Reproducibility

Silvio Peroni

silvio.peroni@unibo.it – https://orcid.org/0000-0003-0530-4305 – @essepuntato
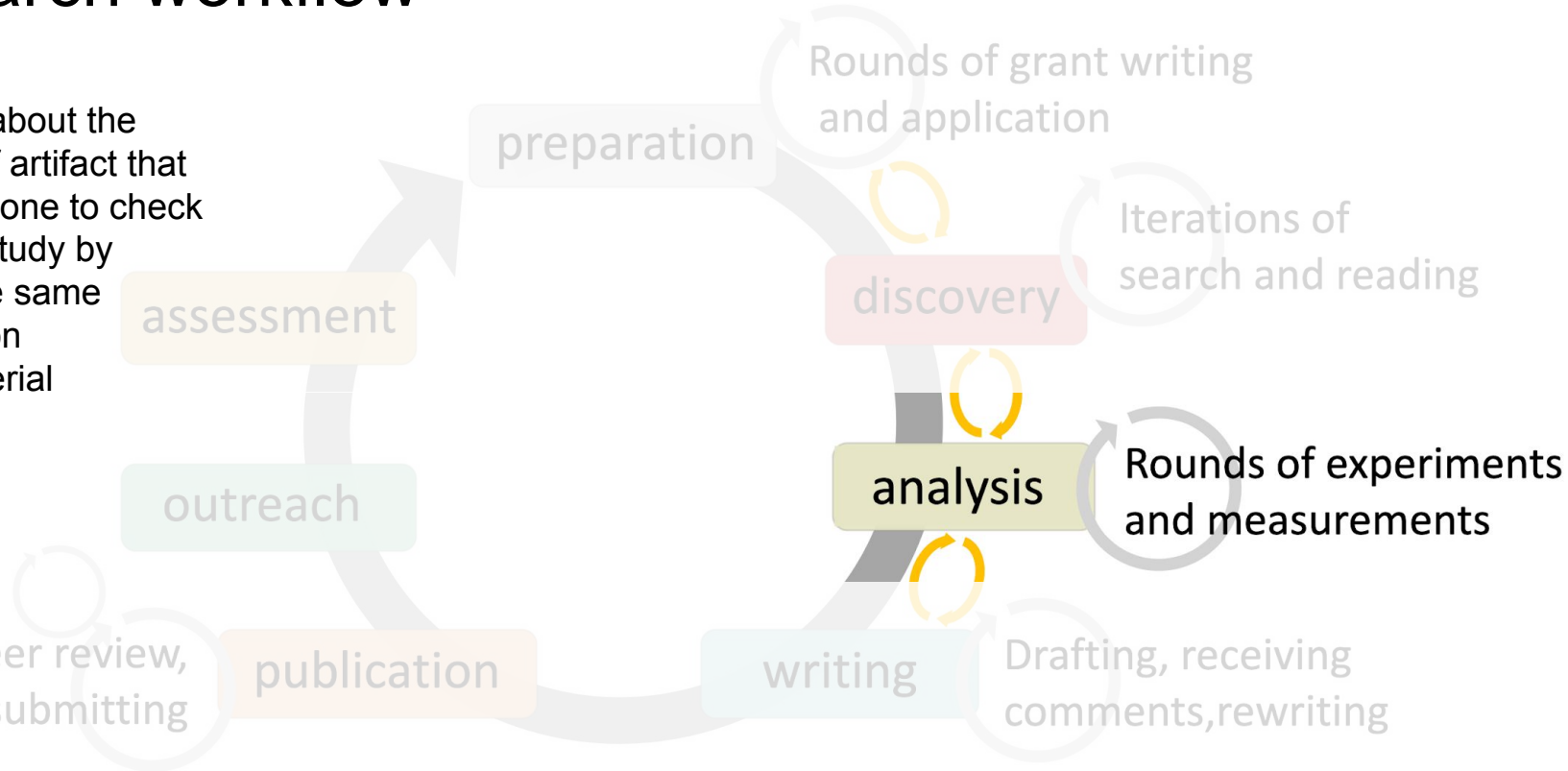
Open Science (A.Y. 2020/2021)
Second Cycle Degree in Digital Humanities and Digital Knowledge
Alma Mater Studiorum - Università di Bologna

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

Rounds of grant writing and application

preparation

Iterations of search and reading

discovery

assessment

analysis

Rounds of experiments and measurements

outreach

Submit, peer review, rejection, resubmitting

publication

writing

Drafting, receiving comments, rewriting

Kramer, B., & Bosman, J. (2015, June 18). The good, the efficient and the open—Changing research workflows and the need to move from Open Access to Open Science. CERN Workshop on Innovations in Scholarly Communication (OAI9), University of Geneva, Geneva, Switzerland. https://www.slideshare.net/bmkramer/the-good-the-efficient-and-the-open-oai9

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

Meng, X.-L. (2020). Reproducibility, Replicability, and Reliability. Harvard Data Science Review, 2(4). https://doi.org/10.1162/99608f92.dbfce7f9
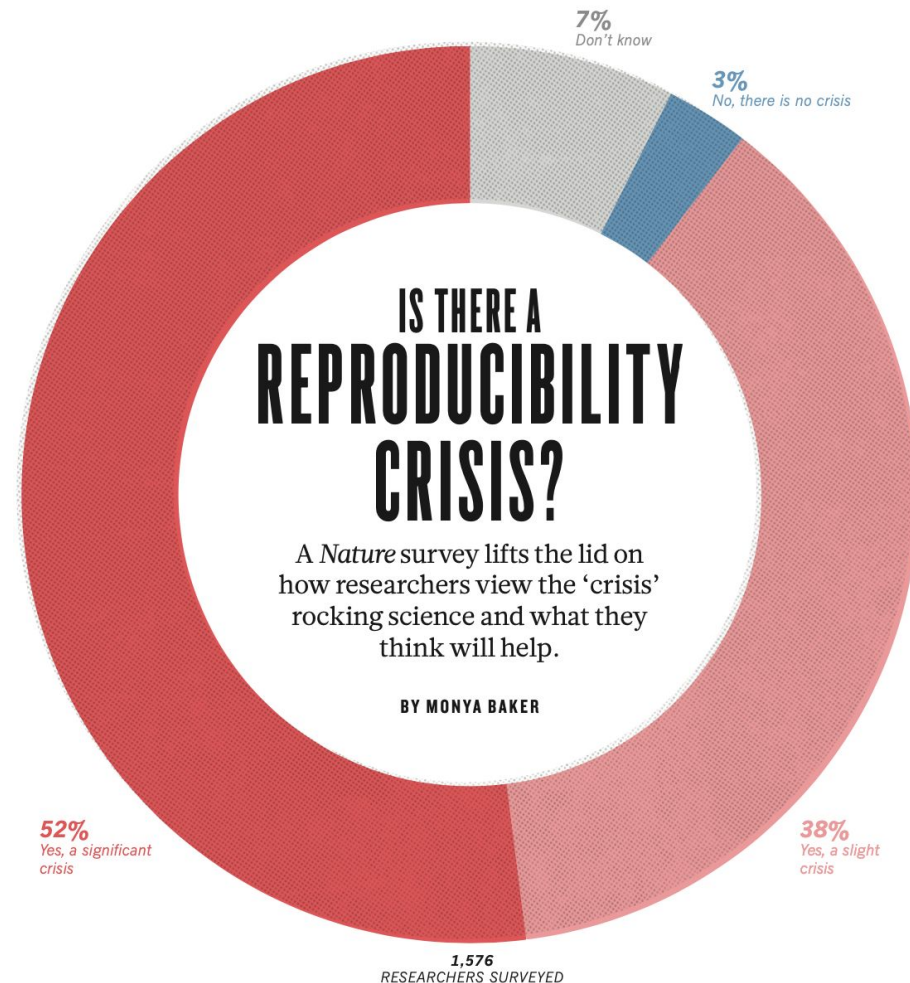
Reproducibility crisis

>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

7%
Don't know

3%
No, there is no crisis

IS THERE A
REPRODUCIBILITY CRISIS?

A *Nature* survey lifts the lid on how researchers view the 'crisis' rocking science and what they think will help.

BY MONYA BAKER

52%
Yes, a significant crisis

38%
Yes, a slight crisis

1,576
RESEARCHERS SURVEYED

Baker, M. (2016). 1,500 scientists lift the lid on reproducibility. Nature, 533(7604), 452–454. https://doi.org/10.1038/533452a
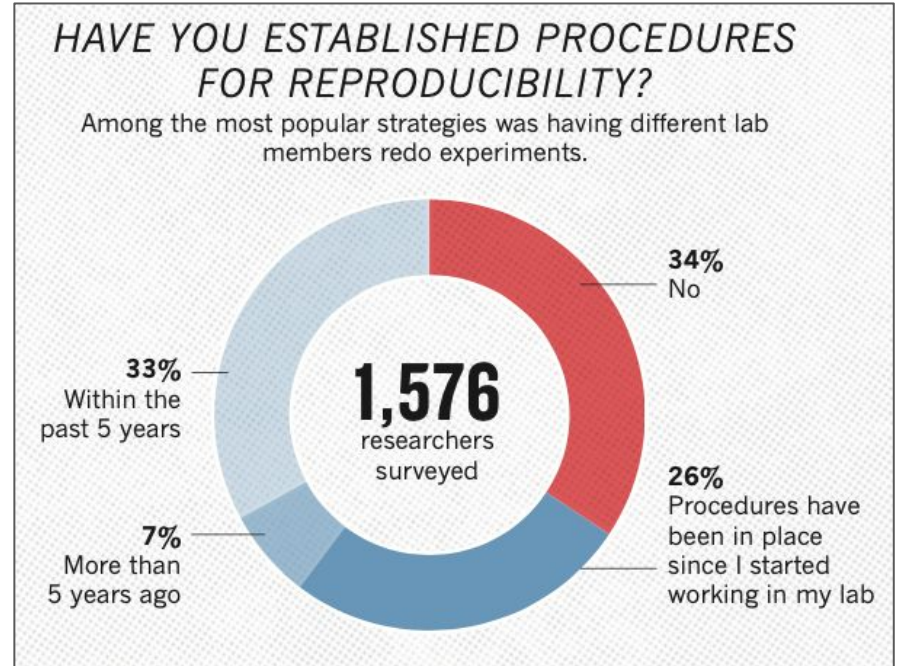
Some additional issues

Work does not reproduce →
there is a perfectly valid reason

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

>60% identified pressure to publish
and selective reporting as the main
aspects leading to problems in
reproducibility

HAVE YOU ESTABLISHED PROCEDURES
FOR REPRODUCIBILITY?
Among the most popular strategies was having different lab
members redo experiments.

1,576 researchers surveyed

34% No

26% Procedures have been in place since I started working in my lab

7% More than 5 years ago

33% Within the past 5 years

Baker, M. (2016). 1,500 scientists lift the lid on reproducibility. Nature, 533(7604), 452–454. https://doi.org/10.1038/533452a

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

Peels, R., & Bouter, L. (2018). The possibility and desirability of replication in the humanities. Palgrave Communications, 4(1), 95. https://doi.org/10.1057/s41599-018-0149-x

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

Peng, R. (2015). The reproducibility crisis in science: A statistical counterattack. Significance, 12(3), 30–32. https://doi.org/10.1111/j.1740-9713.2015.00827.x

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"

Velden, T., Hinze, S., Scharnhorst, A., Schneider, J. W., & Waltman. (2018). Exploration of reproducibility issues in scientometric research. In R. Costas, T. Franssen, & A. Yegros-Yegros (Eds.), STI 2018 Conference Proceedings (pp. 612–624). Centre for Science and Technology Studies. https://hdl.handle.net/1887/65315
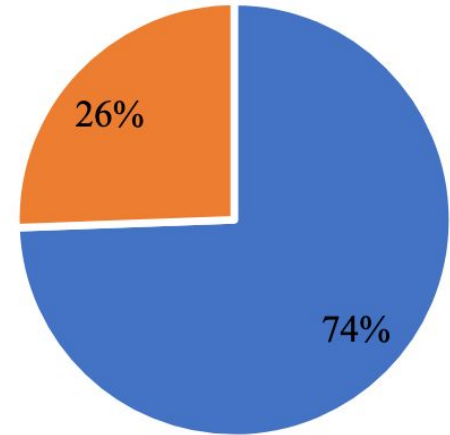
Reproducibility issues are field dependent

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

Cobo, M. J., Dehdarirad, T., García-Sánchez, P., & Moral-Munoz, J. A. (2018). Quantifying the reproducibility of scientometric analyses: A case study. STI 2018 Conference Proceedings, 925–933. https://hdl.handle.net/1887/65242

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

Peng, R. (2015). The reproducibility crisis in science: A statistical counterattack. Significance, 12(3), 30–32. https://doi.org/10.1111/j.1740-9713.2015.00827.x

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) 1 Item(s) Found	Reason(s)
Genomic signatures to guide the use of chemotherapeutics	+Investigation by Company/Institution
(BLS) Biochemistry; (BLS) Biology - Cancer; (BLS) Biology - Cellular; (BLS) Genetics; (HSC) Medicine - Drug Design; (HSC) Medicine - Oncology; (HSC) Medicine - Pharmacology;	+Investigation by Third Party
Nature Medicine --- Springer - Nature Publishing Group	+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	

Moylan, E. C., & Kowalczuk, M. K. (2016). Why articles are retracted: A retrospective cross-sectional study of retraction notices at BioMed Central. BMJ Open, 6(11), e012047.
https://doi.org/10.1136/bmjopen-2016-012047

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

Silvio Peroni

silvio.peroni@unibo.it – https://orcid.org/0000-0003-0530-4305 – @essepuntato

DIPARTIMENTO DI FILOLOGIA CLASSICA E ITALIANISTICA