search techniques (for finding a win) based on the rules of the game and the definition of the winning condition are presented.

The next paper is a tutorial on the frame problem in the context of intelligent robot systems. This is the problem of maintaining and updating the current context or "frame of reference" each time new information is created during problem solving. Raphael describes the problem in a clear, informative manner, and presents lucid evaluations of the primary approaches proposed for solving the frame problem.

The next four papers deal with language and picture processing. Lindsay's paper describes a natural language parsing system, JIGSAW1, based on labelled dependency analysis, which uses both syntax and semantics to guide the parsing. An interesting analogy is drawn between the combined use of syntax and semantics to parse a sentence and the combined use of contour information and picture information to put together a jigsaw puzzle. Simmon's paper describes a generative teaching program which has a semantic net data base and is able to use this information to generate and score quizzes. The paper by Palme is an interesting tutorial on question-answering systems. The one by Clowes is a short, provocative tutorial on picture descriptions. Most of the approaches discussed by Clowes rely on syntax-directed analysis of two-dimensional patterns.

The last paper, by Kochen, discusses the problem of formulating a model of cognitive learning. Examples of how a learning system can learn to maximize the utility of a situation when given a series of situation descriptions are presented. Also, a number of definitions and theorems about cognitive learning are introduced and stated in mathematical terms.

Building Deduction Machines ..... J. A. Robinson
Prolegomena to a Theory of Efficiency of Proof Procedures ..... B. Meltzer
Problem-Solving Compilers ..... E. W. Elcock
A Survey of Seven Projects Using the Same Language ..... N. V. Findler
Heuristic Search: Concepts and Methods ..... E. J. Sandewall
Formation and Execution of Plans by Machine ..... D. Michie
A General Game-Playing Program ..... J. Pitrat
The Frame Problem in Problem-Solving Systems ..... B. Raphael
Jigsaw Heuristics and a Language Learning Model ..... R. K. Lindsay
Natural Language for Instructional Communication ..... R. F. Simmons
Making Computers Understand Natural Language ..... J. Palme
Picture Descriptions ..... M. Clowes
Cognitive Learning Processes: an Explication ..... M. Kochen
Computer Simulation of Verbal Learning and Concept Formation ... L. W. Gregg (abstract only)

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41 [13.35].—F. GÉCSEG & I. PEÁK, *Algebraic Theory of Automata*, Akademiai Kiadó, Budapest, 1972, xiii + 326 pp., 25 cm. Price $13.00.

The intention of this book is to provide an exact and approximately complete algebraic theory of deterministic Mealy-, Moore- and Medvedev-automata. In fact, the authors have been successful in giving a detailed and well comprehensible version of the theory developed in this field up to the year 1966, approximately, especially of authors in Eastern Europe, e.g. V. G. Bodnarčuk, V. M. Gluškov, L. Kalmár, H. Kaphengst, A. A. Letičevskiĭ, V. N. Red'ko, A. Salomaa and, last but not least, the authors of this book. Only a section concerning experiments and a decomposition in the sense of Krohn-Rhodes is omitted, but other decompositions are studied in detail. For nearly all statements and theorems, there are references to the literature and further results are given as "supplements and exercises" at the end of each paragraph. Considering automata as algebraic structures, the development of the theory is similar to that of semigroups and groups.

In Chapters 1 and 2, there are developed the usual well-known concepts concerning homomorphism, reduction, equivalence, minimization, analysis and synthesis of finite automata, i.e., an effective process to determine the input-output mapping and to realize a given behavior, respectively. Furthermore, the algebra of events $E(X)$ is discussed in detail and, in order to deal with general fixed point-equalities, a norm is defined on $E(X)$ making it a complete normed linear space. Commutative, nilpotent, definite, linear and pushdown automata are treated briefly in Chapter 3, whereas general products of automata and their relationships to automaton mappings (i.e., input-output mappings induced by automata) are studied in Chapter 4. A general product in this sense includes feedback, while several other concepts, like the loop-free composition of J. Hartmanis (called R-product), the cascade product, cross product, semidirect product, and direct product, can be obtained as special cases of the general one. The main problem, whether there exists a finite (or minimal) system of automata for a given type of products such that each automaton mapping can be induced by such a product of automata, is treated for the case of the general and the R-product. Furthermore, semigroups and groups of automaton mappings are studied, including methods for metric groups. In Chapter 5, the monoid of transitions, endomorphism semigroups and automorphism groups of automata are treated, especially for the case of cyclic and commutative automata and those having an input-monoid.

Based on monographs by V. M. Gluškov and N. E. Kobrinskiĭ-B. A. Trahtenbrot, the appendix is devoted to structural systems, i.e., systems over a set of automata having powers of $\mathbf{Z}_2$ as states, input and output, such that the system is closed under three operations, which are defined with respect to technical applications. Using methods from universal algebra, it is proved constructively that each automaton can be embedded isomorphically in an automaton belonging to a system containing a memory element and a complete set of logical elements.

Summarizing, it can be said that this book presents an excellent mathematical theory of deterministic automata with special regard to regular events, general products, semigroups and structural systems of automata.

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