Scale Free Networks Complex Webs In Nature And Technology

This open access book chronicles the rise of a new scientific paradigm offering novel insights into the age-old enigmas of existence. Over 300 years ago, the human mind discovered the machine code of reality: mathematics. By utilizing abstract thought systems, humans began to decode the workings of the cosmos. From this understanding, the current scientific paradigm emerged, ultimately discovering the gift of technology. Today, however, our island of knowledge is surrounded by ever longer shores of ignorance. Science appears to have hit a dead end when confronted with the nature of reality and consciousness. In this fascinating and accessible volume, James Glattfelder explores a radical paradigm shift uncovering the ontology of reality. It is found to be information-theoretic and participatory, yielding a computational and programmable universe.

An innovative view of the changing geopolitical landscape that draws on the science of complex adaptive systems to understand changes in global interaction. Liberal internationalism has been the West's foreign policy agenda since the Cold War, and the West has long occupied the top rung of a hierarchical system. In this book, Hilton Root argues that international relations, like other complex ecosystems, exists in a constantly shifting landscape, in which hierarchical structures are giving way to systems of networked interdependence, changing every facet of global interaction. Accordingly, policymakers will need a new way to understand the process of change. Root suggests that the science of complex systems offers an analytical framework to explain the unforeseen development failures, governance trends, and alliance shifts in today's global political economy. Root examines both the networked systems that make up modern states and the larger, interdependent landscapes they share. Using systems analysis—in which institutional change and economic development are understood as self-organizing complexities—he offers an alternative view of institutional resilience and persistence. From this perspective, Root considers the divergence of East and West; the emergence of the European state, its contrast with the rise of China, and the network properties of their respective innovation systems; the trajectory of democracy in developing regions; and the systemic impact of China on the liberal world order. Complexity science, Root argues, will not explain historical change processes with algorithmic precision, but it may offer explanations that match the messy richness of those processes.

This book provides a comprehensive yet short description of the basic concepts of Complex Network theory. In contrast to other books the authors present these concepts through real case studies. The application topics span from Foodwebs, to the Internet, the World Wide Web and the Social Networks, passing through the International Trade Web and Financial time series. The final part is devoted to definition and implementation of the most important network models. The text provides information on the structure of the data and on the quality of available datasets. Furthermore it provides a series of codes to allow immediate implementation of what is theoretically described in the book. Readers already used to the concepts introduced in this book can learn the art of coding in Python by using the online material. To this purpose the authors have set up a dedicated web site where readers can download and test the codes. The whole project is aimed as a learning tool for scientists and practitioners, enabling them to begin working instantly in the field of Complex Networks.

The book outlines selected projects conducted under the supervision of the author. Moreover, it discusses significant relations between Interactive Granular Computing (IGrC) and numerous dynamically developing scientific domains worldwide, along with features characteristic of the author’s approach to IGrC. The results presented are a continuation and elaboration of various aspects of Wisdom Technology,

initiated and developed in cooperation with Professor Andrzej Skowron. Based on the empirical findings from these projects, the author explores the following areas: (a) understanding the causes of the theory and practice gap problem (TPGP) in complex systems engineering (CSE); (b) generalizing computing models of complex adaptive systems (CAS) (in particular, natural computing models) by constructing an interactive granular computing (IGrC) model of networks of interrelated interacting complex granules (c-granules), belonging to a single agent and/or to a group of agents; (c) developing methodologies based on the IGrC model to minimize the negative consequences of the TPGP. The book introduces approaches to the above issues, using the proposed IGrC model. In particular, the IGrC model refers to the key mechanisms used to control the processes related to the implementation of CSE projects. One of the main aims was to develop a mechanism of IGrC control over computations that model a project's implementation processes to maximize the chances of its success, while at the same time minimizing the emerging risks. In this regard, the IGrC control is usually performed by means of properly selected and enforced (among project participants) project principles. These principles constitute examples of c-granules, expressed by complex vague concepts (represented by c-granules too). The c-granules evolve with time (in particular, the meaning of the concepts is also subject of change). This methodology is illustrated using project principles applied by the author during the implementation of the POLTAX, AlgoTradix, Merix, and Excavio projects outlined in the book.

The field of complex network exploded since the 1990s, the number of publications in a variety of different areas has grown exponentially and practically, and every discipline started to recognize the presence of these mathematical structures in its area of research. Actually almost any system from the nowadays traditional example of the Internet to complex patterns of metabolic reactions can be analyzed through the graph theory. In its simplest and non rigorous definition a graph is a mathematical object consisting of a set of elements (vertices) and a series of links between these vertices (edges). This is of course a very general description, and as any mathematical abstraction, the idea is to discard many of the particular properties of the phenomenon studied. Nevertheless, this modeling is remarkably accurate for a variety of situations. Vertices can be persons related by friendship or acquaintances relations. Vertices can be proteins connected with one another if they interact in the cell. Networks have always existed in Nature of course, but it is fair to say that given the present technological explosion, they became more and more important. Starting from the Internet the web of connections between computers we started to link and share our documents through web applications and we start to get connected with a number of persons larger than usual. It is this revolution in our daily habit that made natural thinking of networks in science and research. Once this has been realized it became natural to see the cell as a network of molecular events from chemical reactions to gene expressions. The point is to establish if this new perspective can help researchers in finding new results and by understanding the development of these phenomena and possibly control their evolution. We believe that this is the case and in the following we shall provide the evidence of that. Together with applications there are of course true scientific questions attached to network theory. Consider the various ways in which the edges are distributed among the vertices: even by keeping the number of edges and vertices constant we have many different patterns possible. Interestingly some features used to describe these shapes are not related to the particular example considered, but instead they are universal. That is to say they can be found in almost any network around. In this book, we introduce the subject of complex networks and we present the structure of the associated topics that range from social science to biology and finance. We start by considering the mathematical foundations of networks and we then move to an overview of the various applications

As network science and technology continues to gain popularity, it becomes imperative to develop procedures to examine emergent network

domains, as well as classical networks, to help ensure their overall optimization. Advanced Methods for Complex Network Analysis features the latest research on the algorithms and analysis measures being employed in the field of network science. Highlighting the application of graph models, advanced computation, and analytical procedures, this publication is a pivotal resource for students, faculty, industry practitioners, and business professionals interested in theoretical concepts and current developments in network domains.

Complex networks datasets often come with the problem of missing information: interactions data that have not been measured or discovered, may be affected by errors, or are simply hidden because of privacy issues. This Element provides an overview of the ideas, methods and techniques to deal with this problem and that together define the field of network reconstruction. Given the extent of the subject, the authors focus on the inference methods rooted in statistical physics and information theory. The discussion is organized according to the different scales of the reconstruction task, that is, whether the goal is to reconstruct the macroscopic structure of the network, to infer its mesoscale properties, or to predict the individual microscopic connections.

Recent years have witnessed the rise of analysis of real-world massive and complex phenomena in graphs; to efficiently solve these large-scale graph problems, it is necessary to exploit high performance computing (HPC), which accelerates the innovation process for discovery and invention of new products and procedures in network science. Creativity in Load-Balance Schemes for Multi/Many-Core Heterogeneous Graph Computing: Emerging Research and Opportunities is a critical scholarly resource that examines trends, challenges, and collaborative processes in emerging fields within complex network analysis. Featuring coverage on a broad range of topics such as high-performance computing, big data, network science, and accelerated network traversal, this book is geared towards data analysts, researchers, students in information communication technology (ICT), program developers, and academics.

The last decades have seen the emergence of Complex Networks as the language with which a wide range of complex phenomena in fields as diverse as Physics, Computer Science, and Medicine (to name just a few) can be properly described and understood. This book provides a view of the state of the art in this dynamic field and covers topics ranging from network controllability, social structure, online behavior, recommendation systems, and network structure. This book includes the peer-reviewed list of works presented at the 7th Workshop on Complex Networks CompleNet 2016 which was hosted by the Université de Bourgogne, France, from March 23-25, 2016. The 28 carefully reviewed and selected contributions in this book address many topics related to complex networks and have been organized in seven major groups: (1) Theory of Complex Networks, (2) Multilayer networks, (3) Controllability of networks, (4) Algorithms for networks, (5) Community detection, (6) Dynamics and spreading phenomena on networks, (7) Applications of Networks.

This two-volume set on Mathematical Principles of the Internet provides a comprehensive overview of the mathematical principles of Internet engineering. The books do not aim to provide all of the mathematical foundations upon which the Internet is based. Instead, these cover only a partial panorama and the key principles. Volume 1 explores Internet engineering, while the supporting mathematics is covered in Volume 2. The chapters on mathematics complement those on the engineering episodes, and an effort has been made to make this work succinct, yet self-contained. Elements of information theory, algebraic coding theory, cryptography, Internet traffic, dynamics and control of Internet congestion, and queueing theory are discussed. In addition,

stochastic networks, graph-theoretic algorithms, application of game theory to the Internet, Internet economics, data mining and knowledge discovery, and quantum computation, communication, and cryptography are also discussed. In order to study the structure and function of the Internet, only a basic knowledge of number theory, abstract algebra, matrices and determinants, graph theory, geometry, analysis, optimization theory, probability theory, and stochastic processes, is required. These mathematical disciplines are defined and developed in the books to the extent that is needed to develop and justify their application to Internet engineering.

Though great advances in public health are witnessed world over in recent years, infectious diseases, besides insect vector-borne infectious diseases remain a leading cause of morbidity and mortality. Control of the epidemics caused by the non-vector borne diseases such as tuberculosis, avian influenza (H5N1) and cryptococcus gattii, have left a very little hope in the past. The advancement of research in science and technology has paved way for the development of new tools and methodologies to fight against these diseases. In particular, intelligent technology and machine-learning based methodologies have rendered useful in developing more accurate predictive tools for the early diagnosis of these diseases. In all these endeavors the main focus is the understanding that the process of transmission of an infectious disease is nonlinear (not necessarily linear) and dynamical in character. This concept compels the appropriate quantification of the vital parameters that govern these dynamics. This book is ideal for a general science and engineering audience requiring an in-depth exposure to current issues, ideas, methods, and models. The topics discussed serve as a useful reference to clinical experts, health scientists, public health administrators, medical practioners, and senior undergraduate and graduate students in applied mathematics, biology, bioinformatics, and epidemiology, medicine and health sciences.

Today it appears that we understand more about the universe than about our interconnected socio-economic world. In order to uncover organizational structures and novel features in these systems, we present the first comprehensive complex systems analysis of real-world ownership networks. This effort lies at the interface between the realms of economics and the emerging field loosely referred to as complexity science. The structure of global economic power is reflected in the network of ownership ties of companies and the analysis of such ownership networks has possible implications for market competition and financial stability. Thus this work presents powerful new tools for the study of economic and corporate networks that are only just beginning to attract the attention of scholars.

As network science and technology continues to gain popularity, it becomes imperative to develop procedures to examine emergent network domains, as well as classical networks, to help ensure their overall optimization. Centrality Metrics for Complex Network Analysis: Emerging Research and Opportunities is a pivotal reference source for the latest research findings on centrality metrics and their broader applications for different categories of networks including wireless sensor networks, curriculum networks, social networks etc. Featuring extensive coverage on relevant areas, such as complex network graphs, node centrality metrics, and mobile sensor networks, this publication is an ideal resource for students, faculty, industry practitioners, and business

professionals interested in theoretical concepts and current developments in network domains.

This first monograph of its kind introduces the reader to fundamental definitions, key concepts and case studies addressing the following issues of rapidly growing relevance for online communities: What are emotions? How do they emerge, how are they transmitted? How can one measure emotional states? What are cyberemotions? When do emotions and cyberemotions become collective phenomena? How can one model emotions and their changes? What role do emotions play for on-line communities? Edited and authored by leading scientists in this field, this book is a comprehensive reference for anyone working on applications of complex systems methods in the social sciences, as well as for social scientists, psychologists, experts in on-line communities and computer scientists. This book provides an excellent overview of the current state-of-art in research on collective emotional interactions mediated by the Internet. It introduces a reader in social phenomena occurring in cyberspace, algorithms needed for automatic sentiment detection and data driven modeling of emotional patterns observed in on-line groups. Eugene Stanley, Professor, Boston UniversityWith the explosive hyper-exponential growth of the internet suddenly new ways of communication are emerging that give rise to a digital 'Homo empathicus', each of us suddenly being able to share thoughts and feelings with millions if not billions of others. This book is a true treat, a timely milestone that gives us insight in the co-evolution of the way we interact with each other and the communication technology provided through this new seemingly endless flexible digital world. Prof. Holyst did a great job bringing together real experts in the field of cyber emotions. Peter M.A. Sloot, Professor, University of Amsterdam, the Netherlands, Nanyang University, Singapore The book Cyberemotions embraces the topic of emotion studies in cyberspace from a very rich spectrum of points of view and applications. It is particularly interesting reading the theoretical foundations underlying the concepts of cyberemotions and how these concepts can be captured, modeled and implemented in real-time applications. Catherine Pelachaud, Director of Research CNRS at LTCI, TELECOM ParisTechLogical machines give us a chance to analyze our often illogical behaviors, especially in the vast meadows of the cyberspace. In this important book, authors of different backgrounds present a wide and deep image, not only of methods of analyzing our emotional behavior online but also how the computers can help to break communicational walls the same technology had built. Rafal Rzepka, Professor, Hokkaido University

This book constitutes the refereed proceedings of the 6th IFIP TC 6 International Workshop on Self-Organizing Systems, IWSOS 2012, held in Delft, The Netherlands, in March 2012. The 5 revised full papers and 5 short papers presented together with 2 invited papers were carefully selected from 25 full paper and 8 short paper submissions. The papers address the following key topics: design and analysis of self-organizing and self-managing systems; inspiring models of self-organization in nature and society; structure, characteristics and dynamics of self-organizing networks; techniques and tools for modeling self-organizing systems; robustness and adaptation in self-organizing systems; self-organization in complex networks like peer-to-peer, sensor, ad-hoc, vehicular and social networks; control of self-organizing systems; decentralized power management in the smart grid; self-organizing group and pattern formation; self-organizing mechanisms for task allocation, coordination and resource allocation; self-

organizing information dissemination and content search; and risks and limits of self-organization.

Fuelled by the big data paradigm, the study of networks is an interdisciplinary field that is growing at the interface of many branches of science including mathematics, physics, computer science, biology, economics and the social sciences. This book, written by experts from the Network Science community, covers a wide range of theoretical and practical advances in this highly active field, highlighting the strong interconnections between works in different disciplines. The eleven chapters take the reader through the essential concepts for the structural analysis of networks, and their applications to real-world scenarios. Being self-contained, the book is intended for researchers, graduate and advanced undergraduate students from different intellectual backgrounds. Each chapter combines mathematical rigour with rich references to the literature, while remaining accessible to a wide range of readers who wish to understand some of the key issues encountered in many aspects of networked everyday life.

A comprehensive introduction to the theory and applications of complex network science, complete with real-world data sets and software tools.

Discusses the impact of emerging trends in information technology towards solutions capable of managing information within open, principally unbounded, operational environments.

For over a decade, complex networks have steadily grown as an important tool across a broad array of academic disciplines, with applications ranging from physics to social media. A tightly organized collection of carefully-selected papers on the subject, Towards an Information Theory of Complex Networks: Statistical Methods and Applications presents theoretical and practical results about information-theoretic and statistical models of complex networks in the natural sciences and humanities. The book's major goal is to advocate and promote a combination of graph-theoretic, information-theoretic, and statistical methods as a way to better understand and characterize real-world networks. This volume is the first to present a self-contained, comprehensive overview of information-theoretic models of complex networks with an emphasis on applications. As such, it marks a first step toward establishing advanced statistical information theory as a unified theoretical basis of complex networks for all scientific disciplines and can serve as a valuable resource for a diverse audience of advanced students and professional scientists. While it is primarily intended as a reference for research, the book could also be a useful supplemental graduate text in courses related to information science, graph theory, machine learning, and computational biology, among others.

We live in a world of networks, where everything is amazingly close to everything else. The notion of 'network' turns out to be central to our times: the Internet and WWW are changing our lives; our physical existence is based on various biological networks; we are involved in all-enveloping networks of economic and social relations. Only in the 1990s did physicists begin to explore real networks, both natural and artificial, as evolving systems with intriguingly complex and

effective architectures. Progress has been so immediate and astounding that we actually face a new science based on a new set of concepts, and, one may even say, on a new philosophy: the natural philosophy of a small world. Old ideas from mathematics, statistical physics, biology, computer science, and so on take on quite new forms in applications to real evolving networks. - What is common to all networks? - What are the general principles of the organization and evolution of networks? - How do the laws of nature work in communication, biological, and social networks? - What are networks? This book, written by physicists, answers these questions and presents a general insight into the world of networks.

Econophysics research studies, which apply methods developed by physicists to solve problems in economics, enable you to deepen your understanding of what financial systems are and how they operate. Articles in this book identify and explain the statistical behavior of the underlying networks in trading, banking, and stock markets as well as other financial systems. Authors also debate the latest issues arising from these econophysics studies.

‘This book is a thoroughly researched and well written exploration of one of the most divisive topics in modern democratic discourse. Novak brings careful and clear thinking to a topic too often clouded in emotion and guided by moral intuition. ‘ —Peter Boettke, Professor of Economics and Philosophy, George Mason University, USA ‘Inequality has bred a climate of hostile political discourse reminiscent of the cold war. In this lucid book, Novak explains how we can transcend that hostility by recognizing the deeply entangled character of politics and economics within modern societies.’ —Richard E. Wagner, Hobart R. Harris Professor of Economics, George Mason University, USA ‘Mikayla Novak has provided a bold new intellectual foundation for social policy analysis.’ —Jason Potts, Professor of Economics, RMIT University, Australia In recent years the degree of income and wealth inequality within developed countries has been raised as a central issue in economic and social policy debates. Numerous figures across diverse ideological affinities have advocated policy measures to significantly alter income and wealth distributions, while the inequality debate has become infused with other subjects such as social justice and identity politics. This book presents an account of economic inequality from a contemporary classical liberal perspective. Inequality is seen as a by-product of entangled relationships within society, bringing to the fore key ideas from complexity, evolutionary and network sciences. Novak illustrates that inequality is problematic insofar as it generates pro-rich redistribution and constrains progress by the less well off. Economic inequality has important links with issues such as fiscal and regulatory policies, discrimination and social exclusion, and institutional design. This unique book is important reading for social science academics, policy makers and people interested in exploring the dimensions and solutions to inequality, a critical issue of our time.

There is convergent consensus among scientists that many social, economic and ?nancial phenomena can be described

by a network of agents and their inter- tions. Surprisingly, even though the application ?elds are quite different, those n- works often show a common behaviour. Thus, their topological properties can give useful insights on how the network is structured, which are the most “important” nodes/agents, how the network reacts to new arrivals. Moreover the network, once included into a dynamic context, helps to model many phenomena. Among the t- ics in which topology and dynamics are the essential tools, we will focus on the diffusion of technologies and fads, the rise of industrial districts, the evolution of ?nancial markets, cooperation and competition, information ?ows, centrality and prestige. The volume, including recent contributions to the ?eld of network modelling, is based on the communications presented at NET 2006 (Verbania, Italy) and NET 2007 (Urbino, Italy); offers a wide range of recent advances, both theoretical and methodological, that will interest academics as well as practitioners. Theory and applications are nicely integrated: theoretical papers deal with graph theory, game theory, coalitions, dynamics, consumer behavior, segregation models and new contributions to the above mentioned area. The applications cover a wide range: airline transportation, ?nancial markets, work team organization, labour and credit market.

This book deals with the science of science by applying network science methods to citation networks and uniquely presents a physics-inspired model of citation dynamics. This stochastic model of citation dynamics is based on a well-known copying or recursive search mechanism. The measurements covered in this text yield parameters of the model and reveal that citation dynamics of scientific papers is not linear, as was previously assumed. This nonlinearity has far-reaching consequences including non-stationary citation distributions, diverging citation trajectories of similar papers, and runaways or "immortal papers" with an infinite citation lifespan. The author shows us that nonlinear stochastic models of citation dynamics can be the basis for a quantitative probabilistic prediction of citation dynamics of individual papers and of the overall journal impact factor. This book appeals to students and researchers from differing subject areas working in network science and bibliometrics.

I was invited to join the Organizing Committee of the First International Conference on Complex Sciences: Theory and Applications (Complex 2009) as its ninth member. At that moment, eight distinguished colleagues, General Co-chairs Eugene Stanley and Gaoxi Xiao, Technical Co-chairs János Kertész and Bing-Hong Wang, Local Co-chairs Hengshan Wang and Hong-An Che, Publicity Team Shi Xiao and Yubo Wang, had spent hundreds of hours pushing the conference half way to its birth. Ever since then, I have been amazed to see hundreds of papers flooding in, reviewed and commented on by the TPC members. Finally, more than 200 contributions were - lected for the proceedings currently in your hands. They include about 200 papers from the main conference (selected from more than 320 submissions) and about 33 papers from the five collated workshops: Complexity Theory of Art and Music (COART) Causality in Complex Systems (ComplexCCS) Complex Engineering Networks (ComplexEN)

Modeling and Analysis of Human Dynamics (MANDYN) Social Physics and its Applications (SPA) Complex sciences are expanding their colonies at such a dazzling speed that it - comes literally impossible for any conference to cover all the frontiers.
This book is an introduction to maximum-entropy models of random graphs with given topological properties and their applications. Its original contribution is the reformulation of many seemingly different problems in the study of both real networks and graph theory within the unified framework of maximum entropy. Particular emphasis is put on the detection of structural patterns in real networks, on the reconstruction of the properties of networks from partial information, and on the enumeration and sampling of graphs with given properties. After a first introductory chapter explaining the motivation, focus, aim and message of the book, chapter 2 introduces the formal construction of maximum-entropy ensembles of graphs with local topological constraints. Chapter 3 focuses on the problem of pattern detection in real networks and provides a powerful way to disentangle nontrivial higher-order structural features from those that can be traced back to simpler local constraints. Chapter 4 focuses on the problem of network reconstruction and introduces various advanced techniques to reliably infer the topology of a network from partial local information. Chapter 5 is devoted to the reformulation of certain “hard” combinatorial operations, such as the enumeration and unbiased sampling of graphs with given constraints, within a “softened” maximum-entropy framework. A final chapter offers various overarching remarks and take-home messages.By requiring no prior knowledge of network theory, the book targets a broad audience ranging from PhD students approaching these topics for the first time to senior researchers interested in the application of advanced network techniques to their field.
This volume constitutes the refereed proceedings of the 6th European Performance Engineering Workshop, EPEW 2009, held in London, UK during July 9-10, 2009. The 13 full papers and 4 short papers presented in this volume, together with the abstract of one invited paper, were carefully reviewed and selected from 33 submissions. The papers deal with modeling of auctions and markets, hardware modeling of RAID systems, performance aspects of cellular and fixed-line networks, mean value analysis, stochastic ordering to queuing networks, extension of passage-time analysis, stochastic process algebra (PEPA), tagged customers in generalised stochastic Petri nets, and representation and analysis of generally-distributed stochastic systems.
In the last decade we have seen the emergence of a new inter-disciplinary field concentrating on the understanding large networks which are dynamic, large, open, and have a structure that borders order and randomness. The field of Complex Networks has helped us better understand many complex phenomena such as spread of decease, protein interaction, social relationships, to name but a few. The field of Complex Networks has received a major boost caused by the widespread availability of huge network data resources in the last years. One of the most surprising findings is that real networks behave very distinct from traditional assumptions of network theory. Traditionally, real networks were supposed to have a majority of nodes of about the same number of connections around an average. This is typically modeled by random graphs. But modern network research could show that the majority of nodes of real networks is very low connected, and, by contrast, there exists some nodes of very extreme connectivity (hubs). The current theories coupled with the availability of data makes the field of Complex Networks (sometimes called Network

Sciences) one of the most promising interdisciplinary disciplines of today. This sample of works in this book gives as a taste of what is in the horizon such controlling the dynamics of a network and in the network, using social interactions to improve urban planning, ranking in music, and the understanding knowledge transfer in influence networks.

This primer offers readers an introduction to the central concepts that form our modern understanding of complex and emergent behavior, together with detailed coverage of accompanying mathematical methods. All calculations are presented step by step and are easy to follow. This new fourth edition has been fully reorganized and includes new chapters, figures and exercises. The core aspects of modern complex system sciences are presented in the first chapters, covering network theory, dynamical systems, bifurcation and catastrophe theory, chaos and adaptive processes, together with the principle of self-organization in reaction-diffusion systems and social animals. Modern information theoretical principles are treated in further chapters, together with the concept of self-organized criticality, gene regulation networks, hypercycles and coevolutionary avalanches, synchronization phenomena, absorbing phase transitions and the cognitive system approach to the brain. Technical course prerequisites are the standard mathematical tools for an advanced undergraduate course in the natural sciences or engineering. Each chapter includes exercises and suggestions for further reading, and the solutions to all exercises are provided in the last chapter. From the reviews of previous editions: This is a very interesting introductory book written for a broad audience of graduate students in natural sciences and engineering. It can be equally well used both for teac hing and self-education. Very well structured and every topic is illustrated with simple and motivating examples. This is a true guidebook to the world of complex nonlinear phenomena. (Ilya Pavlyukevich, Zentralblatt MATH, Vol. 1146, 2008) Claudius Gros' Complex and Adaptive Dynamical Systems: A Primer is a welcome addition to the literature. A particular strength of the book is its emphasis on analytical techniques for studying complex systems. (David P. Feldman, Physics Today, July, 2009).

Many different systems both in nature and in technology can be described by means of networks of interconnected components. Despite their different aspects, all of them share similar mathematical properties. In this book we explain how to recognize these features and why these different systems develop this common structure.

This textbook provides an exciting new addition to the area of network science featuring a stronger and more methodical link of models to their mathematical origin and explains how these relate to each other with special focus on epidemic spread on networks. The content of the book is at the interface of graph theory, stochastic processes and dynamical systems. The authors set out to make a significant contribution to closing the gap between model development and the supporting mathematics. This is done by: Summarising and presenting the state-of-the-art in modeling epidemics on networks with results and readily usable models signposted throughout the book; Presenting different mathematical approaches to formulate exact and solvable models; Identifying the concrete links between approximate models and their rigorous mathematical representation; Presenting a model hierarchy and clearly highlighting the links between model assumptions and model complexity; Providing a reference source for advanced undergraduate students, as well as doctoral students, postdoctoral researchers and academic experts who are engaged

in modeling stochastic processes on networks; Providing software that can solve differential equation models or directly simulate epidemics on networks. Replete with numerous diagrams, examples, instructive exercises, and online access to simulation algorithms and readily usable code, this book will appeal to a wide spectrum of readers from different backgrounds and academic levels. Appropriate for students with or without a strong background in mathematics, this textbook can form the basis of an advanced undergraduate or graduate course in both mathematics and other departments alike.

A variety of different social, natural and technological systems can be described by the same mathematical framework. This holds from the Internet to food webs and to boards of company directors. In all these situations a graph of the elements of the system and their interconnections displays a universal feature. There are only few elements with many connections, and many elements with few connections. This book presents the experimental evidence of these "Scale-free networks" and provides students and researchers with a corpus of theoretical results and algorithms to analyse and understand these features. The content of this book and the exposition makes it a clear textbook for beginners, and a reference book for the experts.

Complex Webs synthesises modern mathematical developments with a broad range of complex network applications of interest to the engineer and system scientist, presenting the common principles, algorithms, and tools governing network behaviour, dynamics, and complexity. The authors investigate multiple mathematical approaches to inverse power laws and expose the myth of normal statistics to describe natural and man-made networks. Richly illustrated throughout with real-world examples including cell phone use, accessing the Internet, failure of power grids, measures of health and disease, distribution of wealth, and many other familiar phenomena from physiology, bioengineering, biophysics, and informational and social networks, this book makes thought-provoking reading. With explanations of phenomena, diagrams, end-of-chapter problems, and worked examples, it is ideal for advanced undergraduate and graduate students in engineering and the life, social, and physical sciences. It is also a perfect introduction for researchers who are interested in this exciting new way of viewing dynamic networks.

The Connected City explores how thinking about networks helps make sense of modern cities: what they are, how they work, and where they are headed. Cities and urban life can be examined as networks, and these urban networks can be examined at many different levels. The book focuses on three levels of urban networks: micro, meso, and macro. These levels build upon one another, and require distinctive analytical approaches that make it possible to consider different types of questions. At one extreme, micro-urban networks focus on the networks that exist within cities, like the social relationships among neighbors that generate a sense of community and belonging. At the opposite extreme, macro-urban networks focus on networks between cities, like the web of nonstop airline flights that make face-to-face business meetings possible. This book contains three major sections organized by the level of analysis and scale of network.

Throughout these sections, when a new methodological concept is introduced, a separate ‘method note’ provides a brief and accessible introduction to the practical issues of using networks in research. What makes this book unique is that it synthesizes the insights and tools of the multiple scales of urban networks, and integrates the theory and method of network analysis.

This two-volume set on Mathematical Principles of the Internet provides a comprehensive overview of the mathematical principles of Internet engineering. The books do not aim to provide all of the mathematical foundations upon which the Internet is based. Instead, they cover a partial panorama and the key principles. Volume 1 explores Internet engineering, while the supporting mathematics is covered in Volume 2. The chapters on mathematics complement those on the engineering episodes, and an effort has been made to make this work succinct, yet self-contained. Elements of information theory, algebraic coding theory, cryptography, Internet traffic, dynamics and control of Internet congestion, and queueing theory are discussed. In addition, stochastic networks, graph-theoretic algorithms, application of game theory to the Internet, Internet economics, data mining and knowledge discovery, and quantum computation, communication, and cryptography are also discussed. In order to study the structure and function of the Internet, only a basic knowledge of number theory, abstract algebra, matrices and determinants, graph theory, geometry, analysis, optimization theory, probability theory, and stochastic processes, is required. These mathematical disciplines are defined and developed in the books to the extent that is needed to develop and justify their application to Internet engineering.

This volume provides an introduction to and overview of the emerging field of interconnected networks which include multilayer or multiplex networks, as well as networks of networks. Such networks present structural and dynamical features quite different from those observed in isolated networks. The presence of links between different networks or layers of a network typically alters the way such interconnected networks behave – understanding the role of interconnecting links is therefore a crucial step towards a more accurate description of real-world systems. While examples of such dissimilar properties are becoming more abundant – for example regarding diffusion, robustness and competition – the root of such differences remains to be elucidated. Each chapter in this topical collection is self-contained and can be read on its own, thus making it also suitable as reference for experienced researchers wishing to focus on a particular topic.

Request a FREE 30-day online trial to this title at www.sagepub.com/freetrial This two-volume encyclopedia provides a thorough introduction to the wide-ranging, fast-developing field of social networking, a much-needed resource at a time when new social networks or "communities" seem to spring up on the internet every day. Social networks, or groupings of individuals tied by one or more specific types of interests or interdependencies ranging from likes and dislikes, or

disease transmission to the "old boy" network or overlapping circles of friends, have been in existence for longer than services such as Facebook or YouTube; analysis of these networks emphasizes the relationships within the network . This reference resource offers comprehensive coverage of the theory and research within the social sciences that has sprung from the analysis of such groupings, with accompanying definitions, measures, and research. Featuring approximately 350 signed entries, along with approximately 40 media clips, organized alphabetically and offering cross-references and suggestions for further readings, this encyclopedia opens with a thematic Reader's Guide in the front that groups related entries by topics. A Chronology offers the reader historical perspective on the study of social networks. This two-volume reference work is a must-have resource for libraries serving researchers interested in the various fields related to social networks.

For the last few decades researchers from different fields gather their findings and knowledge trying to give a shape to the new science of complex systems. To address this problem, new tools and methods have to be established. A new, or more precisely an alternative, framework for the characterization of complex system was proposed. In this book we will introduce the applicability of applicability of simplicial complexes in the science of complex systems. After introducing the main definitions and properties of simplicial complexes necessary for representation and analysis of complex systems, we will illustrate the usefulness and versatility of tools and concepts related to the simplicial complexes.

This book arose from a conference organized under the auspices of the Australian Research Council?s Complex Open Systems Research Network (which has become the most prominent for complex systems in the world ? just Google ?complex systems network?), the ANU Centre for Complex Systems, and the Asia-Pacific Center for Theoretical Physics. The book is unique in the scope of its coverage of applications of complex systems science: Extraterrestrial ? astrophysical, solar and space plasmas; Earth System ? climate, ecosystems; Human systems ? brain dynamics, social networks, financial statistics, advanced technologies. It also presents up-to-date discussions of new theoretical approaches, in particular those based on entropy and entropy production maximization, a field still under development but with much promise for providing a much-needed unifying principle for complex systems science. The authors are at the forefront of their fields, and organized their chapters to effectively bring out common features of complex systems. A comprehensive and common lexicon of keywords has been used to unify indexing, thus making the book an invaluable introduction to anyone seeking an overview of complex systems science.

Network Science is the emerging field concerned with the study of large, realistic networks. This interdisciplinary endeavor, focusing on the patterns of interactions that arise between individual components of natural and engineered systems, has been applied to data sets from activities as diverse as high-throughput biological experiments, online

trading information, smart-meter utility supplies, and pervasive telecommunications and surveillance technologies. This unique text/reference provides a fascinating insight into the state of the art in network science, highlighting the commonality across very different areas of application and the ways in which each area can be advanced by injecting ideas and techniques from another. The book includes contributions from an international selection of experts, providing viewpoints from a broad range of disciplines. It emphasizes networks that arise in nature—such as food webs, protein interactions, gene expression, and neural connections—and in technology—such as finance, airline transport, urban development and global trade. Topics and Features: begins with a clear overview chapter to introduce this interdisciplinary field; discusses the classic network science of fixed connectivity structures, including empirical studies, mathematical models and computational algorithms; examines time-dependent processes that take place over networks, covering topics such as synchronisation, and message passing algorithms; investigates time-evolving networks, such as the World Wide Web and shifts in topological properties (connectivity, spectrum, percolation); explores applications of complex networks in the physical and engineering sciences, looking ahead to new developments in the field. Researchers and professionals from disciplines as varied as computer science, mathematics, engineering, physics, chemistry, biology, ecology, neuroscience, epidemiology, and the social sciences will all benefit from this topical and broad overview of current activities and grand challenges in the unfolding field of network science.