Theoretical Computer Science 410 (2009) 1915

Contents lists available at ScienceDirect

Theoretical Computer Science

journal homepage: www.elsevier.com/locate/tcs

Preface

The workshop on Probabilistic and Quantum Automata (PQA 2007) was held in Turku, Finland on July 7, 2007 as a satellite event of the annual conference Developments in Language Theory (DLT 2007). The date is characterized by an extraordinary sequence 070707 not to be repeated for another century.

PQA 2007, as a part of DLT 2007 was supported by The Academy of Finland, The Finnish Cultural Foundation, Finnish Academy of Science and Letters (Vilho, Yrjö and Kalle Väisälä Fund), Nokia Foundation, Turku University Foundation, and Centro Hotel. The support by these institutions is gratefully acknowledged.

The main topic of the workshop was the one indicated by the name of the workshop, but other interesting topics included quantum query algorithms and connections to the first-order logic. The basic pillars of the workshop consisted of three invited talks given by experts on quantum and probabilistic automata. In addition, the program committee accepted four papers to be presented as regular contributions.

The workshop papers, extended to full versions, were invited for the special issue of Theoretical Computer Science, but the invitation was also extended to cover contributions not presented at the workshop. After the refereeing process, five articles were selected.

Probabilistic automata (PA for short) are generalizations of deterministic finite automata: instead of transition function which determines uniquely the action of the automaton, one has transition function which associates probabilities to various potential actions. The theory of probabilistic automata has been developed since 1960's by various researchers, but there are also very recent interesting results on the compactness of probabilistic automata when compared to the deterministic ones.

Quantum finite automata (QFA for short) are variants of finite automata (FA). There are various definitions of QFA, but in most cases, the term "variant" indeed describes them better than "generalization". More precisely, the earliest models of QFA introduced by Crutchfield and Moore, as well as by Kondacs and Watrous, were by no means *generalizations* of FA: from the beginning it was clear the languages accepted by those automata (with reasonable acceptance modes) constitute only a subset of regular languages.

On the other hand, the study of quantum automata has revealed that for some language families, QFA can be exponentially more concise than the minimal deterministic automaton. Nevertheless, in my opinion, the study of QFA is not propelled by the need for small automata. Rather, it is the fascinating variety of mathematical machinery associated to the theory of QFAs which makes the study so interesting. So far it has turned out that in addition to tools used in the theory of deterministic automata, also methods from Hilbert space theory (or more generally, metric space theory), combinatorial tools, discrete Fourier analysis, elementary and advanced number theory, optimization theory, and the use of general algebraic structures are all useful in research on QFA.

There are also definitions of QFA allowing the acceptance of all regular languages, but the three articles of this special issued devoted to QFA concentrate rather on the "early models" (in one, mixed states are allowed, though).

Traditional QFAs are also closely related to probabilistic automata. In fact, one only needs to replace the unitary matrices with stochastic ones, L_2-norm with L_1-norm, initial superposition with initial probability distribution, and the measurement projection with a final state vector. Especially, *reversible* probabilistic automata (with so-called decide-and-halt acceptation), covered by a paper in this issue, bear a notable similarity to QFA as defined by Kondacs and Watrous.

The relationship between logic and computation is a traditional research topic in the theory of computation. Therefore, this special issue is concluded with a survey article on the logical characterizations of quantum automata.

Mika Hirvensalo
Turku, Finland
E-mail address: mikhirve@utu.fi.

doi:10.1016/j.tcs.2009.01.019