

ANR ChaMaNe : Mathematical Challenges emerging from Neurosciences

Postdoctoral research topic : Testing Mean-Field behavior

- **Post-doctoral position of 1 year and a half, about 2450 euros (net)**
 - **Could be extended thanks to 3IA Cote d'Azur (Axis 3) AI for computational biology and Bio-inspired AI (other application to be made if the applicant wants it)**
 - **Supervisors**
 - **Eva Löcherbach, Paris 1, eva.locherbach@univ-paris1.fr**
 - **Patricia Reynaud-Bouret, LJAD, Nice, Patricia.Reynaud-Bouret@univ-cotedazur.fr**
 - **Etienne Tanré, Inria, Sophia-Antipolis, Etienne.Tanre@inria.fr**
 - **Possible interactions with other members of ChaMaNe**
 - **Based in Sophia Antipolis (near Nice, France)**
 - Institute NeuroMod:
<http://web.univ-cotedazur.fr//en/idex/projet-structurant/neuromod>
 - Inria:
<https://www.inria.fr/en/centre-inria-sophia-antipolis-mediterranee>
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Apply by sending an email directly to Patricia.Reynaud-Bouret@univ-cotedazur.fr

The application will include:

- Curriculum vitæ including the list of the scientific publications
 - Motivation letter
 - Letter of recommendation of the thesis supervisor
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- Description of the topic:

Neurons in the brain are organized in a gigantic network (10^{11} neurons in the human brain). Mathematics can help to understand which behavior they collectively have. In particular a lot of attention has been devoted to mean-field approximations of various models (simplified spiking neuron model [1], stochastic integrate and fire models [2] , Hawkes processes [3]) saying heuristically that if the network is homogeneous and the

interactions weak, then the common distribution of the neuron's voltage should satisfy a PDE.

If it is clearly not realistic to assume this kind of behavior on the whole brain, it might be interesting to see if this approximation holds at smaller scales (10^4 neurons typically, which is a typical size of some homogenous brain areas) and under particular behavior (rest etc).

In practice, the neurobiologists have access to Local Field Potential which is the average voltage of the population within some region, a few spike trains (that is the spiking time of a few neurons) and eventually the intracellular voltage trace of one given neuron.

The aim of the present post-doctoral position is to join a team of probabilists, statisticians and PDE experts to develop a statistical test of whether this mean-field approximation holds or not. Skills in probability are of utmost importance. Skills in statistics are not mandatory as long as the applicant is open to develop such statistical procedures (even computationally) in collaboration with statisticians.

References

- [1] Fournier, Löcherbach, "[On a toy model of interacting neurons](#)", Annales de l'IHP, 2016
- [2] Delarue, Inglis, Rubenthaler, Tanré "[Global solvability of a networked integrate-and-fire model of McKean–Vlasov type](#)", The Annals of Applied Probability, 2015
- [3] Chevallier J. : [Mean-field limit of generalized Hawkes processes](#), Stochastic Processes and their Applications, 2017 ([Hal version](#)).