# Formal verification of a transition P system generating the set $\{2^n + n^2 + n : \ n \geq 1\}$

Antonio Pérez-Jiménez; Mario J. Pérez-Jiménez and Fernando Sancho-Caparrini

Dpto. Ciencias de la Computación e Inteligencia Artificial
E.T.S. Ingeniería Informática. Universidad de Sevilla
Avda. Reina Mercedes s/n. 41012 - Sevilla. España

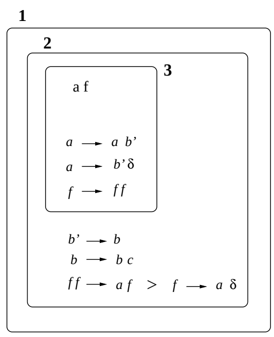
{Antonio.Perez,Mario.Perez,Fernando.Sancho}@cs.us.es

**Abstract.** In the foundational paper of membrane computing [1], an example of a P system generating exactly all the squares of natural numbers greater than or equal to 1 is given. Also, in the same paper it is remarked that a slightly modification of that P system can generate the set $\{2^n + n^2 + n : \ n \geq 1\}$. A formalization of the syntax of this modification following [3] is presented, aa well as the verification of the designed P system by studying the *critical points* of its computations.

## 1 Introduction

In October 1998, Gheorghe Păun ([1]) introduced a new computability model, of a distributed and parallel type, based on the notion of *membrane structure*. This model, called *transition P systems*, starts from the observation that the processes which take place in the complex structure of a living cell can be considered *computations*. Following [1], we can consider the P systems as devices which generate numbers: the total number of objects in the output membrane is the number *generated* by a computation.

In the cited paper, Gh. Păun suggests that the P system represented in Figure 1 (with membrane 1 as the output membrane) generates the set $\{2^n + n^2 + n : n \geq 1\}$ of natural numbers.



This paper follows the line started in [4]. We will present a formal description of the syntax of such P system according to the formalization presented in [3]. Moreover, it is proven that the output of any successful configuration of $\Pi$ encodes a natural number of the form $2^n + n^2 + n$, with $n \geq 1$, and, reciprocally, every natural number of this form is generated by some computation of $\Pi$.

This paper is structured in the following way. In Section 2 some preliminaries about formalization of transition P systems are presented, following [3]. In Section 3 the formal syntax of $\Pi$ is given. In Section 4 characterizations of successful computations of the above P system are established. In Section 5 we show that the output of every successful configuration of $\Pi$ encodes some $2^n + n^2 + n$, with $n$ a natural number greater than or equal to 1 (*soundness* of the P system) and, also, that $2^n + n^2 + n$, with $n$ a natural number greater than or equal to 1, is generated by some successful computation of $\Pi$ (*completeness* of the P system).

## References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