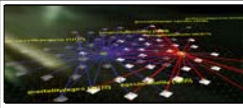


Diffusion of Innovations

Diffusion is the process by which an *Innovation* is *Communicated* through certain *Channels* over *Time* among the members of a *Social System.*

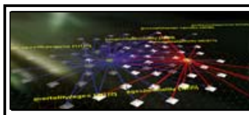
Source: The Diffusion of Innovations Model and Outreach from the National Network of Libraries of Medicine to Native American Communities by Everett M. Rogers and Karyn L. Scott

But, there is a difference in the diffusion of

- Innovations/Information
- Infections
- People

And all three of them might spread over

- Geographic space
- Semantic space and/or
- Time.



The Innovation

Characteristics which determine an innovation's rate of adoption are:

1. relative advantage,
2. compatibility,
3. complexity,
4. trialability, and
5. observability.

Innovations that are perceived by individuals as having <u>greater</u> relative advantage, compatibility, trialability, observability, and <u>less</u> complexity will be adopted more rapidly than other innovations.

Source: The Diffusion of Innovations Model and Outreach from the National Network of Libraries of Medicine to Native American Communities by Everett M. Rogers and Karyn L. Scott

Diffusion Channels

Information diffusion can happen through

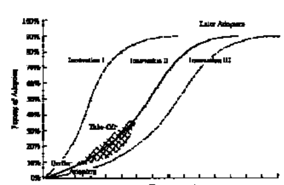
Simultaneous invention: lot's of people simply come to the same conclusion at about the same time (e.g., many companies seem to have decided independently that it is important to have a web site on the internet).

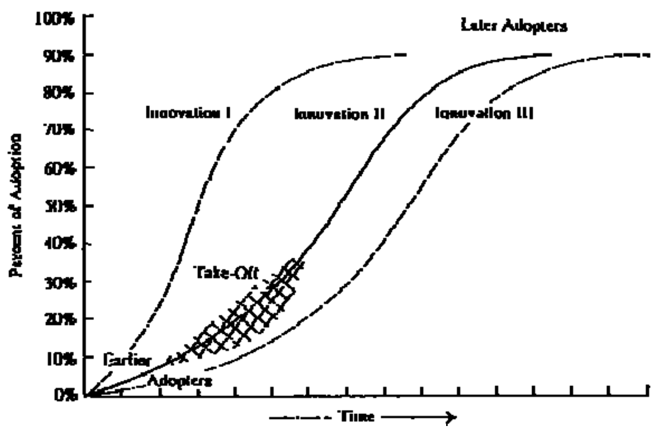
Another way things can diffuse is through some kind of **broadcasting** — such as a radio station broadcasting the news. Another way it occurs is via word-of-mouth: person to person transmission.

Adoption of Innovation is a special kind of diffusion where a new product or behavior is acquired. For example, it used to be that in America people believed that tomatoes were poisonous and wouldn't eat them. Eventually, though, through immigrants, people started eating them. Similarly, people all over the world are buying personal computers, something that essentially did not exist before the 1980s.

Time

- Innovators are the first 2.5 percent of the individuals in a system to adopt an innovation and play a gatekeeping role in the flow of new ideas into a system.
- Early adopters are the next 13.5 percent of the individuals in a system to adopt an innovation. This adopter category, more than any other, has the greatest degree of opinion leadership in most systems.
- Early majority is the next 34 percent of the individuals in a system to adopt an innovation. They are not the first by which the new is tried, nor the last to lay the old aside.
- Late majority is the next 34 percent of the individuals in a system to adopt an innovation.
- Laggards are the last 16 percent of the individuals in a system to adopt an innovation.





Bass Curve

The spread of a new method or concept in a market can be characterized by the *Bass formula*:

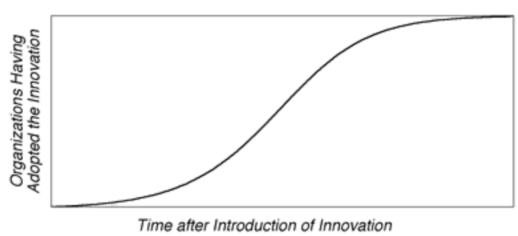
$$N_t = N_{t-1} + p\left(m - N_{t-1}\right) + q\,\frac{N_{t-1}}{m}\left(m - N_{t-1}\right)$$

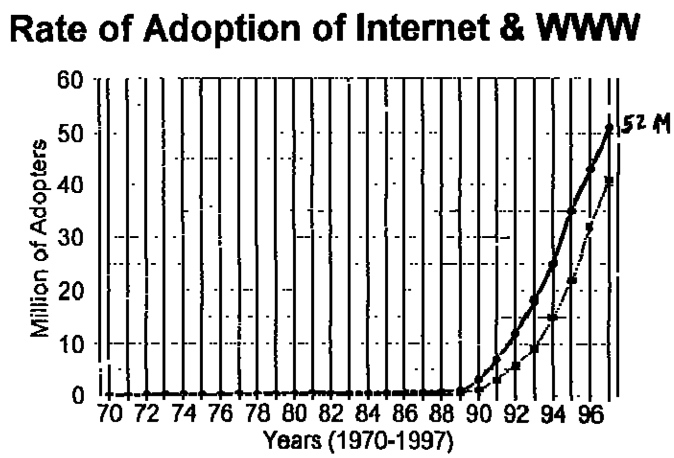
The three parameters of the model are:

m = the market potential; the total number of people who will eventually use the product.

p= the coefficient of external influence; the likelihood that somebody who is not yet using the product will start using it because of mass media coverage/external factors.

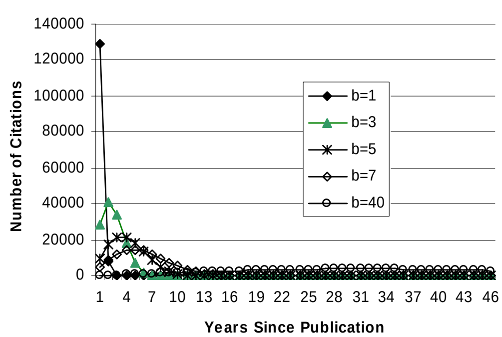
q= the coefficient of internal influence; the likelihood that somebody who is not yet using the product will start using it because of "word-of-mouth" or other influence from those already using the product.

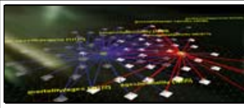




Aging

Old innovations are not very "hot".





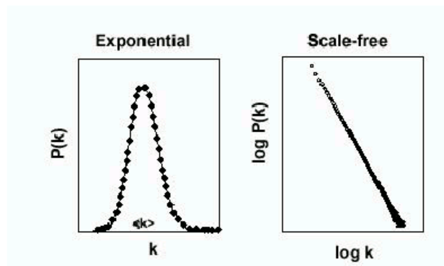
Social Systems/Social Networks

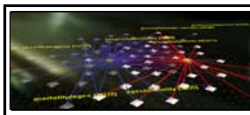
Are important for the diffusion of innovations, diseases, rumors, etc. E.g., a doctor persuades his friends, who then persuade their friends, etc. to adopt a new treatment.

Interestingly, many social and physical networks are scale free.

The degree distribution of a random graph is a Poisson distribution. For most large networks the degree distribution has a power law tail. Such networks are called scale free.

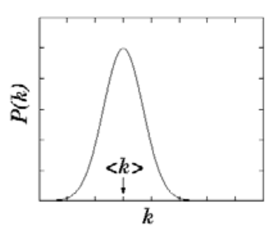
WWW in	$\gamma = 2.1$
WWW out	$\gamma = 2.45$
Actor	$\gamma = 2.3$
Citation Index	$\gamma = 3$
Power Grid	$\gamma = 4$

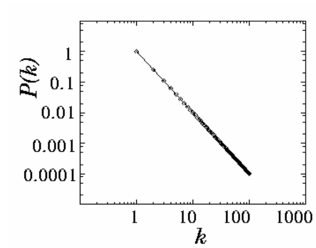


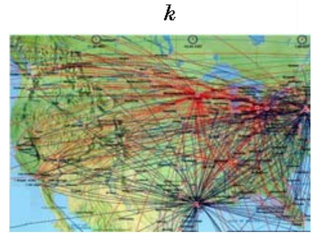


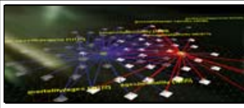
Exponential Network vs. Scale Free Network

Poisson distribution vs. Power-law distribution









Random and Scale Free Networks

(a) The Erdös-Rényi random-graph model is constructed by laying down N nodes and connecting each pair with probability p. This network has $N = 10$ and $p = 0.2$. Since 45 connecting pairs can be formed, we expect the network to contain approximately 9 links.

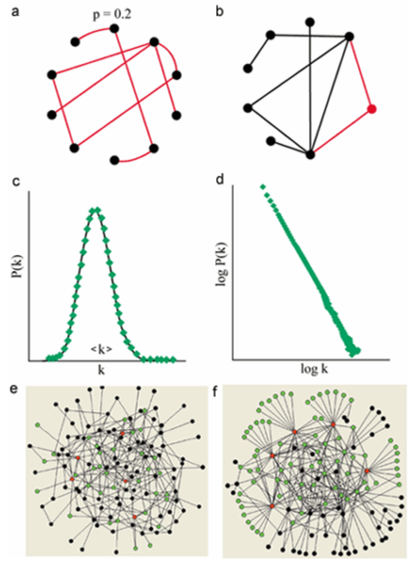
(b) The scale-free model assumes that the network continually grows by the addition of new nodes. A new node (red) connects to two existing nodes in the network (black) at time $t + 1$. This new node is much more likely to connect to highly connected nodes, a phenomenon called preferential attachment.

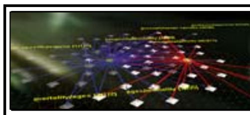
(c) The network connectivity can be characterized by the probability $P(k)$ that a node has k links. For random graphs $P(k)$ is strongly peaked at $k = \langle k \rangle$ and decays exponentially for large k.

(d) A scale-free network does not have a peak in $P(k)$, and decays as a power law $P(k)$ ~ k-g at large k.

(e) A random network is rather homogeneous, i.e. most nodes have approximately the same number of links.

(f) The majority of nodes in a scale-free network have one or two links, but a few nodes have a large number of links; this guarantees that the system is fully connected. More than 60% of nodes (green) can be reached from the five most connected nodes (red) compared with only 27% in the random network. This demonstrates the key role that hubs play in the scale-free network. Both networks contain the 130 nodes and 430 links.





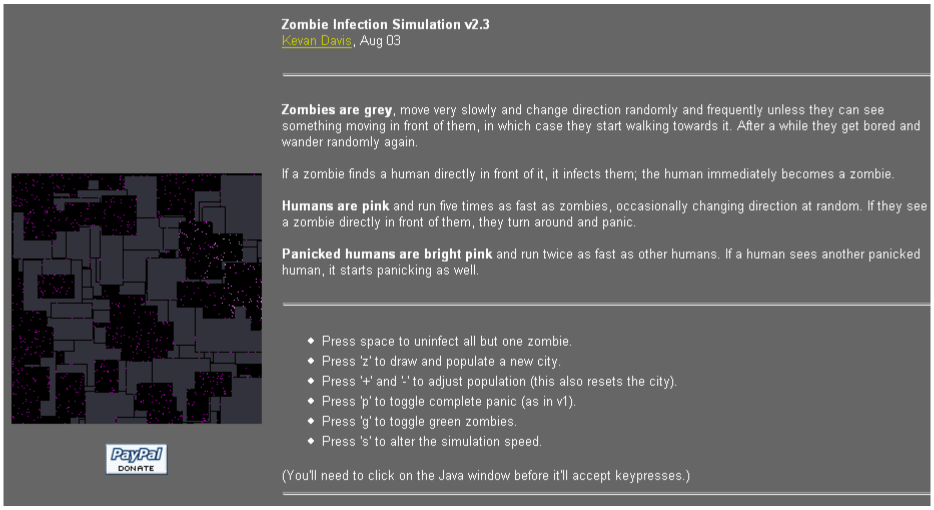
Network Analysis and Modeling – L597

Teaches major network analysis and modeling algorithms to help understand

- **Information diffusion.** How does information spread via a word-of-mouth campaign? Who should receive free samples of a new product to maximize sales?
- **How do viral epidemics spread in contact networks?** How to distribute a limited number of vaccinations throughout the population?
- **Vulnerability of data networks.** How robust are different network structures? Which ones are least vulnerable?

http://www.computerworld.com/securitytopics/security/story/0,10801,73987,00.html

Why Modeling?



http://kevan.org/proce55ing/zombies/

InfoVis Lab Projects

Visualizing Social Diffusion Patterns

- Of user activity in persistent virtual worlds.
- World are online accessible via modem & standard PC using a slim client.
- Some worlds are 8 years old, as large as UK, attract as many as 10,000 users.

Browser client has

- List of worlds (left)
- 3D world browser (middle)
- 2D Web interface (right)
- Chat window (below 3D window).

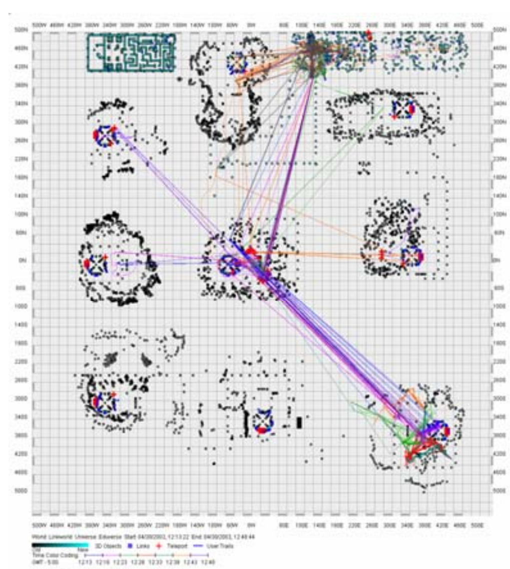
LinkWorld Project - Mapping the Activity of Single Users

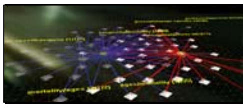
Map of world is generated based on 3D objects in this world. Younger objects are light green, old ones are dark green.

Icons are used to denote Web links, teleports, etc.

Recorded positions of single users are interconnected by polylines.

Color coding indicates the time at which different places were visited.

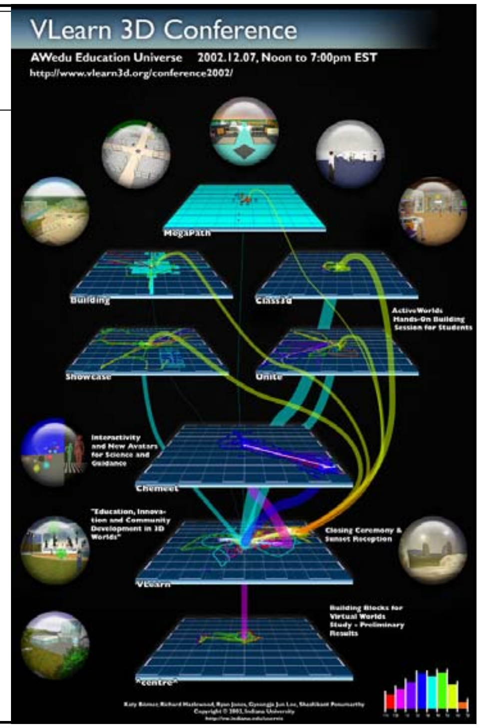


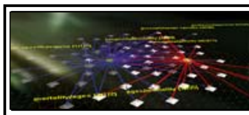


VLearn 3D Vis

Temporal-spatial distribution of Conference attendees

- Conference worlds are represented by square, perspective maps, each labeled by its name.
- Worlds accessed at the beginning of the conference are placed at the bottom, worlds accessed later toward the top.
- Next to each world is a circular snapshot of the virtual venue. Short descriptions of the main sessions are added as text.
- Major jumps between worlds are visualized by transparent lines. The thickness of each line corresponds to the number of traveling users. Color coding was used to denote the chronological paths of the conference sessions.





Information Diffusion Patterns

Top 500 most highly cited U.S. institutions.

Each institution is assumed to produce and consume information.

Does Internet lead to more global citation patterns, i.e., more citation links between papers produced at geographically distant research instructions?