



Offer #2023-06295

Post-Doctoral Research Visit F/M Inverse problems for nonlinear conservation laws and applications to cell physiology

Contract type : Fixed-term contract

Level of qualifications required : PhD or equivalent

Fonction : Post-Doctoral Research Visit

Level of experience : Up to 3 years

About the research centre or Inria department

The Inria Saclay-Île-de-France Research Centre was established in 2008. It has developed as part of the Saclay site in partnership with **Paris-Saclay University** and with the **Institut Polytechnique de Paris**.

The centre has [39 project teams](#), 27 of which operate jointly with Paris-Saclay University and the Institut Polytechnique de Paris; Its activities occupy over 600 people, scientists and research and innovation support staff, including 44 different nationalities.

The centre also hosts the [Institut DATAIA](#), dedicated to data sciences and their disciplinary and application interfaces.

Context

Every year Inria International Relations Department has a few postdoctoral positions **in order to support Inria international collaborations**.

This year, postdoctoral positions within the frame of **Inria London, Inria Brasil and Inria Chile** programs and to strengthen partnerships with **Simula (Norway), University of Waterloo (Canada) and KAIST and ETRI (South Korea)** are eligible.

The postdoc contract will have a duration of **12 to 24 months**. The default start date is November 1st, 2023 and not later than January, 1st 2024. The postdoctoral fellow will be recruited by one of the [Inria Centers](#) in France but it is recommended that the time is shared between France and the partner's country (please note that the postdoctoral fellow has to start his/her contract being in France and that the visits have to respect Inria rules for missions)

Assignment

Candidates for postdoctoral positions are recruited after the end of their Ph.D. or after a first post-doctoral period: for the candidates who obtained their PhD in the Northern hemisphere, the date of the Ph.D. defense shall be later than 1 September 2021; in the Southern hemisphere, later than 1 April 2021.

In order to encourage mobility, the postdoctoral position must take place in a scientific environment that is truly different from the one of the Ph.D. (and, if applicable, from the position held since the Ph.D.); particular attention is thus paid to French or international candidates who obtained their doctorate abroad.

Main activities

This postdoctoral offer, co-supervised by Romain Yvinec (INRAE Tours / Inria Saclay) and Mauricio Sepúlveda (Universidad de Concepción), is within the framework of the associate team [ANACONDA](#), whose focus is on the theoretical and numerical ANALYSIS of CONservation laws for multicellular DynAmics. The consortium gather experts in mathematical biology, partial differential equations of conservation law type, and artificial intelligence, in order to bring new results in cell physiology. The recruited person will be in close connection with researchers of the ANACONDA associate team, and will spend part of her/his time in Chile.

The postdoctoral fellow will develop innovative inverse problems strategies, and apply them in a synergistic way to various cell biology processes studied in the team, including ovarian folliculogenesis maturation within the female reproductive system, cell-size dynamics in the adipocyte system, host-microbiota dialog at the intestinal crypt level. These applications share in common equations of conservation laws with non-local nonlinear terms whose inference with snapshot type data is challenging.

The research program includes (i) the study of the well-posedness of nonlinear non-local conservation laws developed in the team, and their associated adjoint formulations; (ii) the design of efficient

numerical schemes for the direct and adjoint formulations; (iii) the resolution of the inverse problem on several test and application cases developed in the team. The latter will be based on two different approaches. A first one will consider optimization of a cost function thanks to gradient-based strategies derived from the adjoint formulation. This is a standard yet powerful approach, which has to be developed on a case by case study [1-4]. The second strategy will explore innovative physics-informed deep learning approaches, which take advantage of the underlying PDE system or its numerical scheme to construct the architecture of the neural networks that will learn model parameters [5-6]. With the help of the researchers in MUSCA, the post-doctoral fellow will finally tackle the identifiability issues and parameter value interpretation, in order to draw conclusions and predictions in the different physiological applications.

1. D. Givoli, Dan, A tutorial on the adjoint method for inverse problems. Comput. Methods Appl. Mech. Engrg. 380 (2021),113810, 23 pp.
2. A. Coronel, R. Lagos, P. Mulet, M. Sepúlveda, A numerical method for an inverse problem arising in two-phase fluid flow transport through a homogeneous porous medium. Numerical mathematics and advanced applications-ENUMATH, 2017, 615-623, Lect. Notes Comput. Sci. Eng., 126, Springer, Cham, 2019.
3. R. Bürger, A. Coronel, M. Sepúlveda, Numerical solution of an inverse problem for a scalar conservation law modelling sedimentation. Hyperbolic problems: theory, numerics and applications, 445-454, Proc. Sympos. Appl. Math., 67, Part 2, Amer. Math. Soc., Providence, RI, 2009.
4. A. Coronel, F. Huancas, M. Sepúlveda, Identification of space distributed coefficients in an indirectly transmitted diseases model. Inverse Problems 35 (2019), no. 11, 115001, 20 pp.
5. Z. Cai, J. Chen, M. Liu, Least-squares neural network (LSNN) method for scalar nonlinear hyperbolic conservation laws: Discrete divergence operator, Journal of Comp. Appl. Maths., 2023, in press
6. Z. Chen, A. Gelb, Y. Lee, Designing Neural Networks for Hyperbolic Conservation Laws, arXiv:2211.14375 2022

Skills

Technical skills and level required : A Ph.D in applied mathematics, with expert knowledge in PDEs and numerical analysis of PDEs.

Relational skills : Strong motivation to work in an interdisciplinary team.

Other valued appreciated : Experience in inverse problems and/or machine learning will be a plus

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

Monthly salary : 2.746 euros/month

General Information

- **Theme/Domain** : Modeling and Control for Life Sciences
Biologie et santé, Sciences de la vie et de la terre (BAP A)
- **Town/city** : Palaiseau
- **Inria Center** : [Centre Inria de Saclay](#)
- **Starting date** : 2023-11-01
- **Duration of contract** : 2 years
- **Deadline to apply** : 2023-06-15

Contacts

- **Inria Team** : [MUSCA](#)
- **Recruiter** :
Yvinec Romain / romain.yvinec@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

The host team is looking for a candidate who has broadened interest in applied mathematics and is motivated by applications to cell physiology, while using a variety of methods including:

- partial differential equations
- numerical analysis and simulation
- statistical inverse problems
- machine learning

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.