Post-doctoral position (2 years)

Joint determination of neural activity and brain vascularization from multimodal MR images

Research theme: statistics and probability, machine learning, medical image analysis.

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Localization: The candidate will be based at INRIA Grenoble Rhone-Alpes but regular visits to Neurospin in Saclay (near Paris) are planned.

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Subject:
This proposal is part of a larger project that gathers three partners INRIA, CEA NeuroSpin and GIN (Grenoble Institute of Neuroscience) with complementary and multidisciplinary expertise. The focus is the combination of two brain MRI modalities. The goal is to propose an innovative statistically well-based solution to the joint determination of neural activity and brain vascularization by combining BOLD constrast images obtained in functional MRI and quantitative parametric images (Arterial Spin Labelling: ASL).
Functional MRI has been intensively used in cognitive neuroscience but much slower in clinical applications. The availability of other MRI modalities gives new opportunities in terms of data analysis and information fusion to attempt to fill this gap. Our task consists in extracting relevant information from imperfect noisy images using a priori probabilistic sources. Bayesian classification and clustering techniques provide an appropriate framework to deal with such multi-modal, possibly local and global data fusion and to derive a simple neural activity description, using typically activation classes (eg. activated vs non-activated voxels). On a vascular point of view, this framework has the advantage to allow both the detection of brain activity and estimation of hemodynamics without imposing constraints on the hemodynamic response function shape. This joint detection-estimation is more robust when carried out in locally homogeneous brain regions (parcels) and more relevant if perfusion information can be integrated. We will therefore aim at extending the (Markovian and Bayesian) estimation frameworks developed by the partners [Makni et al 08, Vincent et al 2010] to fuse perfusion (ASL) and functional (BOLD) information.
We will then also consider modern machine learning and non-smooth optimization techniques to go from a subject level to a group of subjects level, that is to build an hemodynamics-informed atlas of the healthy brain functional and vascular territories. For a number of pathology examples, we will then investigate the use of appropriate statistical measures to quantify their deviance to the normal brain atlas.
These challenging tasks will be a joint project with neuroimaging and medical image processing experts and with experts in statistics. Neuroimaging data acquired with MR facilities at GIN and NeuroSpin labs during undergoing cognitive and clinical experiments will be used to validate our models.

Skills:
We look for candidates strongly motivated by challenging research and mobility in terms of research topics. The applicant should have good background in statistics and computer science. The required knowledge includes ideally classification methods, Markov random fields and Bayesian statistics. Knowledge in Neuroscience is welcome. As regards to software developments, Python, C, C++, Matlab languages are preferred.

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Key-words: statistical image analysis, machine learning, hidden Markov random field, variational approximations, Bayesian technique, functional MRI.