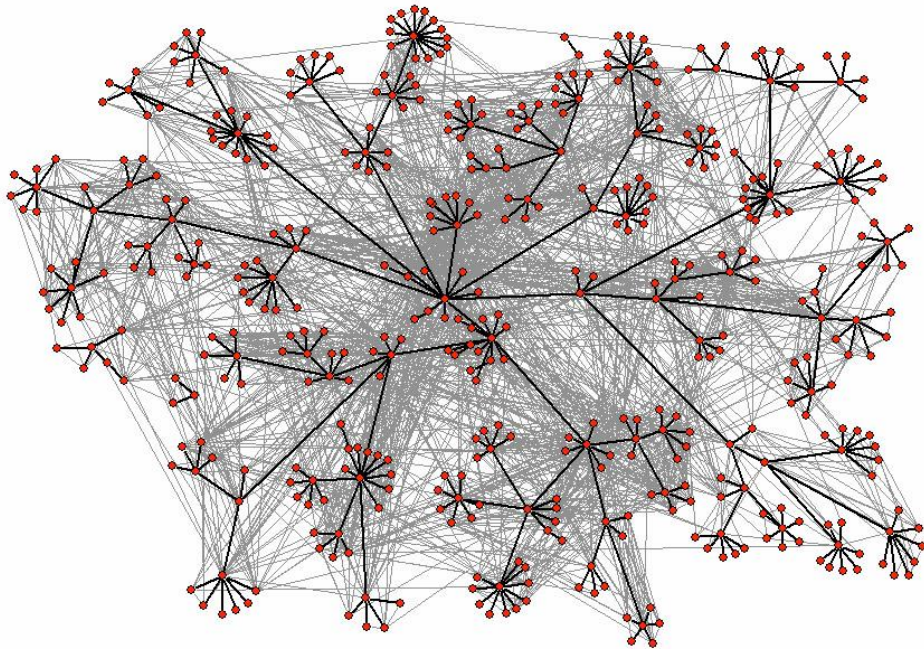


Epidemics in Social Networks



Epidemic Processes

Epidemics, Influence, Propagation

- Viruses, diseases
- Online viruses, worms
- Fashion
- Adoption of technologies
- Behavior
- Ideas

Example: Ebola virus

- First emerged in Zaire 1976 (now Democratic Republic of Kongo)
- Very lethal: it can kill somebody within a few days
- A small outbreak in 2000
- From 10/2000 – 01/2009 173 people died in African villages

Example: HIV

- Less lethal than Ebola
- Takes time to act, lots of time to infect
- First appeared in the 70s
- Initially confined in special groups: homosexual men, drug users, prostitutes
- Eventually escaped to the entire population

Example: Melissa computer worm

- Started on March 1999
- Infected MS Outlook users
- The user
 - Receives email with a word document with a virus
 - Once opened, the virus sends itself to the first 50 users in the outlook address book
- First detected on Friday, March 26
- On Monday had infected >100K computers

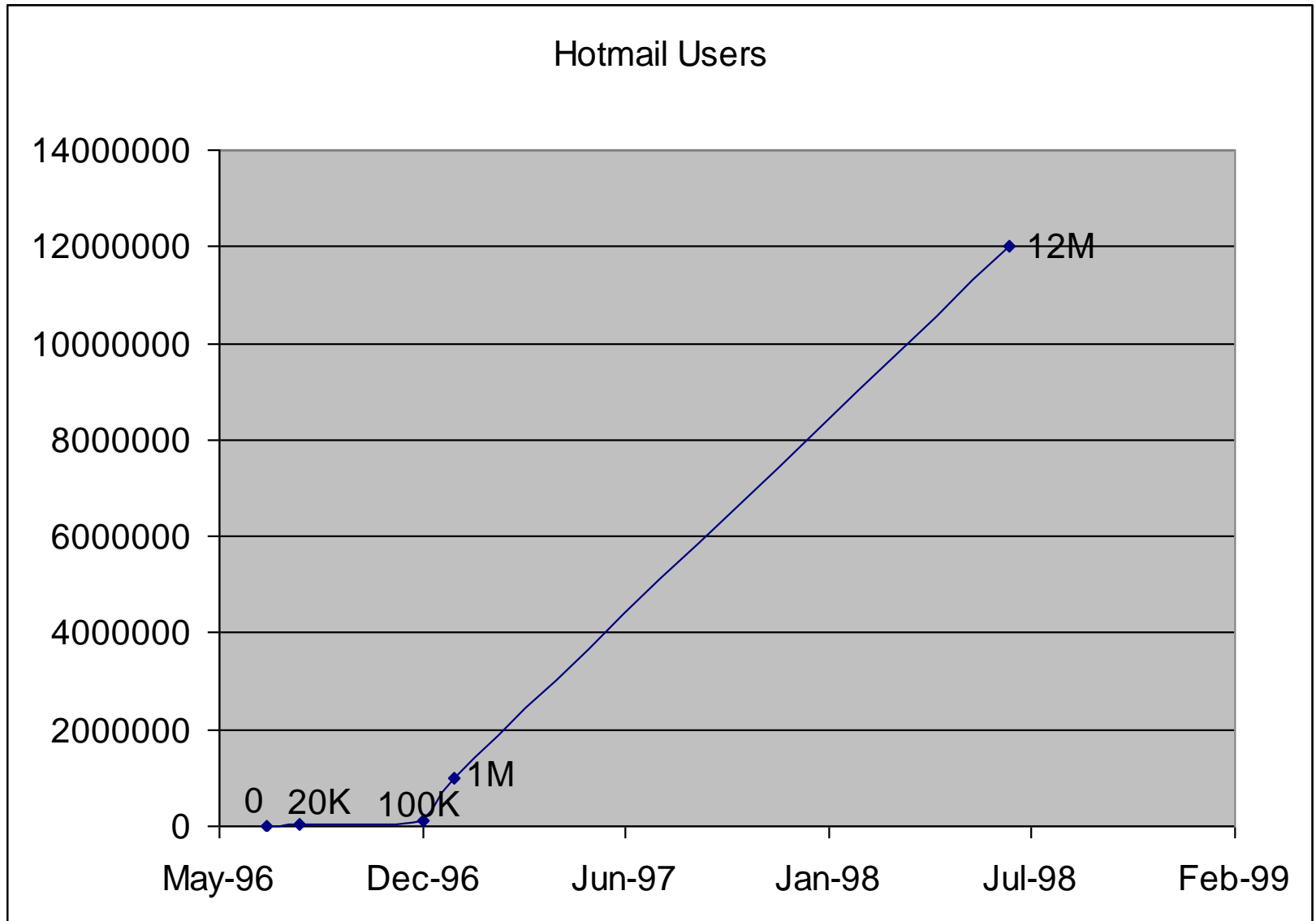
Example: Hotmail

- Example of Viral Marketing: Hotmail.com
- Jul 1996: Hotmail.com started service
- Aug 1996: 20K subscribers
- Dec 1996: 100K
- Jan 1997: 1 million
- Jul 1998: 12 million

Bought by Microsoft for \$400 million

Marketing: At the end of each email sent there was a message to subscribe to Hotmail.com
“Get your free email at Hotmail”

Example: Hotmail



The Bass model

- Introduced in the 60s to describe product adoption
- Can be applied for viruses
- No network structure

$$F(t + 1) = F(t) + p(1 - F(t)) + q(1 - F(t))F(t)$$

- $F(t)$: Ratio of infected at time t
- p : Rate of infection by outside
- q : Rate of contagion

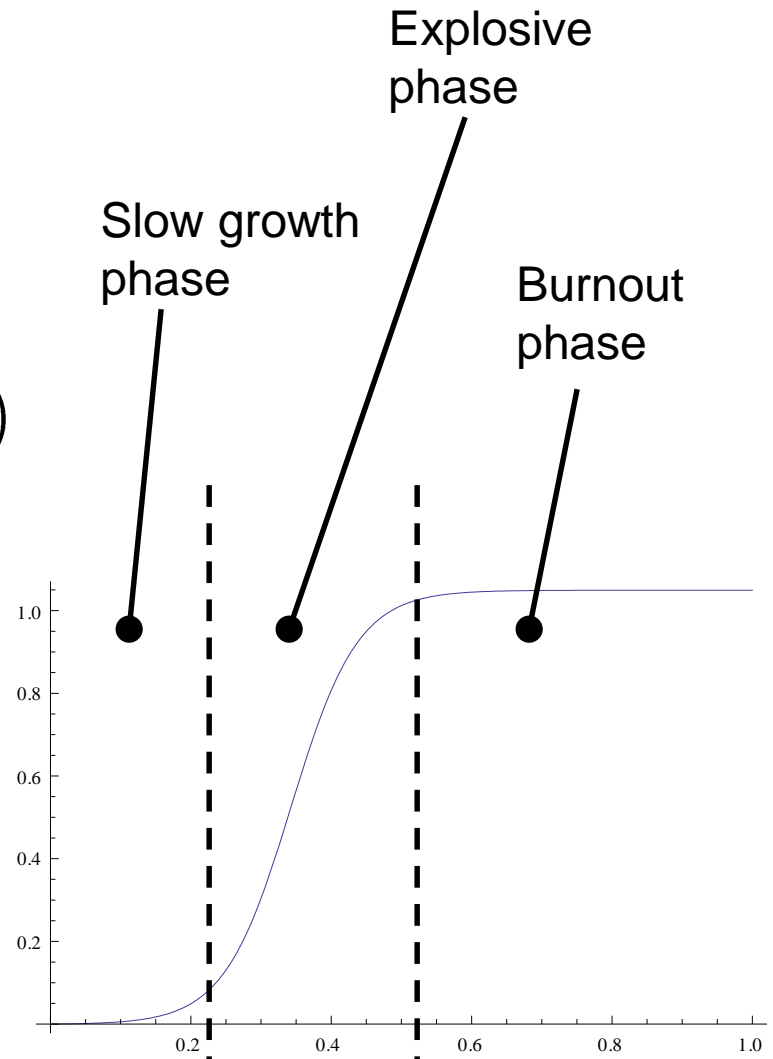
$$\begin{aligned}\frac{dF}{dt} &= p(1 - F) + qF(1 - F) \\ &= (p + qF)(1 - F)\end{aligned}$$

The Bass model

- $F(t)$: Ratio of infected at time t
- p : Rate of infection by outside
- q : Rate of contagion

$$\frac{dF(t)}{dt} = (p + qF(t))(1 - F(t))$$

$$F(t) = \frac{1 - e^{-(p+q)t}}{1 + \frac{q}{p}e^{-(p+q)t}}$$

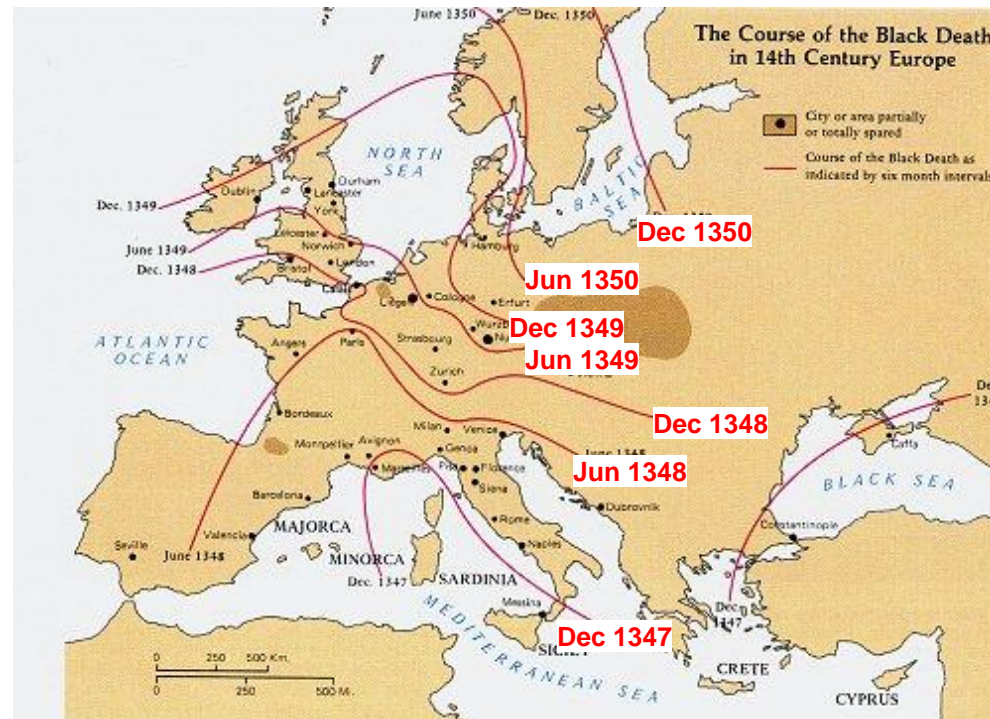


Network Structure

- The Bass model does not take into account network structure
- Let's see some examples

Example: Black Death (Plague) (Pestilenza)

- Started in 1347 in a village in South Italy from a ship that arrived from China
- Propagated through rats, etc.



Example: Mad-cow disease

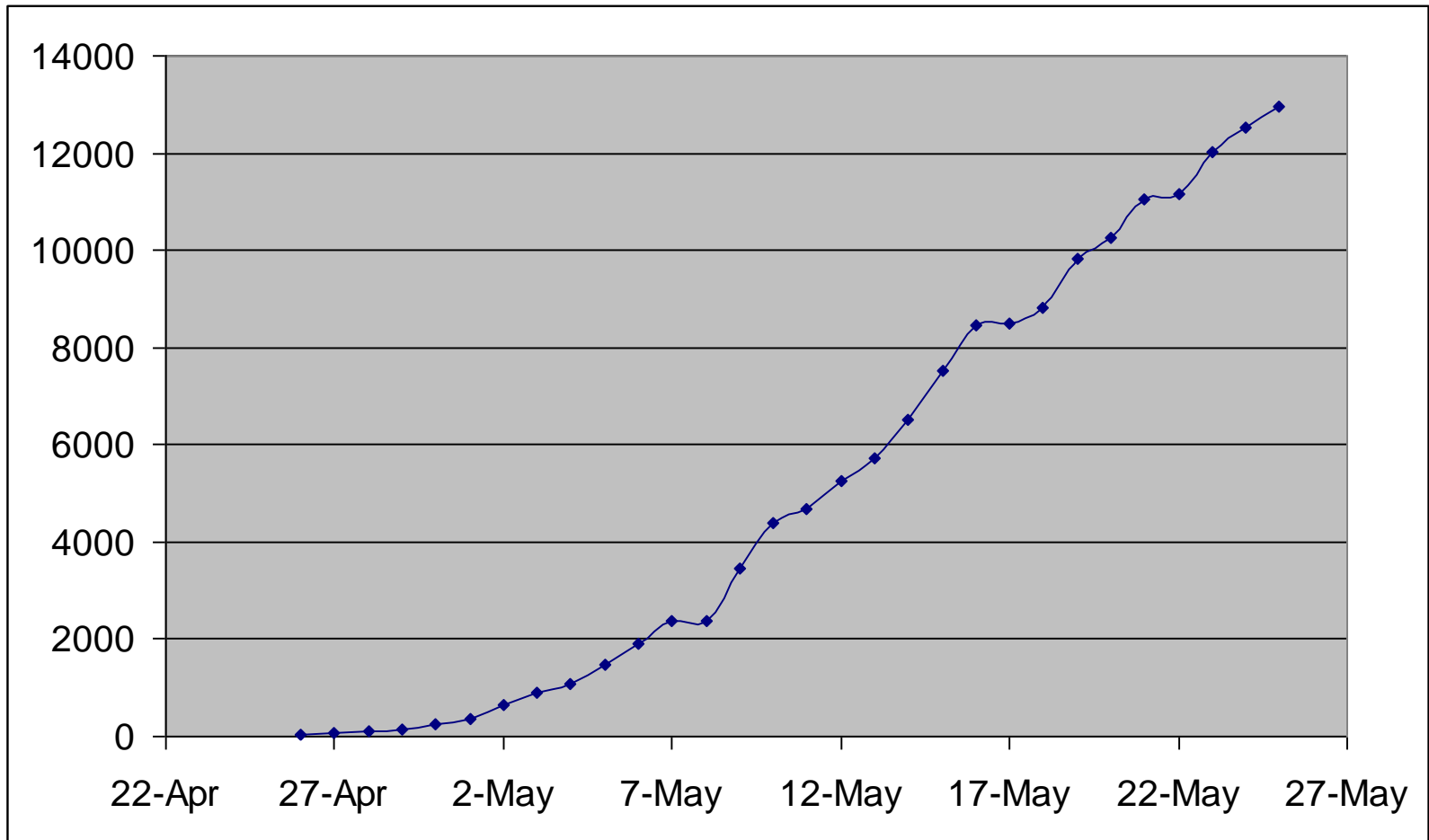
- Jan. 2001: First cases observed in UK
- Feb. 2001: 43 farms infected
- Sep. 2001: 9000 farms infected

- Measures to stop: Banned movement, killed millions of animals

Example: H1N1

<http://www.youtube.com/watch?v=tWKdSQilFj4>

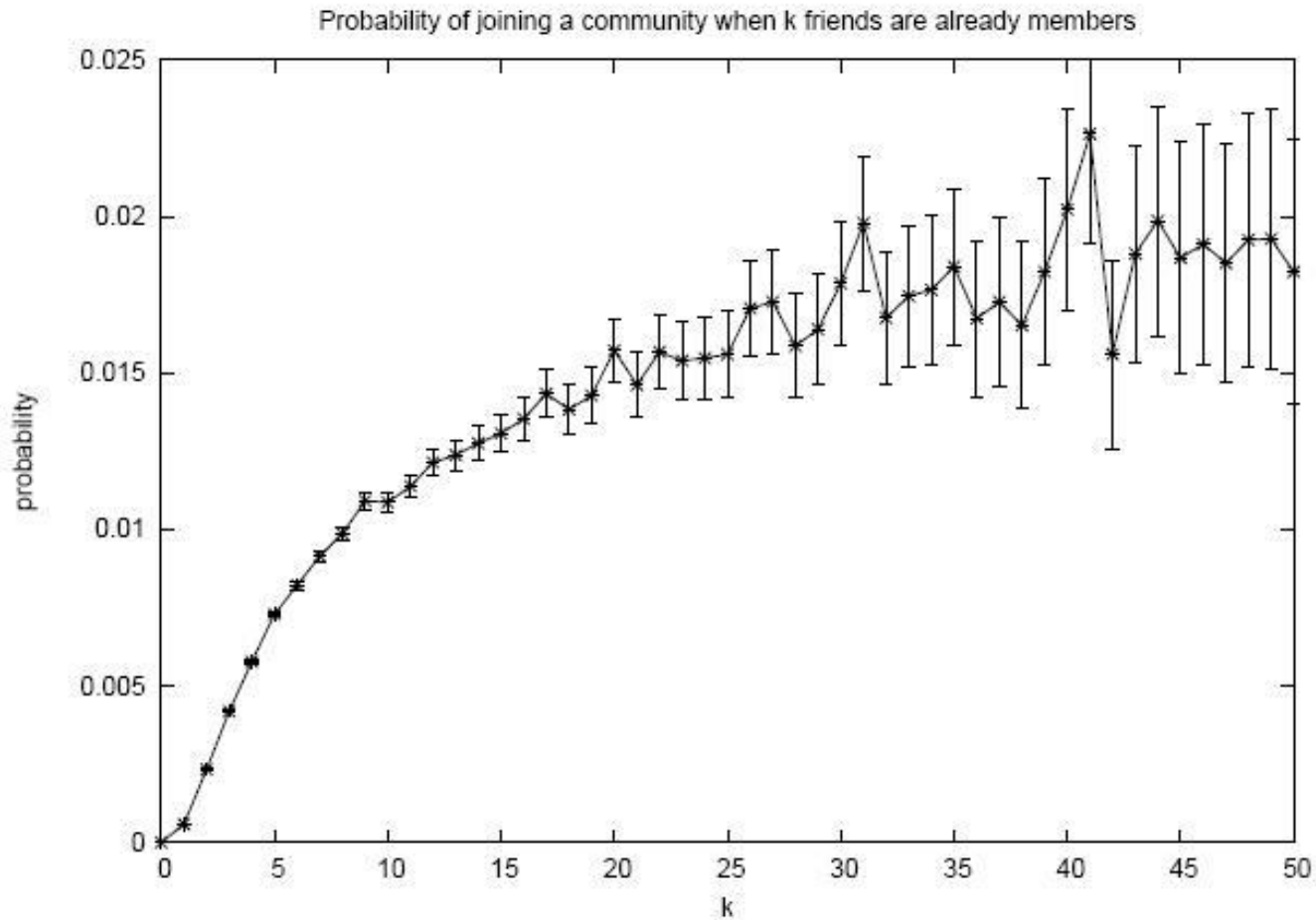
Example: H1N1



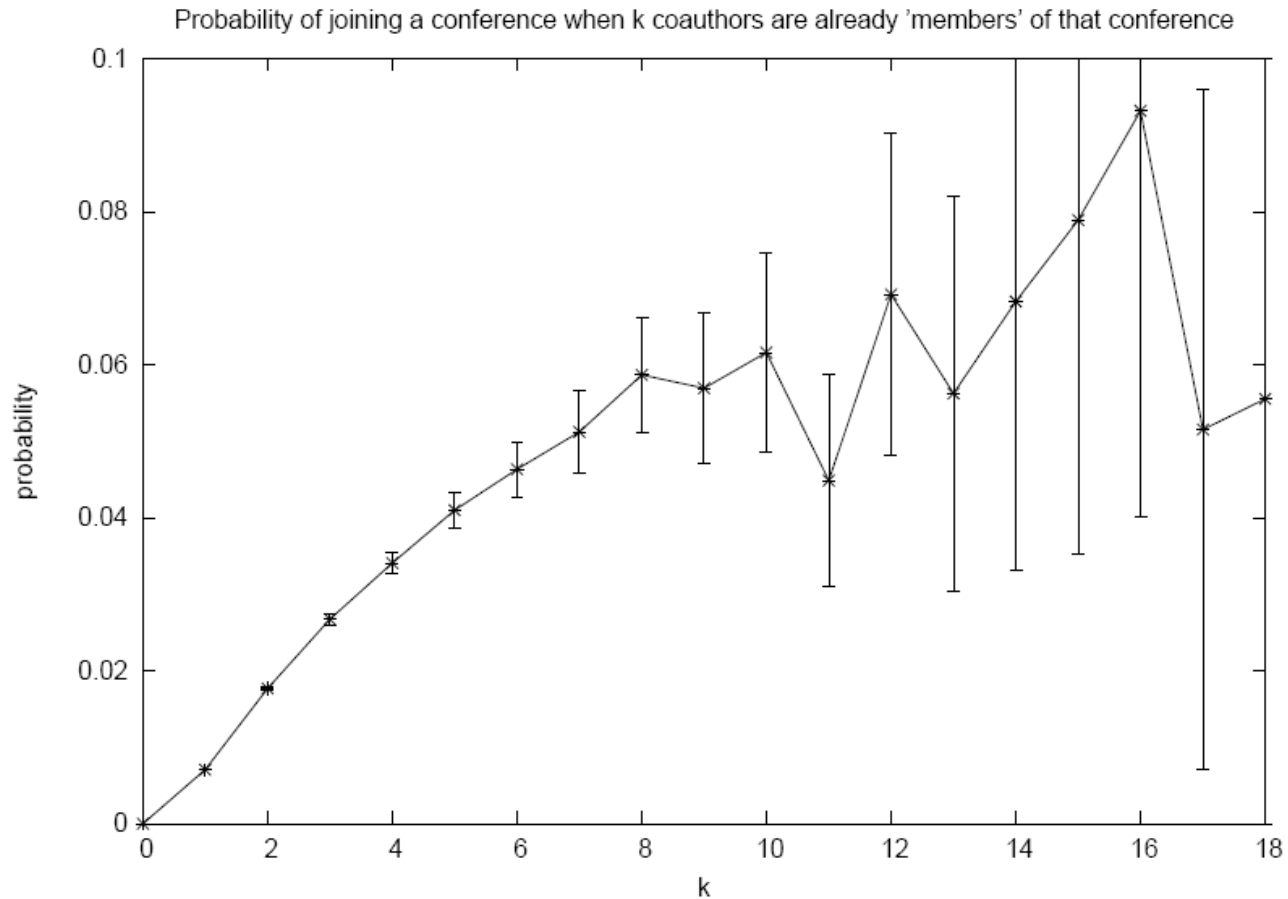
Network Impact

- In the case of the plague it moves on the plain
- In the mad cow we have **weak ties**, so we have a small world
 - Animals being bought and sold
 - Soil from tourists, etc.
- To protect:
 - Make contagion harder
 - Remove weak ties (e.g., mad cows, HIV)

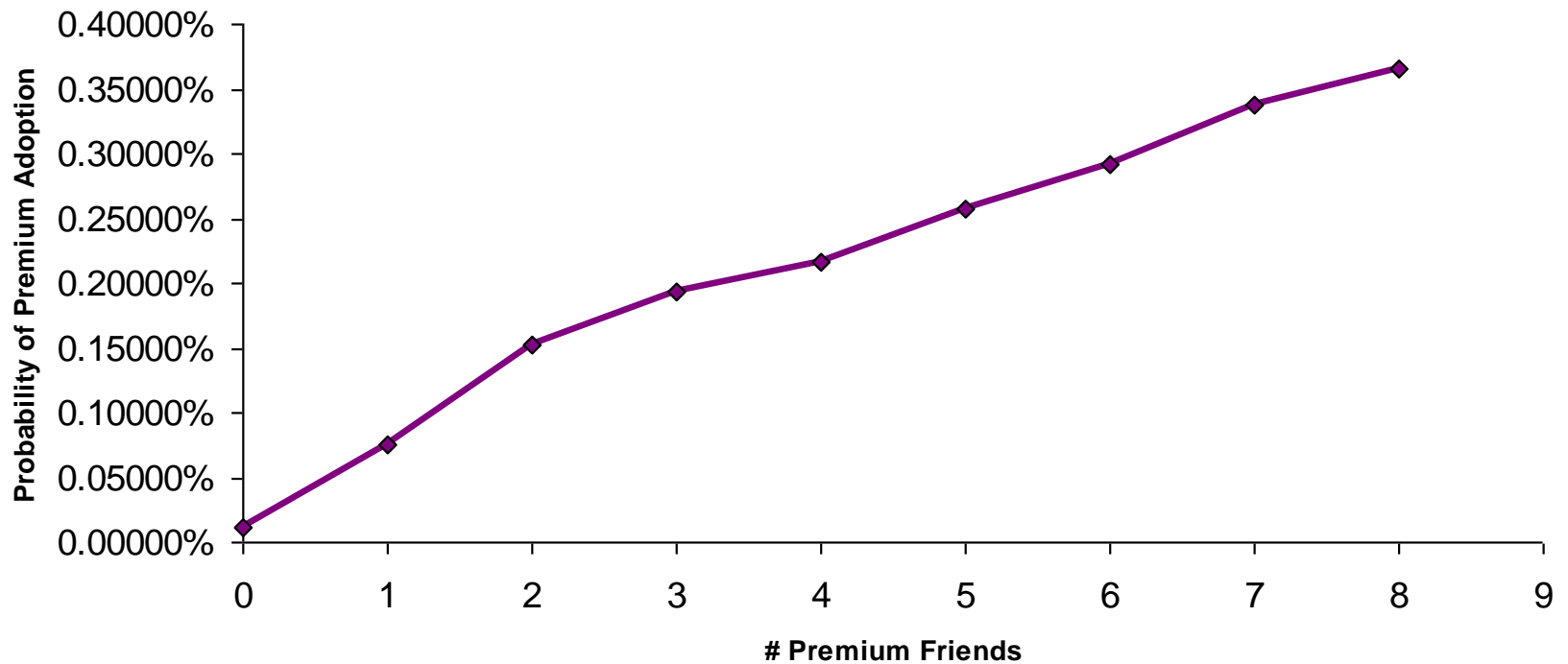
Example: Join an online group



Example: Publish in a conference



Example: Adopt a technology

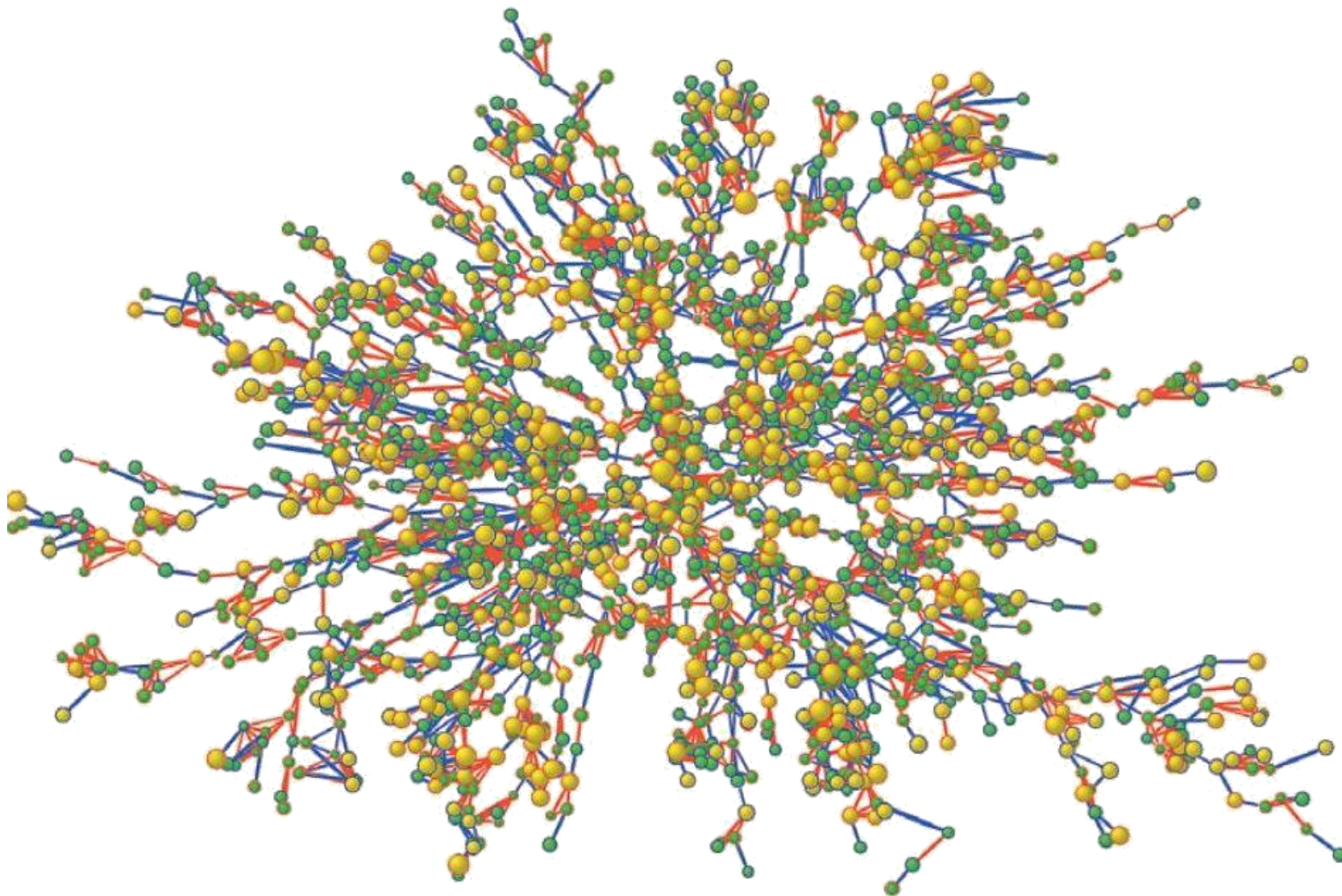


Example: obesity study

Christakis and Fowler, “The Spread of Obesity in a Large Social Network over 32 Years”, New England Journal of Medicine, 2007.

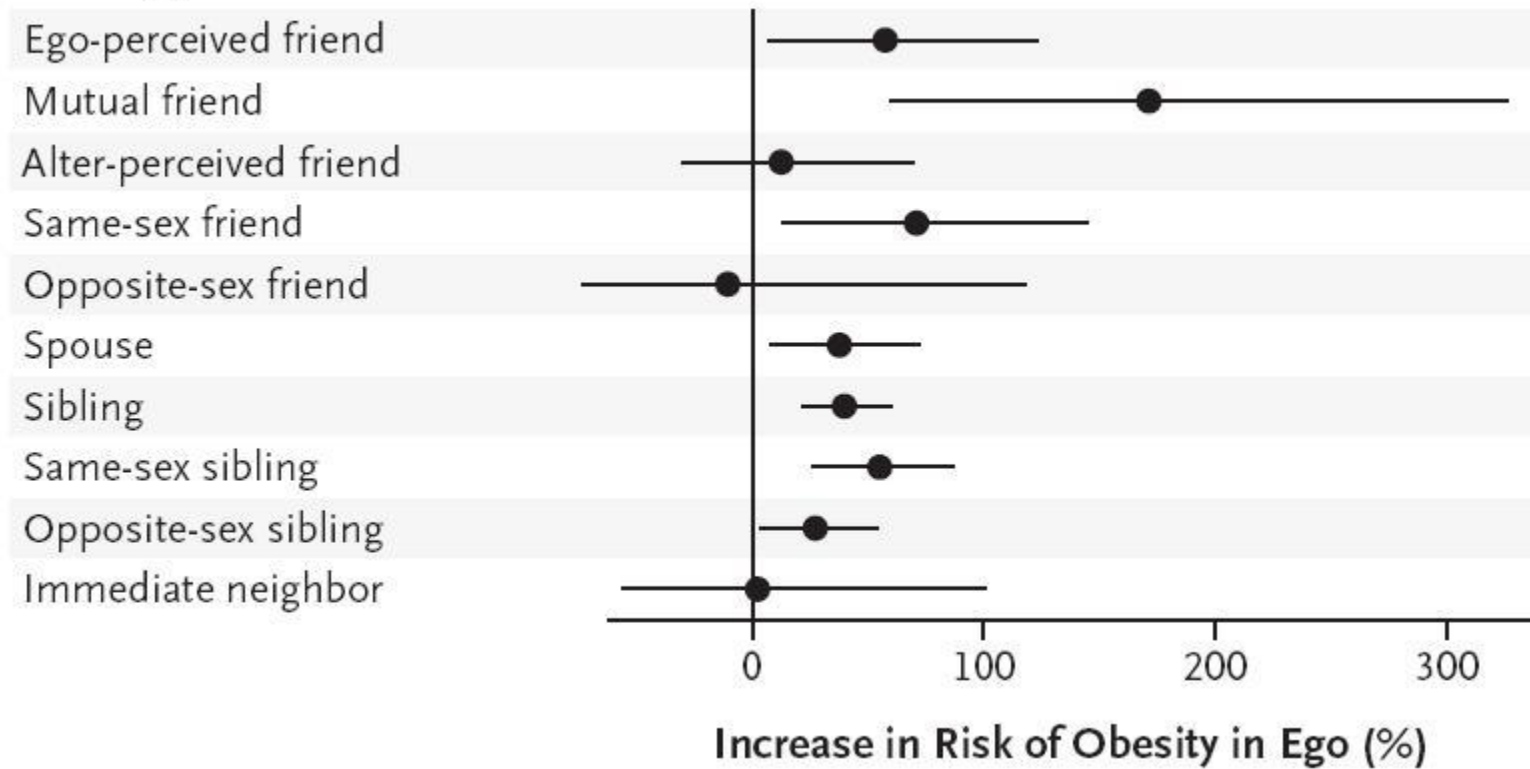
- Data set of 12,067 people from 1971 to 2003 as part of Framingham Heart Study
- Results
 - Having an obese friend increases chance of obesity by 57%.
 - obese sibling → 40%, obese spouse → 37%
- Methodology
 - Logistic regression, taking many attributes into account (e.g., age, sex, education level, smoking cessation)
 - Taking advantage of data that is available over **time**
 - “edge-reversal test”

Obesity study



Obesity study

Alter Type



Example: Use the same tag

