THE UNIVERSITY OF CHICAGO | DEPARTMENT OF STATISTICS

Master's Thesis Presentation

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"Fast Estimation and Valid Statistical Inference for Mixed-Effect Location-Scale Models Using Variational Inference"

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Abstract

With the development of modern technology, richer and more intensive longitudinal data are available for researchers to study more complex model structures. The Mixed-Effect Location-Scale Model (MELS) is useful for modeling the variance components in such data. However, fitting these models is computationally demanding using standard Maximum Likelihood estimation (MLE) or Markov Chain Monte Carlo (MCMC) methods. This paper introduces a fast, deterministic Variational Message Passing (VMP) algorithm for fitting MELS models. We derive the updates for the non-conjugate components using a simplified Laplace approximation and employ a robust M-estimation framework to construct sandwich estimators for valid frequentist inference. Simulation studies confirm our estimator is accurate and consistent. A real data example shows that our algorithm achieves point and interval estimates comparable to MLE in seconds, outperforming MLE (minutes) and MCMC (hours). This MELS-VMP algorithm provides a computationally efficient and reliable alternative for model selection and inference on intensive longitudinal datasets. And an R package is developed for practical usage.
