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Comparative Analysis of Bayesian Logistic Regression Using Gibbs and Metropolis-Hastings Sampling with Diverse Prior Distributions

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Abstract

Investigating the convergence properties of MCMC algorithms is crucial for Bayesian logistic regression, because it is closely related to the accuracy of posterior distribution estimates. Effective convergence is particularly key to enhancing the reliability and precision of Bayesian logistic regression models, which are widely used to solve classification problems in fields such as medicine, biostatistics, finance, and more. This thesis utilizes diverse diagnostic tools to explore and compare the convergence performance of posterior sampling in Bayesian logistic regression using various MCMC algorithms, such as Gibbs Sampling and Metropolis-Hastings random walk, in combination with different prior assumptions, including normal, Student's t, and Cauchy distributions. The primary motivation of this paper is to provide guidance for selecting MCMC algorithms and prior assumptions in Bayesian logistic regression contexts through the experimental results. The primary conclusion of this research is that Gibbs Sampling, in contrast to the Metropolis-Hastings random walk, consistently attains quicker convergence and superior sampling effectiveness across all three of our predetermined prior assumptions. This holds for both low and high correlation scenarios within our simulated data. Moreover, normal priors contribute to higher sampling effectiveness for Gibbs models, and they also lead to faster convergence for Metropolis-Hastings models than Student's t and Cauchy priors.

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