

**INTERNATIONAL SYMPOSIUM AND SUMMER SCHOOL
"MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE"**

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September 3–8, 1973, the International Symposium and Summer School on "Mathematical Foundations of Computer Science" was held under the auspices of the International Federation for Information Processing (IFIP) in Czechoslovakia (Strbske Pleso, High Tatras). The symposium was organized by the Mathematical Institute, Slovak Academy of Sciences in collaboration with the "United Nations Program" Scientific-Research Computing Center in Bratislava and other institutions.

Participating in the work of the symposium were over 150 prominent scientists from different countries of the world (USSR, Czechoslovakia, Poland, Hungary, German Democratic Republic, Roumania, Yugoslavia, USA, England, France, Federal Republic of Germany, Italy, and Finland). The opening speech of the symposium was made by A. Klas, Director of the "United Nations Program" Scientific-Research Computing Center.

The papers presented by the participants of the symposium reflected the most recent developments in theory of formal languages and grammars, automata theory, computer and programming theory, complexity of algorithms and computational complexity, as well as mathematical logic.

The framework of the symposium included a panel discussion on the theme "What is computer science; its object and training." The discussion leaders were J. Gruska (Czechoslovakia), K. P. Schnorr (Federal Republic of Germany), A. Salomaä (Finland), N. M. Nagorny (USSR), J. Hofeš (Czechoslovakia), S. Ginsburg (USA), J. Hartmanis (USA), J. Bečvař (Czechoslovakia), and Z. Pawlak (Poland).

The Symposium maintained a high scientific level. Mention should be made of the great contribution to the splendid organization of the Symposium by its President, J. Gruska, and the Chairman of the Program Committee, J. Bečvař.

A volume of the Proceedings of the Symposium was published for its opening. It is planned that a supplementary volume will be published in the future which will also include the discussions. The next symposium on the same theme is proposed for 1975, to be held in Czechoslovakia.

A brief summary of several papers and reports delivered at the symposium is given below.

THEORY OF FORMAL LANGUAGES AND GRAMMARS

The well-known American mathematician Seymour Ginsburg participated in the work of the symposium. His paper, "Substitution and (semi-) abstract families of languages (AFL)," treated the theoretical language operation of substitution applied to abstract and semiabstract families of languages.

Study of AFL was also treated by the paper of M. Nivat (Paris), "Operators on families of languages," which examined the algebra generated by AFL and the identity relations contained within this algebra.

The same group of problems was broached by the report of B. Rovana (Bratislava) entitled "Necessary conditions for the inclusion of the principal (semi-) AFL with bounded generators."

Great interest was evoked by the paper of the well-known Finnish mathematician, Arto Salomaä, entitled "A-systems: means in the biologically motivated theory of automata," dealing with so-called L-systems, i.e., systems whose effects are defined upon formalization by sequences of letters. A series of special language problems that arise in the theory of L-systems was examined.

The paper of M. Novotni (Brno, Czechoslovakia), "Construction of grammars of formal languages," considered the method of representation of languages. Several criteria for the constructibility of language

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representations were given.

Great interest was evinced by the paper by J. Gruska (Bratislava), "Complexity of description of context-free languages," which reviewed a large number of criteria for the complexity of context-free languages and grammars and examined the algorithmic problem of executing these criteria.

J. Gruska's paper was adjoined by the report of W. Brauer (Hamburg, Federal Republic of Germany), "Grammatical complexity of context-free languages."

The report of A. B. Kremers and O. Maier (Karlsruhe, Federal Republic of Germany) on "Vector languages" examined the class of so-called vector languages. The vector languages are generated by grammars with specific matrix-like constraints on derivations. A number of algorithmic problems was considered. A generalization of Parikh's theorem was given.

The report of A. Bertoni (Milan, Italy), "Equations of formal power series for noncommutative semirings," dealt with the application of the apparatus of formal power series in the study of context-free languages.

THEORY OF AUTOMATA

The paper of F. Heczeg (Szeged, Hungary), "Modeling theory methods in the theory of automata," dealt with the task of composing automata of the direct derivation type. It applied the theoretical modeling approach.

The paper of I. Peak (Salgotarjan, Hungary) and Nguyen Qui Kang (Hanoi, North Vietnam) on "Endomorphism of semigroups of nilpotent automata" was connected with the study of semigroups of endomorphisms in automata.

K. A. Petri (Bonn) presented a paper on "Some concepts in network theory."

The theory of probabilistic automata was treated by the paper of P. G. Starke (Berlin, German Democratic Republic), "Sequential relations in time-variant automata," the report of I. Sudborough and A. Saltzberg (Illinois, USA), "Language families determined by random-choice time-constrained machines," and the report of G. Kuestner (Berlin) on "Algebraic characteristics of finite stochastic automata and their behavioral functions."

D. A. Simovichi (Iasi, Rumania) spoke on "Several measurements on semigroups of induced semiautomata."

The report of F. Flagiolet and D. M. Steer (Rocquencourt, France), "Decision problems for multihead finite automata," treated algorithmic problems belonging to the class of bilateral multihead automata operating on a one-letter alphabet.

The report of D. V. Grzimaly-Busse (Poznan, Poland) on "Connectivity of periodic sums of automata" examined the operation of extension of finite automata.

The report of A. Skowron (Warsaw), "Input and output machines," covered the study of a special class of automata introduced by Z. Pavlak. An analog of Ritchie's theorem was proved for these automata.

MATHEMATICAL LOGIC AND ALGORITHMIC AND COMPUTATIONAL COMPLEXITY

Juris Hartmanis (New York), one of the leading American experts in computational complexity, attended the symposium. He presented a paper on the theme, "The problem of finding a natural measure of computational complexity." The paper considered the question of the properties to be fulfilled for a natural measure of complexity. An interesting review was given, and foreign work in this field was considered.

An important paper, "Lower-bound evaluation of the product of time and memory requirements in a Turing machine," was delivered by K. P. Schnorr (Frankfurt am Main). The basic result was as follows. Let P be an arbitrary program which computes a Boolean function f on a Turing machine. Then the minimum number of Boolean operations which are necessary to compute f yields the lower-bound evaluation of the product of time and memory requirements, the size of program P , and the constant multiplier C_M which depends only on the type of computations.

The paper by J. Bečvář (Prague) was entitled "Computations and complexity." It touched on the basic concepts of computational complexity.

The report of J. P. Cleave (Bristol, England), "Combinatorial problems. III. Degrees of combinatorial problems in computers," for the most part generalized the findings of J. C. Sheperdson relating to combinatorial problems in Turing machines.

The paper by Gelena Rasewa (Warsaw) on "The ω^+ -valued algorithmic logic and its associated problems" was the first paper of the symposium.

Great interest was evoked by the report of Guenter Hotz (Saarbrueckan, Federal Republic of Germany), "Recognition of context-free languages in time n^2 ." The paper stated that in a Turing machine with one input and one working tape, any context-free language can be recognized in time n^2 (it was previously estimated as n^3).

Classical theory of computational complexity on Turing machines was the topic of the papers of R. P. Daily (Chicago, USA), "Complexity of processes and the understanding of sequences," I. Korec (Bratislava), "Computational complexity based on time expectancy in Minsky machines," M. Nekvida (Liberec, Czechoslovakia), "Complexity of computable functions," and P. Strnad (Liberec, Czechoslovakia), "Recognition on Turing machines."

The work of O. Štepankova and I. M. Gavel (Prague), "Some results attending situation calculus," dealt with the theory of situation calculus introduced by McCarthy and Hays. Proof is given of the possibility of establishing a connection between the solutions of patterns formalized in a certain space and formal proofs of theorems in situation calculus.

W. Bertol (Warsaw) spoke on "Semi-Boolean algebra and submachines."

The report of M. P. Hitil (Prague) on "Variations in input and output coding" dealt with automatic aspects of indexing theory.

P. Ng and R. T. Ieg (Austin, Texas, USA) delivered a paper on the theme "Transformation of trees by finite recursive transient machines."

The paper of P. Hays (Colchester, England), "Computing and deduction," examined the connection between the processes of computing and deductive control.

A. Mazurkewicz (Warsaw) gave a paper on "Proofs of properties in processes" in which a study was made of the properties of programs formalized as a certain algorithmic process.

THEORY OF COMPUTERS AND PROGRAMMING

During the first day of the symposium, a paper was read by K. Čulik (Prague), "Equivalence of parallel running in algorithmic networks and precedence block diagrams." The paper examined several types of precedence algorithms which are run on multiprocessor computers. The precedence algorithm operating on an instruction sequence and a certain relation of precedence between the instructions is defined as the precise prescription of instructions which satisfy the following deterministic requirement: the same initial state of memory and execution of the algorithm in any order or simultaneously, although always conforming to the relation of precedence, produces the same resultant state of memory. Ordinary block diagrams (with the concept of branching) and algorithmic networks (with the concept of operation) are special cases of precedence algorithms. Several special cases of branching equivalence were examined. The concept of precedence block diagrams which allow simultaneous execution of several instructions was given. Precedence block diagrams are a generalization of ordinary block diagrams.

The paper of B. Semelki (Budapest) on "A formal description of assembler languages" was on the determination, study, and formulation of general machine-independent characteristics of assembler languages.

The paper by Z. Pawlak (Warsaw), "Mathematical foundations of information retrieval," offered an algebraic model for describing the task of information retrieval. The obtained results present a new, simple method for practical implementation of information retrieval on computer systems.

A. Blikle (Warsaw) presented in his paper "Algebraic approach to programs and their computation" some formalism for the computation of programs.

K. Indermark (Bonn) spoke on "Yanov's schemata with single-address memory." The paper dealt with the theory of program schemata derived from the classical work of Yu. I. Yanov.

The report of L. Carlucci and I. Montanari (Pisa, Italy) on "Formal determination of control in structured programs" studied the broad classes of structured programs generated by special kinds of graphic context-free grammars. These grammars extend the concepts and properties of these graphic languages.

In the report of J. Hořejš (Brno, Czechoslovakia), "Algebraic model of parallel processes," one understands the program to be an unregulated sequence of semiconditional operators (an operator whose action proceeds when its associated conditions are satisfied). A condition status check is solved by introducing several block structures which allow synchronization at different levels. The paper presented a model to explain the nature of the parallel

process bound to the idea of constructing an extended algorithmic language.

It was demonstrated in the paper of J. Kral (Prague), "Some sources of primitive constructions in programming languages," that the characteristics of many programming languages may be deduced from a small number of logically simple, primitive constructions, many of which are assembler-like.

The paper of D. Marini and P. Milioni (Milan, Italy), "Program characteristics and their synthesis by formalized theory," presented the results of a study of the relations between two different formal means associated with the intuitive structure of programs.

The paper of Ja. Moravek (Prague), "Computational optimization of dynamic programming methods," studied the pair consisting of the tasks and the class of algorithms which solve them. Each algorithm has its appropriate measure of complexity (a reflection of the class of algorithms in the set of nonnegative numbers). The problem of determining the optimum algorithm to perform the task was considered. This problem boils down to finding the shortest path on the final directed graph with the noted edges, without loops.

In the report of V. Railih (Prague), "Relational and dynamic structures of some discrete systems," an attempt was made to generalize the theory of automata and nesting for the purpose of applying them to the study of the growth, semireproduction, semirecovery, and other aspects of systems. The basic mathematical structure applied here is the modified structure of relations, which allows description of the natural world consisting of interacting objects, where both the objects and relations of different types are considered statistically.

The communication of W. P. de Rover (Amsterdam, Netherlands), "Operational and mathematical semantics for recursive polyadic programming schemes," defined a language for recursive polyadic programming schemes and a language for binary relations required to characterize the input-output behavior of recursive programs.

The communication of Hans-Georg Stork (Darmstadt, Federal Republic of Germany), "Remarks on improving input chains for paging machines (virtual memory)," dealt with the process of translating input programs to paging algorithms. The concept of paging machines was formulated.

The report of A. V. Anisimov (Kiev, USSR), "Unbiased analysis of programming languages," treated the problem of syntactic analysis. A metalanguage was suggested and investigated for assigning programming languages directed toward an unbiased syntactic scanning-type analysis.

N. M. Nagorny (Moscow, together with A. A. Markov) read a paper on "One approach to describing computer operations" in which a compact description of the operation of computers and computer systems is proposed. This description has a precise syntax and is therefore advantageous for precisely stating and solving various problems in programming theory, designing computers, etc.