On Homogeneous Spiking Neural P System Variants

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Abstract. (ABSTRACT)

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1 Introduction

2 Spiking Neural P System and Some Variants

3 Homogenization of Spiking Neural P Systems

A *state transition diagram* will be used to represent the activities of a neuron. A *state* is a set of spike counts. For example, the state $\{4, 5\}$ represents spike counts 4 and 5, the state $\{0, 2, 4, 8, ...\}$ represents even spike counts, and the state $\{15, 20, 25, 30, 35, ...\}$ represents spike counts that are multiples of 5 starting from 15.

If a neuron has n spikes, the neuron is said to be *in state* S if $n \in S$. For example, let $n = 10$ be the number spikes in the neuron and $S_a = \{1\}$, $S_b = \{2, 4, 9, 10, ...\}$, $S_c = \{5, 10, 15, 20, ...\}$ be states, the neuron is not in state S_a since $n \notin S_a$ but it is in state S_b and S_c since $n \in S_a$ and $n \in S_b$. States can intersect since they are sets which means a neuron can be in multiple states at the same time.

Most states that are associated with a given neuron represent the regular expressions of the rules in the neuron. For example, in Figure 1, neuron 1 have the rules $r_1 : a/a \to \lambda$ and $r_2 : a^3(a^2)^*/a^2 \to a$. The state $S_a = \{1\}$ represents the regular expression a of rule r_1 while the state $S_b = \{3, 5, 7, 9, 11, ...\}$ represents the regular expression $a^3(a^2)^*$ of rule r_2. The state $S_c = \{0, 2, 4, 6, 8, ...\}$, the set of even spike counts, is also associated with neuron 1 even though it does not represent a regular expression of any of the rules in neuron 1. State S_c is relevant to neuron 1 because neuron 1 can be in state S_c. For example, if neuron 1 starts with 0 spike and only receives even number of spikes, then neuron 1 will stay in state S_3.

For neuron 2 in Figure 1, it has the single rule $r_3 : a^3/a^3 \to a$ which means $S_z = \{3\}$ is associated with the neuron and it represents the regular expression a^3 of rule r_3. Neuron 2 only has one incoming synapse so it can only receive one spike at a time assuming the use of non-extended/standard spiking rules. The only other relevant states for neuron 2 are $S_w = \{0\}$, $S_x = \{1\}$, $s_y = \{2\}$. If neuron 2 starts with 0 spike, it will be state S_w. Neuron 2 will be in state S_x after receiving a spike, in state S_y after receiving a total of 2 spikes, and in state S_z after receiving a total of 3 spikes. At state S_z, neuron 2 will use rule r_3 consuming 3 spikes and returning to state S_w. Only states S_w, S_x, S_y, S_z are relevant to neuron 2 since it can only reach the spike counts in those states.

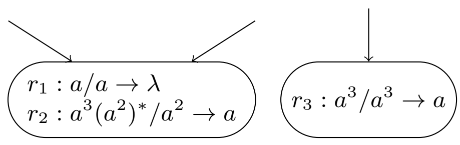

Fig. 1. Example Neurons

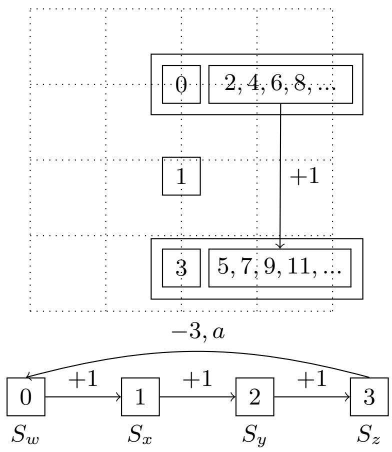

Fig. 2. Example Neurons