Logical Foundations Of Mathematics And Computational Complexity A Gentle Introduction Springer Monographs In Mathematics

This book constitutes the refereed proceedings of the International Symposium on Logical Foundations of Computer Science, LFCS 2020, held in Deerfield Beach, FL, USA, in January 2020. The 17 revised full papers were carefully reviewed and selected from 30 submissions. The scope of the Symposium is broad and includes constructive mathematics and type theory; homotopy type theory; logic, automata, and automatic structures; computability and randomness; logical foundations of programming; logical aspects of computational complexity; parameterized complexity; logic programming and constraints; automated deduction and interactive theorem proving; logical methods in protocol and program verification; logical methods in program specification and extraction; domain theory logics; logical foundations of database theory; equational logic and term rewriting; lambda and combinatory calculi; categorical logic and topological semantics; linear logic; epistemic and temporal logics; intelligent and multiple-agent system logics; logics of proof and justification; non-monotonic reasoning; logic in game theory and social software; logic of hybrid systems; distributed system logics; mathematical fuzzy logic; system design logics; other logics in computer science.

Collection of works by Frank Plumpton Ramsey (1903-1930), who made seminal contributions to philosophy, mathematics and economics. Whilst he was acknowledged as a genius by his contemporaries, some of his most important ideas were not appreciated until decades later; now better appreciated, they continue to bear an influence upon contemporary philosophy. His historic significance was to usher in a new phase of analytic philosophy, which initially built upon the logical atomist doctrines of Bertrand Russell and Ludwig Wittgenstein, raising their ideas to a new level of sophistication, but ultimately he became their successor rather than remain a mere acolyte.

Mathematical logic is a branch of mathematics that takes axiom systems and mathematical proofs as its objects of study. This book shows how it can also provide a foundation for the development of information science and technology. The first five chapters systematically present the core topics of classical mathematical logic, including the syntax and models of first-order languages, formal inference systems, computability and representability, and Gödel's theorems. The last five chapters present extensions and developments of classical mathematical logic, particularly the concepts of version sequences of formal theories and their limits, the system of revision calculus, proschemes (formal descriptions of proof methods and strategies) and their properties, and the theory of inductive inference. All of these themes contribute to a formal theory of axiomatization and its application to the process of developing information technology and scientific theories. The book also describes the paradigm of three kinds of language environments for theories and it presents the basic properties required of a meta-language environment. Finally, the book brings these themes together by describing a workflow for scientific research in the information era in which formal methods, interactive software and human invention are all used to their advantage. The second edition of the book includes major revisions on the proof of the completeness theorem of the Gentzen system and new contents on the logic of scientific discovery, R-calculus without cut, and the operational semantics of program debugging. This book represents a valuable reference for graduate and undergraduate students and researchers in mathematics, information science and technology, and other relevant areas of natural sciences. Its first five chapters serve as an undergraduate text in mathematical logic and the last five chapters are addressed to graduate students in relevant disciplines.

This volume contains the proceedings of the conference Logical Foundations of Mathematics,

Computer Science, and Physics-Kurt Gödel's Legacy, held in Brno, Czech Republic on the 90th anniversary of his birth. The wide and continuing importance of Gödel s work in the logical foundations of mathematics, computer science, and physics is confirmed by the broad range of speakers who participated in making this gathering a scientific event.

Cyber-physical systems (CPSs) combine cyber capabilities, such as computation or communication, with physical capabilities, such as motion or other physical processes. Cars, aircraft, and robots are prime examples, because they move physically in space in a way that is determined by discrete computerized control algorithms. Designing these algorithms is challenging due to their tight coupling with physical behavior, while it is vital that these algorithms be correct because we rely on them for safety-critical tasks. This textbook teaches undergraduate students the core principles behind CPSs. It shows them how to develop models and controls; identify safety specifications and critical properties; reason rigorously about CPS models; leverage multi-dynamical systems compositionality to tame CPS complexity; identify required control constraints; verify CPS models of appropriate scale in logic; and develop an intuition for operational effects. The book is supported with homework exercises, lecture videos, and slides.

First-order logic. The origin of modern foundational studies. Frege's system and the paradoxes. The teory of types. Zermelo-Fraenkel set theory. Hilbert's program and Godel's incompleteness theorems. The foundational systems of W.V. Quine. Categorical algebra.

Philosophical Approaches to the Foundations of Logic and Mathematics consists of eleven articles addressing various aspects of the "roots" of logic and mathematics, their basic concepts and the mechanisms that work in the practice of their use.

This is a proceedings volume of the conference celebrating the 90th anniversary of the birth of Kurt Goedel. The conference has been recognized as an ASL sponsored meeting. Invited papers and contributed papers concern mainly mathematical logic but also philosophy of mathematics, computer science and physics and are devoted to topics related to Goedel's work and reflect the present state of knowledge domains deeply influenced by Goedel.

The transition from school mathematics to university mathematics is seldom straightforward. Students are faced with a disconnect between the algorithmic and informal attitude to mathematics at school, versus a new emphasis on proof, based on logic, and a more abstract development of general concepts, based on set theory. The authors have many years' experience of the potential difficulties involved, through teaching first-year undergraduates and researching the ways in which students and mathematicians think. The book explains the motivation behind abstract foundational material based on students' experiences of school mathematics, and explicitly suggests ways students can make sense of formal ideas. This second edition takes a significant step forward by not only making the transition from intuitive to formal methods, but also by reversing the process- using structure theorems to prove that formal systems have visual and symbolic interpretations that enhance mathematical thinking. This is exemplified by a new chapter on the theory of groups. While the first edition extended counting to infinite cardinal numbers, the second also extends the real numbers rigorously to larger ordered fields. This links intuitive ideas in calculus to the formal epsilon-delta methods of analysis. The approach here is not the conventional one of 'nonstandard analysis', but a simpler, graphically based treatment which makes the notion of an infinitesimal natural and straightforward. This allows a further vision of the wider world of mathematical thinking in which formal definitions and proof lead to amazing new ways of defining, proving, visualising and symbolising mathematics beyond previous expectations.

This book is a study in the logic of questions (sometimes called erotetic logic). The central topics in erotetic logic have been the structure of questions and the question-answer relationship. This book doesn't neglect these problems, but much of it is focussed on other issues. The main subject is the logical analysis of certain relations between questions and the

contexts of their appearance. And our aim is to elaborate the conceptual apparatus of the inferential approach to the logic of questions. Questions are asked for many reasons and for different purposes. Yet, before a question is asked or posed, a questioner must arrive at it. In many cases arriving at a question resembles coming to a conclusion: there are some premises involved and some inferential thought processes take place. If we agree that a conclusion need not be "conclusive", we may say that sometimes questions can play the role of conclusions. But questions can also perform the role of premises: we often pass from some "initial" question to another question. In other words, there are inferential thought processes - we shall call them erotetic inferences - in which questions play the roles of conclusions or conclusions and premises. The inferential approach to the logic of questions focusses its attention on the analysis of erotetic inferences. This book consists of eight chapters.

This volume examines the role of logic in cognitive psychology in light of recent developments, such as Gonzalo Reyes's new semantic theory. Chapters reveal the prospects of applying these new theories to cognitive psychology, cognitive science, linguistics, the philosophy of language and logic.

Part 1 ; Part 2: Demonstative inference; deductive and inductive ; Part 3: The logical foundations of science.

This SpringerBrief provides an interdisciplinary synthesis based on psychology, logic, mathematics, cognitive science, and the history of science. It presents psychology as a science that suffers from a reduced understanding of the most fundamental logic in our practical-bodily encounters with the world, including with our fellow human beings. The Brief offers a new “dual” logic that is based on the duality between identification and description of objects, including persons. The Brief ties in modern mathematics as a tool that can be used to catch this duality in a precise manner. Featured topics in this Brief include: The emergence of Mechanism. The duality in animal and human subject-object relations. Psychology’s compatibility with natural sciences. Four cornerstones of modern mathematics. The Extensional Method. A New Logical Foundation for Psychology will be of interest to psychologist, philosophers, and mathematicians concerned with basic theoretical and methodological problems.

The Symposium on Logical Foundations of Computer Science series provides a forum for the fast-growing body of work in the logical foundations of computer science, e.g., those areas of fundamental theoretical logic related to computer science. The LFCS series began with “Logic at Botik,” Pereslavl-Zalessky,1989, which was co-organized by Albert R. Meyer (MIT) and Michael Taitslin (Tver). After that, organization passed to Anil Nerode. Currently LFCS is governed by a Steering Committee consisting of Anil Nerode (General Chair), Stephen Cook, Dirk van Dalen, Yuri Matiyasevich, John McCarthy, J. Alan Robinson, Gerald Sacks, and Dana Scott. The 2009 Symposium on Logical Foundations of Computer Science (LFCS 2009) took place in Howard Johnson Plaza Resort, Deer?eld Beach, Florida, USA, during January 3–6. This volume contains the extended abstracts of talks selected by the Program Committee for presentation at LFCS 2009. The scope of the symposium is broad and contains constructive mathematics and type theory; automata and automatic structures; computability and r-domness; logical foundations of programming; logical aspects of computational complexity; logic programmingand constraints;automated deduction and int- active theorem proving; logical methods in protocol and program veri?cation; logical methods in program speci?cation and extraction; domain theory l- ics; logical foundations of database theory; equational logic and term rewriting; lambda andcombinatorycalculi;categoricallogicandtopologicalsemantics;l- ear logic; epistemic and temporal logics; intelligent and multiple agent system logics; logics of proof and justi?cation; nonmonotonic reasoning; logic in game theory and social software; logic of hybrid systems; distributed system logics;

Mathematical logic grew out of philosophical questions regarding the foundations of

mathematics, but logic has now outgrown its philosophical roots, and has become an integral part of mathematics in general. This book is designed for students who plan to specialize in logic, as well as for those who are interested in the applications of logic to other areas of mathematics. Used as a text, it could form the basis of a beginning graduate-level course. There are three main chapters: Set Theory, Model Theory, and Recursion Theory. The Set Theory chapter describes the set-theoretic foundations of all of mathematics, based on the ZFC axioms. It also covers technical results about the Axiom of Choice, well-orderings, and the theory of uncountable cardinals. The Model Theory chapter discusses predicate logic and formal proofs, and covers the Completeness, Compactness, and Lowenheim-Skolem Theorems, elementary submodels, model completeness, and applications to algebra. This chapter also continues the foundational issues begun in the set theory chapter. Mathematics can now be viewed as formal proofs from ZFC. Also, model theory leads to models of set theory. This includes a discussion of absoluteness, and an analysis of models such as H( ) and R( ). The Recursion Theory chapter develops some basic facts about computable functions, and uses them to prove a number of results of foundational importance; in particular, Church's theorem on the undecidability of logical consequence, the incompleteness theorems of Godel, and Tarski's theorem on the non-definability of truth.

This text for the first or second year undergraduate in mathematics, logic, computer science, or social sciences, introduces the reader to logic, proofs, sets, and number theory. It also serves as an excellent independent study reference and resource for instructors. Adapted from Foundations of Logic and Mathematics: Applications to Science and Cryptography © 2002 Birkh?user, this second edition provides a modern introduction to the foundations of logic, mathematics, and computers science, developing the theory that demonstrates construction of all mathematics and theoretical computer science from logic and set theory. The focuses is on foundations, with specific statements of all the associated axioms and rules of logic and set theory, and provides complete details and derivations of formal proofs. Copious references to literature that document historical development is also provided. Answers are found to many questions that usually remain unanswered: Why is the truth table for logical implication so unintuitive? Why are there no recipes to design proofs? Where do these numerous mathematical rules come from? What issues in logic, mathematics, and computer science still remain unresolved? And the perennial question: In what ways are we going to use this material? Additionally, the selection of topics presented reflects many major accomplishments from the twentieth century and includes applications in game theory and Nash's equilibrium, Gale and Shapley's match making algorithms, Arrow's Impossibility Theorem in voting, to name a few. From the reviews of the first edition: "...All the results are proved in full detail from first principles...remarkably, the arithmetic laws on the rational numbers are proved, step after step, starting from the very definitions!...This is a valuable reference text and a useful companion for anybody wondering how basic mathematical concepts can be rigorously developed within set theory." —MATHEMATICAL REVIEWS "Rigorous and modern in its theoretical aspect, attractive as a detective novel in its applied aspects, this paper book deserves the attention of both beginners and advanced students in mathematics, logic and computer sciences as well as in social sciences." —Zentralblatt MATH

This is the most extensive examination of Euclid's "Elements" in English since the last revision of T. L. Heath's monumental three-volume translation and commentary appeared over fifty years ago. While the present work augments and updates Heath's in the light of subsequent scholarship, its principal concern is to apply the resources of modern logic and philosophy of mathematics to the "Elements" in order to provide an understanding of the distinctively Greek conception of the foundations of mathematics.Mueller probes the internal logic and development of the "Elements, " giving a careful and full account of the independence and interdependence of its various books and of their mathematical and logical foundations. By

considering alternative paths Euclid might have followed he clarifies the motivations underlying Euclid's actual choices. The results of his analyses are encapsulated in analytic diagrams. Appendixes listing all the propositions and presuppositions of the "Elements" make it easy for a reader to focus on particular parts of the "Elements" and to study the exact role of individual propositions.In order to bring out distinctive aspects of Greek mathematics the author makes frequent comparisons and contrasts with later mathematical developments. For example, he gives a detailed explanation of the differences between Euclid's axiomatic method and Hilbert's, between Euclid's development of arithmetic and modern ones based on Peano's axioms, and between Euclid's theory of proportion and Dedekind's theory of real numbers. The result is not only a clarification of Greek mathematics but of the mathematical enterprise itself.

It is by far the richest twentieth-century source of philosophical ideas, which it will take us more decades yet properly to apprehend and to absorb; despite the difficulty with which his work presents the reader, there is nothing that is likely to be more rewarding. The philosophy of mathematics was one of his earliest and most persistent .

First published in 2000. Routledge is an imprint of Taylor & Francis, an informa company.

This abridged text of the most famous work ever written on the foundations of mathematics contains material that is most relevant to an introductory study of logic and the philosophy of mathematics.

The book presents logical foundations for rule-based systems. An attempt has been made to provide an in-depth discussion of logical and other aspects of such systems, including languages for knowledge representation, inference mechanisms, inference control, design and verification. The ultimate goal was to provide a deeper theoretical insight into the nature of rule-based systems and put together the most complete presentation including details so frequently skipped in typical textbooks. The book may be useful to potentially wide audience, but it is aimed at providing specific knowledge for graduate, post-graduate and Ph.D. students, as well as knowledge engineers and research workers involved in the domain of AI. It also constitutes a summary of the Author’s research and experience gathered through several years of his research work.

The present volume contains the proceedings of Logic at Botik '89, a symposium on logical foundations of computer science organized by the Program Systems Institute of the USSR Academy of Sciences and held at Pereslavl-Zalessky, USSR, July 3-8, 1989. The scope of the symposium was very broad; the topics of interest were: complexity of formal systems, constructive mathematics in computer science, denotational and operational semantics of programs, descriptive complexity, dynamic and algorithmic logics and schematology, formal tools to describe concurrent computations, lambda calculus and related topics, foundations of logic programming, logical foundations of database theory, logics for knowledge representation, modal and temporal logics, type theory in programming, and verification of programs. Thus, the papers in this volume represent many interesting trends in logical foundations of Computer Science, ranging from purely theoretical research to practical applications of theory.

Since their inception, the Perspectives in Logic and Lecture Notes in Logic series have published seminal works by leading logicians. Many of the original books in the series have been unavailable for years, but they are now in print once again. This volume, the sixth publication in the Lecture Notes in Logic series, collects the proceedings of the conference 'Logical Foundations of Mathematics, Computer Science, and Physics - Kurt Gödel's Legacy', held in Brno, Czech Republic, on the 90th anniversary of Gödel's birth. The broad range of speakers who participated in this event affirms the continuing importance of Gödel's work in logic, physics, and the philosophy and foundations of

mathematics and computer science. The papers in this volume range over all these topics and contribute to our present understanding of them.

Logical Foundations of Mathematics and Computational ComplexityA Gentle IntroductionSpringer Science & Business Media

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This book constitutes the refereed proceedings of the International Symposium on Logical Foundations of Computer Science, LFCS 2018, held in Deerfield Beach, FL, USA, in January 2018. The 22 revised full papers were carefully reviewed and selected from 22 submissions. The scope of the Symposium is broad and includes constructive mathematics and type theory; homotopy type theory; logic, automata, and automatic structures; computability and randomness; logical foundations of programming; logical aspects of computational complexity; parameterized complexity; logic programming and constraints; automated deduction and interactive theorem proving; logical methods in protocol and program verification; logical methods in program specification and extraction; domain theory logics; logical foundations of database theory; equational logic and term rewriting; lambda andcombinatory calculi; categorical logic and topological semantics; linear logic; epistemic and temporal logics; intelligent and multiple-agent system logics; logics of proof and justification; non-monotonic reasoning; logic in game theory and social software; logic of hybrid systems; distributed system logics; mathematical fuzzy logic; system design logics; and other logics in computer science.

Published in 1903, this book was the first comprehensive treatise on the logical foundations of mathematics written in English. It sets forth, as far as possible without mathematical and logical symbolism, the grounds in favour of the view that mathematics and logic are identical. It proposes simply that what is commonly called mathematics are merely later deductions from logical premises. It provided the thesis for which Principia Mathematica provided the detailed proof, and introduced the work of Frege to a wider audience. In addition to the new introduction by John Slater, this edition contains Russell's introduction to the 1937 edition in which he defends his position against his formalist and intuitionist critics.

This book constitutes the refereed proceedings of the International Symposium on Logical Foundations of Computer Science, LFCS 2013, held in San Diego, CA, USA in January 2013. The volume presents 29 revised refereed papers carefully selected by the program committee. The scope of the Symposium is broad and includes constructive mathematics and type theory; logic, automata and automatic structures; computability and randomness; logical foundations of programming; logical aspects of computational complexity; logic programming and constraints; automated deduction and interactive theorem proving; logical methods in protocol and program verification; logical methods in program specification and extraction; domain theory logic; logical foundations of database theory; equational logic and term rewriting; lambda and combinatory calculi; categorical logic and topological semantics; linear logic; epistemic and temporal logics; intelligent and multiple agent system logics; logics of proof and justification; nonmonotonic reasoning; logic in game theory and social software; logic of hybrid systems; distributed system logics; mathematical fuzzy logic; system design logics; and other logics in computer science.

This book constitutes the refereed proceedings of the International Symposium on

Logical Foundations of Computer Science, LFCS 2016, held in Deerfield Beach, FL, USA in January 2016. The 27 revised full papers were carefully reviewed and selected from 46 submissions. The scope of the Symposium is broad and includes constructive mathematics and type theory; homotopy type theory; logic, automata, and automatic structures; computability and randomness; logical foundations of programming; logical aspects of computational complexity; parameterized complexity; logic programming and constraints; automated deduction and interactive theorem proving; logical methods in protocol and program verification; logical methods in program specification and extraction; domain theory logics; logical foundations of database theory; equational logic and term rewriting; lambda and combinatory calculi; categorical logic and topological semantics; linear logic; epistemic and temporal logics; intelligent and multiple-agent system logics; logics of proof and justification; non-monotonic reasoning; logic in game theory and social software; logic of hybrid systems; distributed system logics; mathematical fuzzy logic; system design logics; and other logics in computer science.

Since their inception, the Perspectives in Logic and Lecture Notes in Logic series have published seminal works by leading logicians. Many of the original books in the series have been unavailable for years, but they are now in print once again. Logicism, as put forward by Bertrand Russell, was predicated on a belief that all of mathematics can be deduced from a very small number of fundamental logical principles. In this volume, the twenty-third publication in the Lecture Notes in Logic series, Paul C. Gilmore revisits logicism in light of recent advances in mathematical logic and theoretical computer science. Gilmore addresses the need for languages which can be understood by both humans and computers and, using Intensional Type Theory (ITT), provides a unified basis for mathematics and computer science. This yields much simpler foundations for recursion theory and the semantics of computer programs than those currently provided by category theory.

This book addresses the logical aspects of the foundations of scientific theories. Even though the relevance of formal methods in the study of scientific theories is now widely recognized and regaining prominence, the issues covered here are still not generally discussed in philosophy of science. The authors focus mainly on the role played by the underlying formal apparatuses employed in the construction of the models of scientific theories, relating the discussion with the so-called semantic approach to scientific theories. The book describes the role played by this metamathematical framework in three main aspects: considerations of formal languages employed to axiomatize scientific theories, the role of the axiomatic method itself, and the way set-theoretical structures, which play the role of the models of theories, are developed. The authors also discuss the differences and philosophical relevance of the two basic ways of aximoatizing a scientific theory, namely Patrick Suppes' set theoretical predicates and the "da Costa and Chuaqui" approach. This book engages with important discussions of the nature of scientific theories and will be a useful resource for researchers and upper-level students working in philosophy of science.

This book explores the rich and deep interplay between mathematics and physics one century after David Hilbert’s works from 1891 to 1933, published by Springer in six volumes. The most prominent scientists in various domains of these disciplines contribute to this volume providing insight to their works, and analyzing the impact of

the breakthrough and the perspectives of their own contributions. The result is a broad journey through the most recent developments in mathematical physics, such as string theory, quantum gravity, noncommutative geometry, twistor theory, Gauge and Quantum fields theories, just to mention a few. The reader, accompanied on this journey by some of the fathers of these theories, explores some far reaching interfaces where mathematics and theoretical physics interact profoundly and gets a broad and deep understanding of subjects which are at the core of recent developments in mathematical physics. The journey is not confined to the present state of the art, but sheds light on future developments of the field, highlighting a list of open problems. Graduate students and researchers working in physics, mathematics and mathematical physics will find this journey extremely fascinating. All those who want to benefit from a comprehensive description of all the latest advances in mathematics and mathematical physics, will find this book very useful too.

The two main themes of this book, logic and complexity, are both essential for understanding the main problems about the foundations of mathematics. Logical Foundations of Mathematics and Computational Complexity covers a broad spectrum of results in logic and set theory that are relevant to the foundations, as well as the results in computational complexity and the interdisciplinary area of proof complexity. The author presents his ideas on how these areas are connected, what are the most fundamental problems and how they should be approached. In particular, he argues that complexity is as important for foundations as are the more traditional concepts of computability and provability. Emphasis is on explaining the essence of concepts and the ideas of proofs, rather than presenting precise formal statements and full proofs. Each section starts with concepts and results easily explained, and gradually proceeds to more difficult ones. The notes after each section present some formal definitions, theorems and proofs. Logical Foundations of Mathematics and Computational Complexity is aimed at graduate students of all fields of mathematics who are interested in logic, complexity and foundations. It will also be of interest for both physicists and philosophers who are curious to learn the basics of logic and complexity theory.

Anyone involved in the philosophy of science is naturally drawn into the study of the foundations of probability. Different interpretations of probability, based on competing philosophical ideas, lead to different statistical techniques, and frequently to mutually contradictory consequences. This unique book presents a new interpretation of probability, rooted in the traditional interpretation that was current in the 17th and 18th centuries. Mathematical models are constructed based on this interpretation, and statistical inference and decision theory are applied, including some examples in artificial intelligence, solving the main foundational problems. Nonstandard analysis is extensively developed for the construction of the models and in some of the proofs. Many nonstandard theorems are proved, some of them new, in particular, a representation theorem that asserts that any stochastic process can be approximated by a process defined over a space with equiprobable outcomes.