

Complex Networks

Introduction

2013.10.07(Mon)

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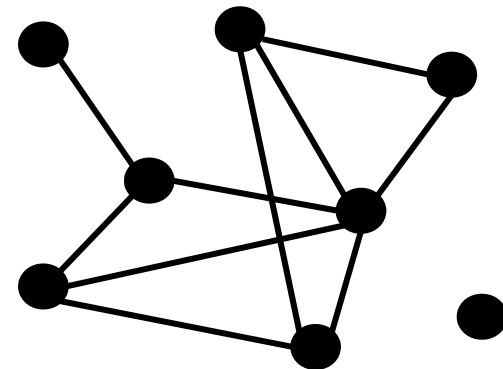
Definition

- a collection of points joined together in pairs by lines

edges

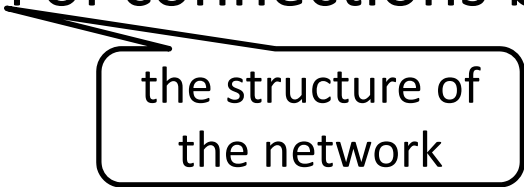
vertices, nodes

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



Why important?

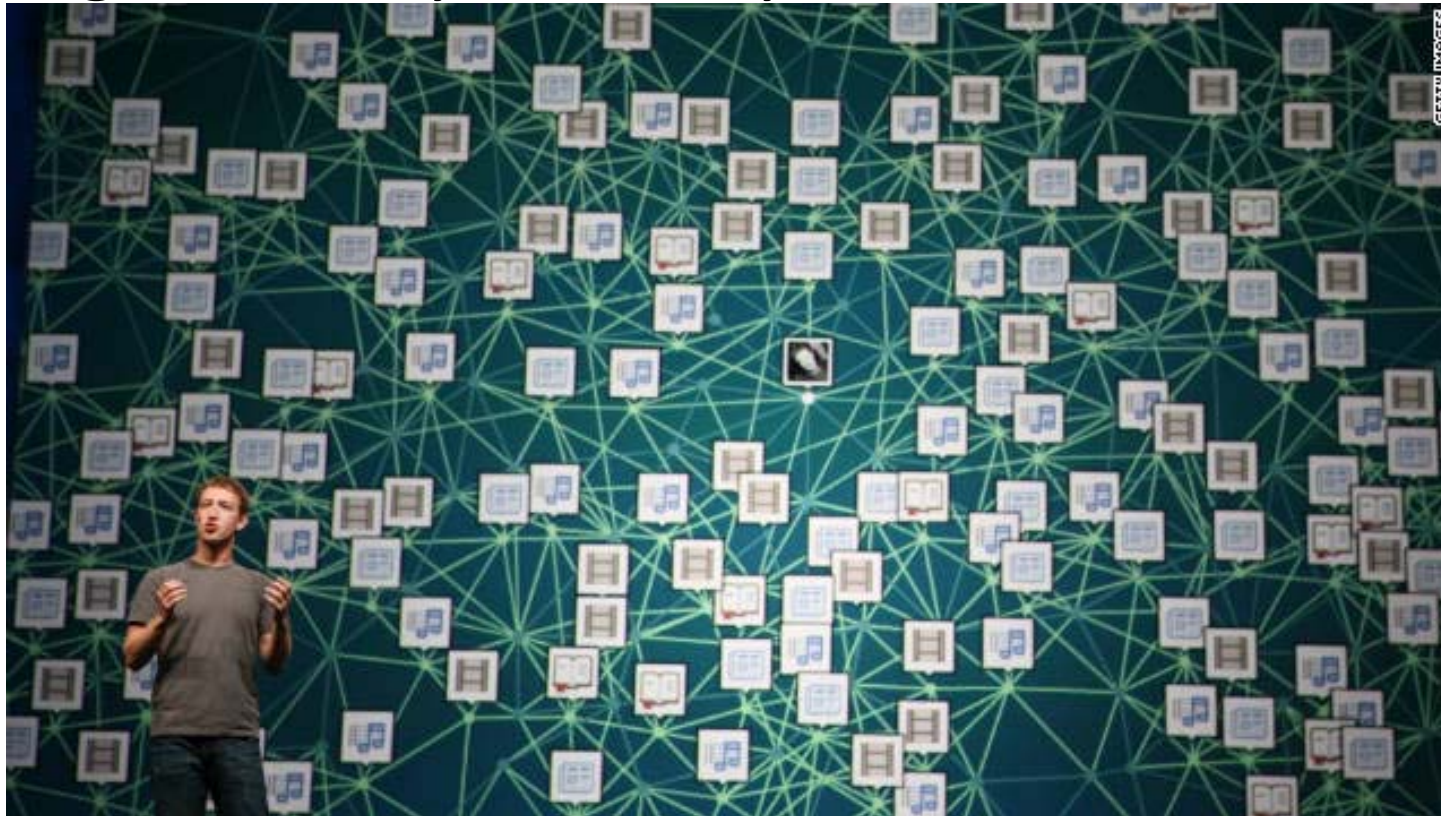
- individual parts or components in many systems are linked together
- many aspects are worthy of study
 - the nature of individual components
 - how a computer works
 - the nature of connections or interactions
 - communication protocols on the Internet
 - the pattern of connections between components



the structure of
the network

Examples - Facebook

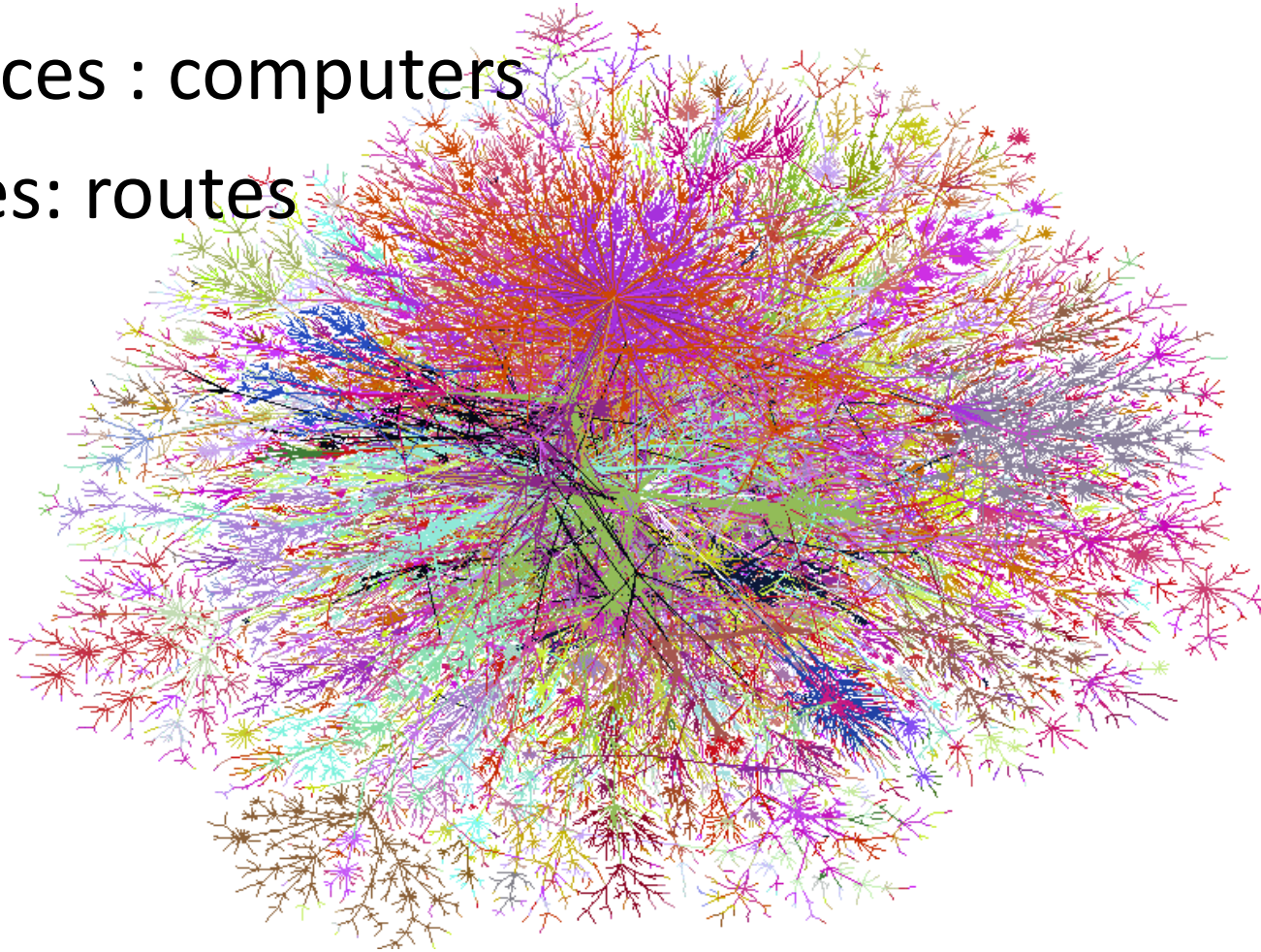
- On Facebook, the average user is only 4.74 degrees away from any other Facebooker.



<http://edition.cnn.com/2011/11/22/tech/social-media/facebook-six-degrees/index.html>

Examples- Internet

- vertices : computers
- edges: routes

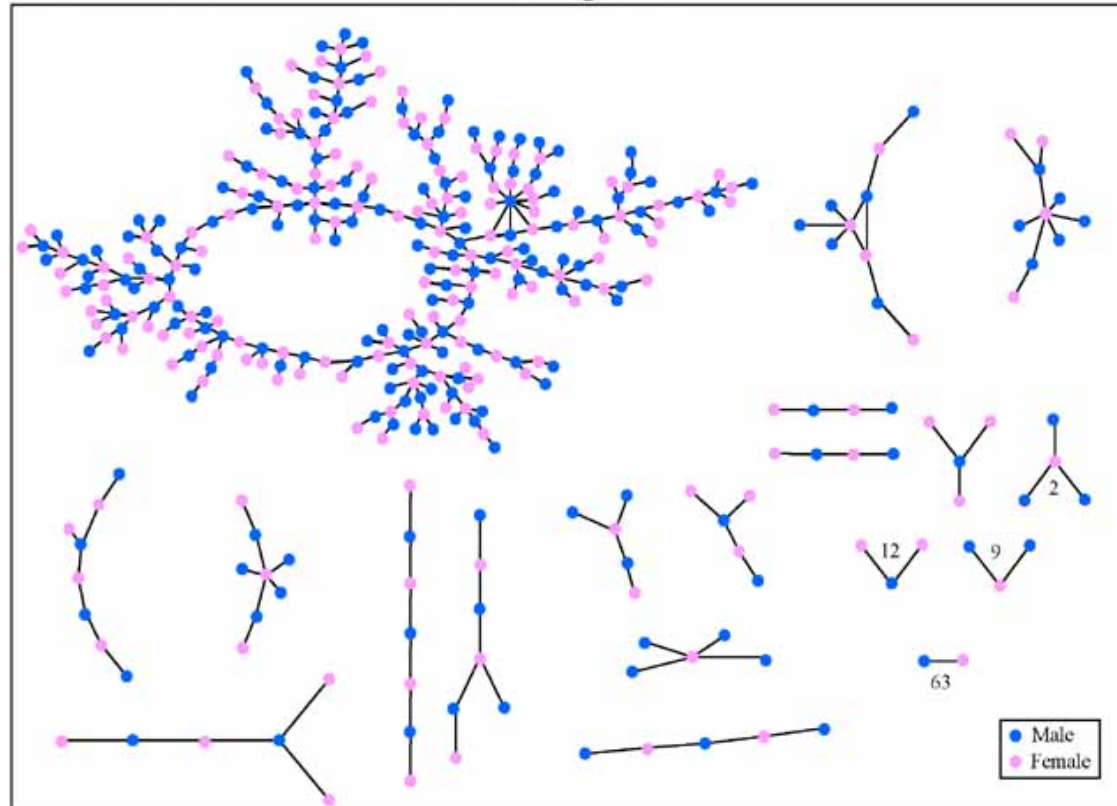


William R. Cheswick, <http://www.cs.bell-labs.com/~ches/map/index.html>

Examples-social network

- vertices: boys & girls
- edges: romantic relations

The Structure of Romantic Relations at "Jefferson High School"

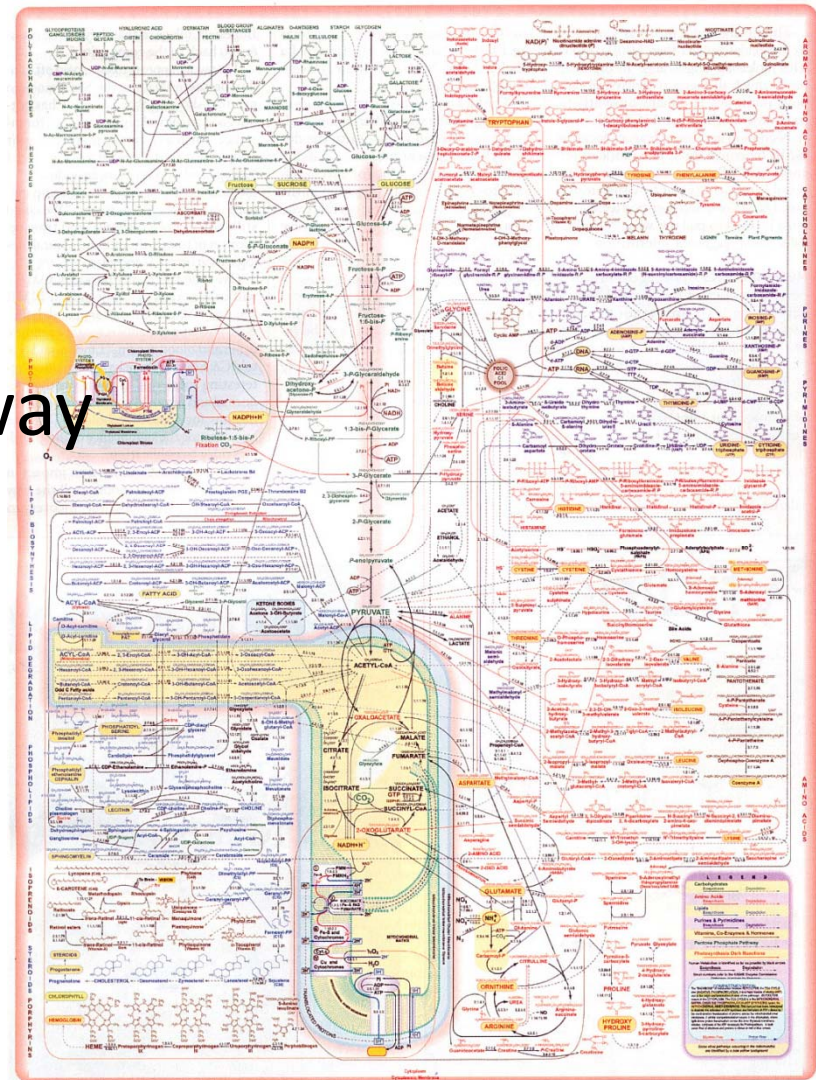


Each circle represents a student and lines connecting students represent romantic relations occurring within the 6 months preceding the interview. Numbers under the figure count the number of times that pattern was observed (i.e. we found 63 pairs unconnected to anyone else).

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

Example-metabolic network

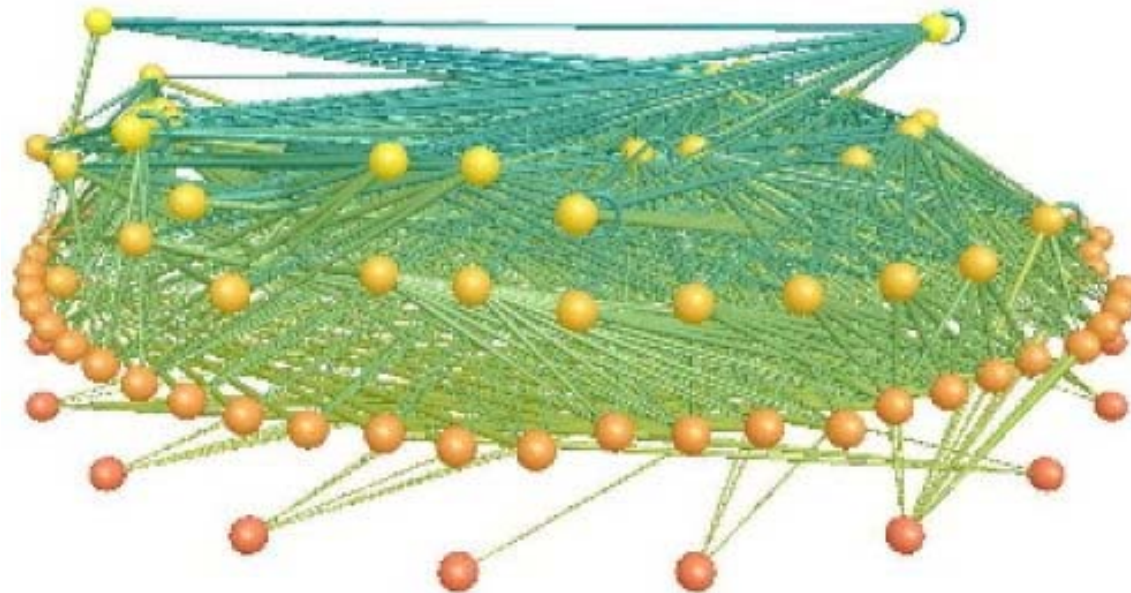
- vertices: carbohydrate, amino acid, lipid
- edges: metabolic pathway



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>

You will find ...

- dense groups
- inherent structures: bipartite, hierarchical
- types of edge : directed/weighted, positive/negative, ...
- dynamics: addition/deletion of edges/vertices

What are the challenges?

- finding groups in networks
- predicting future structures of dynamic networks
- selecting influential vertices
- modeling: properties of degree distributions (scale-free, small world...)
- processes on networks: spread of diseases/news
 - detecting key persons/pathways for diffusion
 - preventing infections of diseases

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?