

Book Review

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The Structure and Dynamics of Networks. M. E. J. Newman, A.-L. Barabási and D. J. Watts, Princeton University Press, Princeton and Oxford, 2006.

Once in a while we are lucky to witness the very first stage of the evolution of a successful field, with new ideas constantly arising in a sort of self-organized process of learning and discovery. The field of complex networks, has experienced an exponentially growing interest since 1998, and is a good example of this phenomenon. Aside from the obvious attractiveness of fashionable fields, there is a key element that justifies complex networks' success. Unlike many other fields in statistical physics, where new ideas and developments barely reach a wide audience outside a narrowly defined and very specific community, information related to complex networks finds immediate application in a variety of real-world systems. This is particularly evident in the current era of information technology, where the network is a basic and elementary form of organization. More than that, many different disciplines, from biology to social sciences have identified networks as fundamental objects, identifying this field as being truly interdisciplinary. As a consequence, today physicists read papers by mathematicians, these look at the work done by computer scientists, biologists ask physicists, mathematicians and computer scientists to analyze their experiments, at the same time that all of them look into the others' fields searching for new problems as well as for solutions to old and classical ones.

The book by Newman, Barabási, and Watts tells the story of the field of complex networks according to their true founders. It is a compendium of some of the most influential papers written in this field from its very foundation in the sixties, by mathematicians and sociologists, to the subsequent explosion of the field at the end of the nineties. The authors do an excellent job in locating and giving the proper credit to the pioneering works that have made today's success of the field possible. Apart from these works, the book is focused on the more recent achievements and contributions that form the contemporary standard body

of knowledge on complex networks. Yet, the book mainly includes works from the period 1999–2001, which correspond to a very early stage in the field, and barely mentions issues such as correlations among vertices, clustering properties of networks or community detection. These topics are left as future directions of research although, in my opinion, they are today well enough established to have been included in this anthology.

The book is comprised of six chapters, each containing a short introduction to the topic of interest followed by comments on each of the papers and a discussion of its main findings. This sets the proper context to facilitate the reader's finding both a general and comparative view of the topic. After a short introduction to the field in chapter 1, chapter 2 is devoted to historical developments. Here the reader will find, among others, the classical paper by P. Erdős and A. Rényi "On the evolution of random graphs" and the celebrated experiment of J. Travers and S. Milgram to prove the concept of "six degrees of separation" within societies. Chapter 3 focuses on some of the important work done to analyze networks in the real world. If we are to look for the ultimate reason of the success of this field, this is the empirical finding that a vast majority of real world networked systems have a distribution of number of contacts per vertex that follows a power law-what we know today as scale-free networks-together with the small-world property. These facts, rather than being mathematical curiosities, have extraordinary consequences for the properties of the network itself and for the dynamical processes that occur on them. In this chapter, the reader will find some of the most important empirical findings in this direction, in particular for two of the most prominent networks of the modern age, the Internet and the World Wide Web, as well as for biological networks and social structures. Chapter 4 introduces models of networks. It is subdivided in three different sections, the first devoted to random graph models, the second to the small-world model, and the last one to models of scale-free networks. Making a selection of papers on models of networks is certainly not easy, specially given the large number of models available in the literature. The papers reproduced in this chapter could be easily classified as the "classics" of the field. However, the authors could have taken a more daring position by including other models that, although not so highly cited, are potential "classics." In particular, I miss some references to exponential random graphs, where the tools and ideas of statistical physics are really at work. Chapter 5 is devoted to three specific applications: reaction-difusion processes (epidemics and rumors), percolation properties of networks (robustness to errors and attacks), and searching in networks (navigability of the WWW and "searchability" of social networks). This chapter is particularly relevant because it is here where networks can make a difference to more traditional approaches. Indeed, the papers reproduced here discover, among other things, the anomalous percolation and epidemic properties of scale-free networks as compared to more homogeneous structures. The book ends in Chapter 6 with a discussion on the possible future trends of the field,

for example, community detection, hierarchies and assortative mixing, or issues such as the identity of individuals within the “social space” and their subjective perception of this space, as a way to model social collective phenomena.

Even though one could argue about which papers should or should not have been included in the book, and even about the order in which these appear, it is also true that each and every one of the featured papers represents a fundamental breakthrough, forming altogether a highly coherent body of knowledge. Professors Newman, Barabási, and Watts succeed in their selection, and, at the same time add an extra value to the book with enlightening and interesting discussions. I strongly recommend this book to researchers and students of the field and, in general, to anyone who wants to enter or learn more about this exciting field of research.

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