Functional parcellation of the cerebral cortex based on brain network identification using resting-state fMRI

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Many functional parcellation schemes that use resting-state functional MRI (rs-fMRI) have been described in the literature. Although several schemes use applied graph-based analysis (e.g., Craddock et al., 2012 and Shen et al., 2013), no clear relationships between these parcellations have been described. Here, we explored these relationships. Moreover, we demonstrate that a more general graph-based method (NetMF) can unify several graph-embedding approaches by approximating graph-embedding as a matrix factorization procedure. Using 3T rs-fMRI data from 1000 subjects from the Human Connectome Project, we first computed group spatial activation maps using a temporal synchronization approach (Group BrainSync) combined with tensor decomposition (NASCAR). Unlike ICA, the spatial maps of different networks' activations obtained by NASCAR are not constrained to be independent of each other, and hence can be more physiologically plausible. We then construct a graph where each vertex on the cortical surface defines a node. The correlation of the previously identified spatial maps across all networks defines the edge strength between a pair of nodes. To ensure spatial contiguity of parcels, we place a k-hop neighbor spatial constraint. NetMF maps this graph to a low-dimensional latent space. The parcellation in then derived using k-means clustering on these low-dimensional embeddings. We show that our parcellation can achieve state-of-the-art performance compared with many other parcellation schemes in several metrics of interest, such as functional homogeneity, concordance with cytoarchitectonics, and delineation of function activation.

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