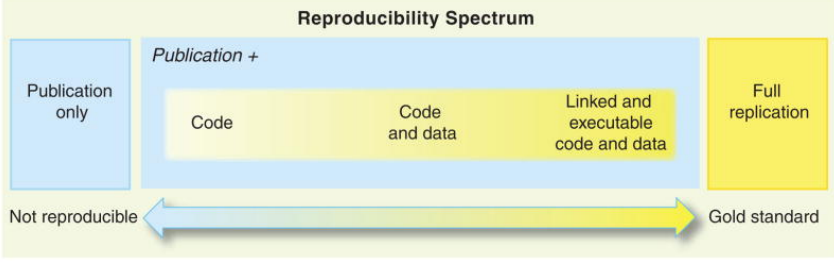
An introduction to reproducible research for the R novice

497 / 597 Reproducible Research



Richard Layton

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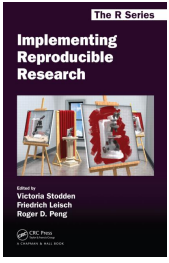
Fall 2018

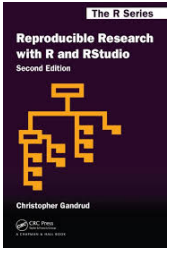
Image from Roger Peng (2011) Reproducible research in computational science. *Science* **334**(6060), 1226–1227.

Getting started

- Introductions
- Mystery question: *What is reproducible research?*

Practitioners tell us:





Research is reproducible when the data and the code used to obtain a finding are available and sufficient for an independent researcher to recreate the finding.

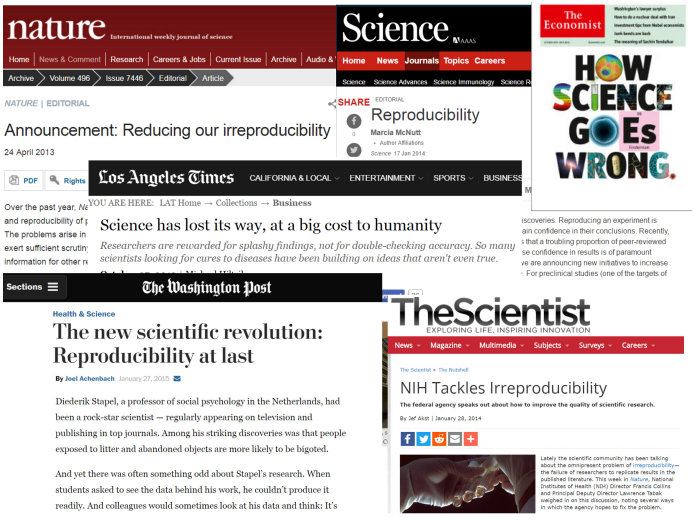
- computational, data-intensive
- spans the full data, analysis, & publication workflow
- most of us have received only perfunctory training (if any)

Victoria Stodden, F. Leisch, & R. Peng, ed., *Implementing Reproducible Research*, CRC Press, 2014.
Christopher Gandrud, *Reproducible Research with R and RStudio, 2/e*, CRC Press, 2015.

Events tell us:

More accountability is needed because of

- data falsification
- erroneous analysis
- misleading presentation of results



Karen EC Levy & David Merritt Johns, When open data is a Trojan Horse: The weaponization of transparency in science and governance, *Big Data and Society*, 2016.

Reproduction revealed that their primary findings were false

Results were used to justify austerity policies, but the major effect disappeared after correcting for

- coding errors
- selective exclusion of available data
- unconventional weighting of summary statistics

Kenneth Rogoff & Carmen Reinhart

Thomas Herdon, Michael Ash, & Robert Pollin, Does high public debt consistently stifle economic growth? A critique of Reinhart and Rogoff, Political Economy Research Institute, U Mass Amherst, 2013.

Reproduction revealed that he falsified data

To obtain the results he wanted, he altered data in several ways. To date (2018) consequences include:

- clinical trials (real patients) terminated and 11 malpractice suits settled
- 18 research journal articles retracted
- Duke University must now obtain preapproval from NIH for funding changes

Anil Potti, formerly a cancer researcher at Duke University

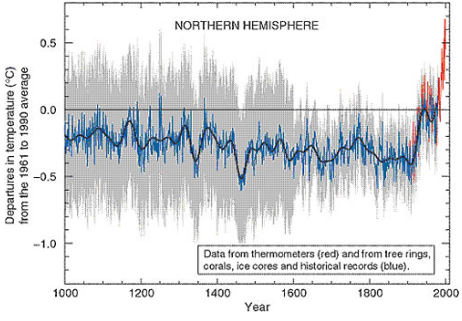
Jason deBruyn, Trial involving disgraced scientist and bunk Duke research, *Triangle Business Journal*, 2015-01-23.
Ivan Oransky, It's official: Anil Potti faked cancer research data, say Feds, *Retraction Watch*, 2015-11-07.

Reproduction, however, is also used to *discredit scientists*

Mann's work has withstood 15 years of scrutiny—and still holds up. But he refused to share.

Scientists and "skeptics" are in a knife fight, and you don't bring data to a knife fight. — Paul Erlich

Why should I make the data available to you, when your aim is to try and find something wrong with it? — Phil Jones



1000 years of temperature variation with uncertainties, Michael Mann

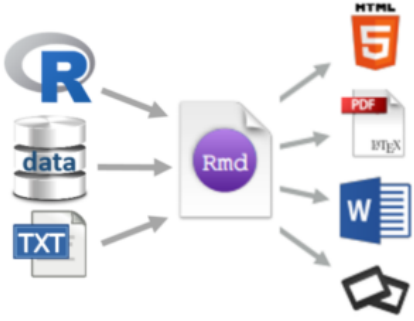
Freed Pearce, Climate change debate overheated after skeptic grasped 'hockey stick', *The Guardian*, 2010-02-09.
Brad Keyes, Mann retirement: Analysis, reax, *Climate Sceptic*, 2016-05-08.
Jeff Leek, De-weaponizing reproducibility, 2015-03-13.

New terminology is proposed to clarify meaning

methods reproducibility	same data, same analysis, same results (*transparency*)
results reproducibility	replication: corroborative results in a new study
inferential reproducibility	independently replicate or re-analyze data and draw draw qualitatively similar conclusions

Steven Goodman, Daniele Fanelli, and John Ioannidis (2016) What does research reproducibility mean?, *Science Translational Medicine*, 8(341).

Our focus is on *methods reproducibility*



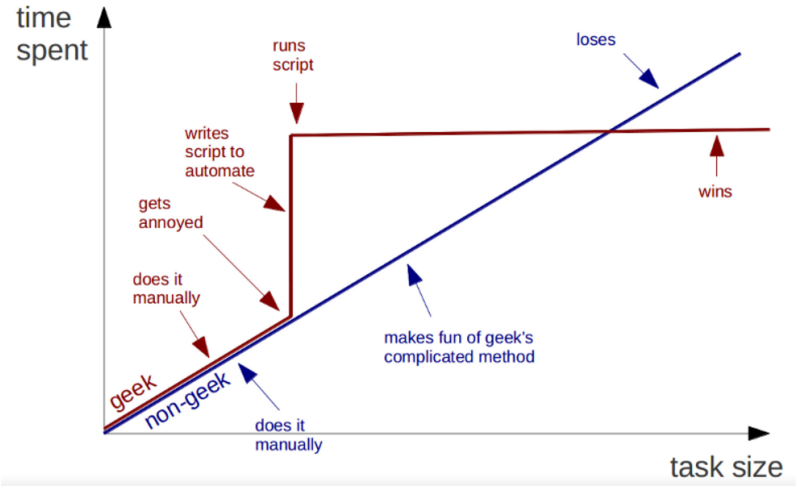
R Markdown (.Rmd) files are the central link

Explicitly linking the report, paper, or talk to the data and scripts that generate the findings

Changes are automatically updated and embedded in the output document.

Cut and paste no more!

The primary (and probably most important) beneficiary is ... you



- reproducible for your future self
- faster updating of results
- faster resumption of work after hiatus

Steps towards reproducibility

- Write scripts (avoid manual copy, paste, mouse-clicks)
- Plan the organization and naming scheme for files
- Strive for simplicity & readability
- Write for reusability & testability
- Agree on a workflow for collaborating before starting a manuscript
- DRY (don't repeat yourself)
- Link files explicitly
- Use version control
- Plan data management
- License your software
- Manage package dependencies

Karl Broman, Initial steps toward reproducible research.
Jenny Bryan, Karen Cranston, Justin Kitzes, Lex Nederbragt, Tracy Teal, and Greg Wilson, Good enough practices for scientific computing, 2016-01.

Steps towards reproducibility: in this course

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Start installing the software today

Installation instructions are on the website

for data carpentry, analysis, and data graphics

our interface to all the software

for local version control

How the course is organized

- Course materials are reproducible
  `https://github.com/DSR-RHIT/me497-reproducible-research`
- Syllabus for policies and procedures
- Calendar for agenda, assignments, and due dates