LABORATORY OF COMPUTATIONAL NEUROSCIENCE (LCN)

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Prof. Wulfram Gerstner
EPFL – IC & SV– LCN
SG –AAB119 (Bâtiment SG-AAB)
Station 15
CH - 1015 LAUSANNE, Switzerland

Monday, December 16th, 2013
Room INM 203

Computational Neuroscience Seminars

9h00 – 9h40
Claudia CLOPATH,
Bioengineering Department, Imperial College London
Synaptic plasticity and its functional implications

9h50 – 10h30
Daniel BRAUN,
Emmy-Noether Group Leader, MPI for Biological Cybernetics
Sensorimotor learning and decision-making in complex environments

***** Coffee Break *****

11h00 – 11h40
Eftychios PNEVMATIKAKIS,
Department of Statistics and the Center for Theoretical Neuroscience at Columbia University
Extracting information from calcium imaging data

11h50 – 12h30
Jakob MACKE,
Neural Computation and Behaviour, MPI for Biological Cybernetics
Statistical methods for characterizing cortical population dynamics

Eftychios A. Pnevmatikakis
Department of Statistics and the Center for Theoretical Neuroscience at Columbia University

Extracting information from calcium imaging data

Abstract

Calcium imaging methods have revolutionized large scale data acquisition in neuroscience, enabling the monitoring of large neural ensembles and detailed dendritic structures. A fundamental problem in calcium imaging data analysis is the identification and demixing of the different sources (neurons, dendrites), and the deconvolution of the underlying neural activity (spikes) from the calcium indicator. In this talk I will present methods for dealing with these problems in a principled way, using tools from matrix factorization, convex optimization, and state-space models.

The methods are scalable and applicable to a large variety of datasets (multi-neuronal recordings, dendritic imaging) and imaging protocols (raster scanning, random access multi-photon microscopy). I will also propose a novel framework for compressive calcium imaging that uses random projections to image neural ensembles. This framework can potentially enable imaging larger neuron populations at considerably faster imaging rates compared to current techniques.

Finally, I will discuss a novel general method for dimensionality reduction of multi-neuronal spike trains using recent tools for low-rank matrix estimation, and present an application to learning low-dimensional neural dynamics.

(top)

Claudia Clopath
Bioengineering Department at Imperial College London

Synaptic plasticity and its functional implications

Abstract

I am broadly interested in the field of neuroscience, especially insofar as it addresses the questions of learning and memory. Learning is thought to change the connections between the neurons in the brain, a process called synaptic plasticity.

Using mathematical and computational tools, I model synaptic plasticity across different time scales, synapse types and brain areas that reproduces experimental findings. I then study the role of synaptic plasticity, by constructing networks of artificial neurons with plastic synapses.

I am working in tight collaboration with experimental laboratories, which measure connectivity and functional changes.

(top)

Daniel Braun
Emmy-Noether Group Leader, MPI for Biological Cybernetics

Sensorimotor learning and decision-making in complex environments

Abstract

Recent advances in movement neuroscience suggest that sensorimotor control can be considered as a continuous decision-making process in complex environments in which uncertainty and task variability play a key role. Leading theories of motor control assume that the motor system learns probabilistic models and that motor behavior can be explained as the optimization of payoff or cost criteria under the expectation of these models. Here we discuss first how the motor system exploits task variability to build up efficient models and then discuss evidence that humans deviate from Bayes optimal behavior in their movements, because they exhibit effects of model uncertainty. Furthermore, we discuss in how far model uncertainty can be considered as a special case of a general decision-making framework inspired by statistical physics and thermodynamics.

(top)

Jakob Macke

Neural Computation and Behaviour, MPI for Biological Cybernetics

Statistical methods for characterizing cortical population dynamics

Abstract

Understanding how neurons collectively represent sensory input, perform computations and guide behaviour is one of the central goals of neuroscience. Simultaneous recordings of the activity of large neural populations are extremely valuable as they can be used to infer the dynamics and interactions of neurons in a local circuit, shedding light on the computations performed. What sort of statistical models best describes the concurrent spiking of cells within a local network in neocortex? What can these models tell us about the underlying neural mechanisms? Can we infer how an animal decodes neural population activity in order to form a perceptual decision? In this talk, I will describe our work on developing statistical methods for describing the dynamics of neural population activity and linking them to behaviour. In particular, I will describe a statistical method for "stitching" together sequentially imaged sets of neurons into one model by phrasing the problem as fitting a latent dynamical system with missing observations. This method allows us to substantially expand the population-sizes for which population dynamics can be characterised—beyond the number of simultaneously imaged neurons. In particular, I will show that---arguably surprisingly---it is possible to predict correlations between neuron-pairs which were never imaged simultaneously.

(top)