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Replicating Brain’s Resting State Functional Connectivity Network Using a Multi-Factor Hub-Based Model

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Abstract : The brain’s functional connectivity while temporally non-stationary does express consistency at a macro spatial level. The study of stable resting state connectivity patterns hence provides opportunities for identification of diseases if such stability is severely perturbed. A mathematical model replicating the brain’s spatial connections will be useful for understanding brain’s representative geometry and complements the empirical model where it falls short. Empirical computations tend to involve large matrices and become infeasible with fine parcellation. However, the proposed analytical model has no such computational problems. To improve replicability, 92 subject data are obtained from two open sources. The proposed methodology, inspired by financial theory, uses multivariate regression to find relationships of every cortical region of interest (ROI) with some pre-identified hubs. These hubs acted as representatives for the entire cortical surface. A variance-covariance framework of all ROIs is then built based on these relationships to link up all the ROIs. The result is a high level of match between model and empirical correlations in the range of 0.59 to 0.66 after adjusting for sample size; an increase of almost forty percent. More significantly, the model framework provides an intuitive way to delineate between systemic drivers and idiosyncratic noise while reducing dimensions by more than 30 folds, hence, providing a way to conduct attribution analysis. Due to its analytical nature and simple structure, the model is useful as a standalone toolkit for network dependency analysis or as a module for other mathematical models.

Keywords : functional magnetic resonance imaging, multivariate regression, network hubs, resting state functional connectivity
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