Hierarchical Generalized Structured Additive Regression

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Models with structured additive predictor provide a very broad and rich framework for complex regression modeling. They can deal simultaneously with nonlinear covariate effects and time trends, unit- or cluster specific heterogeneity, spatial heterogeneity and complex interactions between covariates of different type. In this paper we propose a hierarchical version of regression models with structured additive predictor. That is the regression coefficients of a particular nonlinear term may itself obey a regression model with structured additive predictor. In that sense, the model is composed of a hierarchy of complex structured additive regression models. Inference is fully Bayesian and based on Markov chain Monte Carlo simulation techniques.

We provide an in depth discussion of several highly efficient sampling schemes. Compared to an equivalent non-hierarchical formulation of the model several distinct advantages for MCMC inference arise: MCMC simulation is considerably (sometimes dramatically) faster and the mixing of the Markov Chains is improved. Moreover, the full conditionals of the nonlinear terms in the second stage of the hierarchy are Gaussian even if the response distribution is non-Gaussian. This allows to use highly efficient sampling schemes developed for Gaussian responses. The hierarchical nature of the model and the efficiency of the sampling schemes allows to analyze huge datasets and estimate models with considerable complexity.