Après midi thématique neurosciences
ANR ChaMaNe et GDT MathBio du LJLL

Lundi 8 février 2021

14h à 14h45: Zhennan Zhou, Peking University, China.

Titre : Fokker-Planck equations of neuron networks: rigorous justification and numerical simulation

Résumé : In this talk, we are concerned with the Fokker-Planck equations associated with the Nonlinear Noisy Leaky Integrate-and-Fire model for neuron networks. Due to the jump mechanism at the microscopic level, such Fokker-Planck equations are endowed with an unconventional structure: transporting the boundary flux to a specific interior point. In the first part of the talk, we present an alternative way to derive such Fokker-Planck equations from the microscopic model based on a novel iterative expansion. With this formulation, we prove that the probability density function of the "leaky integrate-and-fire" type stochastic process is a classical solution to the Fokker-Planck equation. Secondly, we propose a conservative and positivity preserving scheme for these Fokker-Planck equations, and we show that in the linear case, the semi-discrete scheme satisfies the discrete relative entropy estimate, which essentially matches the only known long time asymptotic solution property. We also provide extensive numerical tests to verify the scheme properties, and carry out several sets of numerical experiments, including finite-time blowup, convergence to equilibrium and capturing time-period solutions of the variant models.

14h50 à 15h35: Gaetan Vignoud, Inria de Paris, MAMBA

Titre : Titre : Stochastic Models of Neural Synaptic Plasticity

Résumé : In neuroscience, learning and memory are usually associated to long-term changes of neuronal connectivity. Synaptic plasticity refers to the set of mechanisms driving the dynamics of neuronal connections, called synapses and represented by a scalar value, the synaptic weight. Spike-Timing Dependent Plasticity (STDP) is a biologically-based model representing the time evolution of the synaptic weight as a functional of the past spiking activity of adjacent neurons.

In this talk we present a new, general, mathematical framework to study synaptic plasticity associated to different STDP rules. The system composed of two neurons connected

by a single synapse is investigated and a stochastic process describing its dynamical behavior is presented and analyzed. We show that a large number of STDP rules from neuroscience and physics can be represented by this formalism. Several aspects of these models are discussed and compared to canonical models of computational neuroscience. An important sub-class of plasticity kernels with a Markovian formulation is also defined and investigated via averaging principles.