Offre n°2025-08920

PhD Position F/M Stochastic modeling of single-cell plasmid copy number fluctuations

Type de contrat : Fixed-term contract

Niveau de diplôme exigé : Graduate degree or equivalent

Fonction : PhD Position

A propos du centre ou de la direction fonctionnelle

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 ***40 project teams*** *, 32 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.*

Contexte et atouts du poste

The project is part of the ERC Starting Grant of Jakob Ruess (Lifeware team at Inria Saclay). Inria is the French national institute for research in computer science, control, and applied mathematics promoting scientific excellence and technology transfer. Within this project, we primarily work on the development of mathematical modeling approaches and statistical inference/estimation methods but we also collaborate with biologists to apply our methods to real data. Our main long-term goal is to develop a comprehensive methodological framework supporting the development of a quantitative understanding of biochemical processes inside single

cells that are coupled to the dynamics of growing cell populations. Our research topics are at the intersection of mathematical biology, statistics, control engineering, and statistical physics applied to problems in biology.

This job announcement is for a PhD position on the project but we are generally looking for young scientists at all career stages (internship, PhD, postdoc) to join the team at any time in 2025.

Mission confiée

The concrete goal of this position is to develop stochastic models of plasmid copy number fluctuations inside single cells and to couple these models to the dynamics of growing populations and microbial consortia. Finally, statistical methods to infer parameters of these models from experimental data will be developed and applied to data of our collaborators.

Principales activités

Overview of the ERC Project:

Synthetic biology aims at engineering biochemical processes to supplement cells with artificial functionality. To this end, we design synthetic gene circuits that operate as dynamical systems inside cells and deploy methods from control engineering to regulate circuit functionality. A key problem in this is that biochemical processes inside single cells are inherently stochastic and create heterogeneity within cell populations that eventually leads to complex couplings between single-cell processes and population dynamics. It is thus difficult to quantitatively predict how exactly a constructed circuit will function in the context of a growing population and to design single-cell circuits such that desired dynamics emerge at the population scale.

At the single-cell scale, stochastic biochemical processes are typically represented as continuous-time Markov chains governed by a chemical master equation (Kolmogorov forward equations). We have recently started to develop a multi-scale modeling framework that augments models of single-cell processes with population scale processes such as growth and selection (Ruess et al., The Journal of Chemical Physics, 2023).

Our multi-scale modeling framework gives us unprecedented opportunities to forward-simulate coupled dynamics of stochastic single-cell and population processes, which paves the way to model, design, and dynamically control synthetic gene circuits so as to create desired functionality within growing populations. Within this project, we thus aim to focus on the development of methods for reverse engineering and controlling multi-scale models and on applying this methodology in real applications for a collection of gene circuits constructed by our collaborators.

Links to publications:

https://doi.org/10.1063/5.0160529

https://doi.org/10.1371/journal.pcbi.1009214

https://doi.org/10.1073/pnas.2114438119

https://doi.org/10.1007/s00285-023-01876-x

Compétences

Candidates for the position should have a degree in a theoretical field, such as mathematics, physics, computer science, control engineering or similar, and be capable of using methods from these fields to study dynamical systems and stochastic processes in applications. Specific experience with either continuous-time Markov chains, stochastic differential equations, stochastic chemical kinetics is a plus. Expertise in biology is not required but candidates are expected to build up an understanding of our concrete applications throughout the course of the project. Candidates who expect to finish their studies in the near future are also encouraged to apply.

Avantages

- 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
- Social security coverage

Rémunération

2200€ gross/month

Informations générales

- **Thème/Domaine :** Modeling and Control for Life Sciences
  Biologie et santé, Sciences de la vie et de la terre (BAP A)
- **Ville :** Palaiseau
- **Centre Inria :** Centre Inria de Saclay
- **Date de prise de fonction souhaitée :** 2025-09-01
- **Durée de contrat :** 3 years
- **Date limite pour postuler :** 2025-08-31

Contacts

- **Équipe Inria :** LIFEWARE
- **Directeur de thèse :**
  Ruess Jakob / jakob.ruess@inria.fr

A propos d'Inria

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 215 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3900 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 200 start-up. L'institut s'e?orce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

L'essentiel pour réussir

Applications should include a CV, list of publications, and contact details of scientists willing to recommend the candidate.

Attention: Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.

Consignes pour postuler

Sécurité défense :
Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

Politique de recrutement :
Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.