COMPUTATIONAL SOCIAL SCIENCE

Influential networks

While simple contagions spread efficiently from highly connected 'influencers', new research has revealed another kind of spreading process, that of complex contagions, which follows surprisingly different pathways to disperse through social networks.

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Are ordinary people influential? In the 1940s and 1950s, sociologists Paul Lazarsfeld and Elihu Katz pioneered the study of 'opinion leaders'[1,2]. Since then, it has become commonplace for network scientists to emphasize the role that highly connected people play in the spread of new ideas and information. However, a new generation of researchers in computational social science have begun to challenge the classical wisdom[3]. The key insight comes from a distinction between simple contagions, like mundane or familiar news stories, and complex contagions, like contentious news stories or politicized new ideas.

In an exciting new study by Xiaochen Wang, Yueheng Lan and Jinghua Xiao[4] in *Nature Human Behaviour*, the Beijing-based network scientists carefully analyse the diffusion patterns of over 1,000 news stories spreading through the massive Chinese social media platform Sina Weibo. By tracing the spread of simple and complex news stories through the social media networks, they discovered tell-tale signs revealing the different spreading dynamics of these real-world social contagions.

News stories that were simple contagions spread outward in the classical fashion, from highly connected individuals — also known as 'hubs' in the social network (that is, individuals with over 100,000 followers) — to their immediate contacts. Interestingly, the influence of these 'influencers' was found to drop off precipitously once the message started to spread from their contacts further into the network. As the news stories tried to propagate from the hubs' followers to their followers' followers, there was a striking (Gaussian) decay in the ability of messages to reach farther into the network, indicating that the propagation paths of these news stories were not very long. The reason for this is that, while the influence of the hubs on their immediate social network is high, their influence beyond their immediate circle depends upon the effectiveness of their less influential contacts for spreading the message. The steep decay in spreading beyond the hubs' followers means that once the message leaves a hub's immediate circle of friends, it tends to die a quick death.

By contrast, news stories that were complex contagions did not typically spread from the hubs, but instead took hold among the less-connected 'ordinary' people in the network (approximately 97% of individuals in the network had fewer than 100,000 followers). Surprisingly, the pathways among ordinary people were much more effective for sustaining spreading processes that carried these news stories farther into the social network. Compared to the rapid Gaussian decay suffered by messages that spread from the hubs, when new stories propagated through ordinary people's social networks, the typical decay they saw as they spread out into the population was strikingly non-Gaussian, often reaching 200% to 400% farther into the network than messages spreading from hubs. This non-Gaussian pattern of decay indicates an important difference in the kind of spreading dynamics observed within these networks and highlights the unexpected effectiveness of ordinary people for triggering large social cascades.

For anyone interested in understanding or promoting a spreading process, the most important question is, why are the networks of ordinary people so effective at keeping the spreading process going? The authors give us an answer by using a rudimentary social network simulation. The answer is that networks of ordinary people tend to provide more social reinforcement. Unlike hubs, who have large numbers of network ties shooting out in all directions, ordinary people tend to be closely interconnected in ways that allow a person to encounter a news story from multiple, redundant sources. These reinforcing sources offer confirmation, or social proof about the importance and relevance of the story, which encourages people to stay interested in it and keep pushing further into the network. One of the key insights from this study is that social ties among ordinary people form an interconnected network of 'wide bridges' that offer surprisingly resilient pathways for propagating the long-distance spread of new or unusual news stories. These dendrite-like patterns of wide bridges that characterize diffusion chains among ordinary people offer a significant departure from the classical hub-and-spoke structures found in the 'opinion leader' model of diffusion, and they provide a useful new structural approach to characterizing the differing diffusion pathways that are followed by simple and complex contagions.

These exciting findings open the door for exploring several new directions in network science. Most obviously, one of the clearest simplifying assumptions used in the authors' analysis is the dichotomization of the population into two kinds of users: highly connected influencers and less-connected ordinary people. As the authors themselves are fully aware, this is a mathematical convenience that is analytically useful, but it also admittedly obscures the variation and continuity among persons observed in the social world. I expect that interesting extensions to this study will begin by investigating whether there are important new insights to be gained by exploring the heterogeneity of influence that emerges along the continuum of connectedness in the distribution of degree. New work building upon these insights is likely to yield major strides forward by investigating the best ways of identifying the different types of influence that people have in social media networks, which will undoubtedly bring greater sophistication to the discussion of user-types (such as influencers and followers) and the influence they have.

Another interesting implication of this study is the special attention it brings to the familiar misnomer 'influential'. This study shows that highly connected people may be less influential in a spreading process than less-connected people. This observation connects to an age-old question in the social sciences: do we explain differences among people's level of influence by referring to those people's individual characteristics (such as their outgoing personalities), or do we instead explain these differences in terms of the network dynamics that take place around them? This question may finally find resolution through creative extensions of this study, which may be able to determine whether influence is better understood as a property of different types of persons or, instead, whether it is better understood as a property of the network dynamics of simple and complex contagions, which flow differently through different parts of a social network.

The exciting directions that emerge from this study highlight one of the most promising features of the new field of computational social science: the ability to bring large-scale social network analyses into direct dialogue with significant social scientific theories of peer influence and social diffusion[5]. ❒

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References

1. Lazarsfeld, P., Berelson, B. & Gaudet, H. *The People's Choice: How the Voter Makes Up His Mind in a Presidential Campaign* (Columbia University Press, 1948).
2. Katz, E. & Lazarsfeld, P. *Personal Influence* (Free Press, 1955).
3. Centola, D. *How Behavior Spreads* (Princeton University Press, 2018).
4. Wang, X., Lan, Y. & Xiao, J. *Nat. Hum. Behav*. https://www.nature.com/articles/s41562-019-0605-7 (2009).
5. Lazer, D. et al. *Science* **323**, 721–723 (2009).

Competing interests

The author declares no competing interests.