Reproducibility: the What, Why, & How

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Possible Definitions

Reproducibility

Independently confirm results with the same data and code or tools

Replication

Independently confirm results with new data and code or tools

Definitions from another Vicky...

- **Reviewable Research:** Sufficient detail for peer review & assessment.
- **Replicable Research:** Tools are available to duplicate the author's results using their data.
- **Confirmable Research:** Main conclusions can be attained independently without author's software.
- **Auditable Research:** Process & tools archived such that it can be defended later if necessary.
- **Open/Reproducible Research:** Auditable research made openly available.

Stodden et al ICERM report (2013)

Pyramid of Reproducibility

Challenges in Reproducibility

Workload & Time Challenges

It is a time commitment to get data and code ready to share, and to share it

Otherwise known as...

the Incentive Problem

Reproducibility takes time, and is not always valued by the academic reward structure

“Insufficient time is the main reason why scientists do not make their data and experiment available and reproducible.”
Carol Tenopir, Beyond the PDF2 Conference

“77% claim that they do not have time to document and clean up the code.”
Victoria Stodden, Survey of the Machine Learning Community – NIPS 2010

Challenges in Reproducibility

Technical Obsolescence

Technology changes affect the reproducibility

Normative Dissonance¹

Espoused values don't always match practice

Otherwise known as...

the Pipeline Problem

Reproducibility requires skills that are often not included in most curriculums!

“It would require huge amount of effort to make our code work with the latest versions of these tools.” Collberg et al., Repeatability and Benefaction in Computer Systems Research, University of Arizona TR 14-04

¹ <https://www.ncbi.nlm.nih.gov/pubmed/19385804>

Challenges of Reproducibility: Let's Explore

Honest, Human Errors

- People make mistakes--and it impacts their research
- It's *good* to have other people check out your data and analyses--it's like having a copy editor for your data!

	B	C	I	J	K	L	M
2			Real GDP growth				
3			Debt/GDP				
4	Country	Coverage	30 or less	30 to 60	60 to 90	90 or above	30 or less
26			3.7	3.0	3.5	1.7	5.5
27	Minimum		1.6	0.3	1.3	-1.8	0.8
28	Maximum		5.4	4.9	10.2	3.6	13.3
29							
30	US	1946-2009	n.a.	3.4	3.3	-2.0	n.a.
31	UK	1946-2009	n.a.	2.4	2.5	2.4	n.a.
32	Sweden	1946-2009	3.6	2.9	2.7	n.a.	6.3
33	Spain	1946-2009	1.5	3.4	4.2	n.a.	9.9
34	Portugal	1952-2009	4.8	2.5	0.3	n.a.	7.9
35	New Zealand	1948-2009	2.5	2.9	3.9	-7.9	2.6
36	Netherlands	1956-2009	4.1	2.7	1.1	n.a.	6.4
37	Norway	1947-2009	3.4	5.1	n.a.	n.a.	5.4
38	Japan	1946-2009	7.0	4.0	1.0	0.7	7.0
39	Italy	1951-2009	5.4	2.1	1.8	1.0	5.6
40	Ireland	1948-2009	4.4	4.5	4.0	2.4	2.9
41	Greece	1970-2009	4.0	0.3	2.7	2.9	13.3
42	Germany	1946-2009	3.9	0.9	n.a.	n.a.	3.2
43	France	1949-2009	4.9	2.7	3.0	n.a.	5.2
44	Finland	1946-2009	3.8	2.4	5.5	n.a.	7.0
45	Denmark	1950-2009	3.5	1.7	2.4	n.a.	5.6
46	Canada	1951-2009	1.9	3.6	4.1	n.a.	2.2
47	Belgium	1947-2009	n.a.	4.2	3.1	2.6	n.a.
48	Austria	1948-2009	5.2	3.3	-3.8	n.a.	5.7
49	Australia	1951-2009	3.2	4.9	4.0	n.a.	5.9
50							
51			4.1	2.8	2.8	=AVERAGE(L30:L44)	

In this paper, we search for a historical data set of public debt to the main result of growth and “debt mal” debt levels in countries with public debt of GDP are a wise; average percent lower between public debt levels are similar across economies. To find no systematic debt levels across countries as a group, exceptions in contrast, in emerging debt levels are Our topic is Public debt history. In the recent global financial maelstrom, especially in the epicenter countries. This should not be surprising, given the experience of earlier severe

growing populations? Are there a man- empirical, historical central bank M. (2009b). difficult of public es, and markets. countries er, the vations, insti- range- external ments markets, we find that there exists a significantly more severe threshold for total gross external debt (public and private)—which is almost exclu-

Challenges of Reproducibility: Let's Explore

Technical Obsolescence, or ^^Dependency Hell^^

- It's *hard* to keep track of what was used, what version was used, on what hardware/software config it was used, etc.
- You can't just include all the scripts and the data and expect people to be able to run it!
 - Libraries get updated, even operating system changes can disrupt reproducibility

Even if runnable, results may differ

The Effects of FreeSurfer Version, Workstation Type, and Macintosh Operating System Version on Anatomical Volume and Cortical Thickness Measurements

June 1, 2012

<http://dx.doi.org/10.1371/journal.pone.0038234>

We investigated the effects of data processing variables such as FreeSurfer version (v4.3.1, v4.5.0, and v5.0.0), workstation (Macintosh and Hewlett-Packard), and Macintosh operating system version (OSX 10.5 and OSX 10.6). Significant differences were revealed between FreeSurfer version v5.0.0 and the two earlier versions. [...] About a factor two smaller differences were detected between Macintosh and Hewlett-Packard workstations and between OSX 10.5 and OSX 10.6.

Why Reproducibility?

“If I have seen further, it is by standing on the shoulders of giants.”

Sir Isaac Newton

To build on top of previous work – research is incremental!

To verify the correctness of results

To defeat self-deception¹

To help newcomers

To increase impact, visibility² and research quality³

¹<http://www.nature.com/news/how-scientists-fool-themselves-and-how-they-can-stop-1.18517>

²<http://infoscience.epfl.ch/record/136640/files/VandewalleKV09.pdf>

³<http://www.nature.com/nature/journal/v483/n7391/full/483531a.html>

Why Reproducibility? Think **Selfishly**

Why Reproducibility? Think Selflessly

- Others can re-use and extend your work more easily!
 - You can even find interesting collaborations and future research projects out of this.
- YOU can re-use and extend your work more easily! (sort of selfless...)
 - Future you is your greatest collaborator.
- Newbies to the field can more easily learn the methods by reproducing your work!
 - Your reproducible work is their greatest teacher.

Work Being Done (hopefully it's reproducible 😊)

Guidelines & Journals

Transparency & Openness Promotion Guidelines:

<https://cos.io/our-services/top-guidelines/>

myBinder:

<http://www.mybinder.org/>

The Practice of Reproducible Research (book):

<https://www.practicereproducibleresearch.org/>

How to Run a Lab for Reproducible Research
(pres):

<https://tinyurl.com/j53aduv>

Journal of Open Source Software:

<http://joss.theoj.org/about>

Tools

ReproZip, the reproducibility packer

<https://reprozip.org>

VisTrails, provenance & workflow system

<https://vistrails.org>

Jupyter Notebooks, interactive computing:

<https://jupyter.org/>

Docker, containerization of research/apps:

<https://www.docker.com/>

Collective Knowledge, collab Python
framework

<http://cknowledge.org/>

Keepin' Up with Reproducibility

If *YOU* are working on reproducibility initiatives or know of some good ones, submit it to the [reproducibility newsfeed](#) via a GitHub pull request!

And if you do...it gets tweeted out via [@ReproFeed](#)!!

VIDA-NYU / reproducibility-news

Curated reproducibility news displayed on reproducibility.org <https://vida-nyu.github.io/reproducib...>

234 commits 2 branches 0 releases 3 contributors

Branch: master New pull request Create new file Upload files Find file Clone or download

File	Commit Message	Latest commit
build	Fix Travis notification settings	45dcaad 3 days ago
travis.yml	Fix duplicate detection	10 days ago
travis.yml	Fix Travis notification settings	3 days ago
README.md	Update README file for new YAMl format	16 days ago
news.yml	Edited econ paper title	5 days ago

README.md

build passing

Reproducibility news

This repository contains the recent news about reproducibility that are shown on reproduciblescience.org. The raw RSS feed is [here](#).

Please, do not hesitate to provide news about your own work by opening a Pull Request here or by contacting us.

Reproducibility News @ReproFeed · Mar 4

Preprint: Transparency, Reproducibility, and the Credibility of Economics Research osf.io/c4uwk/

Reproducibility News @ReproFeed · Mar 4

Reproducible Data Analysis in Jupyter jakevdp.github.io/blog/2017/03/0/

Reproducibility News @ReproFeed · Mar 4

Publishing a reproducible paper

Publishing a reproducible paper

Adolescence is a period of human brain growth and high incidence of mental health disorders. In 2016 the Neuroscience in Psychiatry Network published a stud...

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