

# Class 15: Complex contagion

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Sociology 204: Social Networks  
Princeton University

1/2 Simple and complex contagion





Greensboro Four (L-R: David McNeil, Franklin McCain, Ezell Blair, Joseph McNeil)

[https://en.wikipedia.org/wiki/Greensboro\\_sit-ins#/media/File:Greensboro\\_Four,\\_Feb\\_1960.jpg](https://en.wikipedia.org/wiki/Greensboro_sit-ins#/media/File:Greensboro_Four,_Feb_1960.jpg)

Distinguish between:

- ▶ spread of information and disease
- ▶ spread of behavior, especially high-risk activism

Two interrelated themes:

- ▶ How do things spread?
- ▶ What does this network look like?

Centola work builds on a lot of the things we read before spring break. I hope you could see that.

1995), and the coordination of collective action (Macy 1990). As Granovetter puts it (1973, p. 1366), “whatever is to be diffused can reach a larger number of people, and traverse a greater social distance, when passed through weak ties rather than strong.” This insight has become one of the most widely cited and influential contributions of sociology to the advancement of knowledge across many disciplines, from epidemiology to computer science.

What are the scope conditions for this claim?

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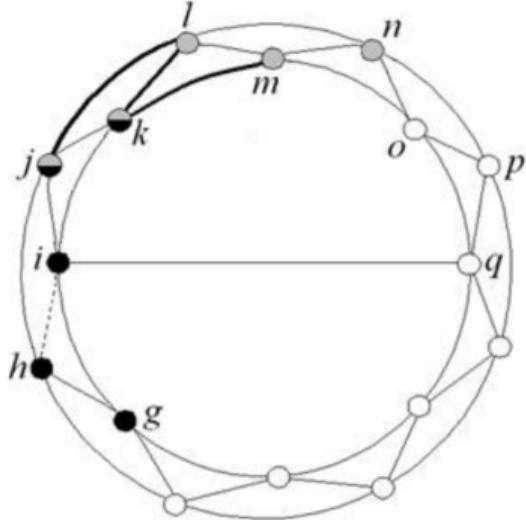
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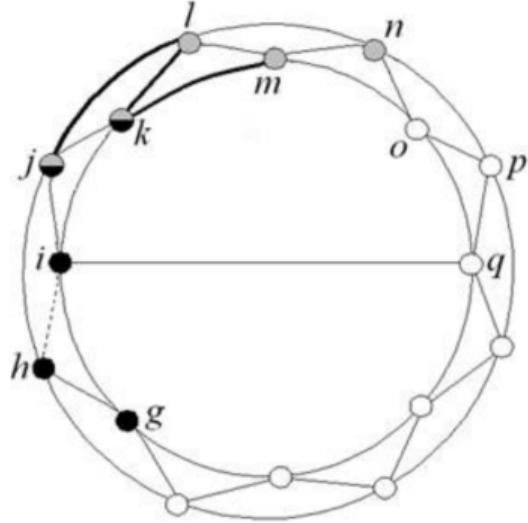
Threshold model  $\tau = \frac{a}{z}$  where

- ▶  $\tau$  is the threshold
- ▶  $a$  is the number of activated neighbors
- ▶  $z$  is the degree

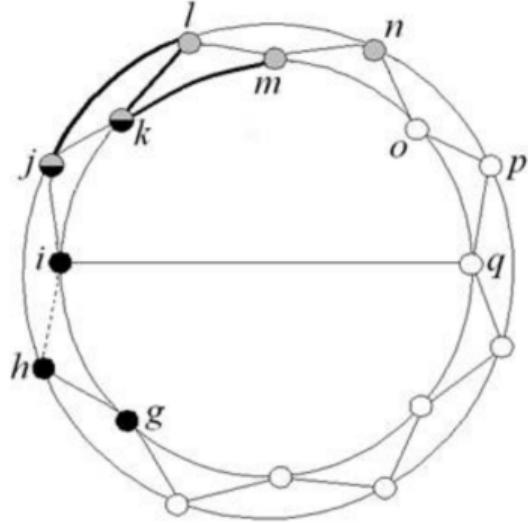
$\tau = \frac{1}{8}$  is different from  $\tau = \frac{6}{48}$



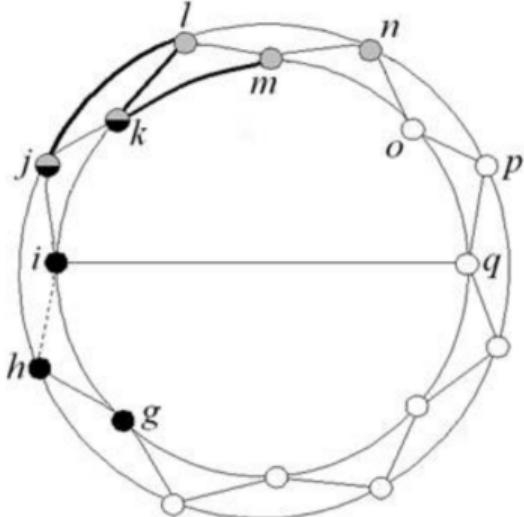
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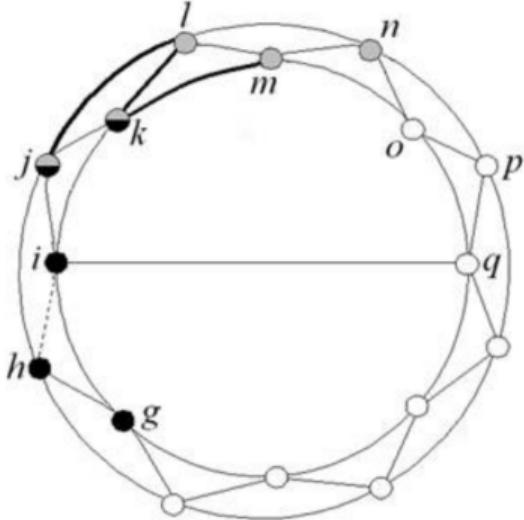
- ▶ Simple contagion:  $l$  and  $m$  are sick, which infects  $k$



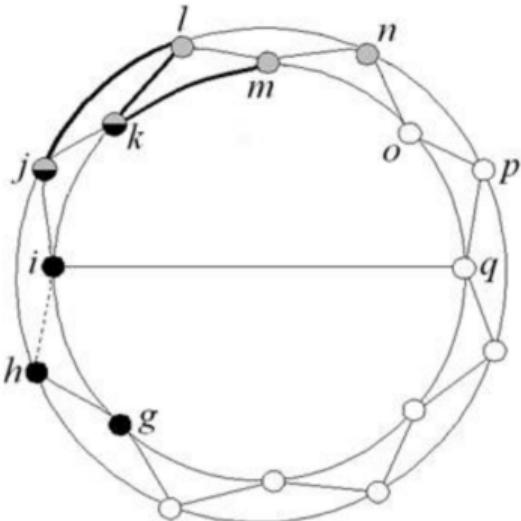
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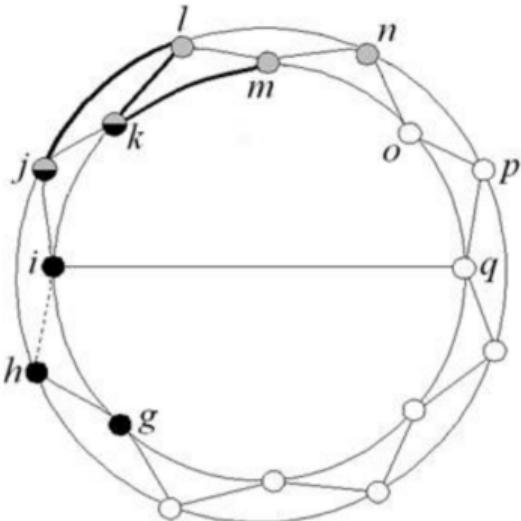
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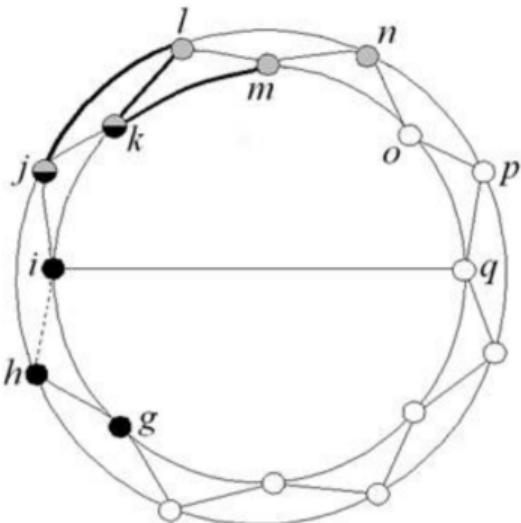
- ▶ Simple contagion:  $i$  and  $m$  are sick, which infects  $k$  which infects  $j$  which infects  $q$  and  $h$  ...



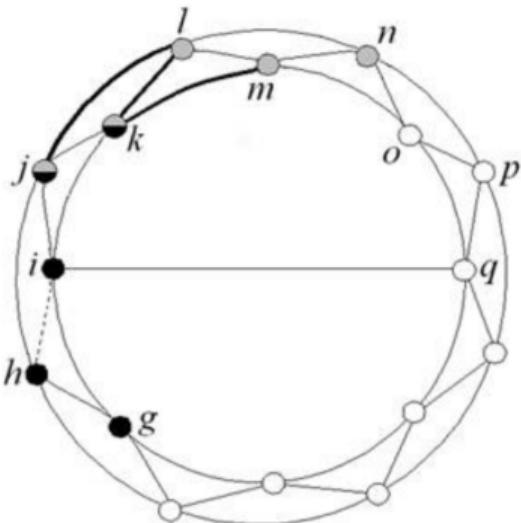
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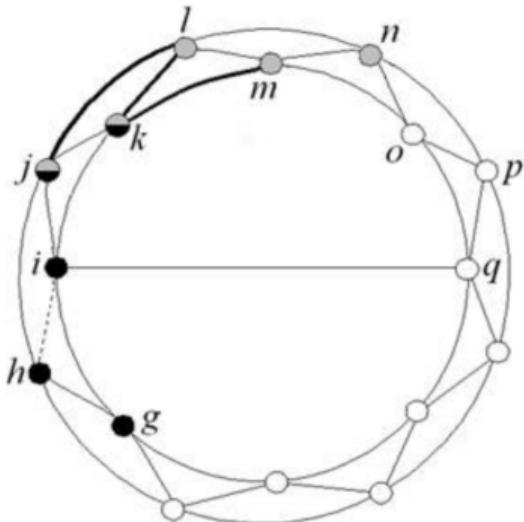
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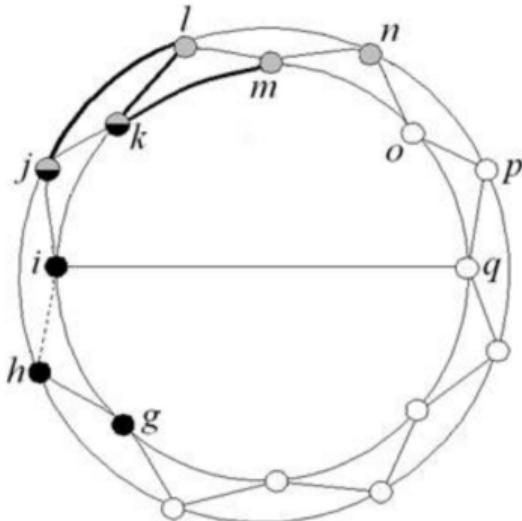
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- ▶ Shortcuts that help with simple contagion can block complex contagion

## Granovetter talks about bridge *length*

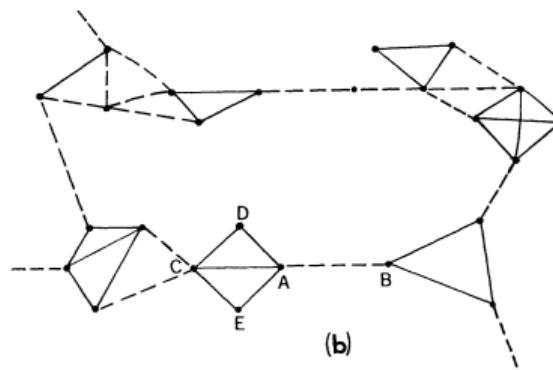
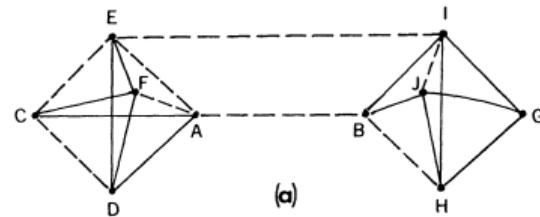
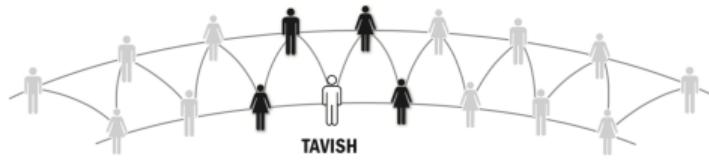
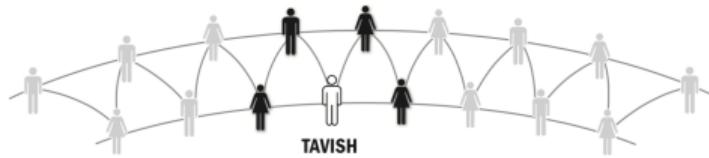


FIG. 2.—Local bridges. *a*, Degree 3; *b*, Degree 13. — = strong tie; - - - = weak tie.

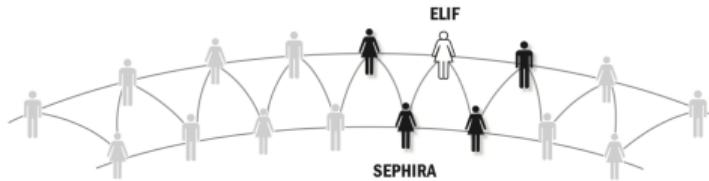
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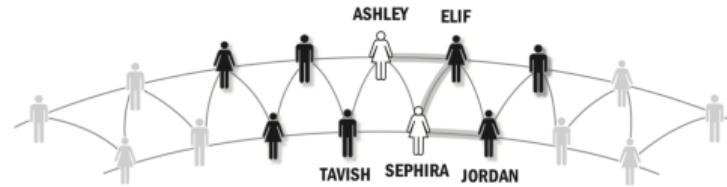
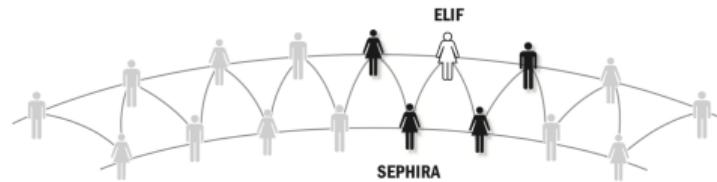
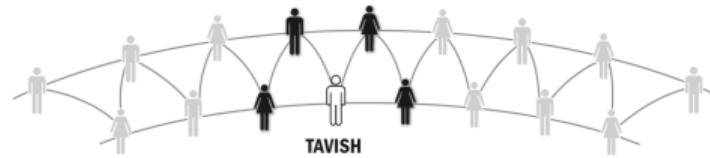
TAVISH



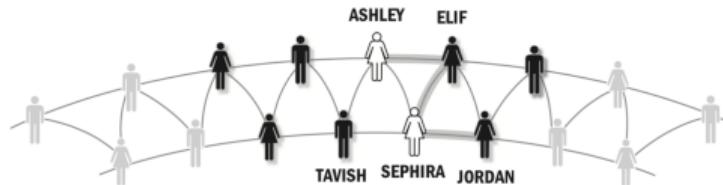
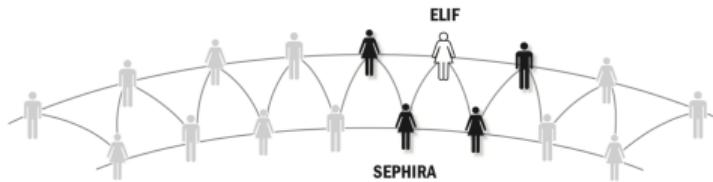
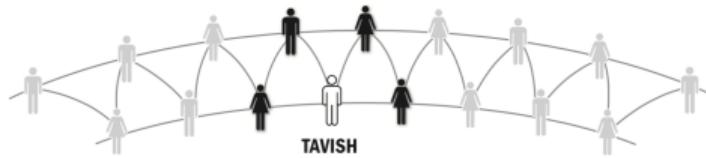
SEPHIRA

ELIF

## Centola talks about bridge width



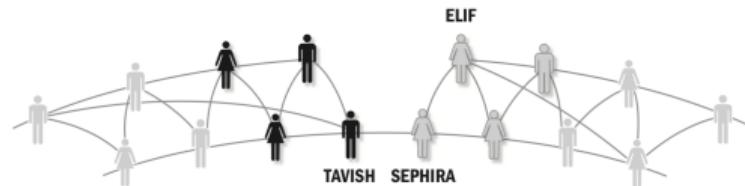
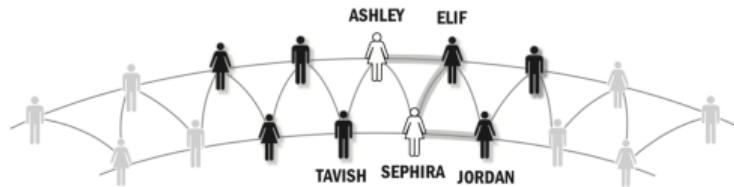
## Centola talks about bridge width



Ties between Tavish's neighborhood and Elif's neighborhood: 3 (bridge width)  
Centola (2018)

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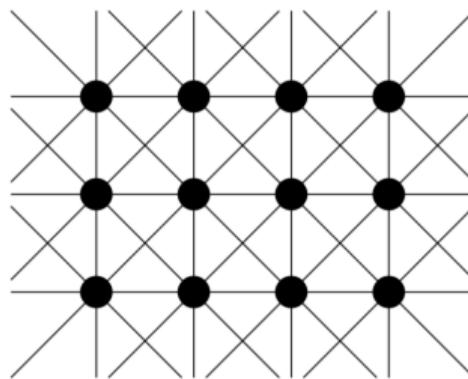
Ties between Tavish's neighborhood and Elif's neighborhood: 1 (bridge width)

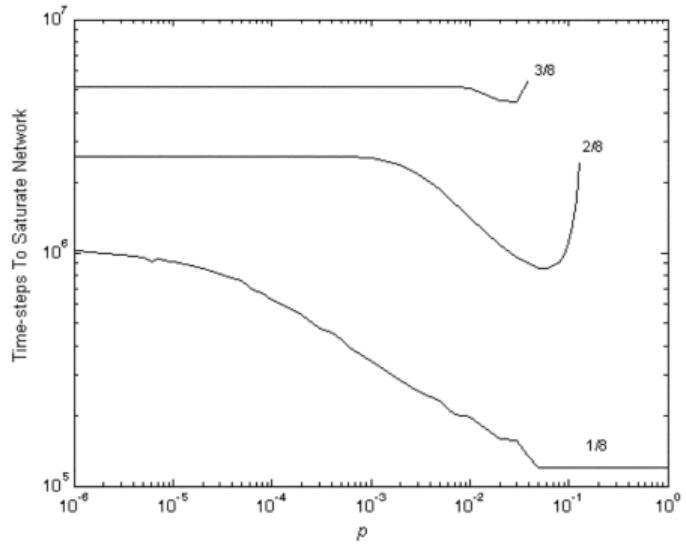
Centola (2018)

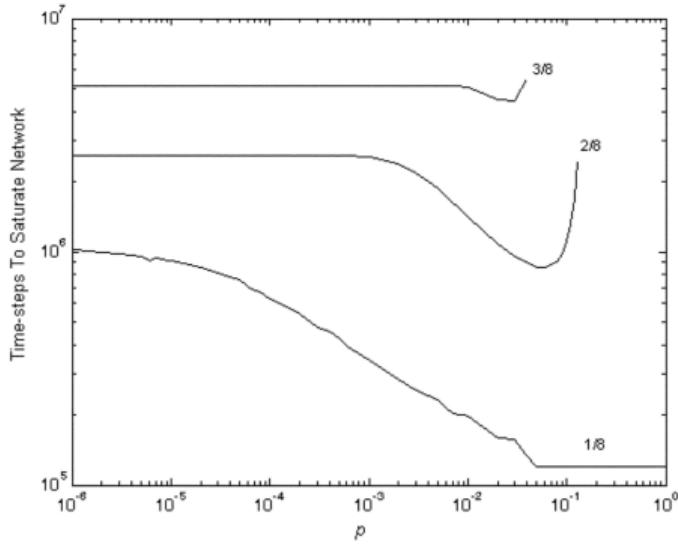
Next step:

- ▶ Move from Ring lattice to two-dimensional lattice with Moore neighborhoods
- ▶ Requires switch from analytic results to simulation.

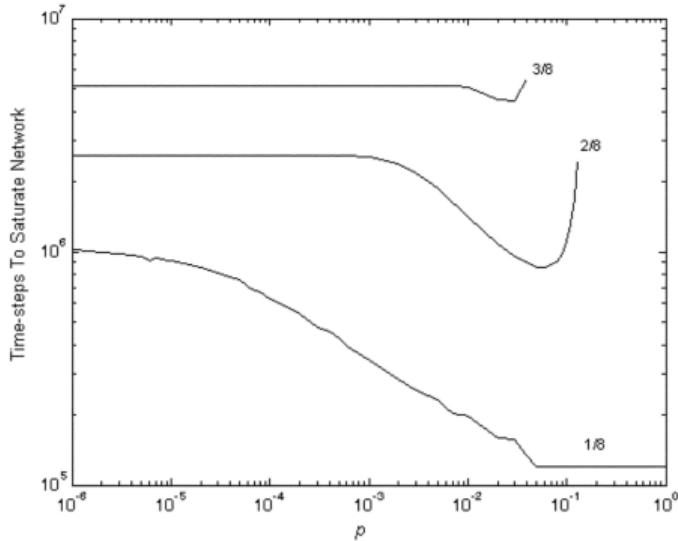
Here's an example of a two-dimensional lattice with Moore neighborhoods



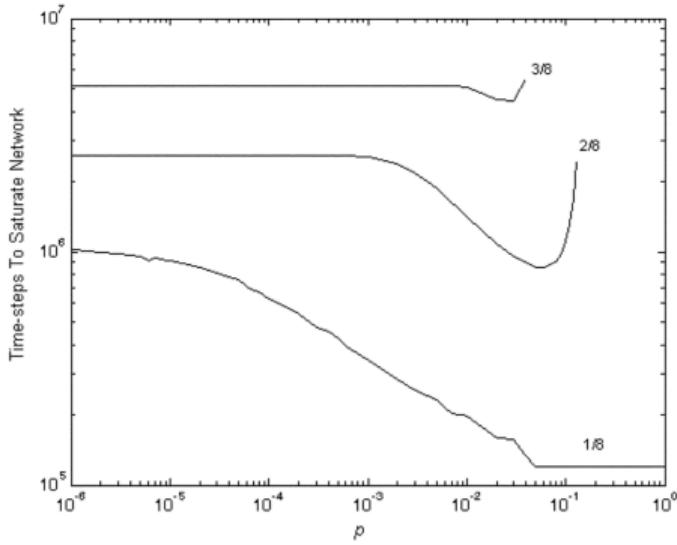




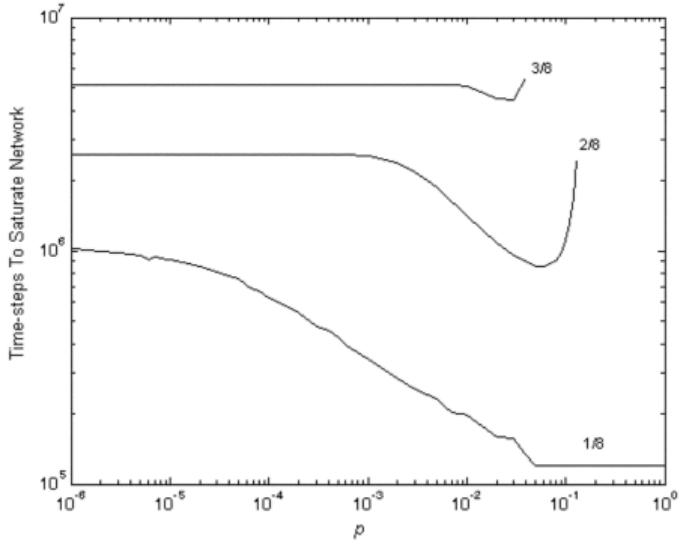
- ▶ simple contagion acts as we expect based on Watts and Strogatz (1998)



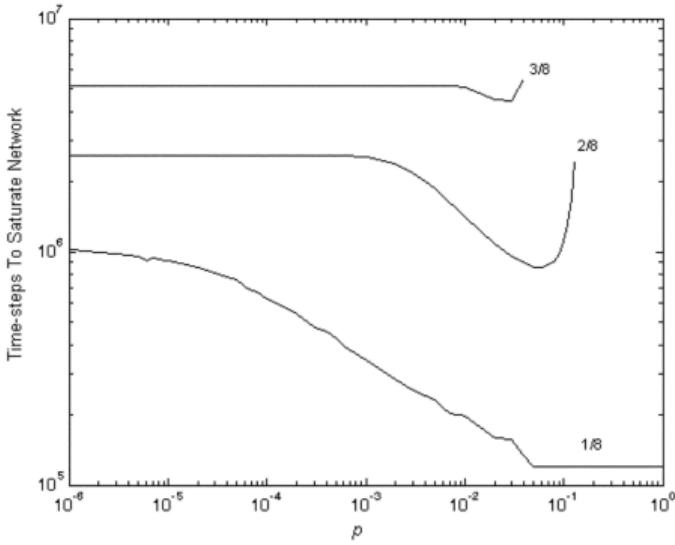
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Notice a research strategy of “replicate and extend”

## Robustness results

- ▶ threshold heterogeneity
- ▶ heterogeneity of influence
- ▶ strong and weak ties
- ▶ heterogeneity of degree

Results in Centola and Macy are based on simple models, could something like this really happen?

## **Complex Contagions and the Weakness of Long Ties<sup>1</sup>**

Damon Centola  
*Harvard University*

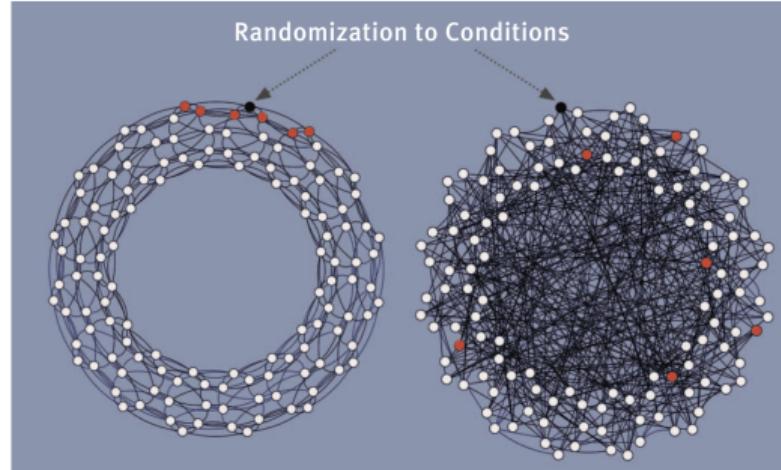
Michael Macy  
*Cornell University*

## **The Spread of Behavior in an Online Social Network Experiment**

Damon Centola

Two competing hypothesis:

- ▶ behavior will spread faster on highly clustered networks
- ▶ behavior will spread faster in networks with many “long ties”



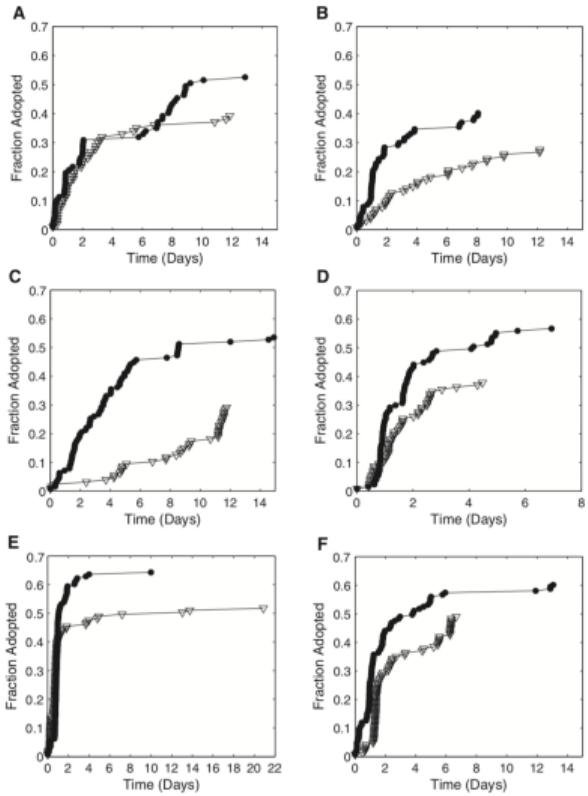
Notice horse race design

Let's listen to Damon tell us about the experimental set-up

<http://www.youtube.com/watch?v=o0fDcUJMzkI&t=48m52s>

Let's listen to Damon tell us about the results

<http://www.youtube.com/watch?v=o0fDcUJMzkI&t=53m39s>



Behavior spreads further and faster in clustered network. This is because redundancy of emails helps with adoption.



<https://www-jstor-org.ezproxy.princeton.edu/stable/j.ctvc7758p>

- ▶ Nickerson, D.W. (2008). Is voting contagious? Evidence from two field experiments. *American Political Science Review*.
- ▶ Kramer, A.D.I. et al. (2014). Experimental evidence of massive-scale emotional contagion through social networks. *Proceedings of the National Academy of Sciences*.