

Dealing With Complexity An Introduction To The Theory And Application Of Systems Science

This book concerns the use of concepts from statistical physics in the description of financial systems. The authors illustrate the scaling concepts used in probability theory, critical phenomena, and fully developed turbulent fluids. These concepts are then applied to financial time series. The authors also present a stochastic model that displays several of the statistical properties observed in empirical data. Statistical physics concepts such as stochastic dynamics, short- and long-range correlations, self-similarity and scaling permit an understanding of the global behaviour of economic systems without first having to work out a detailed microscopic description of the system. Physicists will find the application of statistical physics concepts to economic systems interesting. Economists and workers in the financial world will find useful the presentation of empirical analysis methods and well-formulated theoretical tools that might help describe systems composed of a huge number of interacting subsystems.

This 20-hour free course showed how, by taking a systems approach to complex situations, it can become a lot easier to arrive at management decisions.

This must-read textbook presents an essential introduction to Kolmogorov complexity (KC), a central theory and powerful tool in information science that deals with the quantity of information in individual objects. The text covers both the fundamental concepts and the most important practical applications, supported by a wealth of didactic features. This thoroughly revised and enhanced fourth edition includes new and updated material on, amongst other topics, the Miller-Yu theorem, the Gács-Ku?era theorem, the Day-Gács theorem, increasing randomness, short lists computable from an input string containing the incomputable Kolmogorov complexity of the input, the Lovász local lemma, sorting, the algorithmic full Slepian-Wolf theorem for individual strings, multiset normalized information distance and normalized web distance, and conditional universal distribution. Topics and features: describes the mathematical theory of KC, including the theories of algorithmic complexity and algorithmic probability; presents a general theory of inductive reasoning and its applications, and reviews the utility of the incompressibility method; covers the practical application of KC in great detail, including the normalized information distance (the similarity metric) and information diameter of multisets in phylogeny, language trees, music, heterogeneous files, and clustering; discusses the many applications of resource-bounded KC, and examines different physical theories from a KC point of view; includes numerous examples that elaborate the theory, and a range of exercises of varying difficulty (with solutions); offers explanatory asides on technical issues, and extensive historical sections; suggests structures for several one-semester courses in the preface. As the definitive textbook on Kolmogorov complexity, this comprehensive and self-contained work is an invaluable resource for advanced undergraduate students, graduate students, and researchers in all fields of

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science.

The discipline of silviculture is at a crossroads. Silviculturists are under increasing pressure to develop practices that sustain the full function and dynamics of forested ecosystems and maintain ecosystem diversity and resilience while still providing needed wood products. *A Critique of Silviculture* offers a penetrating look at the current state of the field and provides suggestions for its future development. The book includes an overview of the historical developments of silvicultural techniques and describes how these developments are best understood in their contemporary philosophical, social, and ecological contexts. It also explains how the traditional strengths of silviculture are becoming limitations as society demands a varied set of benefits from forests and as we learn more about the importance of diversity on ecosystem functions and processes. The authors go on to explain how other fields, specifically ecology and complexity science, have developed in attempts to understand the diversity of nature and the variability and heterogeneity of ecosystems. The authors suggest that ideas and approaches from these fields could offer a road map to a new philosophical and practical approach that endorses managing forests as complex adaptive systems. *A Critique of Silviculture* bridges a gap between silviculture and ecology that has long hindered the adoption of new ideas. It breaks the mold of disciplinary thinking by directly linking new ideas and findings in ecology and complexity science to the field of silviculture. This is a critically important book that is essential reading for anyone involved with forest ecology, forestry, silviculture, or the management of forested ecosystems.

Bringing together a team of leading spatial theorists, this book argues that a view of environments which are confronted with discontinuous, non-linear evolving processes is more realistic than the notion that an environment is simply a planner's creation.

An advanced textbook giving a broad, modern view of the computational complexity theory of boolean circuits, with extensive references, for theoretical computer scientists and mathematicians.

Modern cryptology increasingly employs mathematically rigorous concepts and methods from complexity theory. Conversely, current research topics in complexity theory are often motivated by questions and problems from cryptology. This book takes account of this situation, and therefore its subject is what may be dubbed "cryptocomplexity", a kind of symbiosis of these two areas. This book is written for undergraduate and graduate students of computer science, mathematics, and engineering, and can be used for courses on complexity theory and cryptology, preferably by stressing their interrelation. Moreover, it may serve as a valuable source for researchers, teachers, and practitioners working in these fields. Starting from scratch, it works its way to the frontiers of current research in these fields and provides a detailed overview of their history and their current research topics and challenges.

Written by two experts in the field, this is the only comprehensive and unified

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treatment of the central ideas and applications of Kolmogorov complexity. The book presents a thorough treatment of the subject with a wide range of illustrative applications.

Briefly, we review the basic elements of computability theory and probability theory that are required. Finally, in order to place the subject in the appropriate historical and conceptual context we trace the main roots of Kolmogorov complexity. This way the stage is set for Chapters 2 and 3, where we introduce the notion of optimal effective descriptions of objects. The length of such a description (or the number of bits of information in it) is its Kolmogorov complexity. We treat all aspects of the elementary mathematical theory of Kolmogorov complexity. This body of knowledge may be called algorithmic complexity theory. The theory of Martin-Lof tests for randomness of finite objects and infinite sequences is inextricably intertwined with the theory of Kolmogorov complexity and is completely treated. We also investigate the statistical properties of finite strings with high Kolmogorov complexity. Both of these topics are eminently useful in the applications part of the book. We also investigate the recursion theoretic properties of Kolmogorov complexity (relations with Godel's incompleteness result), and the Kolmogorov complexity version of information theory, which we may call "algorithmic information theory" or "absolute information theory." The treatment of algorithmic probability theory in Chapter 4 presupposes Sections 1.6, 1.11.2, and Chapter 3 (at least Sections 3.1 through 3.4).

This proceedings volume presents the latest research from the worldwide mass customization, personalization and co-creation (MCPC) community bringing together new thoughts and results from various disciplines within the field. The chapters are based on papers from The MCPC 2015 Conference where the emphasis was placed on "managing complexity." MCPC is now beginning to emerge in many industries as a profitable business model. But customization and personalization go far beyond the sheer individualization of products and become an extension of current business models and production styles. This book covers topics such as complexity management of knowledge-based systems in manufacturing design and production, sustainable mass customization, choice navigation, and product modeling. The chapters are contributed by a wide range of specialists, offering cutting-edge research, as well as insightful advances in industrial practice in key areas. The MCPC 2015 Conference had a strong focus on real life MCPC applications, and this proceedings volume reflects this. MCPC strategies aim to profit from the fact that people are different. Their objective is to turn customer heterogeneities into profit opportunities, hence addressing the current trend of long tail business models. Mass customization means to provide goods and services that best serve individual customers' personal needs with near mass production efficiency. This book brings together the latest from MCPC thought leaders, entrepreneurs, technology developers, and researchers that use these strategies in practice.

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Chapter One SYSTEMS Origin and Evolution, Terms and Concepts 1. 1. INTRODUCTION We start this book with Theme A (see Figure P. I in the Preface), which aims to develop an essential and fundamental understanding of systems science. So, what is systems science? When asked to explain what systems science is all about, many systems scientists are confronted with a rather daunting task. The discipline tends to be presented and understood in a fragmented way and very few people hold an overview understanding of the subject matter,

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while also having sufficient in-depth competence in many and broad-ranging subject areas where the ideas are used. Indeed, it was precisely this difficulty that identified the need for a comprehensive well-documented account such as is presented here in *Dealing with Complexity*.

[TM]View

Agent-based modeling and simulation (ABMS), a way to simulate a large number of choices by individual actors, is one of the most exciting practical developments in business modeling since the invention of relational databases. It represents a new way to understand data and generate information that has never been available before--a way for businesses to view the future and to understand and anticipate the likely effects of their decisions on their markets and industries. It thus promises to have far-reaching effects on the way that businesses in many areas use computers to support practical decision-making. *Managing Business Complexity* is the first complete business-oriented agent-based modeling and simulation resource. It has three purposes: first, to teach readers how to think about ABMS, that is, about agents and their interactions; second, to teach readers how to explain the features and advantages of ABMS to other people and third, to teach readers how to actually implement ABMS by building agent-based simulations. It is intended to be a complete ABMS resource, accessible to readers who haven't had any previous experience in building agent-based simulations, or any other kinds of models, for that matter. It is also a collection of ABMS business applications resources, all assembled in one place for the first time. In short, *Managing Business Complexity* addresses who needs ABMS and why, where and when ABMS can be applied to the everyday business problems that surround us, and how specifically to build these powerful agent-based models. This book provides the first clear, comprehensive, and accessible account of complex adaptive social systems, by two of the field's leading authorities. Such systems--whether political parties, stock markets, or ant colonies--present some of the most intriguing theoretical and practical challenges confronting the social sciences. Engagingly written, and balancing technical detail with intuitive explanations, *Complex Adaptive Systems* focuses on the key tools and ideas that have emerged in the field since the mid-1990s, as well as the techniques needed to investigate such systems. It provides a detailed introduction to concepts such as emergence, self-organized criticality, automata, networks, diversity, adaptation, and feedback. It also demonstrates how complex adaptive systems can be explored using methods ranging from mathematics to computational models of adaptive agents. John Miller and Scott Page show how to combine ideas from economics, political science, biology, physics, and computer science to illuminate topics in organization, adaptation, decentralization, and robustness. They also demonstrate how the usual extremes used in modeling can be fruitfully transcended. The world has become increasingly networked and unpredictable. Decision makers at all levels are required to manage the consequences of complexity every day. They must deal with problems that arise unexpectedly, generate uncertainty, are characterised by interconnectivity, and spread across traditional boundaries. Simple solutions to complex problems are usually inadequate and risk exacerbating the original issues. Leaders of international bodies such as the UN, OECD, UNESCO and WHO — and of major business, public sector, charitable, and professional organizations — have all declared that systems thinking is an essential leadership skill for managing the complexity of the economic, social and environmental issues that confront decision makers. Systems thinking must be implemented more generally, and on a wider scale, to address these issues. An evaluation of different systems methodologies suggests that they concentrate on different aspects of complexity. To be in the best position to deal with complexity, decision makers must understand the strengths and weaknesses of the various approaches and learn how to employ them in combination. This is called critical systems thinking. Making use of over 25 case studies, the book offers an account of the development of systems thinking and of major efforts to apply the approach in real-world

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interventions. Further, it encourages the widespread use of critical systems practice as a means of ensuring responsible leadership in a complex world. Comments on a previous version of the book: Russ Ackoff: 'the book is the best overview of the field I have seen' JP van Gigh: 'Jackson does a masterful job. The book is lucid ...well written and eminently readable' Professional Manager (Journal of the Chartered Management Institute): 'Provides an excellent guide and introduction to systems thinking for students of management' Chaos and complexity are the new buzz words in both science and contemporary society. The ideas they represent have enormous implications for the way we understand and engage with the world. Complexity Theory and the Social Sciences introduces students to the central ideas which surround the chaos/complexity theories. It discusses key concepts before using them as a way of investigating the nature of social research. By applying them to such familiar topics as urban studies, education and health, David Byrne allows readers new to the subject to appreciate the contribution which complexity theory can make to social research and to illuminating the crucial social issues of our day.

Systems Thinking, System Dynamics offers readers a comprehensive introduction to the growing field of systems thinking and dynamic modelling and its applications. The book provides a self-contained and unique blend of qualitative and quantitative tools, step-by-step methodology, numerous examples and mini-cases, as well as extensive real-life case studies. The content mix and presentation style make the otherwise technical tools of systems thinking and system dynamics accessible to a wide range of people. This book is intended as a text for students in diverse disciplines including business and management, as well as the social, environmental, health and applied sciences. It also has particular relevance for professionals from all backgrounds interested in understanding the dynamic behaviour of complex systems, change management, complex decision making, group problem solving and organisational learning. Systems thinking and system dynamics provide a scientific paradigm, a set of tools and computer technology which can help explain the forces and dynamics that underlie change and complexity in business, political, social, economic and environmental systems. Using systems thinking and system dynamics makes it possible to: examine and foresee the consequences of policy and strategic decisions implement fundamental solutions to chronic problems avoid mistakenly interpreting symptoms as causes test assumptions, hypotheses and scenarios boost staff morale and improve productivity improve the stability and performance of supply chains find long-term sustainable solutions and avoid 'fire-fighting' behaviour.

This text is an introduction to complexity theory and its application to public services management. the difficult concepts of complexity theory are presented in an accessible manner that explains the central concepts in this new approach to social science. the relevance of emerging theories like knowledge management, emotional intelligence and risk management, are also explored. A fundamental problem of public sector governance relates to the very way of thinking it reflects; where organization is thought of as a 'thing', a system designed to deliver what its designers choose. This volume questions that way of thinking and takes a perspective in which organizations are complex responsive

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processes of relating between people. Bringing together the work of participants on the Doctor of Management program at Hertfordshire University, this book focuses on the move to marketization and managerialism, paying particular attention to human relationships and group dynamics. The contributors provide narrative accounts of their work addressing questions of management, pressures, accountability, responsiveness and traditional systems perspectives. In considering such questions in terms of their daily experience, they explore how the perspective of complex responsive processes assists them in making sense of experience and developing practice. Including an editors' commentary which introduces and contextualizes these experiences as well as drawing out key themes for further research, this book will be of value to academics, students and practitioners looking for reflective accounts of real life experiences rather than further prescriptions of what organizational life ought to be.

Dealing with Complexity An Introduction to the Theory and Application of Systems Science Springer Science & Business Media

Managing the Complex is an ambitious title - and it would be an audacious one if we were not to begin with a frank admission: to date few to none of us have a skill set which includes managing the complex. We try various things, we write about others, and we wonder about still others. When a tool, perspective, or technique comes along which seems to evoke success, we emulate it probe it and recoil at the all too often admission that it was situation and context which afforded success its opportunity, and not some quality intrinsic to the tool perspective or technique. Indeed, if the study of complexity has done anything for managers, and for those who espouse managerial theory, it is in providing a 'scientific foundation' for the notion that context matters. Those who preach abstract ideas have then to reconcile themselves to the notion that situation and embodiment matters. Those who believe in strong causality and determinism are left to wrestle with the role of chance, uncertainty, and chaos. Those who prefer to argue that men move history are confronted with the role of environment and affordances, while those who argue the reverse are left to contend with charisma, irrationality of crowds, and the strange qualities we know as emotions. A series on complex systems has less ambitious goals to contend with than this. Such a series can deal with classifications, and categories, and speak of 'noise' as if it were not the central focus of the problem. Managing the complex is about managing 'noise' or perhaps we should say it is about 'dealing with' 'accepting' 'making room for' and 'learning from' 'noise'. The articles in this volume and in volumes to come will each be considered as 'noise' by some and as 'gems' by others, but we hope that practicing managers and academics alike will find plenty of fuel to drive their personal explorations into understanding, and perhaps even managing, the complex.

This volume covers the rapidly developing field of complexity studies with the underlying theme that complexity is to be found everywhere. The volume discusses many chemical applications and offers a comprehensive coverage of

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complexity and the ways in which it may be measured, complexity indices, complexity measures based on Shannon's information theory, and thermodynamic complexity. Complexity: Introduction and Fundamentals provides a valuable source of reference for graduates and researchers for mathematical chemistry.

This concise primer (based on lectures given at summer schools on complex systems and on a masters degree course in complex systems modeling) will provide graduate students and newcomers to the field with the basic knowledge of the concepts and methods of statistical physics and its potential for application to interdisciplinary topics. Indeed, in recent years, statistical physics has begun to attract the interest of a broad community of researchers in the field of complex system sciences, ranging from biology to the social sciences, economics and computer science. More generally, a growing number of graduate students and researchers feel the need to learn some basic concepts and questions originating in other disciplines without necessarily having to master all of the corresponding technicalities and jargon. Generally speaking, the goals of statistical physics may be summarized as follows: on the one hand to study systems composed of a large number of interacting 'entities', and on the other to predict the macroscopic (or collective) behavior of the system considered from the microscopic laws ruling the dynamics of the individual 'entities'. These two goals are, to some extent, also shared by what is nowadays called 'complex systems science' and for these reasons, systems studied in the framework of statistical physics may be considered as among the simplest examples of complex systems—allowing in addition a rather well developed mathematical treatment. Knowledge Management, Organizational Intelligence and Learning, and Complexity is the component of Encyclopedia of Technology, Information, and Systems Management Resources in the global Encyclopedia of Life Support Systems (EOLSS), which is an integrated compendium of twenty one Encyclopedias. The Theme on Knowledge Management, Organizational Intelligence and Learning, and Complexity in the Encyclopedia of Technology, Information, and Systems Management Resources provides the latest scientific insights into the evolution of complexity in both the natural and social realms. Emerging perspectives from the fields of knowledge management, computer-based simulation and the organizational sciences are presented as tools for understanding and supporting this evolving complexity and the earth's life support systems. These three volumes are aimed at the following a wide spectrum of audiences from the merely curious to those seeking in-depth knowledge: University and College students Educators, Professional practitioners, Research personnel and Policy analysts, managers, and decision makers and NGOs.

Organizational complexity is an unavoidable aspect of all businesses, even larger ones, which can hinder their ability to react to sudden or disruptive change. However, with the implementation of enterprise architecture (EA), businesses are able to provide their

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leaders with the resources needed to address any arising challenges. A Systemic Perspective to Managing Complexity with Enterprise Architecture highlights the current advances in utilizing enterprise architecture for managing organizational complexity. By demonstrating the value and usefulness of EA, this book serves as a reference for business leaders, managers, engineers, enterprise architects, and many others interested in new research and approaches to business complexity.

This book introduces leadership and organizational scholars to the potential of complexity science for broadening leadership study beyond its traditional focus on leaders' actions and influence, to a consideration of leadership as a broader, dynamically and interactive organizing process. The book offers a primer on complexity science and its applications to organization studies, and compares the logics of complexity science with those underlying traditional leadership approaches. It describes methodological approaches for studying leadership from a complexity perspective, and offers examples of applications of complexity science to leadership theory. Chapters are written by top scholars in complexity and leadership theory.

This book examines the concept of Liberating Systems Theory (LST), which is made up of two more specific conceptions, the liberation of systems theory and the systems theory for liberation.

This book examines volatility, uncertainty, complexity and ambiguity (VUCA) and addresses the need for broader knowledge and application of new concepts and frameworks to deal with unpredictable and rapid changing situations. The premises of VUCA can shape all aspects of an organization. To cover all areas, the book is divided into six sections. Section 1 acts as an introduction to VUCA and complexity. It reviews ways to manage complexity, while providing examples for tools and approaches that can be applied. The main focus of Section 2 is on leadership, strategy and planning. The chapters in this section create new approaches to handle VUCA environments pertaining to these areas including using the Tetralemma logics, tools from systemic structural constellation (SySt) approach of psychotherapy and organizational development, to provide new ideas for the management of large strategic programs in organizations. Section 3 considers how marketing and sales are affected by VUCA, from social media's influence to customer value management. Operations and cost management are highlighted in Section 4. This section covers VUCA challenges within global supply chains and decision-oriented controlling. In Section 5 organizational structure and process management are showcased, while Section 6 is dedicated to addressing the effects of VUCA in IT, technology and data management. The VUCA forces present businesses with the need to move from linear modes of thought to problem solving with synthetic and simultaneous thinking. This book should help to provide some starting points and ideas to deal with the next era. It should not be understood as the end of the road, but as the beginning of a journey exploring and developing new concepts for a new way of management.

The two main themes of this book, logic and complexity, are both essential for understanding the main problems about the foundations of mathematics. Logical Foundations of Mathematics and Computational Complexity covers a broad spectrum of results in logic and set theory that are relevant to the foundations, as well as the results in computational complexity and the interdisciplinary area of proof complexity. The author presents his ideas on how these areas are connected, what are the most

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fundamental problems and how they should be approached. In particular, he argues that complexity is as important for foundations as are the more traditional concepts of computability and provability. Emphasis is on explaining the essence of concepts and the ideas of proofs, rather than presenting precise formal statements and full proofs. Each section starts with concepts and results easily explained, and gradually proceeds to more difficult ones. The notes after each section present some formal definitions, theorems and proofs. Logical Foundations of Mathematics and Computational Complexity is aimed at graduate students of all fields of mathematics who are interested in logic, complexity and foundations. It will also be of interest for both physicists and philosophers who are curious to learn the basics of logic and complexity theory.

This analysis of emerging practices of collaboration in planning and public policy presents a new theory of collaborative rationality to overcome the challenges of complexity, fragmentation, uncertainty and global processes. This is insightful reading that will move both practice and scholarship to new levels.

In this Very Short Introduction, John Holland presents an introduction to the science of complexity. Using examples from biology and economics, he shows how complexity science models the behaviour of complex systems.

Cognitive Work Analysis (CWA) is a structured framework specifically developed for considering the development and analysis of complex socio-technical systems.

Cognitive Work Analysis: Coping with Complexity contains a comprehensive description of CWA, introducing it to the uninitiated. It then presents a number of applications in complex military domains to explore the benefits of CWA and pays particular attention to investigating the CWA framework in its entirety.

This book illustrates the relevance of chaos and complexity theory to healthcare organisations, public health, clinical governance and the consultation. It explains the terms and ideas at the heart of complexity, the unfamiliar science behind it, and how it applies to the real world. In healthcare, the NHS is a complex adaptive system. So are hospitals, general practices, diseases and patients. The book describes how insights from complexity can help us better understand how organisations, patients or disease develop over time, in an often unpredictable manner. Contributors set out the benefits of applying complexity to their own particular areas of healthcare. Complexity and Healthcare will be of special interest to clinicians and managers in primary and secondary care, researchers and academics, and in particular, general practitioners and public health professionals.

The Department for Work and Pensions (DWP) and its agencies, are responsible for administering around 40 social security benefits to the value of around £100 billion a year. Many of these benefits are linked together; hence some customers are in receipt of more than one benefit. The need for equity and fairness in interpreting legislation, is a cause of complexity. Incentives (e.g. to work) and rewards (e.g. for an individual's savings) have been built into procedures. Problems are caused by the interface between DWP benefits and tax credits (which are administered by HM Revenue and Customs); and by the constant flow

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of major and minor legislative and administrative changes. Simplified procedures would enable both staff and customers to understand the system better, and to avoid duplication of effort. There would also be less scope for benefits fraud (estimated at £2.6 billion in 2004-05). This NAO report also highlights the need for improved communication with customers and better use of new technology. This book explores the interdisciplinary field of complex systems theory. By the end of the book, readers will be able to understand terminology that is used in complex systems and how they are related to one another; see the patterns of complex systems in practical examples; map current topics, in a variety of fields, to complexity theory; and be able to read more advanced literature in the field. The book begins with basic systems concepts and moves on to how these simple rules can lead to complex behavior. The author then introduces non-linear systems, followed by pattern formation, and networks and information flow in systems. Later chapters cover the thermodynamics of complex systems, dynamical patterns that arise in networks, and how game theory can serve as a framework for decision making. The text is interspersed with both philosophical and quantitative arguments, and each chapter ends with questions and prompts that help readers make more connections.

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This book on complexity science comprises a collection of chapters on methods and principles from a wide variety of disciplinary fields -- from physics and chemistry to biology and the social sciences. In this two-part volume, the first part is a collection of chapters introducing different aspects in a coherent fashion, and providing a common basis and the founding principles of the different complexity science approaches; the next provides deeper discussions of the different methods of use in complexity science, with interesting illustrative applications. The fundamental topics deal with self-organization, pattern formation, forecasting uncertainties, synchronization and revolutionary change, self-adapting and self-correcting systems, and complex networks. Examples are taken from biology, chemistry, engineering, epidemiology, robotics, economics, sociology, and neurology.

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