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Is Your Research Reproducible?

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University of Rhode Island Libraries
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1. The Reproducibility Crisis

2. Reproducible Workflows

3. Introduction to the
   Open Science Framework

The Reproducibility Crisis

“It can be proven that most claimed research findings are false.”

— John P. A. Ioannidis, 2005

“Reproducibility crisis” (aka “replication crisis”)

“A methodological crisis in science in which scientists have found that the results of many scientific experiments are difficult or impossible to replicate on subsequent investigation, either by independent researchers or by the original researchers themselves.”

— Wikipedia

Psychology

91.5% of all published studies in psychology found positive results.

"EEG Experiment" from Dr. Hirt's Psychology Lab, Indiana University

Economics

"...We assert that economics research is usually not replicable."

— Andrew C. Chang and Phillip Li, 2015

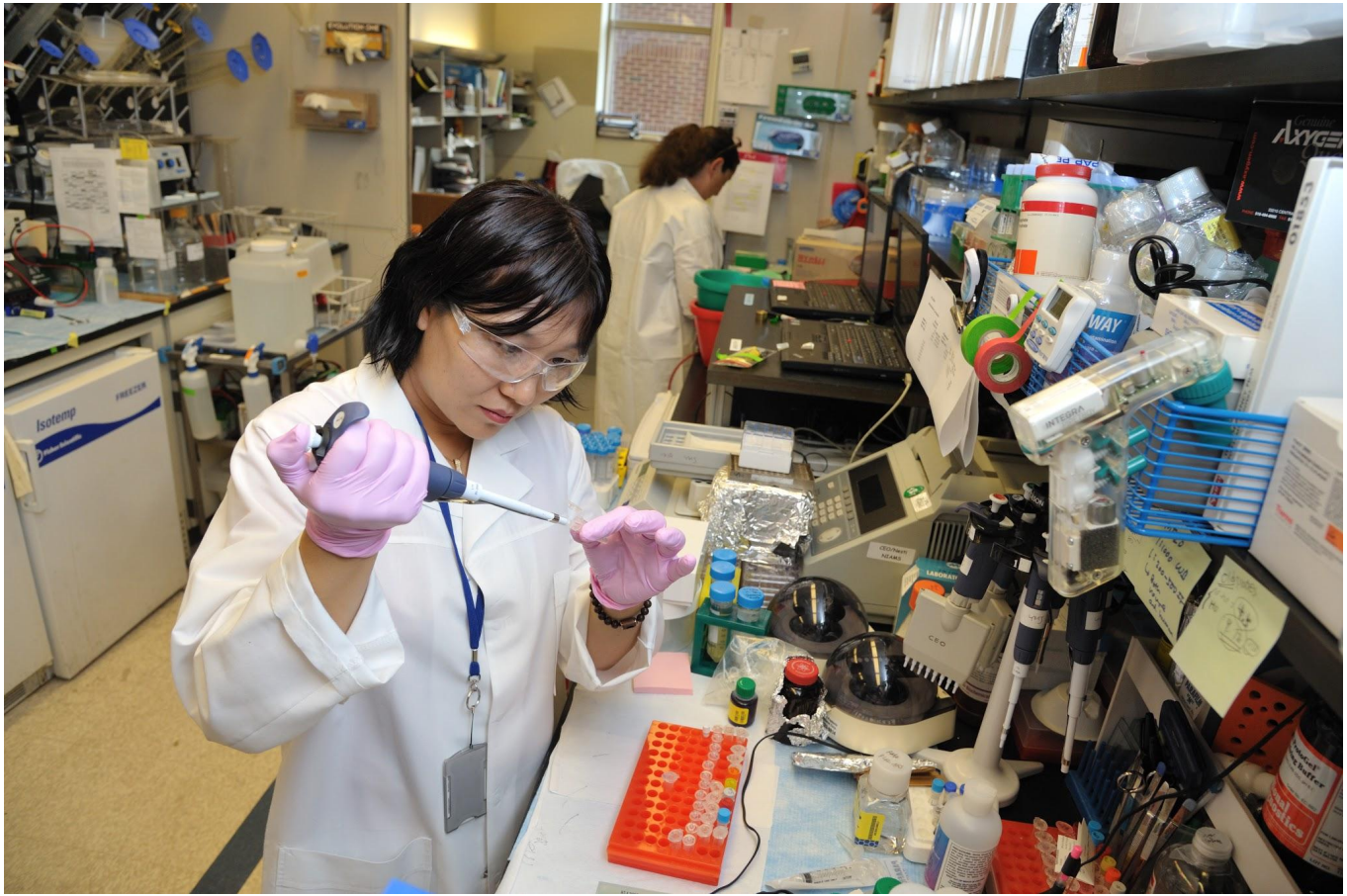
Animal studies

“I think it may have confounded, to whatever degree, some very large subset of existing research.”

– Jeffrey Mogil, 2014

“Lobund Wistar-Rat” by Janet Stephens is in the public domain.

Biomedical research

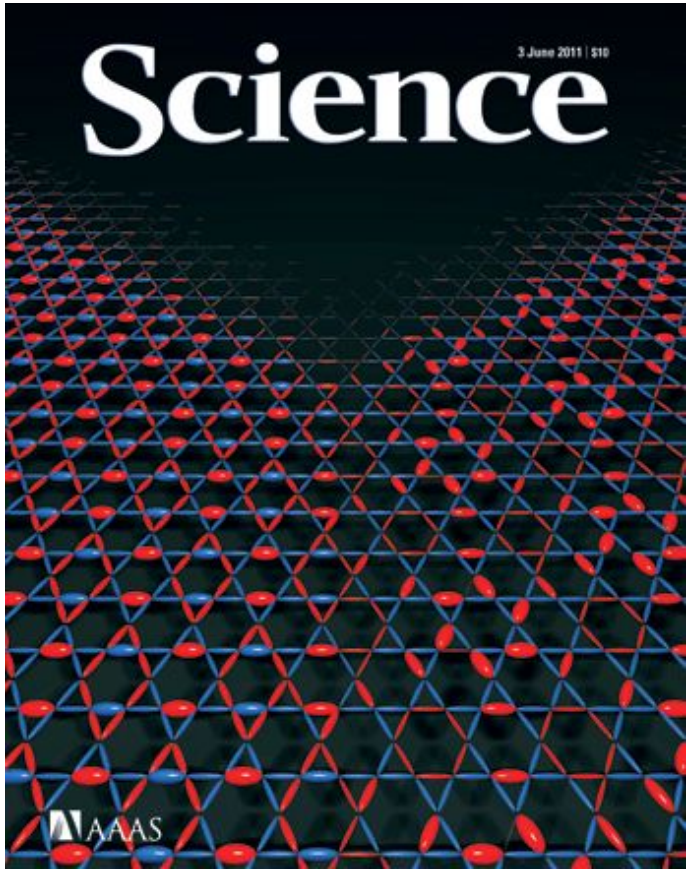


Why? *“File-drawer problem”*

Researchers do not bother to write up experiments with negative / null results or the results of replication studies.

Instead of submitting them to journals, they file them away.

Why? *Publication bias*

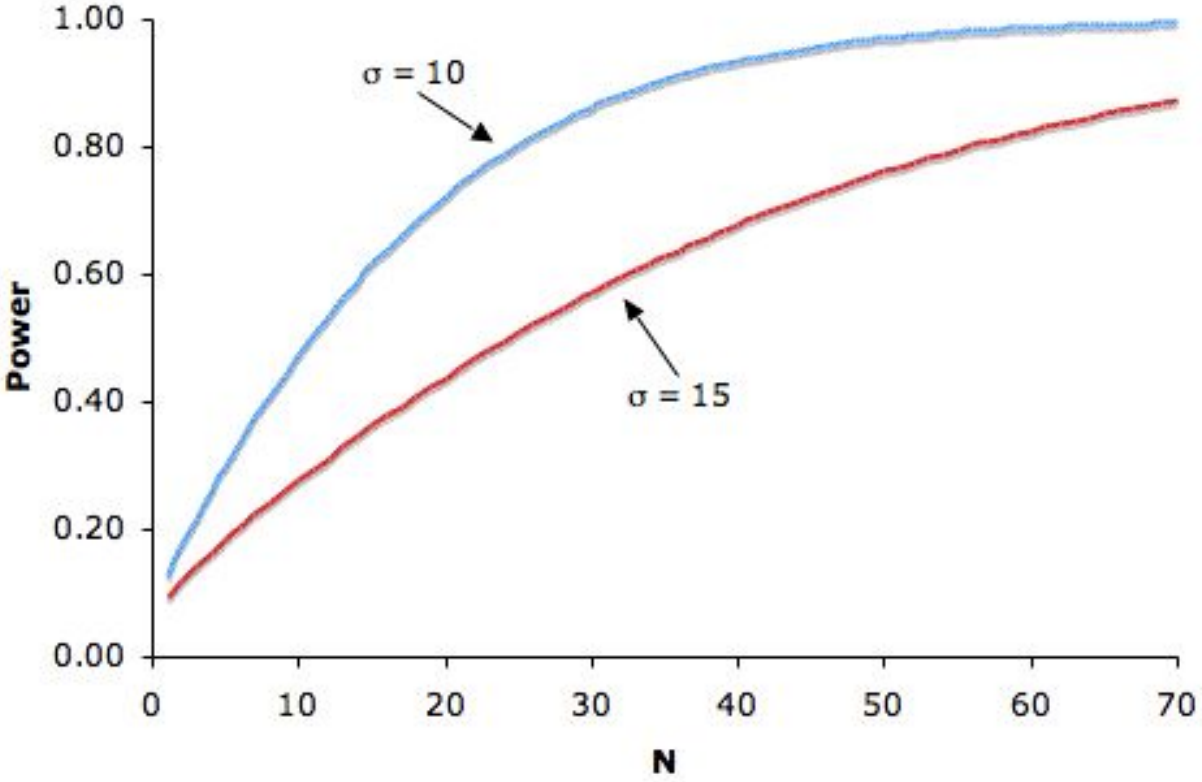


"...the small proportion of results chosen for publication are unrepresentative of scientists' repeated samplings of the real world."

– Neal S. Young, John P. A. Iaonnidis, and Omar Al-Ubaydli, 2008

Cover of Science v. 332, no. 6034 by the American Association for the Advancement of Science. Image by Stephen R. White.

Why? *Bad experimental design & analysis*



"If you torture the data long enough, it will confess."

– Ronald Coase, recipient of the 1991 Nobel Prize in Economics

"The Relationship Between Sample Size and Power" by Online Statistics Education: A Multimedia Course of Study is in the public domain.

Why? *Incentive structure*

"Today I wouldn't get an academic job. It's as simple as that. I don't think I would be regarded as productive enough."

— Peter Higgs, 2013 (winner of the 2013 Nobel Prize in Physics)

What about peer review?

"We need to get away from the notion, proven wrong on a daily basis, that peer review of any kind at any journal means that a work of science is correct."

— Michael Eisen, 2014

Reproducible Workflows

Table 1 | A manifesto for reproducible science.

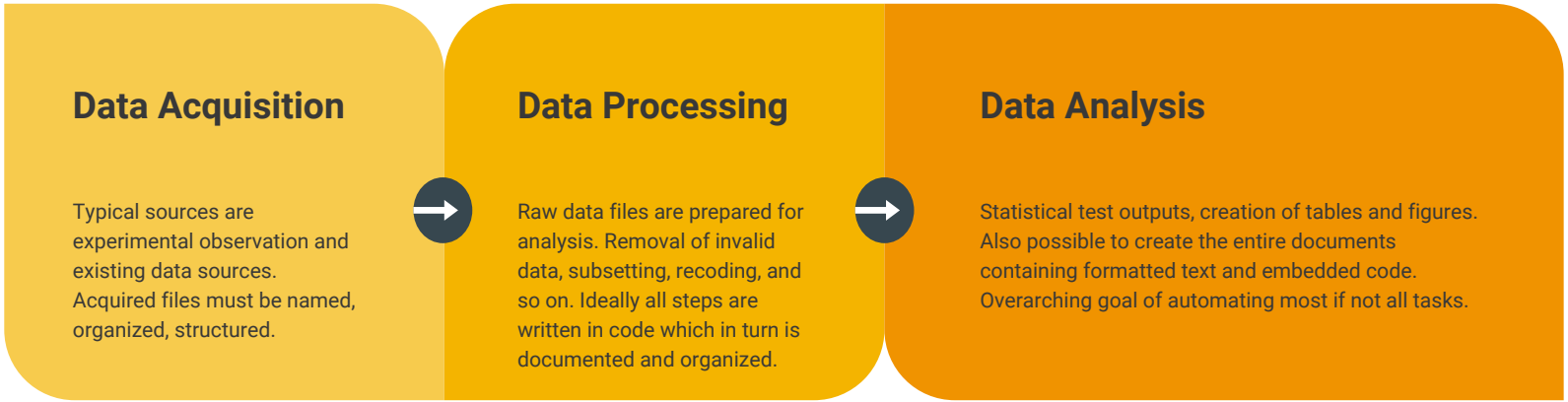
Theme	Proposal	Examples of initiatives/potential solutions (extent of current adoption)	Stakeholder(s)
Methods	Protecting against cognitive biases	All of the initiatives listed below (* to ****) Blinding (**)	J, F
	Improving methodological training	Rigorous training in statistics and research methods for future researchers (*) Rigorous continuing education in statistics and methods for researchers (*)	I, F
	Independent methodological support	Involvement of methodologists in research (**) Independent oversight (*)	F
	Collaboration and team science	Multi-site studies/distributed data collection (*) Team-science consortia (*)	I, F
Reporting and dissemination	Promoting study pre-registration	Registered Reports (*) Open Science Framework (*)	J, F
	Improving the quality of reporting	Use of reporting checklists (**) Protocol checklists (*)	J
	Protecting against conflicts of interest	Disclosure of conflicts of interest (***) Exclusion/containment of financial and non-financial conflicts of interest (*)	J
Reproducibility	Encouraging transparency and open science	Open data, materials, software and so on (* to **) Pre-registration (**** for clinical trials, * for other studies)	J, F, R
Evaluation	Diversifying peer review	Preprints (* in biomedical/behavioural sciences, **** in physical sciences) Pre- and post-publication peer review, for example, Publons, PubMed Commons (*)	J
Incentives	Rewarding open and reproducible practices	Badges (*) Registered Reports (*) Transparency and Openness Promotion guidelines (*) Funding replication studies (*) Open science practices in hiring and promotion (*)	J, I, F

Estimated extent of current adoption: *, <5%; **, 5–30%; ***, 30–60%; ****, >60%. Abbreviations for key stakeholders: J, journals/publishers; F, funders; I, institutions; R, regulators.

A Manifesto for Reproducible Science.

Marcus R. Munafò, Brian A. Nosek, Dorothy V. M. Bishop et al. *Nature Human Behaviour*, Vol. 1, No. 1. (10 January 2017)

Workflow template

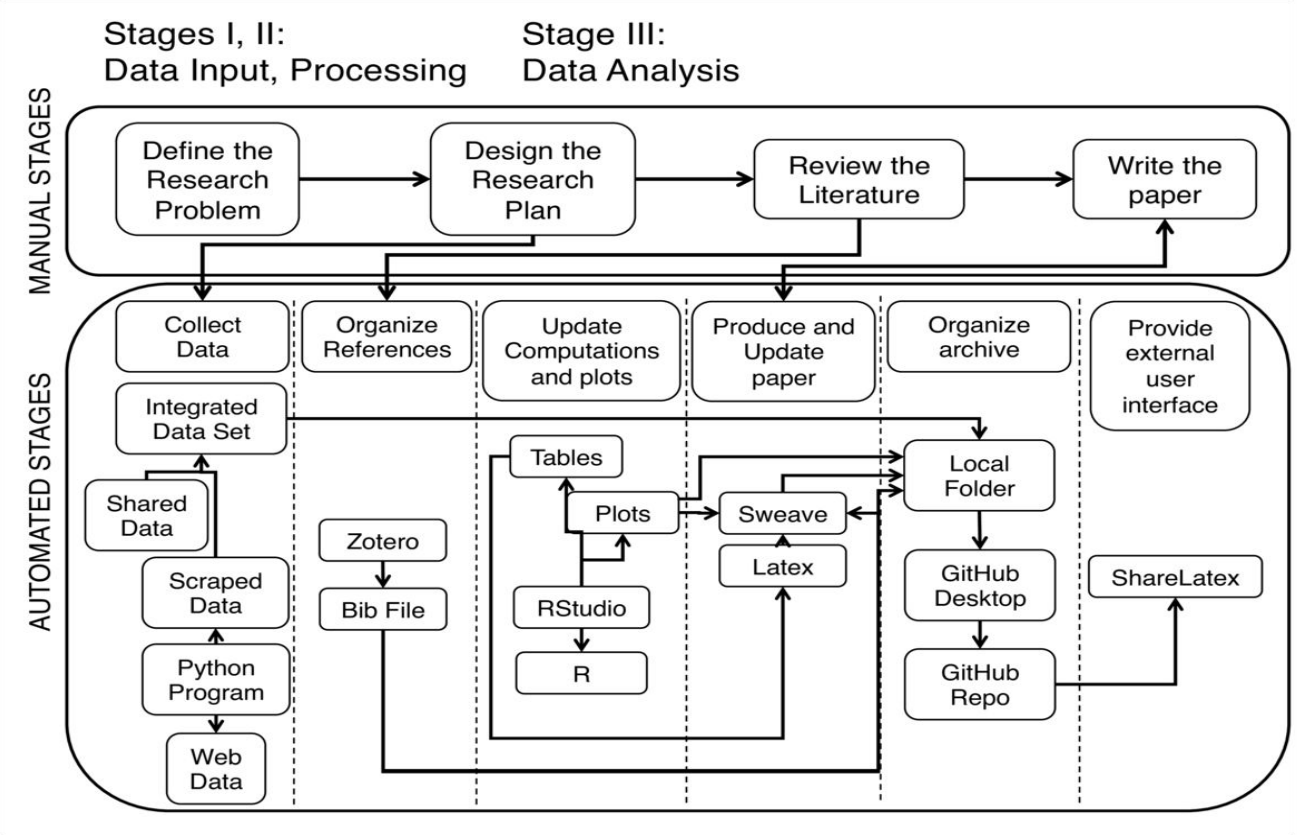


Adapted from Kitzes, 2018

First steps

The first step to making science reproducible is to build good habits. Your most important collaborator is your future self. It’s important to make a workflow that you can use time and time again, and even pass on to others in such a way that you don’t have to be there to walk them through it.

Aaron Culich



Case study from Kitzes, 2018

More information

Case Studies:
Kitzes, J., Turek, D., & Deniz, F. (Eds.). (2018). *The Practice of Reproducible Research: Case Studies and Lessons from the Data-Intensive Sciences*. Oakland, CA: University of California Press. (A free pre-print edition is available)

Documentation standard:
The DRESS Protocol

Teaching materials:
Project TIER

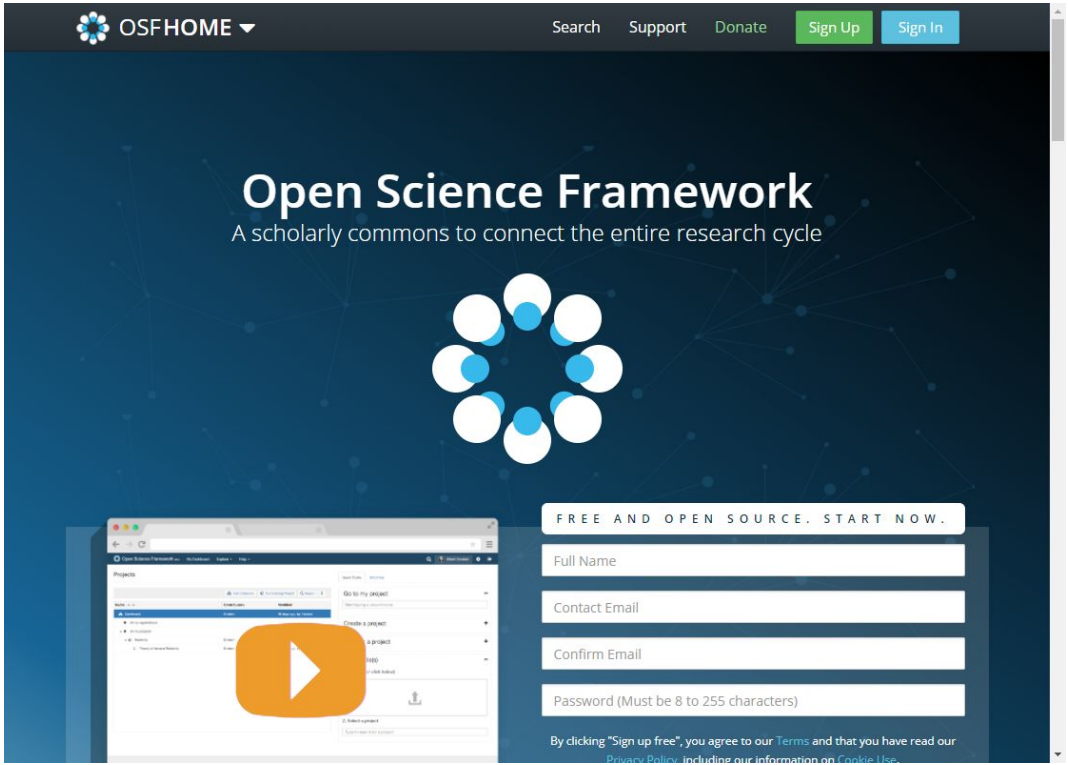
Introduction to The Open Science Framework

Why the Open Science Framework?

Project of the
Center for Open Science,
a nonprofit based in
Charlottesville, VA

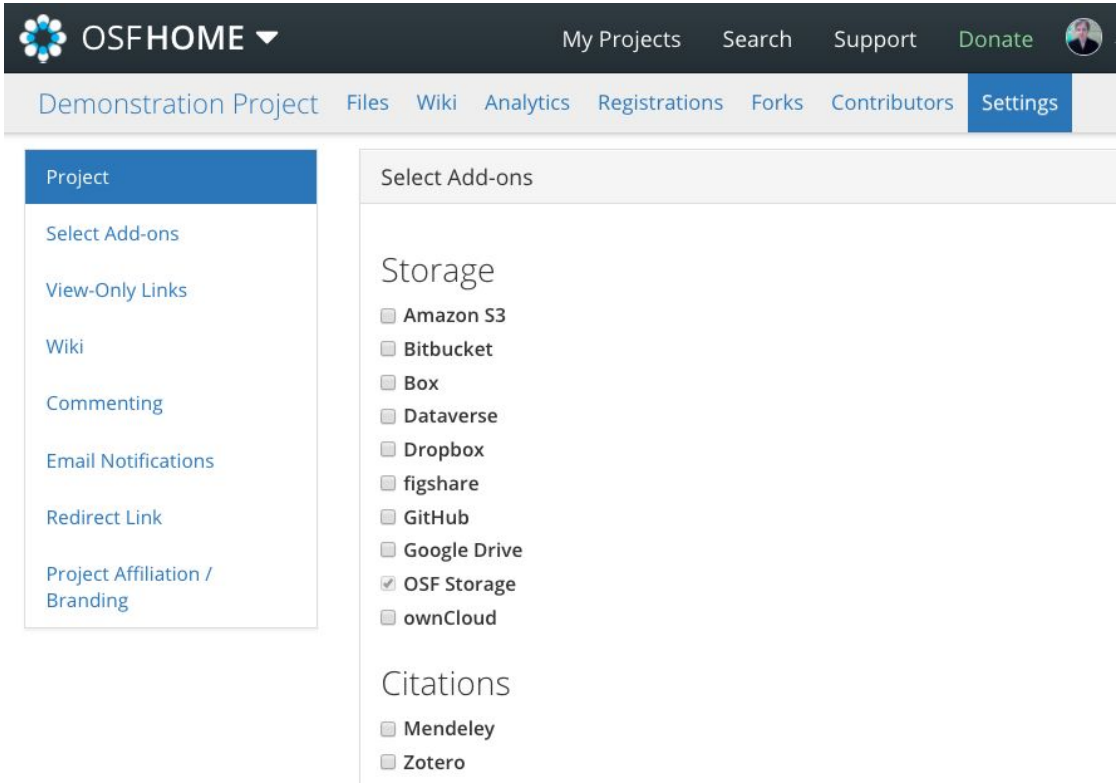
Funded by a variety of
grants and sponsors,
including DARPA, the
NSF, NIH, and others.

https://osf.io/



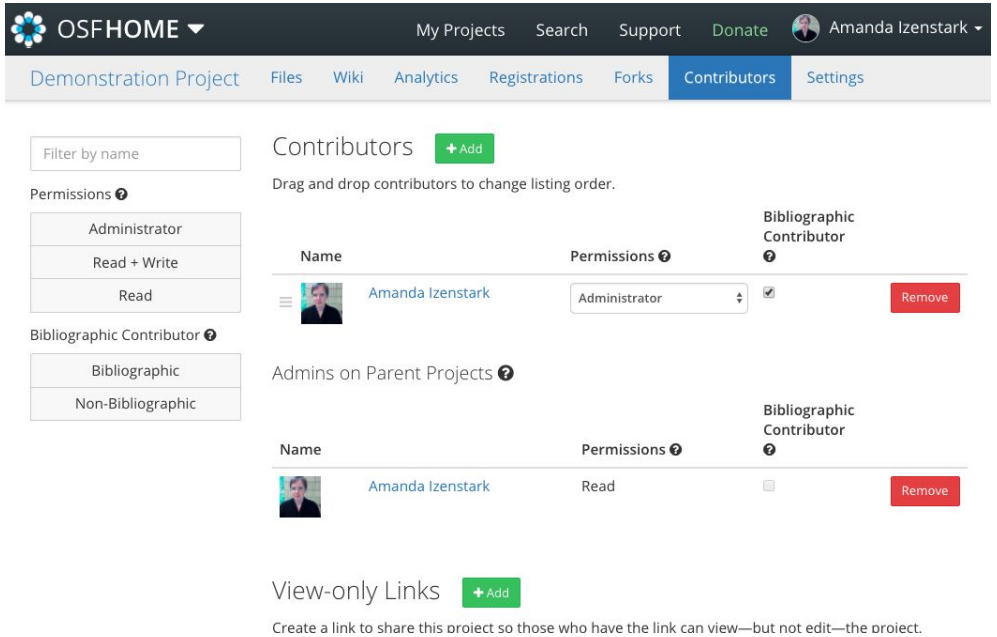
What it does

1. Connects various parts of your workflow, wherever they are
   - Google Drive
   - Dropbox
   - Mendeley
   - FigShare
   - GitHub...
2. Supports versioning



What it does

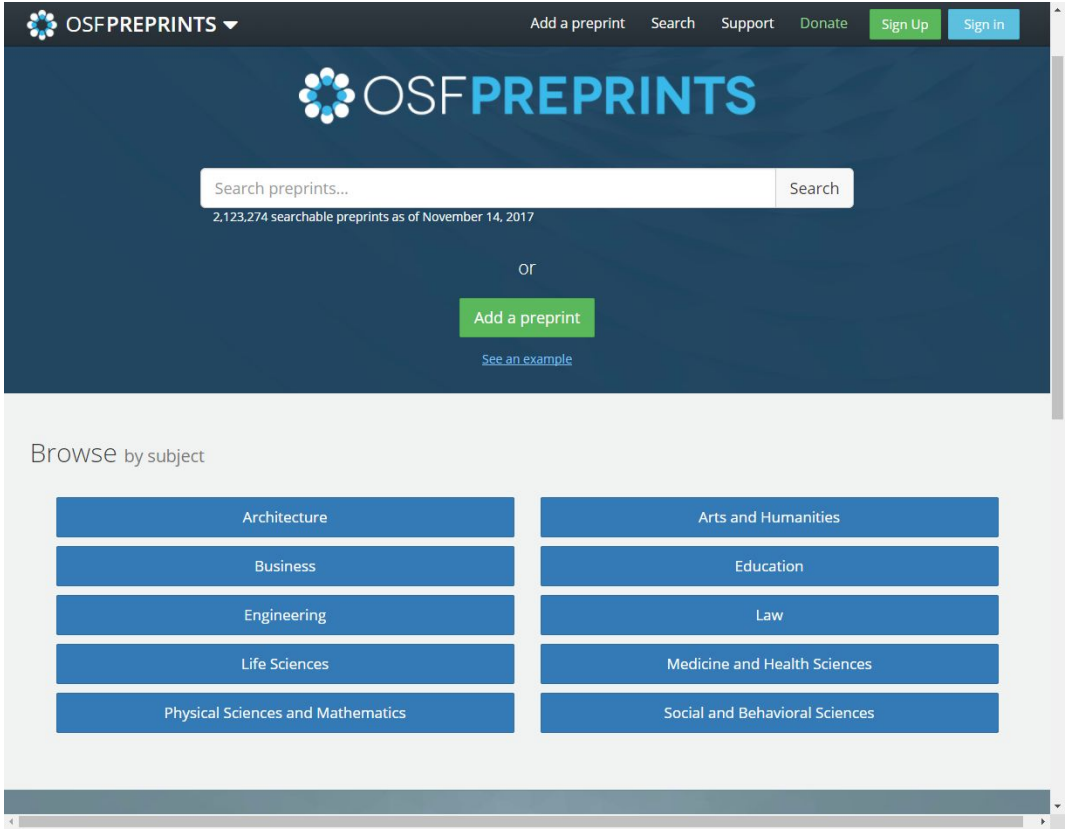
1. Centralizes access to your research information
2. Provides granular sharing of elements with collaborators
3. Provides access for others who can provide feedback at any stage of the research process



Additional Related Project - OSF Preprints

Not just for science - includes the Arts & Humanities, Business, Education, Law, and more.

* Once your article is published, please post your final manuscript in the DigitalCommons@URI for increased visibility!



Closing thoughts

“As readers of scientific work, all we can do is be more skeptical of everything that is published.”

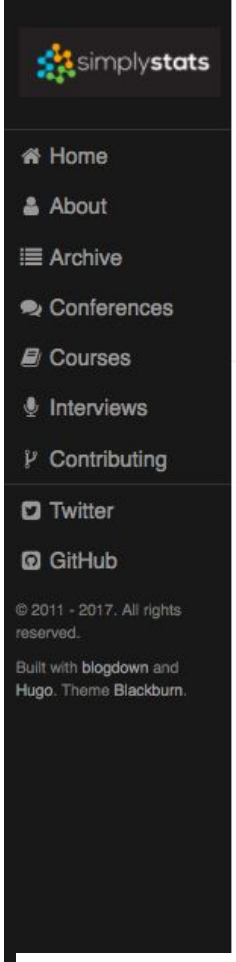
> – Christobal Young, Assistant Professor of Sociology, Stanford University, 2015

“I want to adopt a stance of humility and assume that there are errors and that’s why I need to be cautious in my conclusions.”

> – Brian Nosek, Professor of Psychology, University of Virginia and co-founder and director of the Center for Open Science, 2016

Closing thoughts

Sharing research at various stages of the process for feedback and input from others can improve your visibility, your research, and your final product.



A few things that would reduce stress around reproducibility/replicability in science

Jeff Leek 2017/11/21

I was listening to the Effort Report Episode on The Messy Execution of Reproducible Research where they were discussing the piece about Amy Cuddy in the New York Times. I think both the article and the podcast did a good job of discussing the nuances of the importance of reproducibility and the challenges of the social interactions around this topic. After listening to the podcast I realized that I see a lot of posts about reproducibility/replicability, but many of them are focused on the technical side. So I started to think about compiling a list of more cultural things we can do to reduce the stress/pressure around the reproducibility crisis.

I'm sure others have pointed these out in other places but I am procrastinating writing something else so I'm writing these down while I'm thinking about them :).

1. **We can define what we mean by "reproduce" and "replicate"** Different fields have different definitions of the words *reproduce* and *replicate*. If you are publishing a new study we now have an R package that you can use to create figures that show what changed and what was the same betweeen the original study and your new work. Defining concretely what was the same and different will reduce some of the miscommunication about what a reproducibility/replicability study means.

https://simplystatistics.org/2017/11/21/rr-sress/

From “A few things…”

2. We can remember that replication is statistical, not deterministic

3. We can remember that there is a difference between exploratory and confirmatory research

6. We can be persistent and private as long as possible

7. We can make the realization that data is valuable but in science you don’t own it

Thank you!

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