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Mathematics and Computation The Nature of Computation Mathematics and Computation Mathematical Modeling and Computation of Real-Time Problems Natural Computation Introduction to Computation and Programming Using Python, revised and expanded edition Mathematical Modeling And Computation In Finance: With Exercises And Python And Matlab Computer Codes Feynman And Computation 75 Years of Mathematics of Computation Introduction to the Theory of Computation The Ecology of Computation Information, Physics, and Computation Theory and Computation of Tensors Computation and Human Experience Morphology and Computation Handbook of Human Computation Projects in Scientific Computation Differential Equations, Mechanics, and Computation Economics and Computation Complexity and Real Computation Machines, Languages, and Computation Computation with Finitely Presented Groups Understanding Computation Theory and Computation of Complex Tensors and its Applications Theory of Computation Computation and Intelligence Computation in Science Information and Computation Theory and Computation of Electromagnetic Fields Economic Dynamics, second edition Proof And Computation: Digitization In Mathematics, Computer Science And Philosophy Numerical Analysis and Scientific Computation Classical and New Paradigms of Computation and their Complexity Hierarchies Theory of Computation Mathematical Theory of Computation A New Era in Computation Functions of Matrices Theory of Computation Logics of Time and Computation What Can Be Computed?

Finally, you can learn computation theory and programming language design in an engaging, practical way. Understanding Computation explains theoretical computer science in a context you'll recognize, helping you appreciate why these ideas matter and how they can inform your day-to-day programming. Rather than use mathematical notation or an unfamiliar academic programming language like Haskell or Lisp, this book uses Ruby in a reductionist manner to present formal semantics, automata theory, and functional programming with the lambda calculus. It's ideal for programmers versed in modern languages, with little or no formal training in computer science. Understand fundamental computing concepts, such as Turing completeness in languages Discover how programs use dynamic semantics to communicate ideas to machines Explore what a computer can do when reduced to its bare essentials Learn how universal Turing machines led to today's general-purpose computers Perform complex calculations, using simple languages and cellular automata Determine which programming language features are essential for computation Examine how halting and self-referencing make some computing problems unsolvable Analyze programs by using abstract interpretation and type systems This volume provides a cutting-edge view of the world's leading authorities in fields where information and computation play a central role. By paying close attention to the metaphors of artificial intelligence and their consequences for the field's patterns of success and failure, this text argues for a reorientation of the field away from thought and toward activity. It offers a critical reconstruction of AI research. Reviews the fundamental concepts behind the theory and computation of electromagnetic fields The book is divided in two parts. The first part covers both fundamental theories (such as vector analysis, Maxwell's equations, boundary condition, and transmission line theory) and advanced topics (such as wave transformation, addition theorems, and fields in layered media) in order to benefit students at all levels. The second part of the book covers the major computational methods for numerical analysis of electromagnetic fields for engineering applications. These methods include the three fundamental approaches for numerical analysis of electromagnetic fields: the finite difference method (the finite difference time-domain method in particular), the finite element method, and the integral equation-based moment method. The second part also examines fast algorithms for solving integral equations and hybrid techniques that combine different numerical methods to seek more efficient solutions of complicated electromagnetic problems. Theory and Computation of Electromagnetic Fields, Second Edition: Provides the foundation necessary for graduate students to learn and understand more advanced topics Discusses electromagnetic analysis in rectangular, cylindrical and spherical coordinates Covers computational electromagnetics in both frequency and time domains Includes new and updated homework problems and examples Theory and Computation of Electromagnetic Fields, Second Edition is written for advanced undergraduate and graduate level electrical engineering students. This book can also be used as a reference for professional engineers interested in learning about analysis and computation skills. A thorough and elegant treatment of the theory of matrix functions and numerical methods for computing them, including an overview of applications, new and unpublished research results, and improved algorithms. Key features include a detailed treatment of the matrix sign function and matrix roots; a development of the theory of conditioning and properties of the Fre;chet derivative; Schur decomposition; block Parlett recurrence; a thorough analysis of the accuracy, stability, and computational cost of numerical methods; general results on convergence and stability of matrix iterations; and a chapter devoted to the f(A)b problem. Ideal for advanced courses and for self-study, its broad content, references and appendix also make this book a convenient general reference. Contains an extensive collection of problems with solutions and MATLAB implementations of key algorithms. The classical theory of computation has its origins in the work of Goedel, Turing, Church, and Kleene and has been an extraordinarily successful framework for theoretical computer science. The thesis of this book, however, is that it provides an inadequate foundation for modern scientific computation where most of the algorithms are real number algorithms. The goal of this book is to develop a formal theory of computation which integrates major themes of the classical theory and which is more directly applicable to problems in mathematics, numerical analysis, and scientific computing. Along the way, the authors consider such fundamental problems as: * Is the Mandelbrot set decidable? * For simple quadratic maps, is the Julia set a halting set? * What is the real complexity of Newton's method? * Is there an algorithm for deciding the knapsack problem in a ploynomial number of steps? * Is the Hilbert Nullstellensatz intractable? * Is the problem of locating a real zero of a degree four polynomial intractable? * Is linear programming tractable over the reals? The book is divided into three parts: The first part provides an extensive introduction and then proves the fundamental NP-completeness theorems of Cook-Karp and their extensions to more general number fields as the real and complex numbers. The later parts of the book develop a formal theory of computation which integrates major themes of the classical theory and which is more directly applicable to problems in mathematics, numerical analysis, and scientific computing. Computational complexity is one of the most beautiful fields of modern mathematics, and it is increasingly relevant to other sciences ranging from physics to biology. But this beauty is often buried underneath layers of unnecessary formalism, and exciting recent results like interactive proofs, phase transitions, and quantum computing are usually considered too advanced for the typical student. This book bridges these gaps by explaining the deep ideas of theoretical computer science in a clear and enjoyable fashion, making them accessible to non-computer scientists and to computer scientists who finally want to appreciate their field from a new point of view. The authors start with a lucid and playful explanation of the P vs. NP problem, explaining why it is so fundamental, and so hard to resolve. They then lead the reader through the complexity of mazes and games; optimization in theory and practice; randomized algorithms, interactive proofs, and pseudorandomness; Markov chains and phase transitions; and the outer reaches of quantum computing. At every turn, they use a minimum of formalism, providing explanations that are both deep and accessible. The book is intended for graduate and undergraduate students, scientists from other areas who have long wanted to understand this subject, and experts who want to fall in love with this field all over again. This book discusses the interplay of stochastics (applied probability theory) and numerical analysis in the field of quantitative finance. The stochastic models, numerical valuation techniques, computational aspects, financial products, and risk management applications presented will enable readers to progress in the challenging field of computational finance.When the behavior of financial market participants changes, the corresponding stochastic mathematical models describing the prices may also change. Financial regulation may play a role in such changes too. The book thus presents several models for stock prices, interest rates as well as foreign-exchange rates, with increasing complexity across the chapters. As is said in the industry, 'do not fall in love with your favorite model.' The book covers equity models before moving to short-rate and other interest rate models. We cast these models for interest rate into the Heath-Jarrow-Morton framework, show relations between the different models, and explain a few interest rate products and their pricing.The chapters are accompanied by exercises. Students can access solutions to selected exercises, while complete solutions are made available to instructors. The MATLAB and Python computer codes used for most tables and figures in the book are made available for both print and e-book users. This book will be useful for people working in the financial industry, for those aiming to work there one day, and for anyone interested in quantitative finance. The topics that are discussed are relevant for MSc and PhD students, academic researchers, and for quants in the financial industry.Supplementary Material:Solutions Manual is available to instructors who adopt this textbook for their courses. Please contact sales@wspc.com. Designed for the MIT course, "Natural Computation, this extensive book of readings combines mathematics, artificial intelligence, computer science, experimental psychology, and neurophysiology in studying perception. Mathematics is emphasized for making perceptual inferences and the spectrum of mathematical techniques used is very broad. While the more than thirty readings focus primarily on vision, they also encompass the study of sound perception and the interpretation and application of forces including movement.Each article is a self contained example of how a perceptual problem may be tackled and solved. For example, what makes wood look like wood not like stone, sand, or grass? How can we represent three dimensional shapes when the same shape is rarely seen in exactly the same way? Each of the five sections is preceded by an introduction and the book concludes with problem sets.Whitman A. Richards is Professor in the Brain and Cognitive Science Department at MIT. A Bradford Book. This book provides a theoretical background in computation to scientists who use computational methods. It explains how computing is used in the natural sciences, and provides a high-level overview of those aspects of computer science and software engineering that are most relevant for computational science. The focus is on concepts, results, and applications, rather than on proofs and derivations. The unique feature of this book is that it “connects the dots between computational science, the theory of computation and information, and software engineering. The book should help scientists to better understand how they use computers in their work, and to better understand how computers work. It is meant to compensate a bit for the general lack of any formal training in computer science and information theory. Readers will learn something they can use throughout their careers. With the objective of making into a science the art of verifying computer programs (debugging), the author addresses both practical and theoretical aspects of the process. A classic of sequential program verification, this volume has been translated into almost a dozen other languages and is much in demand among graduate and advanced undergraduate computer science students. Subjects include computability (with discussions of finite automata and Turing machines); predicate calculus (basic notions, natural deduction, and the resolution method); verification of programs (both flowchart and algol-like programs); flowchart schemas (basic notions, decision problems, formalization in predicate calculus, and translation programs); and the fixpoint theory of programs (functions and functionals, recursive programs, and verification programs). The treamtent is self-contained, and each chapter concludes with bibliographic remarks, references, and problems. This book provides a conceptual introduction to the theory of ordinary differential equations, concentrating on the initial value problem for equations of evolution and with applications to the calculus of variations and classical mechanics, along with a discussion of chaos theory and ecological models. It has a unified and visual introduction to the theory of numerical methods and a novel approach to the analysis of errors and stability of various numerical solution algorithms based on carefully chosen model problems. While the book would be suitable as a textbook for an undergraduate or elementary graduate course in ordinary differential equations, the authors have designed the text also to be useful for motivated students wishing to learn the material on their own or desiring to supplement an ODE textbook being used in a course they are taking with a text offering a more conceptual approach to the subject. An introduction to computational complexity theory, its connections and interactions with mathematics, and its central role in the natural and social sciences, technology, and philosophy Mathematics and Computation provides a broad, conceptual overview of computational complexity theory—the mathematical study of efficient computation. With important practical applications to computer science and industry, computational complexity theory has evolved into a highly interdisciplinary field, with strong links to most mathematical areas and to a growing number of scientific endeavors. Avi Wigderson takes a sweeping survey of complexity theory, emphasizing the field’s insights and challenges. He explains the ideas and motivations leading to key models, notions, and results. In particular, he looks at algorithms and complexity, computations and proofs, randomness and interaction, quantum and arithmetic computation, and cryptography and learning, all as parts of a cohesive whole with numerous cross-influences. Wigderson illustrates the immense breadth of the field, its beauty and richness, and its diverse and growing interactions with other areas of mathematics. He ends with a comprehensive look at the theory of computation, its methodology and aspirations, and the unique and fundamental ways in which it has shaped and will further shape science, technology, and society. For further reading, an extensive bibliography is provided for all topics covered. Mathematics and Computation is useful for undergraduate and graduate students in mathematics, computer science, and related fields, as well as researchers and teachers in these fields. Many parts require little background, and serve as an invitation to newcomers seeking an introduction to the theory of computation. Comprehensive coverage of computational complexity theory, and beyond High-level, intuitive exposition, which brings conceptual clarity to this central and dynamic scientific discipline Historical accounts of the evolution and motivations of central concepts and models A broad view of the theory of computation's influence on science, technology, and society Extensive bibliography A very active field of research is emerging at the frontier of statistical physics, theoretical computer science/discrete mathematics, and coding/information theory. This book sets up a common language and pool of concepts, accessible to students and researchers from each of these fields. The year 2018 marked the 75th anniversary of the founding of Mathematics of Computation, one of the four primary research journals published by the American Mathematical Society and the oldest research journal devoted to computational mathematics. To celebrate this milestone, the symposium “Celebrating 75 Years of Mathematics of Computation” was held from November 1–3, 2018, at the Institute for Computational and Experimental Research in Mathematics

(ICERM), Providence, Rhode Island. The sixteen papers in this volume, written by the symposium speakers and editors of the journal, include both survey articles and new contributions. On the discrete side, there are four papers covering topics in computational number theory and computational algebra. On the continuous side, there are twelve papers covering topics in machine learning, high dimensional approximations, nonlocal and fractional elliptic problems, gradient flows, hyperbolic conservation laws, Maxwell's equations, Stokes's equations, a posteriori error estimation, and iterative methods. Together they provide a snapshot of significant achievements in the past quarter century in computational mathematics and also in important current trends. An accessible and rigorous textbook for introducing undergraduates to computer science theory What Can Be Computed? is a uniquely accessible yet rigorous introduction to the most profound ideas at the heart of computer science. Crafted specifically for undergraduates who are studying the subject for the first time, and requiring minimal prerequisites, the book focuses on the essential fundamentals of computer science theory and features a practical approach that uses real computer programs (Python and Java) and encourages active experimentation. It is also ideal for self-study and reference. The book covers the standard topics in the theory of computation, including Turing machines and finite automata, universal computation, nondeterminism, Turing and Karp reductions, undecidability, time-complexity classes such as P and NP, and NP-completeness, including the Cook-Levin Theorem. But the book also provides a broader view of computer science and its historical development, with discussions of Turing's original 1936 computing machines, the connections between undecidability and Gödel's incompleteness theorem, and Karp's famous set of twenty-one NP-complete problems. Throughout, the book recasts traditional computer science concepts by considering how computer programs are used to solve real problems. Standard theorems are stated and proven with full mathematical rigor, but motivation and understanding are enhanced by considering concrete implementations. The book's examples and other content allow readers to view demonstrations of—and to experiment with—a wide selection of the topics it covers. The result is an ideal text for an introduction to the theory of computation. An accessible and rigorous introduction to the essential fundamentals of computer science theory, written specifically for undergraduates taking introduction to the theory of computation Features a practical, interactive approach using real computer programs (Python in the text, with forthcoming Java alternatives online) to enhance motivation and understanding Gives equal emphasis to computability and complexity Includes special topics that demonstrate the profound nature of key ideas in the theory of computation Lecture slides and Python programs are available at whatcanbecomputed.com This textbook connects three vibrant areas at the interface between economics and computer science: algorithmic game theory, computational social choice, and fair division. It thus offers an interdisciplinary treatment of collective decision making from an economic and computational perspective. Part I introduces to algorithmic game theory, focusing on both noncooperative and cooperative game theory. Part II introduces to computational social choice, focusing on both preference aggregation (voting) and judgment aggregation. Part III introduces to fair division, focusing on the division of both a single divisible resource ("cake-cutting") and multiple indivisible and unshareable resources ("multiagent resource allocation"). In all these parts, much weight is given to the algorithmic and complexity-theoretic aspects of problems arising in these areas, and the interconnections between the three parts are of central interest. This volume addresses the emerging area of human computation, The chapters, written by leading international researchers, explore existing and future opportunities to combine the respective strengths of both humans and machines in order to create powerful problem-solving capabilities. The book bridges scientific communities, capturing and integrating the unique perspective and achievements of each. It coalesces contributions from industry and across related disciplines in order to motivate, define, and anticipate the future of this exciting new frontier in science and cultural evolution. Readers can expect to find valuable contributions covering Foundations; Application Domains; Techniques and Modalities; Infrastructure and Architecture; Algorithms; Participation; Analysis; Policy and Security and the Impact of Human Computation. Researchers and professionals will find the Handbook of Human Computation a valuable reference tool. The breadth of content also provides a thorough foundation for students of the field. Theory and Computation of Tensors: Multi-Dimensional Arrays investigates theories and computations of tensors to broaden perspectives on matrices. Data in the Big Data Era is not only growing larger but also becoming much more complicated. Tensors (multi-dimensional arrays) arise naturally from many engineering or scientific disciplines because they can represent multi-relational data or nonlinear relationships. Now you can clearly present even the most complex computational theory topics to your students with Sipser's distinct, market-leading INTRODUCTION TO THE THEORY OF COMPUTATION, 3E. The number one choice for today's computational theory course, this highly anticipated revision retains the unmatched clarity and thorough coverage that make it a leading text for upper-level undergraduate and introductory graduate students. This edition continues author Michael Sipser's well-known, approachable style with timely revisions, additional exercises, and more memorable examples in key areas. A new first-of-its-kind theoretical treatment of deterministic context-free languages is ideal for a better understanding of parsing and LR(k) grammars. This edition's refined presentation ensures a trusted accuracy and clarity that make the challenging study of computational theory accessible and intuitive to students while maintaining the subject's rigor and formalism. Readers gain a solid understanding of the fundamental mathematical properties of computer hardware, software, and applications with a blend of practical and philosophical coverage and mathematical treatments, including advanced theorems and proofs. INTRODUCTION TO THE THEORY OF COMPUTATION, 3E's comprehensive coverage makes this an ideal ongoing reference tool for those studying theoretical computing. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version. The book provides an introduction of very recent results about the tensors and mainly focuses on the authors' work and perspective. A systematic description about how to extend the numerical linear algebra to the numerical multi-linear algebra is also delivered in this book. The authors design the neural network model for the computation of the rank-one approximation of real tensors, a normalization algorithm to convert some nonnegative tensors to plane stochastic tensors and a probabilistic algorithm for locating a positive diagonal in a nonnegative tensors, adaptive randomized algorithms for computing the approximate tensor decompositions, and the QR type method for computing U-eigenpairs of complex tensors. This book could be used for the Graduate course, such as Introduction to Tensor. Researchers may also find it helpful as a reference in tensor research. This book is for graduate students and researchers, introducing modern foundational research in mathematics, computer science, and philosophy from an interdisciplinary point of view. Its scope includes Predicative Foundations, Constructive Mathematics and Type Theory, Computation in Higher Types, Extraction of Programs from Proofs, and Algorithmic Aspects in Financial Mathematics. By filling the gap between (under-)graduate level textbooks and advanced research papers, the book gives a scholarly account of recent developments and emerging branches of the aforementioned fields. Contents: Proof and Computation (K Mainzer) Constructive Convex Programming (J Berger and G Svindland) Exploring Predicativity (L Crosilla) Constructive Functional Analysis: An Introduction (H Ishihara) Program Extraction (K Miyamoto) The Data Structures of the Lambda Terms (M Sato) Provable (and Unprovable) Computability (S Wainer) Introduction to Minlog (F Wiesnet) Readership: Graduate students, researchers, and professionals in Mathematics and Computer Science. Keywords: Proof Theory;Computability Theory;Program Extraction;Constructive Analysis;PredicativityReview: Key Features: This book gathers recent contributions of distinguished experts It makes emerging fields accessible to a wider audience, appealing to a broad readership with diverse backgrounds It fills a gap between (under-)graduate level textbooks and state-of-the-art research papers An introductory text that teaches students the art of computational problem solving, covering topics that range from simple algorithms to information visualization. This book introduces students with little or no prior programming experience to the art of computational problem solving using Python and various Python libraries, including PyLab. It provides students with skills that will enable them to make productive use of computational techniques, including some of the tools and techniques of "data science" for using computation to model and interpret data. The book is based on an MIT course (which became the most popular course offered through MIT's OpenCourseWare) and was developed for use not only in a conventional classroom but in a massive open online course (or MOOC) offered by the pioneering MIT-Harvard collaboration edX. Students are introduced to Python and the basics of programming in the context of such computational concepts and techniques as exhaustive enumeration, bisection search, and efficient approximation algorithms. The book does not require knowledge of mathematics beyond high school algebra, but does assume that readers are comfortable with rigorous thinking and not intimidated by mathematical concepts. Although it covers such traditional topics as computational complexity and simple algorithms, the book focuses on a wide range of topics not found in most introductory texts, including information visualization, simulations to model randomness, computational techniques to understand data, and statistical techniques that inform (and misinform) as well as two related but relatively advanced topics: optimization problems and dynamic programming. Introduction to Computation and Programming Using Python can serve as a stepping-stone to more advanced computer science courses, or as a basic grounding in computational problem solving for students in other disciplines. Learn the skills and acquire the intuition to assess the theoretical limitations of computer programming Offering an accessible approach to the topic, Theory of Computation focuses on the metatheory of computing and the theoretical boundaries between what various computational models can do and not do—from the most general model, the URM (Unbounded Register Machines), to the finite automaton. A wealth of programming-like examples and easy-to-follow explanations build the general theory gradually, which guides readers through the modeling and mathematical analysis of computational phenomena and provides insights on what makes things tick and also what restrains the ability of computational processes. Recognizing the importance of acquired practical experience, the book begins with the metatheory of general purpose computer programs, using URMs as a straightforward, technology-independent model of modern high-level programming languages while also exploring the restrictions of the URM language. Once readers gain an understanding of computability theory—including the primitive recursive functions—the author presents automata and languages, covering the regular and context-free languages as well as the machines that recognize these languages. Several advanced topics such as reducibilities, the recursion theorem, complexity theory, and Cook's theorem are also discussed. Features of the book include: A review of basic discrete mathematics, covering logic and induction while omitting specialized combinatorial topics A thorough development of the modeling and mathematical analysis of computational phenomena, providing a solid foundation of un-computability The connection between un-computability and un-provability: Gödel's first incompleteness theorem The book provides numerous examples of specific URMs as well as other programming languages including Loop Programs, FA (Deterministic Finite Automata), NFA (Nondeterministic Finite Automata), and PDA (Pushdown Automata). Exercises at the end of each chapter allow readers to test their comprehension of the presented material, and an extensive bibliography suggests resources for further study. Assuming only a basic understanding of general computer programming and discrete mathematics, Theory of Computation serves as a valuable book for courses on theory of computation at the upper-undergraduate level. The book also serves as an excellent resource for programmers and computing professionals wishing to understand the theoretical limitations of their craft. This book provides the first broad yet thorough coverage of issues in morphological theory. It includes a wide array of techniques and systems in computational morphology (including discussion of their limitations), and describes some unusual applications.Sproat motivates the study of computational morphology by arguing that a computational natural language system, such as a parser or a generator, must incorporate a model of morphology. He discusses a range of applications for programs with knowledge of morphology, some of which are not generally found in the literature. Sproat then provides an overview of some of the basic descriptive facts about morphology and issues in theoretical morphology and (lexical) phonology, as well as psycholinguistic evidence for human processing of morphological structure. He take up the basic techniques that have been proposed for doing morphological processing and discusses at length various systems (such as DECOMP and KIMMO) that incorporate part or all of those techniques, pointing out the inadequacies of such systems from both a descriptive and a computational point of view. He concludes by touching on interesting peripheral areas such as the analysis of complex nominals in English, and on the main contributions of Rumelhart and McClelland's connectionism to the computational analysis of words. The transition from serial to parallel computing in which many operations are performed simultaneously and at tremendous speed, marks a new era in computation. These original essays explore the emerging modalities and potential impact of this technological revolution. Daniel Hillis, inventor of the superfast Connection Machine®, provides a clear explanation of massively parallel computing. The essays that follow investigate the rich possibilities, as well as the constraints, that parallel computation holds for the future. These possibilities include its tremendous potential for simulating currently intractable physical processes and for solving "monster" scientific problems (involving new algorithms and ways of thinking about problem solving that will change the way we think about the world), and its use in the neural sciences (where the biological model for parallel computation is the brain). Essays also address the gap between the promise of this new technology and our current educational system and look at America's technological agenda for the 1990s. Daniel Hillis is Chief Scientist and James Bailey is Director of Marketing, both at Thinking Machines Corporation. Selected Essays:Preface,Stephen R. Graubard. What is Massively Parallel Computing, and Why Is It Important?W. Daniel Hillis. Complex Adaptive Systems, John H. Holland. Perspectives on Parallel Computing, Yuefan Deng, James Glimm, David H. Sharp. Parallel Billiards and Monster Systems, Brosl Hasslacher. First We Reshape Our Computers, Then Our Computers Reshape Us: The Broader Intellectual Impact of Parallelism, James Bailey. Parallelism in Conscious Experience. Robert Sokolowski. Of Time, Intelligence, and Institutions, Felix E. Browder. Parallel Computing and Education,Geoffrey C. Fox. The Age of Computing: A Personal Memoir, N. Metropolis. What Should the Public Know about Mathematics? Philip J. Davis. America's Economic-Technological Agenda for the 1990s,Jacob T. Schwartz. A Daedalus special issue Propelled by advances in software design and increasing connectivity, distributed computational systems are acquiring characteristics reminiscent of social and biological organizations. This volume is a collection of articles dealing with the nature, design and implementation of these open computational systems. Although varied in their approach and methodology, the articles are related by the goal of understanding and building computational ecologies. They are grouped in three major sections. The first deals with general issues underlying open systems, studies of computational ecologies, and their similarities with social organizations. The second part deals with actual implementations of distributed computation, and the third discusses the overriding problem of designing suitable languages for open systems. All the articles are highly interdisciplinary, emphasizing the application of ecological ideas, game theory, market mechanisms, and evolutionary biology in the study of open systems. Computational properties of use to biological organisms or to the construction of computers can emerge as collective properties of systems having a large number of simple equivalent components (or neurons). The physical meaning of content-addressable memory is described by an appropriate phase space flow of the state of a system. A model of such a system is given, based on aspects of neurobiology but readily adapted to integrated circuits. The collective properties of this model produce a content-addressable memory which correctly yields an entire memory from any subpart of sufficient size. The algorithm for the time evolution of the state of the system is based on asynchronous parallel processing. Additional emergent collective properties include some capacity for generalization, familiarity recognition, categorization, error correction, and time sequence retention. The collective properties are only weakly sensitive to details of the modeling or the failure of individual devices. The second edition of a rigorous and example-driven introduction to topics in economic dynamics that emphasizes techniques for modeling dynamic systems. This text provides an introduction to the modern theory of economic dynamics, with emphasis on mathematical and computational techniques for modeling dynamic systems. Written to be both rigorous and engaging, the book shows how sound understanding of the underlying theory leads to effective algorithms for solving real-world problems. The material makes extensive use of programming examples to illustrate ideas, bringing to life the abstract concepts in the text. Key topics include algorithms and scientific computing, simulation, Markov models, and dynamic programming. Part I introduces fundamentals and part II covers more advanced material. This second edition has been thoroughly updated, drawing on recent research in the field. New for the second edition: “Programming-language agnostic” presentation using pseudocode. New chapter 1 covering conceptual issues concerning Markov chains such as ergodicity and stability. New focus in chapter 2 on algorithms and techniques for program design and high-performance computing. New focus on household problems rather than optimal growth in material on dynamic programming. Solutions to many exercises, code, and other resources available on a supplementary website. This work presents readings in artificial intelligence that should be of relevance to current students and practitioners. It is divided into five parts - each reflecting the stages of development of AI - which include "Foundations", "Knowledge Representation" and "Weak Method Problem Solving". An introduction to computational complexity theory, its connections and interactions with mathematics, and its central role in the natural and social sciences, technology, and philosophy Mathematics and Computation provides a broad, conceptual overview of computational complexity theory—the mathematical study of efficient computation. With important practical applications to computer science and industry, computational complexity theory has evolved into a highly interdisciplinary field, with strong links to most mathematical areas and to a growing number of scientific endeavors. Avi Wigderson takes a sweeping survey of complexity theory, emphasizing the field’s insights and challenges. He explains the ideas and motivations leading to key models, notions, and results. In particular, he looks at algorithms and complexity, computations and proofs, randomness and interaction, quantum and arithmetic computation, and cryptography and learning, all as parts of a cohesive whole with numerous cross-influences. Wigderson illustrates the immense breadth of the field, its beauty and richness, and its diverse and growing interactions with other areas of mathematics. He ends with a comprehensive look at the theory of computation, its methodology and aspirations, and the unique and fundamental ways in which it has shaped and will further shape science, technology, and society. For further reading, an extensive bibliography is provided for all topics covered. Mathematics and Computation is useful for undergraduate and graduate students in mathematics, computer science, and related fields, as well as researchers and teachers in these fields. Many parts require little background, and serve as an invitation to newcomers seeking an introduction to the theory of computation. Comprehensive coverage of computational complexity theory, and beyond High-level, intuitive exposition, which brings conceptual clarity to this central and dynamic scientific discipline Historical accounts of the evolution and motivations of central concepts and models A broad view of the theory of computation's influence on science, technology, and society Extensive bibliography Research in computational group theory, an active subfield of computational algebra, has emphasised three areas: finite permutation groups, finite solvable groups, and finitely presented groups. This book deals with the third of these areas. The author emphasises the connections with fundamental algorithms from theoretical computer science, particularly the theory of automata and formal languages, computational number theory, and computational commutative algebra. The LLL lattice reduction algorithm and various algorithms for Hermite and Smith normal forms from computational number theory are used to study the abelian quotients of a finitely presented group. The work of Baumslag, Cannonito and Miller on computing nonabelian polycyclic quotients is described as a generalisation of Buchberger's Gröbner basis methods to right ideals in the integral group ring of a polycyclic group. Researchers in computational group theory, mathematicians interested in finitely presented groups and theoretical computer scientists will find this book useful. This interdisciplinary book provides a compendium of projects, plus numerous example programs for readers to study and explore. Designed for advanced undergraduates or graduates of science, mathematics and engineering who will deal with scientific computation in their future studies and research, it also contains new and useful reference materials for researchers. The problem sets range from the tutorial to exploratory and, at times, to "the impossible". The projects were collected from research results and computational dilemmas during the authors tenure as Chief Scientist at NeXT Computer, and from his lectures at Reed College. The content assumes familiarity with such college topics as calculus, differential equations, and at least elementary programming. Each project focuses on computation, theory, graphics, or a combination of these, and is designed with an estimated level of difficulty. The support code for each takes the form of either C or Mathematica, and is included in the appendix and on the bundled diskette. The algorithms are clearly laid out within the projects, such that the book may be used with other symbolic numerical and algebraic manipulation products This is an introductory single-term numerical analysis text with a modern scientific computing flavor. It offers an immediate immersion in numerical methods featuring an up-to-date approach to computational matrix algebra and an emphasis on methods used in actual software packages, always highlighting how hardware concerns can impact the choice of algorithm. It fills the need for a text that is mathematical enough for a numerical analysis course yet applied enough for students of science and engineering taking it with practical need in mind. The standard methods of numerical analysis are rigorously derived with results stated carefully and many proven. But while this is the focus, topics such as parallel implementations, the Basic Linear Algebra Subroutines, halfto quadruple-precision computing, and other practical matters are frequently discussed as well. Prior computing experience is not assumed. Optional MATLAB subsections for each section provide a comprehensive self-taught tutorial and also allow students to engage in numerical experiments with the methods they have just read about. The text may also be used with other computing environments. This new edition offers a complete and thorough update. Parallel approaches, emerging hardware capabilities, computational modeling, and data science are given greater weight. This book covers an interdisciplinary approach for understanding mathematical modeling by offering a collection of models, solved problems related to the models, the methodologies employed, and the results using projects and case studies with insight into the operation of substantial real-time systems. The book covers a broad scope in the areas of statistical science, probability, stochastic processes, fluid dynamics, supply chain, optimization, and applications. It discusses advanced topics and the latest research findings, uses an interdisciplinary approach for real-time systems, offers a platform for integrated research, and identifies the gaps in the field for further research. The book is for researchers, students, and teachers that share a goal of learning advanced topics and the latest research in mathematical modeling. The notion of complexity is an important contribution of logic to theoretical computer science and mathematics. This volume attempts to approach complexity in a holistic way, investigating mathematical properties of complexity hierarchies at the same time as discussing algorithms and computational properties. A main focus of the volume is on some of the new paradigms of computation, among them Quantum Computing and Infinitary Computation. The papers in the volume are tied together by an introductory article describing abstract properties of complexity hierarchies. This volume will be of great interest to both mathematical logicians and theoretical computer scientists, providing them with new insights into the various views of complexity and thus shedding new light on their own research. This textbook is uniquely written with dual purpose. It cover cores material in the foundations of computing for graduate students in computer science and also provides an introduction to some more advanced topics for those intending further study in the area. This innovative text focuses primarily on computational complexity theory: the classification of computational problems in terms of their inherent complexity. The book contains an invaluable collection of lectures for first-year graduates on the theory of computation. Topics and features include more than 40 lectures for first year graduate students, and a dozen homework sets and exercises.

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