Time Series Analysis for Near-Infrared Spectroscopy Data

M2 Internship (2nd year MSc degree, 3-6 months), Spring 2017

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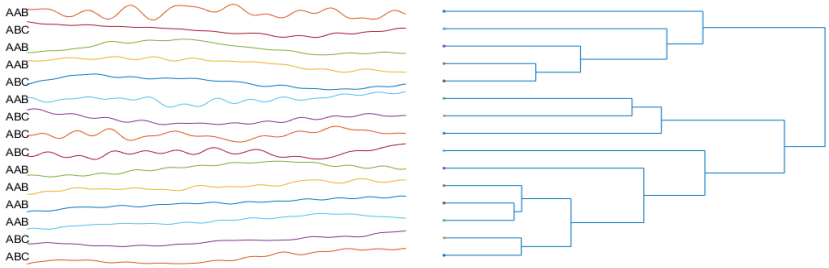
Near-infrared spectroscopy (NIRS) is an increasingly popular non-invasive brain imaging technique, often used in developmental cognitive neuroscience research [1]. As it is a relatively new method, standardized data analysis techniques are still lacking. Our understanding of the hemodynamic response in infants is also incomplete, rendering analysis methods that rely on strong assumptions about the underlying physiology impractical. Compromised data quality due to hair and strong movement artifacts, typical in babies, also plagues data analysis [1,2].



This project aims to develop new analysis methods based on time series management and analysis techniques [3,4]. These techniques can efficiently operate on the original, fully detailed data set (contrary to previous approaches that are aggregating the values in each signal), taking into account the trends that these data exhibit over time. Specifically, similarity search will be used to identify NIRS data that follow similar trends over time and subsequently group those together in clusters, and detect abnormal behaviors.

The analysis to be developed should be used (i) by comparing their results to previously published findings [2], as well as (ii) by applying them to previously unpublished data (both from experiments on newborn speech perception). Some preliminary results suggest that the proposed methods are promising. Specifically, hierarchical cluster analysis was used successfully to separate the experimental conditions in the experiments. The candidate's task is to refine and finalize the analysis methods.

Internship

Accepting this project will make you part of an enthusiastic team working on real, challenging problems! The goal of the internship is to produce original results and publish 1-2 papers (conference and/or journal) based on those.
Prerequisites: Successful candidates will have very good programming skills in MatLab; familiarity with time series management methods, as well brain imaging and/or signal processing, is an advantage.

Team

Judit Gervain is a CNRS research scientist at the Laboratoire Psychologie de la Perception (CNRS & Université Paris Descartes), in Paris France. She work on early speech perception and language acquisition, using behavioral methods, optical brain imaging and electrophysiological measures to understand how babies learn their native language(s).
Themis Palpanas is a full professor of computer science at Paris Descartes University, where he is co-director of diNo, the data management group. He received the MSc and PhD degrees from the University of Toronto, Canada. His team has developed worldwide expertise on data series management and analysis.

References

[1] Gervain, J., J. Mehler, J. F. Werker, C. A. Nelson, G. Csibra, S. Lloyd-Fox, M. Shukla, & R. N. Aslin. 2011. "Near-Infrared Spectroscopy: A report from the McDonnell infant methodology consortium". Developmental Cognitive Neuroscience, 1(1): 22-46.
[2] Gervain, J., Berent, I., Werker, J.F. 2012. "Binding at birth: The newborn brain detects identity relations and sequential position in speech". Journal of Cognitive Neuroscience, 24(3): 564-574.
[3] Keogh, E. and Pazzani, M. (1998). An enhanced representation of time series which allows fast and accurate classification clustering and relevance feedback. In 4th International Conference on Knowledge Discovery and Data Mining. New York, NY, USA.
[4] Kostas Zoumpatianos, Stratos Idreos, Themis Palpanas. ADS: The Adaptive Data Series Index. International Journal on Very Large Data Bases (VLDBJ) 25(6), 2016 (http://www.mi.parisdescartes.fr/~themisp/rinse/).