Formal Languages, Automata and Numeration Systems (Iste)

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Formal Languages, Automaton 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.

Contents to include: • algebraic structures, homomorphisms, relations, free monoid • finite words, prefixes, suffixes, factors, palindromes
• periodicity and Fine–Wilf theorem
• infinite words are sequences over a finite alphabet
• properties of an ultrametric distance, example of the p-adic norm
• topology of the set of infinite words
• converging sequences of infinite and finite words, compactness argument
• iterated morphism, coding, substitutive or morphic words
• the typical example of the Thue–Morse word
• the Fibonacci word, the Mex operator, the n-bonacci words
• wordscomingfromnumbertheory(baseexpansions,continuedfractions,...) • the taxonomy of Lindenmayer systems
• S-adic sequences, Kolakoski word
• repetition in words, avoiding repetition, repetition threshold
• (complete) de Bruijn graphs
• concepts from computability theory and decidability issues
• Post correspondence problem and application to mortality of matrices
• origins of combinatorics on words
• bibliographic notes
• languages of finite words, regular languages
• factorial, prefix/suffix closed languages, trees and codes
• unambiguous and deterministic automata, Kleene’s theorem
• growth function of regular languages
• non-deterministic automata and determinization
• radix order, first word of each length and decimation of a regular language
• the theory of the minimal automata
• an introduction to algebraic automata theory, the syntactic monoid and the syntactic complexity

• star-free languages and a theorem of Schu ?tzenberger
• rational formal series and weighted automata
• context-free languages, pushdown automata and grammars
• growth function of context-free languages, Parikh's theorem
• some decidable and undecidable problems in formal language theory
• bibliographic notes
• factor complexity, Morse–Hedlund theorem
• arithmetic complexity, Van Der Waerden theorem, pattern complexity • recurrence, uniform recurrence, return words
• Sturmian words, coding of rotations, Kronecker's theorem
• frequencies of letters, factors and primitive morphism
• critical exponent
• factor complexity of automatic sequences
• factor complexity of purely morphic sequences
• primitive words, conjugacy, Lyndon word
• abelianisation and abelian complexity
• bibliographic notes
• automatic sequences, equivalent definitions
• a theorem of Cobham, equivalence of automatic sequences with constant length morphic sequences
• a few examples of well-known automatic sequences
• about Derksen's theorem
• some morphic sequences are not automatic
• abstract numeration system and S-automatic sequences
• k – ∞-automatic sequences
• bibliographic notes
• numeration systems, greedy algorithm
• positional numeration systems, recognizable sets of integers
• divisibility criterion and recognizability of N
• properties of k-recognizable sets of integers, ratio and difference of consecutive elements: syndeticity
• integer base and Cobham's theorem on the base dependence of the recognizability
• non-standard numeration systems based on sequence of integers
• linear recurrent sequences, Loraud and Hollander results
• Frougny's normalization result and addition
• morphic numeration systems/sets of integers whose characteristic sequence is morphic
• towards a generalization of Cobham's theorem
• a few words on the representation of real numbers, β-integers, finiteness properties
• automata associated with Parry numbers and numeration systems
• bibliographic notes
First order logic
• Presburger arithmetic and decidable theory
• Muchnik's characterization of semi-linear sets
• Bu ?chi's theorem: k-recognizable sets are k-definable • extension to Pisot numeration systems
• extension to real numbers
• decidability issues for numeration systems

• applications in combinatorics on words

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