Post-Doctoral Research Visit F/M Multiscale Modeling of Dravet Syndrome

Contract type: Fixed-term contract
Level of qualifications required: PhD or equivalent
Fonction: Post-Doctoral Research Visit

About the research centre or Inria department

Inria is a national research institute dedicated to digital sciences that promotes scientific excellence and transfer. Inria employs 2,400 collaborators organised in research project teams, usually in collaboration with its academic partners. This agility allows its scientists, from the best universities in the world, to meet the challenges of computer science and mathematics, either through multidisciplinarity or with industrial partners. A precursor to the creation of Deep Tech companies, Inria has also supported the creation of more than 150 start-ups from its research teams. Inria effectively faces the challenges of the digital transformation of science, society and the economy.

Context

This job offer is part of a recently launched Inria’s exploratory action. This action, entitled Multiscale Modeling of Dravet Syndrome (2MDS), aims to develop a multi-scale modeling framework for channelopathies, a group of diseases caused by the dysfunction of membrane ion channels or their interacting proteins. These pathologies include Dravet syndrome (DS), a severe form of infantile epilepsy. We will study this class of pathologies at different scales, each with dedicated modeling and experimental tools, in close collaboration with a partner laboratory of the Basque Center for Applied Mathematics and with the Basque Center for Neuroscience.

Assignment

Assignments:

The aim of this project is to develop a detailed model of interacting neurons, where the voltage activity of each neuron is itself in interaction with the activity of families of ion channels, sodium and potassium, present along its axon. This model will be presented in the form of an interacting particle system, each particle evolving according to a piecewise-deterministic Markov process (PDMP). We will first focus on the dynamics of a single neuron, then on the dynamics of a neuron network of limited size where the randomness might not be averaged out. The considered mutation will be modeled at the level of the PDMP dynamics of ion channels.

We will also develop a simpler compartmental population model (healthy neurons/mutated neurons) in the form of a continuous-time Markov chain (CTMC). Under assumptions of channel independence and large channel population sizes, the CTMC model converges to the classical Hodgkin-Huxley model. It is therefore relevant to explore two tracks: on the one hand, how do these models behave in the presence of a channel population size that does not allow to wipe-out the randomness? On the other hand, how do these models behave in the presence of correlation between the state of the channels? This will allow us to simplify, at a meso-scale, the detailed stochastic model by proposing by diffusion approximation more practical stochastic differential equation models.

For large size neuron populations, the interaction term in the voltage equation for excitatory neurons can also be simplified using a mean-field approximation. In the case of smaller populations, stochastic deviations from this mean-field approximation should also be considered.

For a better knowledge of the proposed research subject:

A state of the art, bibliography and scientific references are available at the following URL:
http://www-sop.inria.fr/members/Fabien.Campillo/projects/2mds

Collaboration:

The recruited person will be in connection with Fabien Campillo (MathNeuro, Montpellier), and Pierre Del Moral (Astral, Bordeaux), for stochastic modelling and Monte Carlo Simulation, and Mathieu Desroches (Mathneuro) and Serafim Rodrigues (MCEN, BCAM, Bilbao), for mathematical and applied neurosciences.
Main activities

- within the Montpellier/Bordeaux/Bilbao network, the candidate will develop previous models and analyze them.
- particular attention will be paid to the biological foundations of these models.
- the candidate will also develop Monte Carlo tools for simulating these models and integrate them into a computational environment associated with the Bilbao experimental laboratory.
- it may also be possible to confront these models with experimental data.
- the candidate will be based in Montpellier and will travel regularly to Bordeaux and Bilbao, where he or she will meet with experimentalists in the field.

Skills

- Modeling, simulation and analysis of dynamical systems.
- Markov processes, SDEs, PDMPs, Monte Carlo simulation.
- Skills in neuroscience.
- Programming skills, such as Python.

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 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.
- Contribution to mutual insurance (subject to conditions).

Remuneration

Gross Salary: 2746 € per month.

General Information

- Theme/Domain: Computational Neuroscience and Medicine.
- Biologie et santé, Sciences de la vie et de la terre (BAP A).
- Town/city: Montpellier.
- Inria Center: Centre Inria d'Université Côte d'Azur.
- Starting date: 2023-11-01.
- Duration of contract: 2 years.
- Deadline to apply: 2023-12-31.

Contacts

- Inria Team: MATHNEURO.
- Recruiter: Campillo Fabien / Fabien.Campillo@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.

The keys to success

- A pronounced interest in numerical modeling in the life sciences.
- Strong aptitude for interdisciplinary collaborations.
- Collaborative communication skills.

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.