About the research centre or Inria department

Inria, the French National Institute for computer science and applied mathematics, promotes "scientific excellence for technology transfer and society". Graduates from the world's top universities, Inria's 2,700 employees rise to the challenges of digital sciences. With its open, agile model, Inria is able to explore original approaches with its partners in industry and academia and provide an efficient response to the multidisciplinary and application challenges of the digital transformation. Inria is the source of many innovations that add value and create jobs.

This thesis will address two challenges: 1) How to combine neuroimaging data generated by different sources and, on generic features that are meaningful beyond our domain (e.g. biological and molecular images to macros medical images). Another evolution will also consist in adding new effectors during image guided interventional procedures (surgery, interventional radiology...). The classical way of making use of these images, mostly based on human interpretation, becomes less and less feasible. In addition, the societal pressure for a cost effective use of the equipments on the one hand, and a better traceability and quality insurance of the decision making process on the other hand, makes the development of advanced computer assisted medical imaging systems more and more essential.

According to this context, our research team is devoted to the development of new processing algorithms in the context of medical image computing and computer assisted interventions: image fusion (registration and visualization), image segmentation and analysis, management of image related information... In this very large domain, our work are primarily focused on clinical applications and for the most part on head and brain related diseases.

The successful candidate will join the Unit/Project VisAGeS – U1228 (ex U7446). This research team is jointly affiliated with INSERM (National Institute of Health and Medical Research) and INRIA (National Institute of Research in Informatics and Automation). VisAGeS belongs to the IRISA institute (UMR CHRIS 6074, University of Rennes 1) located at Rennes, France on both medical and physical sciences campus.

Since 70%, medical imaging is a very rapidly growing research domain, the last three decades have shown a rapid evolution of the dimension and quantity of data physicians have to work with. The next decade will follow this evolution by adding not only new spatio-temporal dimensions to the image data produced and used in a clinical environment but also new scales of analysis (nano or micro biological and molecular images to macros medical images). Another evolution will also consist in adding new effectors during image guided interventional procedures (surgery, interventional radiology...). The classical way of making use of these images, mostly based on human interpretation, becomes less and less feasible. In addition, the societal pressure for a cost effective use of the equipments on the one hand, and a better traceability and quality insurance of the decision making process on the other hand, makes the development of advanced computer assisted medical imaging systems more and more essential.

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Context

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Locally, this work will be conducted in collaboration with specialists in machine learning and modelling of variability from other Inria / IRISA teams (LACODAM, DIVERSE). The project will also benefit from transverse collaborations with clinical projects through the NeuroInfo experimental platform located at the University Hospital in Rennes (cf. http://www.neurinfo.org/).

The neuroinformatics part of this work will be performed in close collaboration with our international partners of the International Neuroinformatics Coordinating Facility (INCF, cf. https://www.incf.org/) and of the European Project H2020 OpenAir-Connect (https://www.openair-project.eu/connect), and of the France Life Imaging national infrastructure and its digital solution the IAM node (https://project.inria.fr/IAM/en/).

The successful candidate will have the opportunity to travel and present his or her results at top conferences in the field of brain imaging. Travel expenses will be covered within the limits of the scale in force.

Assignment

Thanks to the development of open science practices, more and more public datasets are available to the research community. In the field of brain imaging, these data, combined, bring a critical increase in sample size, necessary to build robust models of the typical and atypical brain.

But, in order to build valid inferences on these data, we need to take into account their heterogeneity. Variability can arise due to many factors such as differences in imaging protocols, in acquisitions protocols and even, in post-processing pipelines. In particular, the expansion of open source machine learning workflows creates a multitude of possible outputs out of the same dataset. The variations induced by this methodological plurality can be referred to as analytic variability which will be the focus of this thesis.

This thesis will address two challenges: 1) How to combine neuroimaging data generated by different analysts pipelines? 2) How to publish neuroimages with an adequate level of metadata to enable their reuse? Methodological developments will combine machine learning techniques with methods from knowledge representation.

Main activities

First, we will define a set of transformations to remove unwanted pipeline-specific variations. To this aim, we will quantify the effects of pipeline variations on neuroimaging results. The neuroimaging pipeline will be treated as a set of elementary blocks and our goal will be to automatically identify hierarchies amongst those blocks. This will eventually lead to deriving measures of closeness between pipelines.

Second, we will develop a semantic model to represent provenance in neuroimaging. We will focus both on having a level of details that is sufficient to model specificities of neuroimaging pipelines (e.g. registration, segmentation) and, on generic features that are meaningful beyond our domain (e.g. method, tools, etc.). This part of the work will be performed in close collaboration with our partners in industry and academia and provide a multitude of possible outputs out of the same dataset. The variations induced by this methodological plurality can be referred to as analytic variability which will be the focus of this thesis.

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References


Skills
This position requires solid background in computer science, data science and machine learning or statistics. Knowledge in neuroimaging and/or knowledge representation would be appreciated. Strong experience in programming, especially in Python and/or Matlab will also be valued.

Benefits package
- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Remuneration
Monthly gross salary amounting to 1982 euros for the first and second years and 2085 euros for the third year.