Journal of Automata, Languages and Combinatorics **25** (2020) 2–3, 115 – 140

AUTOMATA THAT MAY CHANGE THEIR MIND

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ABSTRACT

We introduce the concept of mind-changing automata. Basically, the idea is that at the outset the automaton is partially deterministic. Whenever the automaton encounters a situation for which it has an undefined transition, it may choose an appropriate transition out of a set of available transitions. The chosen transition is then added to the transition function. Finally, whenever the automaton is in a situation for which a transition is defined, it can *change its mind* and interchange the transition by an alternative transition from the set of available transitions. So, the number of transition changes is a natural parameter of the devices considered. We show that mind-changing finite automata (MCFAs) only accept regular languages. Moreover, we prove that, from a descriptional complexity point of view, a single mind-change is already better than nondeterminism, that is, there is a sequence of regular languages $(L_n)_{n\geq 3}$ accepted by n-state complete MCFA with a single alternative transition with at most one mind-change such that any nondeterministic finite automaton accepting L_n requires at least $n + \log n - 1$ states. Moreover, we perform a basic study on computational complexity issues for MCFAs with transition changes limited to a single state. We also consider mind-changing pushdown automata proving that the families of languages induced by the number of mind-changes lie strictly in between the deterministic context-free and context-free language families and form a proper mind-change hierarchy. What concerns the descriptional complexity of these level, it can be shown that there are nonrecursive trade-offs between the hierarchy levels of mind-changing pushdown automata, that is, the change in description size cannot be bounded by any recursive function.

Keywords: descriptional complexity, limited nondeterminism, nondeterministic finite automata, nondeterministic pushdown automata, recursive and nonrecursive trade-offs

1. Introduction

In linguistics it is generally accepted that language and thought influence each other. As said by Chomsky [2], "[. . .] language is a mirror of mind in a deep and significant sense." Although language is a mirror of mind, it is not a model of it. States of mind are used by Turing to model physical processes by abstract machines [13, 14], where the states of mind form a finite control. Thus, simply speaking, an abstract machine

This is a completely revised and expanded version of a paper presented at the 10th Workshop on Non-Classical Models of Automata and Applications (NCMA) held in Košice, Slovakia, August 21–22, 2018.