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Streamlined Computing for Variational Bayesian Inference with Higher-Level Random Effects

Streamlined variational Bayesian inference for multilevel data analysis is hindered by the presence of sparse multilevel matrix problems. Existing methods are such that streamlined variational inference is restricted to mean-field variational Bayes algorithms for two-level random effects models. Streamlined solutions to sparse matrix problems will be presented, which arise in multilevel modelling and longitudinal data analysis. The solutions to two-level and three-level problems provide the blueprint for extensions to higher-level versions of the problem. These results can be applied to mean field variational Bayes algorithms by using a least squares representation of the updates. Whilst the linear system solutions are a concise recasting of existing results, the matrix inverse sub-block results are novel and facilitate streamlined mean field variational Bayesian inference for models containing higher-level random effects. In summary, the barriers for streamlining variational inference algorithms with higher level random effects are removed.