IHP Thematic Program
Random Processes in the Brain: from experimental data to Math and back

1st week: February 27 to March 3

Scratch courses from March 1 to March 3:

- 10:00-12:00: **Neurobiology for mathematicians** by C. Pouzat with F. Najman, P. Passos, B. Ramalho

  Content: Primer on basic neural physiology for mathematicians; von Helmholtz's conjecture of the predictive brain; intrinsic variability of neurobiological data and the need of probabilistic models

- 14:00-16:00: **Stochastics for neurobiologists** by A. Duarte and E. Löcherbach

  Content: Stochastic chains: Markov chains and variable length models; a simple model for spiking neurons and statistical inference; modeling EEG data.

  Bibliography :

  - Galves, A., Löcherbach, E. and Pouzat, C., Probabilistic spiking neuronal nets- Data, Models and Theorems. https://hal.archives-ouvertes.fr/hal-03196369v1
  - Luo, L., Principles of Neurobiology. Garland Science, 2021.

- 16:00-18:00: Informal discussions and project proposals / discussions with younger researchers.

2nd week: March 6 to March 10
Workshop: Structural learning by the brain

Monday March 6

- 9:00 Welcome coffee
- 9:30-10:30 Olivier Faugeras: Mathematical neuroscience
- 10:30-11:30 Aline Duarte: Retrieving context trees from EEG data
- 15:00-16:00 Florent Meyniel: Is human statistical learning Bayesian?
- 16:00-16:30 coffee break
- 16:30-17:30 Antonio Galves: Statistical model selection in the brain

Tuesday March 7

- 9:30-10:30 Gilles Laurent: Exploring the space of neural systems dynamics
- 10:30-11:30 Sonja Gruen: Higher-order spike patterns in cortex and models
- 15:00-16:00 Wojciech Szpankowski: Structural and temporal information
- 16:00-16:30 coffee break
- 16:30-17:30 Risto Ilmoniemi: Randomness in the brain: TMS versus sensory stimulation

Wednesday March 8

- 9:30-10:30 Leonardo Cohen: Consolidation of human skill linked to waking hippocampo-neocortical replay
- 10:30-11:30 Vikram Chib: Subjective valuation of effort.
- 15:00-16:00 Claudia D. Vargas: The goal-keeper game: predicting upcoming events by the brain.
- 16:00-16:30 coffee break
- 16:30-17:30 Bill Lytton: Avalanches in primary motor cortex
- 17:30-19:30 Cocktail and poster session with a short oral introduction: Fernando Najman, Paulo Passos, Bia Ramalho, Victor Hugo Souza, Noslen Hernández, Renan Shimoura, Raquel Carvalho...

Thursday March 9

- 9:30-10:30 Marcela Svarc: EEG clustering and data compression by the brain
- 10:30-11:30 Daniel Fraiman: An ANOVA approach for statistical comparisons of brain networks
- 15:00-16:00 Oswaldo Baffa: Retrieving context tree models driven by structured TMS pulse sequences
- 16:00-16:30 coffee break
- 16:30-17:30 Viktor Jirsa (tbc)

Friday March 10

- 9:30-10:30
- 10:30-11:30 Maria Elisa Pimentel: The Goalkeeper Game: A new assessment tool for prediction of gait performance under complex condition in people with Parkinson's disease
- 15:00-16:00 Antoine Triller: Synaptic receptors mouvement and brain diseases.
- 16:00-16:30 coffee break
- 16:30-17:30 Yves Frégnac: TBA

3rd week: March 13 to 17

1st Doctoral course: Structural learning by the brain

C. Vargas, A. Duarte, M. Svarc.

Content: Learning stochastic sequences of events by the brain; sequences of random objects driven by context tree models; statistical model selection for sequences of random objects driven by context tree models; the projective method; evoked potentials in EEG data; retrieving the structure of probabilistic sequences from EEG data; clustering EEG data by law.

Bibliography :

- Structural learning by the brain: Duarte et al., (2019), Hernandez et al., (2021)
- Selected papers of the special issue New frontiers for statistical learning in the cognitive sciences; compiled and edited by Blair C. Armstrong, Ram Frost and Morten H. Christiansen, Published in Phil. Trans. R. Soc. B, Volume 372 Issue 1711, 2017.

Daily schedule:

- 9:00-10:30 Lecture
- 10:30-11:00 Coffee break
- 11:00-12:00 Lecture
- 15:00-16:00 Coffee and informal discussions
- 16:00-17:30 Work in progress seminars

Séance grand public
Tuesday March 14, 6-8 pm, by Gilles Laurent and Olivier Faugéras

- Olivier Faugeras: Des mathématiques au chevet des neurones et des astrocytes
- Gilles Laurent: Evolution, Fonctions et Dynamique du Cerveau.

4th week: March 20 to 24

2nd Doctoral course: Stochastic modeling of neural networks.

A. Galves and C. Pouzat.

Content : A discrete time stochastic neural network model: a system of interacting chains with memory of variable length; a case study: correlations between successive inter spike intervals; a continuous time model: systems of interacting point processes with memory of variable length; models without reset: Hawkes processes; stationary states in an infinite system; perfect simulation and Kalikow decompositions; statistical model selection in a class of systems of spiking neurons; short-term synaptic facilitation and working memory.

Bibliography :

- Galves, A., Löcherbach, E. and Pouzat, C., Probabilistic spiking neuronal nets- Data, Models and Theorems. https://hal.archives-ouvertes.fr/hal-03196369v1

Daily schedule:

- 9:00-10:30 Lecture
- 10:30-11:00 Coffee break
- 11:00-12:00 Lecture
- 15:00-16:00 Coffee and informal discussions
- 16:00-17:30 Work in progress seminars

5th week: March 27 to 31
Workshop: Networks of spiking neurons

Monday March 27

- 9:00 Welcome coffee
- 9:30-10:30 Markus Diesmann: Simulation of large-scale neural networks.
- 10:30-11:30 Eva Löcherbach: Probabilistic spiking neurons
- 15:00-16:00 Christophe Pouzat: Where data come from and what do we model?
- 16:00-16:30 coffee break
- 16:30-17:30 Shigeru Shinomoto : Searching for neuronal activities involving behavioral changes in animals

Tuesday March 28

- 9:30-10:30 Antonio C. Roque: Spontaneous activity patterns in networks of nonlinear two-dimensional integrate and fire neurons.
- 10:30-11:30 Rodrigo Cofré: Scalable and accurate method for neuronal ensemble detection in spiking neural networks
- 15:00-16:00 Gilles Louppe: Simulation based network inference.
- 16:00-16:30 coffee break
- 16:30-17:30 Mauro Piccioni and Emilio De Santis: Statistical model selection in the class of systems of interacting point processes with memory of variable length

Wednesday March 29

- 9:30-10:30 Bruno Cessac: A dynamical system point of view
- 10:30-11:30 Massimiliano Tamborrino: ABC for neuronal data
- 15:00-16:00 Priscilla Greenwood: Building a stochastic neural circuit of cortical-pulvinar interaction
- 16:00-16:30 coffee break
- 16:30-17:30 Céline Duval: Recent results on Hawkes processes.
- 17:30-19:30 Cocktail and poster session with a short oral introduction: Morgan André, Kadmo de Souza Laxa, Valentin Schmutz, Zoé Agathe-Nerine, Nadia Belmabrouk, Marie Levakova, Francesca Cavallini, Michel Davydov, Elianys Garcia-Pola Cordoves, Flavio Rusch

Thursday March 30

- 9:30-10:30 Thibaud Taillefumier
- 10:30-11:30 Tilo Schwalger : Mesoscopic description of metastability in spiking neural networks
- 15:00-16:00 Étienne Tanré
- 16:00-16:30 coffee break
- 16:30-17:30 Reinhard Höpfner: On circuits of stochastic Hodgkin-Huxley neurons

Friday March 31

- 9:30-10:30 Guilherme Ost
- 10:30-11:30 Sacha van Albada
- 15:00-16:00 Romain Veltz
- 16:00-16:30 coffee break
- 16:30-17:30 Patricia Reynaud-Bouret

6th week: April 3 to 7

0.0.1 Hands-on week: Doctoral courses: conclusion and discussion of projects with students; plus work in progress seminars

Small research projects using the tools and concepts presented during the thematic program will be proposed to the students under supervision of senior researchers.

Daily schedule:

- 10:00-11:30 Research projects discussion.
- 16:30-17:30 Work in progress seminar.