Simulation of Single Neuron Training by Direct Stimulation

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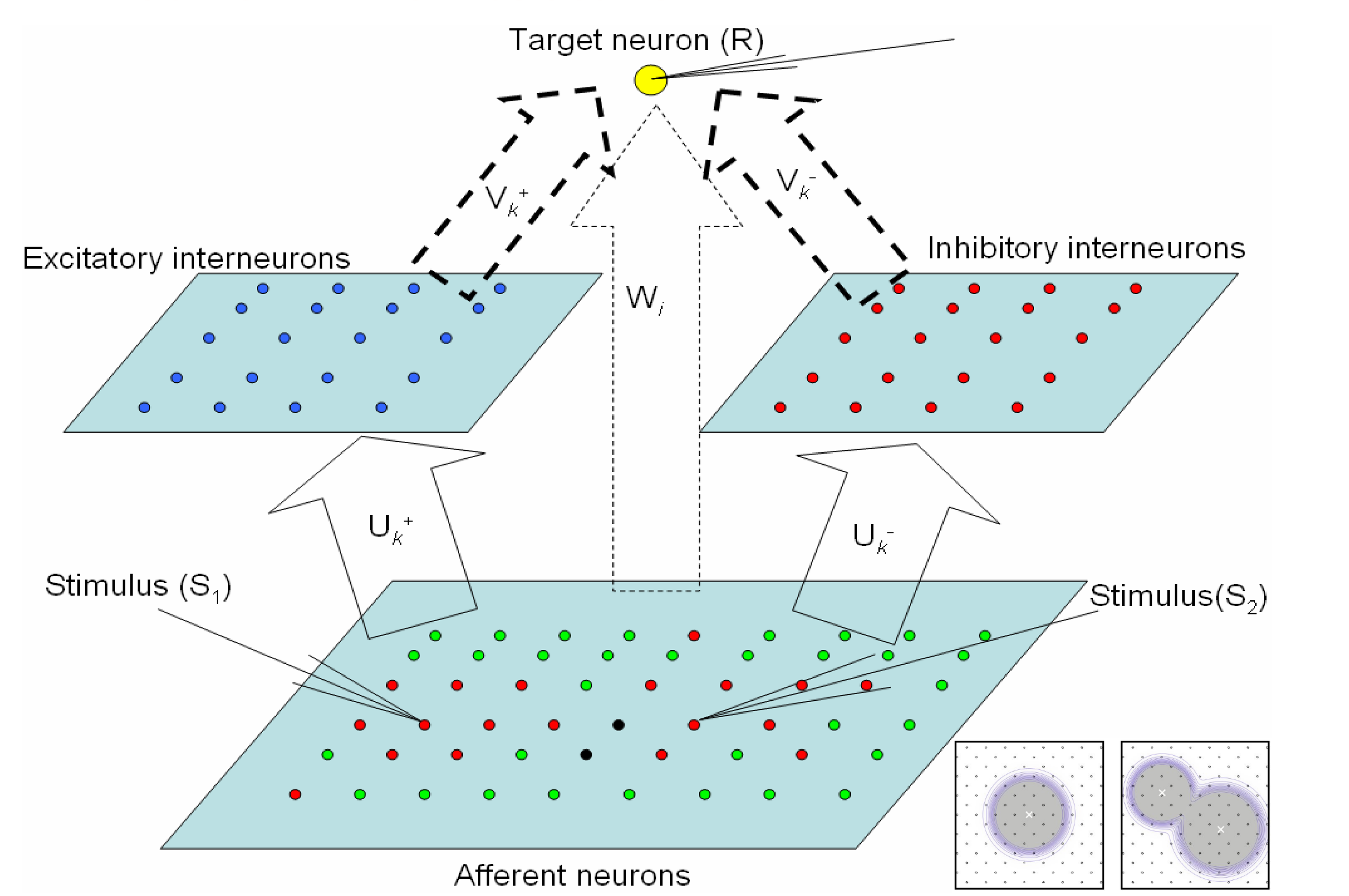
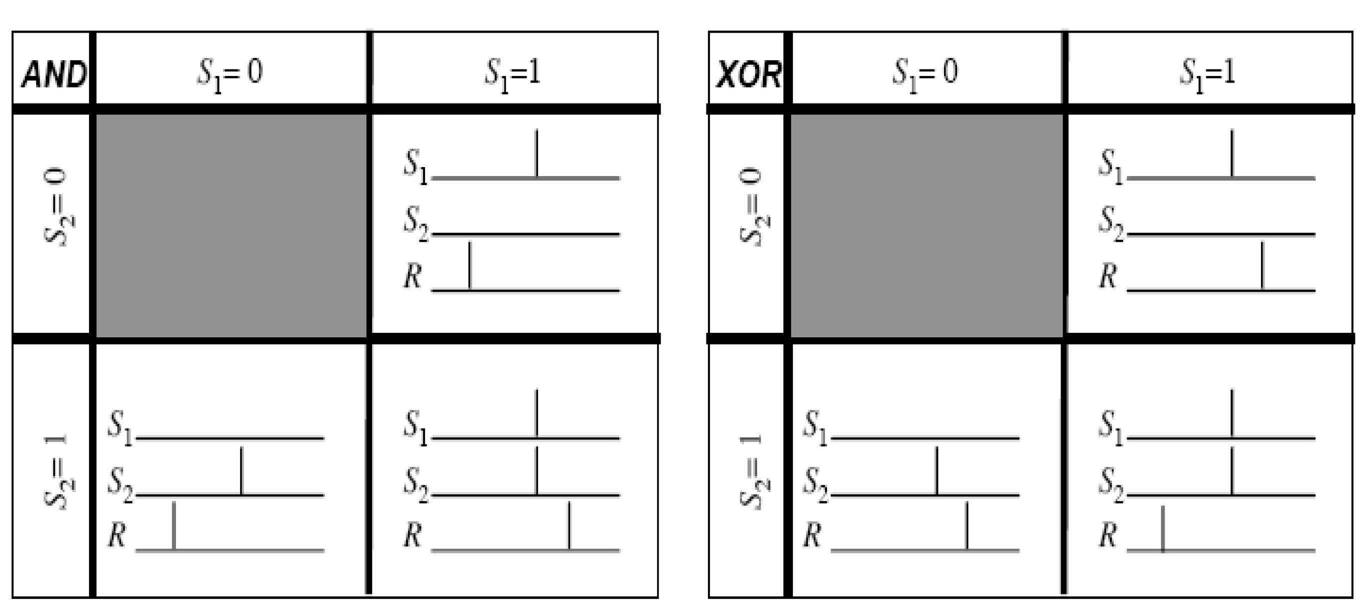
ABSTRACT

We build a feed forward neural network model based on STDP learning rule, and train this network to compute arbitrary functions. Based on this model, we carry out simulations investigating the role of neural plasticity. The goal of the work is to study the rules that specify the activity-dependence of synaptic change, and how the computational properties of neurons depend on the statistics of the afferent activity patterns. Three tasks were performed. First, AND and XOR. Second, three-bit parity. Third, continuous inputs. As results, we show that all the tasks can be learned by a network without inhibitory plasticity, as long as the parameters of the network are in appropriate range. Inhibitory plasticity could improve learning performance of the network.

Network Architecture:



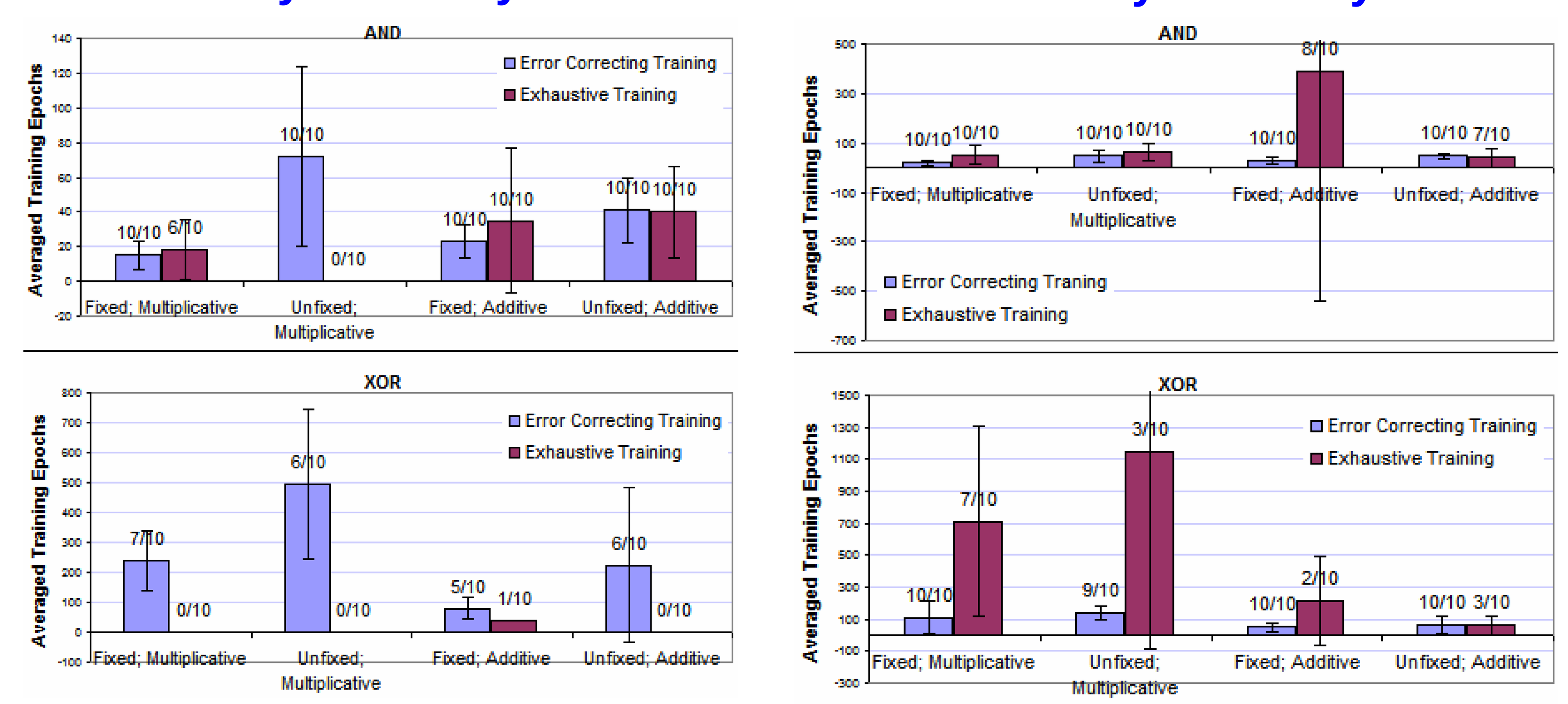
Training



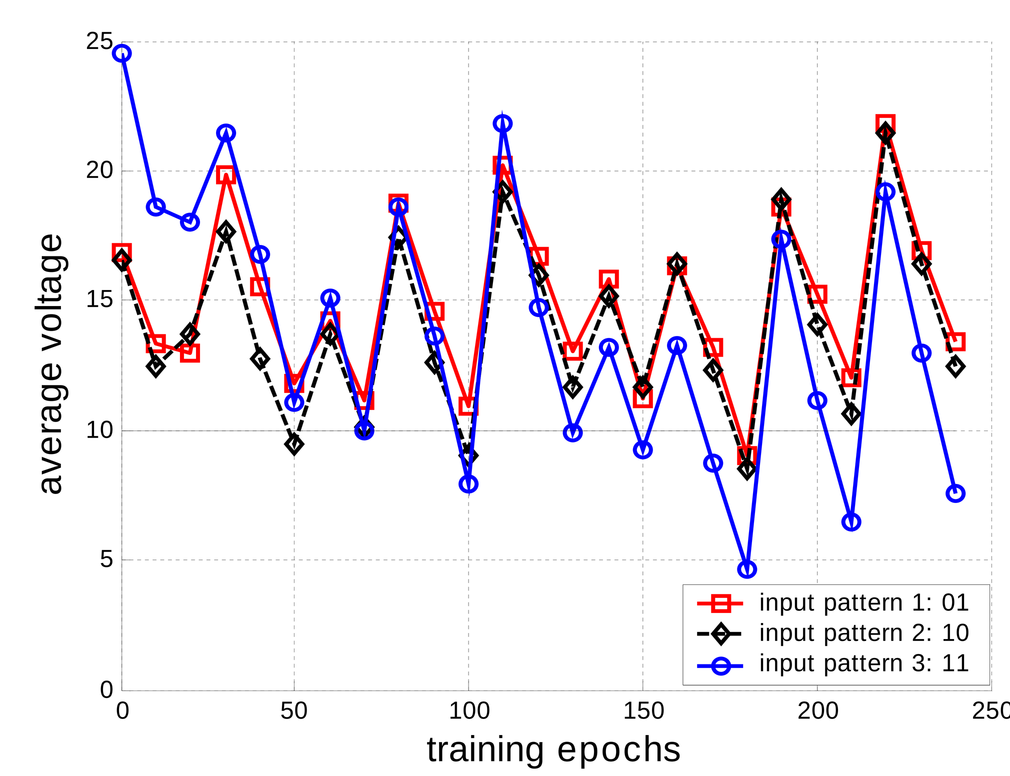
Study 1. AND and XOR

No Inhibitory Plasticity

With Inhibitory Plasticity

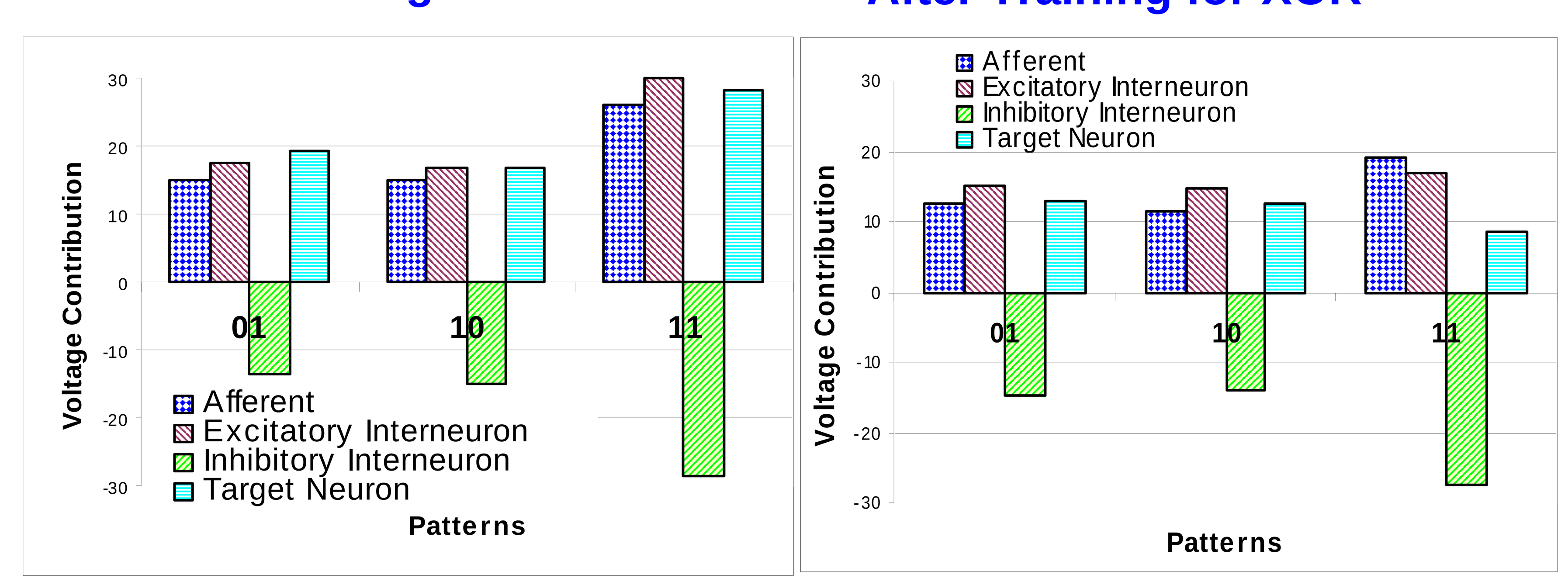


Average Voltage In Learning XOR Function

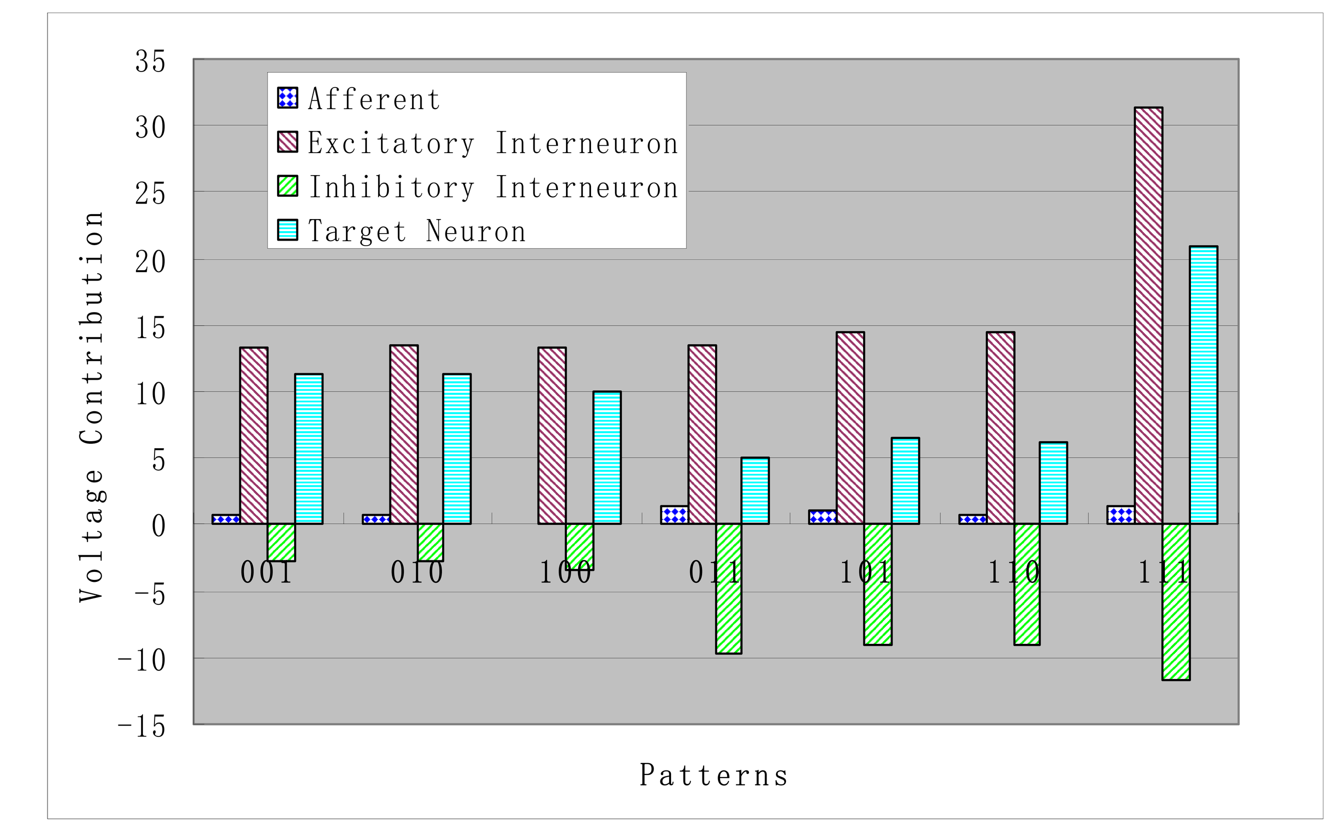


Before Training for XOR

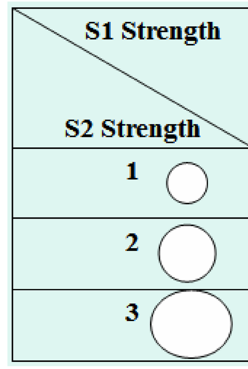
After Training for XOR



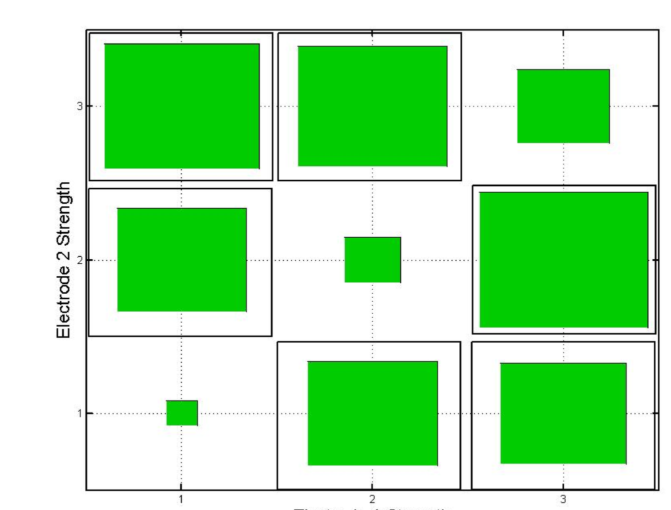
Study 2. Three Bit Parity



Study 3. Continuous Inputs



S2 Strength \ S1 Strength	1	2	3
1	0	1	1
2	1	0	1
3	1	1	0



Future Work

- **Including timing in simulation.**
- **What computational complexity can a neuron learn?**
- **How different architecture parameters affect the performance of the network?**
- **Based on the network performance, can we infer some knowledge about the network architecture?**
- **Experiments on training cortical circuits, results from experiments and computer simulation could be combined**