Proposition de stage de M2 en statistique:
Project title: "Functional data analysis with applications to brain functional network connectivity"

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Project background: Many modern applications, particularly medical applications such as electroencephalogram (EEG) and functional magnetic resonance imaging (fMRI), produce complicated data, where the sampling units are vectors of functions rather than vectors of numbers. As a result, functional data analysis (FDA) techniques have been developed over the past decade aiming to deal with the statistical treatment of samples of functions. A statistical tool in FDA that is gaining increasing attention in recent years is *functional graphical modeling*, where the central goal is to investigate the interdependence structure among multivariate functional data. The motivation is brain functional network connectivity analysis based on fMRI. Functional MRI measures brain activities via blood oxygen level-dependent (BOLD) signals that are recorded over a period of time. The interest is, based on these fMRI data, to estimate the network connectivity of the brain, where the nodes of the network represent brain regions, and links represent interactions and dependencies among the brain regions. Brain functional network connectivity reveals intrinsic functional architecture of the brain, which is shown to alter under different neurological disorders. Such alterations contain crucial insights of both disorder pathology and development of the brain.

Project: There are recent proposals in FDA that model the fMRI data as multivariate functions, where the BOLD signal of each brain region is taken as a function, and estimate the connectivity network of the brain by a functional graphical model. However, several challenges still remain in fMRI data analysis, since as technology advances, heterogeneous and repeated fMRI functional data are becoming increasingly available. The first purpose of this MSc internship project is to introduce the student to the field of FDA, to functional graphical models and to fMRI data analysis. Then, a new approach will be proposed to construct a functional graphical model of heterogeneous and dependent functional data. Next, computational algorithms will be developed for implementation. Finally, the new approach will be evaluated through simulation studies, and it will be applied to real-world fMRI data to characterize the functional network connectivity of the brain for serious neurological diseases of different subtypes.

Qualifications: Applications are welcomed from students in their final year of study (Bac+5) with a strong background in mathematical statistics. Advanced skills in programming with R and/or Python, and some experience with working on real-data sets is also required. The student should have a motivation and interest in working with neuroimaging data. Having experience working with neuroimaging data sets (such as functional MRI or EEG) would be considered an advantage. Good communication skills in oral and written English are required.

Information about CREST and ENSAI: France's top graduate school for statistics and data science, ENSAI has made a name for itself in Europe and beyond thanks to the quality of the education and the research. ENSAI is home to part of the CREST research laboratory, a mixed research unit of the CNRS attached to the Group of National Schools in Economics and Statistics (GENES) and Ecole polytechnique in Paris. CREST is a multidisciplinary research center for Economics, Statistics, and Sociology. It is located in both Saclay (ENSAE Paris and Polytechnique) and Ker Lann (ENSAI). The majority of the CREST lab at ENSAI is made up of Statisticians who are bolstered by Economics researchers and Computer Science researchers specialized in Machine Learning. Research in statistics covers a wide range of research areas related to statistical modeling. ENSAI's reputation as a leader in the field is the result of this high-level scientific and operational expertise that we have cultivated since the founding of the school in 1996. More information about us can be found on our website http://ensai.fr/en/.

Location and period:

- The master student will be supervised by Eftychia Solea at CREST Lab, at ENSAI in Rennes.

- Duration: up to 6 months. The internship could start as soon as March or April 2022.

Funding:

- The internship is funded by the Dispositif Allocation D'Installation Scientifique of Rennes, Metropoles.

- The rule of the French minimal monthly wage for internship will be applied.

Contact: Please send your application (CV, academic transcripts (relevé de notes) and cover letter stating the motivation (lettre de motivation) to Eftychia Solea (eftychia.solea@ensai.fr).