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Fingerprints in online media reveal the organization of social systems

Renaud Lambiotte

The Internet's technological revolution spreads into the social sciences as networking sites and the virtual worlds of web-based games facilitate studies of unprecedented scale.

Quantitative analysis in the social sciences has historically relied on small-scale and static data, typically gathered by questionnaires or observing people in their daily lives. The last few years have witnessed a change of paradigm driven by the emergence of pervasive technologies that fill electronic databases with information about our everyday lives. This may be our personal relations, our whereabouts, or even our taste in music or literature.¹ Through this window of data, researchers observe the collective behaviour of millions of individuals and search for common trends and underlying patterns.²⁻⁶ In parallel, the advent of Internet gaming provides a huge pool of potential participants in online studies, making it possible to conduct laboratory-style experiments involving thousands of people.^{7,8} These studies offer exciting research perspectives by providing the first empirical observations of the dynamics and organization of social systems at a large scale, with the potential to radically improve our understanding of human societies.

The sheer size and sensitive nature of the data raises a series of theoretical, algorithmic and ethical issues. First, traditional social graph theory, which was originally developed to analyse how the connections in small and static networks affect how they function, needs a thorough update to deal with dynamical networks made of millions of nodes. For instance, the algorithms that provide readable maps of the system organization must be more efficient.^{9,10} Another crucial challenge is the development of robust data-sharing practices to facilitate research and respect user privacy. Finally, the field of online experimentation, which is still in its infancy, requires the adoption of common protocols. An example would be setting up incentives, such as services or micropayments, for participation in crowd-sourcing platforms.

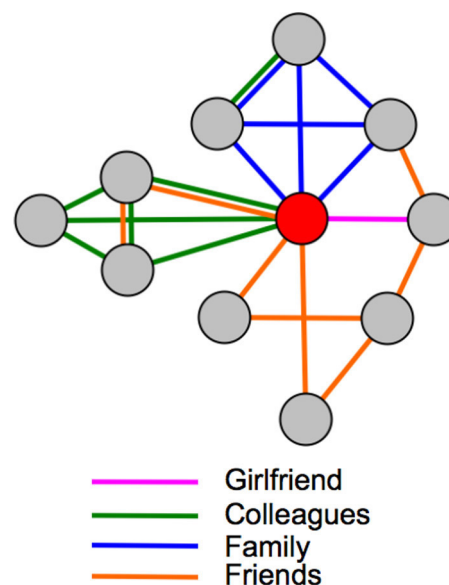


Figure 1. The ego-network around the red individual is composed of connections that correspond to different social processes. Most studies of large-scale networks tend to overlook this aspect, simply identifying the presence or absence of relations. Such representation leads to a limited and sometimes misleading characterization of the social network as a whole.

Large-scale studies often rely on coarse descriptions of the individuals and their relations. For instance, in the tradition of statistical physics, the internal state of an individual is often modeled as a binary variable, for example 'sell' or 'buy,' thereby over-simplifying its complex nature. Similarly, the type of relation between individuals is usually neglected, and is either approximated by a binary variable, such as 'present' or 'absent,' or by a weight characterizing its intensity. Attempts to improve the measurement of such details include real-world experiments where people wear 'sociometers'¹² that capture physical proximity, location, movement and other facets of their social life.

Continued on next page

study of the relationship between sociometric popularity (number of Facebook contacts) and personality traits using data from 200,000 individuals,²⁰ the first of its kind on a large number of subjects. We found that the strongest predictor for an individual's number of contacts is a trait called extraversion, which is usually associated with sociability and excitement-seeking, while other personality traits do not play a significant role.

Social science is about studying how behaviour on a societal level emerges from a large number of interactions between individuals. However, those interactions and the intrinsic properties of individuals are hard to measure, especially at a large scale. Our work aims to find the right balance between high-quality data in small systems and low-quality data in large systems. To do so, we have focused on new types of data in virtual worlds and in Facebook. This approach has opened new research directions related to the dynamics and organization of conflict and to the effect of personality on social behaviour. As a next step, we will explore in detail the dynamic nature of social networks, namely the rearrangement of links in time, and develop theoretical models and algorithms to help understand the temporal behaviour of social networks.

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