RECOGNITION AND COMPLEXITY RESULTS FOR PROJECTION LANGUAGES OF TWO-DIMENSIONAL AUTOMATA

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ABSTRACT

The row projection (resp., column projection) of a given two-dimensional language L is the one-dimensional language consisting of first rows (resp., first columns) of all two-dimensional words in L. The operation of row projection has previously been studied under the name "frontier language", and previous work in this area has focused primarily on one- and two-dimensional language classes.

In this paper, we study projections of languages recognized by various two-dimensional automaton classes. We show that both the row and column projections of languages recognized by (four-way) two-dimensional automata are exactly context-sensitive, and we obtain a similar characterization for row and column projections of two-dimensional local languages. We also show that the column projections of languages recognized by unary three-way two-dimensional automata can be recognized using nondeterministic logspace. Finally, we study the state complexity of projection languages for two-way two-dimensional automata, focusing on the language operations of union and diagonal concatenation.

Keywords: language classes, projection languages, space complexity, three-way automata, two-dimensional automata, two-way automata

1. Introduction

A two-dimensional word, also known in the literature as a picture, is a generalization of the notion of a word from a one-dimensional string to a two-dimensional array or matrix of symbols. Two-dimensional words are used as the input to two-dimensional

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