Offer #2023-06881

Scalable unsupervised subtle anomaly detection from longitudinal MR imaging data: Application to Parkinson’s disease

The offer description below is in French

Contract type: Internship agreement

Level of qualifications required: Master’s or equivalent

Fonction: Internship Research

Level of experience: From 3 to 5 years

About the research centre or Inria department

The Centre Inria de l’Université de Grenoble groups together almost 600 people in 22 research teams and 7 research support departments.

Staff is present on three campuses in Grenoble, in close collaboration with other research and higher education institutions (Université Grenoble Alpes, CNRS, CEA, INRAE, …), but also with key economic players in the area.

The Centre Inria de l’Université Grenoble Alpe is active in the fields of high-performance computing, verification and embedded systems, modeling of the environment at multiple levels, and data science and artificial intelligence. The center is a top-level scientific institute with an extensive network of international collaborations in Europe and the rest of the world.

Context

Context:

Anomaly detection in medical imaging is a challenging task in contexts where abnormalities are not annotated and difficult to detect even for experts. This problem can be addressed through unsupervised anomaly detection (UAD) methods, which identify features that do not match with a reference model of normal profiles. In the context of Parkinson’s disease and newly diagnosed patients, the detection task is all the more challenging as abnormalities may be subtle and hardly visible in structural MR brain scans. Some preliminary work [Oudoumanessah et al 2023] has shown that structural abnormalities could be detected from MR image data in a way that is consistent with the disease progression, as accounted by the Hoehn and Yahr scale [Hoehn & Yahr 1998].

Assignment

The goal of this project is to further improve the reliability of the detection by leveraging additional information coming from longitudinal data. Longitudinal data [Hedeker & Gibbons 2006] consist in the repeated observations of patients over time. In practice, we expect to analyse image data at a few different times corresponding to successive visits of patients. Their analysis informs us on the progression of the disease through the evolution of abnormalities, both in size, numbers, or locations. More specifically, when applied to anomaly detection, the expectation is the confirmation of uncertain detections or the discovery of new ones, not visible at early stages.

Modelling longitudinal data presents different types of challenges. First are the methodological challenges related to the design of relevant models to handle all the data and disease’s characteristics in order to answer the statistical and medical questions. These modelling difficulties cannot be separated from challenges arising from data with very different modalities and time dependencies, in particular involving different acquisition time-sets and different scales of patient screening, resulting on possibly partially missing data [Couronne et al 2019].

Main activities

Directions of research:

As a first direction of research, we propose to consider the modalities used in our previous work [Oudoumanessah et al 2023] and investigate the extension of the model and inference technique
therein to multiple time data. A first idea would be to use analysis and results at previous times to inform analysis at subsequent times using a Bayesian approach as a way to incorporate information from one time to another.

As a second direction of research, we will focus on accounting for possibly missing time sampling point, considering that the sample size of patients having performed all required analysis at regular time intervals, is often quite small. This task will aim at reporting on the uncertainties associated to the individual prediction in this case. The performances, strengths and weaknesses of two approaches will be compared. The first one will consist in making Bayesian predictions from the model already developed. The second will consist in exploring a Bayesian Deep learning approach [Kendal & Gal, 2017].

References:


Skills

Skills and working environment

The selected candidate will be supervised by Florence Forbes and in constant collaboration with a PhD student, Geoffroy Oudoumanessah, working on this project. He/she will also benefit from the expertise of Michel Dojat from Grenoble Neurosciences Institute and Carole Lartizien from CREATIS Lyon.

General Information

- **Theme/Domain:** Optimization, machine learning and statistical methods
  Statistics (Big data) (BAP E)
- **Town/city:** Montbonnot
- **Inria Center:** Centre Inria de l'Université Grenoble Alpes
- **Starting date:** 2024-03-01
- **Duration of contract:** 5 months
- **Deadline to apply:** 2024-02-29

Contacts

- **Inria Team:** STATIFY
- **Recruiter:** Forbes Florence / florence.forbes@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

Data and computer environment:

The selected candidate will have access to data from the PPMI database [Marek, 2018] and the . Computer infrastructures available at Statify/Inria and CREATIS will be used for algorithms development.

**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.