MSc internship proposal

Entropy on graph signals for the medical field: Application to electroencephalographic data recorded in epileptic children

The work is proposed by the LARIS Lab (Laboratoire Angevin de Recherche en Ingénierie des Systèmes) in the University of Angers (**France**).

The Master candidate (1st or 2nd year of Master studies) should have strong background in **engineering** (mathematics, signal processing, and programming, among others).
The internship proposal corresponds to a **6 months** program (start date: January or February 2026).

The Master project work will rely on graphs and information theory-based measures with an application to the biomedical field. **The Sustainable Development Goal is "Good health and well-being" (SDG-3)** as the application has the goal to help clinicians in the detection of pathologies such as epilepsy in children.

Background

Non-linear analysis metrics are now commonly used for studying complex systems. Among these metrics, entropy measures are employed in a large number of studies. Several entropy measures have thus been developed since the 2000's to quantify the irregularity or complexity of time series: approximate entropy, sample entropy, permutation entropy, dispersion entropy to cite only a few [1-4]. The applications are wide: medical imaging, anomaly detection in dynamical network, remote sensing, etc. Each of these algorithms has its advantages and drawbacks (computational time, sensibility to parameter values, dependence on the time series length, to name a few). More recently, these algorithms have been extended to the bi-dimensional and tri-dimensional case to analyze the texture of images and volumes [5-9]. Our lab is the pioneer in this field.

Very recently, entropy on graph signals have also been proposed [10-11]. Compared to AI-based measures, entropy on graph measures have the advantage of being explicit and they do not rely on a training dataset. They also have been extended to multivariate time series [12]. However, more studies on the latter concepts are needed to expand the applications, especially for multivariate data with a large number of channels, such as electroencephalographic (EEG) time series.

Figure: Child wearing a helmet to record EEG data

Goal of the internship

The internship work will be split into two parts:

1. Analysis of the graph-based multivariate entropy measure [10-12] and proposition of improvements, particularly for multivariate data with a large number of channels. Implementation of a new graph-based multivariate entropy-measure.

2. Application of the new algorithm to EEG data. The medical goal is to help clinicians in the detection of pathologies such as epilepsy in children (collaboration with medical doctors).

The student will work in the LARIS lab (University of Angers, France) in a team composed of PhD students, MSc students and Professors. The potential compensation or advantages will be discussed with the EU GREEN coordinator in the University of Angers.

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