

ED STIC - Proposition de Sujets de Thèse
pour la campagne d'Allocation de thèses 2011

Titre du sujet :

Mention de thèse :

HDR Directeur de thèse inscrit à l'ED STIC :

Co-encadrant de thèse éventuel :

Nom :

Prénom :

Email :

Téléphone :

Email de contact pour ce sujet :

Laboratoire d'accueil :

Description du sujet :

Description:

The goal of this subject is to exploit the diffusion MR information to constrain functional analysis timings. Indeed, diffusion MRI provides ways of recovering the fiber bundles that connect the cortical areas through white matter [descoteaux-deriche-et-al:09]. As the speed of information propagation along these tracks is known (with some uncertainty), this provides constraints on the causality of events across various cortical regions. Establishing causality can be done by studying time courses and by inferring the underlying connectivity of several areas. The originality of the proposed work is to work in source space and to integrate connectivity information provided by diffusion MR images as constraints. Extending causality techniques to multi-trial signals without relying on averaging is also an interesting research direction that we would like to tackle in this Ph.D. thesis.

Context:

Understanding the brain functioning remains one of the greatest challenges of modern science. The recent years have seen the development of many new means to observe its structure and activity. Along with all these new means of observation is the need to develop tools to integrate the partial information they each provide into a consistent global model. Developing computerized tools to help building and testing such models is a computational challenge that the Athena project-team would like to address. This includes building computerized versions of biological models, simplifying them, analyzing experimental data to see to which extent they support a given model, etc. The overall goal is to be able to assimilate in a single spatio-temporal model the diversity of observations that currently exist. Indeed, observations are based on very different physical and biological principles. They thus reveal very different aspects of the brain (structural, electrical, haemodynamic, or even chemical) and have very different spatial or temporal resolutions. Among these observation means, this proposal will mainly focus on two complementary types of in-vivo and non-invasive techniques, which are at the heart of the research performed within the INRIA ATHENA project team:

- MEG and EEG (M/EEG) which provide complementary direct measurements of the electrical activity of the brain with a millisecond temporal resolution (the time scale at which interesting macroscopic electrical events happen in the brain), but have poor spatial resolution. These signals are related to the brain functioning.
- Diffusion MR images (dMRI) provide anatomical connectivity information. Together with standard (ie anatomical) MRI, they reveal structural properties of the brain. The spatial resolution of MR images is very good (of the order of the millimeter).

Function (the signals that are transmitted) and structure (the areas that trigger those signals and the wires that connect them) are intrinsically related. Combining the structural and functional informations provided by diffusion MR images and M/EEG respectively is the main goal of this Ph.D.

This PhD will be performed within the framework of various collaborations schemes including national as well international partners.

Required training:

- * MSc in medical imaging or applied maths.
- * Computer science and mathematics (optimization, linear algebra).
- * Signal processing (filtering, Fourier, wavelets).
- * Statistics (machine learning, classification).
- * Programming experience in C/C++, Matlab or Python.

[descoteaux-deriche-et-al:09] M. Descoteaux, R. Deriche, R.T. Knosche, and A. Anwender, « Deterministic and probabilistic tractography based on complex fibre orientation distributions ».

IEEE Transactions in Medical Imaging , 28(2):269-286, February 2009.

URL : <http://www-sop/athena/Site/Jobs>

English version: