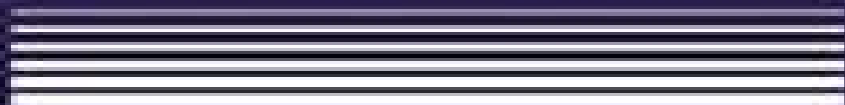


PROGRESS IN THEORETICAL COMPUTER SCIENCE



# **Finite Automata, Formal Logic, and Circuit Complexity**

**Howard Straubing**



**Birkhäuser**

# Finite Automata Formal Logic And Circuit Complexity Progress In Theoretical Computer Science

**Samson Abramsky, Cyril  
Gavoille, Claude Kirchner, Friedhelm  
Meyer auf der Heide, Paul Spirakis**

## **Finite Automata Formal Logic And Circuit Complexity Progress In Theoretical Computer Science:**

*Finite Automata, Formal Logic, and Circuit Complexity* Howard Straubing, 2012-12-06 The study of the connections between mathematical automata and formal logic is as old as theoretical computer science itself In the founding paper of the subject published in 1936 Turing showed how to describe the behavior of a universal computing machine with a formula of first order predicate logic and thereby concluded that there is no algorithm for deciding the validity of sentences in this logic Research on the logical aspects of the theory of finite state automata which is the subject of this book began in the early 1960 s with the work of J Richard Büchi on monadic second order logic Büchi s investigations were extended in several directions One of these explored by McNaughton and Papert in their 1971 monograph Counter free Automata was the characterization of automata that admit first order behavioral descriptions in terms of the semigroup theoretic approach to automata that had recently been developed in the work of Krohn and Rhodes and of Schützenberger In the more than twenty years that have passed since the appearance of McNaughton and Papert s book the underlying semigroup theory has grown enormously permitting a considerable extension of their results During the same period however fundamental investigations in the theory of finite automata by and large fell out of fashion in the theoretical computer science community which moved to other concerns Current Trends In Theoretical Computer Science: The Challenge Of The New Century; Vol 1:

Algorithms And Complexity; Vol 2: Formal Models And Semantics Grzegorz Rozenberg, Arto Salomaa, Gheorghe Paun, 2004-04-19 This book is based on columns and tutorials published in the Bulletin of the European Association for Theoretical Computer Science EATCS during the period 2000 2003 It presents many of the most active current research lines in theoretical computer science The material appears in two volumes Algorithms and Complexity and Formal Models and Semantics reflecting the traditional division of the field The list of contributors includes many of the well known researchers in theoretical computer science Most of the articles are reader friendly and do not presuppose much knowledge of the area in question Therefore the book constitutes very suitable supplementary reading material for various courses and seminars in computer science **Logic and Automata** Jörg Flum, Erich Grädel, Thomas Wilke, 2008 Mathematical logic and automata theory are two scientific disciplines with a fundamentally close relationship The authors of Logic and Automata take the occasion of the sixtieth birthday of Wolfgang Thomas to present a tour d horizon of automata theory and logic The twenty papers in this volume cover many different facets of logic and automata theory emphasizing the connections to other disciplines such as games algorithms and semigroup theory as well as discussing current challenges in the field *Formal Languages, Automata and Numeration Systems 2* Michel Rigo, 2014-09-10 The interplay between words computability algebra and arithmetic has now proved its relevance and fruitfulness Indeed the cross fertilization between formal logic and finite automata such as that initiated by J R Büchi or between combinatorics on words and number theory has paved the way to recent dramatic developments for example the transcendence results for the real numbers having a simple binary

expansion by B Adamczewski and Y Bugeaud This book is at the heart of this interplay through a unified exposition Objects are considered with a perspective that comes both from theoretical computer science and mathematics Theoretical computer science offers here topics such as decision problems and recognizability issues whereas mathematics offers concepts such as discrete dynamical systems The main goal is to give a quick access for students and researchers in mathematics or computer science to actual research topics at the intersection between automata and formal language theory number theory and combinatorics on words The second of two volumes on this subject this book covers regular languages numeration systems formal methods applied to decidability issues about infinite words and sets of numbers

**Current Trends in Theoretical Computer Science** Gheorghe Păun, 2004 This book is based on columns and tutorials published in the Bulletin of the European Association for Theoretical Computer Science EATCS during the period 2000-2003 It presents many of the most active current research lines in theoretical computer science The material appears in two volumes OC Algorithms and ComplexityOC and OC Formal Models and SemanticsOCO reflecting the traditional division of the field The list of contributors includes many of the well known researchers in theoretical computer science Most of the articles are reader friendly and do not presuppose much knowledge of the area in question Therefore the book constitutes very suitable supplementary reading material for various courses and seminars in computer science Contents Vol 1 Algorithms Computational Complexity Distributed Computing Natural Computing Vol 2 Formal Specification Logic in Computer Science Concurrency Formal Language Theory Readership Upper level undergraduates graduate students and researchers in theoretical computer science and biocomputing

**Relational and Algebraic Methods in Computer Science** Peter Höfner, Damien Pous, Georg Struth, 2017-05-08 This book constitutes the proceedings of the 16th International Conference on Relational and Algebraic Methods in Computer Science RAMiCS 2017 held in Lyon France in May 2017 The 17 revised full papers and 2 invited papers presented together with 1 invited abstract were carefully selected from 28 submissions Topics covered range from mathematical foundations to applications as conceptual and methodological tools in computer science and beyond

**Temporal Logics in Computer Science** Stéphane Demri, Valentin Goranko, Martin Lange, 2016-10-13 This comprehensive text provides a modern and technically precise exposition of the fundamental theory and applications of temporal logics in computer science Part I presents the basics of discrete transition systems including constructions and behavioural equivalences Part II examines the most important temporal logics for transition systems and Part III looks at their expressiveness and complexity Finally Part IV describes the main computational methods and decision procedures for model checking and model building based on tableaux automata and games and discusses their relationships The book contains a wealth of examples and exercises as well as an extensive annotated bibliography Thus the book is not only a solid professional reference for researchers in the field but also a comprehensive graduate textbook that can be used for self study as well as for teaching courses

**Current Trends in Theoretical Computer Science** Gheorghe Păeaun, Grzegorz

Rozenberg, Arto Salomaa, 2004 contents vol 1 Algorithms Computational Complexity Distributed Computing Natural Computing

**Their Footprints Remain** Alex McKay, 2007 By the end of the 19th century British imperial medical officers and Christian medical missionaries had introduced Western medicine to Tibet Sikkim and Bhutan Their Footprints Remain uses archival sources personal letters diaries and oral sources in order to tell the fascinating story of how this once new medical system became imbedded in the Himalayas Of interest to anyone with an interest in medical history and anthropology as well as the Himalayan world this volume not only identifies the individuals involved and describes how they helped to spread this form of imperialist medicine but also discusses its reception by a local people whose own medical practices were based on an entirely different understanding of the world

*Computer Science Logic* Georg Gottlob, Etienne Grandjean, Katrin Seyr, 2006-10-11 This book constitutes the strictly refereed post workshop proceedings of the 12th International Workshop on Computer Science Logic CSL 98 held as the Annual Conference of the European Association on Computer Science Logic in Brno Czech Republic in August 1998 The 25 revised full papers presented were carefully reviewed and selected during two rounds of reviewing and revision Also included are three reviewed invited papers The papers span the whole scope of computer science logic and mathematical foundations and represent the state of the art in the area

**Weighted Automata, Formal Power Series and Weighted Logic** Laura Wirth, 2022-10-13 The main objective of this work is to represent the behaviors of weighted automata by expressively equivalent formalisms rational operations on formal power series linear representations by means of matrices and weighted monadic second order logic First we exhibit the classical results of Kleene Bchi Elgot and Trakhtenbrot which concentrate on the expressive power of finite automata We further derive a generalization of the Bchi Elgot Trakhtenbrot Theorem addressing formulas whereas the original statement concerns only sentences Then we use the language theoretic methods as starting point for our investigations regarding power series We establish Schutzenberger's extension of Kleene's Theorem referred to as Kleene Schutzenberger Theorem Moreover we introduce a weighted version of monadic second order logic which is due to Droste and Gastin By means of this weighted logic we derive an extension of the Bchi Elgot Trakhtenbrot Theorem Thus we point out relations among the different specification approaches for formal power series Further we relate the notions and results concerning power series to their counterparts in Language Theory Overall our investigations shed light on the interplay between languages formal power series automata and monadic second order logic

**Proof Theory in Computer Science** Reinhard Kahle, Peter Schroeder-Heister, Robert Stärk, 2003-06-30 Proof theory has long been established as a basic discipline of mathematical logic It has recently become increasingly relevant to computer science The deductive apparatus provided by proof theory has proved useful for metatheoretical purposes as well as for practical applications Thus it seemed to us most natural to bring researchers together to assess both the role proof theory already plays in computer science and the role it might play in the future The form of a Dagstuhl seminar is most suitable for purposes like this as Schlo Dagstuhl provides a very convenient

and stimulating environment to scuss new ideas and developments To accompany the conference with a proc dings volume appeared to us equally appropriate Such a volume not only xes basic results of the subject and makes them available to a broader audience but also signals to the scienti c community that Proof Theory in Computer Science PTCS is a major research branch within the wider eld of logic in computer science

**Subrecursive Programming Systems** James S. Royer,John Case,2012-12-06 **Graph Algebras and Automata** Andrei Kelarev,2003-07-08 Graph algebras possess the capacity to relate fundamental concepts of computer science combinatorics graph theory operations research and universal algebra They are used to identify nontrivial connections across notions expose conceptual properties and mediate the application of methods from one area toward questions of the other four After [The q-theory of Finite Semigroups](#) John Rhodes,Benjamin Steinberg,2009-04-05 Discoveries in finite semigroups have influenced several mathematical fields including theoretical computer science tropical algebra via matrix theory with coefficients in semirings and other areas of modern algebra This comprehensive encyclopedic text will provide the reader from the graduate student to the researcher practitioner with a detailed understanding of modern finite semigroup theory focusing in particular on advanced topics on the cutting edge of research Key features 1 Develops q theory a new theory that provides a unifying approach to finite semigroup theory via quantization 2 Contains the only contemporary exposition of the complete theory of the complexity of finite semigroups 3 Introduces spectral theory into finite semigroup theory 4 Develops the theory of profinite semigroups from first principles making connections with spectra of Boolean algebras of regular languages 5 Presents over 70 research problems most new and hundreds of exercises Additional features 1 For newcomers an appendix on elementary finite semigroup theory 2 Extensive bibliography and index The q theory of Finite Semigroups presents important techniques and results many for the first time in book form and thereby updates and modernizes the literature of semigroup theory

*Approximation, Randomization and Combinatorial Optimization. Algorithms and Techniques* Ashish Goel,Klaus Jansen,José Rolim,Ronitt Rubinfeld,2008-08-28 This volume contains the papers presented at the 11th International Wo shop on Approximation Algorithms for Combinatorial Optimization Problems APPROX 2008 and the 12th International Workshop on Randomization and Computation RANDOM 2008 which took place concurrently at the MIT M sachusetts Institute of Technology in Boston USA during August 25 27 2008 APPROX focuses on algorithmic and complexity issues surrounding the development of e cient approximate solutions to computationally di cult problems and was the 11th in the series after Aalborg 1998 Berkeley 1999 Saarbru cken 2000 Berkeley 2001 Rome 2002 Princeton 2003 Cambridge 2004 Berkeley 2005 Barcelona 2006 and Princeton 2007 RANDOM is concerned with applications of randomness to computational and combinatorial problems and was the 12th workshop in the series following Bologna 1997 Barcelona 1998 Berkeley 1999 Geneva 2000 Berkeley 2001 Harvard 2002 Princeton 2003 Cambridge 2004 Berkeley 2005 Barcelona 2006 and Princeton 2007 Topics of interest for APPROX and RANDOM are design and analysis of proximation algorithms hardness of

approximation small space sub linear time streaming algorithms embeddings and metric space methods mathematical programming methods combinatorial problems in graphs and networks game theory markets economic applications geometric problems packing covering scheduling approximate learning design and analysis of randomized algorithms randomized complexity theory pseudorandomness and derandomization random combinatorial structures random walks Markov chains expander graphs and randomness extractors probabilistic proof systems random projections and beddings error correcting codes average case analysis property testing computational learning theory and other applications of approximation and randomness

Automata, Languages and Programming Samson Abramsky, Cyril Gavoille, Claude Kirchner, Friedhelm Meyer auf der Heide, Paul Spirakis, 2010-06-30 The two volume set LNCS 6198 and LNCS 6199 constitutes the refereed proceedings of the 37th International Colloquium on Automata Languages and Programming ICALP 2010 held in Bordeaux France in July 2010 The 106 revised full papers 60 papers for track A 30 for track B and 16 for track C presented together with 6 invited talks were carefully reviewed and selected from a total of 389 submissions The papers are grouped in three major tracks on algorithms complexity and games on logic semantics automata and theory of programming as well as on foundations of networked computation models algorithms and information management LNCS 6199 contains 46 contributions of track B and C selected from 167 submissions as well as 4 invited talks

Formal Languages, Automata and Numeration Systems 1 Michel Rigo, 2014-11-17 Formal Languages Automata and Numeration Systems presents readers with a review of research related to formal language theory combinatorics on words or numeration systems such as Words DLT Developments in Language Theory ICALP MFCS Mathematical Foundation of Computer Science Mons Theoretical Computer Science Days Numeration CANT Combinatorics Automata and Number Theory Combinatorics on words deals with problems that can be stated in a non commutative monoid such as subword complexity of finite or infinite words construction and properties of infinite words unavoidable regularities or patterns When considering some numeration systems any integer can be represented as a finite word over an alphabet of digits This simple observation leads to the study of the relationship between the arithmetical properties of the integers and the syntactical properties of the corresponding representations One of the most profound results in this direction is given by the celebrated theorem by Cobham Surprisingly a recent extension of this result to complex numbers led to the famous Four Exponentials Conjecture This is just one example of the fruitful relationship between formal language theory including the theory of automata and number theory

**Representation**

**Theory of Finite Monoids** Benjamin Steinberg, 2016-12-09 This first text on the subject provides a comprehensive introduction to the representation theory of finite monoids Carefully worked examples and exercises provide the bells and whistles for graduate accessibility bringing a broad range of advanced readers to the forefront of research in the area Highlights of the text include applications to probability theory symbolic dynamics and automata theory Comfort with module theory a familiarity with ordinary group representation theory and the basics of Wedderburn theory are prerequisites for

advanced graduate level study Researchers in algebra algebraic combinatorics automata theory and probability theory will find this text enriching with its thorough presentation of applications of the theory to these fields Prior knowledge of semigroup theory is not expected for the diverse readership that may benefit from this exposition The approach taken in this book is highly module theoretic and follows the modern flavor of the theory of finite dimensional algebras The content is divided into 7 parts Part I consists of 3 preliminary chapters with no prior knowledge beyond group theory assumed Part II forms the core of the material giving a modern module theoretic treatment of the Clifford Munn Ponizovskii theory of irreducible representations Part III concerns character theory and the character table of a monoid Part IV is devoted to the representation theory of inverse monoids and categories and Part V presents the theory of the Rhodes radical with applications to triangularizability Part VI features 3 chapters devoted to applications to diverse areas of mathematics and forms a high point of the text The last part Part VII is concerned with advanced topics There are also 3 appendices reviewing finite dimensional algebras group representation theory and Mbius inversion

**Modern Applications of Automata Theory** Deepak D'Souza, Priti Shankar, 2012 Automata theory has come into prominence in recent years with a plethora of applications in fields ranging from verification to XML processing and file compression In fact the 2007 Turing Award was awarded to Clarke Emerson and Sifakis for their pioneering work on model checking techniques To the best of our knowledge there is no single book that covers the vast range of applications of automata theory targeted at a mature student audience This book is intended to fill that gap and can be used as an intermediate level textbook It begins with a detailed treatment of foundational material not normally covered in a beginner's course in automata theory and then rapidly moves on to applications The book is largely devoted to verification and model checking and contains material that is at the cutting edge of verification technology It will be an invaluable reference for software practitioners working in this area

## **Finite Automata Formal Logic And Circuit Complexity Progress In Theoretical Computer Science** Book Review: Unveiling the Magic of Language

In an electronic digital era where connections and knowledge reign supreme, the enchanting power of language has become more apparent than ever. Its capability to stir emotions, provoke thought, and instigate transformation is really remarkable. This extraordinary book, aptly titled "**Finite Automata Formal Logic And Circuit Complexity Progress In Theoretical Computer Science**," written by a very acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound effect on our existence. Throughout this critique, we shall delve into the book's central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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