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Social Dynamics of Information

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14. ABSTRACT

This project's goal was to uncover the mechanisms of information flow in social media and relate them to network structure. The findings challenged a widely-held view that information spreads like a pathogen and showed that the differences between the spread of disease and information stem from human cognitive limitations. While highly connected people amplify pathogenic contagion, in social contagion they are cognitively overloaded with messages their friends produce and are less likely to see and spread a particular message. Accounting for cognitive constraints significantly simplifies social contagion, and leads to new ways to measure influence in social networks.

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information diffusion; social networks; social media; cognitive constraints

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Abstract:

The goal of this project was to uncover the mechanisms of information flow and relate them to network structure. Our quantitative analysis of ``in-vivo'' human behavior, made possible by massive data from online social media, has challenged the traditional notions of social contagion and influence. It is commonly believed that information spreads between people like a pathogen, with each exposure by an informed friend potentially resulting in a naive individual becoming informed. This project showed that there are important and surprising differences between the spread of information and disease that stem from human cognitive limitations. In biological contagion, highly connected people amplify the spread of disease, but in social contagion they inhibit the spread. This is because such people are cognitively overloaded with the messages their many friends produce and are less likely to see and spread a particular message. Accounting for the cognitive constraints significantly simplifies the dynamics of social contagion, explains why most information in social media fails to reach viral proportions, and leads to new measures to identify influential individuals in social networks.

Significant results:

- Viral outbreaks in social media are rare
- Human cognitive constraints (e.g., limited attention) play an important role in social contagion and information discovery. Specifically, the more effort it takes to find information, because, e.g., it far down the screen, the less likely a person to process it.
- The more incoming information a person has to process, the less likely he/she is to discover a specific piece of information. On social media, divided attention means that users who follow many others are less susceptible to spreading any message, and act as breaks on information spread
- Incorporating cognitive constraint of divided attention into measures of network centrality enables better identification of influential social media users

Summary of the project:

This project was one of the first to capitalize on easy availability of big data from social media sites like Digg, Twitter, Flickr, and others. Using this data, we traced the flow of information on online social

networks [Lerman and Hogg, 2012; Hogg and Lerman 2012], showing that viral outbreaks, in which information reaches a large audience, are much rarer than predicted by models that liken social contagion to the spread of a pathogen through a population [Ver Steeg et al. 2011]. Our study of how users respond to exposures to information on different social media sites demonstrated that social contagion differs fundamentally from pathogenic contagion. Unlike pathogens, social media users must first discover the information before they can choose to spread it. Because of the constraints of available time and cognitive resources, the ease of discovery will significantly affect information's propensity to go viral. The likelihood a user will consciously see a message depends on how the website presents information, the flux of incoming information, and the effort he or she is willing to expend in discovering information. Accounting for these factors dramatically simplifies social contagion and makes user response more predictable [Hodas and Lerman 2013].

This project also developed a new network analysis measures that model the effect of cognitive constraints. Social media users have to divide their limited attention over all incoming messages from the people they follow. The new measures describe a process in which network nodes broadcast messages to their neighbors, but the neighbors' ability to receive the message depends on the number of their incident connections. We developed new measures of network centrality (limited-attention Alpha Centrality and limited-attention PageRank) that help identify important nodes in a network [Lerman et al, 2013], and also new measures of strength of ties between network nodes [Lerman et al, 2012].

Future research opportunities:

This project has catapulted me in an entirely new research direction. At the beginning of the project, I thought that the interesting questions were all at the interface of information and network structure. Now, we have evidence that interesting questions arise at the interface of information and human cognitive constraints. My goal now is to understand how the brain's finite capacity to process information affects communication, information discovery, social influence and decision-making. Part of this effort will be to understand how cognitive effort affects decisions and how it is in turn impacted by cognitive load, which can be measured by the volume of incoming information [Hodas et al, 2013]. We have evidence that individual human cognitive constraints affect the flow of information, and therefore, access to novel information in networks [Kang and Lerman, 2013], which has implications for our ability to innovate. In addition, we need to develop computational models of cognition which we can use to improve individual and group decision making processes, as well as develop strategies to direct collective attention.

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