

Reproducible research and scientific publication

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The two faces of scientific publications

Dissemination

Scientists publish their findings to allow their peers to

- **verify** them
- **build on** them

for as long as they are relevant to scientific progress (\approx **decades**)

Reproducible research requires **publishing software and data** in addition to the traditional narrative.

Evaluation

Publications are the basis for establishing a scientist's

- **reputation** (content)
- **productivity** (number)
- **importance** (impact)

Journals therefore define **incentives** for research.

For reproducible research to become the norm, it must **have a place in these incentives**.

The two faces of software

Human

what the software does

- models, methods
- concepts
- informal language
- fuzziness, ambiguity
- focus on the essential

We analyzed the data using version 2.1 of the InsightDiscoverer software [42].

Computer

bit-level operations

- algorithm
- representations
- formal language
- extreme precision
- every bit matters

InsightDiscoverer 2.1 compiled with gcc 5.1.3 (compilation options: ...) using libdata 1.0.2 compiled with gcc 4.4.6 running under Linux kernel 2.6.32 on an Intel Xeon CPU series X5675 using 3 cores ...

The world of atoms vs. the world of bits

	Atoms	Bits
quantities	value \pm error	value
comparison	tolerance	exact equality
judgement	good ... bad	true / false
design	robustness	N/A

Common fallacies:

- Software A is similar to software B.

No definition of similarity for software.

- Good results for input A imply good results for similar input B.

Thousands of counterexamples, e.g. [here](#), [here](#), and [here](#).

- Floating-point arithmetic is imprecise.

IEEE-754 defines exact manipulations of precise bit patterns.
The **interpretation** of bit patterns as real numbers is imprecise.

Publishing reproducible computer-aided research

Dissemination/Human

- Notebooks ([Jupyter](#), ...)
- Workflows
- [Software Heritage](#)

Evaluation/Human

- Software journals ([JORS](#), [JOSS](#), [SoftwareX](#))
- [Software citation](#), [transitive credit](#)
- Reproducible research journals ([IPOL](#), [ReScience](#))

Dissemination/Computer

- Containers ([Docker](#), ...)
- [Reproducible builds](#), [Guix](#) / [Nix](#)
- Servers ([IPOL](#), [Code Ocean](#))
- [ActivePapers](#)

Evaluation/Computer

- [ActivePapers](#)

Integration of everything

- [binder](#), [Everpub](#), [Popper](#)

Looking over the fence

Reproducibility in experimental sciences:

- [Political Science Replication Initiative](#)
- [Estimating the Reproducibility of Psychological Science](#)

Automatic partial validation of publications:

- [statcheck](#): automatic validation of statistical analyses in a paper