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Clusterwise-IVA: a new method to uncover patient heterogeneity by clustering subjects based on temporal changes in underlying processes

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Oral presentation

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Abstract

In different fields of science (e.g., neuroscience and psychology) researchers'main focus consists of disclosing the processes and temporal changes therein underlying longitudinal (big) multivariate data. In neuroscience, for example, patients are regularly scanned with fMRI (e.g., yearly sessions) with the aim of disclosing temporal changes in functional connectivity (FC) patterns (i.e., correlated brain regions collaborating in psychological functioning) related to a particular disease (e.g., depression or dementia). In this regard, longitudinal changes in FC patterns that are typical for dementia patients were identified in previous studies (Dautricourt et al., 2021). To extract temporal changes in FC patterns from longitudinal multi-subject fMRI data, Independent Vector Analysis (IVA) was proposed, which performs ICA on the data of each session and restricts the associated components to be dependent across sessions. As such, the extracted (dependent) components capture longitudinal changes in FC patterns.

When studying brain diseases (e.g., dementia), however, often patient heterogeneity in the underlying processes and in the temporal changes therein is present. This heterogeneity often can be linked to the existence of subtypes of the disease (i.e., heterogeneous patterns of disease development across patient groups pointing at different types of dementia). To uncover this patient heterogeneity, we propose to cluster the patients based on similarities and differences in the temporal change profiles underlying subjects'FC patterns. By studying the differences in temporal change profiles across clusters, important insights regarding disease subtypes can be gained.

To our knowledge, however, no statistical procedure exists that is able to simultaneously extract the patient clusters and the temporal changes in FC patterns underlying each cluster. To this end, we propose Clusterwise IVA, which clusters subjects and at the same time estimates the longitudinally changes in FC patterns characterizing each subject cluster. An Alternating Least Squares (ALS) algorithm will be used to optimally estimate the Clusterwise IVA parameters. In our presentation, Clusterwise IVA will be explained and the performance of the method will be evaluated by means of an extensive simulation study and/or an illustrative application to longitudinal multi-subject fMRI data from Alzheimer patients.

References

Dautricourt, S., de Flores, R., Landeau, B., Poisnel, G., Vanhoutte, M., Delcroix, N., Eustache, F., Vivien, D., de la Sayette, V., & Chételat, G. (2021). Longitudinal changes in hippocampal network connectivity in Alzheimer's disease. Annals of Neurology, 90(3), 391-406. https://doi.org/10.1002/ana.26168

Keywords

Clustering, PCA/ICA, heterogeneity, simulation, dementia

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