

# Spreading phenomena

Introduction to Network Science

Carlos Castillo

Topic 16

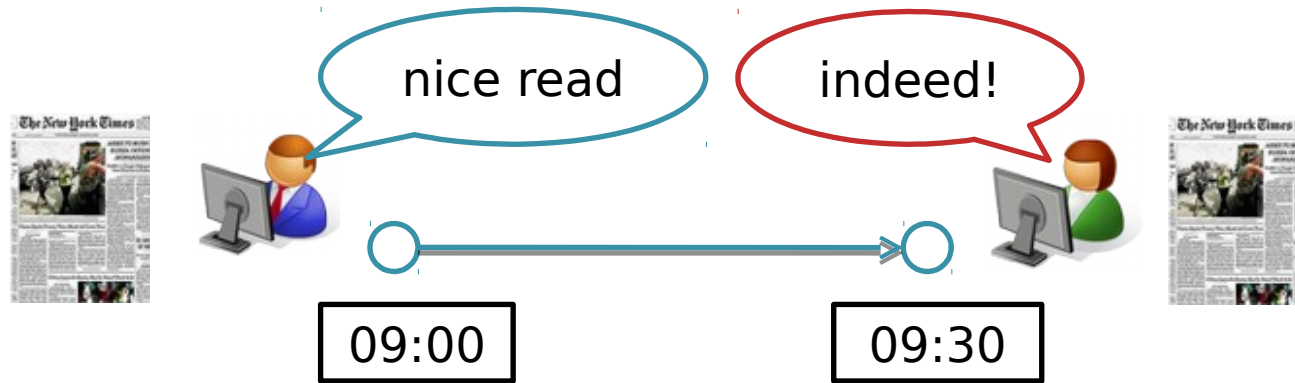


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# Sources

- 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



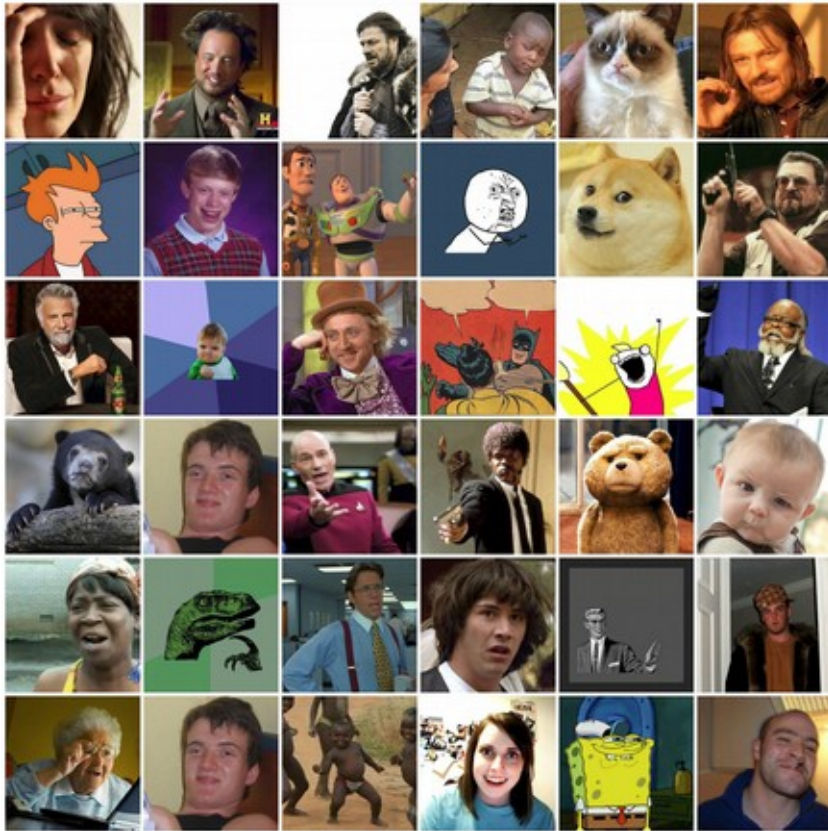
People are **connected** and perform **actions**

↓  
friends, fans,  
followers,  
etc.

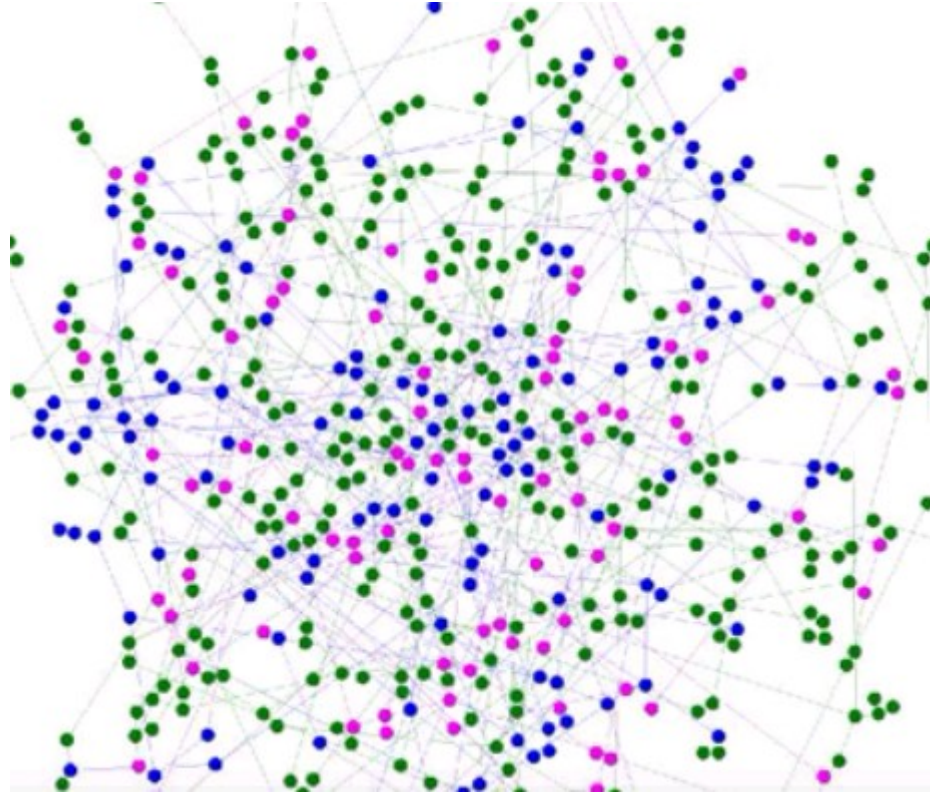
↓  
comment, link, rate, like,  
retweet, post a message,  
photo, or video, etc.

# “The Selfish Gene” by Richard Dawkins (1976)

## *Chapter 11: “Memes: the new replicators”*



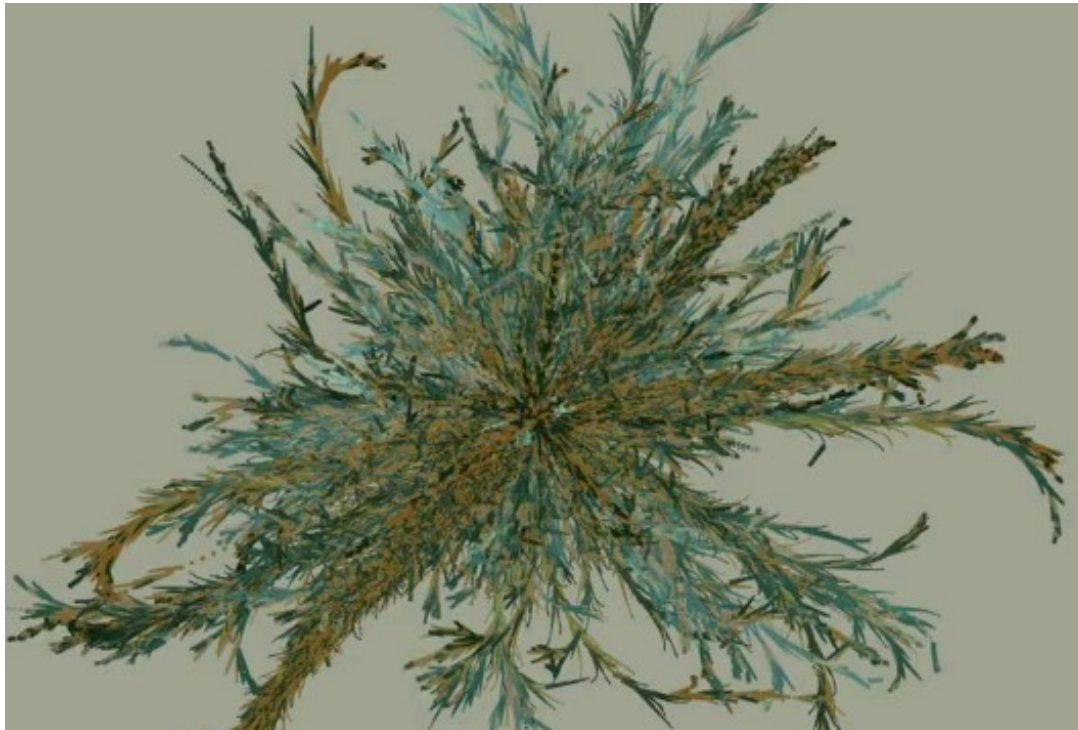
# Contagion in graph



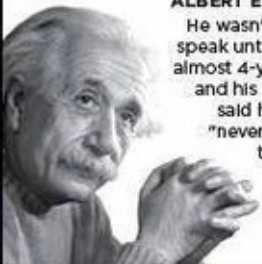
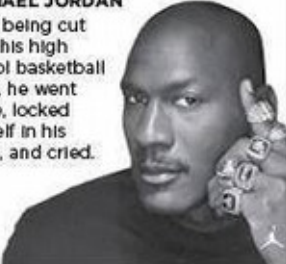

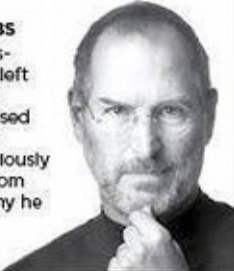


<https://www.youtube.com/watch?v=WWTmRIDsydA>



# Spread of a Meme ("Famous Failures")

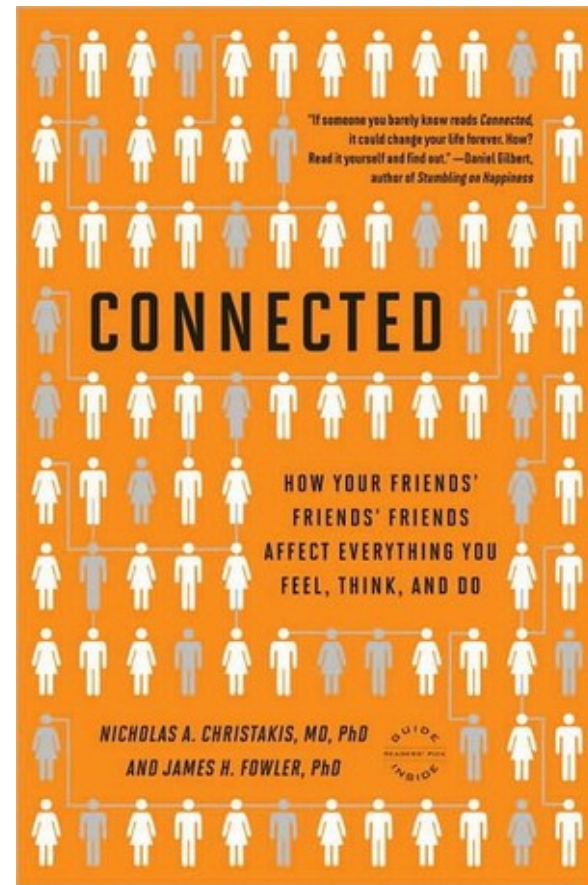


<https://vimeo.com/50730795>

FAMOUS FAILURES	
 <p><b>ALBERT EINSTEIN</b> He wasn't able to speak until he was almost 4-years-old and his teachers said he would "never amount to much"</p>	 <p><b>MICHAEL JORDAN</b> After being cut from his high school basketball team, he went home, locked himself in his room, and cried.</p>
 <p><b>WALT DISNEY</b> Fired from a newspaper for "lacking imagination" and "having no original ideas."</p>	 <p><b>STEVE JOBS</b> At 30-years-old he was left devastated and depressed after being unceremoniously removed from the company he started.</p>
 <p><b>OPRAH WINFREY</b> Was demoted from her job as a news anchor because she "wasn't fit for television."</p>	 <p><b>THE BEATLES</b> Rejected by Decca Recording Studios, who said "We don't like their sound—they have no future in show business."</p>
<b>IF YOU'VE NEVER FAILED, YOU'VE NEVER TRIED ANYTHING NEW</b>	

# 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



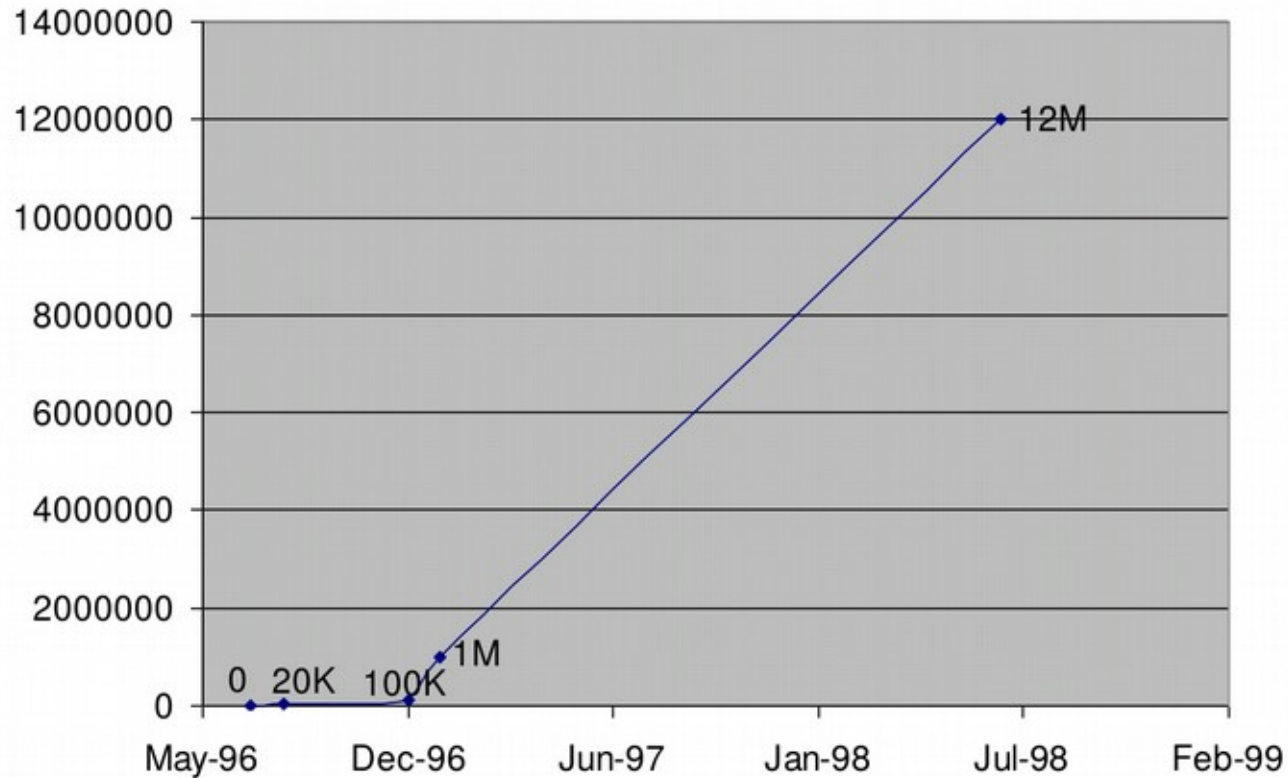
# Viral marketing



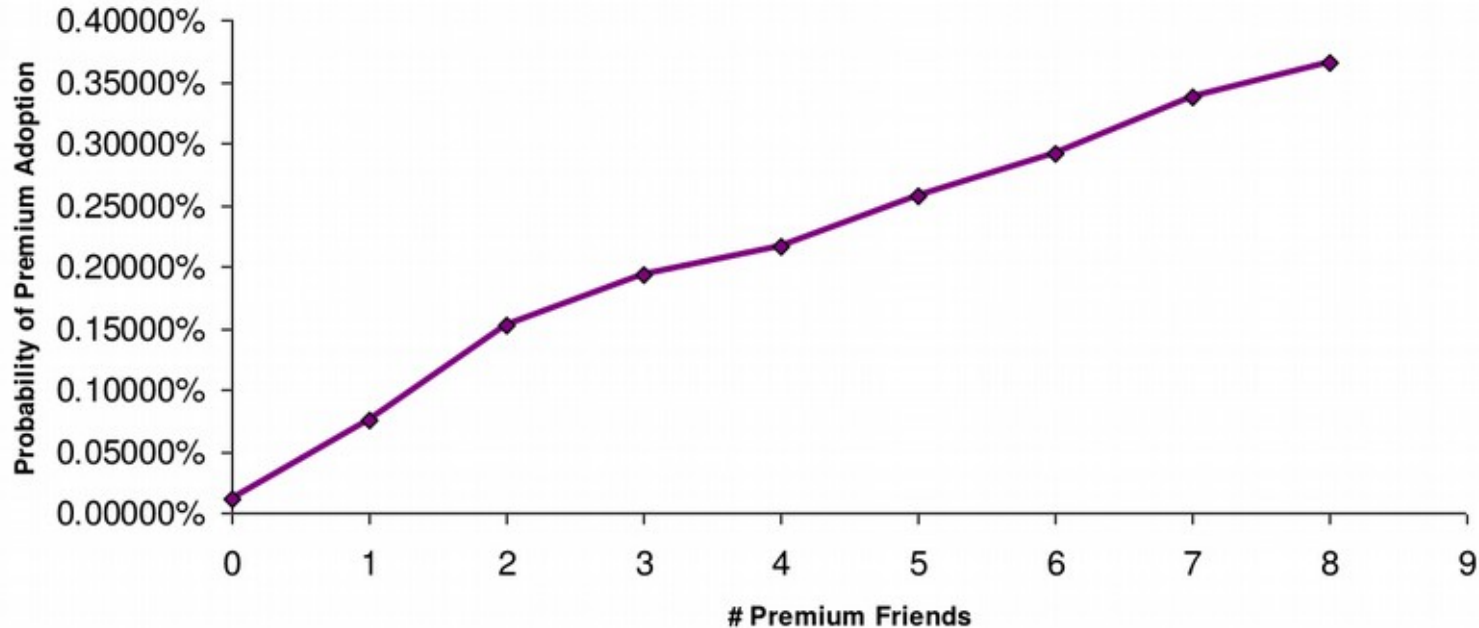
# Viral Marketing Online

- 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



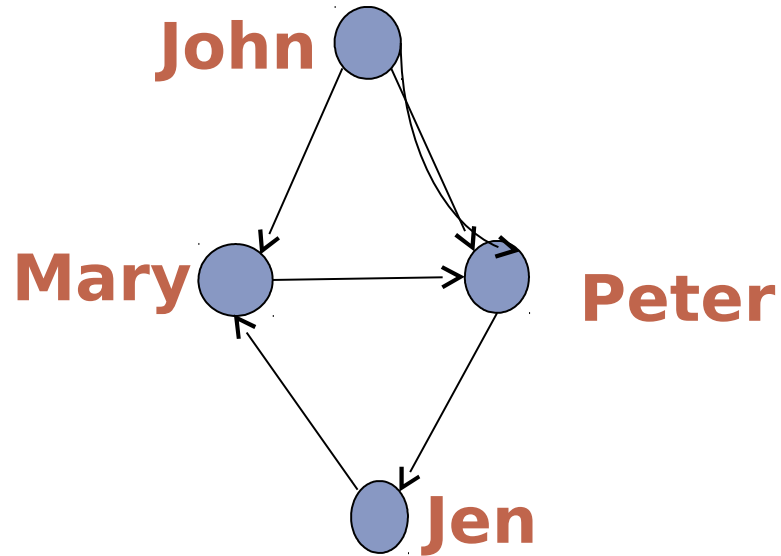
# Peer pressure (pay “premium” subscription)



# Models of influence

# What are our observables?

**Graph**: users,  
links/ties



**Log**: user, action,  
time

User	Action	Time
John	Rates with 5 stars <i>"The Artist"</i>	June 3 <sup>rd</sup>
Peter	Watches <i>"The Artist"</i>	June 5 <sup>th</sup>
Jen	...	...

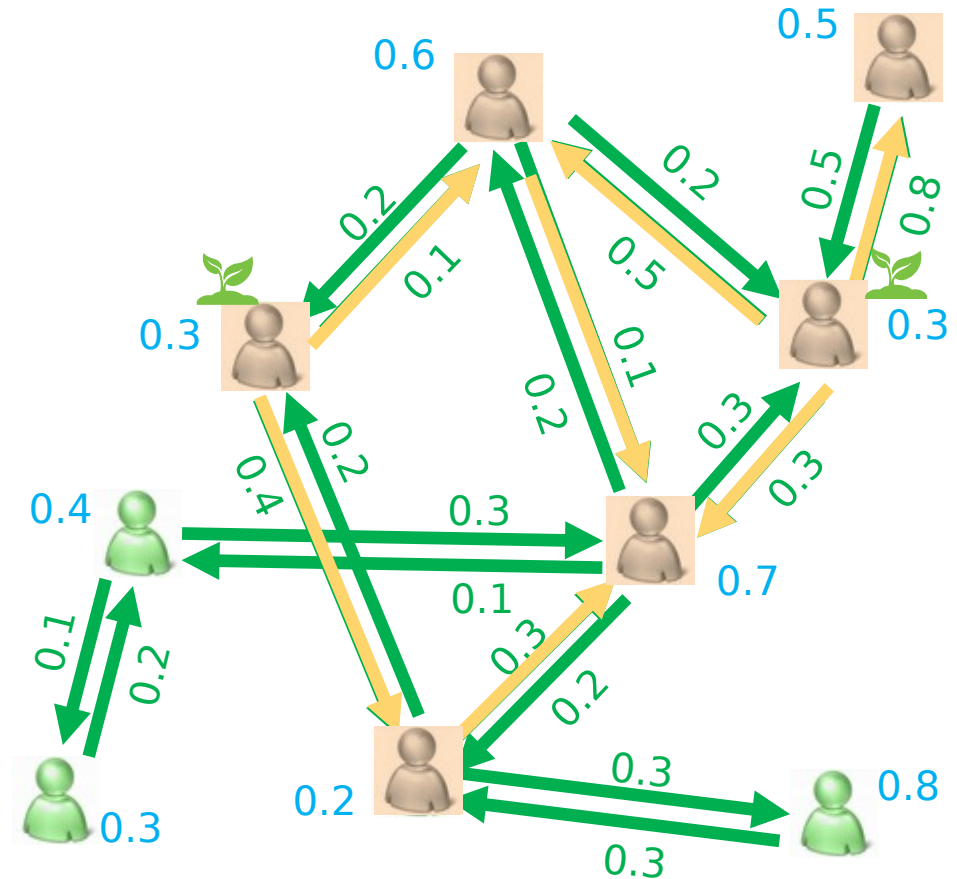


# Two main models

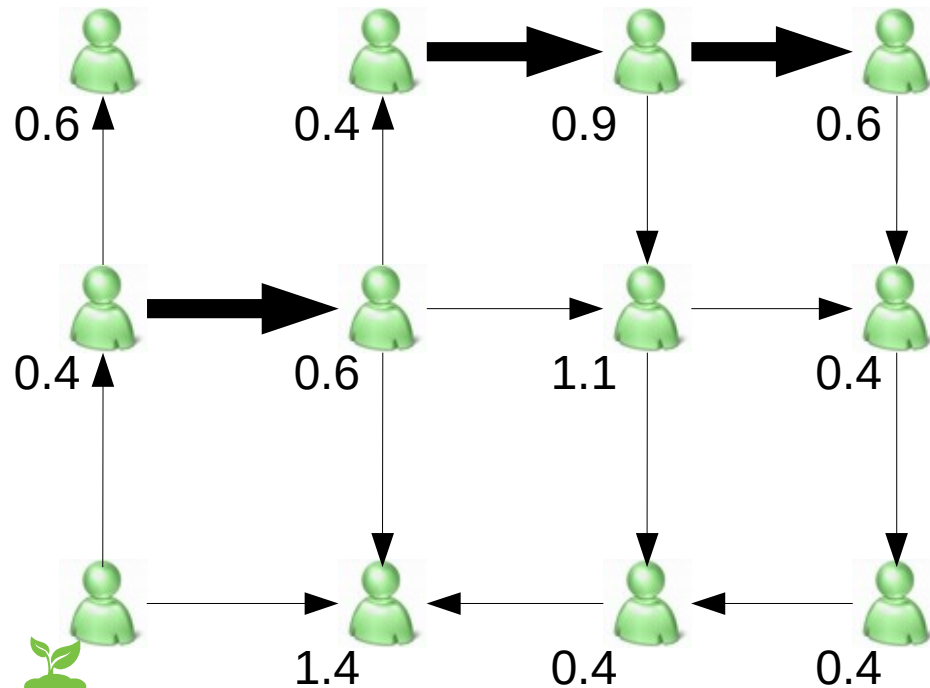
- Linear threshold model
- Independent cascade model

# Linear threshold model

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



# Try it!



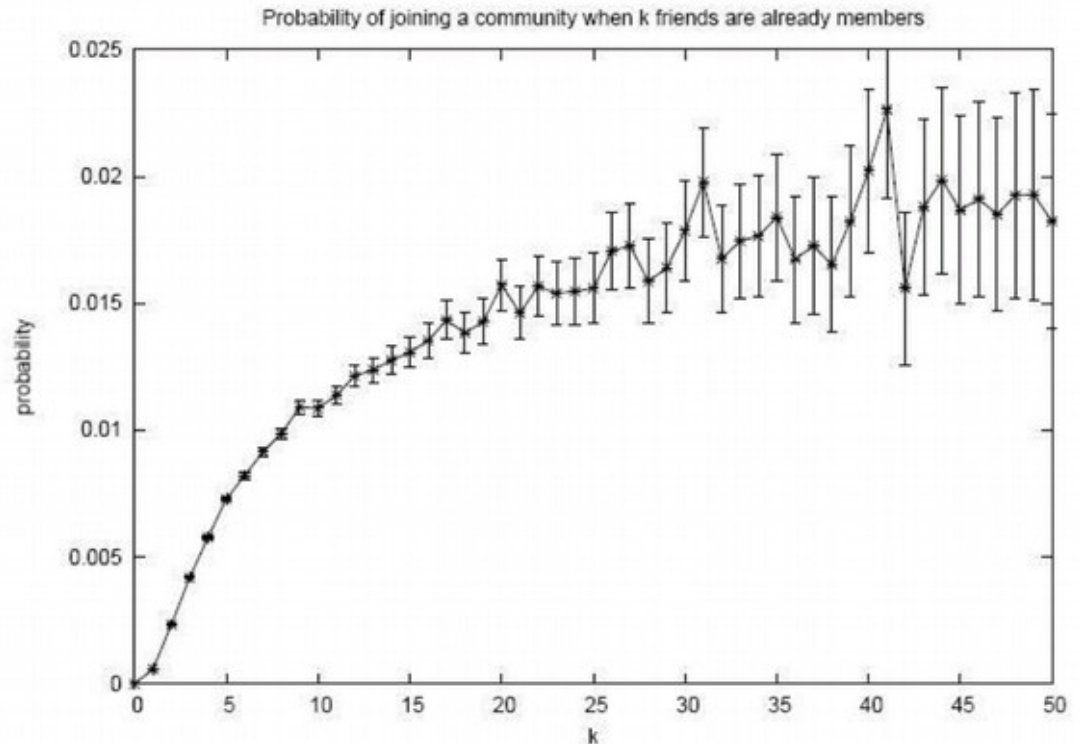
*Thick arrows have weight 1.0*

*Thin arrows have weight 0.5*

*Execute linear threshold model starting from seed node*

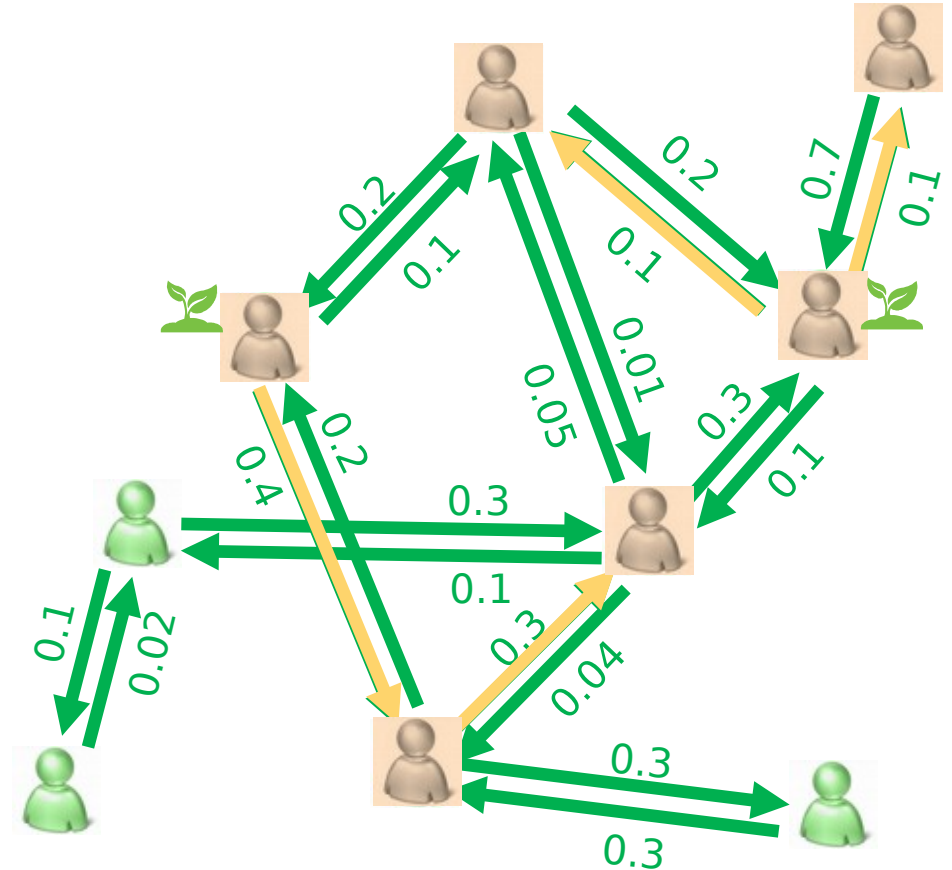
# Linear threshold model

Is the linear threshold model compatible with this observation?



# Independent cascade model

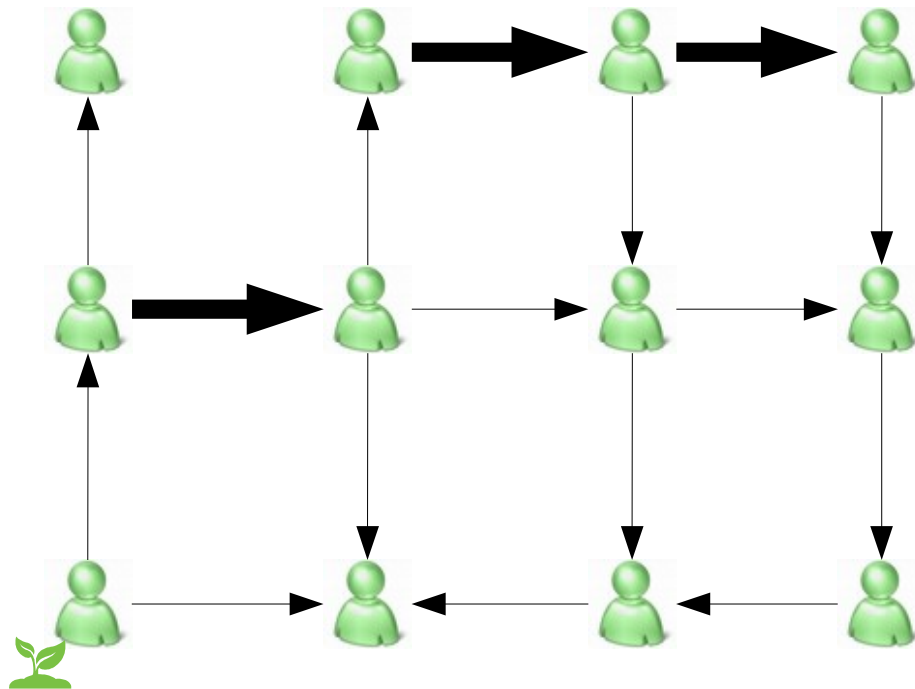
- No thresholds
- Each node, when activating, has one chance of activating each of their neighbors
- Probability of succeeding represented by arc weights



**[Kempe, Kleinberg and Tardos, KDD 2003]**



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



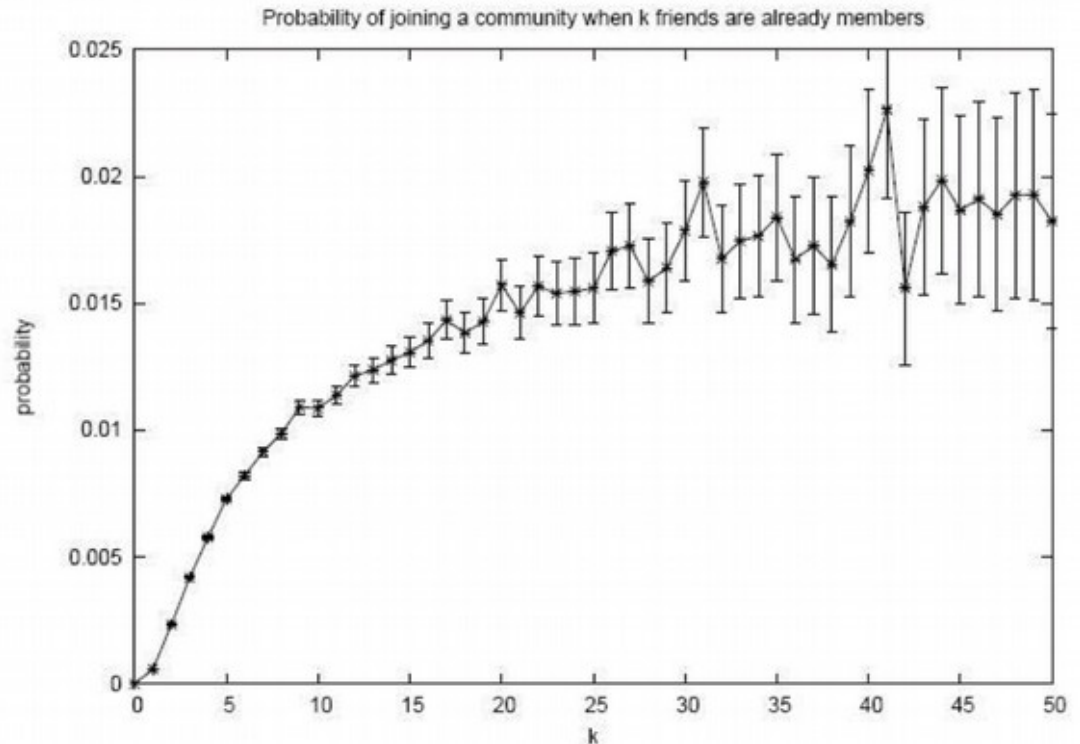
*Thick arrows have probability 0.75*

*Thin arrows have probability 0.5*

*Execute independent cascade model starting from seed node*

# Independent cascade model

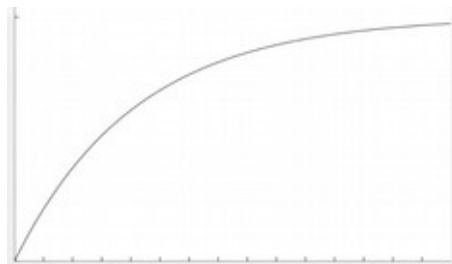
Is the  
independent  
cascade model  
compatible with  
this observation?



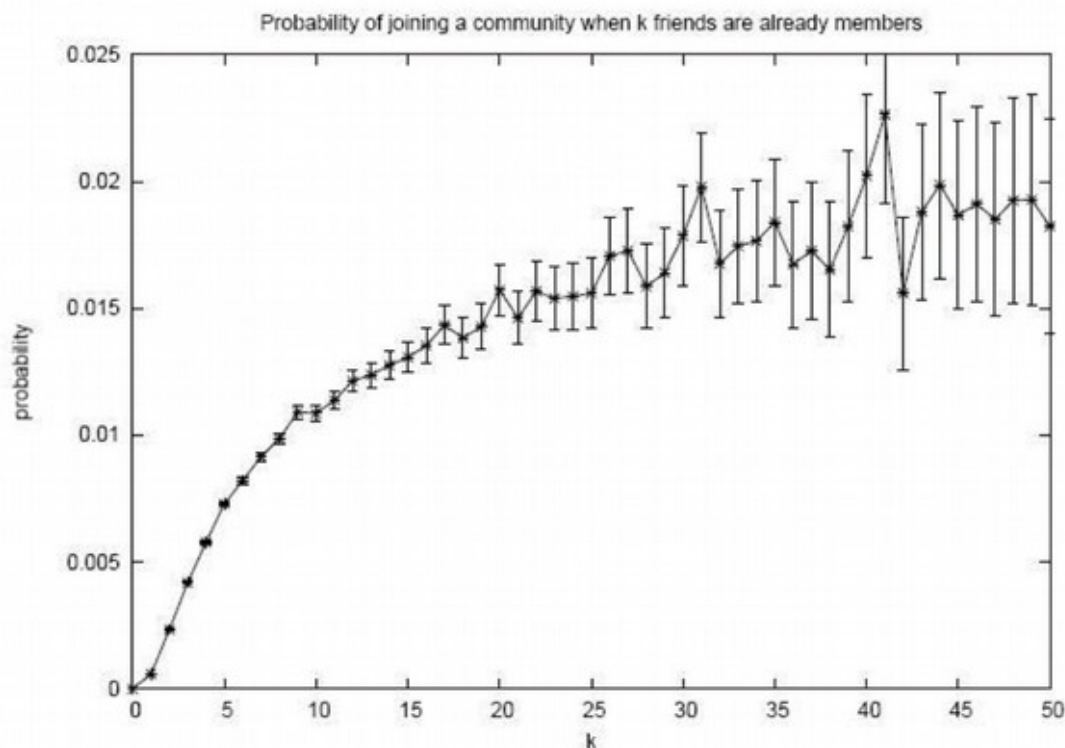
# Independent cascade model

Is the independent cascade model compatible with this observation?

Hint:



$$1 - q^k \text{ for } 0 < q < 1$$



# Influencers and Viral Marketing

# The promise of “influencers”

Influencers **increase** brand awareness.  
product conversions  
through WoMM

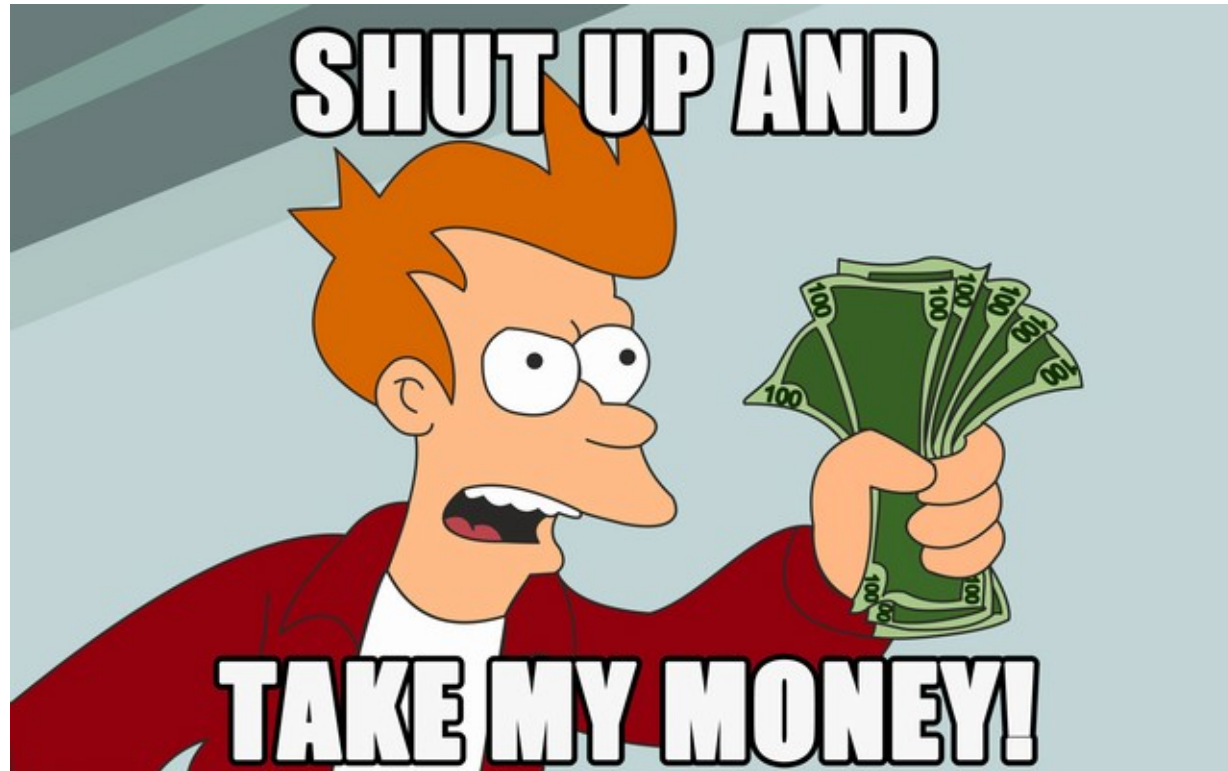
Influencers **advocate** a brand

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

# 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

# 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



Watch "Gun Free"



Watch "Meth - David"

# Summary

- Influence phenomena exist
- They can be modeled
  - And to some extent “predict” **after** they happen
- They are hard to create/engineer