Methods for Simulating High-Conductance States in Neural Microcircuits

Eilif Müller, Karlheinz Meier, Johannes Schemmel
University of Heidelberg, Kirchhoff Institute for Physics,
INF 227, D-69120 Heidelberg
E-mail: emueller@kip.uni-heidelberg.de
http://www.kip.uni-heidelberg.de/vision

Accepted March 28, 2004 to Brain Inspired Cognitive Systems - BICS2004.

Abstract

A network simulation paradigm was developed to be consistent with observations of the high-conductance state of layer IV cortical neurons in an awake brain *in-vivo*. Two classes of integrate-and-fire based neurons, pyramidal (with adaptation) and inhibitory, were modeled. Synapses were conductance based. The high-conductance state was induced by synaptic bombardment with 1000 excitatory and 250 inhibitory Poisson processes with firing rates (e,i) respectively. The rates (e,i) were chosen so that the respective neuron models, (pyramidal, inhibitory), reproduce these rates under this bombardment. Network synapses were then enabled, replacing a fraction of the Poisson process input. A 9x9x9 lattice of neurons with a cortical layer IV inspired network topology was simulated at 1/200th real-time. Coherent network bursting emerged at 5-7 Hz. The dependence of the burst period on the time constant of adaptation was demonstrated to be linear with a slope consistent with unity. The simulation uses event based communication and a scalable Linux cluster implementation is foreseen.