

Reproducibility

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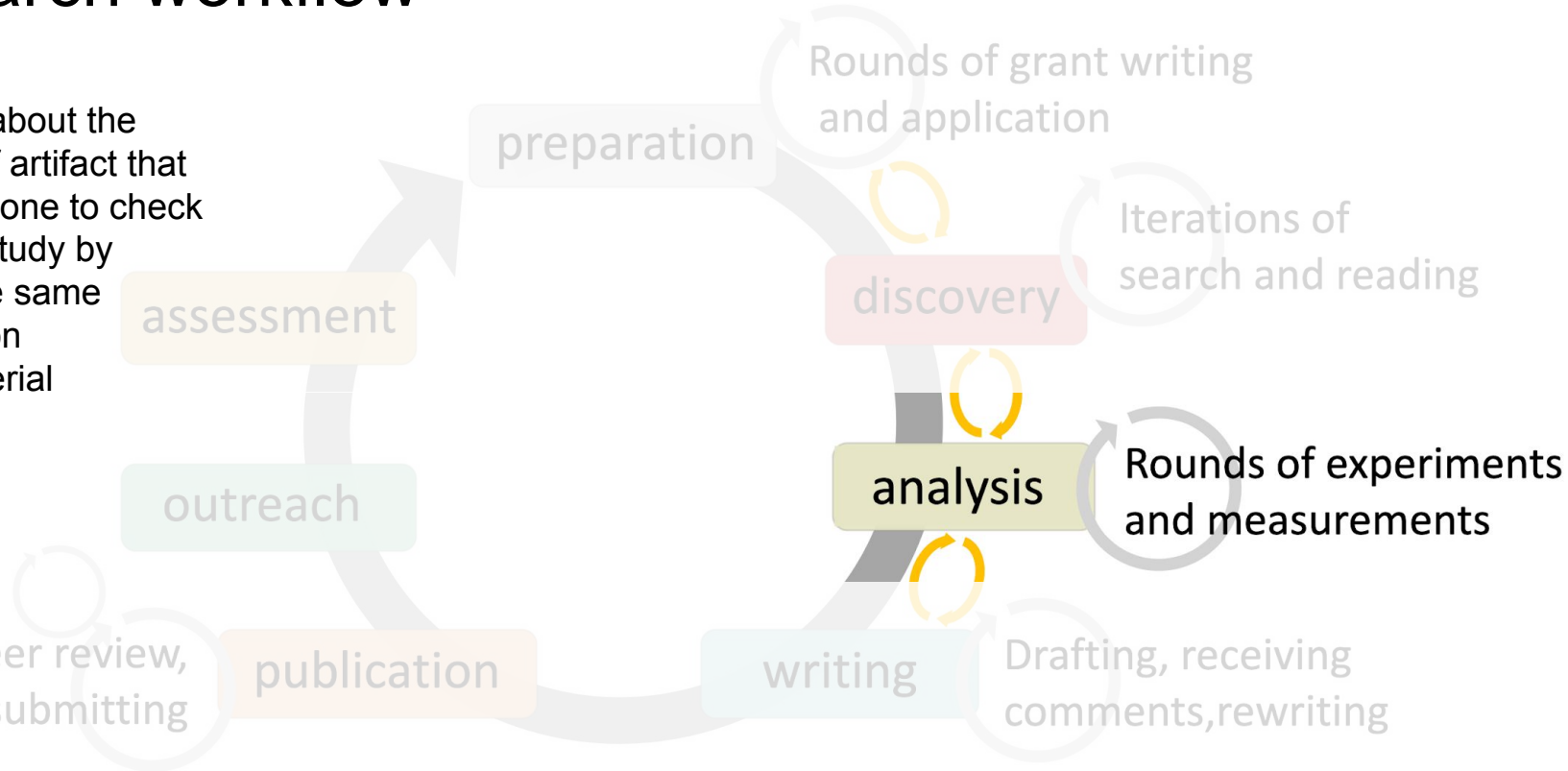
Second Cycle Degree in Digital Humanities and Digital Knowledge

Alma Mater Studiorum - Università di Bologna



Research workflow

We discuss about the availability of artifact that enable someone to check results of a study by run again the same experiment on existing material



What does it mean “to reproduce” in science

Enabling reproducibility of the outcomes of an analysis means that “whatever results we compute and report, **someone else** who uses exactly the **same data, methods or algorithms** should be **able to reproduce the same results**”

Guaranteeing this is the **minimal requirement** for any outcome resulting from any analysis, in particular when we use mathematical and, more generally, computational techniques to run the analysis

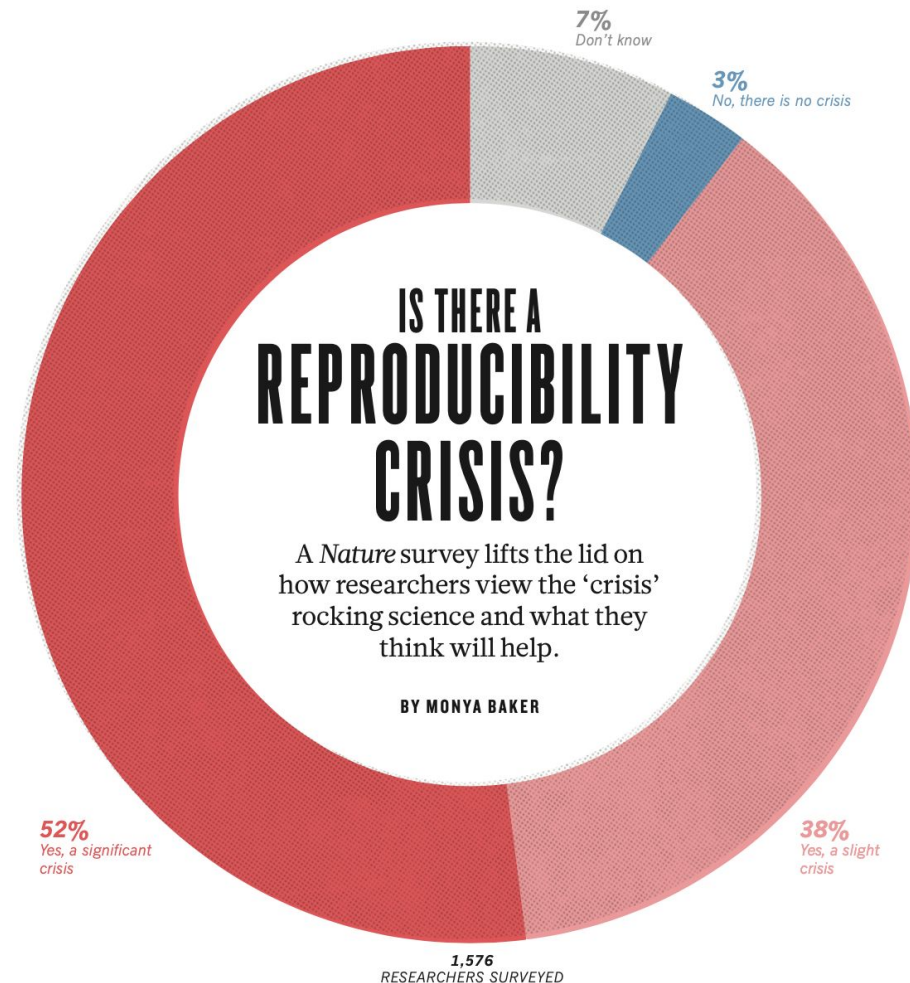
Reproducibility crisis

>70% have tried and failed to reproduce another scientist's experiments

>50% have failed to reproduce their own experiments

<31% think that failure to reproduce means that the result is probably wrong (they trust the literature)

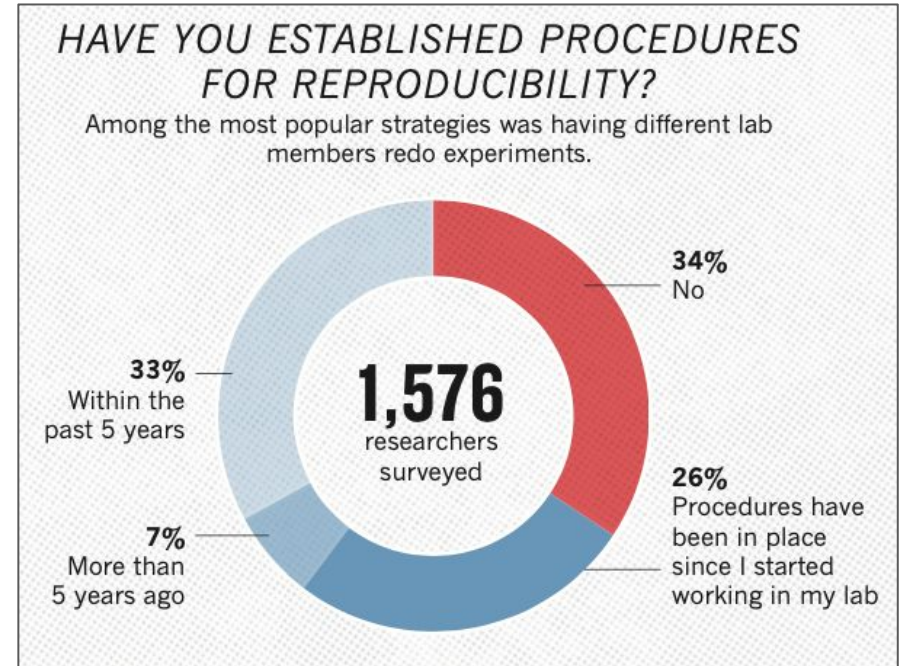
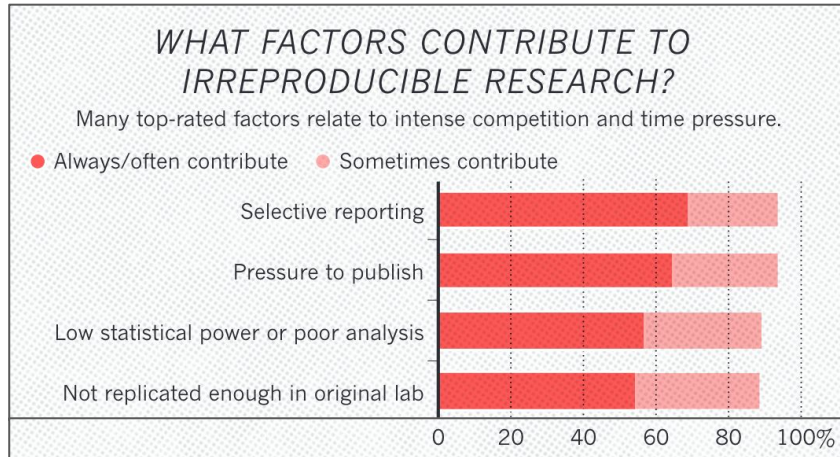
<20% contacted by another researcher unable to reproduce their work



Some additional issues

Work does not reproduce →
there is a perfectly valid reason

Incentives to publish positive replications are low +
journals reluctant to publish negative findings



Reproducibility in the Humanities

Reproducibility is indeed an issue also in the Humanities domain

Often, the **data** supporting a research in the Humanities are **not published** along with the text of a publication and the methodology followed for gathering and analysing such data is not described in sufficient detail to enable a scholar to reproduce the outcomes

Even when data are available, often humanities scholars accept the outcomes of a research made by their colleagues without access to the data from which the discoveries are drawn

In general, the specification of guidelines for study protocols, publications and datasets is an **important factor** for the Humanities research, as well as for other scholarly disciplines, since they increase transparency, limit undesirable degrees of freedom researchers have, minimize selective reporting, and ensure **replicability**

Replicability

While reproducibility is an added value, in the context of the Humanities (and other) domains, also replicability is highly desirable

The **replicability** of a study is related to enabling a scholar to run an independent experiment targeting the same scientific question of a study already performed, producing a result consistent with the original study

This can be done

- by reusing the data available in the original study and applying a new method of analysis
- by gathering new data and reusing the same method of analysis of the original study
- by developing a new approach for gathering data and analysing them to reach the same conclusions

Reproducibility in Scientometrics

The lack of reproducibility of published studies is an issue that is emerging in several scholarly fields and it is largely discussed, in particular, in disciplines where the use and analysis of huge amount of data is key for carrying a research

For instance, in the field of Scietometrics (that concerns measuring and analysing scholarly literature) the reproducibility crisis is, today, a common discussion held at different levels and in different events

The community [organised a workshop](#), a few years ago, to start a discussion about the topic, and have started to push the message of the need for reproducible approaches also [via their association](#): “essential to promote reproducibility and appraisal of research, reduce misconduct, and ensure equitable access to and participation in science”

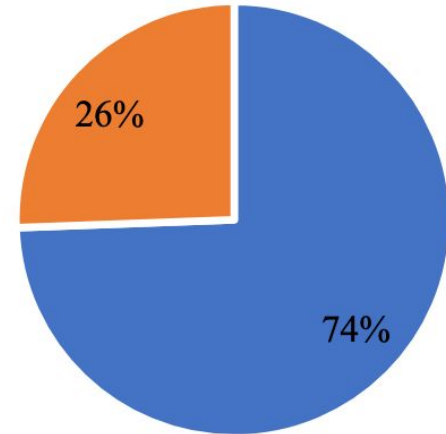
Reproducibility issues are field dependent

Reproducibility concerns in one research field cannot be directly translated to other research fields

Indeed, each research field has **its own set of reproducibility artifacts**, and such artifacts may largely vary according to the discipline

For instance: software could be a relevant artefact to make available for a research in Scientometrics, but it may not be relevant for a research in Philology

Availability percentage of source code for articles published in the journal “Scientometrics” in 2017



■ No ■ Yes

Importance of reproducibility

Two major components to a reproducible study

- raw data from the experiment are available
- code and documentation to reproduce the analysis are available

Enabling reproducibility allows **checking the soundness of analysis** and it is one of the key factors (but not the only one) to build trust

Example: Potti et al.'s article “Genomic signatures to guide the use of chemotherapeutics” published in Nature Medicine in 2006 (<https://doi.org/10.1038/nm1491>) – the authors claimed to have built an algorithm using genomic microarray data that predicted which cancer patients would respond to chemotherapy

Keith Baggerly and Kevin Coombes (<https://doi.org/10.1214/09-AOAS291>) obtained the data and attempted to apply such an algorithm, and found that the data analysis conducted in the original study contained several errors that invalidated the outcomes of the study

Retraction

Usually, articles that are found with factual errors (such as Potti *et al.*'s one) are **retracted** from the journal to alert the reader to serious problems identified with a published article

In practice, a retraction is a formal label assigned by the editorial board of a journal to mark an article as an invalid source of knowledge depending on specific reasons (specified in a document called **retraction notice** – e.g. the one about Potti's *et al.*'s article is at <https://doi.org/10.1038/nm0111-135>) which might include scientific misconduct, fabrication, general content errors, plagiarism, etc.

While retracted, the article is still available to scholars – it is not removed from the journal, just labelled as retracted

Retraction happens after the publication of an article in a venue (e.g. Potti *et al.*'s article was published in 2006 and retracted in 2011) – thus, a retracted article may have been used as starting point of other studies

For monitoring retraction: [Retraction Watch Database](#)

Retraction or Other Notices	
Title/Subject(s)/Journal — Publisher/Affiliation(s)/Retraction Watch Post URL(s)	Reason(s)
1 Item(s) Found	
Genomic signatures to guide the use of chemotherapeutics (BLS) Biochemistry; (BLS) Biology - Cancer; (BLS) Biology - Cellular; (BLS) Genetics; (HSC) Medicine - Drug Design; (HSC) Medicine - Oncology; (HSC) Medicine - Pharmacology; <i>Nature Medicine</i> — Springer - Nature Publishing Group	+Investigation by Company/Institution +Investigation by Third Party +Results Not Reproducible
Duke Institute for Genome Sciences and Policy, Duke University, Durham, North Carolina	
Department of Medicine, Duke University Medical Center, Durham, North Carolina	
Department of Molecular Genetics and Microbiology, Duke University Medical Center, Durham, North Carolina	
Division of Gynecologic Surgical Oncology, H. Lee Moffitt Cancer Center & Research Institute, University of South Florida, Tampa, Florida	
Department of Surgery, Duke University Medical Center, Durham, North Carolina	
Department of Obstetrics and Gynecology, Duke University Medical Center, Durham, North Carolina	

Problems derived from missing reproducibility

In principle, enabling reproducibility increase the chance to identify questionable research practices and misconducts such as fabricated, false, biased, and irreproducible findings

About data falsification: a survey reported that, on average, around 2% of scientists admitted to having fabricated or falsified data at least once

Ideal: the reproducibility of research methods should be expected to be 100%

Reality: the reproducibility of results and inferences is lower and to vary across subfields and methodologies

End

Reproducibility

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