

# Classifying States of a Finite Markov Chain with Membrane Computing

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**Abstract.** In this paper we present a method to classify the states of a finite Markov chain through membrane computing. A specific P system with external output is designed for each boolean matrix associated with a finite Markov chain. The computation of the system allows us to decide the convergence of the process because it determines in the environment the classification of the states (recurrent, absorbent, and transient) as well as the periods of states. The amount of resources required in the construction is polynomial in the number of states of the Markov chain.

## 1 Introduction

Markov chains constitute an important type of stochastic processes characterized by their evolution along determinate values (called states of the process) over time. These chains represent observations of physic systems whose evolution at a future time, conditioned on their present and past values, depends only on their present value. Thus, the Markov chain loses the *memory* of its starting state.

In order to study the evolution in time of a Markov chain as well as the existence of the stationary distribution it is necessary to classify its states. This classification depends on the path structure of the chain.

In this work this problem is approached within the framework of the cellular computing with membranes. The amount of resources that we use is polynomial in the number of states. This subject has been also treated in terms of DNA computing, based on a mathematical proposition of existence rather than on the classical definition of the period of a state. This is due to the fact that DNA computing is good in detecting the existence, but it has difficulties in obtaining numerical quantifications.

The paper is structured as follows. In the next section, basic concepts concerning Markov chains and P systems are introduced. In Section 3 a semi-uniform solution to the problem of classifying the states of a Markov chain

in the framework of membrane computing is presented. Moreover, a formal verification of the system is given, and the run time and the resources required in the description of the system are analyzed.

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