Book Review

Network Science—Theory and Application. Ted G. Lewis. Hoboken, NJ: John Wiley & Sons, Inc., 2009. 512 pp. $110.00 (hardcover). (ISBN: 978-0470331880).

To my knowledge, the emerging field of network science began after 1998 (Watts & Strogatz, 1998), and only a few books and review articles or special reports named after "Network Science" have been published world-wide (Barabasi, 2002; Committee on Network Science for Future Army Applications, 2005; Fang, 2008a, 2006b; Fang, Wang, Zhen, et al., 2007; Wang, Li, & Chen, 2006; Watts, 2003, 2004; Watts & Strogatz, 1998; Zeng, 2006). The words "network science" or "new science of networks" first appeared in the United States (Barabasi, 2002; Committee on Network Science for Future Army Applications, 2005; Watts, 2003, 2004), followed by China (Chen & Xu, 2008; Fang, 2008a, 2008b; Fang et al., 2007; Guo & Xu, 2006; Wang, Xiang, & Chen, 2006; Zeng, 2006) and others. However, "network science" already had been used by Professor Ted G. Lewis for his book, published by John Wiley & Sons, Inc., which was perhaps the first comprehensive and representative book on network science published in the United States. Although common features of these types of books are the theory and methodology from network science and their extensive applications to various interdisciplinary areas, each book has its unique viewpoints and distinguishing features. Here, I would like to provide my personal review on the remarkable merits of this book, which deserve special attention.

Thirteen chapters include key issues with exercises, except for the chapter 1. The first chapter describes the timeline of significant events of network science development, from graph theory (particularly random graphs) to modern network theory and its applications, and is to my knowledge the most complete description about network history. I agree that the history of network science has three milestones (Euler graph theory, Erdos-Renyi random graph theory, and modern network science), corresponding to three time periods (1736–1936, 1950–1990, and 1998–present), as the book shows.

There is an abstractlike introduction to summarize and note the most important part of each chapter. The first half of this book traces the development of network science along a trail blazed by the pioneers and inventors. This makes readers easily understand the objectives.

The book describes each issue (chapter) of network science through the use of illustrations, tables, practical problems with solutions, case studies, and applications to related Java software (There are five major Java applications for demonstration.), where the latter is quite different from all other books on the subject. The first six chapters develop the field from its graph-theory root to the modern definition of a network. These chapters are devoted to the most well-known classes: regular, random, small-world, and scale-free networks. All materials are adequately described and presented.

Chapter 7 describes "emergence," a concept with extensive and profound meaning about complex systems and networks. Searching for emergence has been one of the very important and interesting issues for complex network theory and interdisciplinary science. What is emergence, and what is network emergence? This is one significant subject and phenomenon arising from complex systems and networks. The book gives a definition of network emergence, which is more than a network's transformation from an initial state to the final state. In physical and biological sciences, emergence is a concept of some new phenomena arising from a system that were not initially in the system's specification. This book's definition refers to the repeated application of microrules that result in an unexpected macrostructure that hints at a key point. The book gives a brief explanation and is easy to understand. It also introduces new self-organizing principles for networks and shows how to custom-design networks with an arbitrary degree sequence distribution that may help people design faster, more resilient communication networks and revise some associated networks.

The second half of this book, chapters 8 to 13, briefly describes several important issues from a practical application point of view, with further studies. Chapter 8, "Epidemics," may excite new endeavors of designing antigen countermeasures for the Internet, and can be used to explain human epidemics as well as epidemics that sweep across the Internet. Chapter 9 describes "synchrony," an issue that has received a great deal of attention in the past in the studies of complex networks, but this book gives only a brief description. In chapter 10, "Influence Networks," the author proposes what conditions must be met for a social network to come to consensus. Chapter 11, "Vulnerability," shows how networks might be attacked, which may be used on a daily basis to valuate critical infrastructure and protect against natural and synthetic attacks. Chapter 12, "Netgain," is an exploration of a business model and introduces some classical market models as reference. In chapter 13, "Biology," the reader is introduced to the exciting new field of protein-expression networks and suggests new directions for the reader to consider. It emphasizes both static and dynamical analysis as well as the relationship of dynamics with structure and function, where the latter is the most fascinating application of network science today.

As mentioned in the preface, "This book is a start, but it also leaves many questions unanswered." Yes, some important issues have not been addressed, such as information networks, swarm aggregation or flocking of multiple agents, weighted nonlinear evolution networks, social networks, network centric warfare, and so on. However, I believe that researchers, professionals, and technicians in engineering, computer science, and biology will benefit from an overview of new concepts in network science. It also may inspire a new generation of investigators and researchers.

In summary, the book is a valuable reference, with practicability especially for engineering and graduate students, although some more theoretical subjects or deep-level problems could be added to strengthen and improve its quality and presentation.

Finally, I may mention that the cover of the book is "Network Science: Theory and Application," but it is "Network Science: Theory and Practice" on the opening page. Why is that? A correction may be needed.

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