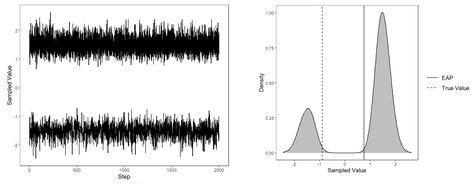
Evaluating solutions to the label-switching issue when estimating latent variable models with the NUTS algorithm

Nathan DePuy, Jonathan Templin

Introduction

- Label switching: convergence of MCMC onto differing modes in posterior densities (Qiu & Yuan, 2023)
- Issue arises in Bayesian item response models that parameterize factor loadings (λ_i) or item discrimination (a_i)

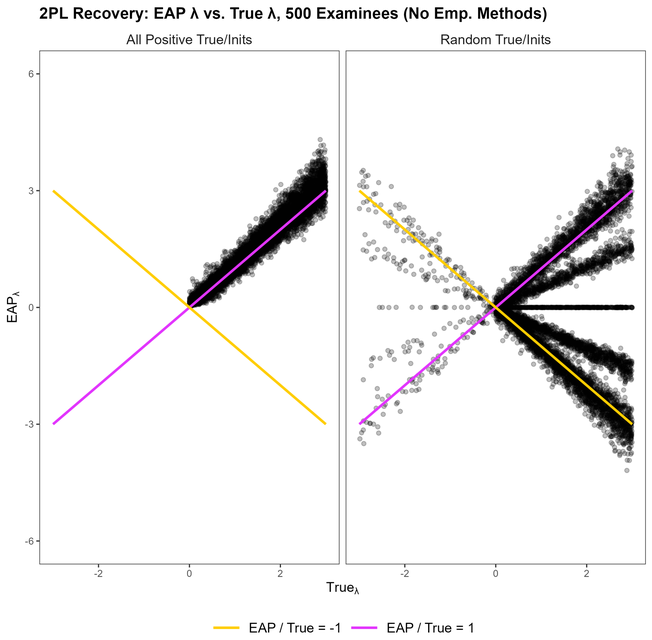


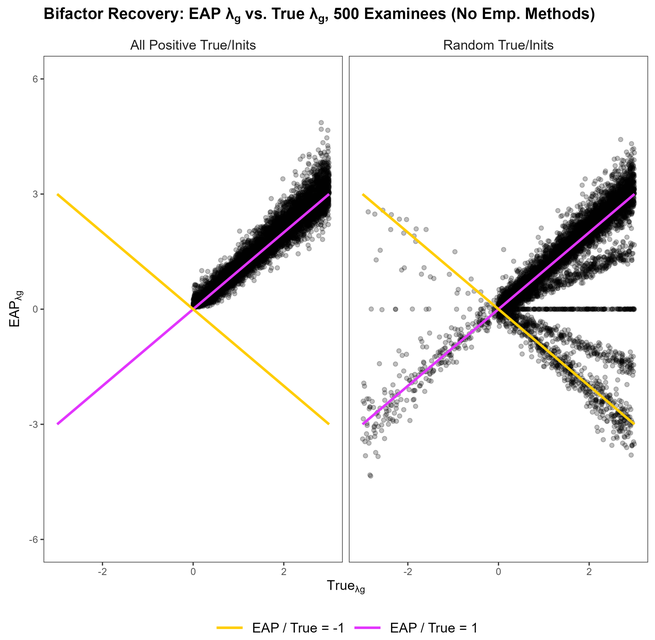
Methods

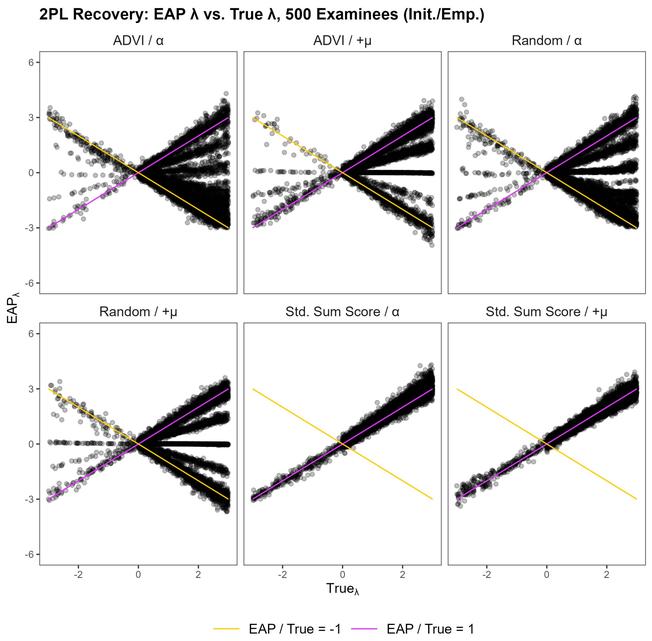
- Parameters sampled with the NUTS algorithm in *Stan* (Gabry, Češnovar, Johnson, & Bronder, 2024)
- Chain convergence determined using $\hat{R} \leq 1.05$ (Vehtari et al., 2021)
- Parameter recovery performance evaluated using bias and RMSE estimates
- Each condition replicated 100 times in parallel using clusters within a High-performance computing environment

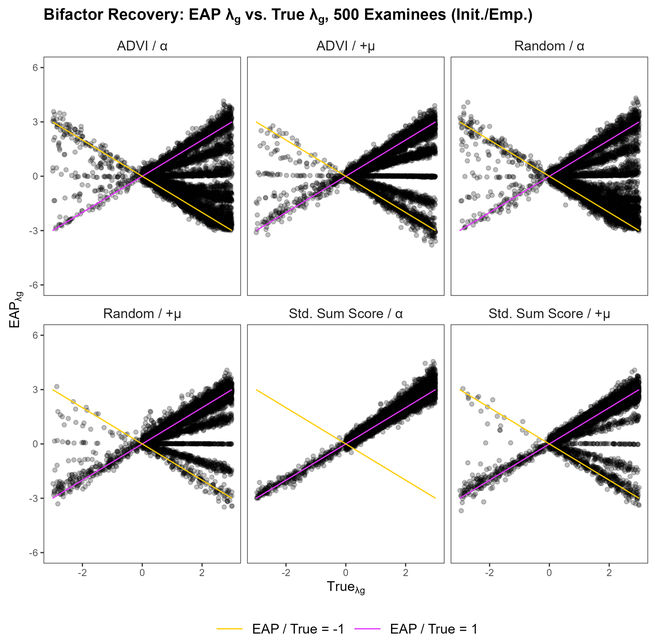
References

View article and citations by scanning the QR code above









Findings

2PL λ (True vs. EAP)			
	Bias	**RMSE**	$N_{\widehat{R} \geq 1.05}$
All Positive True/Inits	0.114	0.256	0
Random True/Inits	-1.585	2.521	2595
ADVI/α	-1.827	2.632	1553
ADVI/+μ	-0.639	1.472	2135
Random/α	-1.514	2.386	1995
Random/+μ	-1.185	2.081	2517
Std. Sum Score/α	0.097	0.25	0
Std. Sum Score/+μ	0.018	0.201	0

Bifactor λ_g (True vs. EAP)			
	Bias	**RMSE**	$N_{\widehat{R} \geq 1.05}$
All Positive True/Init.	0.093	0.275	340
Random True/Init	-0.332	1.225	1231
ADVI/α	-1.524	2.396	2406
ADVI/+μ	-0.694	1.501	2438
Random/α	-1.588	2.469	1993
Random/+μ	-0.235	0.919	1538
Std. Sum Score/α	0.082	0.271	0
Std. Sum Score/+μ	-0.221	0.963	473

Further Information

Scan the QR code below to access reproducible code, additional visualizations, and more on GitHub