Journal of Automata, Languages and Combinatorics **7** (2002) 1, 95–108

THE PARALLEL COMPLEXITY OF DETERMINISTIC AND PROBABILISTIC AUTOMATA [1]

CARLO MEREGHETTI
Dipartimento di Informatica, Sistemistica e Comunicazione (DISCo)
Università degli Studi di Milano – Bicocca
via Bicocca degli Arcimboldi 8, I-20126 Milano, Italy
e-mail: mereghetti@disco.unimib.it

and

BEATRICE PALANO
Dipartimento di Informatica, Università degli Studi di Torino
corso Svizzera 185, I-10149 Torino, Italy
e-mail: beatrice@di.unito.it

ABSTRACT

A deterministic (probabilistic) automaton is said to be in TC^0 whenever its transitions (stochastic event) can be computed by threshold circuits of polynomial size and constant depth. Here, we prove that:

- The class of deterministic automata in TC^0 is closed under homomorphism, subautomaton, and α_0-product operations.
- The class of k-state deterministic (probabilistic) automata is contained in TC^0 if and only if $k \leq 4$ ($k \leq 2$), unless $\mathrm{TC}^0 = \mathrm{NC}^1$.

Moreover, the possibility of ranking regular languages in TC^0 is related to the group-structure of their syntactic monoid.

Keywords: Threshold circuits, deterministic and probabilistic automata, algebraic theory of automata

1. Introduction

In this work, we study *the parallel complexity of computing transitions in deterministic automata and stochastic events defined by probabilistic automata.* As computational model, we use *threshold circuits* [18]. We are interested in solving problems by means of threshold circuits with *constant depth.* To this regard, we focus on the class TC^0 [8]

[1]Partially supported by MURST, under the project "Modelli di calcolo innovativi: metodi sintattici e combinatori". Some results in this paper were presented in a preliminary form [15] at the *6th Italian Conference on Theoretical Computer Science* (*ICTCS* 98), Prato, Italy, November 9–11, 1998.