SPIKE TIMING ANALYSIS IN NEURAL NETWORKS WITH UNSUPERVISED SYNAPTIC PLASTICITY

B. E. P. Mizusaki, E. J. Agnes, L. G. Brunnet, R. Erichsen Jr.

(1) Instituto de Física - Universidade Federal do Rio Grande do Sul, Caixa Postal 15051, 9150-970 Porto Alegre, RS, Brazil
(email:beatriz@if.ufrgs.br)

The synaptic plasticity rules that sculpt a neural network architecture are key elements to understand cortical processing, as they may explain the emergence of stable, functional activity, while avoiding runaway excitation. For an associative memory framework, they should be built in a way as to enable the network to reproduce a robust spatiotemporal trajectory in response to an external stimulus. Still, how these rules may be implemented in recurrent networks and the way they relate to their capacity of pattern recognition remains unclear. We studied the effects of three phenomenological unsupervised rules in sparsely connected recurrent networks for associative memory: spike-timing-dependent-plasticity, short-term-plasticity and an homeostatic scaling [1]. The system is simulated either with analytically calculated integrate-and-fire neurons and discrete synapses or a numerically integrated more phenomenological model [2]. The experiments are divided in trials (as in [3]) composed by the presentation of a static pattern and the recording of the subsequent activity trajectory. The stability is monitored during the learning process of the network, as the mean firing rate converges to a value determined by the homeostatic scaling. Afterwards, it is possible to measure the recovery efficiency of the activity following each initial stimulus. This is compared by two different methods: the precision of the spike timing and the firing rates over time bins. The full memory separation capacity and limitations were analysed in both.

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