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Mathematical Structures Deformations of Mathematical Structures FUNDAMENTALS OF DISCRETE MATHEMATICAL STRUCTURES Nonlinear Systems and Their Remarkable Mathematical Structures Mathematical Structures of Nonlinear Science Discrete Mathematical Structures and Their Applications Introduction to Mathematical Structures Discrete Mathematical Structures for Computer Scientists and Engineers Plant Breeding Reviews, Volume 24, Part 1 Nonlinear Systems and Their Remarkable Mathematical Structures Mathematical Structures for Computer Graphics Mathematical Structure in Human Affairs Mathematical Structures of Natural Intelligence Mathematical Logic Mathematical Structures of Ergodicity and Chaos in Population Dynamics Nonlinear Systems and Their Remarkable Mathematical Structures Our Mathematical Universe

The second printing contains a critical discussion of Dirac derivation of canonical quantization, which is instead deduced from general geometric structures. This book arises out of the need for Quantum Mechanics (QM) to be part of the common education of mathematics students. The mathematical structure of QM is formulated in terms of the C*-algebra of observables, which is argued on the basis of the operational definition of measurements and the duality between states and observables, for a general physical system. The Dirac–von Neumann axioms are then derived. The description of states and observables as Hilbert space vectors and operators follows from the GNS and

Gelfand–Naimark Theorems. The experimental existence of complementary observables for atomic systems is shown to imply the noncommutativity of the observable algebra, the distinctive feature of QM; for finite degrees of freedom, the Weyl algebra codifies the experimental complementarity of position and momentum (Heisenberg commutation relations) and Schrödinger QM follows from the von Neumann uniqueness theorem. The existence problem of the dynamics is related to the self-adjointness of the Hamiltonian and solved by the Kato–Rellich conditions on the potential, which also guarantee quantum stability for classically unbounded-below Hamiltonians. Examples are discussed which include the explanation of the discreteness of the atomic spectra. Because of the increasing interest in the relation between QM and stochastic processes, a final chapter is devoted to the functional integral approach (Feynman–Kac formula), to the formulation in terms of ground state correlations (the quantum mechanical analog of the Wightman functions) and their analytic continuation to imaginary time (Euclidean QM). The quantum particle on a circle is discussed in detail, as an example of the interplay between topology and functional integral, leading to the emergence of superselection rules and θ sectors. Errata(s) Errata A comprehensive exploration of the mathematics behind the modeling and rendering of computer graphics scenes Mathematical Structures for Computer Graphics presents an accessible and intuitive approach to the mathematical ideas and techniques necessary for two- and three-dimensional computer graphics. Focusing on the significant mathematical results, the book establishes key algorithms used to build complex graphics scenes. Written for readers with various levels of mathematical background, the book develops a solid foundation for graphics techniques and fills in relevant graphics details often overlooked in the literature. Rather than use a rigid theorem/proof approach, the book provides a flexible discussion that moves from vector geometry through transformations, curve modeling, visibility, and lighting models. Mathematical Structures for Computer Graphics also includes: Numerous examples of two- and three-dimensional techniques along with numerical calculations Plenty of mathematical and programming exercises in each chapter, which are designed particularly for graphics tasks Additional details at the end of each chapter covering historical notes, further calculations, and connected concepts for readers who wish to delve deeper Unique coverage of topics such as calculations with homogeneous coordinates, computational geometry for polygons, use of barycentric coordinates, various descriptions for curves, and L-system techniques for recursive images Mathematical Structures for Computer Graphics is an excellent textbook for undergraduate courses in computer science, mathematics, and engineering, as well as an ideal reference for practicing engineers, researchers, and professionals in computer graphics fields. The book is also useful for those readers who wish to understand algorithms for producing their own interesting computer images. The third volume in this sequence of books consists of a collection of contributions that aims to describe the recent progress in nonlinear differential equations and nonlinear dynamical systems (both continuous and discrete). Nonlinear Systems and Their Remarkable Mathematical Structures: Volume 3, Contributions from China just like the first two volumes, consists of contributions by world-leading experts in the subject of nonlinear systems, but in this instance only featuring contributions by leading Chinese scientists who also work in China (in some cases in collaboration with western scientists). Features Clearly illustrate the mathematical theories of nonlinear systems and its progress to both the non-expert and active researchers in this area Suitable for graduate students in Mathematics, Applied Mathematics and some of the Engineering sciences Written in a careful pedagogical manner by those experts who have been involved in the research themselves, and each contribution is reasonably self-contained This textbook presents in a concise and self-contained way the advanced fundamental mathematical structures in quantum theory. It is based on lectures prepared for a 6 months course for MSc students. The reader is introduced to the beautiful interconnection between logic, lattice theory, general probability theory, and general spectral theory including the basic theory of von Neumann algebras and of the algebraic formulation, naturally arising in the study of the mathematical machinery of quantum theories. Some general results concerning hidden-variable interpretations of QM such as Gleason's and the Kochen-Specker theorems and the related notions of realism and non-contextuality are carefully discussed. This is done also in relation with the famous Bell (BCHSH) inequality concerning local causality. Written in a didactic style, this book includes many examples and solved exercises. The work is organized as follows. Chapter 1 reviews some elementary facts and properties of quantum systems. Chapter 2 and 3 present the main results of spectral analysis in complex Hilbert spaces. Chapter 4 introduces the point of view of the orthomodular lattices' theory. Quantum theory form this perspective turns out to the probability measure theory on the non-Boolean lattice of elementary observables and Gleason's theorem characterizes all these measures. Chapter 5 deals with some philosophical and interpretative aspects of quantum theory like hidden-variable formulations of QM. The Kochen-Specker theorem and its implications are analyzed also in relation BCHSH inequality, entanglement, realism, locality, and non-contextuality. Chapter 6 focuses on the algebra of observables also in the presence of superselection rules introducing the notion of von Neumann algebra. Chapter 7 offers the idea of (groups of) quantum symmetry, in particular, illustrated in terms of Wigner and Kadison theorems. Chapter 8 deals with the elementary ideas and results of the so called algebraic formulation of quantum theories in terms of both *-algebras and C*-algebras. This book should appeal to a dual readership: on one hand mathematicians that wish to acquire the tools that unlock the physical aspects of quantum theories; on the other physicists eager to solidify their understanding of the mathematical scaffolding of quantum theories. Nonlinear Systems and Their Remarkable

Mathematical Structures, Volume 2 is written in a careful pedagogical manner by experts from the field of nonlinear differential equations and nonlinear dynamical systems (both continuous and discrete). This book aims to clearly illustrate the mathematical theories of nonlinear systems and its progress to both non-experts and active researchers in this area. Just like the first volume, this book is suitable for graduate students in mathematics, applied mathematics and engineering sciences, as well as for researchers in the subject of differential equations and dynamical systems. Features Collects contributions on recent advances in the subject of nonlinear systems Aims to make the advanced mathematical methods accessible to the non-experts Suitable for a broad readership including researchers and graduate students in mathematics and applied mathematics The work of Erwin Engeler in the logic and algebra of computer science has been influential but has become difficult to access because it has appeared in different types of publications. This collection of selected papers is therefore timely and useful. It represents an original and coherent approach to the basic interrelationships between mathematics and computer science.The volume begins with the area of enrichment of classical model theory by languages which express properties representing the outcome of hypothetical computer programs executed in a given class of mathematical structures, and is related to questions of correctness and provability of programs. This point of view allowed the generalization of classical Galois theory to the point of discussing the relation between structure and complexity of solution programs for problems posed in various mathematical theories. The algebraic approach is deepened and enlarged in the later papers by showing that the algorithmic aspects of any mathematical structure can be uniformly dealt with by expanding these structures into combinatory algebras. Nonlinear Systems and Their Remarkable Mathematical Structures aims to describe the recent progress in nonlinear differential equations and nonlinear dynamical systems (both continuous and discrete). Written by experts, each chapter is self-contained and aims to clearly illustrate some of the mathematical theories of nonlinear systems. The book should be suitable for some graduate and postgraduate students in mathematics, the natural sciences, and engineering sciences, as well as for researchers (both pure and applied) interested in nonlinear systems. The common theme throughout the book is on solvable and integrable nonlinear systems of equations and methods/theories that can be applied to analyze those systems. Some applications are also discussed. Features Collects contributions on recent advances in the subject of nonlinear systems Aims to make the advanced mathematical methods accessible to the non-expert in this field Written to be accessible to some graduate and postgraduate students in mathematics and applied mathematics Serves as a literature source in nonlinear systems This book, presented in two parts, offers a slow introduction to mathematical logic, and several basic concepts of model theory, such as first-order definability, types, symmetries, and elementary extensions. Its first part, Logic Sets, and Numbers, shows how mathematical logic is used to develop the number structures of classical mathematics. The exposition does not assume any prerequisites; it is rigorous, but as informal as possible. All necessary concepts are introduced exactly as they would be in a course in mathematical logic; but are accompanied by more extensive introductory remarks and examples to motivate formal developments. The second part, Relations, Structures, Geometry, introduces several basic concepts of model theory, such as first-order definability, types, symmetries, and elementary extensions, and shows how they are used to study and classify mathematical structures. Although more advanced, this second part is accessible to the reader who is either already familiar with basic mathematical logic, or has carefully read the first part of the book. Classical developments in model theory, including the Compactness Theorem and its uses, are discussed. Other topics include tameness, minimality, and order minimality of structures. The book can be used as an introduction to model theory, but unlike standard texts, it does not require familiarity with abstract algebra. This book will also be of interest to mathematicians who know the technical aspects of the subject, but are not familiar with its history and philosophical background. The dynamics of infectious diseases represents one of the oldest and ri- est areas of mathematical biology. From the classical work of Hamer (1906) and Ross (1911) to the spate of more modern developments associated with Anderson and May, Dietz, Hethcote, Castillo-Chavez and others, the subject has grown dramatically both in volume and in importance. Given the pace of development, the subject has become more and more di?use, and the need to provide a framework for organizing the diversity of mathematical approaches has become clear. Enzo Capasso, who has been a major contributor to the mathematical theory, has done that in the present volume, providing a system for organizing and analyzing a wide range of models, depending on the str- ture of the interaction matrix. The ?rst class, the quasi-monotone or positive feedback systems, can be analyzed e?ectively through the use of comparison theorems, that is the theory of order-preserving dynamical systems; the s- ond, the skew-symmetrizable systems, rely on Lyapunov methods. Capasso develops the general mathematical theory, and considers a broad range of - amples that can be treated within one or the other framework. In so doing, he has provided the ?rst steps towards the uni?cation of the subject, and made an invaluable contribution to the Lecture Notes in Biomathematics. Simon A. Levin Princeton, January 1993 Author's Preface to Second Printing In the Preface to the First Printing of this volume I wrote: \ . . This contributed volume features invited papers on current research and applications in mathematical structures. Featuring various disciplines in the mathematical sciences and physics, articles in this volume discuss fundamental scientific and mathematical concepts as well as their applications to topical problems. Special emphasis is placed on important methods, research directions and applications of analysis within and beyond each field. Covered topics include Metric operators and generalized hermiticity, Semi-frames, Hilbert-Schmidt operator, Symplectic affine action, Fractional Brownian motion, Walker Osserman metric, Nonlinear Maxwell equations, The Yukawa model, Heisenberg observables, Nonholonomic systems, neural networks, Seiberg-Witten invariants, photon-added coherent state, electrostatic double layers, and star products and functions. All contributions are from the participants of the conference held October 2016 in Cotonou, Benin in honor of Professor Mahouton Norbert Hounkonnou for his outstanding contributions to the mathematical and physical sciences and education. Accessible to graduate students and postdoctoral researchers, this volume is a useful resource to applied scientists, applied and pure mathematicians, and mathematical and theoretical physicists. This volume presents a collection of papers on geometric structures in the context of Hurwitz-type structures and applications to surface physics. The first part of this volume concentrates on the analysis of geometric structures. Topics covered are: Clifford structures, Hurwitz pair structures, Riemannian or Hermitian manifolds, Dirac and Breit operators, Penrose-type and Kaluza--Klein-type structures. The second part contains a study of surface physics structures, in particular boundary conditions, broken symmetry and surface decorations, as well as nonlinear solutions and dynamical properties: a near surface region. For mathematicians and mathematical physicists interested in the applications of mathematical structures. Computing Curricula 2001 (CC2001), a joint undertaking of the Institute for

Electrical and Electronic Engineers/Computer Society (IEEE/CS) and the Association for Computing Machinery (ACM), identifies the essential material for an undergraduate degree in computer science. This Sixth Edition of "Mathematical Structures for Computer Science" covers all the topics in the CC2001 suggested curriculum for a one-semester intensive discrete structures course, and virtually everything suggested for a two-semester version of a discrete structures course. Gersting's text binds together what otherwise appears to be a collection of disjointed topics by emphasizing the following themes: - Importance of logical thinking- Power of mathematical notation- Usefulness of abstractions This book contains fundamental concepts on discrete mathematical structures in an easy to understand style so that the reader can grasp the contents and explanation easily. The concepts of discrete mathematical structures have application to computer science, engineering and information technology including in coding techniques, switching circuits, pointers and linked allocation, error corrections, as well as in data networking, Chemistry, Biology and many other scientific areas. The book is for undergraduate and graduate levels learners and educators associated with various courses and progammes in Mathematics, Computer Science, Engineering and Information Technology. The book should serve as a text and reference guide to many undergraduate and graduate programmes offered by many institutions including colleges and universities. Readers will find solved examples and end of chapter exercises to enhance reader comprehension. Features Offers comprehensive coverage of basic ideas of Logic, Mathematical Induction, Graph Theory, Algebraic Structures and Lattices and Boolean Algebra Provides end of chapter solved examples and practice problems Delivers materials on valid arguments and rules of inference with illustrations Focuses on algebraic structures to enable the reader to work with discrete structures This book provides a broad introduction to some of the most fascinating and beautiful areas of discrete mathematical structures. It starts with a chapter on sets and goes on to provide examples in logic, applications of the principle of inclusion and exclusion and finally the pigeonhole principal. Computational techniques including the principle of mathematical introduction are provided, as well as a study on elementary properties of graphs, trees and lattices. Some basic results on groups, rings, fields and vector spaces are also given, the treatment of which is intentionally simple since such results are fundamental as a foundation for students of discrete mathematics. In addition, some results on solutions of systems of linear equations are discussed. This updated text, now in its Third Edition, continues to provide the basic concepts of discrete mathematics and its applications at an appropriate level of rigour. The text teaches mathematical logic, discusses how to work with discrete structures, analyzes combinatorial approach to problem-solving and develops an ability to create and understand mathematical models and algorithms essentials for writing computer programs. Every concept introduced in the text is first explained from the point of view of mathematics, followed by its relation to Computer Science. In addition, it offers excellent coverage of graph theory, mathematical reasoning, foundational material on set theory, relations and their computer representation, supported by a number of worked-out examples and exercises to reinforce the students’ skill. Primarily intended for undergraduate students of Computer Science and Engineering, and Information Technology, this text will also be useful for undergraduate and postgraduate students of Computer Applications. New to this Edition Incorporates many new sections and subsections such as recurrence relations with constant coefficients, linear recurrence relations with and without constant coefficients, rules for counting and shorting, Peano axioms, graph connecting, graph scanning algorithm, lexicographic shorting, chains, antichains and order-isomorphism, complemented lattices, isomorphic order sets, cyclic groups, automorphism groups, Abelian groups, group homomorphism, subgroups, permutation groups, cosets, and quotient subgroups. Includes many new worked-out examples, definitions, theorems, exercises, and GATE level MCQs with answers. This is a textbook for a one-term course whose goal is to ease the transition from lower-division calculus courses to upper-division courses in linear and abstract algebra, real and complex analysis, number theory, topology, combinatorics, and so on. Without such a "bridge" course, most upper division instructors feel the need to start their courses with the rudiments of logic, set theory, equivalence relations, and other basic mathematical raw materials before getting on with the subject at hand. Students who are new to higher mathematics are often startled to discover that mathematics is a subject of ideas, and not just formulaic rituals, and that they are now expected to understand and create mathematical proofs. Mastery of an assortment of technical tricks may have carried the students through calculus, but it is no longer a guarantee of academic success. Students need experience in working with abstract ideas at a nontrivial level if they are to achieve the sophisticated blend of knowledge, disci pline, and creativity that we call "mathematical maturity. " I don't believe that "theorem-proving" can be taught any more than "question-answering" can be taught. Nevertheless, I have found that it is possible to guide stu dents gently into the process of mathematical proof in such a way that they become comfortable with the experience and begin asking them selves questions that will lead them in the right direction. This book contains fundamental concepts on discrete mathematical structures in an easy to understand style so that the reader can grasp the contents and explanation easily. The concepts of discrete mathematical structures have application to computer science, engineering and information technology including in coding techniques, switching circuits, pointers and linked allocation, error corrections, as well as in data networking, Chemistry, Biology and many other scientific areas. The book is for undergraduate and graduate levels learners and educators associated with various courses and progammes in Mathematics, Computer Science, Engineering and Information Technology. The book should serve as a text and reference guide to many undergraduate and graduate programmes offered by many institutions including colleges and universities. Readers will find solved examples and end of chapter exercises to enhance reader comprehension. Features Offers comprehensive coverage of basic ideas of Logic, Mathematical Induction, Graph Theory, Algebraic Structures and Lattices and Boolean Algebra Provides end of chapter solved examples and practice problems Delivers materials on valid arguments and rules of inference with illustrations Focuses on algebraic structures to enable the reader to work with discrete structures Max Tegmark leads us on an astonishing journey through past, present and future, and through the physics, astronomy and mathematics that are the foundation of his work, most particularly his hypothesis that our physical reality is a mathematical structure and his theory of the ultimate multiverse. In a dazzling combination of both popular and groundbreaking science, he not only helps us grasp his often mind-boggling theories, but he also shares with us some of the often surprising triumphs and disappointments that have shaped his life as a scientist. Fascinating from first to last—this is a book that has already prompted the attention and admiration of some of the most prominent scientists and mathematicians. Discrete Mathematical Structures provides comprehensive, reasonably rigorous and simple explanation of the concepts with the help of numerous applications from computer science and engineering. Every chapter is equipped with a good number of solved examples that elucidate the definitions and theorems discussed. Chapter-end exercises are graded, with the easier ones in the beginning and then the complex ones, to help students for easy solving. This book describes two stages in the historical development of the notion of mathematical structures: first, it traces its rise in the context of algebra from the mid-1800s to 1930, and then considers attempts to formulate elaborate theories after 1930 aimed at elucidating, from a purely mathematical perspective, the precise meaning of this idea. Since the last century, a large part of Mathematics is concerned with the study of mathematical structures, from groups to fields and vector spaces, from lattices to Boolean algebras, from metric spaces to topological spaces, from topological groups to Banach spaces.More recently, these structured sets and their transformations have been assembled in higher structures, called categories.We want to give a structural overview of these topics, where the basic facts of the different theories are unified through the 'universal properties' that they satisfy, and their particularities stand out, perhaps even more.This book can be used as a textbook for undergraduate studies and for self-study. It can provide students of Mathematics with a unified perspective of subjects which are often kept apart. It is also addressed to students and researchers of disciplines having strong interactions with Mathematics, like Physics and Chemistry, Statistics, Computer Science, Engineering. Plant Breeding Reviews, Volume 24, Part 1 presents state-of-the-art reviews on plant genetics and the breeding of all types of crops by both traditional means and molecular methods.

The emphasis of the series is on methodology, a practical understanding of crop genetics, and applications to major crops. This book uncovers mathematical structures underlying natural intelligence and applies category theory as a modeling language for understanding human cognition, giving readers new insights into the nature of human thought. In this context, the book explores various topics and questions, such as the human representation of the number system, why our counting ability is different from that which is evident among non-human organisms, and why the idea of zero is so difficult to grasp. The book is organized into three parts: the first introduces the general reason for studying general structures underlying the human mind; the second part introduces category theory as a modeling language and use it for exposing the deep and fascinating structures underlying human cognition; and the third applies the general principles and ideas of the first two parts to reaching a better understanding of challenging aspects of the human mind such as our understanding of the number system, the metaphorical nature of our thinking and the logic of our unconscious dynamics. The launch ofa new book series is always a challenging eventn ot only for the Editorial Board and the Publisher, but also, and more particularly, for the first author. Both the Editorial Board and the Publisher are delightedt hat the first author in this series isw ell able to meet the challenge. Professor Freudenthal needs no introduction toanyone in the Mathematics Education field and it is particularly fitting that his book should be the first in this new series because it was in 1968 that he, and Reidel, produced the first issue oft he journal Edu cational Studies in Mathematics. Breakingfresh ground is therefore nothing new to Professor Freudenthal and this book illustrates well his pleasure at such a task. To be strictly correct the 'ground' which he has broken here is not new, but aswith Mathematics as an Educational Task and Weeding and Sowing, it is rather the novelty oft he manner in which he has carried out his analysis which provides us with so many fresh perspectives. It is our intention that this new book series should provide those who work int he emerging discipline of mathematicseducation with an essential resource, and at a time of considerable concern about the whole mathematics cu rriculum this book represents just such resource. ALAN J. BISHOP Managing Editor vii A LOOK BACKWARD AND A LOOK FORWARD Men die, systems last. This text has been designed as a complete introduction to discrete mathematics, primarily for computer science majors in either a one or two semester course. The topics addressed are of genuine use in computer science, and are presented in a logically coherent fashion. The material has been organized and interrelated to minimize the mass of definitions and the abstraction of some of the theory. For example, relations and directed graphs are treated as two aspects of the same mathematical idea. Whenever possible each new idea uses previously encountered material, and then developed in such a way that it simplifies the more complex ideas that follow. This edition offers a pedagogically rich and intuitive introduction to discrete mathematics structures. It meets the needs of computer science majors by being both comprehensive and accessible. A comprehensive exploration of the mathematics behind the modeling and rendering of computer graphics scenes Mathematical Structures for Computer Graphics presents an accessible and intuitive approach to the mathematical ideas and techniques necessary for two- and three-dimensional computer graphics. Focusing on the significant mathematical results, the book establishes key algorithms used to build complex graphics scenes. Written for readers with various levels of mathematical background, the book develops a solid foundation for graphics techniques and fills in relevant graphics details often overlooked in the literature. Rather than use a rigid theorem/proof approach, the book provides a flexible discussion that moves from vector geometry through transformations, curve modeling, visibility, and lighting models. Mathematical Structures for Computer Graphics also includes: Numerous examples of two- and three-dimensional techniques along with numerical calculations Plenty of mathematical and programming exercises in each chapter, which are designed particularly for graphics tasks Additional details at the end of each chapter covering historical notes, further calculations, and connected concepts for readers who wish to delve deeper Unique coverage of topics such as calculations with homogeneous coordinates, computational geometry for polygons, use of barycentric coordinates, various descriptions for curves, and L-system techniques for recursive images Mathematical Structures for Computer Graphics is an excellent textbook for undergraduate courses in computer science, mathematics, and engineering, as well as an ideal reference for practicing engineers, researchers, and professionals in computer graphics fields. The book is also useful for those readers who wish to understand algorithms for producing their own interesting computer images. Mathematical Structures in Languages introduces a number of mathematical concepts that are of interest to the working linguist. The areas covered include basic set theory and logic, formal languages and automata, trees, partial orders, lattices, Boolean structure, generalized quantifier theory, and linguistic invariants, the last drawing on Edward L. Keenan and Edward Stabler's Bare Grammar: A Study of Language Invariants, also published by CSLI Publications. Ideal for advanced undergraduate and graduate students of linguistics, this book contains numerous exercises and will be a valuable resource for courses on mathematical topics in linguistics. The product of many years of teaching, Mathematic Structures in Languages is very much a book to be read and learned from. 'Discrete Mathematical Structures' provides an introductory mathematical foundation for further advanced study in data structures, algorithms, compilers and theory of computation. This textbook serves as an introduction to groups, rings, fields, vector and tensor spaces, algebras, topological spaces, differentiable manifolds and Lie groups --- mathematical structures which are foundational to modern theoretical physics. It is aimed primarily at undergraduate students in physics and mathematics with no previous background in these topics. Applications to physics --- such as the metric tensor of special relativity, the symplectic structures associated with Hamilton's equations and the Generalized Stokes's Theorem --- appear at appropriate places in the text. Worked examples, end-of-chapter problems (many with hints and some with answers) and guides to further reading make this an excellent book for self-study. Upon completing this book the reader will be well prepared to delve more deeply into advanced texts and specialized monographs in theoretical physics or mathematics. This is the first volume of a series of books that will describe current advances and past accompli shments of mathemat i ca 1 aspects of nonlinear sCience taken in the broadest contexts. This subject has been studied for hundreds of years, yet it is the topic in whi ch a number of outstandi ng di scoveri es have been made in the past two decades. Clearly, this trend will continue. In fact, we believe some of the great scientific problems in this area will be clarified and perhaps resolved. One of the reasons for this development is the emerging new mathematical ideas of nonlinear science. It is clear that by looking at the mathematical structures themselves that underlie experiment and observation that new vistas of conceptual thinking lie at the foundation of the unexplored area in this field. To speak of specific examples, one notes that the whole area of bifurcation was rarely talked about in the early parts of this century, even though it was discussed mathematically by Poi ncare at the end of the ni neteenth century. I n another di rect ion, turbulence has been a key observation in fluid dynamics, yet it was only recently, in the past decade, that simple computer studies brought to light simple dynamical models in which chaotic dynamics, hopefully closely related to turbulence, can be observed. This book concerns issues related to biomathematics, medicine, or cybernetics as practiced by engineers. Considered population dynamics models are still in the interest of researchers, and even this interest is increasing, especially now in the time of SARS-CoV-2 coronavirus pandemic, when models are intensively studied in order to help predict its behaviour within human population. The structures of population dynamics models and practical methods of finding their solutions are discussed. Finally, the hypothesis of the existence of non-trivial ergodic properties of the model of erythropoietic response dynamics formulated by A. Lasota in the form of delay differential equation with unimodal feedback is analysed. The research can be compared with actual medical data, as well as shows that the structures of population models can reflect the dynamic structures of reality.

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