

Chain letters reveal surprising circulation patterns

A chain letter hoax that fooled thousands of people may help computer scientists understand how information spreads on a global scale.

The chain e-mail originated sometime in 2002, and claimed to be a petition to organize opposition to the impending US-Iraq war. Tens of thousands of people signed their names to several hundred copies of the petition, with some copies appearing on Web archives. Like most Internet chain letters, the petition had its origins in a hoax, but its widespread dissemination is one of the few instances of a single piece of traceable information spreading on a global scale.

“Given the many ways in which information, news, and new ideas are constantly spreading through our social networks, it’s surprising how difficult it is to collect data on the ways in which this spreading happens,” researchers David Liben-Nowell and Jon Kleinberg told *PhysOrg.com*. “Data from chain-letter petitions lets us look at processes that are otherwise essentially invisible, and begin to formulate theories for the patterns we observe.”

Liben-Nowell and Kleinberg are computer scientists from Carleton College and Cornell University, respectively. The duo used online search engines to collect copies of the signed petitions that were posted on numerous Web sites. When they analyzed the 20,000 names on the 637 lists they found, and removed various “mutations,” they discovered some surprising patterns.

Contrary to predictions that large-scale information spreads exponentially, like an explosive epidemic, the researchers found that the letter did not reach a large number of individuals in a few steps. Rather, it took hundreds of steps of people forwarding the e-mail on to reach the 20,000 who signed the found copies.

As the researchers explain, this pattern suggests that the mechanics of a single piece of information spreading on a global scale is more complex than originally thought. Some of their results, which appear in a recent issue of the *Proceedings of the National Academy of Sciences*, reveal that people who forwarded the letter generally forwarded it to large numbers of other individuals. By contrast, most senders (94%) produced just one “daughter” that signed the letter. In other words, it seemed that most people ignored the e-mail.

The final result was a “tree” of nodes and connections that was long and thin, not one that funneled out as in the case of rapidly spreading information. Gossip in smaller communities may fan out quickly, but – as the new study shows – such a pattern changes with scale. This large-scale spreading of information is a rare case, since most circulated e-mail messages never reach such a large number of recipients.

“A natural assumption going into this study was that information would spread explosively, reaching many people in only a few steps,” said Liben-Nowell and Kleinberg. “Instead, a much more complex picture emerges, with the chain letter following longer, narrower paths. After this initial surprise, we eventually found possible ways to reconcile the deep, narrow structures we observed with the facts we knew about human social networks.”

A couple things that might explain the pattern include individuals “forwarding” the petition to the same group of e-mail addresses copied on the e-mail they received (“replying to all”). Individuals who received the petition more than once typically only signed one of them, leaving others as dead ends. Also, individuals in the same network might have tried to all sign the same petition, and keep forwarding it to

each other rather than adding their names to different lists – which produces the observed “single daughter” characteristic.

Understanding how a single piece of information spreads on a large scale may have applications in a variety of areas, such as word-of-mouth marketing and investigating the spreading of technological innovations, news, and opinions. Contrary to spreading explosively, information traveling on large scales seems to be quite fragile, with many opportunities for getting lost. The pattern might hold true for different kinds of information spreading, as well.

“We expect this kind of pattern would show up in certain other settings, but it's an open question how general it is,” the researchers said. “For example, the other large-scale chain-letter for which we have data – a petition to support funding of National Public Radio – exhibits a spreading pattern that looks very similar. It's natural to believe that jokes and news clippings on the Internet may well spread in similar ways, though there certainly could be differences in spreading patterns between information that is politically charged and information that is free of controversy.

“Once we look more generally – say, at the spread of new technologies or new products by word-of-mouth, or the rise in name recognition of new celebrities or new political figures – it's a fascinating open question to consider how diverse the different spreading patterns might be. But we expect that in all these cases, the spreading will likely have a structure that is more complex than simple models have suggested.”

More information: Liben-Nowell, David, and Kleinberg, Jon. “Tracing information flow on a global scale using Internet chain-letter data.” *Proceedings of the National Academy of Sciences*, March 25, 2008, vol. 105, no. 12. 4633-4638.

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