

Preface

Nowadays, networks exist everywhere. In the recent decade, complex networks have been widely investigated partly due to their wide applications in biological neural networks, ecosystems, metabolic pathways, the Internet, the WWW, electrical power grids, communication systems, etc., and partly due to their broad scientific progress in physics, mathematics, engineering, biology, etc. The key character for a complex network is that it can represent a large-scale system in nature, human societies, and technology with the nodes representing the individual agents and the edges representing the mutual connections. Thus, the research work on fundamental properties, such as dynamics, controls, and applications of various complex networks has become overwhelming recently.

Actually, complex network studies can be dated back to the eighteenth century when the great mathematician Leonhard Euler studied the well-known Königsburg seven-bridge problem. Then, in the early 1960s, Erdős and Rényi (ER) proposed a random-graph model, which can be regarded as the modern network theory framework. In order to describe a transition from a regular network to a random network, Watts and Strogatz (WS) rewired the connections on some nodes in a regular network and proposed a small-world network model. Then, Barabási and Albert (BA) proposed a new scale-free network model, in which the degree distribution of the nodes follows a power-law form. Thereafter, complex networks have been widely discussed. In particular, small-world and scale-free complex networks have been extensively investigated worldwide.

The contents of this book are summarized as follows. First, the dynamics of complex networks are studied regarding, for example, the cluster dynamic analysis using kernel spectral methods, community detection algorithms in bipartite networks, epidemiological modeling with demographics and epidemic spreading on multi-layer networks, and resilience of spatial networks leading to the catastrophic cascading failures under various local perturbations. Then, some evolving hyper-network and color-network models are generated by adopting both growth and preferential attachment mechanisms and some new nonlinear chaotic pseudo random number generator, based on tent and logistic maps are also discussed.

Second, the controls of complex networks are investigated. The interesting topics include distributed finite-time cooperative control of multi-agent systems by applying homogeneous-degree and Lyapunov methods, composite finite-time containment control for disturbed second-order multi-agent systems, fractional-order observer design of multi-agent systems, chaos control and anti-control of complex systems via Parrondos game, collective behavior coordination with predictive mechanisms, convergence, consensus and synchronization of complex networks via contraction theory, and structural controllability of temporal complex networks.

Third, the applications of complex networks provide some applicable carriers, which show the importance of theories developed in complex networks. In particular, a general model for studying time evolution of transition networks, deflection routing in complex networks, recommender systems for social networks analysis and mining, strategy selection in networked evolutionary games, integration and methods in computational biology, are discussed in detail.

Recently, studies of the dynamics and controls of complex networks have become more attractive. In particular, some emergent behaviors of complex networks need to be investigated because new applied science and technology require new methods and theories to solve new challenging problems. Thus, an in-depth study with detailed description of dynamics, controls, and applications of complex networks will benefit both theoretical research and applications in the near-future development of related subjects. This book provides some state-of-the-art research results on broad disciplinary sciences in complex networks to meet such demands.

We would like to express our sincere thanks to all the chapter contributors for their great support to our book, without which this book would not have been possible. Special thanks are directed to the founding editor of the Springer Series in Understanding Complex Systems, Scott Kelso, for his encouragement and support to edit this volume. Thanks also go to Dr. Thomas Ditzinger, Holger Schäpe, and Priyadarshini Senthilkumar from Springer for their assistance during the publication of this book. Last but not least, we also would like to thank the financial support from the National Science and Technology Major Project of China under Grant 2014ZX10004001-014, the 973 Project under Grant 2014CB845302, and the National Natural Science Foundation of China under Grant Nos. 11472290, 61322302, and 61104145, Australian Research Council Discovery under Grants Nos. DP130104765 and DP140100544, and Hong Kong Research Grants Council under the GRF Grants CityU 11201414 and 11208515.

Beijing
Melbourne
Hong Kong
Nanjing
May 2015

Jinhu Lü
Xinghuo Yu
Guanrong Chen
Wenwu Yu

Complex Systems and Networks

Dynamics, Controls and Applications

Lu, J.; Yu, X.; Chen, G.; Yu, W. (Eds.)

2016, VIII, 482 p. 196 illus., 158 illus. in color.,

Hardcover

ISBN: 978-3-662-47823-3