Bayesian inference in semiparametric mixed models for longitudinal data

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Abstract: We consider Bayesian inference in semiparametric mixed models (SPMMs) for longitudinal data. We define SPMMs as a class of models that use a nonparametric function to model a longitudinal mean function, parametric fixed effects to represent the covariate effects, and parametric or nonparametric random effects to account for the within-subject correlation. We model the nonparametric function using a cubic smoothing spline, and we consider two alternative assumptions for the random effects distribution, namely a parametric normal model and a nonparametric model with a Dirichlet process (DP) prior. When the random effects are assumed to be normally distributed, we propose a uniform shrinkage prior (USP) for the variance components and for a smoothing parameter that defines the smoothing spline. The proposed USP is an extension of the USPs proposed in the recent literature. When the random effects are assumed to be nonparametric, we use a DP prior with a normal base measure and propose a USP for the hyperparameters of the DP base measure. In both models we show that the posterior is proper under the proposed USPs and a flat prior for the fixed effects parameters. Furthermore, in the SPMM with the DP prior on the random effects distribution we argue that the non-zero mean of the random effects distribution complicates inference for the fixed effects and the smoothing spline. We propose to use a post-processing technique to correct inference for the fixed effects and the nonparametric function. We illustrate the proposed approach by analyzing a longitudinal hormone dataset. We carry out extensive simulation studies to assess the robustness and efficiency of the normality assumption, to compare the performance of the USP with conventional inverse gamma priors for the variance components, and to compare the adjusted DP method with corresponding inference without adjustment in the SPMM setting.