Bayesian Model Selection for Random Effects Models with Spike and Slab Priors

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Model selection for random effects models involves not only selection of covariates which should be included in the final model but also to decide whether their effects should be specified as fixed or random, i.e. selection of the variance of a potentially random effect as zero or non-zero. Many Bayesian methods for variable selection use mixture priors with a spike and a (flat) slab component for the regression coefficients: The spike with its mass concentrated around zero allows shrinkage of small effects to zero. Using a suitable parameterization of a random effects model these priors are useful also for variance and covariance selection of random effects. Inference based on MCMC for absolutely continuous and Dirac spikes is discussed and illustrated on a medical application.

However, model selection in random effects models can be regarded more generally as a problem of unit-specific selection of random effects. As an illustrative example we consider regression models with a random intercept, which are widely used to take into account individual heterogeneity in longitudinal data. The heterogeneity distribution acts as a smoothing prior which ties the random intercepts together and encourages shrinkage of the individual intercepts toward the overall intercept. We demonstrate that by an appropriate specification of the heterogeneity distribution, individual shrinkage for random intercepts toward zero can be achieved. Thus identification of units which are "average" in the sense that they do not deviate from the overall mean and units which deviate significantly from the "average" is feasible.

Simulation studies comparing the various priors show that spike-and slab random effects priors outperform unimodal, non Gaussian priors as far as correct classification of non-zero random effects is concerned and that there is surprisingly little difference between an absolutely continuous and a Dirac spike. Finally extensions to more general random effects and state space models are discussed.