

More on the small world problem and some history

Sociology 204: Social Networks

Matthew J. Salganik

2/13/17

Logistics:

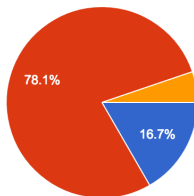
- ▶ Precepts begin this week
- ▶ Homework due by 10am on Wednesday (late policy for homework)
- ▶ Don't wait until the last minute
- ▶ Office hours

Questions?

Thank you for the feedback:

For today's class, how was the balance between reviewing the readings and covering new material?

(96 responses)



- spent too much time reviewing the reading and not enough time covering new material
- had the right mix of reviewing the reading and covering new material
- spent too much time covering new material and not enough time reviewing the reading

Please move forward again



West Wing, Veep, or House of Cards?

Policy and Technology in the Obama White House



Ed Felten

Robert E. Kahn Professor of Computer Science and Public Affairs and the Director for the Center for Information Technology Policy and Program in Technology and Society, Information Technology Track

Professor Felten recently completed a 20-month tour of duty at the White House, where he served as Deputy U.S. Chief Technology Officer. In this talk he will discuss his experience there, describe ongoing policy challenges, and reflect on the role of technology and academic expertise in policymaking.

Monday, February 13, 2017

4:30 p.m.

104 Computer Science



COMPASS Workshops

Computing for Data Analysis in the Social Sciences

Wednesdays, 7:30 to 9:00pm, Friend Center Auditorium 101

<https://compass-workshops.github.io/info/>

Vote

1. Granovetter, M. (2003). Ignorance, knowledge, and outcomes in a small world. Science.
2. Dodds, P.S., Muhamad, R., and Watts, D.J. (2003). An experimental study of search in a global social networks. Science.
3. Watts, Chapter 2.

POP QUIZ

POP QUIZ FOR CANDY

POP QUIZ FOR CANDY

In the Dodds, Muhamad, Watts experiments what percentage of chains that started reached their target?

Let's think back to 1967



http://upload.wikimedia.org/wikipedia/commons/f/f5/1967_Ford_Fairlane_Ranchero.jpg



http://commons.wikimedia.org/wiki/File:Ericsson_Dialog_in_green.JPG



http://commons.wikimedia.org/wiki/File:Computer_in_County_of_Orange_offices,_1967.jpg

Story → problem statement

Given two individuals selected randomly from the population, what is the probability that the minimum number of intermediaries required to link them is $0, 1, 2, \dots, k$?

Empirical approach
(Harvard approach)

vs.

Modeling approach
(MIT approach)

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Today

- ▶ see how Dodds, Muhamad, and Watts tried to improve the empirical approach
- ▶ learn some background so that we can understand a modeling approach

“I read somewhere that everybody on the planet is separated by only six other people. Six degrees of separation. Between us and everybody else on this planet. The president of the United States. A gondolier in Venice . . . It's not just the big names. It's anyone. A native in the rain forest. A Tierra del Fuegan. An Eskimo. I am bound to everyone on this planet by a trail of six people. It's a profound thought . . . ”

Ouisa in *Six Degrees of Separation* by John Guare

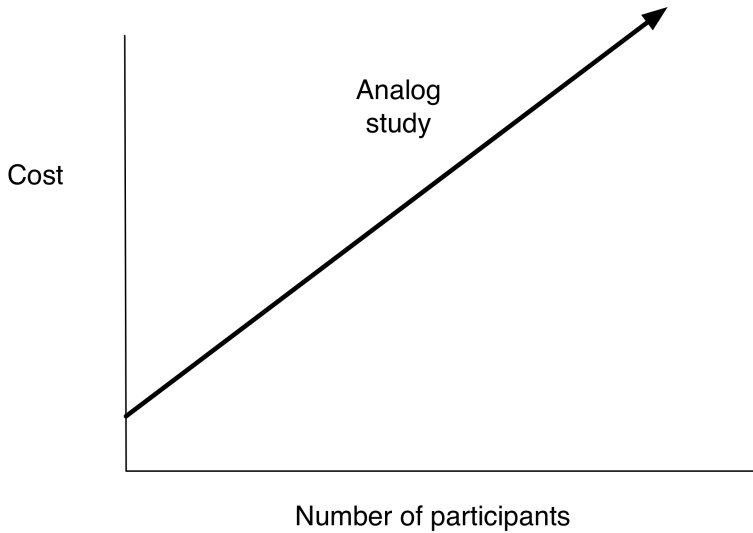
BIG DATA

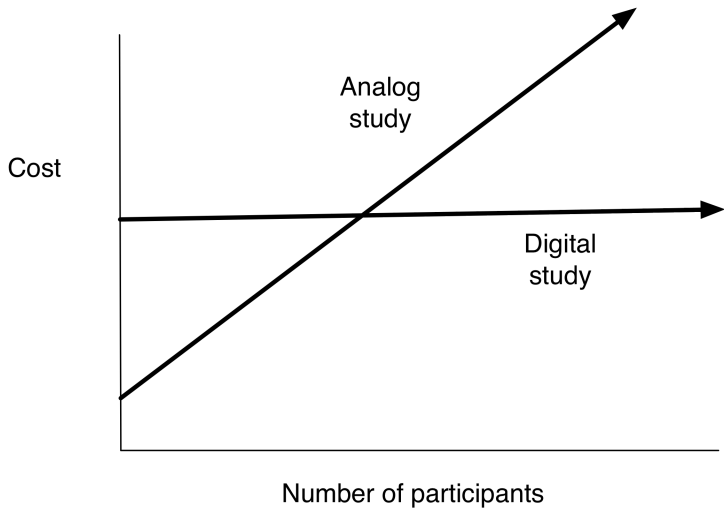
BIG DATA

analog vs digital

Digital enables:

- ▶ zero-marginal cost data





Digital enables:

- ▶ zero-marginal cost data
- ▶ 100x'ing the number of participants

Digital enables:

- ▶ zero-marginal cost data
- ▶ 100x'ing the number of participants
- ▶ global scale

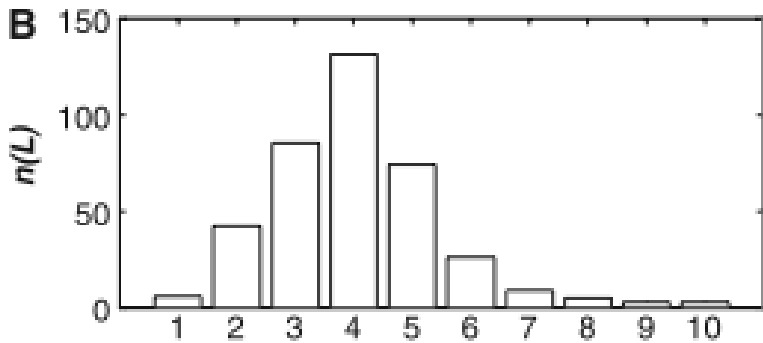
Digital enables:

- ▶ zero-marginal cost data
- ▶ 100x'ing the number of participants
- ▶ global scale

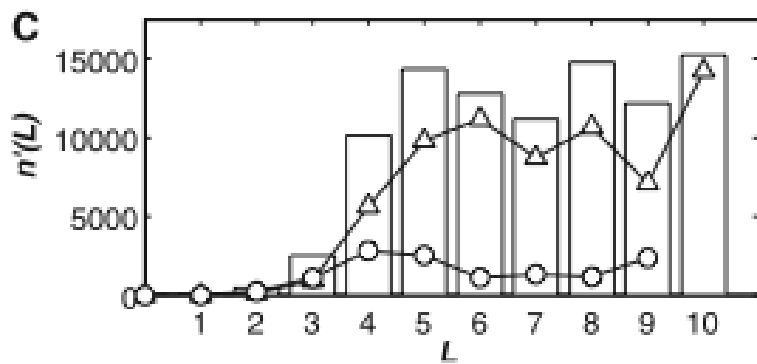
For more: Salganik (2017) *Bit by Bit: Social Research in the Digital Age*: <http://www.bitbybitbook.com>

- ▶ What was the limiting factor for Milgram?
- ▶ What was the limiting factor for Dodds, Muhamad, and Watts?

24,163 chains started toward 18 targets all over the world. The first time ever we have an experiment like this on a global scale. What did they find?



L = chain length (number of edges)



What was the chain completion rate for Dodds, Muhamad, and Watts?

Although the average participation rate (about 37%) was high relative to those reported in most e-mail-based surveys (26), the compounding effects of attrition over multiple links resulted in exponential attenuation of chains as a function of their length and therefore an extremely low chain completion rate (384 of 24,163 chains reached their targets). Chains may have terminated (i)

$$\frac{384}{24,163} = 1.6\%$$

| <i>Target</i> | <i>City</i> | <i>Country</i> | <i>Occupation</i> | <i>Gender</i> | <i>N</i> |
|---------------|--------------------|----------------|--------------------------|---------------|----------|
| 1 | Novosibirsk | Russia | PhD student | F | 8234 |
| 2 | New York | USA | Writer | F | 6044 |
| 3 | Bandung | Indonesia | Unemployed | M | 8151 |
| 4 | New York | USA | Journalist | F | 5690 |
| 5 | Ithaca | USA | Professor | M | 5855 |
| 6 | Melbourne | Australia | Travel Consultant | F | 5597 |
| 7 | Bardufoss | Norway | Army veterinarian | M | 4343 |
| 8 | Perth | Australia | Police Officer | M | 4485 |
| 9 | Omaha | USA | Life Insurance Agent | F | 4562 |
| 10 | Welwyn Garden City | UK | Retired | M | 6593 |
| 11 | Paris | France | Librarian | F | 4198 |
| 12 | Tallinn | Estonia | Archival Inspector | M | 4530 |
| 13 | Munich | Germany | Journalist | M | 4350 |
| 14 | Split | Croatia | Student | M | 6629 |
| 15 | Gurgaon | India | Technology Consultant | M | 4510 |
| 16 | Managua | Nicaragua | Computer analyst | M | 6547 |
| 17 | Katikati | New Zealand | Potter | M | 4091 |
| 18 | Elderton | USA | Lutheran Pastor | M | 4438 |
| Totals | | | | | 98,847 |

| Target | City | Country | Occupation | Gender | N | N _c (%) |
|--------|--------------------|-------------|-----------------------|--------|--------|--------------------|
| 1 | Novosibirsk | Russia | PhD student | F | 8234 | 20(0.24) |
| 2 | New York | USA | Writer | F | 6044 | 31 (0.51) |
| 3 | Bandung | Indonesia | Unemployed | M | 8151 | 0 |
| 4 | New York | USA | Journalist | F | 5690 | 44 (0.77) |
| 5 | Ithaca | USA | Professor | M | 5855 | 168 (2.87) |
| 6 | Melbourne | Australia | Travel Consultant | F | 5597 | 20 (0.36) |
| 7 | Bardufoss | Norway | Army veterinarian | M | 4343 | 16 (0.37) |
| 8 | Perth | Australia | Police Officer | M | 4485 | 4 (0.09) |
| 9 | Omaha | USA | Life Insurance Agent | F | 4562 | 2 (0.04) |
| 10 | Welwyn Garden City | UK | Retired | M | 6593 | 1 (0.02) |
| 11 | Paris | France | Librarian | F | 4198 | 3 (0.07) |
| 12 | Tallinn | Estonia | Archival Inspector | M | 4530 | 8 (0.18) |
| 13 | Munich | Germany | Journalist | M | 4350 | 32 (0.74) |
| 14 | Split | Croatia | Student | M | 6629 | 0 |
| 15 | Gurgaon | India | Technology Consultant | M | 4510 | 12 (0.27) |
| 16 | Managua | Nicaragua | Computer analyst | M | 6547 | 2 (0.03) |
| 17 | Katikati | New Zealand | Potter | M | 4091 | 12 (0.3) |
| 18 | Elderton | USA | Lutheran Pastor | M | 4438 | 9 (0.21) |
| Totals | | | | | 98,847 | 384 (0.4) |

The largest empirical study of all time is mostly about connections to Steve Strogatz! (About 40% of completed chains)

Questions?

Empirical approach
(Harvard approach)

vs.

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- ▶ What is the point of mathematical models?

- ▶ What is the point of mathematical models?
- ▶ How will we work with mathematical models in this class?

Models of networks:

- ▶ Erdos - Renyi

Net logo demo

<https://ccl.northwestern.edu/netlogo/>

We all get connected very quickly . . .

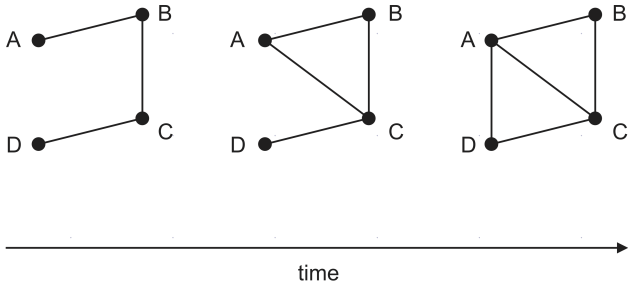
Network models

- ▶ Erdos-Reyni (dyadic)

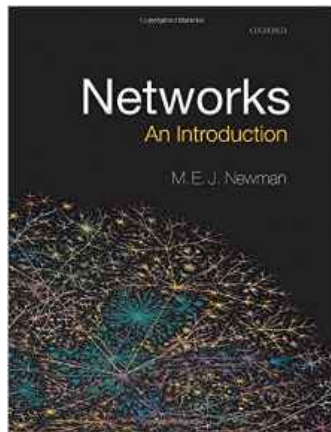
Network models

- ▶ Erdos-Reyni (dyadic)
- ▶ Rappaport (triadic), wants the balance between randomness and order

2.3



For a detailed mathematical treatment of random graphs, I recommend:



Triadic closure today

The Effect of Recommendations on Network Structure

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<http://dx.doi.org/10.1145/2872427.2883040>

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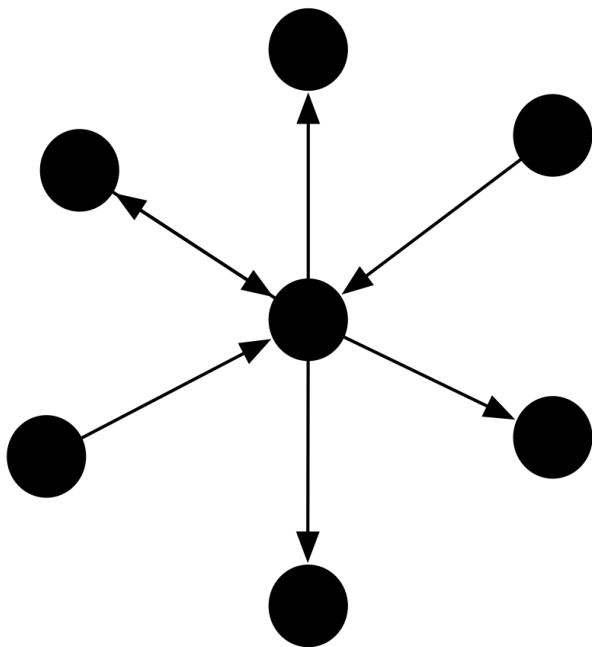


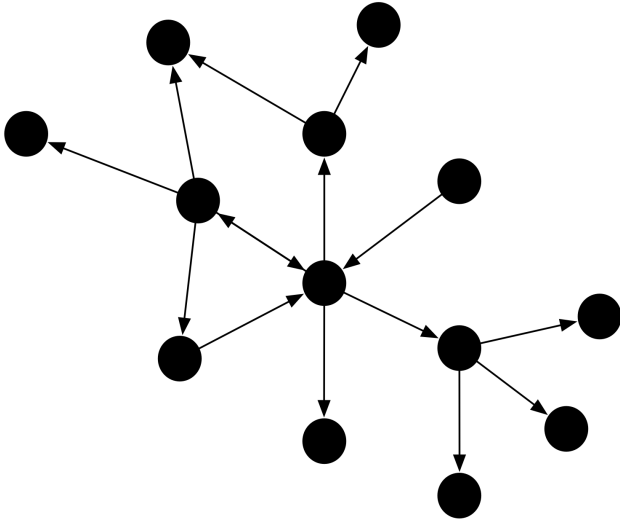
Follow



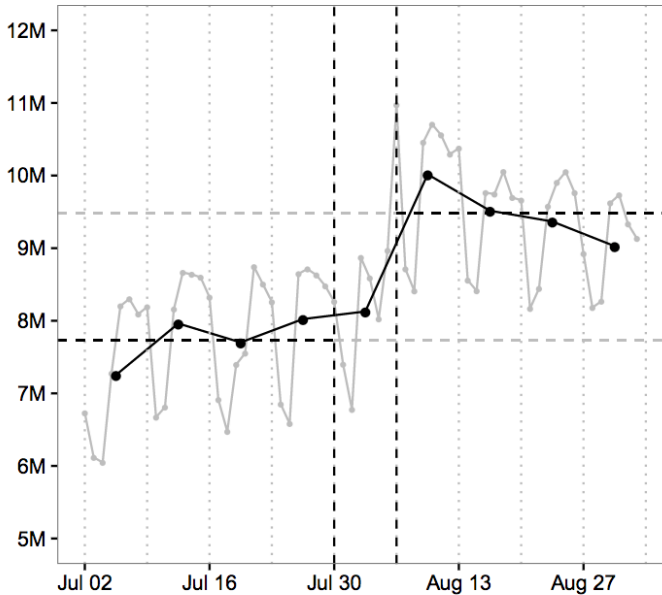
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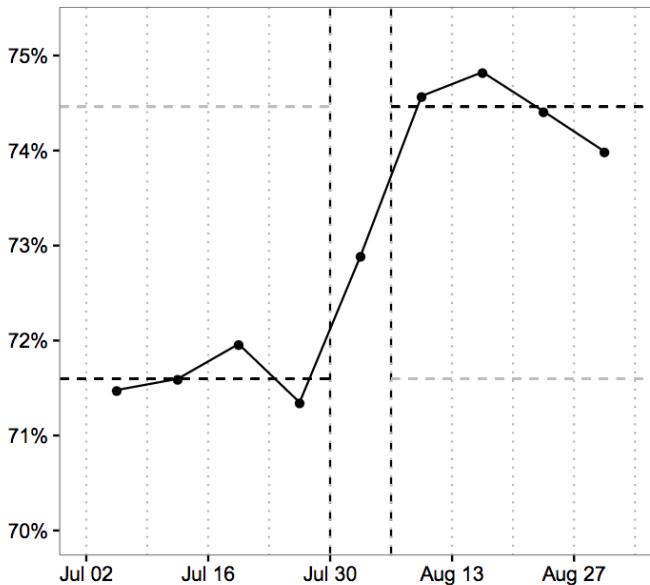




Daily number of new edges



Percent of edges that close a triangle



Online behavior = human behavior + algorithmic bias

Next class:

Next class:

- ▶ Watts, Chapter 3.
- ▶ Watts, D.J. and Strogatz, S.H. (1998). Collective dynamics of 'small-world' networks. Nature 393, 440-442.
- ▶ Victor, B. (2011). Scientific Communication As Sequential Art.
- ▶ Watts, D.J. (1999). Networks, dynamics, and the small world phenomenon. American Journal of Sociology, 105(2):493-527

<http://bit.ly/socnet204>