# Post doctoral position on time series analysis of data living on the SPD manifold. Application to the neural caracterisation of different levels of wakefulness.

November 30, 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 time series of data corresponding to SPD matrices. The challenge here will be to define machine learning methods and more specifically deep learning methods (either convolutional or recursive) to analyze these data by using all the interesting properties of this specific manifold.

## Context

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

## Objectives and challenges

The project is based on data from a cohort being currently acquired. It includes EEG and MRI acquisitions performed while subjects are falling asleep for a nap.

In both cases, an acquisition in a given time window, is characterized by a SPD matrix. Each entry of this matrix correspond either to a correlation between two sensors in the case of an EEG acquisition or a correlation between two brain's zones in the case of an IRM acquisition.

In a first step the candidate will have to work on EEG acquisitions in order to design a deep learning algorithm predicting quantified levels of wakefulness along long EEG sequences. Convolutional [1, 3] or recurrent [2, 4] networks on the SPD manifold will be both studded and evaluated before a focus on the more promising approach.

While functional IRM sequences may also be characterized as time series of SPD matrices, these sequences are based on data with a much better spatial resolution than EEGs. This come at the price of a much lower temporal resolution compared EEG acquisitions. The candidate will have to adapt the work already done on EEG data to functional IRM datum and to compare both results.

## 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.

**Starting date:** from January 2020

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

## References


[1] Rudrasis Chakraborty, Jose Bouza, Jonathan Manton, and Baba C Vemuri. Manifoldnet: A deep neural network for manifold-valued data with applications. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, pages 1–1, 2020.

[2] Rudrasis Chakraborty, Chun-Hao Yang, Xingjian Zhen, Monami Banerjee, Derek Archer, David Vaillancourt, Vikas Singh, and Baba Vemuri. A statistical recurrent model on the manifold of symmetric positive definite matrices. In S. Bengio, H. Wallach, H. Larochelle, K. Grauman, N. Cesa-Bianchi, and R. Garnett, editors, *Advances in Neural Information Processing Systems*, volume 31. Curran Associates, Inc., 2018.

[3] Xuan Son Nguyen, Luc Brun, Olivier Lezoray, and Sébastien Bougleux. A neural network based on SPD manifold learning for skeleton-based hand gesture recognition. In *IEEE Conference on Computer Vision and Pattern Regognition (CVPR)*, Long Beach, United States, 2019.

[4] Xuan Son Nguyen, Luc Brun, Olivier Lézoray, and Sébastien Bougleux. Learning Recurrent High-order Statistics for Skeleton-based Hand Gesture Recognition. In *International Conference on Pattern Recognition (ICPR - IEEE)*, Milan (virtual), Italy, 2021.