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SELF-ASSEMBLING FINITE AUTOMATA

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ABSTRACT

We investigate a model of self-assembling finite automata. An automaton is assembled on demand during its computation from copies out of a finite set of items. These items are pieces of a finite automaton which are connected to the already assembled automaton by identifying states. Depending on the allowed number of such interface states, the degree, infinite hierarchies of properly included language families are shown. The presented model is a natural and unified generalization of regular and context-free languages since degrees one and two are characterizing the finite and pushdown automata, respectively. Moreover, by means of different closure properties nondeterministic and deterministic language families are separated.

Keywords: Self-assembly, finite automata, context-free languages, closure properties

1. Introduction

In nature, self-assembly is appearing in several ways. One of the simplest mechanisms is the merging of drops of water when placed close together. The process is directed by minimization of potential energy and, thus, an example of uncoded self-assembly. On the other extreme in complexity, protein molecules inside biological cells self-assemble to reproduce cells each time they divide. In this example, the assembly instructions are built in the components and, therefore, it is coded self-assembly [3]. Originally, the study of self-assembly was motivated by biologists. A well-studied example is the assembly of bacteriophages, a type of virus which infects bacterial cells [1]. Formal investigations in this field are accompanied by the development of corresponding computational models which are also of great interest from an engineering point of view. An introduction can be found in [7] where an automaton model of self-assembling systems is presented. The model operates on one-dimensional strings that are assembled