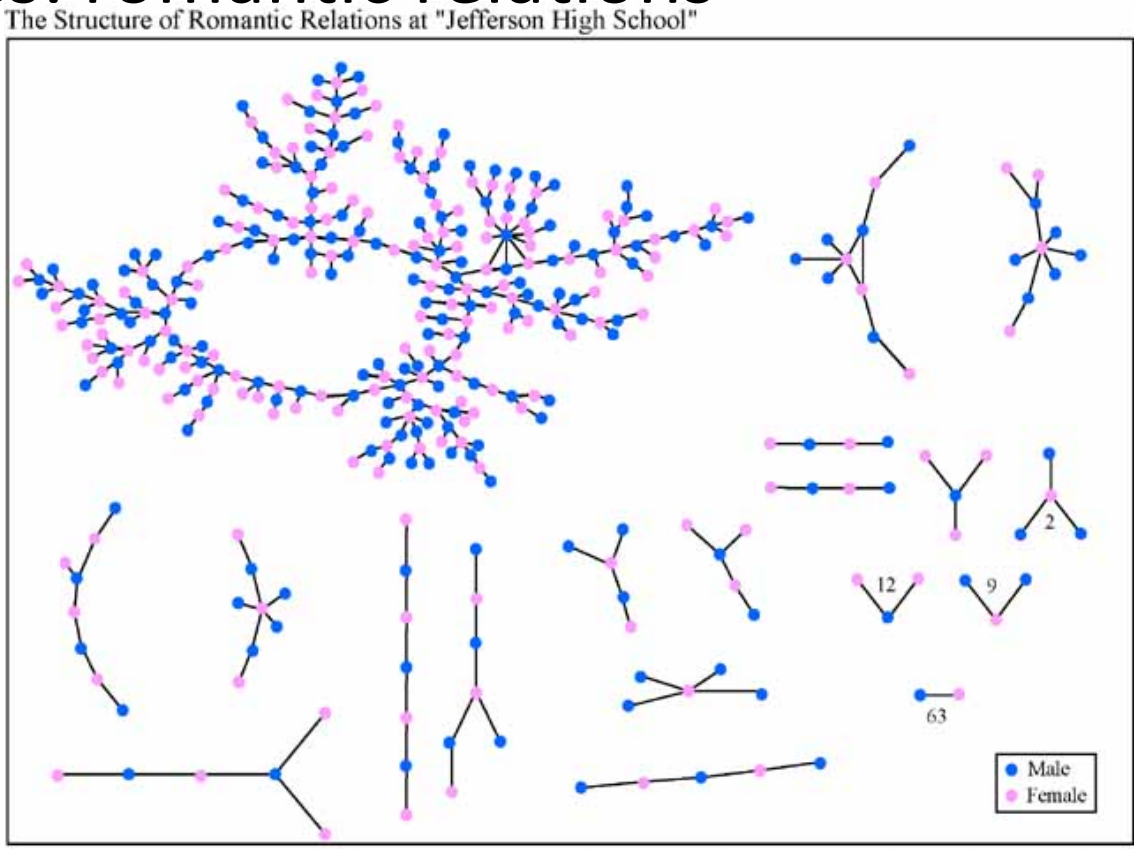
- vertices : computers
- edges: routes



William R. Cheswick, http://www.cs.bell-labs.com/~ches/map/index.html

Examples-social network

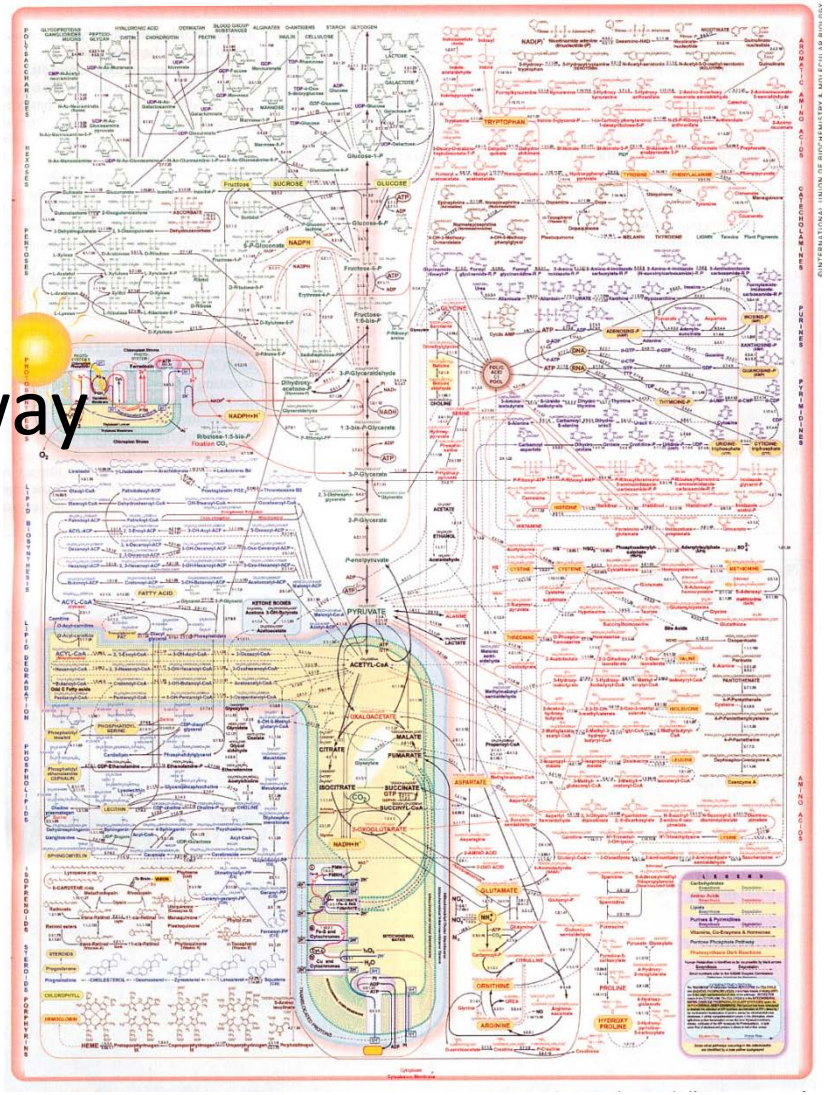
- vertices: boys & girls
- edges: romantic relations



http://researchnews.osu.edu/archive/chainspix.htm

Example-metabolic network

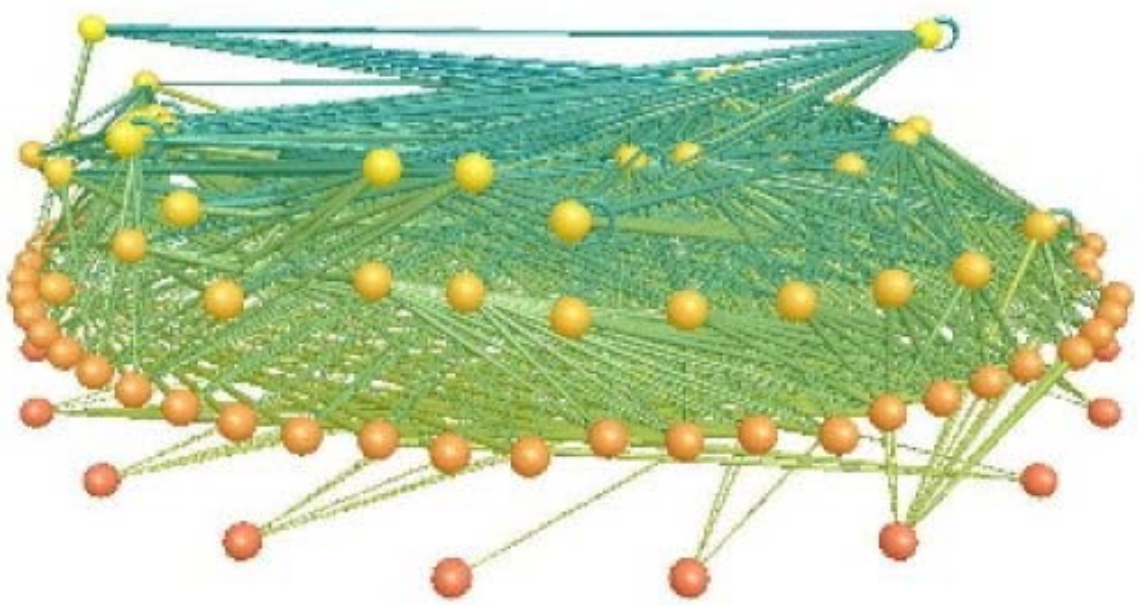
- vertices: carbohydrase, amino acid, lipid
- edges: metabolic pathway



Donald Nicholson, http://www.iubmb-nicholson.org/chart.html

Example-food web

- vertices: species in a lake in northern US
- edges: predatory interactions



http://thecity.sfsu.edu/~wow/gallery.html

What you should see

- dense groups
- inherent structures: bipartite, hierarchical
- dynamic: addition/deletion of edges/vertices
- properties of networks: connectivity, robustness
- properties of vertices: hubs
- properties of edges : betweenness

What are the challenges

- finding groups
- predicting dynamic networks
- describing characteristics: properties of degree distributions (scale-free, small world...)
- connectivity : robustness for changes
- spread of diseases/news : detecting key persons/pathways

questions about the networks

- What can we do with the network?
- What can they tell us about the form and functions of the system the network represents?
- What properties of networked systems can we measure or model and how are those properties related to the practical issues we care about?

analyzing networks

- make a picture of the network
  - only useful for networks up to a few hundreds or thousands of vertices -> needs for other techniques
- properties of networks
  - centrality : importance of vertices (or edges)
    - degree (undirected)
    - in-degree, out-degree (directed)
    - hub : vertices with high degree
  - small-world effect
    - mean geodesic distance between vertex pair is very short (logarithm of the number of vertices in the network)
    - six degrees of separation <-rumor will spread fast
  - communities : tightly knit groups
    - the way a network breaks down into communities can help us to understand how a system is structured