Offer #2025-09025

PhD Position F/M Construction of a simulation-ready torso conductivity map library and data generation for the electrical impedance tomography (EIT) Bayesian inverse problem

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

Level of experience : Recently graduated

About the research centre or Inria department

The Inria centre at the University of Bordeaux is one of nine Inria centres in France and has around twenty research teams. The Inria centre is a major and recognised player in the field of digital sciences. It is at the heart of a rich ecosystem of R&D and innovation: highly innovative SMEs, major industrial groups, competitive clusters, research and higher education players, laboratories of excellence, technological research institutes, etc.

Context

The aim of this thesis project is to study the reconstruction capabilities of Bayesian inference methods for the inverse problem of electrical impedance tomography of the human torso.

The project is related to the global topic of detecting cardiac arrhythmias, in particular ventricular fibrillation. More specifically, it aims to improve a medical imaging modality (electrocardiographic imaging - ECGi) used to non-invasively reconstruct the heart's electrical activity. One of the main aims of this imaging technique is to detect individuals at high risk of ventricular fibrillation. However, it is not yet possible to detect high-risk individuals in the general population, because current techniques for imaging the heart's electrical activity are not sufficiently accurate or reliable.

Electrical Impedance Tomography (EIT) is a potential solution for obtaining additional information. It is a non-invasive technique for reconstructing inclusions and internal conductivities from electrical measurements at the body surface. The direct problem of EIT is to determine the electrical potential in the domain for a given conductivity distribution and for a set of currents injected through the electrodes. The inverse problem involves estimating the conductivities themselves from measurements made at the body surface. Current applications of EIT include detecting breast cancer or acute strokes, monitoring lung ventilation and sometimes monitoring cardiac activity. However, to our knowledge, EIT has never been applied in ECGi to enrich the description of the volume of the torso and its internal conductivities.

The person recruited will work as part of the Inria CARMEN team (Inria Centre at the University of Bordeaux), which specialises in digital models dedicated to cardiac arrhythmias, at the IHU-Liryc, the Institute of Electrophysiology and Cardiac Modelling, dedicated to cardiac rhythm disorders. This project is part of a collaboration with an Inria Paris-Saclay researcher: Jing-Rebecca Li.

Assignment

The aim of this project is to construct and incorporate statistical distributions of realistic human torso

volume geometries from a large set of realistic biological images. This a priori information will be obtained

from publicly available CT and MRI images as well as artificially generated images from training images.

The CT images will be used to construct a library of realistic conductivity maps that serve as inputs to the

forward solver of the EIT problem. The forward solver will be an immersed boundary method to which

the pixelated conductivity maps can be coupled in a natural way. A large number of numerical simulations

will be performed to generate EIT data under a variety of experimental conditions for the conductivity maps in the library

in the library.

Main activities

The constructed data libraries will be used to provide prior distribution information on the conductivity

maps to be estimated in the EIT torso inverse problem. We will also provide statistical distributions of

biological and geometrical parameters associated with the conductivity maps in the library. We expect to

incorporate the libraries and the statistical information in a Bayesian inversion algorithm.

The methodology will be developed in two dimensions and extended to three dimensions using HPC tools.

Both the conductivity map library and the simulated EIT data library will be made publicly available.

Skills

Numerical analysis of PDEs or analysis of PDEs with a strong interest in applications and programming. Some knowledge of probability would be desirable.

Benefits package

- Subsidised catering
- Public transport partially reimbursed
- Leave: 7 weeks' annual leave + 10 days' RTT (full-time basis) + possibility of exceptional leave (e.g. sick children, moving house)
- Possibility of partial teleworking and reorganisation of working hours
- Professional equipment available (videoconferencing, loan of IT equipment, etc.)
- Social, cultural and sports benefits (Association de gestion des œuvres sociales d'Inria)

Remuneration

The gross monthly salary will be €2,200 (before social security contributions and income tax) over 2025 and €2,300 from 01/01/2026.

General Information

- **Theme/Domain :** Modeling and Control for Life Sciences
  Scientific computing (BAP E)
- **Town/city :** Talence
- **Inria Center :** Centre Inria de l'université de Bordeaux
- **Starting date :** 2025-10-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2025-07-10

Contacts

- **Inria Team :** CARMEN
- **PhD Supervisor :**
  Weynans Lisl / Lisl.Weynans@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

recent Master 2 or engineering school graduate

Diploma required: Master's degree or engineering school in applied mathematics

The candidate should be able to work in a team, communicate results clearly and be interested in modelling and the application of mathematics to real-life problems.

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

Please apply via the jobs.inria website by sending the following documents:

- cv
- covering letter -
- letter of recommendation (if applicable)
- transcripts and rankings of Master's years (or equivalent)

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.