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MINIMAL AND REDUCED REVERSIBLE AUTOMATA

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ABSTRACT

A condition characterizing the class of regular languages which have several nonisomorphic minimal reversible automata is presented. The condition concerns the structure of the minimum automaton accepting the language under consideration. It is also observed that there exist reduced reversible automata which are not minimal, in the sense that all the automata obtained by merging some of their equivalent states are irreversible. Furthermore, a sufficient condition for the existence of infinitely many reduced reversible automata accepting a same language is given. It is also proved that, when the language is accepted by a unique minimal reversible automaton (that does not necessarily concide with the minimum deterministic automaton), then no other reduced reversible automata accepting it can exist.

Keywords: reversible automata, minimal automata, regular languages

1. Introduction

The principle of reversibility is fundamental in thermodynamics: a process is said to be reversible if its reversal causes no change in the original state of the system. This concept has been investigated in the case of computational devices by several authors (e. g. [9, 2]). On the one hand, a device is said to be *reversible* when each configuration has exactly one predecessor and one successor, thus implying that there is no loss of information during the computation. On the other hand, as observed by Landauer, logical irreversibility is associated with physical irreversibility and implies a certain amount of heat generation [9]. In order to avoid power dissipation and, hence, to reduce the overall power consumption of computational devices, the possibility of realizing reversible machines looks appealing.

A lot of work has been done to study reversibility in different computational devices. Just to give a few examples in the case of general devices as Turing machines, Bennet proved that each machine can be simulated by a reversible one [2], while Lange, McKenzie, and Tapp proved that each deterministic machine can be simulated by a reversible machine which uses the same amount of space [10]. As a corollary, in the case of a constant amount of space, this implies that each regular language is