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Bayesian nonparametric regression with varying residual density

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Abstract We consider the problem of robust Bayesian inference on the mean regression function allowing the residual density to change flexibly with predictors. The proposed class of models is based on a Gaussian process (GP) prior for the mean regression function and mixtures of Gaussians for the collection of residual densities indexed by predictors. Initially considering the homoscedastic case, we propose priors for the residual density based on probit stick-breaking mixtures. We provide sufficient conditions to ensure strong posterior consistency in estimating the regression function, generalizing existing theory focused on parametric residual distributions. The homoscedastic priors are generalized to allow residual densities to change nonparametrically with predictors through incorporating GP in the stick-breaking components. This leads to a robust Bayesian regression procedure that automatically down-weights outliers and influential observations in a locally adaptive manner. The methods are illustrated using simulated and real data applications.

Keywords Data augmentation · Exact block Gibbs sampler · Gaussian process · Nonparametric regression · Outliers · Symmetrized probit stick-breaking process