A twenty-first century science

If handled appropriately, data about Internet-based communication and interactivity could revolutionize our understanding of collective human behaviour.

Duncan J. Watts

Few would deny that many of the major problems currently facing humanity are social and economic in nature. From the apparent wave of religious fundamentalism sweeping the Islamic world (and parts of the Western world), to collective economic security, global warming and the great epidemics of our times, powerful yet mysterious social forces come into play.

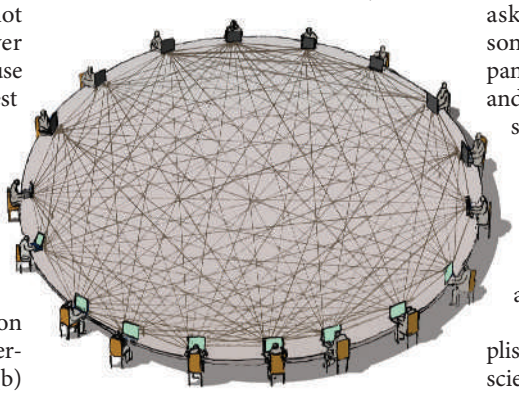
But few readers of *Nature* would consider social science to be the science of the twenty-first century. Although economics, sociology, political science and anthropology have produced a plethora of findings regarding human social behaviour, they have been much less successful than the physical and life sciences in producing a coherent theoretical framework that can account for their discoveries. This is not because social scientists are less clever than their peers in other fields, but because social phenomena are among the hardest scientific problems to solve.

Social phenomena involve the interactions of large (but still finite) numbers of heterogeneous entities, the behaviours of which unfold over time and manifest themselves on multiple scales. It is hard to understand, for example, why even a single organization behaves the way it does without considering (a) the individuals who work in it; (b) the other organizations with which it competes, cooperates and compares itself to; (c) the institutional and regulatory structure within which it operates; and (d) the interactions between all these components. To draw an analogy with physics, one must solve the equivalent of quantum mechanics, general relativity and the multi-body problem at the same time — even string theorists don't have it that bad! Fortunately, recent developments in network science auger some hope for the future.

For the past 50 years or so, sociologists have thought deeply about the importance of interactions between people, institutions and markets in determining collective social behaviour. They have even built a language — network analysis — to describe these interactions in quantitative terms. But the objects of analysis, such as friendship ties, are hard to observe, especially for large numbers of people over extended periods of time. As a result, network data have historically comprised one-time snapshots, often for quite small groups. And most studies have relied on self-reports from participants, which suffer from cognitive biases, errors of perception and framing ambiguities.

The striking proliferation over the past decade of Internet-based communication and interactivity, however, is beginning to lift these constraints. For the first time, we can begin to observe the real-time interactions of millions of people at a resolution that is sensitive to effects at the level of the individual. Meanwhile, ever-faster computers permit us to simulate large networks of social interactions. The result has been tremendous interest in social networks: thousands of papers and a growing number of books have been published in less than a decade, leading some to herald the arrival of a 'science of networks'.

This label, unsurprisingly, has attracted its share of critics, and with some justification. Some of the ideas are not as new as sometimes advertised; many of the popular models are too simplistic to stand up to scrutiny; and even the more sober-looking empirical studies tend to use data that happen to be available, rather than obtained with a specific research question in mind. As a result, despite the avalanche of publications and breathless headlines, it is probably true that little has been learned about real social processes.



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Nevertheless, the near future looks promising, especially if a few fundamental features of social networks can be emphasized. First, social networks are not static structures, but evolve in time as a consequence of the social and organizational environments in which they are embedded. Second, they are not unitary, but multiplex, meaning that people maintain a portfolio of types of ties — formal, informal, strong, weak, sexual, business and friendship — each of which serves different functions. And finally, network structure must be understood within the larger framework of collective social dynamics. People do not just interact: their interactions have consequences for the choices they, and others, make.

Studies that combine all these features are currently beyond the state of the art, but two of my group's recent projects indicate tentative progress. The first used the anonymized e-mail logs of a university community of around 40,000 people to track daily network evolution over a year as a function of existing network structure, shared activities (such as classes) and individual attributes. Dynamic data of this type may shed light on the relative roles of structural constraints and individual preferences in determining, for example, observed homogeneity of friendship circles.

The second was a Web-based experiment in which 14,000 participants were asked to listen to, rate and download songs by unknown bands. Some participants made their decisions independently, and others could see how many times the songs had been downloaded previously. Experiments of this kind measure not only the influence that individuals have over each others' decisions, but also the consequences of these individual-level effects on macro properties, such as the predictability of 'hit' products.

Clearly, the leap from these still simplistic studies to the 'big questions' of social science remains formidable. In this regard, cooperation between academic researchers and the large Internet companies who currently dominate data collection may be extremely productive. Although such collaborations will encounter challenges, including privacy and intellectual-property issues, the questions are too difficult to be left to intuition, or even experience, alone. We must start asking how the technological revolution of the Internet can lead to a revolution in social science as well. ■

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FURTHER READING
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