Digital Tools for Reproducible Research

Materials https://bolibaugh.github.io/DigitalTools/ https://osf.io/jrxyw/

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Research increasingly reliant on computational and data skills...

“Some other time”

Too many options

Inefficient to learn on your own

Shaming?

Thanks to Rochelle Terman for the motivation.

Research increasingly reliant on computational and data skills...

"Some other time"

Reproducible workflows (including code) save time once set up

"Too many options"

Learn the logic now, specialise later

Inefficient to learn on your own

True -- do it here

Shaming? Everyone started somewhere; very few are experts

Week 5 Reproducible research 15 May 2019

Week 6 Preregistration 22 May 2019

Week 8 Open data 5 June 2019

Week 9 Reproducible analyses, power analysis and simulation 12 June 2019

Week 10 Writing a reproducible manuscript 19 June 2019

Thanks to Rochelle Terman for the motivation.

04 Reproducible analyses

Today

Reproducible analyses, power analysis and simulation

Learn about reproducible analyses by drafting a script for power analysis based on a given effect size for your project using simulation methods (practical).

Tasks

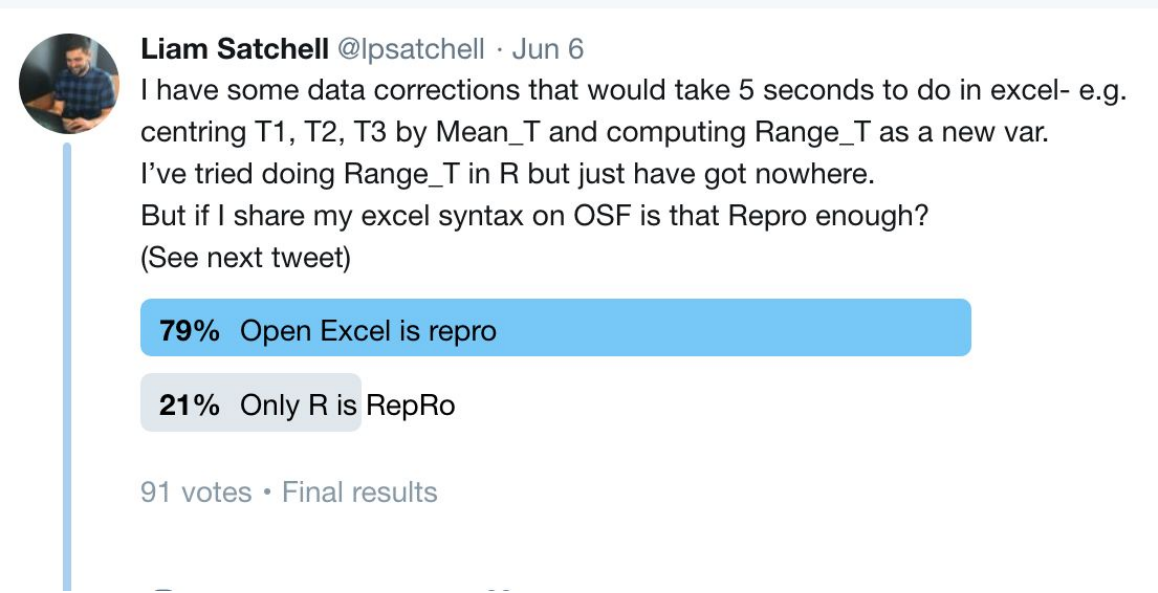
1. Learn about what is meant by reproducible analysis
2. Learn about benefits of reproducible analysis
3. Think about SESOI for your project
4. Generate a dataset & power analysis for your project (practical)

By the end of the today, you should be able to determine the basis for the smallest effect size of interest in your study, generate a simulated dataset for at least two variables, and carry out a simulation based power analysis for a single focal test.

What is a reproducible analysis?

Authors provide all the necessary data and the computer codes to run the analysis again, re-creating the results.

(Claerbout and Karrenbach, 1992)



Why work reproducibly?

The most likely beneficiary is you – your most likely collaborator in the future is Past You, and Past You doesn't answer email.

Every analysis I've ever done I've had to repeat, sometimes years later. It saves time in the long run to invest in making a reproducible analysis first time around.

@tomstafford

@CBolibaugh

But my code is horrible...

➔ So is everyone else's

Published online 13 October 2010 | *Nature* **467**, 753 (2010) | doi:10.1038/467753a

Column: World View

Publish your computer code: it is good enough

Freely provided working code — whatever its quality — improves programming and enables others to engage with your research, says Nick Barnes.

Nick Barnes

I am a professional software engineer and I want to share a trade secret with scientists: most professional computer software isn't very good. The code inside your laptop, television, phone or car is often badly documented, inconsistent and poorly tested.

@CBolibaugh

Five selfish reasons to work reproducibly:

Avoiding disaster: By working reproducibly, you can trust your own research results and will not have to retract published results or keep publications back because you cannot reproduce your results. [See here]

Writing papers easier: Well documented analyses ensure that you have easy access to the latest results, your work can easily be written up, and collaborators can easily get on board as additional authors. Furthermore, you can be sure that you easily comply with the highest-level journal guidelines.

Convincing reviewers: Making code and data available to the reviewers means their review comments will be constructive as they are able to develop an in-depth understanding of your work and can even try changes to your analysis themselves and see the impact.

Facilitating continuity of work: Well documented work means your work can easily be picked up and continued - either by others in your laboratory, or yourself if you want to build on your own work after a longer period.

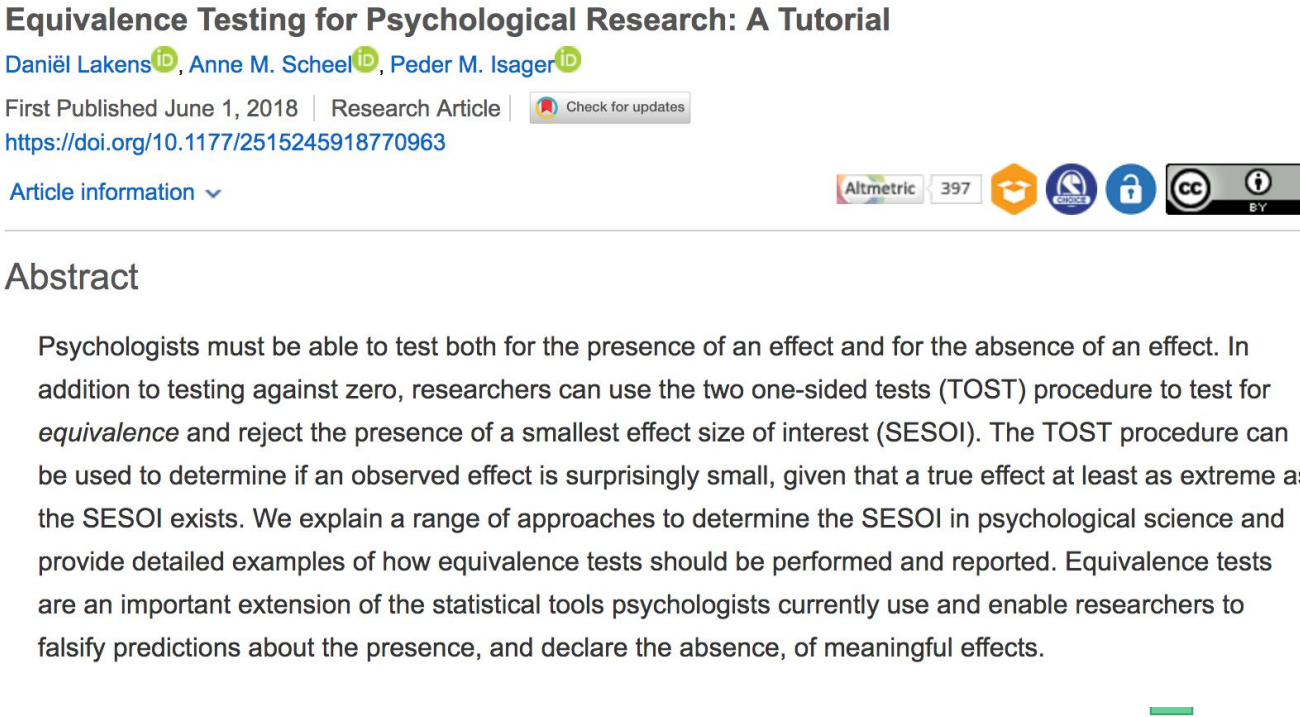
Building your reputation: Putting in effort to make your research reproducible shows that you are a careful researcher and makes your research results more robust.

Markowetz, F. (2015). Five selfish reasons to work reproducibly. Genome Biology, 16(1). https://doi.org/10.1186/s13059-015-0850-7

Reproducible analyses are better analyses:

Frontload the work by drafting your analysis before you collect your data.

Determine how much data to collect based on the Smallest Effect Size of Interest.



Equivalence Testing for Psychological Research: A Tutorial

Daniël Lakens, Anne M. Scheel, Peder M. Isager

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https://doi.org/10.1177/2515245918770963

Article information

Altmetric 397

Abstract

Psychologists must be able to test both for the presence of an effect and for the absence of an effect. In addition to testing against zero, researchers can use the two one-sided tests (TOST) procedure to test for *equivalence* and reject the presence of a smallest effect size of interest (SESOI). The TOST procedure can be used to determine if an observed effect is surprisingly small, given that a true effect at least as extreme as the SESOI exists. We explain a range of approaches to determine the SESOI in psychological science and provide detailed examples of how equivalence tests should be performed and reported. Equivalence tests are an important extension of the statistical tools psychologists currently use and enable researchers to falsify predictions about the presence, and declare the absence, of meaningful effects.

Determining the Smallest Effect Size of Interest:

Objectively if possible

- Quantified theoretical predictions (rare)
- Threshhold at which effect would be ‘noticeable’
- Minimum clinically or practically relevant difference (e.g. score bands on clinical inventories, or bands in assessment)

Subjectively if necessary:

- Using Cohen’s benchmarks (Lakens cautions that this is to be avoided)
- Based on related published studies (e.g. using lower end of a confidence interval around meta-analytic effect size)
- Smallest observed effect size that could have been detected with sample in previous study
- Based on resources: given sample size constraints, and alpha level, what is smallest effect that can be reliably detected?

Use SESOI as a way to learn reproducible analyses

TODAY:

Identify “smallest effect size of interest” (SESOI) for your study’s focal test

Simulate a dataset with that effect

Write a function to iterate data simulation for SESOI and analysis, saving the output each time.

Run analysis with different samples sizes

Print power estimate for different sample sizes.

Resources

- Simulate correlations, and test difference between them: https://medium.com/@adrien.mierop_82721/how-can-we-calculate-the-statistical-power-to-test-a-correlation-difference-60851bc7c61a
- Dorothy Bishop suite of simulations:
  - https://osf.io/dzhae/
- Vashith et al on statistical significance, containing details for simulating LMMs in appendix:
  - https://www.sciencedirect.com/science/article/pii/S0749596X18300640?via%3Dihub#s0010
- Brysbaert et al article on power for LMMs;
  - https://www.journalofcognition.org/articles/10.5334/joc.10/
- Lakens ANOVA designs power simulations
  - https://github.com/Lakens/ANOVA_power_simulation
- Rogerginersorolla blog post on powering for interactions; very understandable
  - https://approachingblog.wordpress.com/2018/01/24/powering-your-interaction-2/amp/?__twitter_impression=true
- Lisa Debruine & Dale Barr preprint on lmm simulation
  - https://psyarxiv.com/xp5cy
- Lakens, D., Scheel, A. M., & Isager, P. M. (2017, November 17). Equivalence Testing for Psychological Research: A Tutorial. https://doi.org/10.31234/osf.io/v3zkt
- Simulating linear models: https://aosmith.rbind.io/2018/01/09/simulate-simulate-part1/

Follow-up

Preparation for Week 10

Simulate dataset and at least one analysis to report in reproducible manuscript squib next week.