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Computation, Proof, Machine Computation, Proof, Machine Computation, Proof, Machine Mathematics for Machine Learning Book of Proof Machine Proofs in Geometry Explanation and Proof in Mathematics Discrete Mathematics - Proof Techniques And Mathematical Structures Discrete Mathematics with Proof The Story of Proof Lectures on the Philosophy of Mathematics New Directions in the Philosophy of Mathematics Brains, Machines, and Mathematics Good Math Proof And Computation: Digitization In Mathematics, Computer Science And Philosophy Kurt Gödel and the Foundations of Mathematics Mathematics for Computer Science Mathematics in Computing Proof Technology in Mathematics Research and Teaching Philosophy of Mathematics Guide to Discrete Mathematics Analysis: A Gateway To Understanding Mathematics Mechanizing Proof What Is Mathematics, Really? A Reflection on Sraffa's Revolution in Economic Theory From Mathematics to Philosophy (Routledge Revivals) Proof And Computation Ii: From Proof Theory And Univalent Mathematics To Program Extraction And Verification Interdisciplinary Perspectives on Math Cognition Uses of Technology in Primary and Secondary Mathematics Education Intelligent Computer Mathematics Mathematics (Education) in the Information Age Roads to Infinity Kernel Methods for Machine Learning with Math and R Excursions in the History of Mathematics Mathematical Intelligence Automated Deduction - CADE-25 Fundamental Proof Methods in Computer Science Kernel Methods for Machine Learning with Math and Python Three Views of Logic Studying Mathematics

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 proof theory, constructive mathematics and type theory, univalent mathematics and point-free approaches to topology, extraction of certified programs from proofs, automated proofs in the automotive industry, as well as the philosophical and historical background of proof theory. 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. A Trusted Guide to Discrete Mathematics with Proof?Now in a Newly Revised Edition Discrete mathematics has become increasingly popular in recent years due to its growing applications in the field of computer science. Discrete Mathematics with Proof, Second Edition continues to facilitate an up-to-date understanding of this important topic, exposing readers to a wide range of modern and technological applications. The book begins with an introductory chapter that provides an accessible explanation of discrete mathematics. Subsequent chapters explore additional related topics including counting, finite probability theory, recursion, formal models in computer science, graph theory, trees, the concepts of functions, and relations. Additional features of the Second Edition include: An intense focus on the formal settings of proofs and their techniques, such as constructive proofs, proof by contradiction, and combinatorial proofs New sections on applications of elementary number theory, multidimensional induction, counting tulips, and the binomial distribution Important examples from the field of computer science presented as applications including the Halting problem, Shannon's mathematical model of information, regular expressions, XML, and Normal Forms in relational databases Numerous examples that are not often found in books on discrete mathematics including the deferred acceptance algorithm, the Boyer-Moore algorithm for pattern matching, Sierpinski curves, adaptive quadrature, the Josephus problem, and the five-color theorem Extensive appendices that outline supplemental material on analyzing claims and writing mathematics, along with solutions to selected chapter exercises Combinatorics receives a full chapter treatment that extends beyond the combinations and permutations material by delving into non-standard topics such as Latin squares, finite projective planes, balanced incomplete block designs, coding theory, partitions, occupancy problems, Stirling numbers, Ramsey numbers, and systems of distinct representatives. A related Web site features animations and visualizations of combinatorial proofs that assist readers with comprehension. In addition, approximately 500 examples and over 2,800 exercises are presented throughout the book to motivate ideas and illustrate the proofs and conclusions of theorems. Assuming only a basic background in calculus, Discrete Mathematics with Proof, Second Edition is an excellent book for mathematics and computer science courses at the undergraduate level. It is also a valuable resource for professionals in various technical fields who would like an introduction to discrete mathematics. 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 This book brings together ideas from experts in cognitive science, mathematics, and mathematics education to discuss these issues and to present research on how mathematics and its learning and teaching are evolving in the Information Age. Given the ever-broadening trends in Artificial Intelligence and the processing of information generally, the aim is to assess their implications for how math is evolving and how math should now be taught to a generation that has been reared in the Information Age. It will also look at the ever-spreading assumption that human intelligence may not be unique—an idea that dovetails with current philosophies of mind such as posthumanism and transhumanism. The role of technology in human evolution has become critical in the contemporary world. Therefore, a subgoal of this book is to illuminate how humans now use their sophisticated technologies to chart cognitive and social progress. Given the interdisciplinary nature of the chapters, this will be of interest to all kinds of readers, from mathematicians themselves working increasingly with computer scientists, to cognitive scientists who carry out research on mathematics cognition and teachers of mathematics in a classroom. An introduction to the philosophy of mathematics grounded in mathematics and motivated by mathematical inquiry and practice. In this book, Joel David Hamkins offers an introduction to the philosophy of mathematics that is grounded in mathematics and motivated by mathematical inquiry and practice. He treats philosophical issues as they arise organically in mathematics, discussing such topics as platonism, realism, logicism, structuralism, formalism, infinity, and intuitionism in mathematical contexts. He organizes the book by mathematical themes--numbers, rigor, geometry, proof, computability, incompleteness, and set theory--that give rise again and again to philosophical considerations. This book offers an introduction to mathematical proofs and to the fundamentals of modern mathematics. No real prerequisites are needed other than a suitable level of mathematical maturity. The text is divided into two parts, the first of which constitutes the core of a one-semester course covering proofs, predicate calculus, set theory, elementary number theory, relations, and functions, and the second of which applies this material to a more advanced study of selected topics in pure mathematics, applied mathematics, and computer science, specifically cardinality, combinatorics, finite-state automata, and graphs. In both parts, deeper and more interesting material is treated in optional sections, and the text has been kept flexible by allowing many different possible courses or emphases based upon different paths through the volume. Most philosophers of mathematics treat it as isolated, timeless, ahistorical, inhuman. Reuben Hersh argues the contrary, that mathematics must be understood as a human activity, a social phenomenon, part of human culture, historically evolved, and intelligible only in a social context. Hersh pulls the screen back to reveal mathematics as seen by professionals, debunking many mathematical myths, and demonstrating how the "humanist" idea of the nature of mathematics more closely resembles how mathematicians actually work. At the heart of his book is a fascinating historical account of the mainstream of philosophy--ranging from Pythagoras, Descartes, and Spinoza, to Bertrand Russell, David Hilbert, and Rudolph Carnap--followed by the mavericks who saw mathematics as a human artifact, including Aristotle, Locke, Hume, Mill, and Lakatos. What is Mathematics, Really? reflects an insider's view of mathematical life, and will be hotly debated by anyone with an interest in mathematics or the philosophy of science. This book presents a substantial collection of essays from a wide range of well respected scholars addressing several aspects of Piero Sraffa's economics in light of continuing controversies over the interpretation that should be placed on his work. It moves beyond extant scholarship with an added emphasis on the philosophical dimension of Sraffa's seminal work, Production of Commodities by Means of Commodities. Contributors probe new ways of thinking about the political economy of Sraffa and in doing so, alongside the comments to each contribution by other scholars, provide a cutting edge debate and discussion on non-mainstream economic theory. This book will be of interest to academics and advanced graduate students in economics, with additional interest from scholars in philosophy and the methodology of science. The most crucial ability for machine learning and data science is mathematical logic for grasping their essence rather than relying on knowledge or experience. This textbook addresses the fundamentals of kernel methods for machine learning by considering relevant math problems and building R programs. The books main features are as follows: The content is written in an easy-to-follow and self-contained style. The book includes 100 exercises, which have been carefully selected and refined. As their solutions are provided in the main text, readers can solve all of the exercises by reading the book. The mathematical premises of kernels are proven and the correct conclusions are provided, helping readers to understand the nature of kernels. Source programs and running examples are presented to help readers acquire a deeper understanding of the mathematics used. Once readers have a basic understanding of the functional analysis topics covered in Chapter 2, the applications are discussed in the subsequent chapters. Here, no prior knowledge of mathematics is assumed. This book considers both the kernel for reproducing kernel Hilbert space (RKHS) and the kernel for the Gaussian process; a clear distinction is made between the two. Computation is revolutionizing our world, even the inner world of the 'pure' mathematician. Mathematical methods - especially the notion of proof - that have their roots in classical antiquity have seen a radical transformation since the 1970s, as successive advances have challenged the priority of reason over computation. Like many revolutions, this one comes from within. Computation, calculation, algorithms - all have played an important role in mathematical progress from the beginning - but behind the scenes, their contribution was obscured in the enduring mathematical literature. To understand the future of mathematics, this fascinating book returns to its past, tracing the hidden history that follows the thread of computation. Along the way it invites us to reconsider the dialog between mathematics and the natural sciences, as well as the relationship between mathematics and computer science. It also sheds new light on philosophical concepts, such as the notions of analytic and synthetic judgment. Finally, it brings us to the brink of the new age, in which machine intelligence offers new ways of solving mathematical problems previously inaccessible. This book is the 2007 winner of the Grand Prix de Philosophie de l'Académie Française. A fresh exploration into the 'human nature versus technology' argument, revealing an unexpected advantage that humans have over our future robot masters: we're actually good at mathematics. There's so much discussion about the threat posed by intelligent machines that it sometimes seems as though we should simply surrender to our robot overlords now. But Junaid Mubeen isn’t ready to throw in the towel just yet. As far as he is concerned, we have the creative edge over computers, because of a remarkable system of thought that humans have developed over the millennia. It’s familiar to us all, but often badly taught in schools and misrepresented in popular discourse—math. Computers are, of course, brilliant at totting up sums, pattern-seeking, and performing mindless tasks of, well, computation. For all things calculation, machines reign supreme. But Junaid identifies seven areas of intelligence where humans can retain a crucial edge. And in exploring these areas, he opens up a fascinating world where we can develop our uniquely human mathematical talents. Just a few of the fascinating subjects covered in MATHEMATICAL INTELLIGENCE include: -Humans are endowed with a natural sense of numbers that is based on approximation rather than precise calculation. Our in-built estimation skills complement the precision of computers. Interpreting the real world depends on both. -What sets humans apart from other animals is language and abstraction. We have an extraordinary ability to create powerful representations of knowledge— more diverse than the binary language of computers. -Mathematics confers the most robust, logical framework for establishing permanent truths. Reasoning shields us from the dubious claims of pure pattern-recognition systems. -All mathematical truths are derived from a starting set of assumptions, or axioms. Unlike computers, humans have the freedom to break free of convention and examine the logical consequences of our choices. Mathematics rewards our imagination with fascinating and, on occasion, applicable concepts that originate from breaking the rules. -Computers can be tasked to solve a range of problems, but which problems are worth the effort? Questioning is as vital to our repertoire of thinking skills as problem-solving itself. The fundamental mathematical tools needed to understand machine learning include linear algebra, analytic geometry, matrix decompositions, vector calculus, optimization, probability and statistics. These topics are traditionally taught in disparate courses, making it hard for data science or computer science students, or professionals, to efficiently learn the mathematics. This self-contained textbook bridges the gap between mathematical and machine learning texts, introducing the mathematical concepts with a minimum of prerequisites. It uses these concepts to derive four central machine learning methods: linear regression, principal component analysis, Gaussian mixture models and support vector machines. For students and others with a mathematical background, these derivations provide a starting point to machine learning texts. For those learning the mathematics for the first time, the methods help build intuition and practical experience with applying mathematical concepts. Every chapter includes worked examples and exercises to test understanding. Programming tutorials are offered on the book's web site. Mathematics is beautiful--and it can be fun and exciting as well as practical. Good Math is your guide to some of the most intriguing topics from two thousand years of mathematics: from Egyptian fractions to Turing machines; from the real meaning of numbers to proof trees, group symmetry, and mechanical computation. If you've ever wondered what lay beyond the proofs you struggled to complete in high school geometry, or what limits the capabilities of computer on your desk, this is the book for you. Why do Roman numerals persist? How do we know that some infinities are larger than others? And how can we know for certain a program will ever finish? In this fast-paced tour of modern and not-so-modern math, computer scientist Mark Chu-Carroll explores some of the greatest breakthroughs and disappointments of more than two thousand years of mathematical thought. There is joy and beauty in mathematics, and in more than two dozen essays drawn from his popular "Good Math" blog, you'll find concepts, proofs, and examples that are often surprising, counterintuitive, or just plain weird. Mark begins his journey with the basics of numbers, with an entertaining trip through the integers and the natural, rational, irrational, and transcendental numbers. The voyage continues with a look at some of the oddest numbers in mathematics, including zero, the golden ratio, imaginary numbers, Roman numerals, and Egyptian and continuing fractions. After a deep dive into modern logic, including an introduction to linear logic and the logic-savvy Prolog language, the trip concludes with a tour of modern set theory and the advances and paradoxes of modern mechanical computing. If your high school or college math courses left you grasping for the inner meaning behind the numbers, Mark's book will both entertain and enlighten you. This illuminating textbook provides a concise review of the core concepts in mathematics essential to computer scientists. Emphasis is placed on the practical computing applications enabled by seemingly abstract mathematical ideas, presented within their historical context. The text spans a broad selection of key topics, ranging from the use of finite field theory to correct code and the role of number theory in cryptography, to the value of graph theory when modelling networks and the importance of formal methods for safety critical systems. This fully updated new edition has been expanded with a more comprehensive treatment of algorithms, logic, automata theory, model checking, software reliability and dependability, algebra, sequences and series, and mathematical induction. Topics and features: includes numerous pedagogical features, such as chapter-opening key topics, chapter introductions and summaries, review questions, and a glossary; describes the historical contributions of such prominent figures as Leibniz, Babbage, Boole, and von Neumann; introduces the fundamental mathematical concepts of sets, relations and functions, along with the basics of number theory, algebra, algorithms, and matrices; explores arithmetic and geometric sequences and series, mathematical induction and recursion, graph theory, computability and decidability, and automata theory; reviews the core issues of coding theory, language theory, software engineering, and software reliability, as well as formal methods and model checking; covers key topics on logic, from ancient Greek contributions to modern applications in AI, and discusses the nature of mathematical proof and theorem proving; presents a short introduction to probability and statistics, complex numbers and quaternions, and calculus. This engaging and easy-to-understand book will appeal to students of computer science wishing for an overview of the mathematics used in computing, and to mathematicians curious about how their subject is applied in the field of computer science. The book will also capture the interest of the motivated general reader. The first interdisciplinary textbook to introduce students to three critical areas in applied logic Demonstrating the different roles that logic plays in the disciplines of computer science, mathematics, and philosophy, this concise undergraduate textbook covers select topics from three different areas of logic: proof theory, computability theory, and nonclassical logic. The book balances accessibility, breadth, and rigor, and is designed so that its materials will fit into a single semester. Its distinctive presentation of traditional logic material will enhance readers' capabilities and mathematical maturity. The proof theory portion presents classical propositional logic and first-order logic using a computer-oriented (resolution) formal system. Linear resolution and its connection to the programming language Prolog are also treated. The computability component offers a machine model and mathematical model for computation, proves the equivalence of the two approaches, and includes famous decision problems unsolvable by an algorithm. The section on nonclassical logic discusses the shortcomings of classical logic in its treatment of implication and an alternate approach that improves upon it: Anderson and Belnap's relevance logic. Applications are included in each section. The material on a four-valued semantics for relevance logic is presented in textbook form for the first time. Aimed at upper-level undergraduates of moderate analytical background, Three Views of Logic will be useful in a variety of classroom settings. Gives an exceptionally broad view of logic Treats traditional logic in a modern format Presents relevance logic with applications Provides an ideal text for a variety of one-semester upper-level undergraduate courses This volume commemorates the life, work and foundational views of Kurt Gödel (1906–78), most famous for his hallmark works on the completeness of first-order logic, the incompleteness of number theory, and the consistency - with the other widely accepted axioms of set theory - of the axiom of choice and of the generalized continuum hypothesis. It explores current research, advances and ideas for future directions not only in the foundations of mathematics and logic, but also in the fields of computer science, artificial intelligence, physics, cosmology, philosophy, theology and the history of science. The discussion is supplemented by personal reflections from several scholars who knew Gödel personally, providing some interesting insights into his life. By putting his ideas and life's work into the context of current thinking and perceptions, this book will extend the impact of Gödel's fundamental work in mathematics, logic, philosophy and other disciplines for future generations of researchers. First published in 1974. Despite the tendency of contemporary analytic philosophy to put logic and mathematics at a central position, the author argues it failed to appreciate or account for their rich content. Through discussions of such mathematical concepts as number, the continuum, set, proof and mechanical procedure, the author provides an introduction to the philosophy of mathematics and an internal criticism of the then current academic philosophy. The material presented is also an illustration of a new, more general method of approach called substantial factualism which the author asserts allows for the development of a more comprehensive philosophical position by not trivialising or distorting substantial facts of human knowledge. This is an anthology of contemporary studies from various disciplinary perspectives written by some of the world's most renowned experts in each of the areas of mathematics, neuroscience, psychology, linguistics, semiotics, education, and more. Its purpose is not to add merely to the accumulation of studies, but to show that math cognition is best approached from various disciplinary angles, with the goal of broadening the general understanding of mathematical cognition through the different theoretical threads that can be woven into an overall understanding. This volume will be of interest to mathematicians, cognitive scientists, educators of mathematics, philosophers of mathematics, semioticians, psychologists, linguists, anthropologists, and all other kinds of scholars who are interested in the nature, origin, and development of mathematical cognition. This stimulating textbook presents a broad and accessible guide to the fundamentals of discrete mathematics, highlighting how the techniques may be applied to various exciting areas in computing. The text is designed to motivate and inspire the reader, encouraging further study in this important skill. Features: This book provides an introduction to the building blocks of discrete mathematics, including sets, relations and functions; describes the basics of number theory, the techniques of induction and recursion, and the applications of mathematical sequences, series, permutations, and combinations; presents the essentials of algebra; explains the fundamentals of automata theory, matrices, graph theory, cryptography, coding theory, language theory, and the concepts of computability and decidability; reviews the history of logic, discussing propositional and predicate logic, as well as advanced topics such as the nature of theorem proving; examines the field of software engineering, including software reliability and dependability and describes formal methods; investigates probability and statistics and presents an overview of operations research and financial mathematics. This book covers elementary discrete mathematics for computer science and engineering. It emphasizes mathematical definitions and proofs as well as applicable methods. Topics include formal logic notation, proof methods; induction, well-ordering; sets, relations; elementary graph theory; integer congruences; asymptotic notation and growth of functions; permutations and combinations, counting principles; discrete probability. Further selected topics may also be covered, such as recursive definition and structural induction; state machines and invariants; recurrences; generating functions. Computation, calculation, algorithms - all have played an important role in mathematical progress from the beginning - but behind the scenes, their contribution was obscured in the enduring mathematical literature. To understand the future of mathematics, this fascinating book returns to its past, tracing the hidden history that follows the thread of computation. This book is an introduction to the language and standard proof methods of mathematics. It is a bridge from the computational courses (such as calculus or differential equations) that students typically encounter in their first year of college to a more abstract outlook. It lays a foundation for more theoretical courses such as topology, analysis and abstract algebra. Although it may be more meaningful to the student who has had some calculus, there is really no prerequisite other than a measure of mathematical maturity. The most crucial ability for machine learning and data science is mathematical logic for grasping their essence rather than relying on knowledge or experience. This textbook addresses the fundamentals of kernel methods for machine learning by considering relevant math problems and building Python programs. The book's main features are as follows: The content is written in an easy-to-follow and self-contained style. The book includes 100 exercises, which have been carefully selected and refined. As their solutions are provided in the main text, readers can solve all of the exercises by reading the book. The mathematical premises of kernels are proven and the correct conclusions are provided, helping readers to understand the nature of kernels. Source programs and running examples are presented to help readers acquire a deeper understanding of the mathematics used. Once readers have a basic understanding of the functional analysis topics covered in Chapter 2, the applications are discussed in the subsequent chapters. Here, no prior knowledge of mathematics is assumed. This book considers both the kernel for reproducing kernel Hilbert space (RKHS) and the kernel for the Gaussian process; a clear distinction is made between the two. This book shows that it is possible to provide a fully rigorous treatment of calculus for those planning a career in an area that uses mathematics regularly (e.g., statistics, mathematics, economics, finance, engineering, etc.). It reveals to students on the ways to approach and understand mathematics. It covers efficiently and rigorously the differential and integral calculus, and its foundations in mathematical analysis. It also aims at a comprehensive, efficient, and rigorous treatment by introducing all the concepts succinctly. Experience has shown that this approach, which treats understanding on par with technical ability, has long term benefits for students. This book presents chapters exploring the most recent developments in the role of technology in proving. The full range of topics related to this theme are explored, including computer proving, digital collaboration among mathematicians, mathematics teaching in schools and universities, and the use of the internet as a site of proof learning. Proving is sometimes thought to be the aspect of mathematical activity most resistant to the influence of technological change. While computational methods are well known to have a huge importance in applied mathematics, there is a perception that mathematicians seeking to derive new mathematical results are unaffected by the digital era. The reality is quite different. Digital technologies have transformed how mathematicians work together, how proof is taught in schools and universities, and even the nature of proof itself. Checking billions of cases in extremely large but finite sets, impossible a few decades ago, has now become a standard method of proof. Distributed proving, by teams of mathematicians working independently on sections of a problem, has become very much easier as digital communication facilitates the sharing and comparison of results. Proof assistants and dynamic proof environments have influenced the verification or refutation of conjectures, and ultimately how and why proof is taught in schools. And techniques from computer science for checking the validity of programs are being used to verify mathematical proofs. Chapters in this book include not only research reports and case studies, but also theoretical essays, reviews of the state of the art in selected areas, and historical studies. The authors are experts in the field. How the concept of proof has enabled the creation of mathematical knowledge The Story of Proof investigates the evolution of the concept of proof—one of the most significant and defining features of mathematical thought—through critical episodes in its history. From the Pythagorean theorem to modern times, and across all major mathematical disciplines, John Stillwell demonstrates that proof is a mathematically vital concept, inspiring innovation and playing a critical role in generating knowledge. Stillwell begins with Euclid and his influence on the development of geometry and its methods of proof, followed by algebra, which began as a self-contained discipline but later came to rival geometry in its mathematical impact. In particular, the infinite processes of calculus were at first viewed as “infinitesimal algebra,” and calculus became an arena for algebraic, computational proofs rather than axiomatic proofs in the style of Euclid. Stillwell proceeds to the areas of number theory, non-Euclidean geometry, topology, and logic, and peers into the deep chasm between natural number arithmetic and the real numbers. In its depths, Cantor, Gödel, Turing, and others found that the concept of proof is ultimately part of arithmetic. This startling fact imposes fundamental limits on what theorems can be proved and what problems can be solved. Shedding light on the workings of mathematics at its most fundamental levels, The Story of Proof offers a compelling new perspective on the field’s power and progress. This book provides international perspectives on the use of digital technologies in primary, lower secondary and upper secondary school mathematics. It gathers contributions by the members of three topic study groups from the 13th International Congress on Mathematical Education and covers a range of themes that will appeal to researchers and practitioners alike. The chapters include studies on technologies such as virtual manipulatives, apps, custom-built assessment tools, dynamic geometry, computer algebra systems and communication tools. Chiefly focusing on teaching and learning mathematics, the book also includes two chapters that address the evidence for technologies’ effects on school mathematics. The diverse technologies considered provide a broad overview of the potential that digital solutions hold in connection with teaching and learning. The chapters provide both a snapshot of the status quo of technologies in school mathematics, and outline how they might impact school mathematics ten to twenty years from now. This is a book whose time has come-again. The first edition (published by McGraw-Hill in 1964) was written in 1962, and it celebrated a number of approaches to developing an automata theory that could provide insights into the processing of information in brainlike machines, making it accessible to readers with no more than a college freshman's knowledge of mathematics. The book introduced many readers to aspects of cybernetics-the study of computation and control in animal and machine. But by the mid-1960s, many workers abandoned the integrated study of brains and machines to pursue artificial intelligence (AI) as an end in itself-the programming of computers to exhibit some aspects of human intelligence, but with the emphasis on achieving some benchmark of performance rather than on capturing the mechanisms by which humans were themselves intelligent. Some workers tried to use concepts from AI to model human cognition using computer programs, but were so dominated by the metaphor "the mind is a computer" that many argued that the mind must share with the computers of the 1960s the property of being serial, of executing a series of operations one at a time. As the 1960s became the 1970s, this trend continued. Meanwhile, experi mental neuroscience saw an exploration of new data on the anatomy and physiology of neural circuitry, but little of this research placed these circuits in the context of overall behavior, and little was informed by theoretical con cepts beyond feedback mechanisms and feature detectors. This book constitutes the joint refereed proceedings of the 10th International Conference on Artificial Intelligence and Symbolic Computation, AISC 2010, the 17th Symposium on the Integration of Symbolic Computation and Mechanized Reasoning, Calculemus 2010, and the 9th International Conference on Mathematical Knowledge Management, MKM 2010. All submissions passed through a rigorous review process. From the 25 papers submitted to AISC 2010, 9 were selected for presentation at the conference and inclusion in the proceedings volume. A total of 14 papers were submitted to Calculemus, of which 7 were accepted. MKM 2010 received 27 submissions, of which 16 were accepted for presentation and publication. The events focused on the use of AI techniques within symbolic computation and the application of symbolic computation to AI problem solving; the combination of computer algebra systems and automated deduction systems; and mathematical knowledge management, respectively. Offers an introduction to modern ideas about infinity and their implications for mathematics. It unifies ideas from set theory and mathematical logic, and traces their effects on mainstream mathematical topics of today, such as number theory and combinatorics.--From publisher description. This book is dedicated to preparing prospective college students for the study of mathematics. It can be used at the end of high school or during the first year of college, for personal study or for introductory courses. It aims to set a meeting between two relatives who rarely speak to each other: the Mathematics of Beauty, which shows up in some popular books and films, and the Mathematics of Toil, which is widely known. Toil can be overcome through an appropriate method of work. Beauty will be found in the achievement of a way of thinking. The first part concerns the mathematical language: the expressions “for all”, “there exists”, “implies”, “is false”, ...; what is a proof by contradiction; how to use indices, sums, induction. The second part tackles specific difficulties: to study a definition, to understand an idea and apply it, to fix a slightly wrong argument, to discuss suggestions, to explain a proof. The third part presents customary techniques and points of view in college mathematics. The reader can choose one of three difficulty levels (A, B, C). A textbook that teaches students to read and write proofs using Athena. Proof is the primary vehicle for knowledge generation in mathematics. In computer science, proof has found an additional use: verifying that a particular system (or component, or algorithm) has certain desirable properties. This book teaches students how to read and write proofs using Athena, a freely downloadable computer language. Athena proofs are machine-checkable and written in an intuitive natural-deduction style. The book contains more than 300 exercises, most with full solutions. By putting proofs into practice, it demonstrates the fundamental role of logic and proof in computer science as no other existing text does. Guided by examples and exercises, students are quickly immersed in the most useful high-level proof methods, including equational reasoning, several forms of induction, case analysis, proof by contradiction, and abstraction/specialization. The book includes auxiliary material on SAT and SMT solving, automated theorem proving, and logic programming. The book can be used by upper undergraduate or graduate computer science students with a basic level of programming and mathematical experience. Professional programmers, practitioners of formal methods, and researchers in logic-related branches of computer science will find it a valuable reference. In the four decades since Imre Lakatos declared mathematics a "quasi-empirical science," increasing attention has been paid to the process of proof and argumentation in the field -- a development paralleled by the rise of computer technology and the mounting interest in the logical underpinnings of mathematics. Explanantion and Proof in Mathematics assembles perspectives from mathematics education and from the philosophy and history of mathematics to strengthen mutual awareness and share recent findings and advances in their interrelated fields. With examples ranging from the geometrists of the 17th century and ancient Chinese algorithms to cognitive psychology and current educational practice, contributors explore the role of refutation in generating proofs, the varied links between experiment and deduction, the use of diagrammatic thinking in addition to pure logic, and the uses of proof in mathematics education (including a critique of "authoritative" versus "authoritarian" teaching styles). A sampling of the coverage: The conjoint origins of proof and theoretical physics in ancient Greece. Proof as bearers of mathematical knowledge. Bridging knowing and proving in mathematical reasoning. The role of mathematics in long-term cognitive development of reasoning. Proof as experiment in the work of Wittgenstein. Relationships between mathematical proof, problem-solving, and explanation. Explanation and Proof in Mathematics is certain to attract a wide range of readers, including mathematicians, mathematics education professionals, researchers, students, and philosophers and historians of mathematics. The traditional debate among philosophers of mathematics is whether there is an external mathematical reality, something out there to be discovered, or whether mathematics is the product of the human mind. This provocative book, now available in a revised and expanded paperback edition, goes beyond foundationalist questions to offer what has been called a "postmodern" assessment of the philosophy of mathematics--one that addresses issues of theoretical importance in terms of mathematical experience. By bringing together essays of leading philosophers, mathematicians, logicians, and computer scientists, Thomas Tymoczko reveals an evolving effort to account for the nature of mathematics in relation to other human activities. These accounts include such topics as the history of mathematics as a field of study, predictions about how computers will influence the future organization of mathematics, and what processes a proof undergoes before it reaches publishable form. This expanded edition now contains essays by Penelope Maddy, Michael D.

Resnik, and William P. Thurston that address the nature of mathematical proofs. The editor has provided a new afterword and a supplemental bibliography of recent work. This book reports recent major advances in automated reasoning in geometry. The authors have developed a method and implemented a computer program which, for the first time, produces short and readable proofs for hundreds of geometry theorems.The book begins with chapters introducing the method at an elementary level, which are accessible to high school students; latter chapters concentrate on the main theme: the algorithms and computer implementation of the method.This book brings researchers in artificial intelligence, computer science and mathematics to a new research frontier of automated geometry reasoning. In addition, it can be used as a supplementary geometry textbook for students, teachers and geometers. By presenting a systematic way of proving geometry theorems, it makes the learning and teaching of geometry easier and may change the way of geometry education. Most aspects of our private and social lives—our safety, the integrity of the financial system, the functioning of utilities and other services, and national security—now depend on computing. But how can we know that this computing is trustworthy? In Mechanizing Proof, Donald MacKenzie addresses this key issue by investigating the interrelations of computing, risk, and mathematical proof over the last half century from the perspectives of history and sociology. His discussion draws on the technical literature of computer science and artificial intelligence and on extensive interviews with participants. MacKenzie argues that our culture now contains two ideals of proof: proof as traditionally conducted by human mathematicians, and formal, mechanized proof. He describes the systems constructed by those committed to the latter ideal and the many questions those systems raise about the nature of proof. He looks at the primary social influence on the development of automated proof—the need to predict the behavior of the computer systems upon which human life and security depend—and explores the involvement of powerful organizations such as the National Security Agency. He concludes that in mechanizing proof, and in pursuing dependable computer systems, we do not obviate the need for trust in our collective human judgment. This book comprises five parts. The first three contain ten historical essays on important topics: number theory, calculus/analysis, and proof, respectively. Part four deals with several historically oriented courses, and Part five provides biographies of five mathematicians who played major roles in the historical events described in the first four parts of the work. Excursions in the History of Mathematics was written with several goals in mind: to arouse mathematics teachers' interest in the history of their subject; to encourage mathematics teachers with at least some knowledge of the history of mathematics to offer courses with a strong historical component; and to provide an historical perspective on a number of basic topics taught in mathematics courses. One of the most striking features of mathematics is the fact that we are much more certain about the mathematical knowledge we have than about what mathematical knowledge is knowledge of. Are numbers, sets, functions and groups physical entities of some kind? Are they objectively existing objects in some non-physical, mathematical realm? Are they ideas that are present only in the mind? Or do mathematical truths not involve referents of any kind? It is these kinds of questions that have encouraged philosophers and mathematicians alike to focus their attention on issues in the philosophy of mathematics. Over the centuries a number of reasonably well-defined positions about the nature of mathematics have been developed and it is these positions (both historical and current) that are surveyed in the current volume. Traditional theories (Platonism, Aristotelianism, Kantianism), as well as dominant modern theories (logicism, formalism, constructivism, fictionalism, etc.), are all analyzed and evaluated. Leading-edge research in related fields (set theory, computability theory, probability theory, paraconsistency) is also discussed. The result is a handbook that not only provides a comprehensive overview of recent developments but that also serves as an indispensable resource for anyone wanting to learn about current developments in the philosophy of mathematics. -Comprehensive coverage of all main theories in the philosophy of mathematics -Clearly written expositions of fundamental ideas and concepts -Definitive discussions by leading researchers in the field -Summaries of leading-edge research in related fields (set theory, computability theory, probability theory, paraconsistency) are also included This book constitutes the proceedings of the 25th International Conference on Automated Deduction, CADE-25, held in Berlin, Germany, in August 2015. The 36 revised full papers presented (24 full papers and 12 system descriptions) were carefully reviewed and selected from 85 submissions. CADE is the major forum for the presentation of research in all aspects of automated deduction, including foundations, applications, implementations and practical experience.