The Software Pillar of Open Science

policy, needs, and how to address them

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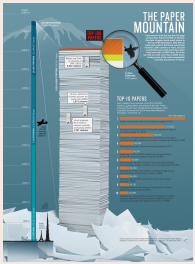
Software Heritage

THE GREAT LIBRARY OF SOURCE CODE

Outline

Software is a pillar of Open Science

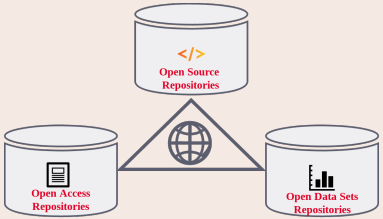
Software powers modern research



[…] software […] essential in their fields.
Top 100 papers (Nature, 2014)

Sometimes, if you dont have the software, you dont have the data
Christine Borgman, Paris, 2018

A key pillar: software (source code)



The links in the picture are important

Nota Bene

software may be a *tool*, a *research outcome* and a *research object*

access to the *source code* is essential!

Preserving (the history of) source code is necessary for *reproducibility*

Software *Source Code* is Precious Knowledge

Harold Abelson, Structure and Interpretation of Computer Programs (1st ed.) 1985

"Programs must be written for people to read, and only incidentally for machines to execute."

Apollo 11 source code (excerpt)

```
P63SPOT3        CA      BIT6            # IS THE LR ANTENNA IN POSITION 1 YET
                EXTEND
                RAND    CHAN33
                EXTEND
                BZF     P63SPOT4        # BRANCH IF ANTENNA ALREADY IN POSITION 1

                CAF     CODE500         # ASTRONAUT:    PLEASE CRANK THE
                TC      BANKCALL        #               SILLY THING AROUND
                CADR    GOPERF1
                TCF     GOTOPOOH        # TERMINATE
                TCF     P63SPOT3        # PROCEED       SEE IF HE'S LYING

P63SPOT4        TC      BANKCALL        # ENTER         INITIALIZE LANDING RADAR
                CADR    SETPOS1

                TC      POSTJUMP        # OFF TO SEE THE WIZARD ...
                CADR    BURNBABY
```

Quake III source code (excerpt)

```
float Q_rsqrt( float number )
{
    long i;
    float x2, y;
    const float threehalfs = 1.5F;

    x2 = number * 0.5F;
    y = number;
    i = * ( long * ) &y; // evil floating point bit level hacking
    i = 0x5f3759df - ( i >> 1 ); // what the fuck?
    y = * ( float * ) &i;
    y = y * ( threehalfs - ( x2 * y * y ) ); // 1st iteration
// y = y * ( threehalfs - ( x2 * y * y ) ); // 2nd iteration, this
can be removed

    return y;
}
```

Len Shustek, Computer History Museum 2006

"Source code provides a view into the mind of the designer."

Outline

The Paris Call on Software Source code (2019, UNESCO)

UNESCO, Inria, Software Heritage invite
40 international experts to meet in Paris

The call is published on Feb 2019

"[We call to] promote software development as a valuable research activity, and research software as a key enabler for Open Science/Open Research, sharing good practices and recognising in the careers of academics their contributions to high quality software development, in all their forms"
https://en.unesco.org/foss/paris-call-software-source-code

Second French National plan for Open Science (2021, MESRI)

2nd National Plan for Open Science (6/7/2021)

Open and promote research software source code

- actions (selection)
  - charter for research software policy
  - recognize software development (see announcement of the 2021 prize)
  - coordinate communities of practice
  - connected ecosystem of research outputs
- recommendations (selection)
  - archive in Software Heritage
  - standardise and use SWHID
  - build a national catalog of research software
  - leverage ADAC network

See official announcement

Research Software is getting recognized

MINISTÈRE
DE L'ENSEIGNEMENT
SUPÉRIEUR
ET DE LA RECHERCHE
Liberté
Égalité
Fraternité

Accueil > Recherche > Science ouverte

Publié le 05.02.2022

Sommaire

- The Coq proof assistant : lauréat de la catégorie Scientifique et technique
- Scikit-learn : lauréat de la catégorie Communauté
- Faust : lauréat de la catégorie Documentation
- Gammapy : prix du jury
- Jury

Remise des prix science ouverte du logiciel libre de la recherche

Le ministère de l'Enseignement supérieur, de la Recherche et de l'Innovation remet pour la première année les Prix science ouverte du logiciel libre de la recherche. Dix logiciels mis au point par des équipes françaises sont récompensés pour leur contribution à l'avancée de la connaissance scientifique.

A plurality of needs that we must address

Researchers

- archive and reference software used in articles
- find useful software
- get credit for developed software
- verify, reproduce, improve results

Laboratories/teams

- track software contributions
- produce reports
- maintain web page

Research Organization

know its software assets

- technology transfer
- impact metrics
- funding strategy
- career evaluation

Archive, Reference, Describe, Cite and Credit

Archive

Research software artifacts must be properly archived

make sure we can *retrieve* them (*reproducibility*)

Reference

Research software artifacts must be properly referenced

make sure we can *identify* them (*reproducibility*)

Describe

Research software artifacts must be properly described

make it easy to *discover* and *reuse* them (*visibility*)

Cite/Credit

Research software artifacts must be properly cited *(not the same as referenced!)*

to give *credit* to authors (*evaluation*!)

Outline

A word of warning: forges are *not* archives!

2015: the first big bad news

Google Code and Gitorious.org shutdown: ~1M endangered repositories

- broken links in the web of knowledge (my papers too)

2019: big bad news keep coming in

- summer 2019: BitBucket announces Mercurial VCS sunset
- july 2020: BitBucket erases *250.000+* repositories (including research software)

2021: … in Academia too

- october 2021: Inria's old gforge is unplugged
  - breaks the build chain of the OCaml package manager (Opam)

Bottomline

we need a universal archive of software source code: now we have one!

Software Heritage

THE GREAT LIBRARY OF SOURCE CODE

Collect, preserve and share *all* software source code

Preserving our heritage, enabling better software and better science for all

Reference catalog

find and reference all software source code

Universal archive

preserve all software source code

Research infrastructure

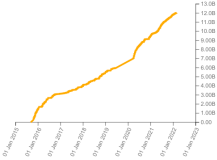
enable analysis of all software source code

The largest software archive, a shared infrastructure

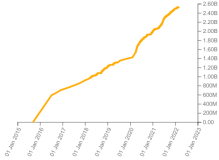
Cultural Heritage | Industry | Research | Public Administration

Software Heritage

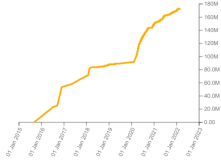
Source files
12,032,627,304



Commits
2,536,918,821



Projects
173,242,749



Directories
9,946,192,395

Authors
47,334,620

Releases
31,763,605

Sharing the vision

United Nations Educational, Scientific and Cultural Organization

And many more ...

www.softwareheritage.org/support/testimonials

Donors, members, sponsors

Diamond sponsor

Platinum sponsors

Gold sponsors

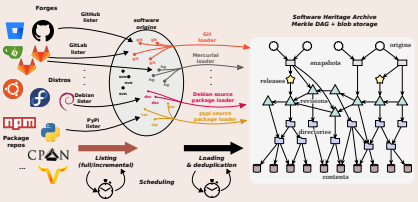
Silver sponsors

Bronze sponsors

Addressing the four needs…

(see ICMS 2020 for details)

Archive (12B+ files, 170M+ projects)



- save.softwareheritage.org
- deposit.softwareheritage.org

Reference (20 billion SWHIDs)

Intrinsic, decentralised, cryptographically strong identifiers, SWHIDs

Now supported in SPDX 2.2, Wikidata etc.

Describe

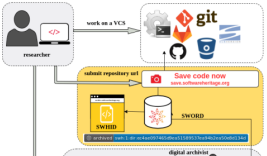
- *Intrinsic metadata* from source code
- Contributed the Codemeta generator

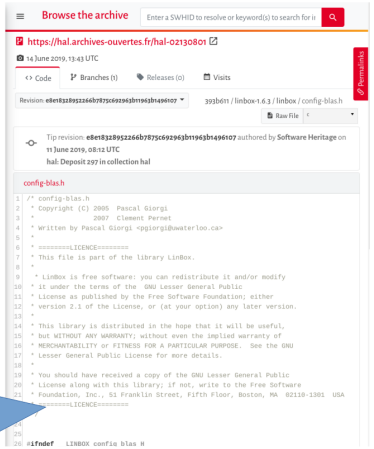
Cite/Credit

- Contributed *software citation* style biblatex-software, v 1.2-2 now on CTAN

HAL and Software Heritage: building a curated software catalog

https://hal.archives-ouvertes.fr/hal-02130801





swh:1:dir:393b611a1424f032e83569bf6762502371cfcf65

Outline

An example is worth a thousand words

- Browse the archive (your work may be already there !)
- Trigger archival of your preferred software in a breeze
- Get and use SWHIDs (full specification available online)
- Cite software using the biblatex-software package from CTAN
- Example in a journal: an article from IPOL
- Example with Parmap: devel on Github, archive in SWH, curated deposit in HAL
- Extracting all the software products for Inria, for CNRS, for LIRMM or for Rémi Gribonval using HalTools
- Curated deposit in SWH via HAL, see for example: LinBox, SLALOM, Givaro, NS2DDV, SumGra, Coq proof, ...
- Example use in a research article: compare Fig. 1 and conclusions
  - in the 2012 version
  - in the updated version using SWHIDs and Software Heritage
- Example use in a research article: extensive use of SWHIDs in a replication experiment

Outline

Best practices for ARDC actionable today …

Archiving and referencing

For all source code used in research (*yes, even small scripts!*)

- ensure it is archived in Software Heritage (see save code now)
- get the proper SWHID for your software (see detailed HOWTO)
- add it to research articles for reproducibility (see detailed HOWTO)

Describing and Citing/Crediting

For software you want to put forward (*mention in your CV, reports, etc., get citations and credit for it*), do the following extra steps:

- add codemeta.json with description (see the codemeta generator)
- reference in the HAL portal (french partners, see online HAL documentation)
- cite software using the biblatex-software package (in CTAN and TeXLive)

Bottomline

HAl+SWH let you address all the needs at once…

- *researcher, engineer*: archival, reference, credit, CV etc. *with a little effort from them*
- *labs, organizations*: track and report software production in a simple way
- *technology transfer offices*: view the software production
- *national level*: a *curated* catalog of the software production

… with a little effort from your side

- Update the Open Science policy to include software
- Train on the use of SWH and HAL for software
- Join the network of HAL moderators for software

it's a long road, but together we can make it

Questions?