Journal of Automata, Languages and Combinatorics **13** (2008) 2, 125–139

QUANTUM FINITE AUTOMATA AND WEIGHTED AUTOMATA [1]

M. V. Panduranga Rao [2]
Tata Research Development and Design Centre
Pune 411013, India
e-mail: mvprao@gmail.com

and

V. Vinay
Geodesic Information Systems Ltd.
Bangalore, India
e-mail: vinay@geodesic.com

ABSTRACT

Quantum finite automata derive their strength by exploiting interference in complex valued probability amplitudes. Of particular interest is the 2-way model of Ambainis and Watrous that has both quantum and classical states (2QCFA) [A. Ambainis and J. Watrous, Two-way finite automata with quantum and classical state, Theoretical Computer Science, 287 (2002) 1, 299–311], since it combines the advantage of the power of interference in a constant-sized quantum system with a 2-way head.

This paper is a step towards finding the least powerful model which is purely classical and can mimic the dynamics of quantum phase. We consider weighted automata with the Cortes-Mohri definition of language recognition [C. Cortes and M. Mohri, Context-Free Recognition with Weighted Automata, Grammars 3 (2000) 2/3, 133–150] as a candidate model for simulating 2QCFA.

Given any 2QCFA that (i) uses the accept-reject-continue observable, (ii) recognizes a language with one-sided error and (iii) the entries of whose unitary matrices are algebraic complex numbers, we show a method of constructing a weighted automaton over $\mathbb{C}$ that simulates it efficiently.

Keywords: Weighted automata, quantum finite automata, automata with classical and quantum states

1. Introduction

Quantum Finite Automata (QFA) have been an area of active research in the recent past, with a lot models being investigated for their power. The first of such models,

[2] Work done when the first author was at the Department of Computer Science and Automation, Indian Institute of Science, Bangalore, India.

[1] A preliminary version of this paper appeared in the proceedings of workshop on Algorithms and Complexity in Durham (ACiD-2005).