Offre n°2025-08547

PhD Position F/M Stochastic modelling of dynamical resource allocation and analysis of single-cell data

Le descriptif de l'offre ci-dessous est en Anglais

Type de contrat : CDD

Niveau de diplôme exigé : Bac + 5 ou équivalent

Fonction : Doctorant

A propos du centre ou de la direction fonctionnelle

The Centre Inria de l'Université de Grenoble groups together almost 600 people in 22 research teams and 7 research support departments.

Staff is present on three campuses in Grenoble, in close collaboration with other research and higher education institutions (Université Grenoble Alpes, CNRS, CEA, INRAE, …), but also with key economic players in the area.

The Centre Inria de l'Université Grenoble Alpe is active in the fields of high-performance computing, verification and embedded systems, modeling of the environment at multiple levels, and data science and artificial intelligence. The center is a top-level scientific institute with an extensive network of international collaborations in Europe and the rest of the world.

Contexte et atouts du poste

The Ph.D. project will be carried out in the project-team MICROCOSME at Inria Grenoble - Rhône-Alpes under the joint supervision of Aline Marguet (https://team.inria.fr/microcosme/aline-marguet/) and Hidde de Jong (https://team.inria.fr/microcosme/hidde-de-jong/) within the framework of the ARBOREAL ANR project (https://project.inria.fr/arboreal/). MICROCOSME is an

interdisciplinary team that includes applied mathematicians, engineers, computer scientists, biologists as well as experimentalists from the microbiology/biophysics team BIOP of the Université Grenoble-Alpes (https://liphy.univ-grenoble-alpes.fr/fr/recherche/equipes/biop-fluctuations-regulations-et-evolution-systemes-vivants).

Mission confiée

Gaining an understanding of the cellular processes underlying bacterial growth is crucial for fundamental research in biology as well as for applications in biotechnology, health, and environmental technology. New experimental technologies have been developed to monitor growth and gene expression at the single-cell level, opening the path to the exploration of the origins of variability in growth phenotypes within a population of bacterial cells. So far, the data obtained from these technological breakthroughs have been exploited only in part. In particular, appropriate mathematical models and methods to relate single-cell gene expression data with the emergence of growth variability in a population are rare [1].
The ARBOREAL ANR project aims at developing a new mathematical framework for the analysis of growth variability from single-cell data, by combining structured branching processes [2, 3] with models of bacterial growth [4] at the single-cell level. We will obtain a new class of stochastic individual-based models, called Branching Resource allocation Processes (BRP), that will enable investigation of the variability of growth phenotypes in a proliferating microbial population in terms of the variability of physiological and cell division processes. The development of the BRP framework will entail modelling, analysis, and inference, and will exploit microfluidics experiments comprising single-cell measurements of growth and expression levels of ribosomes and enzymes in the model organism Escherichia coli [5].

The proposed Ph.D. project involves the development, numerical simulation, and analysis of branching resource allocation processes and the application of this new framework to existing single-cell datasets in the team to study the onset of growth variability in bacterial populations.

Principales activités

Using a variety of mathematical tools and algorithmic approaches (Continuous-Time Markov chains, Mixed-Effects modelling, Branching processes, stochastic simulation) as well as single-cell gene expression datasets, we will address several of the following points:

- Explore different combination of models of single-cell resource allocation and cellular replication (varying lifetime distribution for the individuals, possible asymmetry in the sharing of the cell content at division, switching mechanisms etc.)

- Analyse the new BRP models (asymptotic behavior, comparison of population and lineage dynamics, compute the large population limit and compare with existing population-average resource allocation models).

- Develop numerical simulation tools for the BRP models.

- Use the BRP framework to analyse single-cell *E. coli* datasets from our laboratory [5] and other datasets to relate growth phenotypes on the population level to resource allocation strategies on the single-cell level.

[1] Thomas, P., G. Terradot, V. Danos, and A. Y. Wei?e, Sources, propagation and consequences of stochasticity in cellular growth. *Nat Commun* 9:4528, 2018.

[2] A. Marguet, Uniform sampling in a structured branching population, *Bernoulli*, 25, pp. 2649–2695, 2019.

[3] S. Méléard and V. Bansaye, Stochastic Models for Structured Populations: Scaling Limits and Long Time Behavior, Springer Cham, 2015.

[4] N. Giordano, F. Mairet, J.-L. Gouzé, J. Geiselmann, and H. de Jong, Dynamical allocation of cellular resources as an optimal control problem: Novel insights into microbial growth strategies, *PLoS Comput Biol*, 12, p. e1004802, 2016.

[5] A. Pavlou, E. Cinquemani, C. Pinel, N. Giordano, M. Van Melle-Gateau, I. Mihalcescu, J. Geiselmann and H. de Jong. Single-cell data reveal heterogeneity of investment in ribosomes across a bacterial population. *Nat Commun* **16**, 285 (2025).

Compétences

Interested candidates are expected to have a solid preparation in dynamical system / stochastic process modelling and analysis and some familiarity with scientific programming, and to be interested in biological applications and data processing.

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 (90 daus per yerar) 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

Informations générales

- **Thème/Domaine :** Modélisation et commande pour le vivant
  Biologie et santé, Sciences de la vie et de la terre (BAP A)
- **Ville :** Montbonnot
- **Centre Inria :** Centre Inria de l'Université Grenoble Alpes
- **Date de prise de fonction souhaitée :** 2025-10-01
- **Durée de contrat :** 3 ans
- **Date limite pour postuler :** 2025-09-30

Contacts

- **Équipe Inria :** MICROCOSME
- **Directeur de thèse :**
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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

The successful candidate shall be able to work in collaboration with other people. He/she will be working in a stimulating international context. English reading and writing skills are necessary, English speaking skills are highly desirable.

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.