universal in the strict sense for $\mathscr{A}$ if there exist two mappings $\phi_1: \mathscr{A} \to \Sigma_M^*$ and $\phi_2: (\bigcup_{A \in \mathscr{A}} \Sigma_A^*) \to \Sigma_M^*$ with the two following properties: (i) For any A in $\mathscr{A}$ and x in Σ_A^*, $\phi_1(A)\phi_2(x) \in T(M)$ iff $x \in T(A)$; and (ii) there exists an effective procedure such that for any A in $\mathscr{A}$ and any x in $T(A)$, given the derivation of $\phi_1(A)\phi_2(x)$ in M, one can construct a derivation of x in A and vice versa.

M is said to be *universal in the broad sense for* $\mathscr{A}$ if there exists a mapping $\psi: \bigcup_{A \in \mathscr{A}}\{(A, x): x \in \Sigma_A^*\} \to \Sigma_M^*$ with the two following properties: (iii) For any A in $\mathscr{A}$ and x in Σ_A^*, $\psi(A, x) \in T(M)$ iff $x \in T(A)$; and (iv) there exists an effective procedure such that for any A in $\mathscr{A}$ and x in $T(A)$, given the derivation of $\psi(A, x)$ in M, one can construct a derivation of x in A and vice versa.

The author's main results given in this paper are the following: (1) For any finite class of finite automata there exists a finite automaton that is universal for this class in the strict sense. (2) For the class $\mathscr{A}_{FS}$ of all finite automata there exists a push-down automaton universal in the broad sense for $\mathscr{A}_{FS}$ and a linear-bounded automaton universal in the strict sense for $\mathscr{A}_{FS}$. (3) For any finite class of push-down automata there exists a push-down automaton universal in the strict sense for this class. (4) For the class $\mathscr{A}_{PD}^0$ of all push-down automata that can not change configurations independently of the input symbol there exists a push-down automaton universal for $\mathscr{A}_{PD}^0$ in the broad sense. (5) For the class $\mathscr{A}_{LB}$ of all linear-bounded automata there exists a linear-bounded automaton universal for $\mathscr{A}_{LB}$ in the broad sense and a Turing machine universal for $\mathscr{A}_{LB}$ in the strict sense.

As it is well known, for each type of automaton considered here there exists an equivalent type of generative grammar. The author defines parallel notions of universal grammars and formulates theorems analogous to (1)–(5).

As it is easy to imagine, universal automata are very complicated devices. In order to describe them in a more compact way, the author introduces a special-purpose algorithmic language with procedures. "Programs" in this language describe linear-bounded automata. Unfortunately, the language itself is quite complicated. Its syntax is described by approximately fifty Backus equations.

The paper is mathematically fairly clean and precise but, on the other hand, rather hard to read. There are very few explanations of the ideas and notions introduced; e.g. the relation $\alpha \vdash_D \beta$ (page 59) is defined by an alternation of twenty-four (two-line) conditions, but no explanation of this definition is given. Of course, the reader can try to understand it without any help from the author, but how many of the readers will do this? ANDRZEJ BLIKLE

ROBERT MCNAUGHTON. *The theory of automata, a survey.* ***Advances in computers,*** Volume 2, edited by Franz L. Alt, Academic Press, New York and London 1961, pp. 379–421.

This paper provides a compact, philosophically penetrating historical survey of automata theory during its Adam-and-Eve years. After defining the notion of an automaton, the paper develops the results of the theory as it existed in 1961. There are eight sections: *Introduction*; *Finite automata*; *Probabilistic automata*; *Behavioral descriptions*; *Various concepts of growing automata*; *Operations by finite and growing automata, real-time and general*; *Automata recognition*; and *Imitation of life-like processes by automata.* The bibliography lists 119 references. As we can easily observe from the titles of the sections, all areas of investigation are covered in the survey. With a specialist's keen insight, the author provides correct explanations and accurate evaluations of the studies in these areas. Open questions are given in several places, along with the author's suggestions. This paper is recommended to all computer scientists with abstract minds. S. HUZINO

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