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Robust Spatial Varying Coefficient Model in Neuroimaging Data Analysis

Neuroimaging studies aim to analyze imaging data with complex spatial patterns in a large number of locations (called voxels) on a two-dimensional (2D) surface or in a 3D volume. We proposed three methods to spatially model the varying association between imaging measures with a set of covariates, namely, spatially varying coefficient model (SVCM), multiscale adaptive composite quantile regression model (MACQRM), and spatially statistical parametric mapping model (SSPM). For each method, we develop a three-stage estimation procedure to simultaneously estimate the effect images and the complex spatial correlation. Theoretically, we establish consistency and asymptotic normality of the adaptive estimates and the asymptotic distribution of the test statistics. Our Monte Carlo simulation and real data analysis have confirmed their excellent performance.