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Addressing convergence problems in latent variable models

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Addressing convergence problems in latent variable models

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Abstract

Convergence problems are difficult to circumvent in psychometric analyses. Sometimes, these problems arise because models are wrongly specified but when this is not the case, convergence issues are due to slow and rigid optimization algorithms that are unable to set proper constraints over the parameter space. In the latent R package, we implemented a new optimization framework, termed optimization on matrix manifolds, where these problems are correctly addressed. latent is a user-friendly and flexible package capable of fitting a wide variety of latent variable models with guarantees of high-speed performance and convergence. This new package offers a unified approach towards different statistical frameworks such as Structural Equation Modeling (SEM) and Latent Class Analysis (LCA). In all of these frameworks, model fitting problems happen. For example, Ultra-Heywood cases (negative variances) and, more generally, non-positive-definite latent covariances are problematic in SEM. In these cases, the researcher either needs to be cautious in the interpretation of the parameter estimates and disregard standard errors or needs to set up an ad-hoc model in order to attain proper convergence. Meanwhile, local minima are frequent in LCA and optimization algorithms are usually slow. We present solutions to these problems. First, we implemented in latent an algorithm (the partially oblique manifold) for estimating covariance matrices that are strictly positive-semi-definite. This algorithm can even estimate matrices that are sparse (with many zeroes in specific positions). This way, researchers can estimate properly any model and extract standard errors as long as the model is well-specified. Second, we show how LCA models can be estimated very fast with multiple starting values in the latent package due to high-performing optimization algorithms written in C++. This manner, latent offers an alternative to fit models that otherwise cannot be fitted and saves time in the estimation of complex models.

Keywords

LCA; SEM; software

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