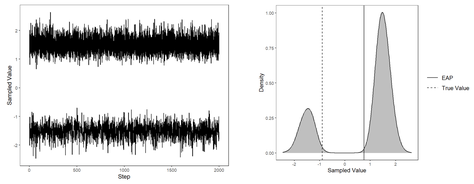
Evaluating solutions to the label-switching issue when estimating latent variable models with the NUTS algorithm

Nathan DePuy, Jonathan Templin

Introduction

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

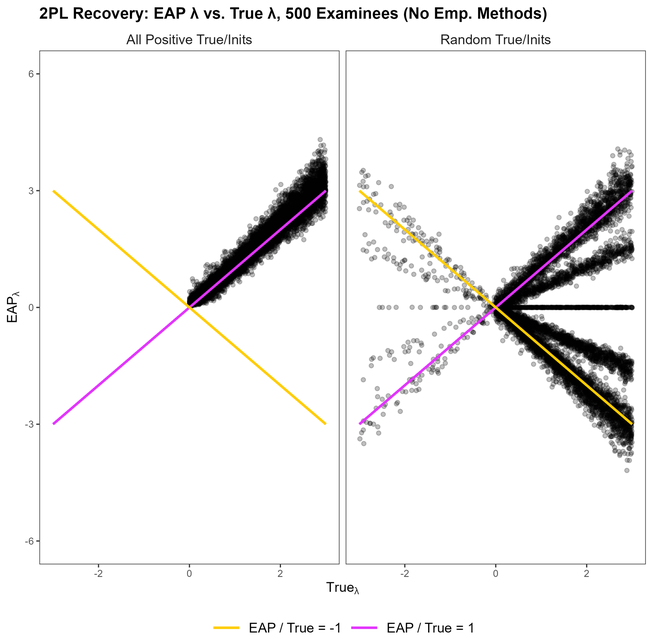


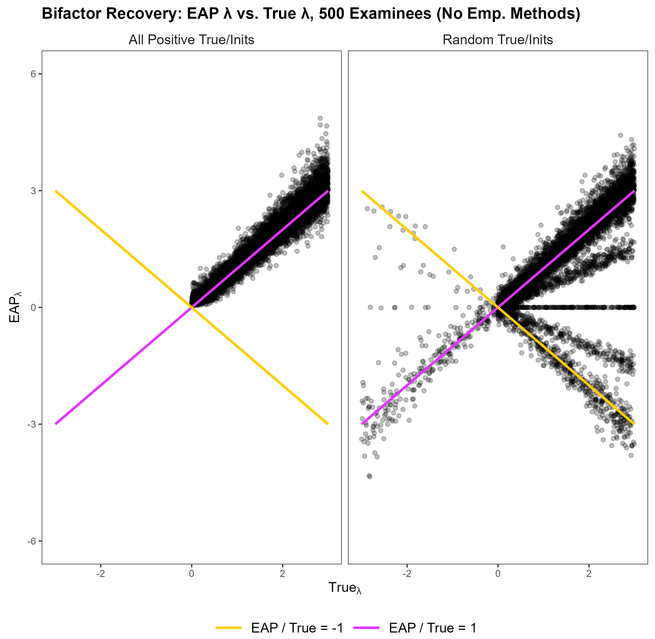
Methods

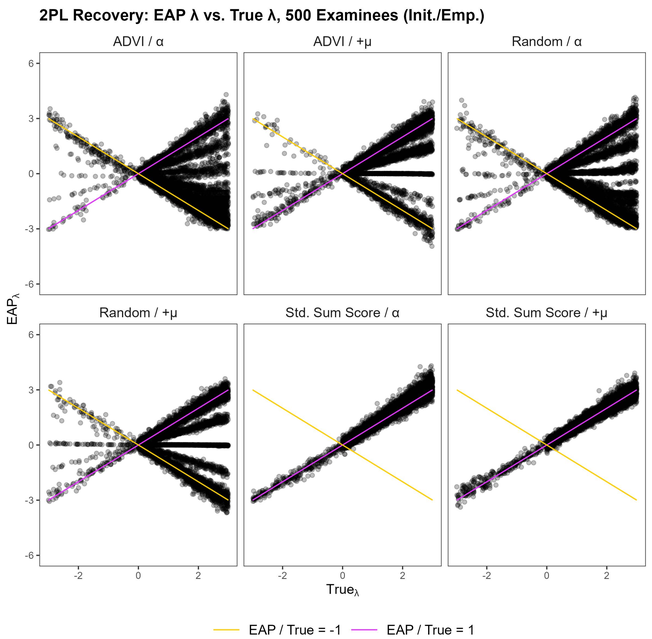
- Parameters sampled with the NUTS algorithm in Stan (Gabry, Češnovar, Johnson, & Bronder, 2024)
- Chain convergence determined using $\hat{R} \leq 1.05$ (Vehtari et al., 2021)
- Parameter recovery performance evaluated using bias and RMSE estimates
- Each condition replicated 100 times in parallel using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

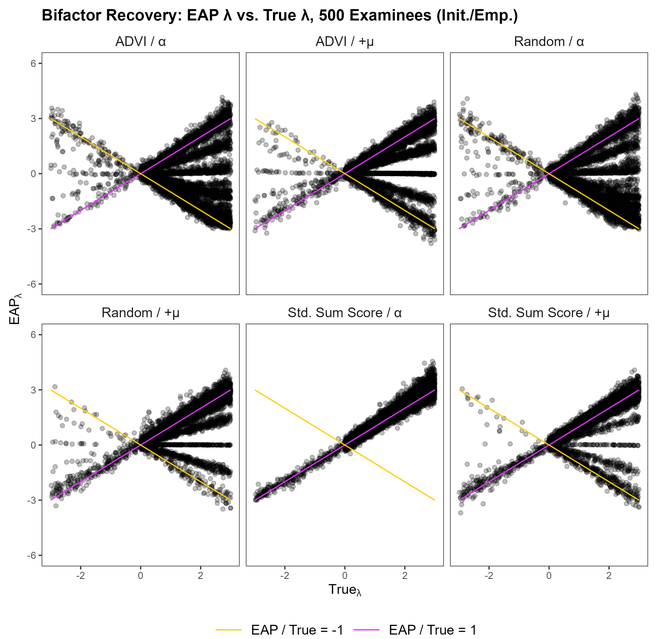
References

View article and citations by scanning the QR code above









Findings

2PL λ	Bias	RMSE	$N_{\widehat{R}}$
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	Bias	RMSE	$N_{\widehat{R}}$
All Positive True/Init.	0.016	0.163	712
Random True/Init	-0.816	1.756	2252
ADVI/α	-1.543	2.421	2847
ADVI/+μ	-0.883	1.753	2572
Random/α	-1.525	2.422	1881
Random/+μ	-0.455	1.212	1929
Std. Sum Score/α	0.021	0.121	0
Std. Sum Score/+μ	-0.021	0.313	79

Further Information

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