

Covariate Assisted Principal Regression for Covariance Matrix Outcomes with an Application to fMRI

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Abstract: Modeling variances in data has been an important topic in many fields, including in financial and neuroimaging analysis. We consider the problem of regressing covariance matrices on vector covariates, collected from each observational unit. The main aim of this paper is to uncover the variation in the covariance matrices across units that are explained by the covariates. This paper introduces Covariate Assisted Principal (CAP) regression, an optimization-based method for identifying the components predicted by (generalized) linear models of the covariates. We develop computationally efficient algorithms to jointly search the linear projections of the covariance matrices as well as the regression coefficients, and we establish the asymptotic properties. Using extensive simulation studies, our method shows higher accuracy and robustness in coefficient estimation than competing methods. Applied to a resting-state functional magnetic resonance imaging study, our approach identifies the human brain network changes associated with age and sex.