Moore / Sloan Data Science Environment

Working Group on Reproducibility and Open Science

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Joe Hellerstein
Bill Howe
Dan Halperin
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Many others... You??

http://escience.washington.edu/reproducible

http://uwescience.github.io/reproducible

What does Reproducible Research mean?

Ability to determine exactly how scientific results were obtained.

- Basis of scientific method.
- Required for confidently building on past results.
- Critical for accountability in engineering analysis / decision making.

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- Experimental science: Lab notebooks, methodology section of publications, etc.
- Mathematics: Proofs are required in publications.

Quote from Reproducible Research: A Cautionary Tale

By David Crotty, March 26, 2014 on **the scholarly kitchen blog**

If your experiment consists of running numerical data through an algorithm, then releasing your data and your code allows others to quickly verify that you've done what you've said you've done. But when it comes to other types of research, wet bench experiments or observational work for example, reproduction is not quite so simple.

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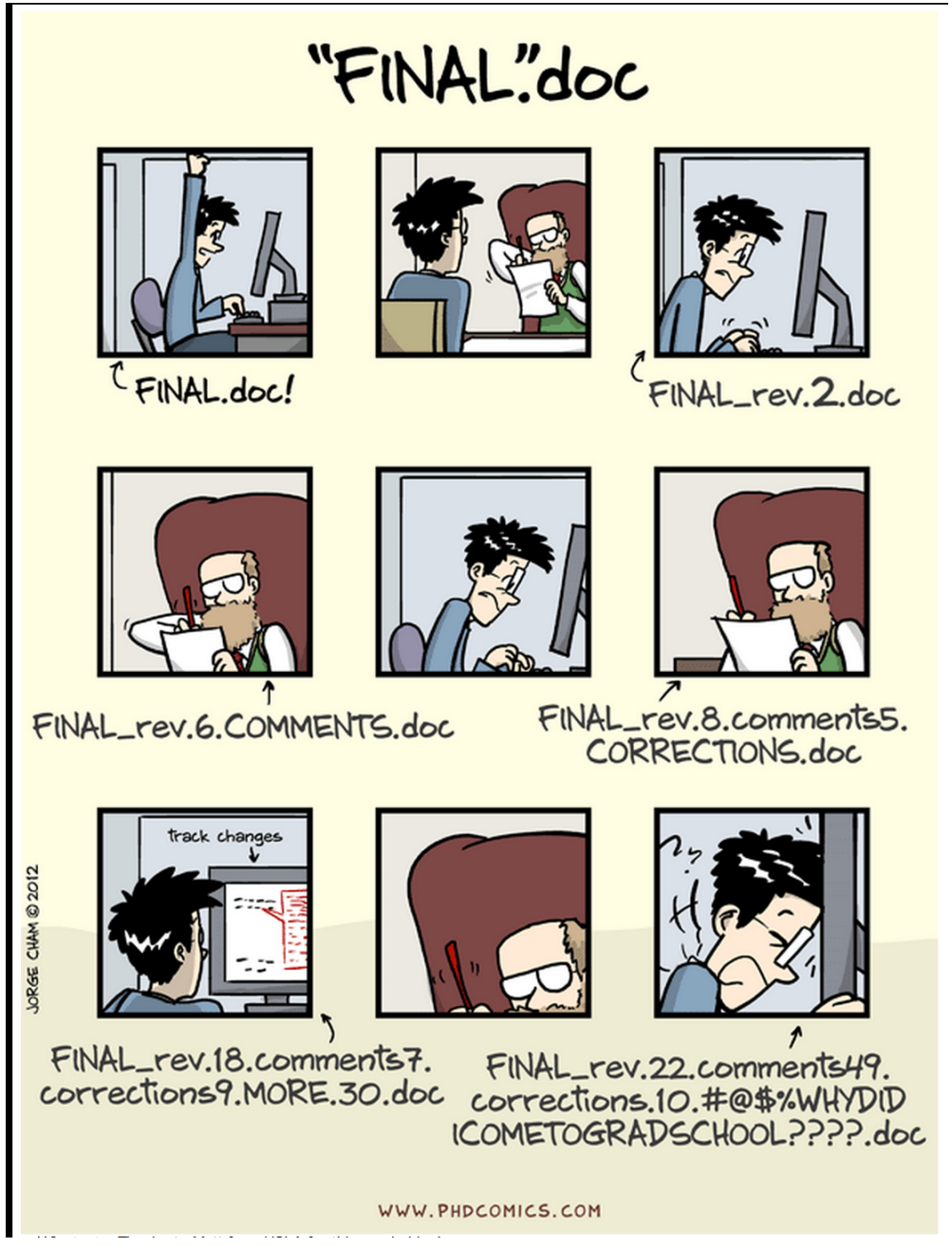
If only it were so easy in computational/data science!



http://www.phdcomics.com/comics/archive.php?comicid=1531

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Auditable Research: Even if code and data are not shared, there should be a permanent record that can be checked.

Analogous to lab notebooks.

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Why?

- Verifying scientific integrity of results.
- Aids in understanding ideas, implementing methods
- Increases impact of work.

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Terms such as replicable or repeatable are sometimes used in addition to reproducible.

Science Code Manifesto

Manifesto Discussion Endorse Resources About

Software is a cornerstone of science. Without software, twenty-first century science would be impossible. Without better software, science cannot progress.

But the culture and institutions of science have not yet adjusted to this reality. We need to reform them to address this challenge, by adopting these five principles:

Code	All source code written specifically to process data for a published paper must be available to the reviewers and readers of the paper.
Copyright	The copyright ownership and license of any released source code must be clearly stated.
Citation	Researchers who use or adapt science source code in their research must credit the code's creators in resulting publications.
Credit	Software contributions must be included in systems of scientific assessment, credit, and recognition.
Curation	Source code must remain available, linked to related materials, for the useful lifetime of the publication.

Endorsements at: `http://sciencecodemanifesto.org/`

Tools to facilitate reproducibility

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- Other archives with stable URLs, DOIs

  Institutional or public data repositories,
  journal supplementary materials,
  figshare.com

Tools to facilitate reproducibility

- Workflow Management Systems

  VisTrails, Madagascar, Sumatra, Taverna, Galaxy, etc.

  Capture the workflow used to generate figures, tables, etc.

  Facilitate tracking the provinance of individual results.
  Data, code, compilers, graphics tools, etc.

  Often work together with VCS for source code.

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- Notebooks / Publishing tools

  Mathematica, Maple, Matlab,

  Sage, IPython, knitr, RStudio, etc.

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- Virtualization

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- Web platforms for running code

  E.g., RunMyCode.org, wakari.io,

  cloud.sagemath.com

Policy Issues

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Some already do, e.g. Science:

> **Data and materials availability.**
>
> *All data necessary to understand, assess, and extend the conclusions of the manuscript must be available to any reader of* Science*.*
>
> *All computer codes involved in the creation or analysis of data must also be available to any reader of* Science*.*
>
> *After publication, all reasonable requests for data and materials must be fulfilled.*

http://www.sciencemag.org/site/feature/contribinfo/prep/

Certification of reproduciblity?

Stamp of reproducibility on journal papers.

E.g. *Biostatistics* awards “kite marks”,

- **D** for data availability,
- **C** for code availability,
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Checked by “reproducibility editor”.

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Campus-wide certification of labs or research groups following “best practices?” (What are these?)

Reward structure

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- Concerns for young researchers in particular.

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Altmetrics: Measuring contributions other than traditional journal publications, e.g., **ImpactStory.org**

Guidelines for Reproducibility & Open Science

See: **http://uwescience.github.io/reproducible**

Goals:

- To achieve greater scientific validity and integrity by making it easier to verify published results.
- To increase productivity of current and future researchers on funded projects.
- To increase the impact of the research performed, software developed, and papers published.
- To help promote data and code as first class research products.
- To increase access to and usability of research products by other researchers.
- To use the DSE as a test bed for developing and promoting tools and cultural changes across a broad spectrum of academic disciplines.