Journal of Automata, Languages and Combinatorics **15** (2010) 1/2, 135–153


# ONE-WAY CELLULAR AUTOMATA, BOUNDED LANGUAGES, AND MINIMAL COMMUNICATION [1]

MARTIN KUTRIB and ANDREAS MALCHER
*Institut für Informatik, Universität Giessen*
*Arndtstr. 2, 35392 Giessen, Germany*
*e-mail:* {kutrib,malcher}@informatik.uni-giessen.de

ABSTRACT

Cellular automata are one-dimensional arrays of interconnected interacting finite automata. We investigate one of the weakest classes, the real-time one-way cellular automata, and impose an additional restriction on their inter-cell communication by bounding the number of allowed uses of the links between cells. In order to get closer to the borderline at which non-trivial decidability problems of cellular automata classes may become decidable, we impose additional restrictions. First, we consider the devices as acceptors for *bounded* languages. It is shown that several problems are still undecidable if the number of communications between each two neighboring cells is logarithmically or if the total number of communications during a computation is linearly bounded in the length of the input. Moreover, it turns out that even devices with drastically reduced communication, that is, every two neighboring cells may communicate only constantly often, accept bounded languages that are not semilinear. Second, we consider devices where, in addition, the bandwidth of the communication links between cells is bounded by some constant number of bits. Again, undecidability results are shown. This is also true when all restrictions are combined.

*Keywords:* Cellular automata, limited communication, bounded languages, decidability, formal languages

## 1. Introduction

Devices of homogeneous, interconnected, parallel acting automata have been widely investigated from a computational capacity point of view. In particular, many results are known about *cellular automata* (see, for example, the surveys [12, 13]) which are linear arrays of identical copies of deterministic finite automata, where the single nodes, which are sometimes called cells, are homogeneously connected to both their immediate neighbors. Additionally, they work synchronously at discrete time steps.

Clearly, the computational power of systems of parallel acting automata, here cellular automata, relies on the ability of the system to communicate information between single automata within given time and space constraints. Thus, it is essential to know how communication should be organized in order to employ cellular automata

[1] Full version of a submission presented at the 11th Workshop on *Descriptional Complexity of Formal Systems* (Magdeburg, Germany, July 6–9, 2009).