Class 14: Complex contagion

Matthew J. Salganik

Sociology 204: Social Networks
Princeton University

Wednesday, October 27, 2021

1. Gladwell, M. (2010). Small change: The revolution will not be tweeted. *New Yorker*.
2. Centola, D. and Macy, M.W. (2007). Complex contagion and the weakness of long ties. *American Journal of Sociology*.
3. Centola, D. (2010). The spread of behavior in an online social network experiment. *Science*.

Community minute

Colleagues, we write to ask that you take what the Office of Environmental Health and Safety is calling a "Community Minute" at the start of each class, so that students can learn the names of others seated around them. We ask that you invite students to take a moment to write down the names of those seated within six feet for 15 minutes or more, along with their location in the classroom. If students don't know one another's names, they should briefly introduce themselves.

This "Community Minute" will facilitate the University's contact tracing efforts. So far this semester, we've noted several instances in which COVID-positive students couldn't identify their close contacts because they didn't know who they were seated near in their classes. As a result, Global and Community Health at UHS had to notify everyone in the class that they were a potential close contact.

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

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 the 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?

- simple contagion: 1 source of contact may enable activation

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- complex contagion: 2 or more sources of contact needed for activation

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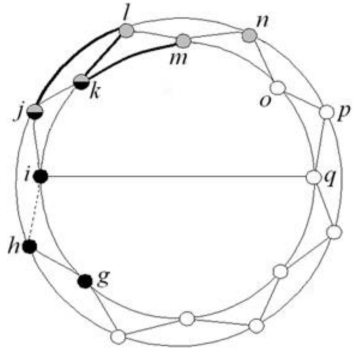
- simple contagion: 1 source of contact may enable activation (disease)
- complex contagion: 2 or more sources of contact needed for activation (behavior)

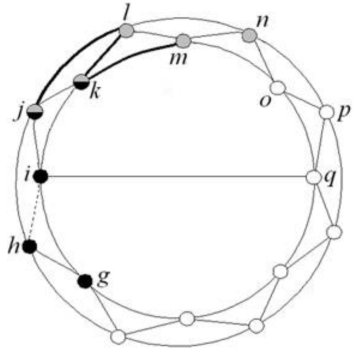
Threshold model $\tau = \frac{a}{z}$ where

- τ is the threshold
- a is the number of activated neighbors
- z is the degree

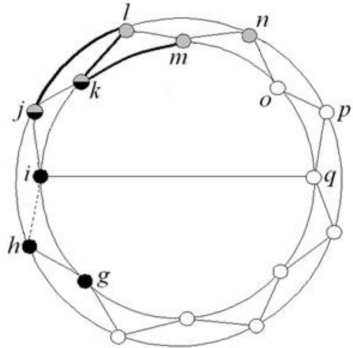
$\tau = \frac{1}{8}$ is different from $\tau = \frac{6}{48}$



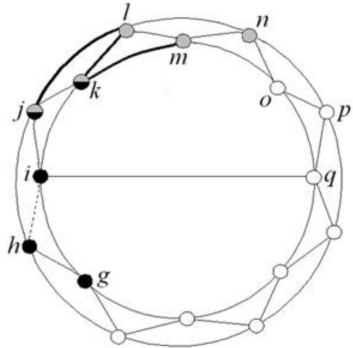
- Simple contagion: l and m are sick,



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



- Simple contagion: *l* and *m* are sick, which infects *k* which infects *j*



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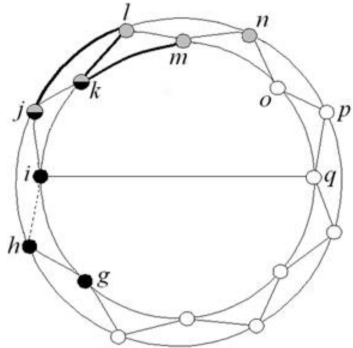

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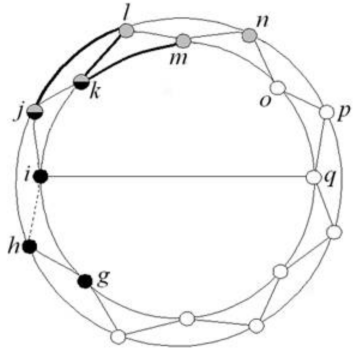

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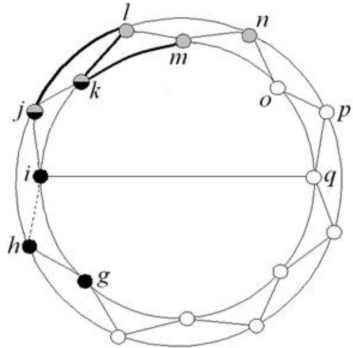
- Complex contagion ($\tau = 2/4$): l and m are protesting,



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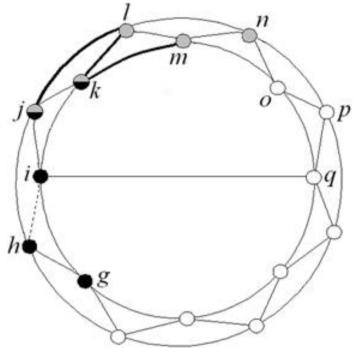

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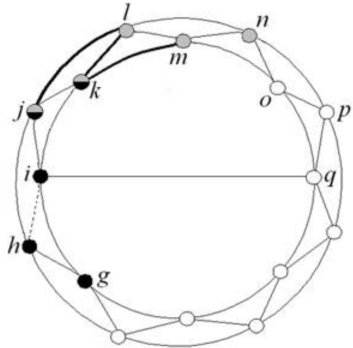

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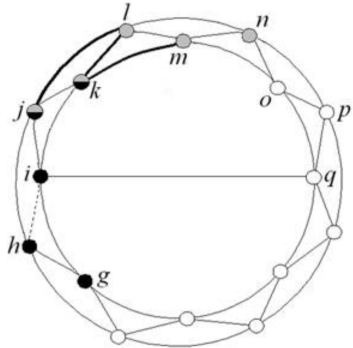

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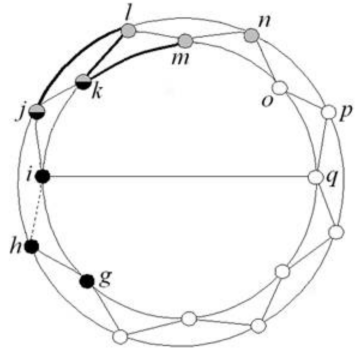

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- Complex contagion ($\tau = 2/4$): l and m are protesting, which activates k which activates j which activates i but does not activate h.
- Changes in the network that help help a simple contagion and hinder a complex contagion

Granovetter talks about bridge *length*

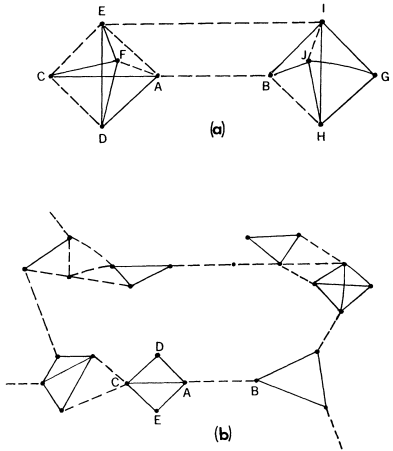
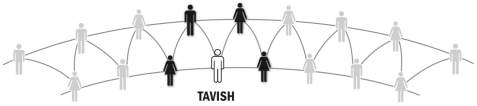


FIG. 2.—Local bridges. *a*, Degree 3; *b*, Degree 13. ——— = strong tie; — — — = weak tie.

Centola talks about bridge *width* between neighborhoods



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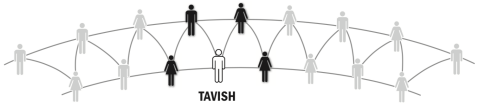

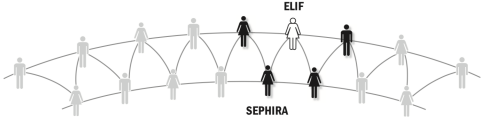

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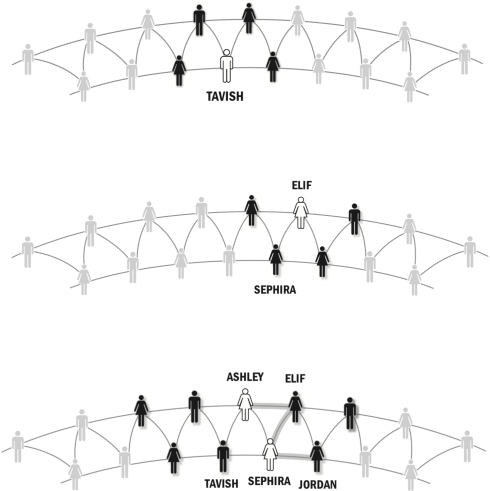

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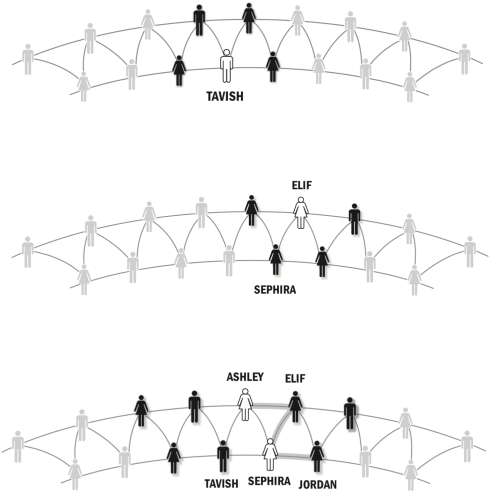

Ties between Tavish's neighborhood and Elif's neighborhood: 3 (bridge width)

Centola (2018), p 43-45

Creating shortcuts can hurt complex contagion if it breaks local redundancy

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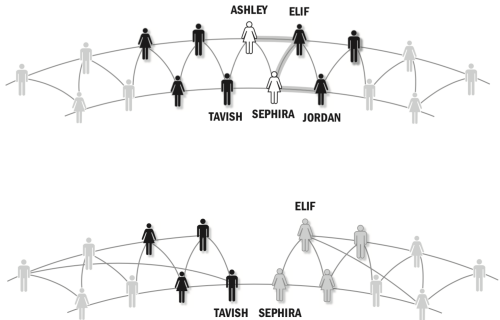


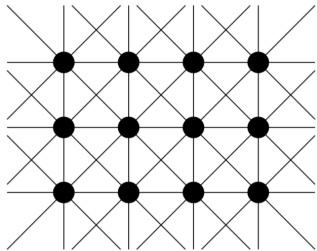
Ties between Tavish's neighborhood and Elif's neighborhood: 1 (bridge width)

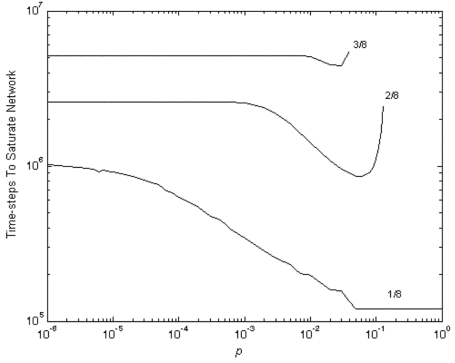
Centola (2018), p 43-45

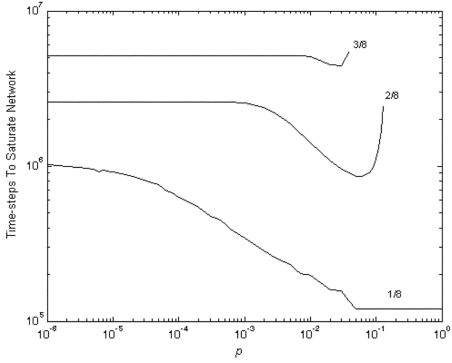
Next step:

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

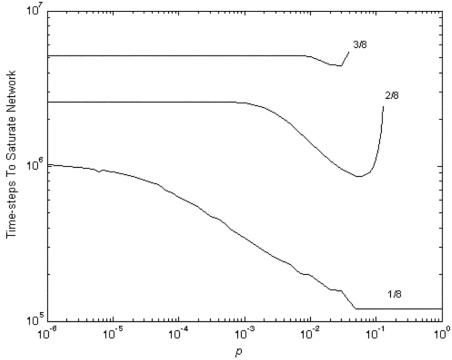
Here's an example of a two-dimensional lattice with Moore neighborhoods




Time-steps To Saturate Network
p
3/8
2/8
1/8
10^7
10^6
10^5
10^-6
10^-5
10^-4
10^-3
10^-2
10^-1
10^0



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



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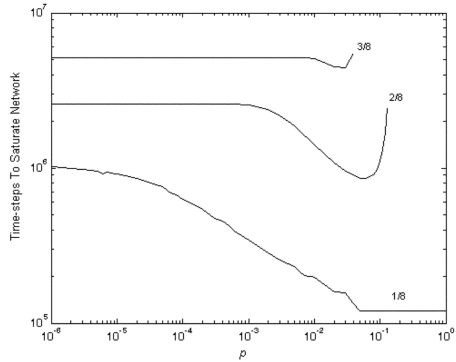

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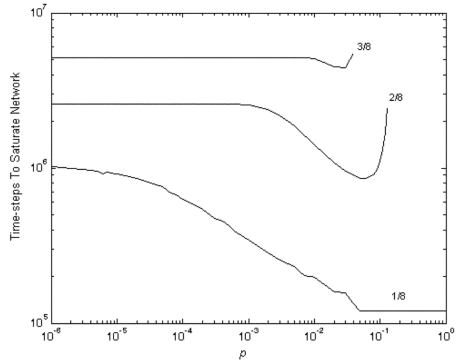

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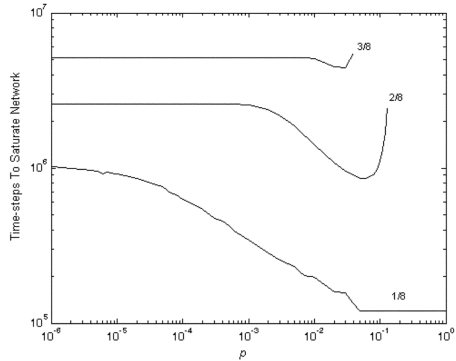

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Notice a research strategy of "replicate and extend"

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[1]

Damon Centola
Harvard University

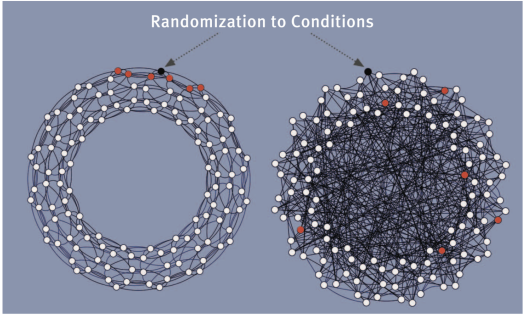
Michael Macy
Cornell University

The Spread of Behavior in an Online Social Network Experiment

Damon Centola

Two competing hypothesis:

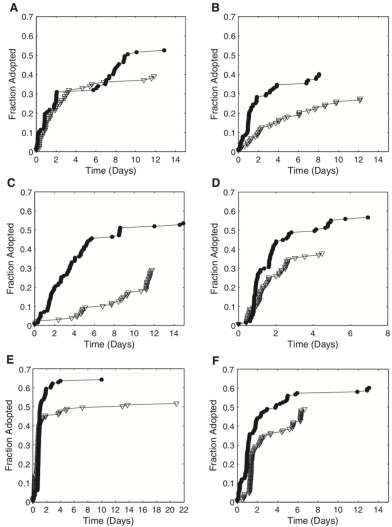
- behavior will spread faster on highly clustered networks
- behavior will spread faster in networks with many "long ties"



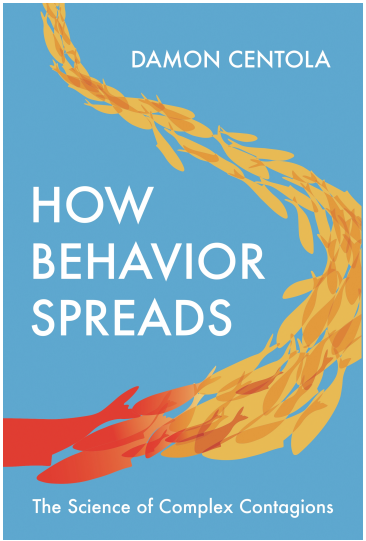
Notice horse race design

Let's listen to Damon tell us about the experimental set-up (about 4 minutes)
http://www.youtube.com/watch?v=o0fDcUJMzkI&t=47m52s

Let's listen to Damon tell us about the results (about 2 minutes)
http://www.youtube.com/watch?v=o0fDcUJMzkI&t=53m35s



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

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Research design strategies

- replicate and extend
- horse race

A different approach to contagion

- 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*.