LABORATORY OF COMPUTATIONAL NEUROSCIENCE (LCN)

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

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Station 15
CH - 1015 LAUSANNE, Switzerland

Tuesday, December 10th, 2013
9h00, Room INM 200

Computational Neuroscience Seminars

9h00 – 9h50
Jean-Pascal PFISTER,
Dept. of Physiology, Uni Bern

Short-term and long-term plasticity from a normative perspective

9h50 – 10h40
Wolfgang EINHÄUSER,
Neurophysik Philipps-Universität Marburg

Ambiguity and Attention in the Real World

10h40– 11h00
Coffee Break

11h00 – 11h50
Costas Anastassiou,
Allen Institute for Brain Science

Electric fields in the brain

Jean-Pascal Pfister
Dept. of Physiology, Uni Bern

Short-term and long-term plasticity from a normative perspective

ABSTRACT:

Synapses are highly dynamical elements with extraordinary complexity. The up- or down-regulation of synaptic strength depends on more than 100 different interacting proteins and have effects over a wide range of time constants: from milliseconds to hours or days. Given this stunning complexity, developing a complete biophysical model of synaptic plasticity becomes a challenging task. In this talk, I will take another approach and present two top-down models of synaptic plasticity that provide a computational perspective on short-term and long-term synaptic plasticity.

In the first part, I will present a normative model of short-term plasticity (see Pfister et al. Nat. Neurosc. 2010). This study starts from the observation that spiking neurons are hybrid computational units in that they compute with analog signals in the dendrites and transmit only an incomplete (digital) account of this information by sending an action potential down the axon. This raises the question to what extent the original (analog) information can be reconstructed based only on the observed spiking information. Interestingly, the optimal bayesian estimator has a dynamic that can be matched to a standard phenomenological model of short-term plasticity thereby offering a functional interpretation of short-term plasticity.

The focus of the second part is on a normative model of long-term plasticity in the context of sequence learning (see Brea et al. J. Neurosc. 2013). Indeed, learning to produce specific spiking sequences is a general task the brain needs to solve, but it is unclear what type of biologically plausible learning rule is suited to learn a wide class of spatiotemporal activity patterns in a robust way. I will consider a recurrent network of stochastic spiking neurons composed of both visible and hidden neurons. I will then derive from first principles a generic synaptic learning rule that can accommodate a wide range of neuronal dynamics. Interestingly the proposed learning rule is both computationally relevant and biologically plausible. On the computational side, I will show that the capacity clearly outperforms the one of a Hopfield network. On the biological side, I will show that the learning rule is consistent with spike-timing dependent plasticity in that a presynaptic spike preceding a postsynaptic spike elicits potentiation while otherwise depression emerges. Furthermore, the learning rule for synapses that target visible neurons can be matched to the recently proposed voltage-triplet rule.

Finally, the learning rule for synapses that target hidden neurons is modulated by a global factor, which shares properties with astrocytes and gives rise to testable predictions.

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Wolfgang Einhäuser
Neurophysik Philipps-Universität Marburg

Ambiguity and Attention in the Real World

ABSTRACT:

When operating in realistic settings, humans and other organisms must continuously extract relevant information from complex sensory signals, which provide ambiguous information about their real-world sources. Besides exploiting statistical regularities inherent in natural input, humans can actively select relevant subsets through attention. In the first part of my talk, I will review my work as to which features drive human attention when encountering natural input. Particular emphasis will be given to the relation of objects and low-level features as well as to the differences between merely watching natural scenes and actively operating in the real world.

Second, I will show examples as to how rivalry - a common model for perceptual ambiguity - can be used to link perception, decision-making, memory and action. Based on my data, I will argue that ambiguity can be viewed as linking principle between these domains. Third, I will present ongoing work on how attention and rivalry can be jointly understood as competitive processes and may be modelled in a common framework based on winner-take-all circuits.

Finally, I will briefly review applied aspects of my work and their feedback on my basic-science research.

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Costas Anastassiou
Allen Institute for Brain Science

Electric fields in the brain

ABSTRACT:

Despite decades of extracellular voltage (Ve) recordings monitoring brain activity, the biophysical origin and functionality of these signals as well as their inherent variability remains enigmatic. This is particularly true for the local field potential (LFP), i.e., the lowpass-filtered part (typically <300 Hz) of Ve-recordings. I will present recent work on recreating such LFP-activity using a large-scale modeling approach that, for the first time, allows teasing apart the LFP into its primary constituents.

I will also discuss ongoing modeling efforts to recreate in vivo-like ensemble activity and its usefulness to experimentalists.

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