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DESCRIPTIONAL COMPLEXITY ISSUES IN QUANTUM COMPUTING [1]

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ABSTRACT

The recent discovery that foundations of computing should be based on the laws of quantum physics brings new challenges also for descriptional complexity.

The aim of the paper is to present and analyse these challenges, as well as the results obtained so far and the methods used to get them. The paper discusses also various open problems and research directions in quantum descriptional complexity to deal with.

Keywords: Quantum finite automata, succinctness, recognition power, quantum data compression, random access coding, entanglement.

1. Introduction

It is nowadays clear that it is more proper to build foundations of computing on models that are proper abstractions, for computational/descriptional purposes, of the principles, laws and limitations on which quantum physics is based, than on the models based on the classical physics.

The first task is, of course, to develop appropriate quantum computational models. The very basic steps in this direction have already been made and some further research lines to follow are also getting quite clear. Various quantum generalizations of such classical computational models as finite automata, Turing machines and cellular automata have already been developed and intensively investigated (see [13] and its web-extention[3], for a presentation). Most of these models are actually quite straightforward generalizations (quantumization) of the corresponding classical models.[4]

[1] Full version of an invited lecture presented at the First International Workshop on *Descriptional Complexity of Automata, Grammars and Related Structures* held in Magdeburg, Germany, July 20 – 23, 1999.

[2] The original version of the paper was written for DCAGRS '99 during the author stay at University of Nice, in Sophia Antipolis, within the PAST program. Support of the GAČR grant 201/98/0369 is also to acknowledge.

[3] For the book extension see `http://www.mcgraw-hill.co.uk/gruska` and files `updatings.ps` and `additions.ps`.

[4] Development of these models has not always been straightforward, especially in the case of