Archetypal Analysis for Modeling Multisubject fMRI Data - DTU Orbit (14/12/2018)

Functional magnetic resonance imaging (fMRI) is widely used to measure brain function during various cognitive states. However, it remains a challenge to obtain low-rank models of functional networks in fMRI that have interpretable latent features and generalize across groups of subjects, due to significant intersubject variability in the signal structure and noise. Group-level modeling is typically performed using component decompositions such as independent component analysis (ICA), which represent data as a linear combination of latent brain patterns, or using clustering models, where data are assumed to be generated by a set of 'prototype' time series. Archetypal analysis (AA) provides a promising alternative, combining the advantages of component-model flexibility with highly interpretable latent 'archetypes' (similar to cluster-model prototypes). To date, AA has not been applied to group-level fMRI; a major limitation is that it does not generalize to multi-subject datasets, which may have significant variations in blood oxygenation-level-dependent signal and heteroscedastic noise. We develop multi-subject AA (MS-AA), which accounts for group-level data by assuming that archetypal temporal profiles have a common latent generator across subjects, ensuring that the temporal components are derived from a consistent set of brain regions. In addition, the model accounts for noise heteroscedasticity by modeling subject-and voxel-specific noise variance. This provides a novel approach to group-level modeling and an alternative to preexisting methods that account for inter-subject variability by extracting individual maps as a postprocessing step (e.g., dual-regression ICA), or assuming spatial dependency of maps across subjects (e.g., independent vector analysis). MS-AA shows robust performance when modeling archetypes for a motor task experiment. The procedure extracts a 'seed map' across subjects, used to provide brain parcellations with subject-specific temporal profiles. Our approach thus decomposes multisubject fMRI data into distinct interpretable component archetypes that may help to model both consistent group-level measures of fMRI data and individual variability.

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