Learning Signal Subgraphs from Longitudinal Brain Networks with Symmetric Bilinear Logistic Regression

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Abstract: Modern neuroimaging technologies, combined with state-of-the-art data processing pipelines, have made it possible to collect longitudinal observations of an individual's brain connectome at different ages. It is of substantial scientific interest to study how brain connectivity varies over time in relation to human cognitive traits. In brain connectomics, the structural brain network for an individual corresponds to a set of interconnections among brain regions. We propose a symmetric bilinear logistic regression to learn a set of small subgraphs relevant to a binary outcome from longitudinal brain networks as well as estimating the time effects of the subgraphs. We enforce the extracted signal subgraphs to have clique structure which has appealing interpretations as they can be related to neurological circuits. The time effect of each signal subgraph reflects how its predictive effect on the outcome varies over time, which may improve our understanding of interactions between the aging of brain structure and neurological disorders. Application of this method on longitudinal brain connectomics and cognitive capacity data shows interesting discovery of relevant interconnections among a small set of brain regions in frontal and temporal lobes with better predictive performance than competitors.