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A Novel Relative Entropy - Posterior Predictive Model Checking Approach with Limited Information Statistics for Latent Trait Models in Sparse 2^k Contingency Tables

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Abstract. Limited information statistics have been recommended as the goodness-of-fit measures in sparse 2^k contingency tables, but the p-values of these test statistics are computationally difficult to obtain. A Bayesian model diagnostic tool, Relative Entropy - Posterior Predictive Model Checking (RE-PPMC), is proposed to assess the global fit for latent trait models in this paper. This approach utilizes the relative entropy (RE) to resolve possible problems in the original PPMC procedure based on the posterior predictive p-value (PPP-value). Compared with the typical conservatism of PPP-value, the RE value measures the discrepancy effectively. Simulated and real data sets with different item numbers, degree of sparseness, sample sizes, and factor dimensions are studied to investigate the performance of the proposed method. The estimates of univariate information and difficulty parameters are found to be robust with dual characteristics, which produce practical implications for educational testing. Compared with parametric bootstrapping, RE-PPMC is much more capable of evaluating model adequacy.

Keywords: Goodness-of-fit; Latent trait model; Limited information statistics; Parametric bootstrapping; Posterior predictive model checking; Relative entropy

1. Introduction

Dichotomous data with k items are common in social sciences and considered as 2^k contingency tables in the context of statistics. Latent variable models (LVM; for an overview, see Bartholomew et al., 2011) provide a unified framework for the analysis of the latent structure of complex data. In particular, when the observed variables are categorical with continuous latent variables, it is referred to as a latent trait model (LTM). Note that the LTM is often otherwise known as the item response theory (IRT) model. This type of models has been widely applied in many fields, especially for

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