

2021-03628 - Post-Doctoral Research Visit F/M Statistical Learning of the Intestinal Microbiota Metabolism in Space and Time: Metabolic model modelling and reduction

Type de contrat : CDD

Niveau de diplôme exigé : Thèse ou équivalent

Fonction : Post-Doctorant

A propos du centre ou de la direction fonctionnelle

The study of biology combines studies of forms (diversity) and modelling of processes (functional or evolutionary). Pleiade addresses the dual challenge of rapidly measuring relevant dissimilarities between biological objects and exploring the relationships between trait diversity and functional diversity at multiple scales. We develop algorithms, models, and software frameworks for applications in ecology, evolution and biotechnology.

Contexte et atouts du poste

The position is funded by Inria and is part of the **Inria Exploratory Action SLIMMEST: Statistical Learning of the Intestinal Microbiota Metabolism in Space and Time**. This project consists in **two postdoc positions**: one scientist with a systems biology background, and a second with an applied mathematical background. Both scientists will work in close collaboration on an exciting project aiming at building a spatio-temporal numerical model of the gut microbiota. This particular offer concerns the **systems biology profile**.

The main objective of the SLIMMEST project is to resolve a numerical bottleneck in **spatio-temporal modeling of microbiota: the coupling between microbe-scale metabolic models with community-scale dynamics described with PDE models**. The recruited person will provide expertise in **system biology, microbial metabolism, and community-wide metabolic network modeling**. Missions will include modelling and simplification of metabolic models in order to identify metabolic drivers of ecosystems. Such drivers will in turn be used by the second postdoc scientist of the project to develop machine learning techniques and build a partial differential equations (PDE) model of the gut microbiota.

The two recruited candidates will be members of the Pleiade team, a joint research group between Inria and **INRAE**, in the beautiful city of **Bordeaux**. **Pleiade** is an **interdisciplinary group** at the frontier of **computer science, mathematics, bioinformatics and biology**. One of our main research interests is to develop and validate new computational and numerical models for microbial ecology, that we dedicate to better understand the complex interactions occurring in complex communities of microorganisms known as microbiotas.

Mission confiée

Assignments:

The recruited person will be taken to carry the **metabolic-modelling related part of the SLIMMEST project**.

The **dynamics of a microbial community** is driven by the metabolism of its microorganisms, the interactions between those microorganisms, and spatio-temporal interactions between them and the environment. Mathematical and computational models of such dynamics are crucial to **build mechanistic hypotheses of the biological observations, as well as predict the evolution of the ecosystems, and actions to lead ecosystems in a desired state**. SLIMMEST will combine logic programming and metamodelling of metabolism in a scalable framework applied to communities of the gut microbiota.

The mission of this postdoc position is to **develop methods suitable to the reduction of metabolic models for a community**. The purpose is to simplify the metabolism of an ecosystem by **targeting crucial functions that are main drivers of the ecosystem**. The results will be used in mathematical models by the second postdoc scientist of the project.

For that purpose, we must **model the metabolism of bacteria** from their genome, and connect metabolic networks to the available literature resources on pathways of interest such as short-chain fatty acid production. The **simplification of the community metabolism** will be performed by **modelling constraints and solving combinatorial optimisation problems**. In addition, the successful candidate will contextualise the results of community metamodelling back to metabolic networks. The first application of the project will be a model of the murine gut microbiota, with expectations to successfully scale up the size of the community during the project.

For a better knowledge of the proposed research subject:

- J. D. Orth, I. Thiele, and B. Ø. Palsson, « What is flux balance analysis? ». In : Nat Biotechnol, vol. 28, no. 3, pp. 245–248, 2010, doi: 10.1038/nbt.1614.
- Arnaud Belcour et al. « Metage2Metabo, microbiota-scale metabolic complementarity for the identification of key species ». In : eLife 9 (2020), e61968. doi : 10.7554/elife.61968.
- Seth R Bordenstein et Kevin R Theis. « Host biology in light of the microbiome : ten principles of holobionts and hologenomes ». In : PLoS Biol 13.8 (2015), e1002226.
- Oliver Ebenhöf, Thomas Handorf et Reinhart Heinrich. « Structural analysis of expanding metabolic networks. » In : Genome informatics. International Conference on Genome Informatics 15.1 (2004), p. 35–45. issn : 0919-9454.

Informations générales

- **Thème/Domaine** : Biologie numérique
Biologie et santé, Sciences de la vie et de la terre (BAP A)
- **Ville** : Talence
- **Centre Inria** : **CRI Bordeaux - Sud-Ouest**
- **Date de prise de fonction souhaitée** : 2021-10-01
- **Durée de contrat** : 2 ans
- **Date limite pour postuler** : 2021-12-31

Contacts

- **Equipe Inria** : **PLEIADE**
- **Recruteur** :
Frioux Clemence / clemence.frioux@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 200 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3500 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 180 start-up. L'institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

L'essentiel pour réussir

The candidate should have a taste for interdisciplinary projects. He/she would ideally have some basic knowledge in biology or previous application of her/his methods in life sciences.

The candidate would ideally have a computer science PhD in a field related to bioinformatics or systems biology.

Background or previous experience in metabolic modelling is a real asset.

Consignes pour postuler

Thank you to send:

- CV
- Cover letter
- Support letters (mandatory)
- List of publication

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.

Attention : Les candidatures doivent être déposées en ligne sur le site Inria.

- Clémence Frioux, Simon M Dittami et Anne Siegel. « Using automated reasoning to explore the metabolism of unconventional organisms : a first step to explore host-microbial interactions ». In : Biochemical Society Transactions 48.3 (2020), p. 901-913. issn : 0300-5127. doi : 10.1042/bst20190667.
- Simon Labarthe et al. « A mathematical model to investigate the key drivers of the biogeography of the colon microbiota ». In : Journal of theoretical biology 462 (2019), p. 552-581.
- Ilias Lagkouravdos et al. « The Mouse Intestinal Bacterial Collection (miBC) provides host-specific insight into cultured diversity and functional potential of the gut microbiota ». In : Nature microbiology 1.10 (2016), p. 1-15.
- Arun S Moorthy et al. « A spatially continuous model of carbohydrate digestion and transport processes in the colon ». In : PloS one 10.12 (2015), e0145309.
- Alberto Noronha et al. « The Virtual Metabolic Human database: integrating human and gut microbiome metabolism with nutrition and disease ». In : Nucleic Acids Research 47.D1 (2018), p. D614- D624. issn : 0305-1048. doi : 10.1093/nar/gky992.
- Clémence Frioux et al. « Scalable and exhaustive screening of metabolic functions carried out by microbial consortia ». In : Bioinformatics 34.17 (2018), p. i934-i943. issn : 1367-4803. doi : 10.1093/bioinformatics/bty588.

Principales activités

Main activities:

- Build high quality metabolic models of a simplified model of murine gut microbiota using state-of-the-art methods. Model them using qualitative and quantitative (Flux Balance Analysis) techniques.
- Develop methods to simplify a community of metabolic models using logic constraints and combinatorial optimisation.
- Characterize the main functions and interactions that drive the community
- Analyse results of metamodelling by identifying and visualising metabolic functions provided by the simulations
- Share the results of the projects through scientific publications and code/documentation distribution

Additional activities:

- Collaborate with the second post-doc of the project by providing expertise on community-scale metabolic modeling. This expertise will be crucial to build the community scale problem and to analyse the results to identify the metabolic significance of the results.
- Participate in supervising students in the team.

Compétences

Technical skills and level required:

- Systems biology skills: metabolic network modelling or skills in a close area.
- Python programming
- Data analysis: Python or R
- Scientific writing

Languages:

- English for scientific communication
- English or French for day to day work

Relational skills:

- Ability to work in a collaborative environment
- Good communication skills (sharing results, supervising students)

Other valued appreciated: logic programming (e.g. Answer Set Programming) is a plus but is not mandatory.

Avantages

- Subsidized meals
- Partial reimbursement of public transport costs
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Rémunération

2653€ / month (before taxes)