Winter School on Deterministic and Stochastic Models in Neuroscience 11-15/12/17

Invited speakers :

— Daniele Avitabile (daniele.avitabile@nottingham.ac.uk)
— Bruno Cessac (bruno.cessac@inria.fr)
— François Delarue (delarue@unice.fr)
— Zachary Kilpatrick (zpkilpat@colorado.edu)
— Carlo Laing (c.r.laing@massey.ac.nz)
— Eva Löcherbach (eva.loecherbach@u-cergy.fr)
— Cristobal Quiñinao (cristobal.quininao@uoh.cl)
— Delphine Salort (delphine.salort@upmc.fr)
— Wilhelm Stannat (stannat@math.tu-berlin.de)
— Romain Veltz (romain.veltz@inria.fr)

Location : Amphitheater Laurent Schwartz, Institut de Mathématiques de Toulouse, Building 1R3

Tentative of Schedule :

	Monday	Tuesday	Wednesday	Thursday	Friday
9h-10h30	Course 1	Course 2	Course 3	Course 4	Course 3
11h-12h30	Course 2	Course 1	Talk 3	Course 3	Course 4
14h-15h	Talk 1	Talk 2	Talk 4	Talk 5	Talk 6
15h30- 17h	Course 1	Course 2		Course 4	

Table 1

Titles & Abstracts

Research courses

François Delarue (Laboratoire J.A. Dieudonné, University of Nice-Sophia Antipolis)

Ttile : Neuronal networks driven by a singular mean field self-excitation.
Abstract : The goal of these three lectures is to introduce a mean field model for a neural network with excitatory interactions. The key feature of this model is that it exhibits different behaviors depending on the value of the excitation parameter. We shall first introduce the finite model. It includes a large (but finite) population of interacting neurons. Inspired by usual results on McKean-Vlasov equations, we shall derive formally the limiting equation as the number of neurons tends to infinity. We shall address the solvability of the limiting equation in a second step. As a noticeable fact, we shall prove that a singularity may emerge when the excitation parameter driving the interactions between the neurons grows up. Conversely, we shall prove there is no singularity when the excitation parameter is small enough. Finally, we shall justify the passage from the finite to the limiting model. Possibly, we shall also discuss some extensions, including cases when the interaction graph between the neurons is not complete. The lecture will be mostly based on the following two papers :

Delarue F., Inglis J., Rubenthaler R., Tanré, E. (2015). Global solvability of a networked integrate-and-fire model of McKean-Vlasov type. Annals of Applied Probability, 2015, 2096–2133.

Delarue F., Inglis J., Rubenthaler R., Tanré E. (2015). Particle systems with a singular mean-field self-excitation. Application to neuronal networks. Stochastic Processes and their Applications, 125, pp.2451-2492

Eva Löcherbach (Département de Mathématiques, University of Cergy-Pontoise)

Title : Modeling interacting networks as processes with variable length.
Abstract : A class of recently introduced models to describe networks of neurons as stochastic processes with memory of variable length will be presented. These are non-Markovian processes in high or infinite dimension in which the past dependence of transition probabilities or intensities has a range that is finite but depends on the particular history. Starting from existence results and results on perfect simulation, we study related mean-field models in continuous time and their large population limits, and discuss the relation with associated Piecewise Deterministic Markov Processes (PDMP's) and state results concerning their longtime behavior. Finally, we will look at two important problems of statistical inference in such models : estimation of the spiking rate function and estimation of the neuronal interaction graph.

Delphine Salort (Laboratory of Computational and Quantitative Biology, University of Pierre and Marie Curie)

Title : Mathematical deterministic models in neurosciences.
Abstract : The aim of this course is to present some mathematical deterministic tools and models to study qualitative dynamics of single neuron and interacting neurons in a network. We will first consider some simple ordinary differential equation models for the modelling of single neurons in order to show how very simple mathematical models are able to capture some classical dynamic observed in a neuron. We will then explore the case of interacting neurons which communicate between them via they mean activity, using partial differential equations. We will particularly focus on two choices of descriptions : the time elapsed model and the Leaky Integrate and Fire model.

Romain Veltz (MathNeuro Team, Inria Sophia-Antipolis)

Title : Invariants manifolds for dynamical models in neurosciences.
Abstract : In these lectures, we focus on two methods for the analysis of bifurcations in infinite dimensions e.g.the center manifold and the normal form theory. The center manifold in a finite dimensional invariant manifold for the dynamics and the normal form theory allows the study of the flow restricted to it. We then study various applications of these tools to neural hallucinations in the visual cortex and to the effects of propagation delays in spatially extended neural networks, both applications involve spontaneous symmetry breaking.

Invited talks

Daniele Avitabile (School of Mathematical Sciences, University of Nottingham)

Ttile :
Abstract :

Bruno Cessac (Biovision Team, Inria Sophia-Antipolis)

Title :
Abstract :

Zachary Kilpatrick (University of Colorado Boulder)

Title :
Abstract :

Carlo Laing (Institute of Natural and Mathematical Sciences, Massey University)

Title :
Abstract :

Cristobal Quiñinao (Institute of Engineering Sciences, University of O'Higgins)

Title :

Abstract :

Wilhelm Stannat (Institute of Mathematics, Technische Universität Berlin)

Title :

Abstract :

Liste des participants

1. Eric Agius (Uniersity of Toulouse 3)
2. Daniele Avitabile (University of Nottingham)
3. Hugo Bringuier (University of Toulouse 3)
4. Patrick Cattiaux (University of Toulouse 3)
5. Bruno Cessac (Inria Nice Sophia-Antipolis)
6. Joachim Crevat (University of Toulouse 3)
7. François Delarue (University of Nice)
8. Christèle Etchegaray (University of Toulouse 3)
9. Grégory Faye (University of Toulouse 3)
10. Susely Figueroa Iglesias (University of Toulouse 3)
11. Zachary Kilpatrick (University of Colorado Bolder)
12. Carlo Laing (Massey University NZ)
13. Eva Löcherbach (University of Cergy)
14. Alexis Leculier (University of Toulouse 3)
15. Nadège Merabet (University of Toulouse 3)
16. Simon Moisselin (University of Toulouse 3)
17. Cristobal Quiñinao (University O'Higgins - Chili)
18. Delphine Salort (University Pierre et Marie Curie)
19. Wilhelm Stannat (TU Berlin)
20. Léonard Torossian (INRA Toulouse and University of Toulouse 3)
21. Romain Veltz (Inria Nice Sophia-Antipolis)