Book Review

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Networks—An Introduction. Mark E. J. Newman. (2010, Oxford University Press.) $65.38, £35.96 (hardcover), 772 pages. ISBN-978-0-19-920665-0.

Network science or graph theory has its roots in the first half of the 18th century when Leonhard Euler, a Prussian mathematician, analyzed the problem of finding a route through the city of Königsberg that crossed every one of the city's seven major bridges once and only once. Ever since then, network theory has attracted the interest of mathematicians like the famous Paul Erdős, who (together with Alfréd Rényi [2] and independently Gilbert [3]) was first to define random graphs in the late 1950s. Later, social scientists joined in founding social network theory as a new branch of the field. In the last two decades, an explosion of research into network science has been stimulated by the recent introduction of the *small-world* [4] and *scale-free* [1] network paradigms. As a result, the field has become ever more multidisciplinary, and concepts from network theory have become standard knowledge in many areas of the natural and social sciences. Examples of fields where network approaches have almost become standard tools are computer science, systems biology, engineering, and physics, just to name a few. At the same time, the knowledge about network theory has become somewhat fragmented: Different terminology is used in different fields, and often solutions to problems that have been developed for one set of applications are not readily accessible to practitioners in other areas.

With his new book *Networks—An Introduction*, Mark Newman aims at bridging this gap. Using a consistent terminology, the book provides a summary of the knowledge about the empirical analysis and theory of networks that has been accumulated in this diverse set of disciplines over many years. The book is very successful in this pursuit and gives an excellent introduction to the topic of network theory. Not only this, gradually working its way up from introductory content to more advanced topics, the book also provides a neat collection of relevant material for the more advanced reader. A set of problems at the end of most chapters allows the reader to check his or her understanding of the presented material. Altogether, I highly recommend this book, not only for the non-specialist reader who wants to understand what network theory is all about, but also for the specialist who wants to use the book as a quick reference or as the basis for an undergraduate or more advanced course taught at a university.

After so much praise, let us have a brief look at the content of the book. It basically consists of five parts. The first part highlights the interdisciplinary nature of network applications and discusses examples from four different areas of research: infrastructure networks, social networks, networks linked to the transmission of information, and biological networks. In each of these broad application areas the author explains the most prominent examples and illustrates the relevance of network approaches.

The second part of the book is composed of an introduction to the fundamentals of network theory. Chapter II.6 sets out with a series of definitions of various types of networks, followed by the introduction of various metrics generally used to classify networks. Chapter II.8 discusses small-worldness, degree distributions, clustering, and assortative mixes of degrees, and finishes by giving a classification of networks in terms of their macroscopic appearance.

Having defined network metrics, the next logical step is to think about efficient computer algorithms to evaluate them for a given network. Accordingly, the third part of the book gives a very useful summary of some frequently applied computer algorithms. Again the chapter starts with a readily accessible introduction to some basics, such as various methods of storing a networks in computer memory. The author then quickly progresses to algorithms for the efficient computation of graph

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metrics, while leaving a last large chapter at the end of the part to the topics of graph partitioning and modularity. It is this part that makes the book particularly useful for readers who want to employ network approaches in their own fields of work.

Part IV of the book gives an overview of the most well-known models of networks. This includes the topics of random graphs and—more generally—random graphs with general degree distributions. The book then proceeds to models of network formation that give rise to power law degree distributions. In the last sections of the part the small-world model and exponential random graphs find their place.

The last part of the book brings the reader close to topics of very active current research. It is devoted to processes on networks and is composed of topics such as percolation and issues of network robustness; it also discusses epidemics on networks via various models of disease spread. The part also includes a general chapter on dynamical systems on networks and synchronization. A chapter on various aspects of the problem of search on networks concludes the book.

Network approaches are a very fashionable topic in the scientific literature at the moment, and a word of caution is necessary. In some literature, researchers have not gone much beyond identifying questionable "power law" patterns in obscure data sets. By contrast, the present book is to be recommended for its sober approach, very careful selection of included topics, and firm grounding in relevant applications. I think this is one of the best among the recently published books about network theory.

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