Spreading phenomena

Introduction to Network Science

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Topic 12

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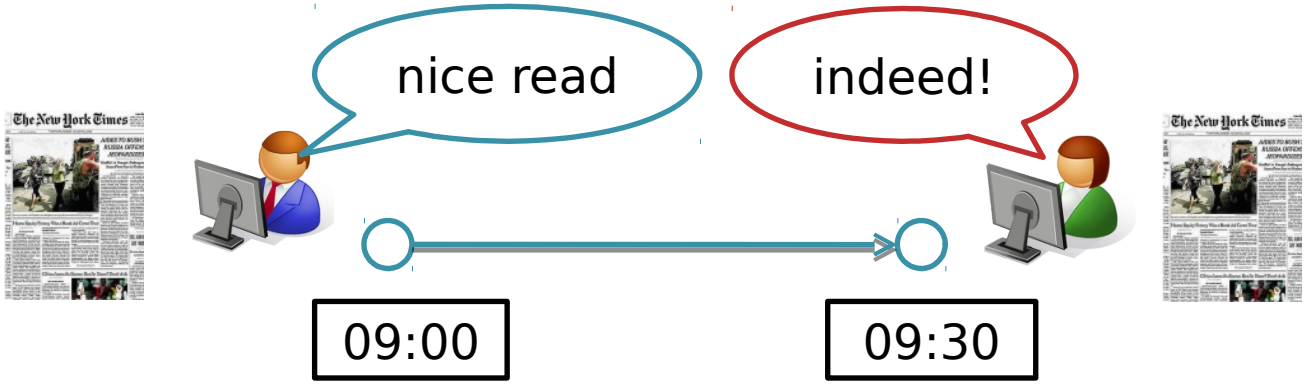
Sources

- Easley and Kleinberg (2010): Networks, Crowds, and Markets Ch 19
- Carlos Castillo, Wei Chen, Laks V. S. Lakshmanan (2012): Information and Influence Spread in Social Networks, KDD Tutorial.
- Carlos Castillo (2017): Social influence slides

Social influence



People are **<u>connected</u>** and perform **<u>actions</u>**

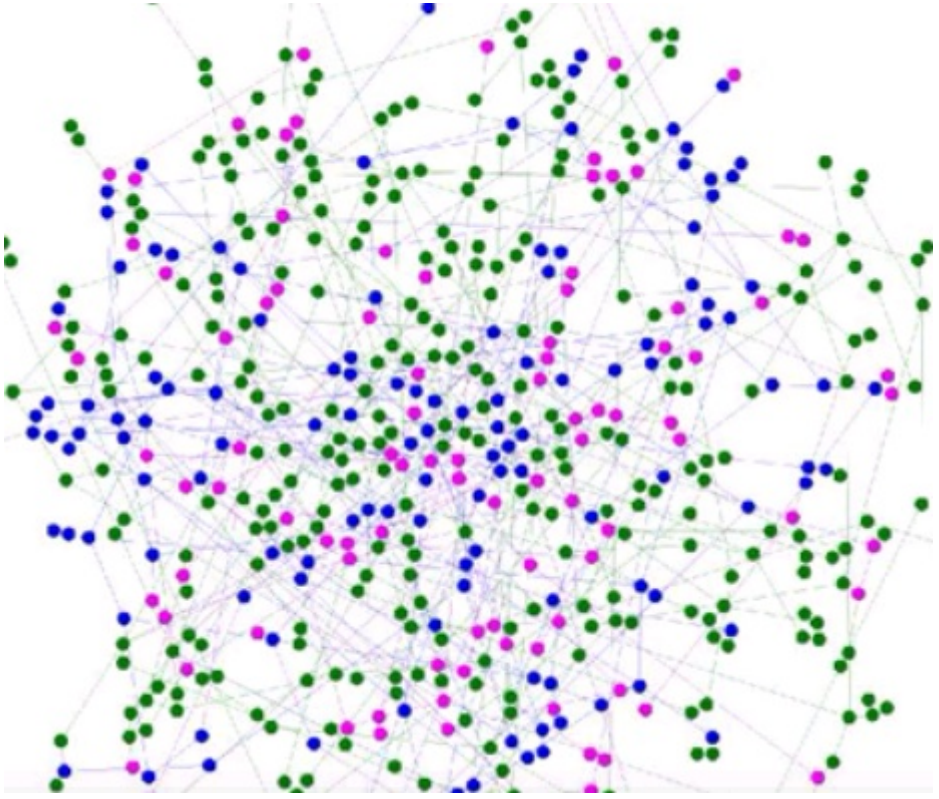
friends, fans,
followers,
etc.

comment, link, rate, like,
retweet, post a message,
photo, or video, etc.

“The Selfish Gene” by Richard Dawkins (1976)

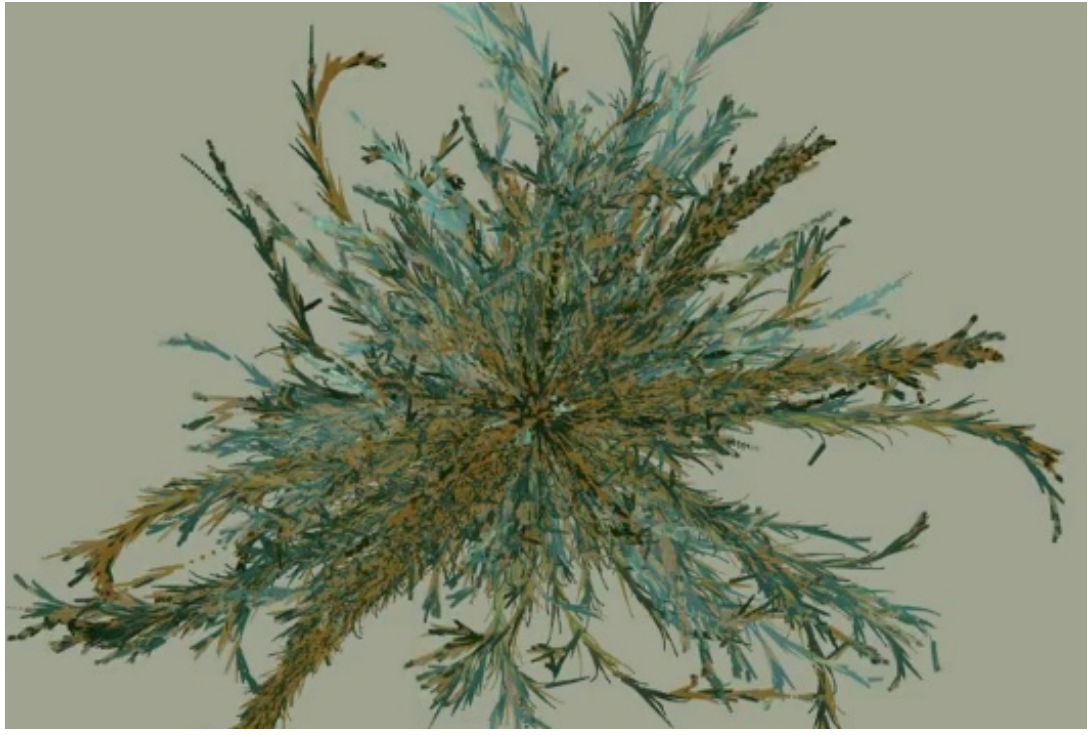
Chapter 11: “Memes: the new replicators”

Contagion in graph

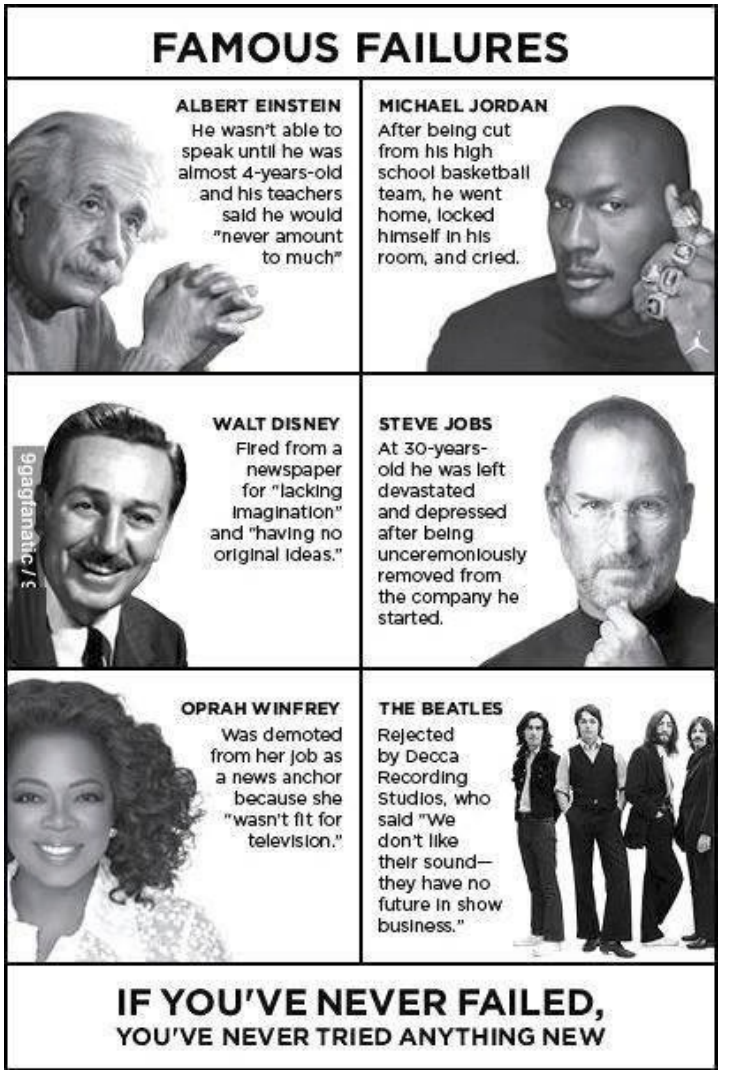


https://www.youtube.com/watch?v=WWTmRlDsydA

Spread of a Meme
(“Famous Failures”)

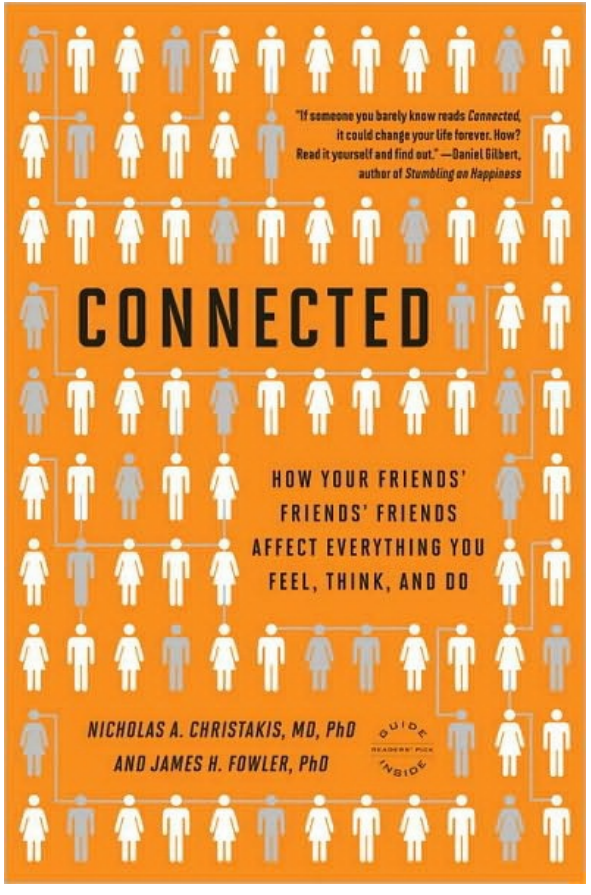


https://vimeo.com/50730795



Non-trivial examples

- **Back pain:** spread from West to East in Germany after fall of Berlin Wall
- **Suicide:** well known to spread throughout communities on occasion
- **Sexual “scripts”:** expected sequences of behaviors during intimate situations
- **Politics:** the denser your connections, the more intense your convictions

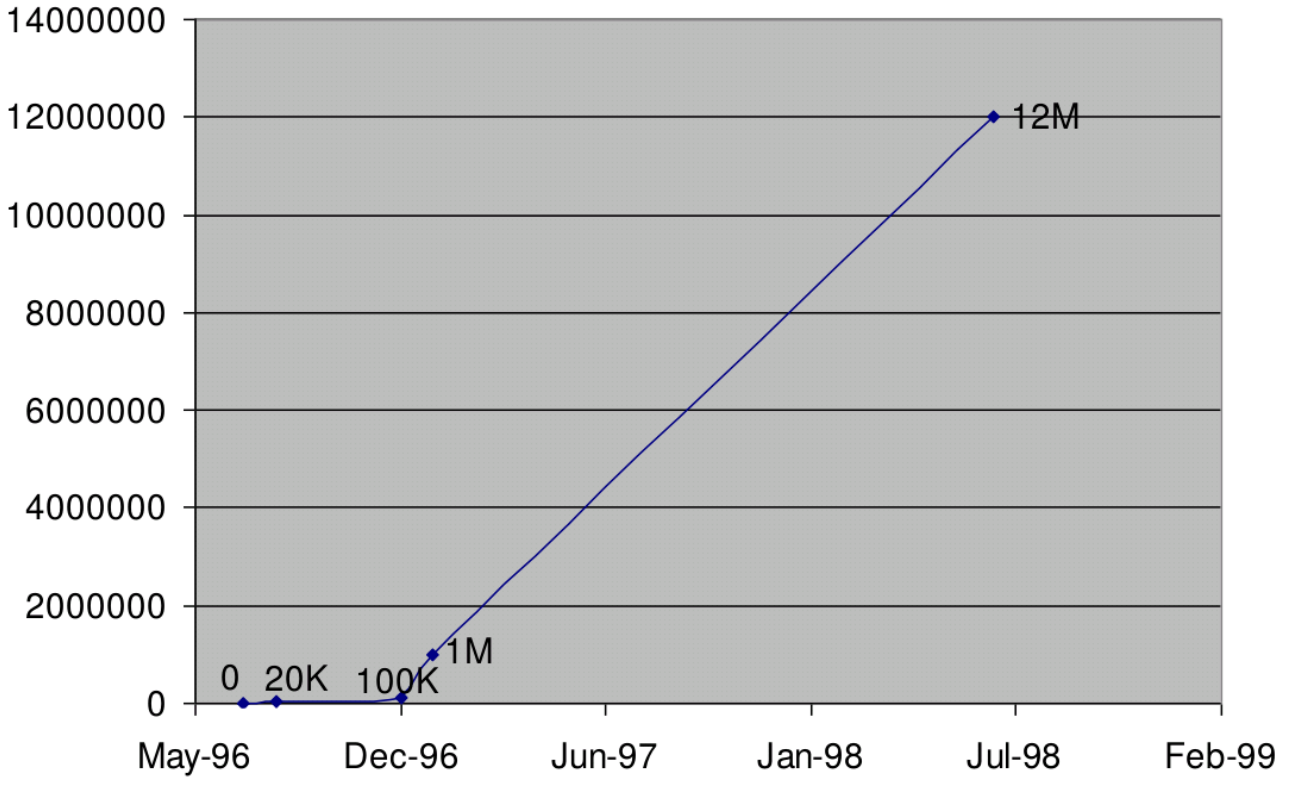


Viral marketing

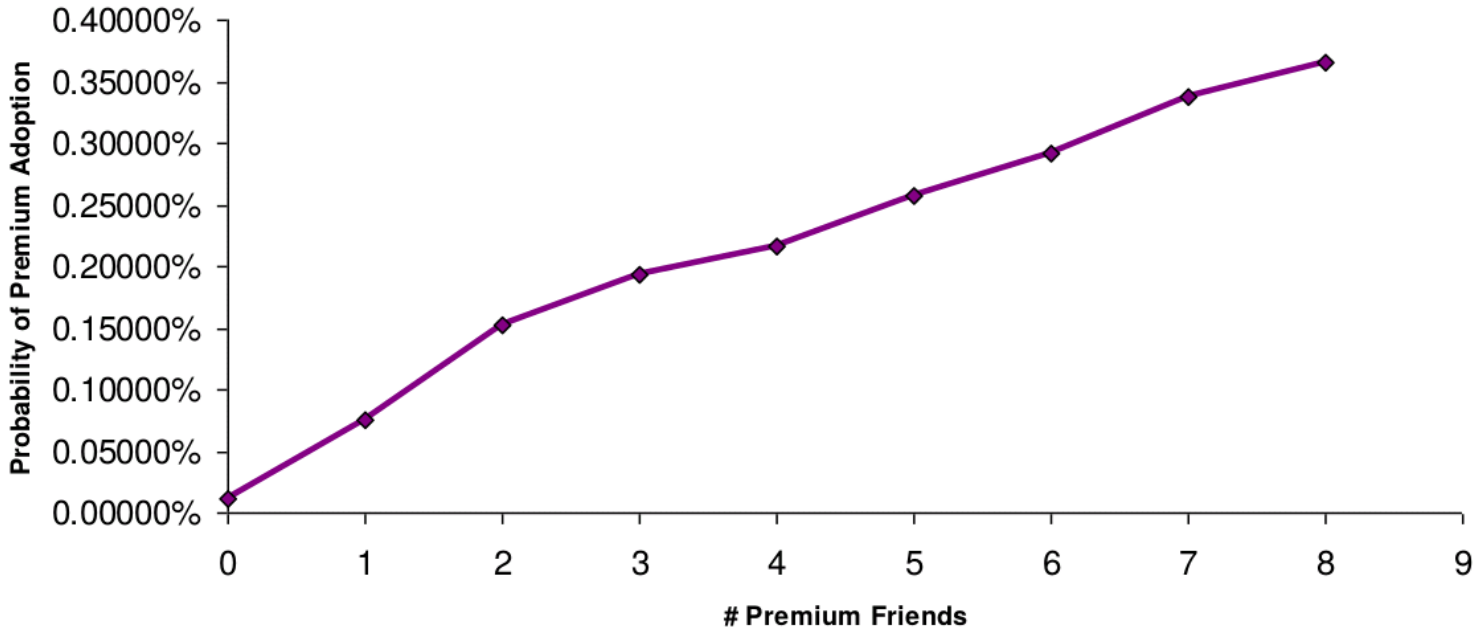
Viral Marketing Online

- Early example: Hotmail
  - 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
- At the end of each email sent there was a message to subscribe to Hotmail.com: “Get your free email at Hotmail"

Hotmail users



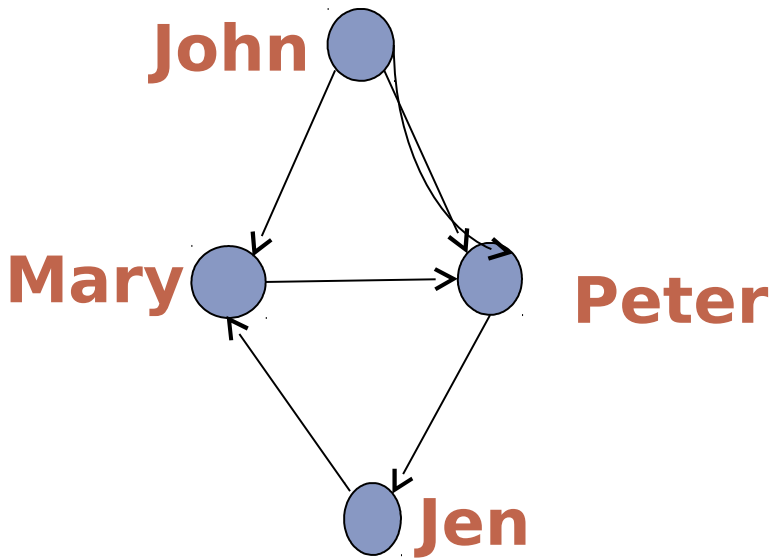
Peer pressure
(pay “premium” subscription)



Models of influence

What are our observables?

Graph: users, links/ties



Log: user, action, time

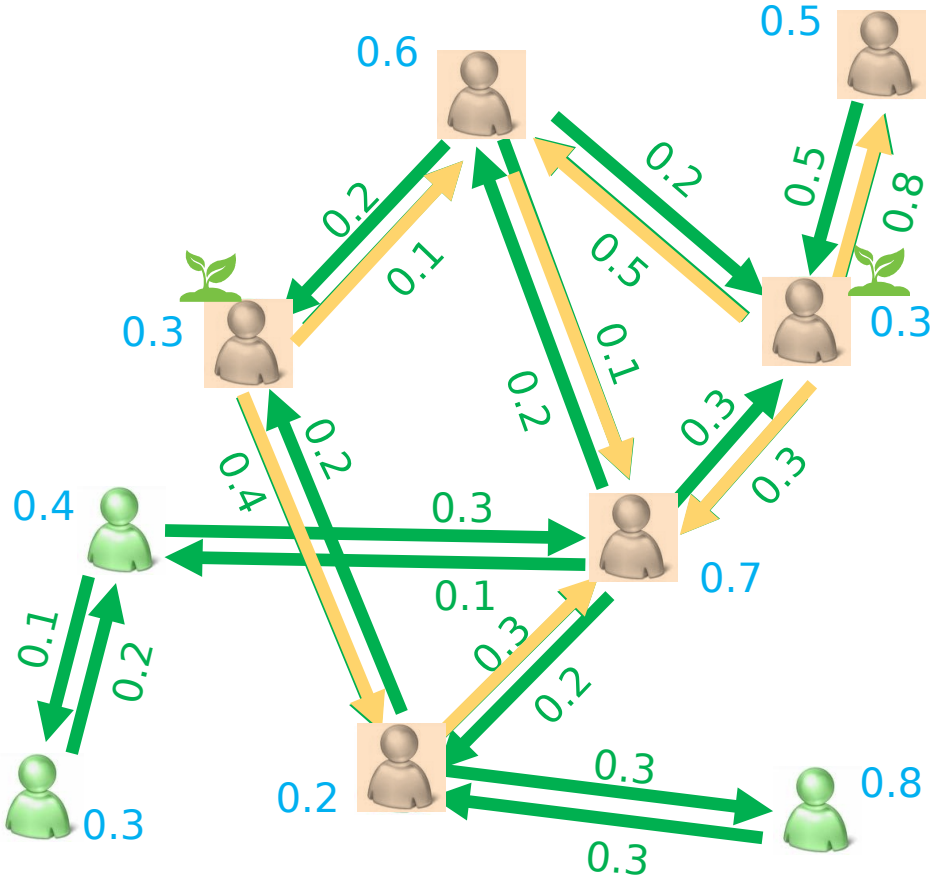
User	Action	Time
John	Rates with 5 stars “*The Artist*”	June 3rd
Peter	Watches “*The Artist*”	June 5th
Jen	…	…

Two main models

- Linear threshold model
- Independent cascade model

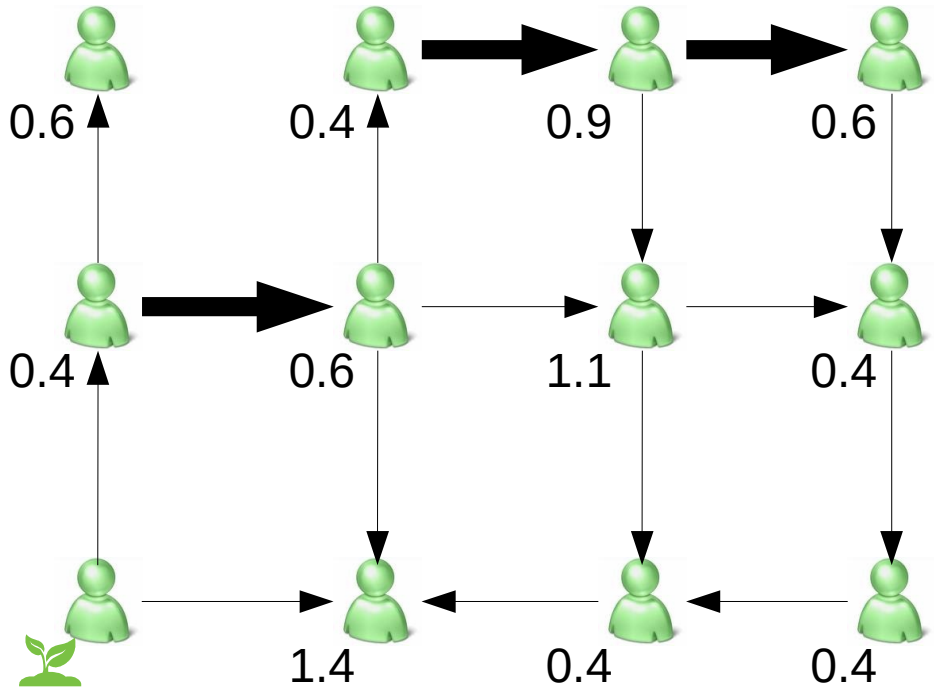
Linear threshold model

- Nodes have thresholds
- Arcs have weights
- Nodes that receive weighted influence equal or above their threshold become active



[Kempe, Kleinberg and Tardos, KDD 2003]

Try it!



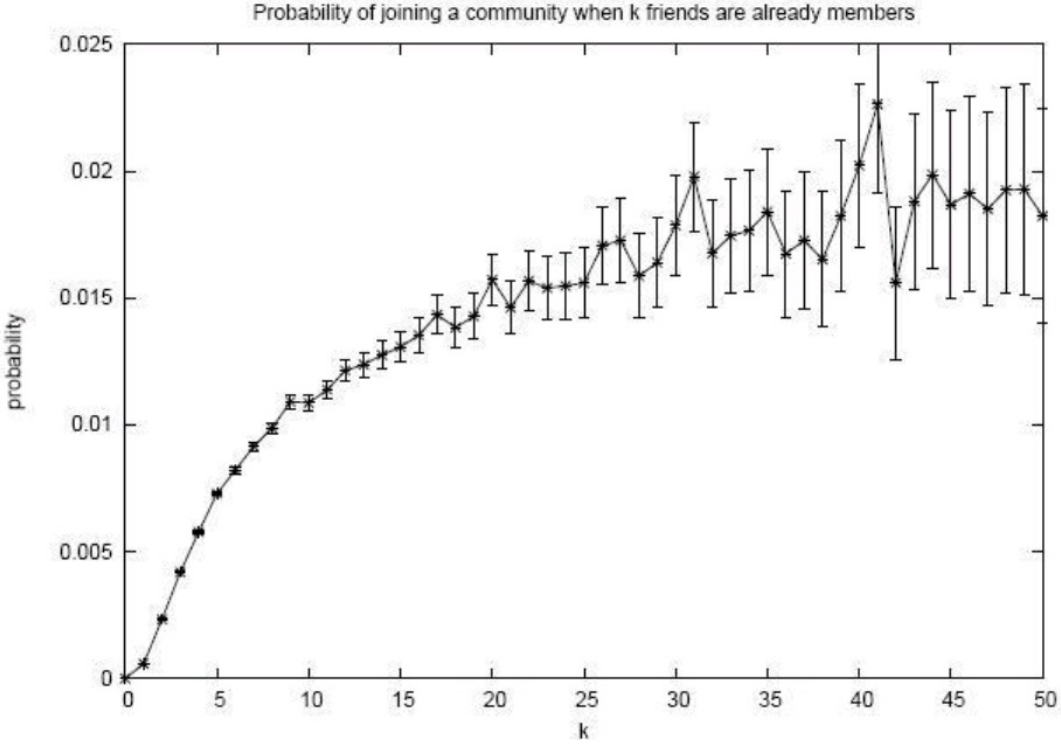
Thick arrows have weight 1.0

Thin arrows have weight 0.5

Execute linear threshold model starting from seed node

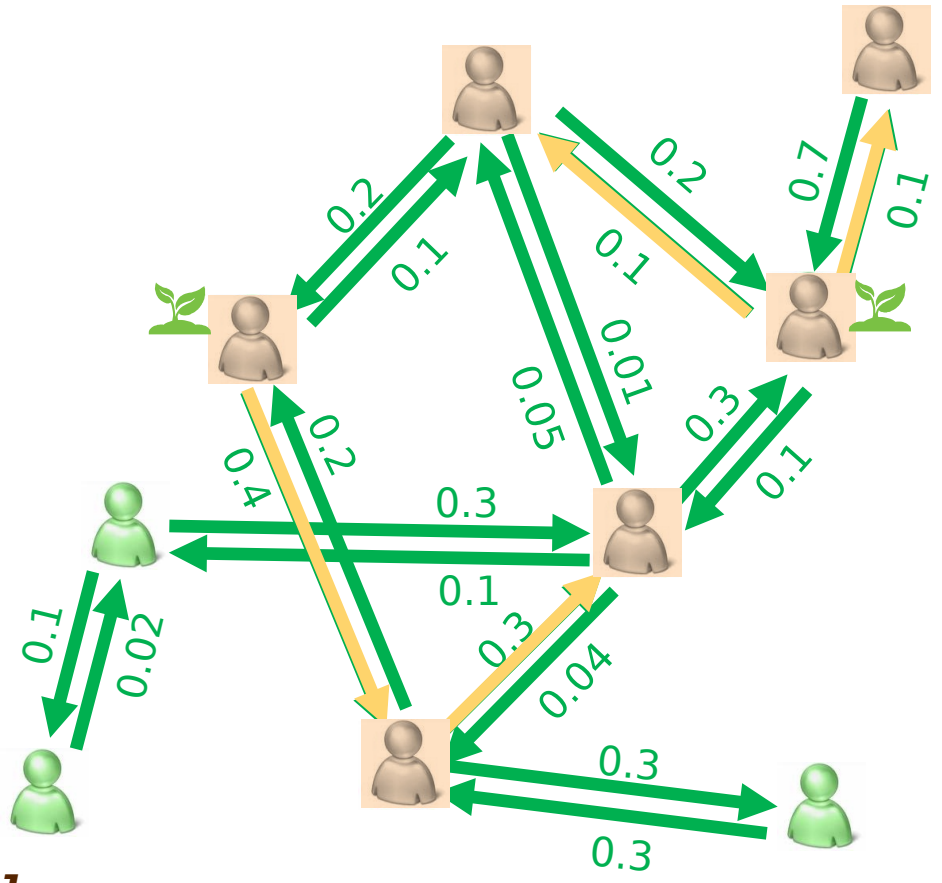
Linear threshold model

Is the linear threshold model compatible with this observation?



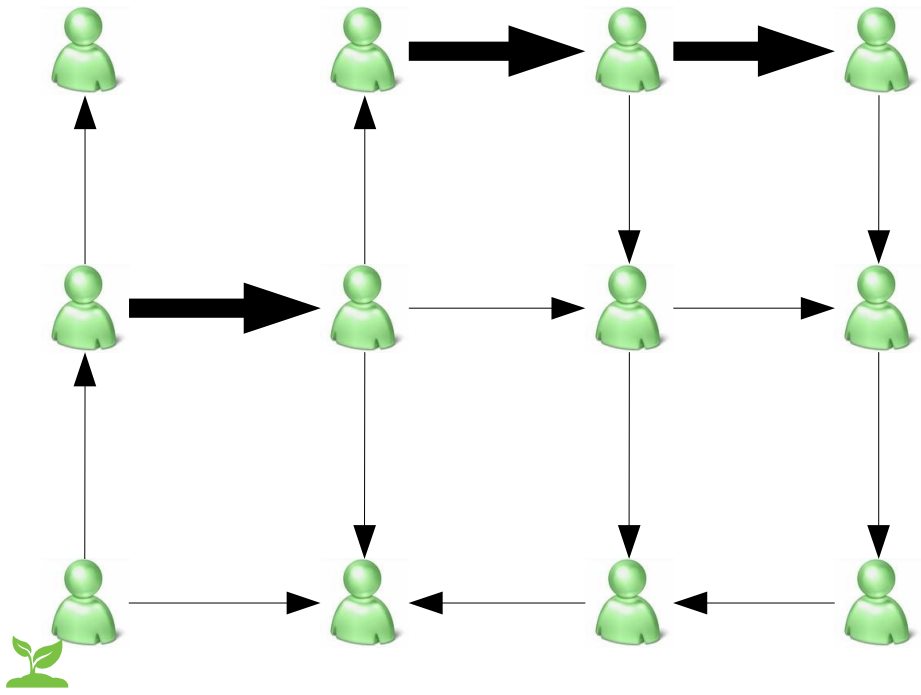
Independent cascade model

- No thresholds
- Each node, when activating, has one chance of activating each of their neighbors
- Probability of succeeding represented by arc weights



[Kempe, Kleinberg and Tardos, KDD 2003]

Try it! (you need a coin or 1d4)



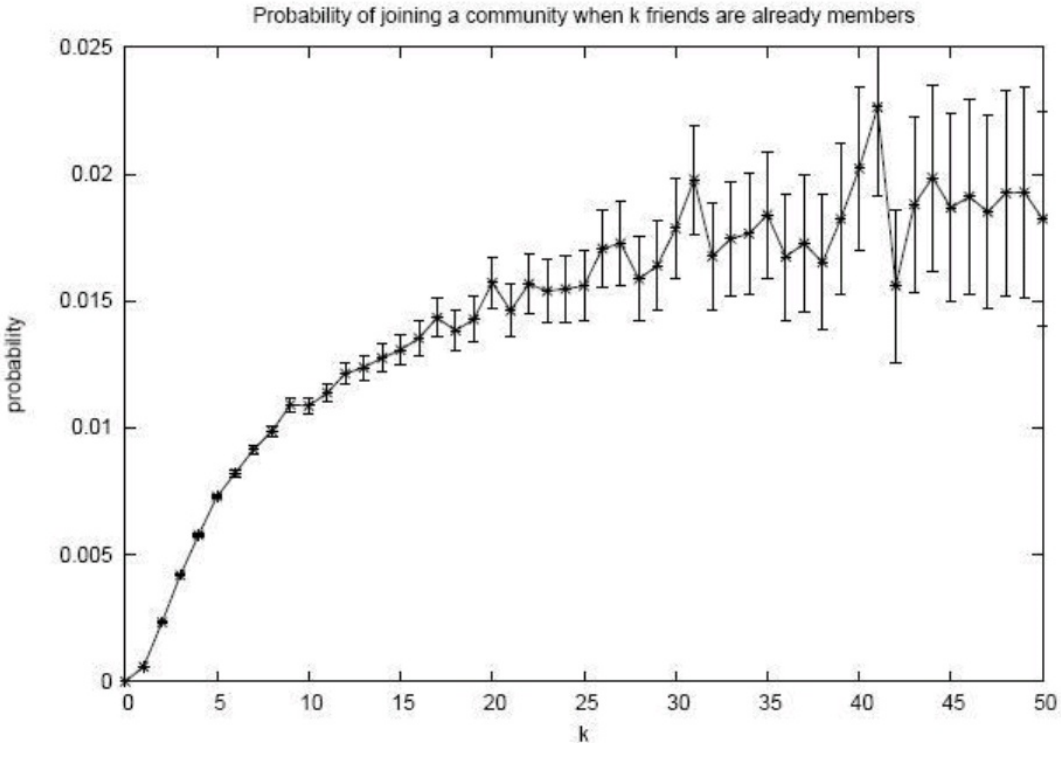
Thick arrows have probability 0.75

Thin arrows have probability 0.5

Execute independent cascade model starting from seed node

Independent cascade model

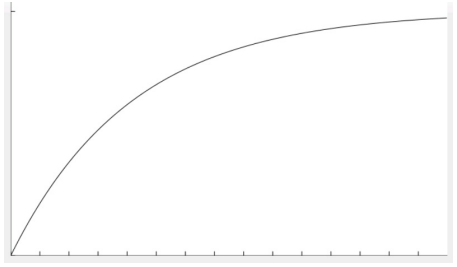
Is the independent cascade model compatible with this observation?



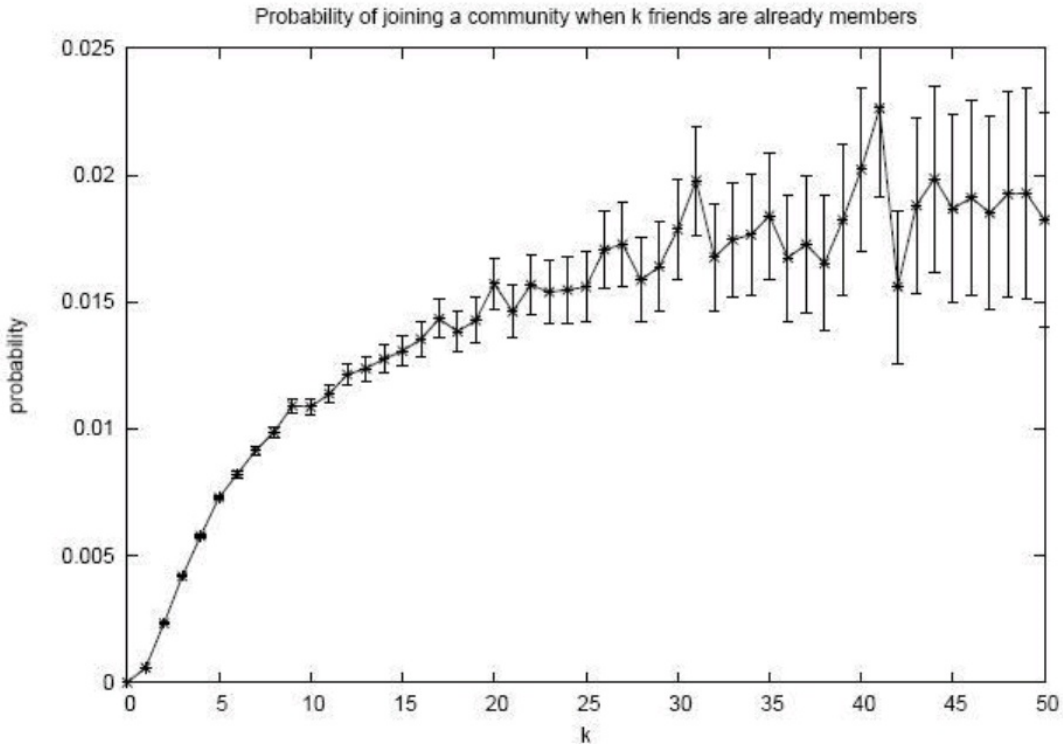
Independent cascade model

Is the independent cascade model compatible with this observation?

Hint:



$1 - q^k$ for $0<q<1$



What are these models assuming?

(List as many assumptions as you can)

Influencers and Viral Marketing

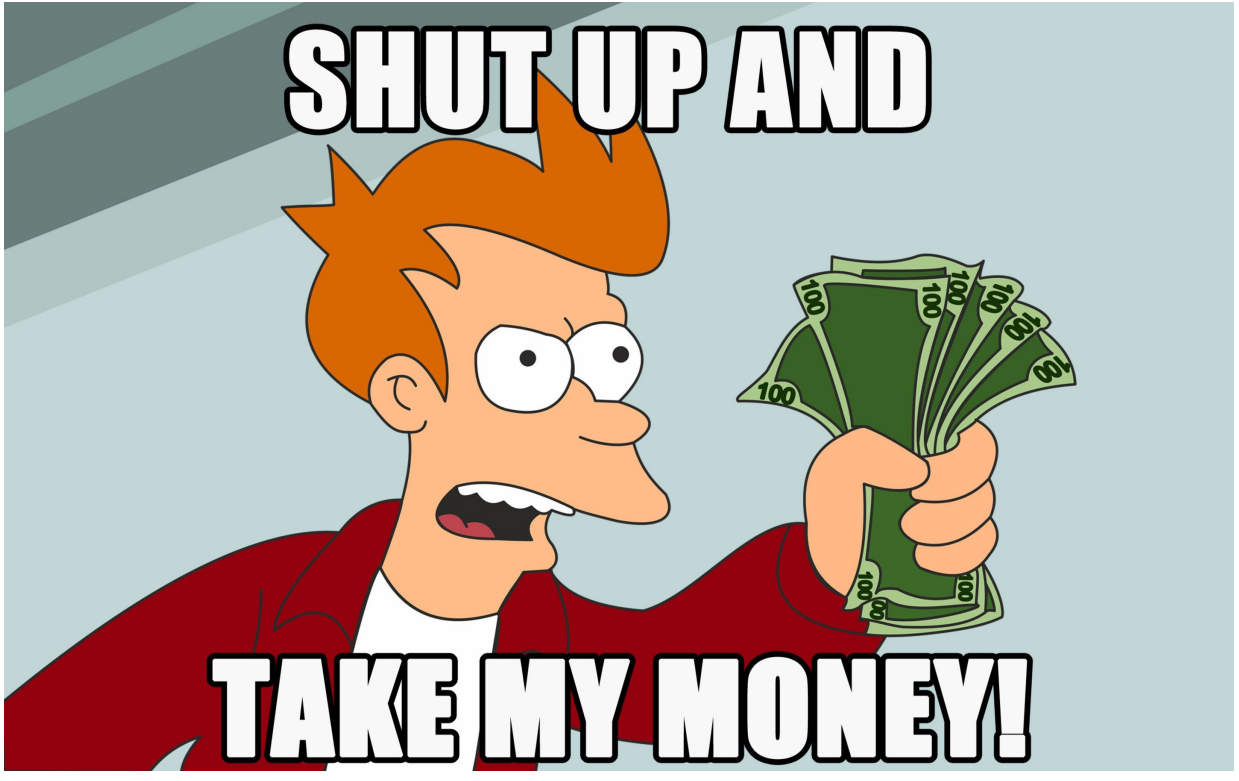
The promise of “influencers”

Influencers increase brand awareness. product conversions through WoMM

Influencers advocate a brand

Influencers influence purchasing actions

Viral marketing went through a stage of ...



Can social influence really drive viral cascades?

- Watts et al. challenge the traditional notions and intuitions about SI causing viral spread
- Social epidemics are not always responsible for dramatic, possibly sudden social change
- Influence is hard to prove
- Do not dismiss influence altogether

https://hbr.org/2007/05/viral-marketing-for-the-real-world

How useful is viral marketing?

- Hard to predict which campaign will succeed virally
- Lack of predictability makes VM hard to implement;
- The magic might not be in a small number of influentials
- “Big seed” marketing is a predictable, practical alternative

https://hbr.org/2007/05/viral-marketing-for-the-real-world

Example: Huffington Post

- Ad agency buys all of the ad slots for a week
- Displays attractive videos with options for easy sharing
- Gets 7x more views due to social referrals, but …
- None of the videos “goes viral” (grows exponentially in views) at any time

https://hbr.org/2007/05/viral-marketing-for-the-real-world

Summary

Things to remember

- Influence phenomena exist, they can be modeled, they are hard to create/engineer
- Linear threshold model
- Independent cascade model
- Practice executing these models in small graphs by hand
- Practice writing code implementing them