



Offre n°2023-06881

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

Type de contrat : Internship agreement

Niveau de diplôme exigé : Master's or equivalent

Fonction : Internship Research

Niveau d'expérience souhaité : From 3 to 5 years

Contexte et atouts du poste

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].

Mission confiée

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].

Raphael Couronne, Marie Vidailhet, Jean-Christophe Corvol, Stephane Lehericy, and Stanley Durlleman. Learning disease progression models with longitudinal data and missing values. In ISBI 2019 - International Symposium on Biomedical Imaging, Venice, Italy, April 2019.

Donald Hedeker and Robert D. Gibbons. Longitudinal data analysis. John Wiley & Sons, Inc, New Jersey, 2006.

Hoehn, M. and Yahr, M. D. Parkinsonism: onset, progression, and mortality, Neurology 1998.

Kendall, A and Gal, Y. What Uncertainties Do We Need in Bayesian Deep Learning for Computer Vision? NeurIPS 2017.

Oudoumanessah G, Lartizien C, Dojat M, Forbes F, Frugal unsupervised detection of subtle abnormalities in medical imaging, in: Greenspan H, Madabhushi A, Mousavi P, Salcudean S, James Duncan J, Syeda-Mahmood T, R T (Eds.) Miccai, Springer-Verlag AG Switzerland, Vancouver (Ca), 2023, pp. 411-421.

Marek S. Chowdhury, A. Siderowf, et al., "The parkinson's progression markers initiative (ppmi) - establishing a pd biomarker cohort," Annals of Clinical and Translational Neurology, p. 1460-1477, 2018

Principales activités

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].

Compétences

Hard skills:

- Applied mathematics, probability theory.
- Data analytics, learning and more specifically

-Statistical and deep learning, Longitudinal analysis, Clustering, Mixture distributions, Online EM algorithm, Biomarkers.

- Programming (Python or equivalent).
- Fluent in English or in French

Soft skills:

- Strong communication skills.
- Rigor in problem analysis, and formulation.
- Autonomy, enthusiasm.
- Curiosity, ability to propose ideas

Informations générales

- **Thème/Domaine** : Optimization, machine learning and statistical methods
Statistics (Big data) (BAP E)
- **Ville** : Montbonnot
- **Centre Inria** : [Centre Inria de l'Université Grenoble Alpes](#)
- **Date de prise de fonction souhaitée** : 2024-03-01
- **Durée de contrat** : 5 months
- **Date limite pour postuler** : 2024-05-23

Contacts

- **Équipe Inria** : [STATIFY](#)
- **Recruteur** :
Forbes Florence / florence.forbes@inria.fr

A propos d'Inria

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 215 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3900 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 200 start-up. L'institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

L'essentiel pour réussir

The topic of this proposal requires background in statistical learning and big longitudinal data and skills in computer science, applied mathematics, interest for statistics applied to medical data.

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Attention: Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.

Consignes pour postuler

Sécurité défense :

Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le

décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

Politique de recrutement :

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