Projection-Based Bayesian Regression for Matrix-Valued Predictors

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Abstract

We present a novel Bayesian approach for nonlinear regression with connectivity predictors encoded as symmetric matrices or symmetric positive definite matrices. Unlike methods that vectorize matrices as predictors, resulting in a large number of parameters, our approach extracts informative features through dimension reduction projections, yielding a projection-pursuit-type estimator of the regression model. We establish the identifiability conditions of the proposed model and impose sparsity priors on the projection directions to prevent overfitting and enhance interpretability of the parameter estimates. The performance of our approach is evaluated through simulation studies and a case study investigating the relationship between brain connectivity features and behavioral outcomes.

Keywords

Bayesian nonlinear regression, Projection pursuit, Matrix predictors