Master 2 Internship

Title: ***Classification of cardiac physiological signals using time-frequency analysis methods combined with AI tools***

Type: theoretical

Supervisor(s): Françoise Argoul

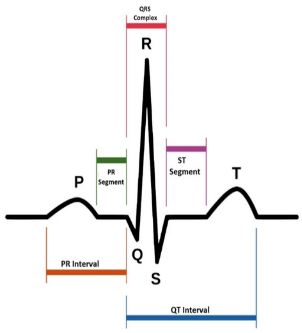
Email(s): francoise.argoul@u-bordeaux.fr

PhD funding (if any): ANR PhD funding planned

Project:

The electrocardiogram (ECG) is currently the most commonly used biosignal for the rapid detection of cardiovascular disease. The ECG is a graphic representation of the heart's electrical activity, and is used to identify various cardiac diseases and abnormalities such as arrhythmia, atrial fibrillation and myocardial infarction [1].

An ECG signal is made up of PQRS complexes and T waves, as shown in the figure in the right. By analyzing variations in these waves, we can diagnose many heart diseases. ECG machines are safe and inexpensive. However, noise and other factors, known as artifacts, can produce peaks in ECG signals. These artifacts can be caused by patients' body movements, loss of contact between the electrodes and the chest, or interference from electrical cables. Consequently, noise and artifacts must be eliminated from ECG signals to ensure accurate ECG analysis. Various transforms have been used to pre-process ECG signals in order to remove noise and artifacts, and one of the most commonly used transforms is the wavelet transform [2]. Several algorithms have been reported previously to detect P waves, the QRS complex and T waves, in order to achieve noise- and artifact-free ECG signals, and they have been validated on the MIT-BIH arrhythmia database. Nevertheless, most of these algorithms are limited to a small number of parameters to characterize these complexes.



Objectives :

- carry out a state-of-the-art review of the literature; compare the various published methods for detecting PQRS-T complexes, and compare the performance of open-source programs
- extend methods already published and/or validated, in particular on the MIT-BIH base, by proposing machine learning methods based on time-frequency data analysis, for extracting variability and structural complexity from cardiac signals [3].
- reproduce recently published regression approaches to improve machine learning and AI models in the context of these cardiac signals
- then, based on these results, propose the functional architecture of a cardiac data classification program combining both time-frequency analysis and machine learning tools.

Expected profile :

The profile we're looking for is that of a student in computer science, data science, physics or applied mathematics, who is curious and open to applications in transdisciplinary fields (health, medicine).

References :

[1] G. Attuel, E. Gerasimova-Checkine, F. Argoul, H. Yahia & A. Arneodo, Multifractal desynchronization of the cardiac excitable cell network during atrial fibrillation. I. Multifractal analysis of clinical data, *Front Physiol.* 8 (2018) 1139

[2] A. Guillet, A. Arneodo & F. Argoul. Tracking rhythms coherence from polysomnographic records: A time-frequency approach. *Frontiers in Applied Mathematics and Statistics*, 7 (2021) 624456.

[3] S. Aziz, S. Ahmed & M.S.Alouini, ECG-based machine-learning algorithms for heartbeat classification, *Sci. Rep.* 11 (2021) 18738.