**Physiology relevant spectral peak characterization of time-resolved functional near infrared spectroscopy (TR-fNIRS)**

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**Area**: Data analysis and signal processing.

*Aim*: To establish and validate a set of features for characterizing spectral peaks that identify relevant physiological phenomena in a Fourier’s spectral decomposition that are robust to different processing pipelines.

*Background*: The classical definition of a peak in a signal is that of a local maxima. However, upon applying a Fourier transform algorithm to a certain signal, sticking to that strict definition one will end up with a large number of peaks that are of no interest for a research question at hand. Driven by the necessity of identifying spectral peaks corresponding to brain haemodynamics phenomena occurring in time-resolved functional near infrared spectroscopy (TR-fNIRS) [1], it is necessary to establish an alternative characterization of peaks i.e. a set of features, such that only those related with the targeted physiological phenomena are selected from the myriad of original peaks. Moreover, it is known that the set of spectral peaks -whether physiologically related or not- occurring in an spectral decomposition is strongly influenced by the processing pipeline e.g. choice of Fourier transform algorithm, application of filters both prior to Fourier’s transform and after the transform, evaluation endpoints, etc. Hence, we seek a characterization of peaks that is robust to the choice of the pipeline. Such peak characterization will include but may not be limited to features such as central frequency, width, amplitude, kurtosis, spectral resolution, contrast to noise ratio, prominence, etc.

*Methods*: You will be provided with a neuroimaging dataset collected using time-resolved functional near infrared spectroscopy (TR-fNIRS) by our colleagues at Politecnico di Milano. In this dataset, brain haemodynamics was collected from a cohort of healthy subjects in two conditions known to induce physiological changes; free and modulated breathing. You will systematically explore the spaces of pipelines and peaks characteristics subject to physiological rhythms in order to establish a set of robust characteristics across:

* phenomenon -different phenomenon may be characterized by different features-,
* processing pipelines and their parameterization, and
* subjects and experimental factors.

*Expected outcome*: You will evaluate your success based on a set of physiology driven endpoints; e.g. but not limited to, number of (correctly identified) peaks, peaks consistency (following some peak pairing criterion), peak spectral resolution, relatedness to known brain heamodynamic phenomena, etc.

*Related literature*:

[1] Re, R et al (2023). Reliable Fast (20 Hz) Acquisition Rate by a TD fNIRS Device: Brain Resting-State Oscillation Studies. Sensors, 23, 196. <https://doi.org/10.3390/s23010196>

[2] Re, R et al (2023). Cerebral resting state oscillations study with TD fNIRS. European Conference of Biomedical Optics (ECBO)