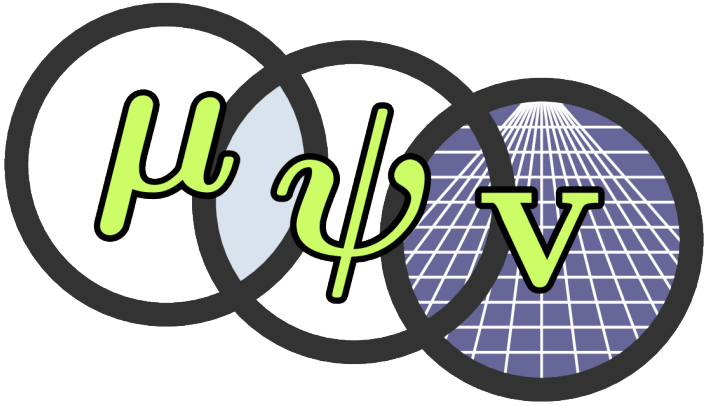


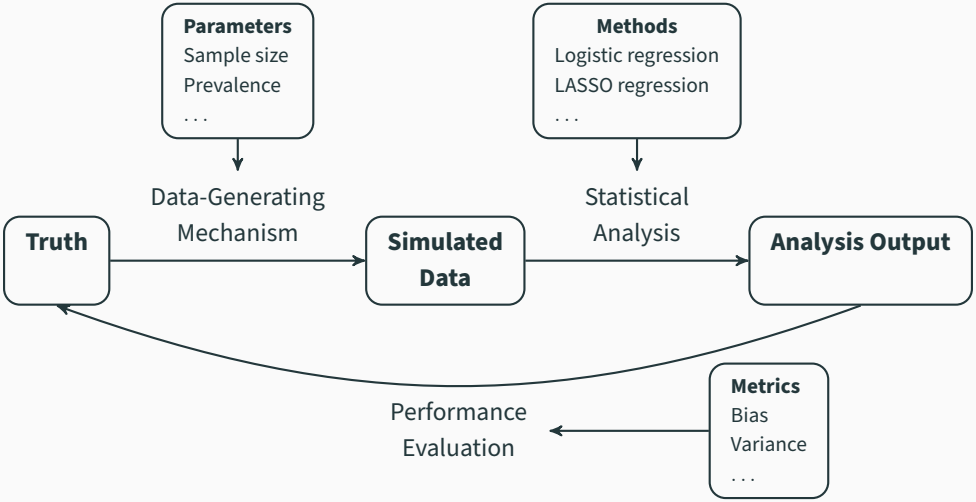
Virtual MathPsych/ICCM 2024
mathpsych.org
June 2024

Simulation Studies for Methodological Research in Psychology

Björn Siepe ~ University of Marburg

Simulation studies

Simulation studies



Simulation studies can have huge impact

A **simulation study** of the number of events per variable in logistic regression analysis

P **Peduzzi**, J Concato, E Kemper, TR Holford… - Journal of clinical …, 1996 - Elsevier

… In a **simulation study** of forward stepwise multiple linear regression, Freedman and Pee [3] demonstrated that the … In **simulation studies** of the effect of EPV on proportional … Peter **Peduzzi**. …

☆ Save 99 Cite Cited by 8827 Related articles All 9 versions

Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives

L **Hu**, PM **Bentler** - Structural equation modeling: a …, 1999 - Taylor & Francis

This article examines the adequacy of the "rules of thumb" conventional cutoff criteria and several new alternatives for various fit indexes used to evaluate model fit in practice. Using a 2-…

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Collinearity: a review of methods to deal with it and a **simulation study** evaluating their performance

CF Dormann, J Elith, S Bacher, C Buchmann… - …, 2013 - Wiley Online Library

… In the fourth part we carry out a large **simulation study** to compare all reviewed methods. We provide complementary case studies on real data in Supplementary material Appendix 1.2. …

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Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo **simulation study**

KL Nylund, T Asparouhov… - … equation modeling: A …, 2007 - Taylor & Francis

… This article presents the results of a **simulation study** that examines the performance of likelihood-based tests and the traditionally used Information Criterion (ICs) used for determining …

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Issues in simulation studies

> *"…extensive simulation studies show that the proposed method performs on par or* ***better than existing methods*** *…"*

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- Over-Optimism (e.g., Ullmann et al., 2022)
- Insufficient reporting standards (e.g., Hoaglin and Andrews, 1975)
- Little assessment of reproducibility (e.g., Luijken et al., 2023)

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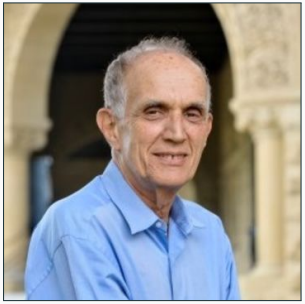
Issues in simulation studies

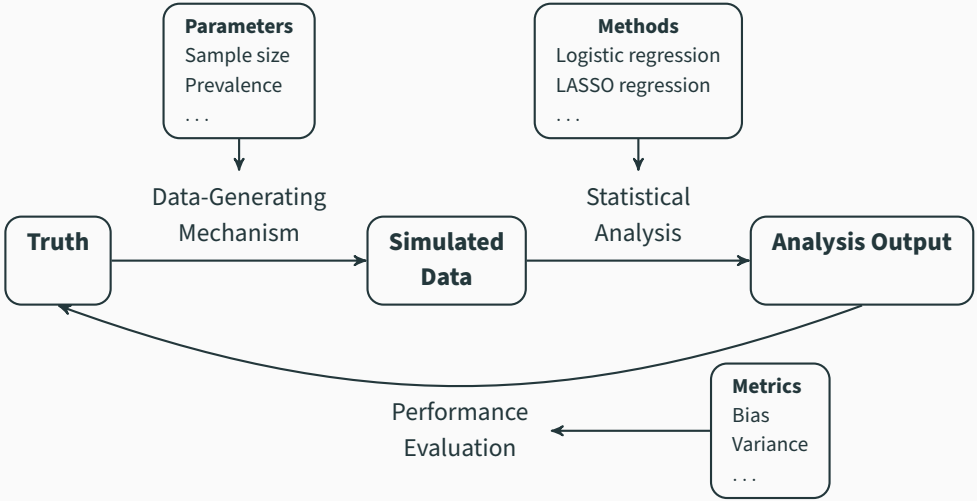
"*In fact it is* ***very difficult to run an honest simulation*** *comparison, and* ***easy to inadvertently cheat*** *by choosing favorable examples, or by not putting as much effort into optimizing the dull old standard as the exciting new challenger.*"

Brad Efron (2001)



https://statistics.stanford.edu/people/bradley-efron

Questionable research practices in simulation studies



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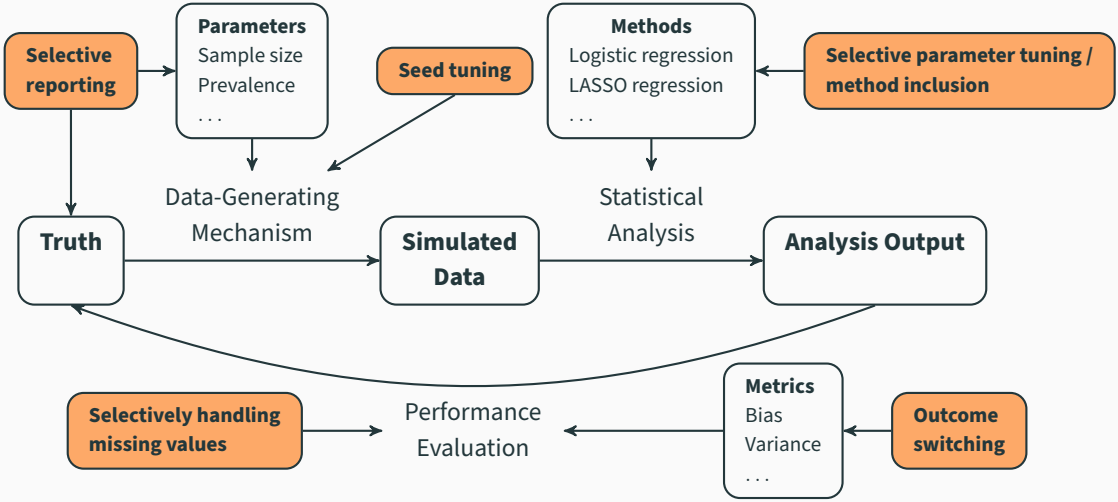


Questionable research practices in simulation studies

Received: 25 March 2022 | Revised: 5 January 2023 | Accepted: 9 January 2023

DOI: 10.1002/bimj.202200091

Biometrical Journal

RESEARCH ARTICLE

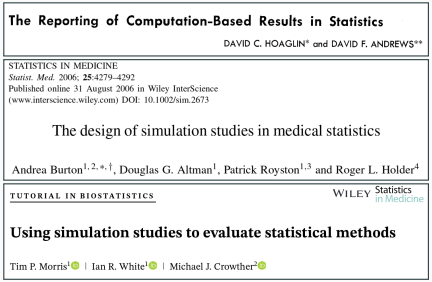
Pitfalls and potentials in simulation studies: Questionable research practices in comparative simulation studies allow for spurious claims of superiority of any method

Samuel Pawel | Lucas Kook | Kelly Reeve

"*By **deliberately using several QRPs**, we were able to **present a method with no expected benefits** […] **as an improvement** over […] well-established competitors.*"

Literature Review

"*Statisticians ... often pay too little attention to their own principles of design*"(Hoaglin & Andrews, 1975)



The Reporting of Computation-Based Results in Statistics

DAVID C. HOAGLIN* and DAVID F. ANDREWS**

STATISTICS IN MEDICINE
Statist. Med. 2006; **25**:4279–4292
Published online 31 August 2006 in Wiley InterScience
(www.interscience.wiley.com) DOI: 10.1002/sim.2673

The design of simulation studies in medical statistics

Andrea Burton[1, 2, *, †], Douglas G. Altman[1], Patrick Royston[1,3] and Roger L. Holder[4]

TUTORIAL IN BIOSTATISTICS

WILEY Statistics in Medicine

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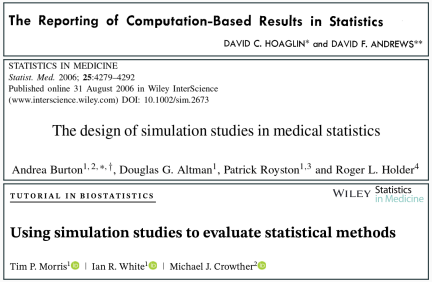

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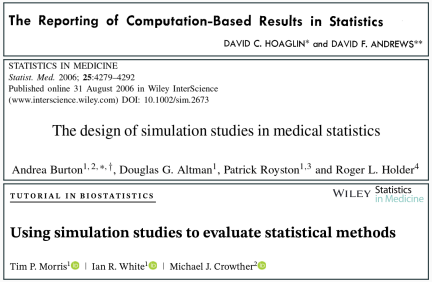

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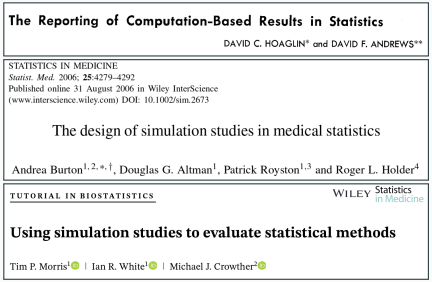

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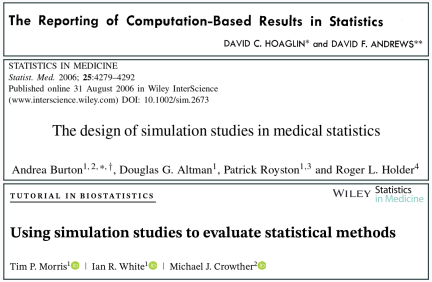

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- Review of 100 simulation studies in psychology
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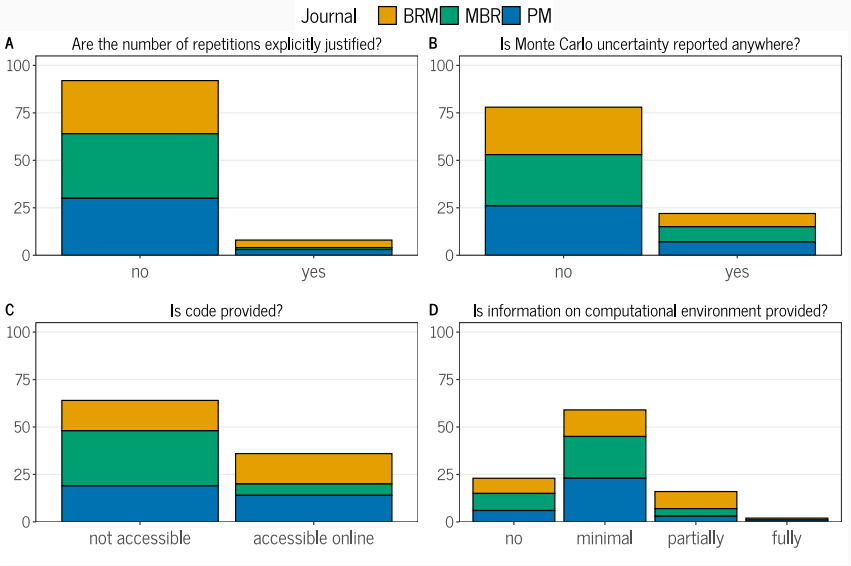
- Coding of various aspects of reporting

Main Results

Main Results



The ADEMP-PreReg template

ADEMP-PreReg
Template for Simulation Studies

Version: 0.1.0
Last updated: 2023-10-31
Preregistration template designed by
Björn S. Siepe, František Bartoš, Tim P. Morris, Anne-Laure Boulesteix, Daniel W. Heck, and Samuel Pawel

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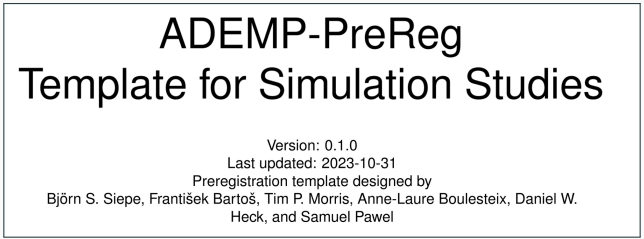

- Protocol template based on **ADEMP structure** (Morris et al., 2019) + **open science** + **reproducibility** aspects

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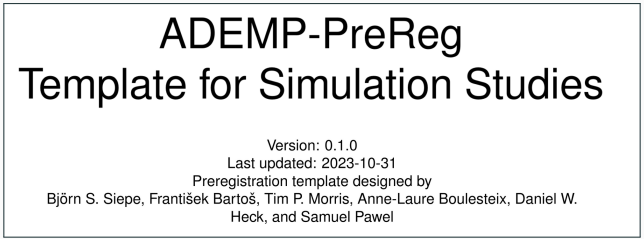

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- **Different versions**: LaTeX, Overleaf, MS/Libre office, Google docs
- **Living document**: https://github.com/bsiepe/ADEMP-PreReg

ADEMP: doi.org/10.1214/ss/1009213726, ADEMP-PreReg: doi.org/10.31234/osf.io/ufgy6

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1. Instructions
2. General information
3. **A**ims
4. **D**ata-generating mechanism
5. **E**stimands and targets
6. **M**ethods
7. **P**erformance Measures
8. Computational details

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7. **P**erformance Measures
8. Computational details

7 Performance Measures

7.1 Which performance measures will be used?

Explanation: Please provide details on why they were chosen and on how these measures will be calculated. Ideally, provide formulas for the performance measures to avoid ambiguity. Some models in psychology, such as item response theory or time series models, often contain multiple parameters of interest, and their number may vary across conditions. With a large number of estimated parameters, their performance measures are often combined. If multiple estimates are aggregated, specify how this aggregation will be performed. For example, if there are multiple parameters in a particular condition, the mean of the individual biases of these parameters or the bias of each individual parameter may be reported.

Example

Our primary performance measures are the type I error rate (in conditions where the true effect is zero) and the power (in conditions where the true effect is non-zero) to reject the null hypothesis of no difference between the control and treatment condition. The null hypothesis is rejected if the p-value for the null hypothesis of no effect is less than or equal to the conventional threshold of 0.05. The rejection rate (the type I error rate or the power, depending on the data generating mechanism) is estimated by

$$\widehat{\text{RRate}} = \frac{\sum_{i=1}^{n_{\text{sim}}} 1(p_i \leq 0.05)}{n_{\text{sim}}}$$

where $1(p_i \leq 0.05)$ is the indicator of whether the p-value in simulation i is equal to or less than 0.05. We use the following formula to compute the MCSE of the rejection rate

$$\text{MCSE}_{\widehat{\text{RRate}}} = \sqrt{\frac{\widehat{\text{RRate}}(1 - \widehat{\text{RRate}})}{n_{\text{sim}}}}.$$

The ADEMP-PreReg template

Purposes

The ADEMP-PreReg template

Purposes

- **Planning** of simulation studies

The ADEMP-PreReg template

Purposes

- **Planning** of simulation studies
- **Preregistration**

The ADEMP-PreReg template

Purposes

- **Planning** of simulation studies
- **Preregistration**
- **Blueprint** for reporting

The ADEMP-PreReg template

Purposes

- **Planning** of simulation studies
- **Preregistration**
- **Blueprint** for reporting
- **Reviewing** of simulation studies

Limitations

The ADEMP-PreReg template

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- **Planning** of simulation studies
- **Preregistration**
- **Blueprint** for reporting
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Limitations

- Preregistration could be **faked**

The ADEMP-PreReg template

Purposes

- **Planning** of simulation studies
- **Preregistration**
- **Blueprint** for reporting
- **Reviewing** of simulation studies

Limitations

- Preregistration could be **faked**
- May **slow down** exploratory research

doi:10.5281/zenodo.7994221

Conclusions

Simulation Studies for Methodological Research in Psychology:

A Standardized Template for Planning, Preregistration, and Reporting

Björn S. Siepe*[1], František Bartoš*[2], Tim P. Morris[3], Anne-Laure Boulesteix[4], Daniel W. Heck[1], and Samuel Pawel*[5]

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* contributed equally

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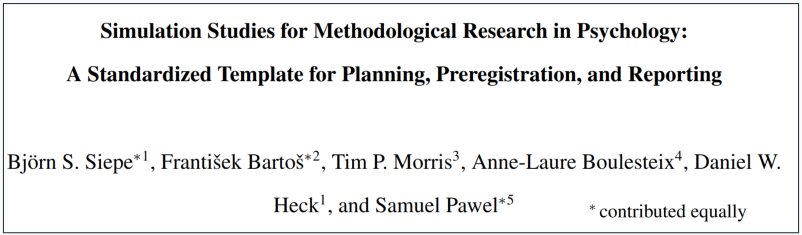
- **Protocols** can make simulation studies **more reliable**

Conclusions



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- Simulation studies can have **big impact**, should be **conducted carefully**
- **Protocols** can make simulation studies **more reliable**
- **ADEMP-PreReg template** helps in preregistration, planning, reporting, reviewing of simulation studies

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