

Network Basics

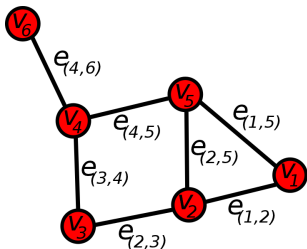
Nick McCullen

Complex systems

- Complex System:
 - System of many components;
 - relationships between components are important;
 - evolution of components' properties governed by *rules* of interaction;
 - behaviour of system at larger scales emerges naturally through interactions:
 - “*emergent properties*”:

Network models of complex systems

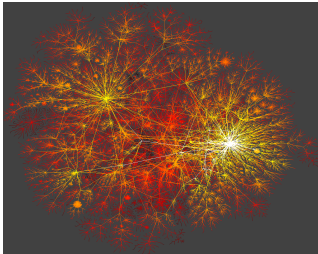
- Individuals are considered as *nodes* on a network.
 - Properties of nodes are associated with variables.
- *Links* ('edges') transmit information between individuals.



- Dynamical equations determine system evolution.

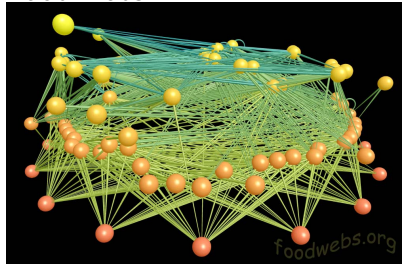
Examples of Networks

The Internet:



http://www.eee.bham.ac.uk/com_test/dsnl.aspx

Food webs:



www.foodwebs.org, Yoon *et al.* (2004)

Network models

- Various complex network models exist to reproduce empirical observations.

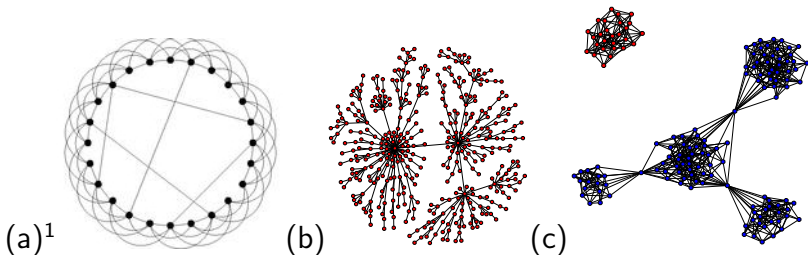


Figure: (a): *Small world* network. (b): *Preferential attachment* model. (c): *Community structured* model.

¹ *Networks: An Introduction*, M. E. J. Newman, Oxford University Press (2010).

Summary of Dynamical Network Models

- Networks can be used to represent interactions between individuals in a complex system.
- Specify topology:
 - who interacts with whom:
 - the **network**.
- Specify dynamics:
 - behaviour of individual components,
 - interaction of components:
 - **coupled dynamical systems**.
- Simulate on a computer and use analysis to gain insight.