Offer #2021-03818

Post-Doctoral Research Visit F/M Heterogeneity in Network of Interacting Neurons

Contract type : Fixed-term contract

Level of qualifications required : PhD or equivalent

Fonction : Post-Doctoral Research Visit

About the research centre or Inria department

The Inria Sophia Antipolis - Méditerranée center counts 34 research teams as well as 8 support departments. The center's staff (about 500 people including 320 Inria employees) is made up of scientists of different nationalities (250 foreigners of 50 nationalities), engineers, technicians and administrative staff. 1/3 of the staff are civil servants, the others are contractual agents. The majority of the center's research teams are located in Sophia Antipolis and Nice in the Alpes-Maritimes. Four teams are based in Montpellier and two teams are hosted in Bologna in Italy and Athens. The Center is a founding member of Université Côte d'Azur and partner of the I-site MUSE supported by the University of Montpellier.

Context

Within the framework of a partnership

- project/programme/European fund HBP SGA3

Supervision

Etienne Tanré and Romain Veltz, Permanent researcher Inria

Context

Olivier Faugeras is a member of the HBP project since the beginning.
His team, including Romain Veltz and Etienne Tanré, has developed and studied mathematical models with mean-field behaviors [1,2,3,4,5,6,7,8].
A common idea in most of these works is the following: an exchangeable interacting particle system has an asymptotic behavior as the number of particles tends to infinity.

Please, contact Etienne.Tanre@inria.fr and Romain.Veltz@inria.fr for more details.

Assignment

Role of the Post-Doc

This position is related to the HBP project. As such, the post-doc student will investigate the effect of heterogeneous cell diversity (neuron parameters, synaptic weights, etc) on the dynamics of stochastic networks of spiking neurons. We no more consider that the synaptic weights are equal but we take into account biological variability in the interactions.

Some results have already been obtained [9,10,11,12] when the weights are static.
In this project, a precise comparison between heterogeneous and homogeneous networks will be done on the mean-field equation [12]. In addition, the finite size effects will also be investigated.

Research environment

The student will be advised by Etienne Tanré, Romain Veltz and Olivier Faugeras. He/she will benefit from the environment of the HBP project. In particular, frequent meetings with the consortium are scheduled.

Additionally, the student will have the opportunity to interact with the members of the NeuroMod institute and the ChaMaNe ANR project.

Bibliography

[1] B. Aymard, F. Campillo, and R. Veltz. Mean-field limit of interacting 2D

nonlinear stochastic spiking neurons. 2019. https://arxiv.org/abs/1906.10232

[2] Q. Cormier, E. Tanré, and R. Veltz. Hopf bifurcation in a Mean-Field model of spiking neurons. 2021. https://arxiv.org/abs/2008.11116

[3] Q. Cormier, E. Tanré, and R. Veltz. Long time behavior of a mean-field model of interacting neurons". In: Stochastic Process. Appl. 130.5 (2020), pp. 2553-2595. https://doi.org/10.1016/j□spa.2019.07.010.

[4] F. Delarue, J. Inglis, S. Rubenthaler, and E. Tanré. Particle systems with a singular mean-field self-excitation. Application to neuronal networks". In: Stochastic Process. Appl. 125.6 (2015), pp. 2451-2492. https://doi.org/10.1016/j.spa.2015.01.007.

[5] F. Delarue, J. Inglis, S. Rubenthaler, and E. Tanré. Global solvability of a networked integrate-and-fire model of McKean-Vlasov type". In: Ann. Appl. Probab. 25.4 (2015), pp. 2096-2133. https://doi.org/10.1214/14-AAP1044.

[6] A. Drogoul and R. Veltz. Exponential stability of the stationary distribution of a mean-field of spiking neural network". In: J. Differential Equations 270 (2021), pp. 809-842. https://doi.org/10.1016/j.jde.2020.08.001

[7] A. Drogoul and R. Veltz. Hopf bifurcation in a nonlocal nonlinear transport equation stemming from stochastic neural dynamics". In: Chaos 27.2 (2017), pp. 021101, 6. https://doi.org/10.1063/1.4976510.

[8] P. Grazieschi, M. Leocata, C. Mascart, J. Chevallier, F. Delarue, and E□Tanré. Network of interacting neurons with random synaptic weights". In: CEMRACS 2017|numerical methods for stochastic models: control, uncertainty quantification, mean-field. Vol. 65. ESAIM Proc. Surveys. 2019, pp. 445-475. https://doi.org/10.1051/proc/201965445.

[9] D. Lacker, K. Ramanan, and R. Wu. Locally interacting diffusions as space-time Markov random fields. 2020. https://arxiv.org/abs/1911.01300

[10] D. Lacker, K. Ramanan, and R. Wu. Marginal dynamics of interacting diffusions on unimodular Galton-Watson trees. 2020. https://arxiv.org/abs/2009.11667

[11] E. Luçon. Quenched asymptotics for interacting diffusions on inhomogeneous random graphs". In: Stochastic Process. Appl. 130.11 (2020), pp. 6783-6842. https://doi.org/10.1016/j□spa.2020.06.010.

[12] M. di Volo and A. Destexhe. Optimal responsiveness and collective oscillations emerging from the heterogeneity of inhibitory neurons". https://arxiv.org/pdf/2005.05596.pdf

Main activities

Main activities:

Develop and study a mathematical model of heterogeneous network.

Skills

The student will use classical tools issued from stochastic calculus, dynamical systems and numerical methods.

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Remuneration

Gross Salary: 2653 € per month

General Information

- **Town/city :** Sophia Antipolis
- **Inria Center :** Centre Inria d'Université Côte d'Azur
- **Starting date :** 2021-09-01
- **Duration of contract :** 2 years
- **Deadline to apply :** 2021-08-31

Contacts

- **Inria Team :** AT-SOP AE
- **Recruiter :**
  Tanré Etienne / Etienne.Tanre@inria.fr

About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

Instruction to apply

Defence Security :
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :
As part of its diversity policy, all Inria positions are accessible to people with disabilities.