On P Systems with Bounded Parallelism

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***Abstract*— A framework that describes the evolution of P systems with bounded parallelism is defined by introducing basic formal features that can be then integrated into a structural operational semantics. This approach investigates a generic strategy of selecting membranes and rules and applying the rules. P systems with boundary rules are used to illustrate the case and an example dealing with an evolution strategy involving bounded parallelism is discussed.**

I. Introduction

Membrane computing has been introduced with the aim of defining a computing device, called P system, which abstracts from the structure and the functioning of living cells [21]. The main results in this area show that P systems are a very powerful computational model mostly equivalent to Turing machines. Recent researches have been instead dedicated to the study of P systems as a modelling tool for biological systems [7], [8], [24], [5], [9]. In this case P systems are not used as a computing paradigm, but rather as a formalism for describing the behaviour of the system to be modelled. Therefore, there is a growing interest in developing implementations for the membrane computing paradigm in order to be able to execute a P system model and run simulations of biological phenomena. In this respect, a number of tools have already been produced (some of them are available from [29]) but yet correct implementation techniques need to be identified, especially when the quantitative aspects featuring the "reality" of a biological phenomenon are considered by the model.

Apart from the main stream of the research involving the study of the computational capabilities of different variants of P systems and applications in biology, there were investigations into formally defining the semantics of the behaviour and evolution of such systems. In [2] an operational semantics for a class of P systems is defined and its implementation in Maude is described. A step further has been taken by providing a structural operational semantics for that class of P systems with correctness proofs for each set of inference rules [3]. Both approches refer to P systems evolving in a maximally parallel manner, which is the cornerstone of most of the variants of the model.

In this paper, we present a variant of P systems with boundary rules where the rules have associated conditions and attributes. Then, for this variant, we provide some operational semantics definitions that characterise different strategies for the application of the rules based on the notion of parallelism of type (k, q) (in each step, at most k membranes can evolve and, inside each one of them, at most q rules can be used). The selection of membranes and rules relies on the structure of the systems and conditions and attributes associated to rules. This evolution strategy will cover some more recent approaches dropping the maximal parallelism and considering asynchronous sequential behaviour [13], bounded parallelism [12], probabilistic approaches [25], biologically oriented methods [8], [10], [5], [24].

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