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Editorial

Social network analysis: Measuring tools, structures and dynamics

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This special issue of *Physica A* presents contributions drawn from papers presented at a conference on Social Network Analysis and Complexity held from July 31 to August 2, 2006 at the Collegium Budapest in Budapest, Hungary. Co-chaired by András Lőrincz of the Eötvös Loránd University and Nigel Gilbert of the University of Surrey, United Kingdom, the conference brought together scientists and scholars from mathematics, computer science, graph theory, statistical physics, network analysis, sociology, political science, technology and media.

Papers were delivered on tools for social network analysis; abstract mathematical concepts, analogies, and algorithms; and methods for measuring the dynamics and structure of social network. Case studies were presented as well as papers on large-scale simulations of agent networks and artificial societies. A picture was presented of an area of research that is fertile with possibilities for productive inter-disciplinary collaboration, and where important results are beginning to emerge.

In this issue, the contributions to the conference have been divided into three sections. First, there are papers that address the problem of characterising complex social networks. This is an area where it is particularly fruitful to bring together social scientists, who have long been collecting empirical data about actual networks, and statistical physicists, who have been wrestling with how to analyse network phenomena, but have generally been more concerned with the relatively orderly domain of particles than the apparently messy social world.

Jost et al. develop an analysis of social inter-dependence that they suggest could be used to understand social differentiation, developing a theme that has been central to social science since Durkheim's work in the late nineteenth century, but now with a complex twist. Chen et al. use ideas from percolation theory to develop a new measure of the fragmentation of a social network and apply it to data on links between workplaces. Vicsek uses tools from statistical mechanics to find overlapping communities in a social network. Shi et al. examine the conditions under which networks can transmit information efficiently and show that non-transitive links make very little contribution, testing their theory with data from real networks as well as with a random network. Ormerod shows, through an empirical example of access to financial services, that it is possible to make inferences about the structure of a network from rather limited information about the characteristics of a random sample of individuals. Finally, Roth stands back from these analyses and outlines an epistemological perspective on the application of statistical physics to the analysis of complex social networks.

Second, there were contributions that were concerned with applying tools and methods to a variety of specific social networks. Pentland has collected data on the location and behaviour of groups of people, using

devices based on mobile phones or active badges that allow the precise identification of interactions such as conversations in both space and time, and he shows that these allow remarkably accurate predictions about subsequent behaviour. Toroczkai and Guclu describe an agent-based simulation of disease spread in urban networks and show that a simple model can account for qualitative differences between the networks of infection for short and long-infectivity period diseases. Takács and Janky describe a more abstract, experimentally created and controlled network that they use to investigate the social control mechanisms that promote or inhibit collective action. Using Hungary as a case study, Csanádi develops a model of the inter-relationships between decision makers in communist regimes and shows that it can also be applied productively in Romania and China. In the last paper of this section, Bunce and Wolchik show how the diffusion of a particular model of political change, in which authoritarian governments were replaced by more democratic regimes across post-Communist Europe and Eurasia, can be traced to networks that included local, regional and US participants.

In the third section, four papers consider the effect of learning and adaptation in complex social networks. Gilbert et al. model networks of high technology firms within an industrial sector competing to produce innovations, but also co-operating in partnerships and producer/consumer relationships. They propose that the success of such firms depends crucially on their ability to learn and examine the development of the sector when firms have different learning capacities. Gulyás investigates the effect of two different learning strategies (copy the strategy of the most profitable neighbour versus choose one of the neighbour's strategies using a probability distribution) on agents playing Iterated Prisoners' Dilemma games with other agents located within a 'small world' network. Gabbay considers the learning of individuals, as they adapt their opinions in response to the opinions of others around them in their social network. Finally, Lőrincz et al. study the dependencies of learning methods on network topologies in fast changing worlds, and designed experiments in real scale-free small worlds and in transformed scale-free and random-like copies. They describe experiments with web crawlers, programs that search the World Wide Web for interesting pages.

In a concluding paper, Bunce and Csanádi reflect on what was learned at the conference about social networks and complexity, and what remains open for further study. They highlight the fact that social networks are not equal: in practice not all social networks have apparent 'small world' or 'preferential attachment' structures, and it is to be expected that network structures will vary according to the reasons for their existence, their origins, their history, their formality and a host of other factors. Nevertheless, there is a tendency at present to assume that social networks are all slight variations on the same theme. They also point to the question, not yet adequately addressed, of why networks flourish at particular moments and why they then fade away, and suggest that the dynamics of network development is so far a neglected topic.

While these major issues remain open, the conference was successful in bringing to bear methods and tools from statistical physics on several examples of social networks and in demonstrating that an exchange between the social sciences and statistical mechanics can be a fruitful avenue to explore further. We expect that many of the contributors to this issue will remain in touch following the conference and will help to cement the bond between the two disciplines.

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