On the Power of Dissolution in P Systems with Active Membranes

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Abstract

In this paper we study the membrane dissolution rules in the framework of P systems with active membranes but without using electrical charges. The main results of this paper are the following: the polynomial computational complexity class associated with the class of recognizer P systems with active membranes, without polarizations and without dissolution is equal to the standard complexity class **P**, but using dissolution the above class contains the class **NP**.

1 Introduction

Membrane Computing is inspired by the structure and functioning of living cells, and it provides a new non–deterministic model of computation which starts from the assumption that the processes taking place in the compartmental structure of a living cell can be interpreted as computations. The devices of this model are called *P systems*.

Roughly speaking, a P system consists of a cell-like membrane structure, in the compartments of which one places multisets of objects which evolve according to given rules in a synchronous non–deterministic maximally parallel manner.

P systems with active membranes were introduced in [11] abstracting the way of obtaining new membranes through the process of *mitosis* (membrane division) and providing a tool able to construct an exponential workspace in

linear time. In these devices, the membranes have polarizations, one of the "electrical charges" $0, -, +$, and several times the problem was formulated whether or not these polarizations are necessary in order to obtain polynomial solutions to **NP**–complete problems. The last current result is that from [1], where one proves that two polarizations suffice.

P systems with active membranes have been successfully used to design (uniform) solutions to well-known **NP**-complete problems, such as SAT [20], *Subset Sum* [17], *Knapsack* [18], *Bin Packing* [19], *Partition* [4], and the *Common Algorithmic Problem* [21].

The present paper can be considered as a contribution to the interesting problem of characterizing the tractability in terms of descriptional resources required in membrane systems.

Specifically, in the framework of recognizer P systems with membrane division but without using polarizations we prove the following: (a) the class of problems which can be solved in a polynomial time by a family of such P systems but *without dissolution*, is equal to class **P**, and (b) the class of problems which can be solved in a polynomial time by a family of such P systems but *with dissolution*, contains the class **NP**. Hence, we have shown a surprising role of the –apparently "innocent"– operation of membrane dissolution, as it makes the difference between efficiency and non–efficiency for P systems with membrane division and without polarization.

The paper is organized as follows. In the next section some preliminary ideas about recognizer membrane systems and polynomial complexity classes are introduced. In Section 3 we present a characterization of the class **P** through the polynomial complexity class associated with recognizer P systems with active membranes, without polarization and without dissolution. In Section 4 we show that every **NP**–complete problem can be solved in a semi–uniform way by families of recognizer P systems using membrane dissolution rules and division for elementary and non–elementary membranes. Conclusions and some final remarks are given in Section 5.

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