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SMALLER UNIVERSAL SPIKING NEURAL P SYSTEMS WITH ANTI-SPIKES

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ABSTRACT

Spiking neural P systems with anti-spikes (in short, SN PA systems) are parallel computing models based on the way neurons communicate using two types of electrical impulses called excitatory impulses (spikes) and inhibitory impulses (anti-spikes). A universal computing SN PA system was designed by T. Song et al. using 75 neurons with 6 different types of neurons, 8 different types of rules and a total of 125 rules. In this paper, we continue the study small universal spiking neural P systems with anti-spikes and we improve in the types of neurons and the number of rules. We construct a small universal SN PA system with 104 simple neurons i. e., neurons having only one rule of the form $a \to \overline{a}$ or $a \to a$.

Keywords:

1. Introduction

Spiking neural P systems (in short, SN P systems) are membrane computing models which abstract the way neurons communicate by means of electrical impulses of identical shape, called spikes. The SN P systems were introduced in [6], and then investigated in a large number of papers. We refer to the respective chapter of [2] for general information in this area, and to the membrane computing website from [8] for details.

Spiking neural P systems with anti-spikes [5] consist of a set of neurons placed in the nodes of a directed graph and sending two types of signals (spikes, denoted by the symbol a and anti-spikes, denoted by the symbol $\overline{a}$) along synapses (arcs of the graph). Thus, the architecture is same as that of a spiking neural P system, but with two kinds of objects present in the neurons. The objects evolve by means of spiking rules, which are of the form $E/b^c \to b'$, where $b, b' \in \{a, \overline{a}\}$. If $L(E) = \{b^c\}$ then the rules are written as $b^c \to b'$ and are called pure. The system has four categories of spiking rules identified by (a, a), $(a, \overline{a})$ (anti-spikes are produced from usual spikes by means of usual spiking rules), $(\overline{a}, a)$ and $(\overline{a}, \overline{a})$ (rules consuming anti-spikes can produce spikes or anti-spikes). The latter two rules are generally avoided as they are quite unnatural. Each neuron in the system has an implicit annihilation rule of the