Preface

Propagation phenomena have become a pervasive and significant feature of real world networks. These interdisciplinary phenomena are influencing science, engineering, finance, business, and ultimately society itself. The development of propagation techniques plays an important role in maintaining existing networks and has allowed, for example, synchronization in electrical power grids, prediction of complex system behavior, resource discovery and monitoring, locating biological invasions and assessing damage, virus propagation control and containment, and decomposition and immunization of social and large-scale infrastructure networks. By studying propagation processes, one can better understand information and knowledge spreading in systems which in turn can lead to some improvements in performance and robustness.

The purpose of this book is to bring into one volume the different types of propagation models and techniques including: epidemic models, models for trust inference, coverage strategies for networks, vehicle flow propagation, bio-inspired routing algorithms, P2P botnet attacks and defenses, fault propagation in gene-cellular networks, malware propagation for mobiles, information propagation in crisis situations, financial contagion in interbank networks, and finally how to maximize the spread of influence in social networks. This volume provides a unique compendium of current and emerging problems of propagation and related subjects. Thus, it is truly a guide designed for interdisciplinary use.

Fourteen chapters provided by established scientists in the area of complex networks have been carefully selected to reflect the diversity, complexity, and the depth and breadth of this multidisciplinary area which encompasses closely intertwined conceptual and empirical issues in real world networks.

More precisely, we start with the critical issues regarding epidemics and their outbursts in network structures. Chapter 1 mainly focused on susceptible-infectious-recovered (SIR) and susceptible-infectious-susceptible (SIS) models as well as the various modeling techniques for studying cascading failures, where the damage spreads through the network. Chapter 2 explores an interesting example of information propagation provided by the shoaling and schooling behaviors of fish. The presented fish algorithm (FA), considered as a swarm optimization, using bottom-up

learning of individual perception and the propagation of social information in the population, can usefully spread information amongst the agents. In Chap. 3, an approach named Appleseed, which is based on mechanics taken from neuropsychology, known as spreading activation models, is presented. Several algorithms for inferring trust and distrust that go beyond network structure and demonstrate their accuracy in real social networks are evaluated and discussed. Chapter 4 examines how basic network properties can affect the propagation of ideas, beliefs, and behaviors that shape mental models, showing how these different structures can either promote or hinder the adaptation of mental models, and indicating what strategies may be used for improving them. Using methods from statistical mechanics, in Chap. 5, flooding-based strategies are shown to develop random walk strategies to maximize the coverage in large-scale unstructured networks, which takes into account the resource constraints in the form of consumed bandwidth and latency time.

Modeling propagation in transport and communication networks is the central topic of the next two contributions. The first of these chapters, Chap. 6 utilizes three kinds of Petri nets: place/transitions Petri nets, timed Petri nets, and hybrid Petri nets to model and simulate agents of a transport network. A similar line of research is explored in Chap. 7 but the focus is on the role of propagation phenomena in bio-inspired routing.

Another popular area where propagation methods are highly topical is building reliable systems with respect to errors, faults, and failures. This is the focus of Chap. 8, where the life cycle of P2P botnets is studied. This chapter provides guidance for security professionals on how to implement two mitigation techniques against P2P botnets index poisoning defense and Sybil defense, and one monitoring technique—passive monitoring—to achieve better performance. Network modifications with the aim of enhancing robustness against targeted attacks is proposed in Chap. 9. The outlined procedure optimized for the cost function of Integral Efficiency could be used to generate highly robust and efficient networks. Chapter 10 in turn examines problems related to propagation phenomena in biological networks. As an example, carcinogenesis and cancer progression are examined as processes that propagate molecular failures. These processes are based on evolutionary and spatial evolutionary games, which describe propagation phenomena in time and space. A number of recently developed propagation models and algorithms that could be utilized to understand mobile phone datasets are presented in Chap. 11. It discusses how to analyze the spreading dynamics of mobile phone malware using SIR, SIS, and SIDR epidemiological models, how to identify fraudulent activity over a phone network, and how to predict churners in a phone network. Chapter 12 deals with structural information propagation in crisis situations referring to disaster, emergency, or catastrophe management loosely defined as all actions taken before, during, and after the event. It proposes a framework for detecting and propagating valuable information to the public, and to the first responders in particular. A model of a financial network and the three methods of the propagation of losses: the linear threshold algorithm, the graph-theoretic approach, and the fictitious default algorithm, used to simulate contagion in such a network is proposed in

Chap. 13. The volume closes with Chap. 14. It presents the state of the art in the area of maximizing the spread of influence in social networks, limitations of using a static network representation, and recent trends that use temporal properties of social networks as an alternative.

We are extremely grateful to the Intelligent Systems Reference Library by Springer for having hosted this theme book. Special thanks are due to series editors: Janusz Kacprzyk, and Lakhmi C. Jain. We would principally like to express our most sincere thanks and great appreciation to all those colleagues who have helped us in the realization of this book, in particular, to the contributors and referees.

Many researchers have contributed to this volume with their work. We deeply thank them for their great contributions. In alphabetical order they are: Baber Aslam, Damian Borys, Abdelhamid Bouchachia, Anthony Brabazon, Newton Paulo Bueno, František Čapkovič, Wei Cui, Fabio Daolio, Derek Doran, Mario Eboli, Niloy Ganguly, Jennifer Golbeck, Hans J. Herrmann, Roman Jaksik, Przemysław Kazienko, Pavel Krömer, Michał Krześlak, Vitor H.P. Louzada, Veena Mendiratta, Radosław Michalski, Petr Musilek, Subrata Nandi, Michael ONeill, Daniela Pohl, Jarosław Śmieja, Andrzej Świerniak, Somnath Tagore, Marco Tomassini, Ping Wang, Lei Wu, Cai-Nicolas Ziegler, and Cliff C. Zou.

Warm thanks are also due to the following referees who reviewed the chapters with remarkable expertise and engagement: Nuno Araujo, Francesca Arcelli Fontana, Emili Balaguer-Ballester, František Čapkovič, Richard Clegg, Ireneusz Czarnowski, Anirban Dasgupta, Paul Davidsson, Damien Fay, Evelina Gabasova, Bogdan Gabryś, Sergio Gomez, Hamed Haddadi, Jason Jung, Dariusz Król, Hui Li, Katarzyna Musial, Marco Rossetti, Ruben Sanchez-Garcia, Antonio Scala, Fabio Stella, Mirko Viroli, Ye Wu, and Rong Yang.

We anticipate that our work results in a coherent and comprehensive presentation of the vast recent research activity concerning propagation processes in real world networks. The large number of citations that found room in every chapter makes us believe that the present volume will be a convenient reference to all scholars who consider studying this exciting research area. It should be also clear that these 14 chapters should not be construed as covering all aspects of propagation research.

Wrocław, November 2014   Dariusz Król
Bournemouth   Damien Fay
                                                                                       Bogdan Gabryś

Propagation Phenomena in Real World Networks
Król, D.; Fay, D.; Gabryś, B. (Eds.)
2015, XVIII, 364 p. 97 illus., 32 illus. in color., Hardcover
ISBN: 978-3-319-15915-7