Offer #2023-06938

Post-Doctoral Research Visit F/M Development and analysis of FEM numerical schemes for the understanding of inflammatory disease known as keloids

Contract type: Fixed-term contract
Level of qualifications required: PhD or equivalent
Fonction: Post-Doctoral Research Visit

Context

Biomedical context

A keloid scar is an enlarged, raised scar that can be pink, red, skin-colored or darker than the surrounding skin. It is characterized by increased deposition of fibrous tissue in the skin and subcutaneous tissue. Accordingly, keloid is not considered to be only pathological scars, but also the outcome of an abnormal wound healing process with features similar to that of chronic inflammatory diseases and cancer. S-Keloid project aims to investigate the role of mechanical and inflammatory environmental factors on cells associated with keloid disorders.

Biomechanical and numerical context

Numerical models using the finite element method (FEM) to simulate the mechanisms of soft tissues in the human body have attracted great interest from the scientific community. Among other things, FEM models (digital twins) are tools that contribute to the development of medical devices and also have the potential to improve surgical planning and assistance strategies. The difficulty in the case the keloid is to take into account the evolution in time of the geometry.

Assignment

Subject area

With the help of the supervisor, the successful candidate will work on numerical analysis of finite element numerical schemes, scientific computing, partial differential equations, numerical analysis of finite element numerical schemes.

Subject

For a better understanding of the proposed research topic, please see the following link:

https://anr.fr/Projet-ANR-21-CE45-0025

Supervision

The person will be supervised by:

- Michel Duprez, Inria research fellow, MIMESIS team, Strasbourg (https://michelduprez.fr)
- Stéphane Bordas, University Professor, University of Luxembourg (Stéphane Bordas)
- Raluca Eftimie, University Professor (https://lmb.univ-fcomte.fr/Eftimie-Raluca)

Travel

The candidate will be required to travel to conferences to attend lectures or present his/her work. Travel expenses will be reimbursed in accordance with current rates.

Main activities

The missions of the candidate will be the followings:

- A first work will consist in analyzing the influence of the different error sources in a FEM simulation of the deformation of an organ: precision of the geometry, the applied forces, the elastic parameters, the discretisation, the choice of the comportment law...
- We have recently developed a FEM approach called β-FEM (see [2]) which allow to simulate complex geometry as organs. The goal here will be to consider free boundary problem associated
with the keloid growth, i.e. the development of an appropriate FEM scheme and its mathematical analysis. The mesh will be adapted in time with goal-oriented error measures (see [1]) targeting the front velocity.

- One alternative would be to compute the velocity from an underlying discrete model. The multiscale moving boundary models for cell proliferation and collective cell movement invasion of ECM introduced in (see [3]) were solved numerically by combining the Finite Difference method (for the macroscale dynamics of cells) and the Finite element method (for the degradation of the ECM at the invasive front of cellular aggregations). The mathematical analysis of the stability and convergence of these schemes is still an open problem and can be analyzed.

Skills

Technical skills and level required

- Scientific computing and numerical analysis (finite element method)
- Programming (Python and C++)

Languages

- Good knowledge of English and French

Interpersonal skills

- Organizational skills, autonomy, rigor
- Taste for teamwork
- Ability to listen and communicate with study participants

Additional skills appreciated

- Ability to write reports

Benefits package

- Restauration subventionnée
- Transports publics remboursés partiellement
- Congés: 7 semaines de congés annuels + 10 jours de RTT (base temps plein) + possibilité d’autorisations d’absence exceptionnelle (ex: enfants malades, déménagement)
- Possibilité de télétravail (après 6 mois d’ancienneté) et aménagement du temps de travail
- Équipements professionnels à disposition (visioconférence, prêts de matériels informatiques, etc.)
- Prestations sociales, culturelles et sportives (Association de gestion des œuvres sociales d’Inria)
- Accès à la formation professionnelle
- Sécurité sociale

Remuneration

2788 € gross/month

General Information

- Theme/Domain: Computational Neuroscience and Medicine
- Scientific computing (BAP E)
- Town/city: Strasbourg
- Inria Center: Centre Inria de l’Université de Lorraine
- Starting date: 2024-04-01
- Duration of contract: 1 year, 6 months
- Deadline to apply: 2024-01-20

Contacts

- Inria Team: MIMESIS
- Recruiter: Duprez Michel / michel.duprez@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**

**Contact:** Michel Duprez (michel.duprez@inria.fr)

**Application deadline**
March 1st, 2024 (Midnight Paris time)

**Please attach to your application:**
- CV
- A cover letter describing their interest in the subject.
- Diploma certificates and transcripts for bachelor's and master's degrees (or last 5 years)
- Master's dissertation (or equivalent) if already completed, or a description of work in progress, if not.
- Candidate's publications (or preferably Internet links), if any (not expected).

In addition, at least one letter of recommendation from the person supervising the Master's thesis (or research project or internship) must be sent directly by its author to the future thesis supervisor.

Master 2 or specialized engineering school in mathematics or computer science
- An interest in numerical computation and applied mathematics in general.
- The candidate must be comfortable with C++ and/or Python programming, and knowledge of parallel computing would be a plus.

**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.