Offer #2024-08310

Post-Doctoral Research Visit F/M Postdoc: computational modeling of slime mold growth, using fractal and differential formalism on networks

Contract type : Fixed-term contract

Level of qualifications required : PhD or equivalent

Fonction : Post-Doctoral Research Visit

About the research centre or Inria department

The Inria research centre in Lyon is the 9th Inria research centre, formally created in January 2022. It brings together approximately 300 people in 17 research teams and research support services.

Its staff are distributed in Villeurbanne, Lyon Gerland, and Saint-Etienne.

The Lyon centre is active in the fields of software, distributed and high-performance computing, embedded systems, quantum computing and privacy in the digital world, but also in digital health and computational biology.

Context

Scientific context:
Slime molds (Physarum polycephalum) are unicellular organisms that display two levels of fractality. First, their intracellular cytoskeleton forms a complex cytoplasmic fractal network of “veins”. The vein network allows the transport of respiratory gases, molecules and organelles within a cell ranging from 500 □m² to 10 m². The vein network shows properties of almost self-similarity and complex patterns that emerge from simple rules, which are hallmarks of fractal geometry. This network adapts continuously in response to environmental conditions, optimizing the transport for resource delivery and resilience. In addition, the slime mold plasma membrane presents an irregular appearance with numerous invaginations at multiple scales. The membrane invaginations are involved in the uptake of nutrients, transport of water and ions, extrusion of molecules, secretion of slime. This membrane is a dynamic structure, constantly changing as the organism moves, feeds, and explores its environment. Like the vein network, the membrane can display complex, adaptive behavior that can fold and unfold at various length scales, thus also exhibiting a fractal-like organization.
The aim of the project is to model the multiscale functioning and growth of slime molds using fractal geometry.
This works takes place in the ANR project Fractals (2025-2028).
Partners:

- Claire David, Sorbonne Université, Paris
- Christophe Godin, Inria-ENS de Lyon, Lyon
- Audrey Dussutour, CNRS & University Paul Sabatier, Toulouse
- Michel Lapidus, University of California, USA

Assignment

Post-doc project:
A 2-years post-doc position is open in the project to model the functioning and growth of the slime mold. On the one hand, graphs describing the fractal vein network in space and time of the slime mold will be available (based on previous work of the partners that relies on segmentation of 2D images of the slime mold structure and dynamics). On the other new concepts and tools from fractal theory will be used and further developed in the project to model the transport of substances in such fractal structures. The goal of the work will be to adapt the new mathematical fractal theory to the modeling of substance transport through these fractal networks using an adapted form of differential equations on fractals, solve these equations and study the properties of such dynamical models. A 2D computational model of the slime mold growth will be implemented as a proof on concept to map the theoretical development of the model onto quantitative observations and test responses of the model to various types of changes in the growth conditions (e.g. temperature, nutrients, etc.).

Main activities

Main activities :

- Conceive a mathematical model of the slime mold growth, including transport and geometrical

processes, based on fractal and differential formalisms
- Develop a computational implementation of this model to carry out growth simulations and test biological/physical hypotheses
- Analyze the results and compare them with biological data obtained by our partners
- Publish the results in international journals/conferences

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 (90 days / year) and flexible organization of working hours Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage under conditions

Remuneration

2788 € gross salary / month

General Information

- **Theme/Domain :** Computational Biology
  Biologie et santé, Sciences de la vie et de la terre (BAP A)
- **Town/city :** Lyon
- **Inria Center :** Centre Inria de Lyon
- **Starting date :** 2025-01-01
- **Duration of contract :** 2 years
- **Deadline to apply :** 2024-11-30

Contacts

- **Inria Team :** MOSAIC
- **Recruiter :**
  Godin Christophe / Christophe.Godin@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

Required skills:
The candidate should have a PhD in computational modeling in biology or in computational physics. (S)he should have a strong knowledge of numerical methods to solve partial differential equations. (S)he should also have practical experience of in implementing such numerical methods in languages such as C/C++ and/or Python and in techniques to parallelize the corresponding code on GPU or multicore architectures. Finally, knowledge in some areas of computational geometry (including differential geometry, discrete geometry, fractals,) would be an additional asset.

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

Applications must be submitted online via the Inria website. Processing of applications submitted via other channels is not guaranteed.

This position is likely to be assigned to a restricted area (ZRR), as defined in decree no. 2011-1425 relating to the protection of the nation's scientific and technical potential (PPST). Authorisation to access a zone is issued by the head of the establishment, following a favourable ministerial opinion, as defined in the decree of 03 July 2012 relating to the PPST. An unfavourable ministerial opinion for a post assigned to a ZRR would result in the recruitment being cancelled.

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.