Post-doc offer – Labex Numev Funding – Montpellier
Medical Imaging / Applied Mathematics
Starting mid 2015

InteREsT – Interval-valued Reconstruction in Emission Tomography – a new paradigm in medical imaging. Application to Alzheimer's disease diagnosis and monitoring.

The diagnosis of Alzheimer's disease (AD) is often established at the state of dementia, whereas neuro-degeneration is developing over decades (> 20 years). Positron Emission Tomography (PET) can be used to detect in vivo molecular dysfunctions several years before the first obvious symptoms, leading to possible early AD diagnosis in patients with mild cognitive impairment (MCI). Early diagnosis opens the way to possible patient treatments involving drugs that slow the evolution of the disease. Detection of molecular abnormalities with PET could even be earlier if an objective and reliable statistical technique was available to replace the conventional visual inspection used in clinical routine. Our project aims to develop such a reliable analysis tool for PET-based detection of early molecular abnormalities.

PET images are 3D maps of radiotracer uptake reconstructed using tomographic reconstruction techniques. These maps are currently never associated with an estimate of uncertainty in each voxel. During an initial project funded by the AAP Inserm Physicancer 2012, we developed an "intervalist" tomographic reconstruction algorithm, called NIBEM, that enables the estimation of the uncertainty associated with each estimated value in the reconstructed voxels.

The main objective of this project is the development of a method to enhance that reconstruction technique and use the reconstruction uncertainties estimated by the NIBEM algorithm for determining whether the reconstructed tracer uptake, which reflects brain activity for a given patient, is significantly different between the temporo-parietal-occipital left and right junctions, since an asymmetry is a biomarker of AD. Statistical tests dedicated to interval-valued data that result from NIBEM should be used to make a decision at a given significance level.

The post-doctoral work will be dedicated to:
- Adapt the model used in the NIBEM algorithm in order to reconstruct PET interval-valued images reflecting the uncertainties in the reconstructed images due to measurement and modelling uncertainties.
- Design and validate a statistical test for exploiting the interval-valued nature of the reconstructed images and determine, for a given p-value, whether two regions of interest in the image have identical uptakes.
- Developing a software prototype for FDG PET-assisted AD diagnosis that includes the methods developed in the first two stages. This software should allow a physician to get confidence intervals for each measurement that would assist him in determining whether a patient has a significant asymmetry in brain activity.
- Evaluating this software prototype retrospectively in a group of MCI patients for which the evolution to AD disease is known.

The candidate must be a PhD, have skills in signal and image processing, applied mathematics and statistics, inverse problems and tomographic reconstruction. He also should have skills in programming and software development. He finally should be interested in organizing a collaborative research project. He / she will be the backbone of this project that involves the cooperation of three partners (CHU Montpellier, IMIV CEA-SHFJ Orsay, LIRMM Montpellier). Only applications from candidates with a good scientific publication record will be examined. The initial duration of the contract will be one year, with a possible 1-year extension.

To apply, please send a resume highlighting the appropriateness of your profile and your skills, a motivation letter, and letters of recommendation or at least 2 references to:
– Olivier Strauss, olivier.strauss@lirmm.fr
– Irène Buvat, irene.buvat@u-psud.fr