Post doctoral position on time series analysis for the neural caracterisation of different levels of wakefulness.

November 16, 2021

We are seeking an outstanding postdoctoral research fellow with experience in deep learning / machine learning to work with us at Caen University, France on a project investigating the analysis of multimodal time series for the characterization of brain functional connectivity in different levels of wakefulness.

Context

The postdoctoral position is funded under the research project LOR supported by the Region Normandy (France). The LOR project gathers engineering schools and universities around the design of a better understanding of the brain states during different states of wakefulness.

Background

Brain activity can be recorded in humans either by techniques based on the metabolic functioning of the neuron, such as Positron Emission Tomography (PET) or Magnetic Resonance Imaging (MRI), or by techniques based on the electrical functioning of the neuron, such as electroencephalography (EEG) or magnetoencephalography (MEG). If the first type of measurement allows to obtain recordings with an interesting spatial resolution, the second type allows a higher temporal resolution. To summarize, these two approaches are both imperfect but complementary.

In this project, we are interested by this double approach in the context of the human characterization of different levels of wakefulness (from full awake to deep sleep). Data in animals indicate that the transition from wakefulness to sleep causes changes in the relationships between different brain structures. Sensory inputs via the thalamus are inhibited leading to a decrease in thalamo-cortical links in favor of intra-cortical relations. These modifications progressively isolate the cortex in order to facilitate the descent into sleep. In terms of connectivity, these modifications are reflected in EEG by a clear decrease

in global long-distance connections which are progressively replaced by an intensification of local cortico-cortical connectivity [1]. On the other hand, MRI connectivity analyses tend to show that the spatial extent of the networks is preserved during the early phases of sleep [2]. It is necessary to explore this apparent paradox in order to better understand the cerebral mechanisms at play during the descent into sleep but also more broadly to explore the networks of human consciousness...

Objectives and challenges

The project is based on data from a cohort being currently acquired. It includes EEG and MRI acquisitions performed while the subjects are falling asleep for a nap. In a first step, the candidate will study the dynamic evolution of the functional connectivity measured in EEG as a function of the correlation metric (spectral coherence, synchronization probability, phase synchronization method, etc.). In a second step, these results will have to be compared to those obtained in MRI by taking into account the physical characteristics of the different signals.

Work plan

In both cases (EEG/MRI) the correlations between the different areas will be measured using positive defined matrices measuring the correlation of the signals. For the EEG, these correlations can be measured directly from the temporal signals or from time-frequency analyses. In a first step, and for the EEG, we will have to characterize the matrices corresponding to the different phases of sleep using the calculation of averages on the variety of positive defined matrices [3]. In a second step, we will try (in EEG as well as in fMRI) to design recurrent networks on such matrices [4] in order to automatically classify the sleep phases as the acquisition progresses.

Candidate profile

- The candidate must have a recent Ph.D. (within 5 years) in Computer Science (or Applied Mathematics) in the field of Machine Learning.
- Knowledge and experience within Deep Learning frameworks is highly recommended.
- The candidate will perform research and algorithmic developments and solid programming skills are required.
- Interpersonal skills and the ability to work well individually or as a member of a project team are recommended.

- Good written and verbal communication skills are required, the candidate has to be fluent in spoken French or English and written English. Working language can be English or French.

Location

Caen, France in the GREYC UMR CNRS laboratory. Situated in the Normandy region of France close to the sea and about 240km west of Paris the city still has many old quarters, a population of around 120,000 the city area has roughly 250,000 inhabitants. Some photos

Application

Interested candidates should submit their application to

- lluc.brun@ensicaen.fr and
- lolivier.etard@unicaen.fr

Please include in your application email one Curriculum Vitae, one statement of research letter explaining your interest and your skills for this position, and 2 reference letters (all in a single pdf file). Applications will be admitted until the position is filled.

Additional information

Host institution: ENSICAEN, University of Caen Normandy and CNRS, GREYC laboratory (UMR 6072)

Gross Salary: between 2339 and 3268 euros per month according to experience (charges included)

Duration: 12 months with possible extensions.

Starting date: from January 2020

Advantages: Possibility of French courses, participation in transport costs, possibility of restoration on site.

References

1 M. Bouchard, J.-M. Lina, P.-O. Gaudreault, J. Dubé, N. Gosselin, et J. Carrier, EEG connectivity across sleep cycles and age, Sleep, p. zsz236, nov. 2019, doi: 10.1093/sleep/zsz236.

2 E. Tagliazucchi et E. J. W. van Someren, The large-scale functional connectivity correlates of consciousness and arousal during the healthy and pathological human sleep cycle, NeuroImage, vol. 160, p. 55-72, oct. 2017, doi: 10.1016/j.neuroimage.2017.06.026.

3 Nguyen, Xuan Son, Brun, Luc, Lezoray, Olivier & Bougleux, Sebastien. A Neural Network Based on SPD Manifold Learning for Skeleton-Based Hand Gesture Recognition. In The IEEE Conference on Computer Vision and Pattern Recognition (CVPR) , June 2019 .

4 Nguyen, Xuan Son, Brun, Luc, Lezoray, Olivier & Bougleux, Sébastien. Skeleton-Based Hand Gesture Recognition by Learning SPD Matrices with Neural Networks. In Proceedings of the 14th IEEE International Conference on Automatic Face and Gesture Recognition (FG 2019) 2019 .