Preserving Software

Challenges and Opportunities for Reproducibility of Science and Technology

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Scilabtec 2015 - Paris

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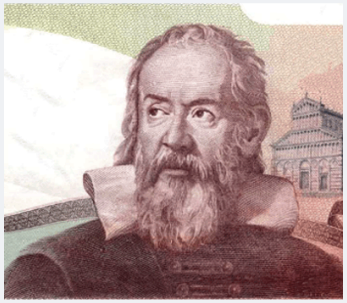
21st of May 2015

Outline

How we built our scientific knowledge

The experimental method

- make an *observation*
- formulate an *hypothesis*
- set up an experiment
- formulate a *theory*



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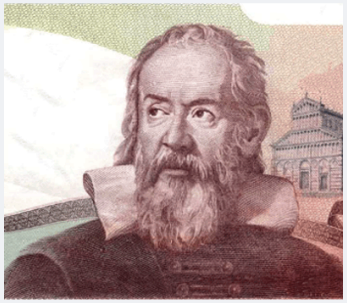

And then we reproduce and verify.

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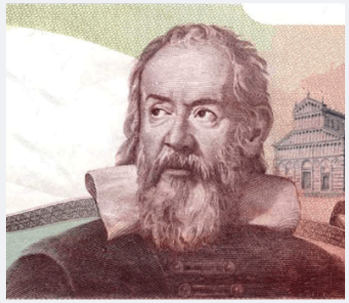

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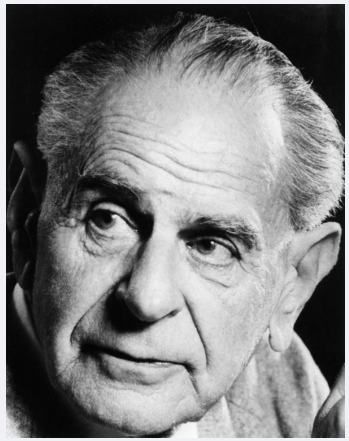
Reproducibility is the key

non-reproducible single occurrences are of no significance to science

Karl Popper, The Logic of Scientific Discovery, 1934



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necessary for industrial transfer

reproducibility is *the essence* of *industry*!

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Today: Software is Science's cornerstone

Software is *an essential component* of modern scientific research

Deep knowledge from *all fields* is embodied in complex software systems

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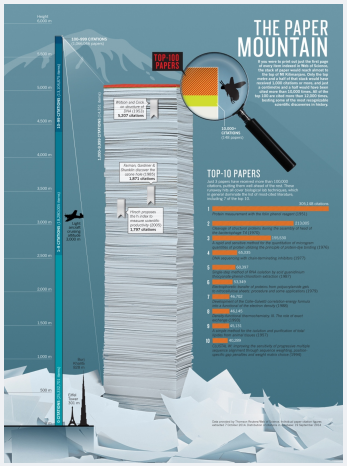
Top 100 papers (Nature, October 2014)

[...] the vast majority describe experimental methods or software that have become essential in their fields.

http://www.nature.com/news/the-top-100-papers-1.16224



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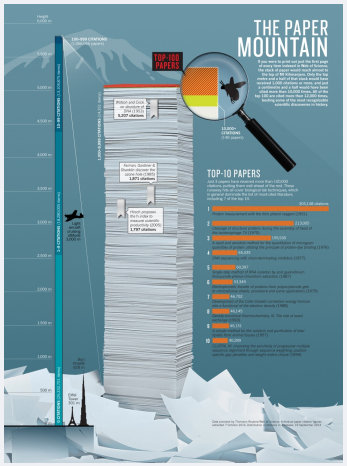

Software is *the pillar of science*

Software is Pervasive

At the heart of *technology*

televisions/fridges $\approx$ 10M SLOC

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IoT ...

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Key mediator for accessing *all* information

(c) Banski

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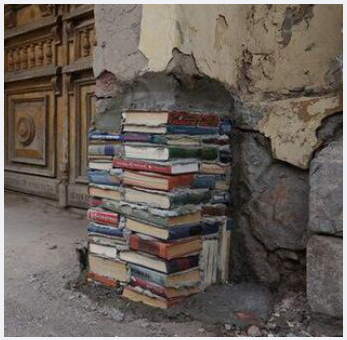

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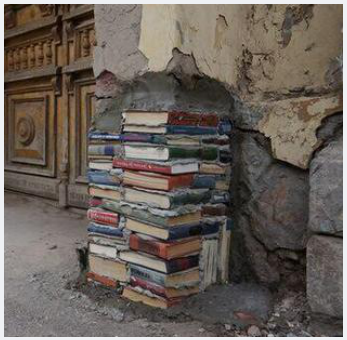

Software is an *essential* enabler for all technology

Reproducibility in the digital age

For an experiment involving software, we need

- **open access** to the scientific article describing it
- **open data sets** used in the experiment
- **source code** of all the components
- **environment** of execution
- **stable references** between all this

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For science, *and industry* ...
Free and Open Source Software is the best choice!

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Software and reproducibility

A fundamental question

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Measuring Reproducibility in Computer Systems Research

Long and detailed technical report, March 2014
`http://reproducibility.cs.arizona.edu/v1/tr.pdf`

Collberg's report from the trenches

Analysis of 613 papers

- 8 ACM conferences: ASPLOS'12, CCS'12, OOPSLA'12, OSDI'12, PLDI'12, SIGMOD'12, SOSP'11, VLDB'12
- 5 journals: TACO'9, TISSEC'15, TOCS'30, TODS'37, TOPLAS'34

all very practical oriented

The basic question

- can we get the code to build and run?

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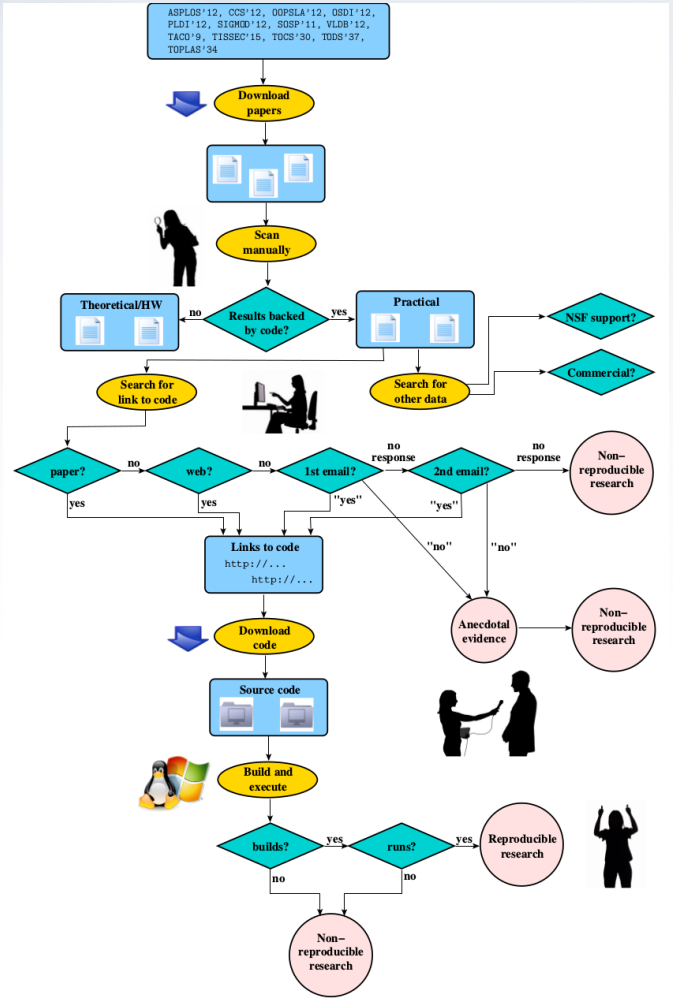
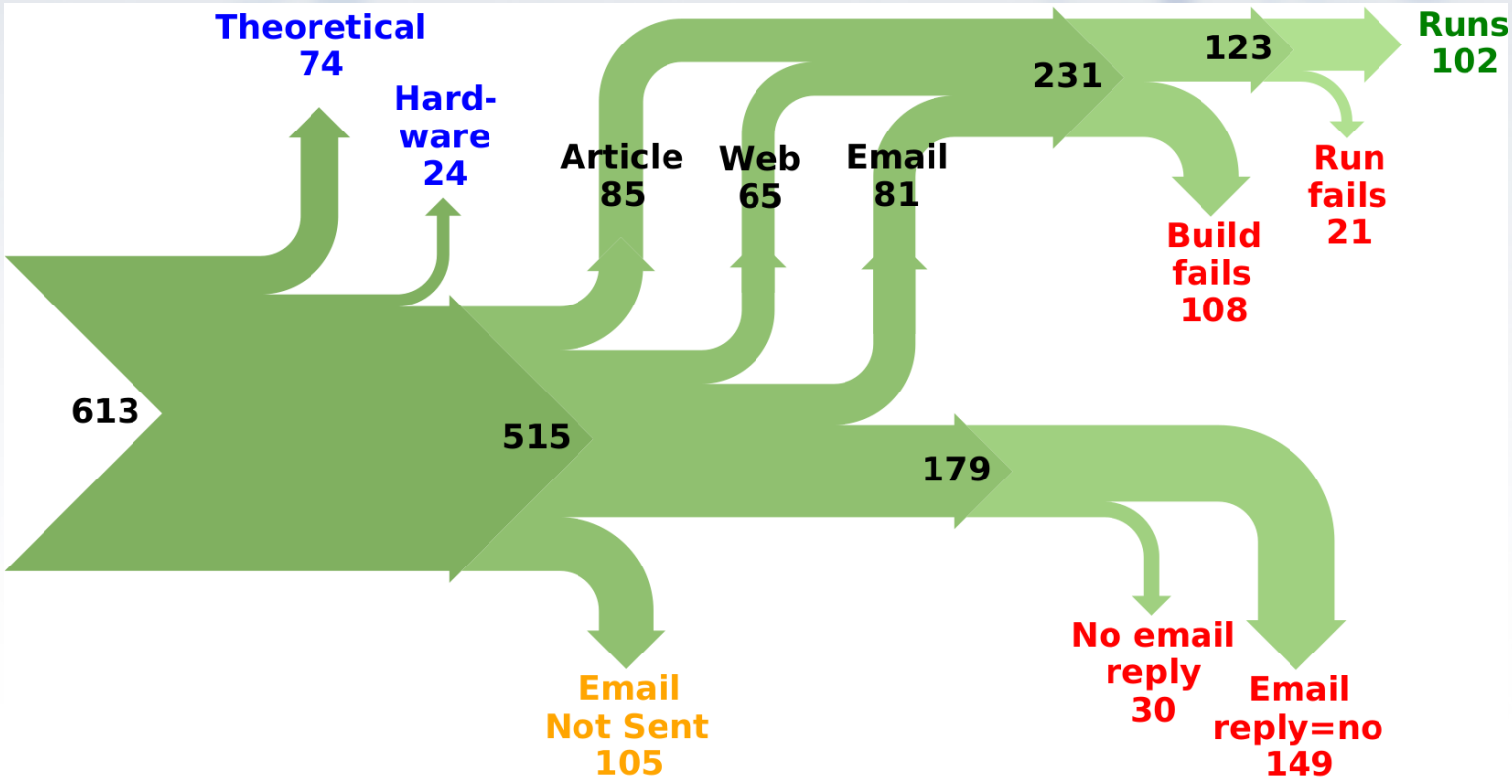
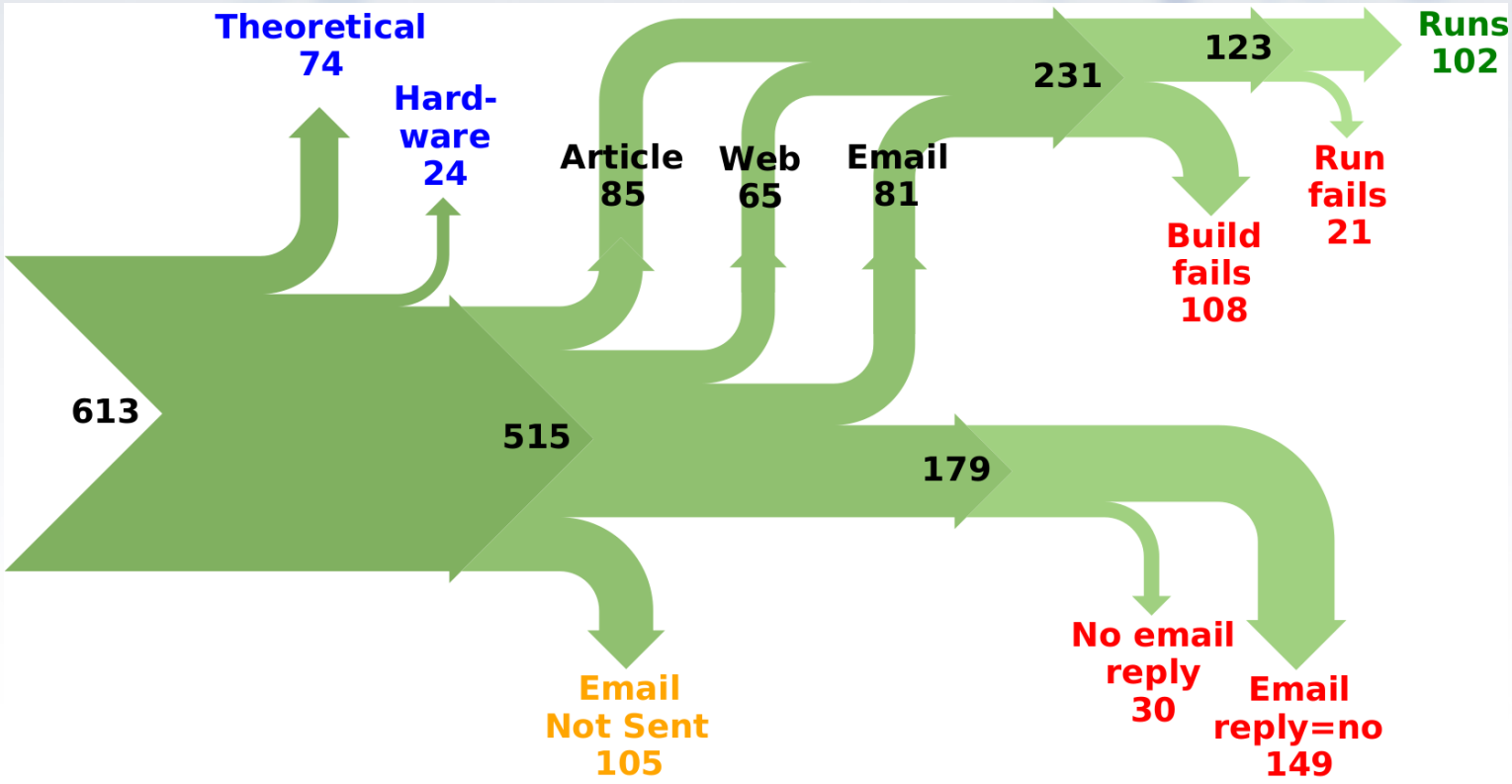


The result


Theoretical
74
Hard-
ware
24
Article
85
Web
65
Email
81
231
123
Runs
102
Run
fails
21
Build
fails
108
613
515
179
Email
Not Sent
105
No email
reply
30
Email
reply=no
149

The result



That's a whopping 81% of non reproducible works!

The reasons (or, "the dog ate my program")

Many issues, nice anectotes, and it finally boils down to

- Availability
- Traceability
- Environment
- Automation
- Documentation
- Understanding (Open Source)

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The first two are actually important *software preservation* issues:
yes, code can be destroyed, and we can loose trace of it!

Outline

Like all digital information, software is *fragile*

An example is worth a thousand words...

Inconsiderate or malicious loss of code

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Yes, for *seven years* all seemed ok.
No, they did not recover the data.

Business-driven loss of code support: Google

A Change to Google Code Download Service

Posted: Monday, May 20, 2013

+1 391 Tweet 249 Like 295

Project Hosting on Google Code provides a free collaborative development environment for open source projects. Each project comes with its own member controls, Subversion/Mercurial/Git repository, issue tracker, wiki pages, and downloads service.

Downloads were implemented by Project Hosting on Google Code to enable open source projects to make their files available for public download. Unfortunately, downloads have become a source of abuse with a significant increase in incidents recently. Due to this increasing misuse of the service and a desire to keep our community safe and secure, we are deprecating downloads.

Starting today, existing projects that do not have any downloads and all new projects will not have the ability to create downloads. Existing projects with downloads will see no visible changes until January 14, 2014 and will no longer have the ability to create new downloads starting on January 15, 2014. All existing downloads in these projects will continue to be accessible for the foreseeable future.

If your project is using downloads to host and distribute files and has a need to periodically create new downloads, we recommend you move your downloads to an alternate service like Google Drive before January 15, 2014. If you choose to move your files to Google Drive, check out our help article.

By Google Project Hosting

Business-driven loss of code support: Google, cont'd.

Posted: Thursday, March 12, 2015

When we started the Google Code project hosting service in 2006, the world of project hosting was limited. We were worried about reliability and stagnation, so we took action by giving the open source community another option to choose from. Since then, we've seen a wide variety of better project hosting services such as GitHub and Bitbucket bloom. Many projects moved away from Google Code to those other systems. To meet developers where they are, we ourselves migrated nearly a thousand of our own open source projects from Google Code to GitHub.

As developers migrated away from Google Code, a growing share of the remaining projects were spam or abuse. Lately, the administrative load has consisted almost exclusively of abuse management. After profiling non-abusive activity on Google Code, it has become clear to us that the service simply isn't needed anymore.

Beginning today, we have disabled new project creation on Google Code. We will be shutting down the service about 10 months from now on January 25th, 2016. Below, we provide links to migration tools designed to help you move your projects off of Google Code. We will also make ourselves available over the next three months to those projects that need help migrating from Google Code to other hosts.

- March 12, 2015 - New project creation disabled.
- August 24, 2015 - The site goes read-only. You can still checkout/view project source, issues, and wikis.
- January 25, 2016 - The project hosting service is closed. You will be able to download a tarball of project source, issues, and wikis. These tarballs will be available throughout the rest of 2016.

Google will continue to provide Git and Gerrit hosting for certain projects like Android and Chrome. We will also continue maintaining our mirrors of projects like Eclipse, kernel.org and others.

Disruption of the *web of reference*

Web links *are not* permanent (even *permalinks*)

there is no general guarantee that a URL which at one time points to a given object continues to do so

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URLs used in articles *decay*!

Analysis of IEEE Computer (Computer), and the Communications of the ACM (CACM): 1995-1999

- *the* **half-life** *of a referenced URL* **is approximately 4 years** *from its publication date*

D. Spinellis. The Decay and Failures of URL References. Communications of the ACM, 46(1):71-77, January 2003.

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Preservation of digital information is on the rise

A wealth of initiatives around us

generalist	the Web at `archive.org`; National Digital Information Infrastructure and Preservation Program (NDIIPP, USA); ...
culture	books, music, video: INA (FR); `http://www.nationalarchives.gov.uk` (UK) ...
social networks	Twitter is archived by the Library of Congress!
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And yet, up to now...

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It's time to change all this!

Software Preservation Challenges: it's *different*!

Unlike for books or movies, there is a big difference between *using* and *understanding* a piece of software.

Using software

Requires an executable, and access to the *execution environment*

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For reproducibility, we need *both*!

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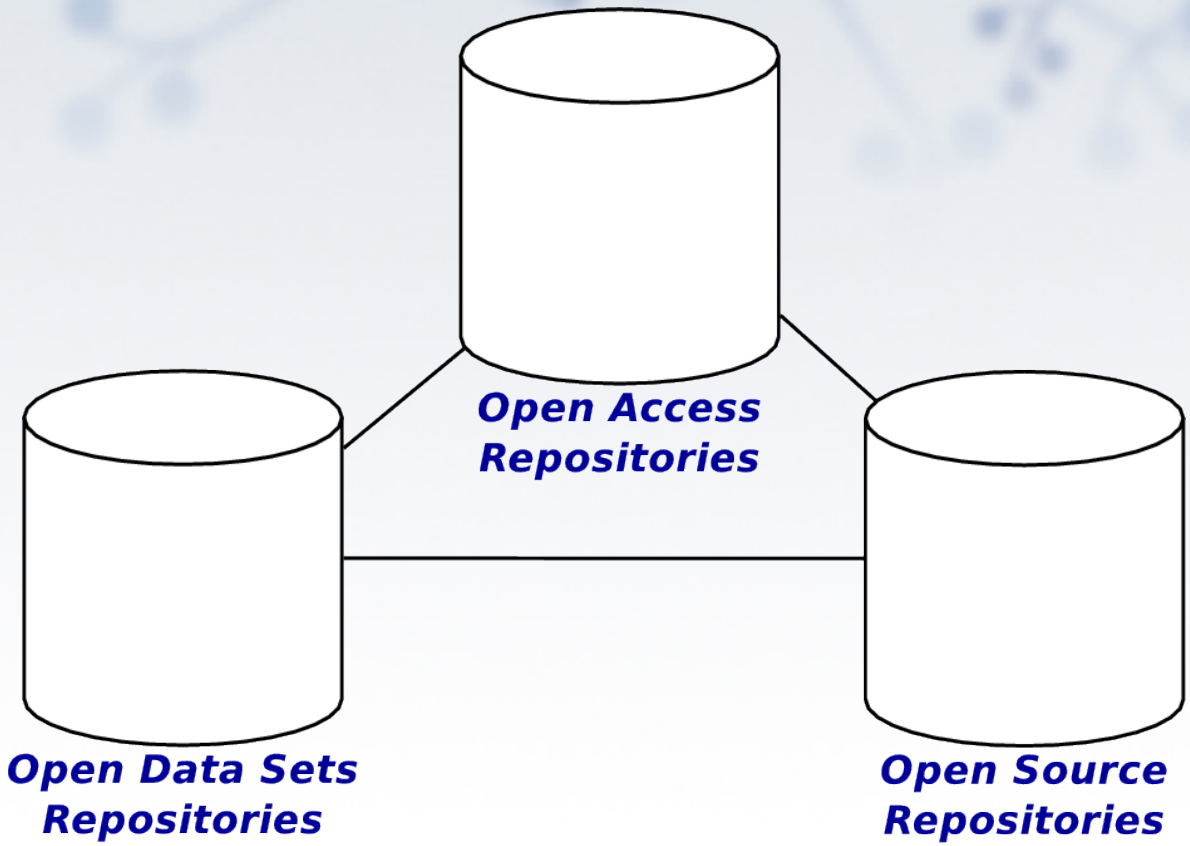
To preserve *software* it is *not enough* to mimic processes that were intended to archive books, scientific articles or data.

The Knowledge Conservancy Magic Triangle



articles	ArXiv, HAL, ...
data	Zenodo, OpenAire, ...
software	is the next to come, and is our mission

Conclusions

Preservation is the _foundation_ of all reproductibility efforts

We all must do our best to

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Questions ?