

Automata Studies

This book constitutes the refereed proceedings of the 20th International Conference on Implementation and Application of Automata, CIAA 2015, held in Umeå, Sweden, in August 2015. The 22 revised full papers presented together with 4 invited papers and 2 tool demonstration papers were carefully reviewed and selected from 49 submissions. The papers cover all aspects of automata, counter automata, decision algorithms on automata, descriptive complexity, expressive power of automata, homing sequences, jumping finite automata, multi-dimensional languages, parsing and pattern matching, quantum automata, realtime pushdown automata, random generation of automata, regular expressions, security issues, sensors in automata, transducers, transformation of automata, and weighted automata.

This book constitutes the proceedings of the 4th International Conference, LATA 2010, held in May 2010 in Trier, Germany. The 47 full papers presented were carefully selected from 115 submissions and focus on topics such as algebraic language theory, algorithmic learning, bioinformatics, computational biology, pattern recognition, program verification, term rewriting and tree machines.

Theory of Automata deals with mathematical aspects of the theory of automata

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theory, with emphasis on the finite deterministic automaton as the basic model. All other models, such as finite non-deterministic and probabilistic automata as well as pushdown and linear bounded automata, are treated as generalizations of this basic model. The formalism chosen to describe finite deterministic automata is that of regular expressions. A detailed exposition regarding this formalism is presented by considering the algebra of regular expressions. This volume is comprised of four chapters and begins with a discussion on finite deterministic automata, paying particular attention to regular and finite languages; analysis and synthesis theorems; equivalence relations induced by languages; sequential machines; sequential functions and relations; definite languages and non-initial automata; and two-way automata. The next chapter describes finite non-deterministic and probabilistic automata and covers theorems concerning stochastic languages; non-regular stochastic languages; and probabilistic sequential machines. The book then introduces the reader to the algebra of regular expressions before concluding with a chapter on formal languages and generalized automata. Theoretical exercises are included, along with "problems" at the end of some sections. This monograph will be a useful resource for beginning graduate or advanced undergraduates of mathematics. The thirty four contributions in this book cover many aspects of contemporary

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studies on cellular automata and include reviews, research reports, and guides to recent literature and available software. Cellular automata, dynamic systems in which space and time are discrete, are yielding interesting applications in both the physical and natural sciences. The thirty four contributions in this book cover many aspects of contemporary studies on cellular automata and include reviews, research reports, and guides to recent literature and available software. Chapters cover mathematical analysis, the structure of the space of cellular automata, learning rules with specified properties: cellular automata in biology, physics, chemistry, and computation theory; and generalizations of cellular automata in neural nets, Boolean nets, and coupled map lattices. Current work on cellular automata may be viewed as revolving around two central and closely related problems: the forward problem and the inverse problem. The forward problem concerns the description of properties of given cellular automata. Properties considered include reversibility, invariants, criticality, fractal dimension, and computational power. The role of cellular automata in computation theory is seen as a particularly exciting venue for exploring parallel computers as theoretical and practical tools in mathematical physics. The inverse problem, an area of study gaining prominence particularly in the natural sciences, involves designing rules that possess specified properties or perform specified task. A long-term

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goal is to develop a set of techniques that can find a rule or set of rules that can reproduce quantitative observations of a physical system. Studies of the inverse problem take up the organization and structure of the set of automata, in particular the parameterization of the space of cellular automata. Optimization and learning techniques, like the genetic algorithm and adaptive stochastic cellular automata are applied to find cellular automaton rules that model such physical phenomena as crystal growth or perform such adaptive-learning tasks as balancing an inverted pole. Howard Gutowitz is Collaborateur in the Service de Physique du Solide et Résonance Magnétique, Commissariat à l'Énergie Atomique, Saclay, France.

"Et moi ..., si j'avait SII comment en revenir. One service mathematics has rendered the human race. It has put common sense back je n'y serais point alle.' Jules Verne whe", it belongs, on the topmost shelf next to the dusty canister labelled 'discarded non- The series is divergent; therefore we may be smse'. able to do something with it. Eric T. Bell O. Heaviside Mathematics is a tool for thought. A highly necessary tool in a world where both feedback and non linearities abound. Similarly, all kinds of parts of mathematics serve as tools for other parts and for other sciences. Applying a simple rewriting rule to the quote on the right above one finds such statements as: 'One service topology has

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rendered mathematical physics .. .'; 'One service logic has rendered computer science .. .'; 'One service category theory has rendered mathematics .. .'. All arguably true. And all statements obtainable this way form part of the raison d'être of this series.

The papers contained in this volume were presented at the third international Workshop on Implementing Automata, held September 17-19, 1998, at the University of Rouen, France. Automata theory is the cornerstone of computer science theory. While there is much practical experience with using automata, this work covers diverse areas, including parsing, computational linguistics, speech recognition, text searching, device controllers, distributed systems, and protocol analysis. Consequently, techniques that have been discovered in one area may not be known in another. In addition, there is a growing number of symbolic manipulation environments designed to assist researchers in experimenting with and teaching on automata and their implementation; examples include FLAP, FADELA, AMORE, Fire-Lite, Automate, AGL, Turing's World, FinITE, INR, and Grail. Developers of such systems have not had a forum in which to expose and compare their work. The purpose of this workshop was to bring together members of the academic, research, and industrial communities with an interest in implementing automata, to

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demonstrate their work and to explain the problems they have been solving. These workshops started in 1996 and 1997 at the University of Western Ontario, London, Ontario, Canada, prompted by Derick Wood and Sheng Yu. The major motivation for starting these workshops was that there had been no single forum in which automata-implementation issues had been discussed. The interest shown in the first and second workshops demonstrated that there was a need for such a forum. The participation at the third workshop was very interesting: we counted sixty-three registrations, four continents, ten countries, twenty-three universities, and three companies.

Automata and Computability is a class-tested textbook which provides a comprehensive and accessible introduction to the theory of automata and computation. The author uses illustrations, engaging examples, and historical remarks to make the material interesting and relevant for students. It incorporates modern/handy ideas, such as derivative-based parsing and a Lambda reducer showing the universality of Lambda calculus. The book also shows how to sculpt automata by making the regular language conversion pipeline available through a simple command interface. A Jupyter notebook will accompany the book to feature code, YouTube videos, and other supplements to assist instructors and students. Features Uses illustrations, engaging examples, and historical remarks to make the material accessible Incorporates modern/handy ideas,

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such as derivative-based parsing and a Lambda reducer showing the universality of Lambda calculus Shows how to "sculpt" automata by making the regular language conversion pipeline available through simple command interface Uses a mini functional programming (FP) notation consisting of lambdas, maps, filters, and set comprehension (supported in Python) to convey math through PL constructs that are succinct and resemble math Provides all concepts are encoded in a compact Functional Programming code that will tessellate with Latex markup and Jupyter widgets in a document that will accompany the books. Students can run code effortlessly. Applied Automata Theory provides an engineering style of presentation of some of the applied work in the field of automata theory. Topics covered range from algebraic foundations and recursive functions to regular expressions, threshold logic, and switching circuits. Coding problems and stochastic processes are also discussed, along with content addressable memories, probabilistic reliability, and Turing machines. Much emphasis is placed on engineering applications. Comprised of nine chapters, this book first deals with the algebraic foundations of automata theory, focusing on concepts such as semigroups, groups and homomorphisms, and partially ordered sets and lattices, as well as congruences and other relations. The reader is then introduced to regular expressions; stochastic automata and discrete systems theory; and switching networks as models of discrete stochastic processes. Subsequent chapters explore applications of automata theory in coding; content addressable and distributed logic memories;

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recursive functions and switching-circuit theory; and synthesis of a cellular computer. The book concludes with an assessment of the fundamentals of threshold logic. This monograph is intended for graduates or advanced undergraduates taking a course in information science or a course on discrete systems in modern engineering curriculum. Automata Studies Annals of Mathematics Studies. Number 34 Princeton University Press

ICALP 2008, the 35th edition of the International Colloquium on Automata, Languages and Programming, was held in Reykjavik, Iceland, July 7–11, 2008. ICALP is a series of annual conferences of the European Association for Theoretical Computer Science (EATCS) which first took place in 1972. This year, the ICALP program consisted of the established Track A (focusing on algorithms, automata, complexity and games) and Track B (focusing on logic, semantics and theory of programming), and of the recently introduced Track C (focusing on security and cryptography foundations). In response to the call for papers, the Program Committees received 477 submissions, the highest ever: 269 for Track A, 122 for Track B and 86 for Track C. Out of these, 126 papers were selected for inclusion in the scientific program: 70 papers for Track A, 32 for Track B and 24 for Track C. The selection was made by the Program Committees based on originality, quality, and relevance to theoretical computer science. The quality of the manuscripts was very high indeed, and many deserving papers could not be selected. ICALP 2008 consisted of five invited lectures

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and the contributed papers.

Regular languages have a wide area of applications. This makes it an important task to convert between different forms of regular language representations, and to compress the size of such representations. This book studies modern aspects of compressions and conversions of regular language representations. The first main part presents methods for lossy compression of classical finite automata. Lossy compression allows to reduce the size of a language representation below the limits of classical compression methods, by the cost of introducing tolerable errors to the language. The complexity of many problems related to compression with respect to different error profiles is classified. The other main part is devoted to the study of biautomata, which were recently introduced as a new descriptive model for regular languages. Although biautomata are in many ways similar to finite automata, this book carves out some notable differences. While classical methods for finite automata can successfully be applied to biautomata, one observes a drastic increase of the computational complexity when considering lossy compression for biautomata.

Finite Automata and Application to Cryptography mainly deals with the invertibility theory of finite automata and its application to cryptography. In addition, autonomous finite automata and Latin arrays, which are relative to the canonical form for one-key cryptosystems based on finite automata, are also discussed. Finite automata are regarded as a natural model for ciphers. The Ra Rb transformation method is

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introduced to deal with the structure problem of such automata; then public key cryptosystems based on finite automata and a canonical form for one-key ciphers implementable by finite automata with bounded-error-propagation and without data expansion are proposed. The book may be used as a reference for computer science and mathematics majors, including seniors and graduate students. Renji Tao is a Professor at the Institute of Software, Chinese Academy of Sciences, Beijing. The volume contains the proceedings of the 16th Spring School on Theoretical Computer Science held in Ramatuelle, France, in May 1988. It is a unique combination of research level articles on various aspects of the theory of finite automata and its applications. Advances made in the last five years on the mathematical foundations form the first part of the book. The second part is devoted to the important problems of the theory including star-height, concatenation hierarchies, and connections with logic and word problems. The last part presents a large variety of possible applications: number theory, distributed systems, algorithms on strings, theory of codes, complexity of boolean circuits and others.

The author, who died in 1984, is well-known both as a person and through his research in mathematical logic and theoretical computer science. In the first part of the book he presents the new classical theory of finite automata as unary

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algebras which he himself invented about 30 years ago. Many results, like his work on structure lattices or his characterization of regular sets by generalized regular rules, are unknown to a wider audience. In the second part of the book he extends the theory to general (non-unary, many-sorted) algebras, term rewriting systems, tree automata, and pushdown automata. Essentially Büchi worked independent of other research, following a novel and stimulating approach. He aimed for a mathematical theory of terms, but could not finish the book. Many of the results are known by now, but to work further along this line presents a challenging research program on the borderline between universal algebra, term rewriting systems, and automata theory. For the whole book and again within each chapter the author starts at an elementary level, giving careful explanations and numerous examples and exercises, and then leads up to the research level. In this way he covers the basic theory as well as many nonstandard subjects. Thus the book serves as a textbook for both the beginner and the advanced student, and also as a rich source for the expert.

The Fifth International Conference on Implementation and Application of Automata (CIAA 2000) was held at the University of Western Ontario in London, Ontario, Canada on July 24-25, 2000. This conference series was formerly called the International Workshop on Implementing Automata (WIA) This volume of the

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Lecture Notes in Computer Science series contains all the papers that were presented at CIAA 2000, and also the abstracts of the poster papers that were displayed during the conference. The conference addressed issues in automata application and implementation. The topics of the papers presented at this conference ranged from automata applications in software engineering, natural language and speech recognition, and image processing, to new representations and algorithms for efficient implementation of automata and related structures. Automata theory is one of the oldest areas in computer science. Research in automata theory has always been motivated by its applications since its early stages of development. In the 1960s and 1970s, automata research was motivated heavily by problems arising from compiler construction, circuit design, string matching, etc. In recent years, many new applications have been found in various areas of computer science as well as in other disciplines. Examples of the new applications include statecharts in object-oriented modeling, finite transducers in natural language processing, and nondeterministic finite-state models in communication protocols. Many of the new applications do not and cannot simply apply the existing models and algorithms in automata theory to their problems.

This book constitutes the refereed proceedings of the 7th International

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Conference on Language and Automata Theory and Applications, LATA 2013, held in Bilbao, Spain in April 2013. The 45 revised full papers presented together with 5 invited talks were carefully reviewed and selected from 97 initial submissions. The volume features contributions from both classical theory fields and application areas (bioinformatics, systems biology, language technology, artificial intelligence, etc.). Among the topics covered are algebraic language theory; algorithms for semi-structured data mining; algorithms on automata and words; automata and logic; automata for system analysis and program verification; automata, concurrency and Petri nets; automatic structures; cellular automata; combinatorics on words; computability; computational complexity; computational linguistics; data and image compression; decidability questions on words and languages; descriptonal complexity; DNA and other models of bio-inspired computing; document engineering; foundations of finite state technology; foundations of XML; fuzzy and rough languages; grammars (Chomsky hierarchy, contextual, multidimensional, unification, categorial, etc.); grammars and automata architectures; grammatical inference and algorithmic learning; graphs and graph transformation; language varieties and semigroups; language-based cryptography; language-theoretic foundations of artificial intelligence and artificial life; parallel and regulated rewriting; parsing; pattern recognition; patterns and

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codes; power series; quantum, chemical and optical computing; semantics; string and combinatorial issues in computational biology and bioinformatics; string processing algorithms; symbolic dynamics; symbolic neural networks; term rewriting; transducers; trees, tree languages and tree automata; weighted automata.

This volume of Lecture Notes in Computer Science contains the revised versions of the papers presented at the 9th International Conference on Implementation and Application of Automata, CIAA 2004. Also included are the extended abstracts of the posters accepted to the conference. The conference was held at Queen's University in Kingston, Ontario, Canada on July 22–24, 2004. As for its predecessors, the theme of CIAA 2004 was the implementation of automata and grammars of all types and their application in other fields. The topics of the papers presented at the conference range from applications of automata in natural language and speech processing to protein sequencing and gene compression, and from state complexity and new algorithms for automata operations to applications of quantum finite automata.

The 25 regular papers and 14 poster papers were selected from 62 submissions to the conference. Each submitted paper was evaluated by at least three Program Committee members, with the help of external referees. Based on the referee

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reports, the paper “Substitutions, Trajectories and Noisy Channels” by L. Kari, S. Konstantinidis and P. Sos ? ?k was chosen as the winner of the CIAA 2004 Best Paper Award. The award is sponsored by the University of California at Santa Barbara. The authors of the papers presented here come from the following countries and regions: Austria, Canada, Czech Republic, Finland, France, Germany, Hong Kong, Netherlands, Portugal, Russia, Slovakia, South Africa, Spain, UK, and USA.

The description for this book, Automata Studies. (AM-34), Volume 34, will be forthcoming.

The purpose of this book is to present an up to date account of fuzzy ideals of a semiring. The book concentrates on theoretical aspects and consists of eleven chapters including three invited chapters. Among the invited chapters, two are devoted to applications of Semirings to automata theory, and one deals with some generalizations of Semirings. This volume may serve as a useful hand book for graduate students and researchers in the areas of Mathematics and Theoretical Computer Science.

This monograph presents a comprehensive introduction to timed automata (TA) and time Petri nets (TPNs) which belong to the most widely used models of real-time systems. Some of the existing methods of translating time Petri nets to timed automata are presented, with a focus on the translations that correspond to the semantics of time Petri nets, associating clocks with various components of the nets.

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This book constitutes the thoroughly refereed post-proceedings of the 4th International Workshop on Implementing Automata, WIA'99, held in Potsdam, Germany, in July 1999. The 16 revised full papers presented were carefully selected and improved during two rounds of reviewing and revision. The papers are devoted to issues of implementing automata of various types important for areas such as parsing, finite languages, computational linguistics, speech recognition, image and signal processing, and systems analysis.

This dictionary supplies associations which have been evoked by certain words, signs, etc. in Western civilization in the past, and which may float to the surface again tomorrow; for however 'daringly new' a modern use of imagery may look, it generally appears to have roots in what has been said and done in the past. No fine distinctions have been made between symbols (in the limited sense), allegories, metaphors, signs, types, images, etc. (not to mention 'ascending' and 'descending' symbols), since such subtle distinctions, however sensible from a scientific point of view, are useless to a person struggling with the deeper comprehension (and thus appreciation) of a particular 'symbol'.

The book deals with analytical and computational studies of spatially-extended discrete dynamical systems: one-dimensional cellular automata. The topics included are non-constructible configurations, reversibility, probabilistic analysis and De Bruijn diagrams. Techniques discussed are based on topology, matrix theory, formal languages and probability theory. The book is an excellent reading for anybody interested in non-linearity, emergency, complexity and self-organization.

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

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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.

Semigroups, Automata, Universal Algebra, Varieties

Cellular automata are a class of spatially and temporally discrete mathematical systems characterized by local interaction and synchronous dynamical evolution. Introduced by the mathematician John von Neumann in the 1950s as simple models of biological self-reproduction, they are prototypical models for complex systems and processes consisting of a large number of simple, homogeneous, locally interacting components. Cellular automata have been the focus of great attention over the years because of their ability to generate a rich spectrum of very complex patterns of behavior out of sets of relatively simple underlying rules. Moreover, they appear to capture many essential features of complex self-organizing cooperative behavior observed in real systems. This book provides a summary of the basic properties of cellular automata, and explores in depth many important cellular-automata-related research areas, including artificial life, chaos, emergence, fractals, nonlinear dynamics, and self-organization. It also presents a broad review of the speculative proposition that cellular automata may eventually prove to be theoretical harbingers of a fundamentally new

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information-based, discrete physics. Designed to be accessible at the junior/senior undergraduate level and above, the book will be of interest to all students, researchers, and professionals wanting to learn about order, chaos, and the emergence of complexity. It contains an extensive bibliography and provides a listing of cellular automata resources available on the World Wide Web.

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