Statistical and Machine Learning Approaches to Functional Neuroimaging Data

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Abstract

Statistical methods have been utilized in functional neuroimaging research for assisting scientific discovery by extracting information from data and assessing the robustness of research results. In the meantime, machine learning methods are typically used in decoding or encoding settings for linking brain activations with behavioral or clinical observations. These approaches are capable of detecting task-related brain activation regions and identifying brain networks with similar temporal patterns. Moreover, it is possible to investigate the mechanism of information processing in the human brain that may further improve the design of machine learning models. However, methodological challenges remain because the recorded brain signals are noisy, non-stationary and with high-dimensional features distributed in the temporal and spatial domains. In this talk, I will highlight some machine learning and statistical procedures we have developed for analyzing neuroimaging data including nonlinear dimensionality reduction, predictive model fitting, statistical thresholding, and reproducibility estimation, by a focus on time series of functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and magnetoencephalography (MEG). Also, I will discuss the future direction of statistical machine learning in neuroimaging research and applications.

Keywords: machine learning; neuroimaging; nonlinear dimensionality reduction; predictive model; statistical thresholding; reproducibility estimation.