Discrete Math. Appl., Vol. 3, No. 6, pp. 623–633 (1993)

Indistinguishability of finite automata in a stationary observation medium*

I. S. GRUNSKII and O. M. KOPYTOVA

Abstract — We consider criteria of finiteness of the class of automata indistinguishable by simple experiments of infinite and finite length under the condition that, instead of the input–output sequence generated by an automaton, an experimenter observes this sequence coded by some function (observation medium). Under the same conditions we obtain a criteria of break of the chain of classes of automata indistinguishable by experiments of finite length as the length of the experiments increases.

1. INTRODUCTION

One of the classic problems of the theory of automata is the investigation of indistinguishability of automata by means of various experiments [1–3]. In this paper the property of indistinguishability of automata by simple experiments which has not been studied earlier is investigated. In the case considered here the input–output sequence generated by an automaton is hidden from an experimenter by an observation medium and he observes only the code-image of this sequence. The following objects can be considered as the observation medium:

(1) a logical scheme such that the investigated automaton is a part of it;
(2) a device of preliminary processing of observations, e.g. a signature analyzer [4];
(3) a discrete communication channel with noise [5].

In this paper we consider a stationary observation medium without memory realizing an alphabetic coding of input–output sequences.

Criteria of finiteness of the class of automata indistinguished in this observation medium by means of simple experiments of unlimited length (Theorem 2) and of fixed length (Theorem 3) are obtained. Conditions of break of the chain of classes of automata indistinguished by means of experiments of length i as i increases (Theorem 1) are obtained. The main instruments are the sequences of observed codes whose continuations are decoded into input–output sequences in a special way. The role of these codes is analogous to the role of the identifiers of states [3]. In the particular case of the medium with one-to-one coding, these codes coincide with the identifiers of states.

2. THE MAIN DEFINITIONS

Let an automaton $A = (S, X, Y, \delta, \lambda)$ be a finite completely defined determinate Meely machine where S, X, Y are the sets of states, input and output symbols, δ, λ are the transition function and output function, respectively. Let $p = x_1 \dots x_k \in X^*$ be an input word. We denote by $\delta(s, p)$ the state which the automaton A transits into from a

*UDC 519.95. Originally published in *Diskretnaya Matematika* (1993) **5**, No. 4, 124–134 (in Russian). Translated by N. I. Primenko.