LABORATORY OF COMPUTATIONAL NEUROSCIENCE (LCN)

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13h30, Room BC 02

Computational Neuroscience Seminar

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Spike-Based Probabilistic Inference in Analog Graphical Models Using Interspike-Interval Coding

Temporal spike codes play a crucial role in neural information processing.
In particular, there is strong experimental evidence that interspike intervals (ISIs) are used for stimulus representation in neural systems.
However, very few algorithmic principles exploit the benefits of such temporal codes for probabilistic inference of stimuli or decisions. In this talk I will describe the functional properties of a spike-based processor that uses ISI distributions to perform probabilistic inference.
The abstract processor architecture serves as a building block for more concrete, neural implementations of the belief-propagation (BP) algorithm in arbitrary graphical models (e.g., Bayesian networks and factor graphs). The distributed nature of graphical models matches well with the architectural and functional constraints imposed by biology. In our model, ISI distributions represent the BP messages exchanged between factor nodes, leading to the interpretation of a single spike as a random sample that follows such a distribution. I will show simulation results that verify the functionality of the abstract processor model in full graphs, and demonstrate that it can be applied even in the presence of analog variables. As a particular example, I will also show results of a concrete, neural implementation of the processor, although in principle our approach is more flexible and allows different neurobiological interpretations. Furthermore, electrophysiological data from area LIP during behavioral experiments are assessed in light of ISI coding, leading to concrete testable, quantitative predictions and a more accurate description of these data compared to hitherto existing models.