SNA 5: small world networks

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Outline

- Small world phenomenon
  - Milgram's small world experiment

- Local structure
  - clustering coefficient
  - motifs

- Small world network models:
  - Watts & Strogatz (clustering & short paths)
  - Kleinberg (geographical)
  - Kleinberg, Watts/Dodds/Newman (hierarchical)

- Small world networks: why do they arise?

- Next week: what are the consequences for diffusion, coordination and learning.

Small world phenomenon:
Milgram's experiment
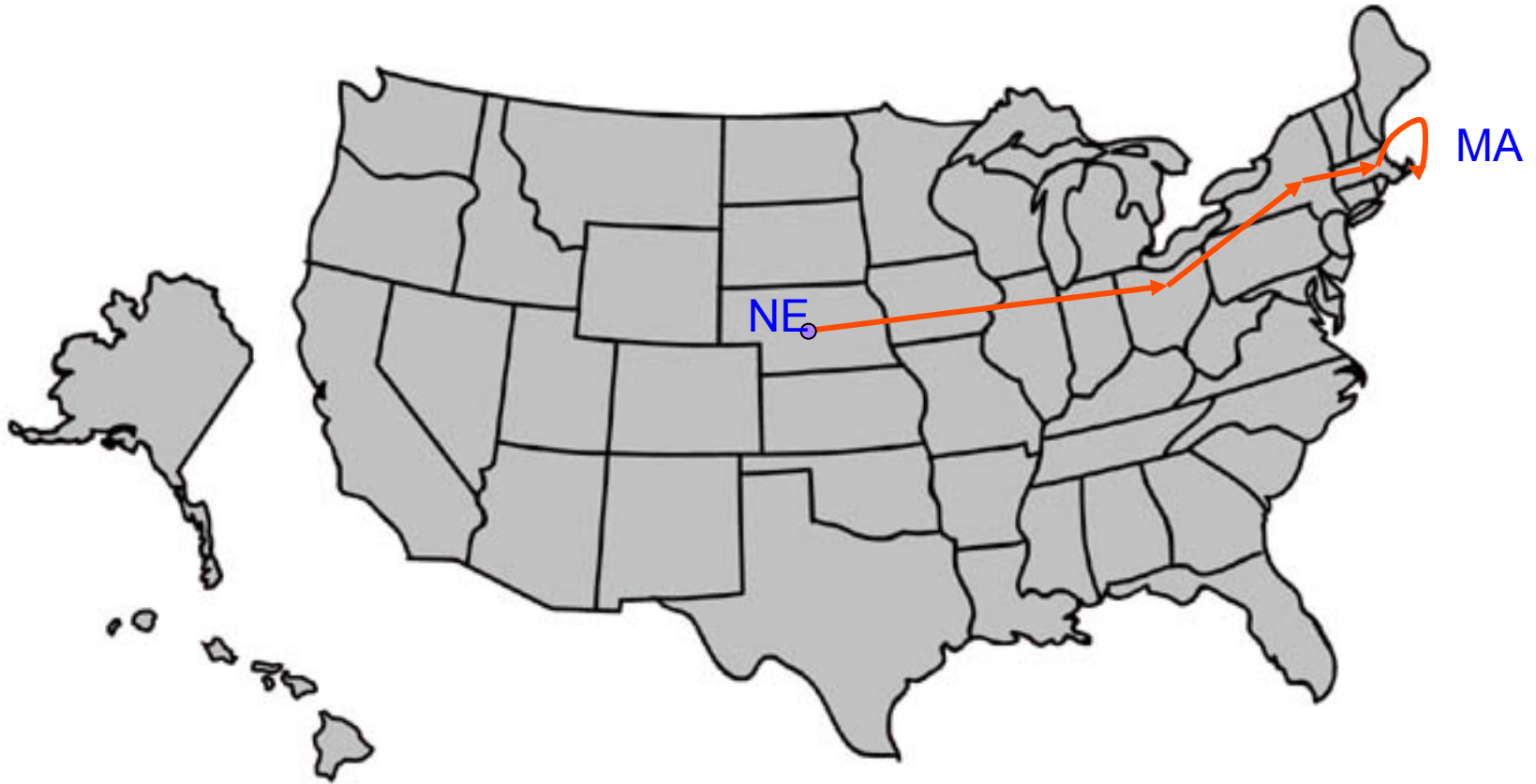
Milgram's experiment

Instructions:
Given a target individual (stockbroker in Boston), pass the message to a person you correspond with who is "closest" to the target.

Outcome:

20% of initiated chains reached target
average chain length = 6.5

❑ "Six degrees of separation"

Milgram's experiment repeated

email experiment
Dodds, Muhamad, Watts,
Science 301, (2003)
(optional reading)

- 18 targets
- 13 different countries

- 60,000+ participants
- 24,163 message chains
- 384 reached their targets
- average path length 4.0

Source: NASA, U.S. Government; http://visibleearth.nasa.gov/view_rec.php?id=2429

Interpreting Milgram's experiment

- Is 6 is a ***surprising*** number?
  - In the 1960s? Today? Why?

- Pool and Kochen in (1978 established that the average person has between 500 and 1500 acquaintances)

Quiz Q:

☐ Ignore for the time being the fact that many of your friends' friends are your friends as well. If everyone has 500 friends, the average person would have how many friends of friends?

Quiz Q:

- With an average degree of 500, a node in a random network would have this many friends-of-friends-of-friends (3rd degree neighbors):

Interpreting Milgram's experiment

■ Is 6 is a ***surprising*** number?
- In the 1960s? Today? Why?

■ If social networks were random… ?
- Pool and Kochen (1978) - ~500-1500 acquaintances/person
- ~ 500 choices 1st link
- ~ 500^2 = 250,000 potential 2nd degree neighbors
- ~ 500^3 = 125,000,000 potential 3rd degree neighbors

■ If networks are completely cliquish?
- all my friends' friends are my friends
- what would happen?

Quiz Q:

□ If the network were completely cliquish, that is all of your friends of friends were also directly your friends, what would be true:
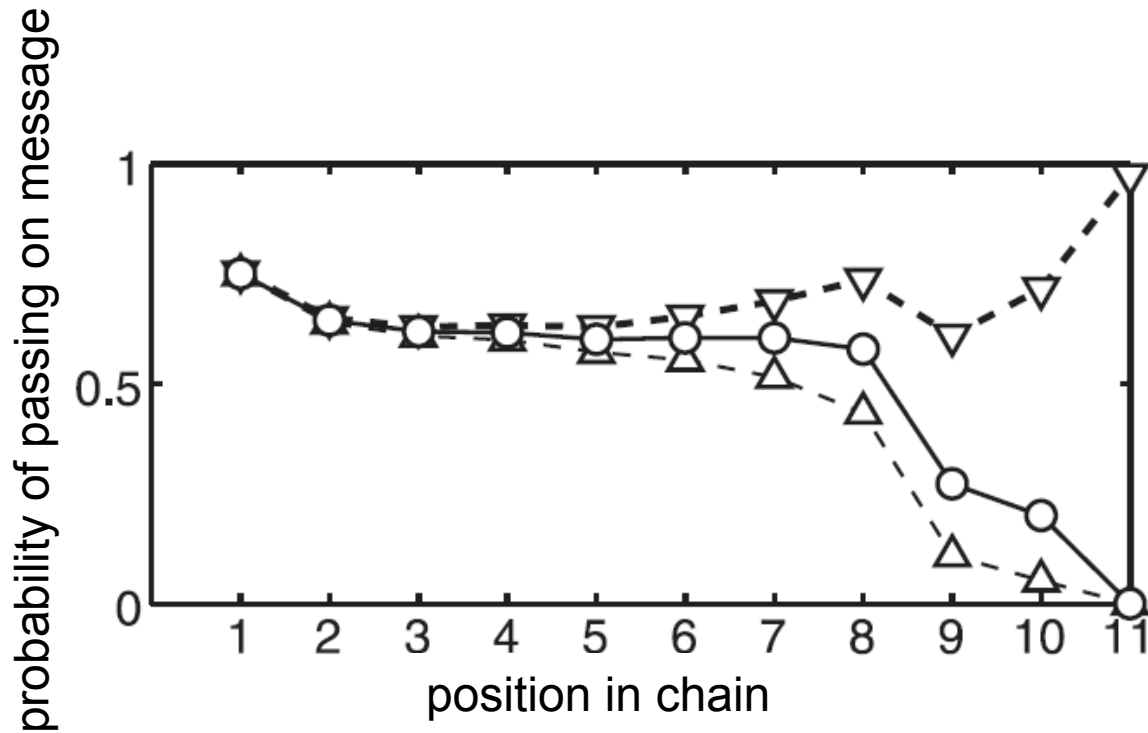
complete cliquishness

- If all your friends of friends were also your friends, you would be part of an isolated clique.

Uncompleted chains and distance

- Is 6 an *accurate* number?

- What bias is introduced by uncompleted chains?
  - are longer or shorter chains more likely to be completed?

Attrition

Source: An Experimental Study of Search in Global Social Networks: Peter Sheridan Dodds, Roby Muhamad, and Duncan J. Watts (8 August 2003); Science 301 (5634), 827.

Quiz Q:

- if each intermediate person in the chain has 0.5 probability of passing the letter on, what is the likelihood of a chain being completed
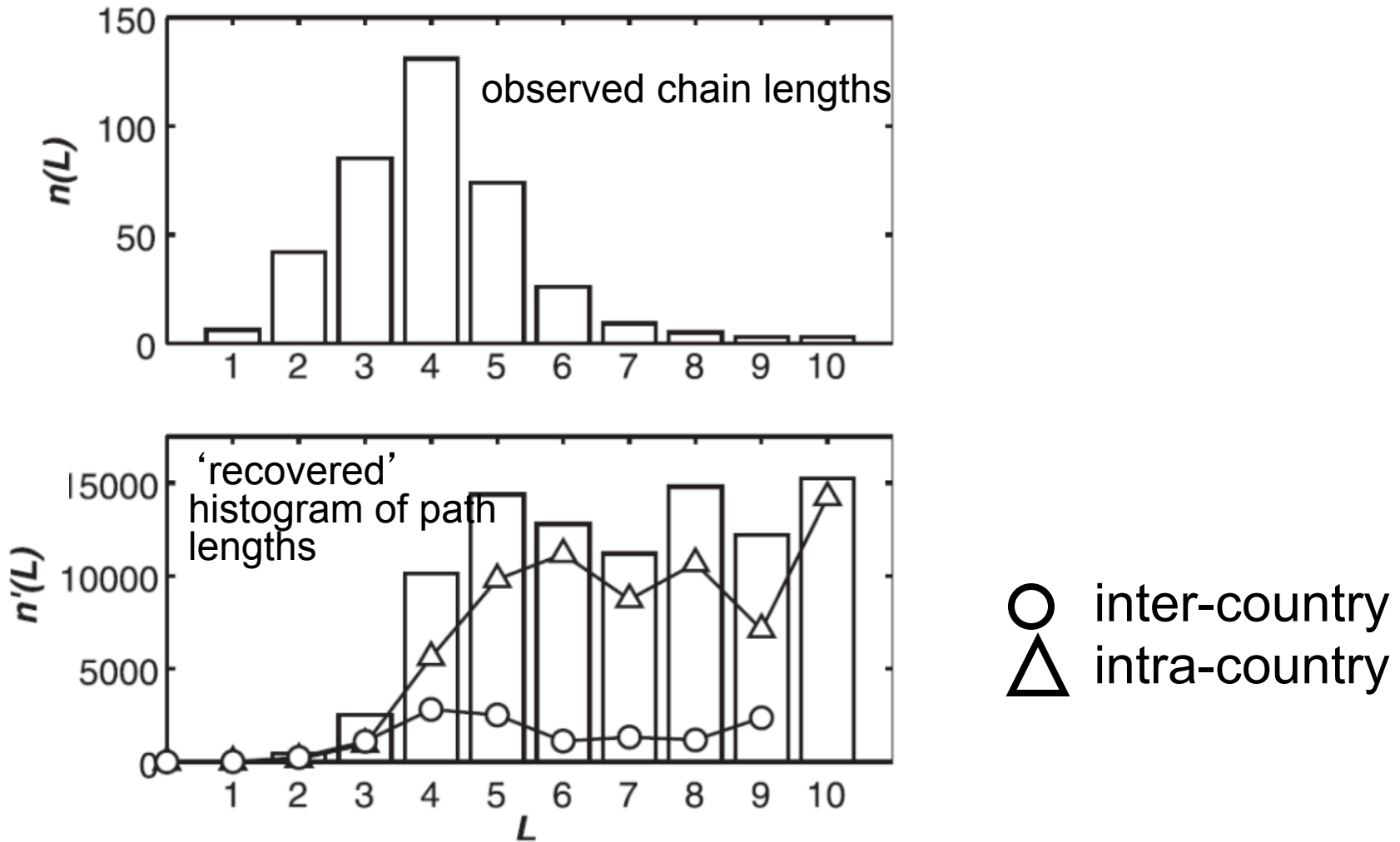 - of length 2?
  - of length 5?

sends for sure   receives

O———————O————————O   chain of length 2

passes on with probability 0.5

Estimating the true distance

observed chain lengths

'recovered' histogram of path lengths

○ inter-country
△ intra-country

Source: An Experimental Study of Search in Global Social Networks: Peter Sheridan Dodds, Roby Muhamad, and Duncan J. Watts (8 August 2003); Science 301 (5634), 827.

Navigation and accuracy

- Is 6 an ***accurate*** number?

- Do people find the ***shortest*** paths?
  - Killworth, McCarty ,Bernard, & House (2005, optional):
  - less than optimal choice for next link in chain is made ½ of the time

Small worlds & networking

What does it mean to be 1, 2, 3 hops apart on Facebook, Twitter, LinkedIn, Google Plus?