basque center for applied mathematics

Working Seminar
(MTB)

Friday, October 1st 15:00

Susanne Ditlevsen

Department of Mathematical Sciences, University of Copenhagen

Can brain states predict visual processing?

Joint work with Marie Levakova, Jeppe Christensen and Søren Kyllingsbæk

When the brain interprets visual information that is only presented for a very short time it sometimes makes mistakes. The question is then if the brain state just before the visual stimulus is presented might influence the cognitive performance – and in that case, if it is possible to characterize the brain state from electrophysiological measurements. Here, we use cointegration analysis of EEG signals to classify brain states that predict future performance in visual tasks.
Recordings obtained during EEG sessions are an invaluable source of information about brain activity. The statistical toolbox to handle this kind of data has been growing over the last decades, with techniques focusing both on time and frequency domain. The aim of our work is to enrich the toolbox with a statistical methodology suited to investigate the functional network structure of the EEG channels setup. The cointegration methodology has been originally developed with econometrics applications in mind [1], however, the idea to use cointegration for phase-coupled oscillating systems in physics [2] and in neuroscience [3] has emerged recently. It has a solid statistical foundation [4].
We assume that the generating process of the EEG signals is a system of coupled Ornstein-Uhlenbeck processes, which implies that observations in discrete time are an integrated (nonstationary) vector autoregressive (VAR) process. The idea of cointegration analysis is to split the dynamics into stochastic trends of random-walk type and long-term linear equilibrium relationships, termed cointegration relationships. The results from applying cointegration analysis to a real dataset from a visual task experiment with human participants will be presented.

References

[1] C. W. Granger. Some properties of time series data and their use in econometric model specification. J. Econometrics, 16(1): 121–130, 1981.
[2] R. Dahlhaus, I. Z. Kiss. J. C. Neddermeyer. On the Relationship between the Theory of Cointegration and the Theory of Phase Synchronization. Statist. Sci., 33(3): 334–357, 2018.
[3] J. Østergaard, A. Rahbek, and S. Ditlevsen. Oscillating systems with cointegrated phase processes. J. Math. Biol., 75(4): 845–883, 2017.
[4] S. Johansen. Likelihood-Based Inference in Cointegrated Vector autoregressive Models. Oxford University Press, 1996.

Link to the sesión: https://us06web.zoom.us/j/82664466629?pwd=U3c0NXk0RTNETzNReUtqcWFNQURYdz09

EUSKO JAURLARITZA GOBIERNO VASCO
HEZKUNTZA SAILA
DEPARTAMENTO DE EDUCACIÓN

EXCELENCIA SEVERO OCHOA

matematika mugaz bestalde