Editing Configurations of P Systems

Erzsébet Csuhaj-Varjú[1], **Antonio Di Nola**[2],
Gheorghe Păun[3,4], **Mario J. Pérez-Jiménez**[4], **György Vaszil**[1]

[1]Computer and Automation Institute
Hungarian Academy of Sciences
Kende utca 13–17, H-1111 Budapest, Hungary
E-mail: {`csuhaj, vaszil`}`@sztaki.hu`

[2]Department of Mathematics and Computer Science
University of Salerno
84081 Baronissi, Salerno, Italy
E-mail: `adinola@unisa.it`

[3]Institute of Mathematics of the Romanian Academy
PO Box 1-764, 014700 Bucureşti, Romania
E-mail: `george.paun@imar.ro`

[4]Research Group on Natural Computing
Department of Computer Science and Artificial Intelligence
University of Sevilla
Avda. Reina Mercedes s/n, 41012 Sevilla, Spain
E-mail: {`gpaun, marper`}`@us.es`

Abstract. This paper proposes and preliminarily investigates the possibility of transforming a configuration (membrane structure and multisets of symbol-objects present in the compartments of this membrane structure) of a P system into another configuration, by means of a given set of rules acting both on the membranes and on the multisets of objects. Although such a transformation can be obtained during a computation of a P system, we consider it as a goal *per se*, as a pre-computation phase, when the system itself is built. In this framework, several important topics appear, such as the edit-distance between configurations (with respect to a given set of editing rules; actually, this is a weak metric, because it is not necessarily symmetric), normal forms, reachability, existence of single configurations from which a given family of configurations can be constructed, etc. We investigate here only a few of these questions; the paper is mainly devoted to formulating problems in the new framework, calling attention to the possible extensions and usefulness of the present approach.

1 Introduction

Membrane computing aims to abstract computing models from the cell structure and functioning, [14], [15]. With such a goal, the main research topics of the domain concern the computing power (comparing the power of the models obtained with inspiration from the cell biology with the power of Turing machines and of their restrictions) and the computing efficiency (solving computationally hard problems in a feasible time, by making use of a time-space trade-off which is made possible by various ways of producing an exponential working space in a linear time). The investigations were rather successful from these points of view – see details in [15] and in the web page from `http://psystems.disco.unimib.it`.

Roughly speaking, a cell-like P system consists of a membrane structure (a hierarchical arrangement of membranes), in the compartments of which one places multisets of symbol-objects; these two elements, the membrane structure and the multisets of objects present in its compartments, form a *configuration* of a system at a given time. In the compartments or associated with the membranes there also are sets of rules, according to which the objects and the membrane structure evolve; otherwise stated, by using these rules we obtain transitions among configurations. A sequence of transitions is called a computation. A computation is successful only if it halts, and with a halting computation we associate a result, e.g., in the form of the vector describing the multiplicity of objects from a given compartment of the halting configuration.

Here we switch the focus from computations to configurations, and we consider the problem of passing from a configuration to another configuration with the help of a given set of rules. This is similar to looking for transitions which link the two configurations, but the interest is different: we do not care about the computation itself (halting/non-halting) or about its result, while the rules we consider are mainly devoted to handling membrane structures. In some sense, our approach is directed to founding a "membrane calculus", as attempted also in [4], in another context.

Actually, there are several motivations for this kind of investigation. For instance, as already mentioned in [6] (the present paper can also be considered as a continuation of [6]), if a good (weak) metric related to the time of passing from a configuration to another configuration, with respect to the rules of a given P system, can be found, then it can be useful in a heuristic strategy to solving hard problems, based on the A^* algorithm from [13]. Then, taking into account that a P system is nothing else than an initial configuration and given sets of rules associated with membranes, constructing the initial configuration is a way to construct the system itself; otherwise stated, we can consider a specific set of rules for the pre-computing case, when the computing model itself is build, and other rules for the computation. This can have interesting consequences, for instance, in building a family of P systems associated with a decidability problem, in order to solve it (the particular systems from the family solve particular instances of the problem – see details, e.g., in [16]); in the standard computational complexity theory, this construction is done in polynomial time by a Turing machine, but the problem was formulated several times to have the P systems solving a problem constructed by another P system, so that the whole procedure is "uniformly bio-inspired". Links with other areas (such as the theory of abstract families of languages, graph theory, or evolutionary computing) will be mentioned below.

However, as already said, the present paper is only a preliminary exploration of the "membrane calculus" we propose, with several results and much more research topics formulated.

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