Offer #2023-07010

Optimizing Computational Efficiency in Feto-Placental Vasculature Modeling: Identifying the Optimal Cut-off for Reduced Elements Integration

Contract type: Internship agreement
Renewable contract: Yes
Level of qualifications required: Master's or equivalent
Other valued qualifications: Master level or end of engineering studies
Function: Internship Research

About the research centre or Inria department

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 39 project teams, 27 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.

Context

This project is part of an ongoing collaboration between the SimbiotX team of Inria-Saclay and the Cardiovascular Biomechanics group at the TU Eindhoven. Therefore, you will be supervised by both groups.

The project is funded by the Horizon 2020 ERC program ERC MoDeLLiver.

Assignment

Topic

It is believed that a dysfunctional placenta leads to a complicated pregnancy in which the foetus will have a high risk of being born preterm. This also comes with increased risk of cardiovascular diseases later in life for both mother and child. Therefore, it is important to understand the mechanisms of the placenta in order to intervene and medicate in time.

A mathematical model has been created to represent a term feto-placental vasculature [1]. This model is extended to combine one-dimensional (1D) modelling (PDEs) with 0D (lumped) modelling (ODEs) to simulate the hemodynamics through the vascular tree of the feto-placental circulation [2]. Currently, the arterial system is modelled with 1D elements, resulting in a computationally heavy model.

It is noteworthy that the compliances of the 1D-elements do not have much influence on the pressure and flow in the very small vessels. What vessels in the tree are small enough to be modelled as 0D-elements instead? Finding a cut-off for the right balance in model error and computational time will lead to a more efficient, yet robust model.

You will work on finding this cut-off. The idea is to apply the method introduced in [3] to the existing model.

Bibliography


**Main activities**

Main activities:

- Understand the mathematical models & numerical scheme
- Design numerical experimental tests
- Conduct the experiment and devise the most robust numerical model
- Communicate regularly between the two groups
- Write report & disseminate the results possibly in a conference

**Skills**

The ideal candidate will have a passion for mathematical modelling in the biomedical field. Therefore, strong analytical skills are advised together with experience in programming (preferably Python).

The candidate should be able to communicate in English fluently.

Key words: PDEs, ODEs, numerical scheme, blood flow simulation, placenta.

**Benefits package**

- Canteen and cafeteria;
- Sports equipment;
- Transport reimbursement

**Remuneration**

**General Information**

- **Theme/Domain**: Modeling and Control for Life Sciences, Biologie et santé, Sciences de la vie et de la terre (BAP A)
- **Town/city**: Palaiseau
- **Inria Center**: Centre Inria de Saclay
- **Starting date**: 2024-02-01
- **Duration of contract**: 8 months
- **Deadline to apply**: 2024-01-31

**Contacts**

- **Inria Team**: SBIMOTX
- **Recruiter**: Vignon Clementel Irene / Irene.Vignon-Clementel@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.

**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.