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MUTUALLY ACCEPTING CAPACITATED AUTOMATA

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ABSTRACT

We study *capacitated automata* (CAs) [10], where transitions correspond to resources and have capacities, bounding the number of times they may be traversed. We follow the *utilization semantics* of CAs and view them as recognizers of *multi-languages* – sets of multisets of words, where a multiset S of words is in the multi-language of a CA A if all the words in S can be mutually accepted by A: the multiset of runs on all the words in S together respects the bounds induced by the capacities. Thus, capacitated automata model possible utilizations of systems with bounded resources. We study the basic properties of CAs: their expressive power in the non-deterministic and deterministic models, closure under classical operations, and the complexity of basic decision problems.

Keywords: automata, multi-languages, expressive power, decision problems

1. Introduction

Finite state automata are used in the modelling and design of finite-state systems and their behaviors, with applications in engineering, databases, linguistics, biology, and many more. The traditional definition of an automaton does not refer to its transitions as consumable resources. Indeed, a run of an automaton is a sequence of successive transitions, and there is no bound whatsoever on the number of times that a transition may be traversed. In some settings, the use of a transition may correspond to the use of some resource. For example, it may be associated with the usage of some energy-consuming machine, application of some material, or consumption of bandwidth.

In [6], the authors introduced *Parikh automata*, which do impose restrictions related to consumption. Essentially, a Parikh automaton is a pair $\langle A, C\rangle$, where A is a nondeterministic finite automaton (NFA) over alphabet Σ, and $C \subseteq \mathbb{N}^{\Sigma}$ is a set of "allowed occurrences". A word w is accepted by $\langle A, C\rangle$ if A accepts w and the Parikh's

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