LABORATORY OF COMPUTATIONAL NEUROSCIENCE (LCN)

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Wednesday, April 25th, 2012
10h30, Room SV2715

Computational Neuroscience Seminar

Moritz DEGER,
Bernstein Center Freiburg

Stochastic models of neurons and of the plasticity of neocortical synaptic connections

Neurons communicate via action potentials, also called spikes. The times of neuronal spike emission define a sequence of point-like events, the spike train. Firstly, I will introduce stochastic point processes that allow to define concise models of spike trains of single neurons. Analyses of the dynamics of such models allow to draw conclusions about the encoding of time-dependent signals by neuronal populations. A neuron in a neocortical network typically receives spike trains from thousands of other neurons as input. This input signal can be modelled as a superposition of point processes. As we found, the effective refractory period of the component spike trains dominates the superposition's statistics. This result suggests to use superpositions of Poisson processes with dead-time as a minimal and analytically tractable model of pooled neuronal input. Secondly, I will discuss the stochastic dynamics of the membrane potential of neurons driven by fluctuating inputs. Our extension of the theory of the integrate-and-fire neuron allows for pulsed inputs instead of diffusive noise and reveals the neuron's non-linear, instantaneous response to perturbations -- a property that enables neurons to act as coincidence detectors. Thirdly, I will present recent modeling results that explain the cooperative nature of the plasticity of neocortical synaptic contacts, based on correlations in the timing of pre- and postsynaptic spikes.