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A Class of P Systems for the Matrix Multiplication ⋆

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Abstract

P system is a computing model that imitates a natural process that occurs at a cellular level where all objects evolve in a maximal parallelism and distributed manner. Recent results show that it could be used to solve some problems for less computation time. In this paper, to obtain another new application of P systems, a class of P system for the matrix multiplication with integer numbers is proposed, which provides new ideas and methods for the parallel problem solving in today's big data environment. Firstly, a P system is constructed for matrix multiplication with integer numbers, and it is proven whether it is feasible through a simple example. This is a new attempt in applications of membrane computing, which gives a more effective method to implement the operation than the existing other results.

Keywords: P System; Membrane Computing; Matrix Multiplication; Big Data; Parallel Computing

1 Introduction

Membrane computing (P systems) is a new computing model that was named after and first proposed by Romanian scientist Gheorghe Păun. It simulates the function of living cells and abstracts biochemical reactions and material exchanges to calculate the process on a cellular level [1]. Membrane computing has been applied in many fields such as biological modeling, NPC problems and combinatorial problems. It is more suitable to solve huge data problems for all objects in it can evolve in a maximal parallelism and distributed manner. The parallelism lessens the time of computing process, so it meets requirement of huge data processing speed [1-3].

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The matrix multiplication is regarded as an important computing process in mathematics, which plays an indispensable role in science and technology. In today's big data environment, many researchers focus on achieving these operations by the P system which is a promising abstract computing model for its maximal parallelism and distributed manner. In this paper, we consider computing the matrix multiplication in a P system. In fact, the paper not only proves this kind of possibility, but also gives a more effective method to implement the operations than the existing other results.

2 Preliminary on P Systems

Membrane computing is an area within computer science that seeks to discover new computational models from the study of biological cells. It deals with distributed and parallel computing models, processing multiple sets of symbol objects in a localized manner.

There are a large number of cells in a living body, each region separated by membranes that can be a relatively independent computing unit, which completes its own calculation process. In a sense, the entire organism or even a biological system can be regarded as a membrane system. Therefore, this system can complete the calculation of process in the maximum degree of parallelism, and the computational efficiency will far exceed the existing computers. The known results show that most of the computation models in membrane computing are equivalent to the Turing machine. Its capacity of powerful parallel computing can be used to solve the bottleneck that computer serial computing faces.

There are 3 types: cell type, tissue type and neural type [4-9], where: [4, 5] for cell P systems, [6, 7] for tissue P systems, [8, 9] for spiking neural P systems. And cell P systems are the focus in this paper.

In a cell-like P system, there is a layered structure, and its basic elements include membrane structure, objects and rules. Membranes divide the entire system into different regions. The outermost layer of the membrane structure is called skin membrane. The skin can have sub-membranes which can also have membranes of the next layer. If there are no other membranes in the interior of a membrane, we call it basic membrane [4]. The basic membrane structure is shown as Fig. 1 [10-12].

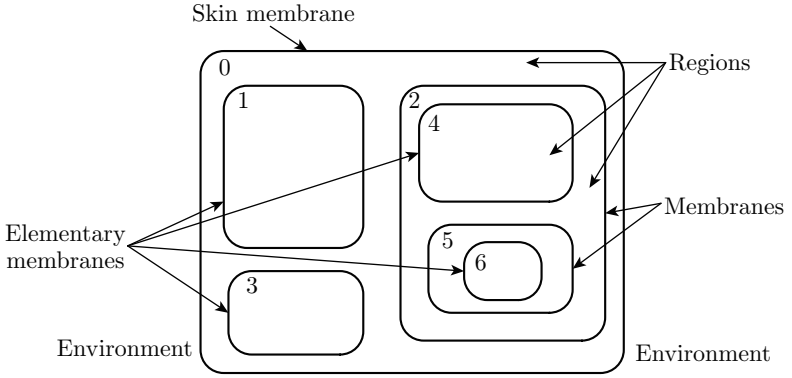

Fig. 1: The basic membrane structure