Archiving and Referencing all the source code

working together to make software count

Roberto Di Cosmo
Director, Software Heritage

Open Access Week

November 5th, 2020

Software Heritage
THE GREAT LIBRARY OF SOURCE CODE

Outline

1. Software Source Code is knowledge
2. Software Heritage
3. Demo time!
4. The way forward
5. Conclusion

Software source code: *human readable* and *executable 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.”

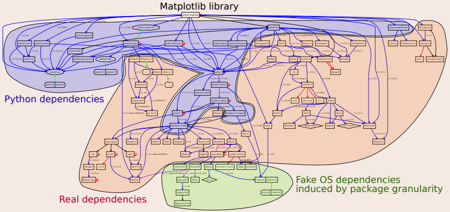
Source code is *special* (software is *not* data)

Software *evolves* over time

- projects may last decades
- the *development history* is key to its *understanding*

Complexity

- *millions* of lines of code
- large *web of dependencies*
  - easy to break, difficult to maintain
  - *research software* a thin top layer
- sophisticated *developer communities*



Precious, endangered *executable* and *human readable* knowledge

key people passing away, platforms (GoogleCode, Gitorious, etc.) closing down ...

no organised effort to catalog and archive it

Source code is *special*, cont'd

Versioning, granularity

Project “Inria created OCaml and Scikit-learn”

Release “2D Voronoi Diagrams were introduced in CGAL 3.1.0”

Precise state of a project “This result was produced using commit 0064fbd. . . ”

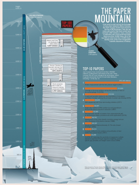
Code fragment “The core algorithm is in lines 101 to 143 of the file parmap.ml contained in the precise state of the project corresponding to commit 0064fbd. . . ”

Authors can have multiple roles:

- Architecture, Management, Development, Documentation, Testing, . . .

Software Source code: a pillar of Open Science

Software is everywhere in modern research



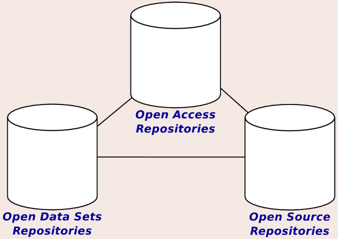
[…] software […] essential in their fields.

Top 100 papers (Nature, 2014)

Sometimes, if you dont have the software, you dont have the data

Christine Borgman, Paris, 2018

Open Science: three pillars



Open Access Repositories

Open Data Sets Repositories

Open Source Repositories

Nota bene

The links in the picture are essential

A plurality of needs

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 for: technology transfer, impact metrics, strategy

What is at stake: ARDC — in increasing order of difficulty

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*!)

Need infrastructures *designed* for software: now we have one!

Outline

1. Software Source Code is knowledge
2. Software Heritage
3. Demo time!
4. The way forward
5. Conclusion

Software Heritage, in a nutshell

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

Sourceforge
Debian
CPAN
Gitorious
Maven
Inria
Bitbucket
GitHub
BerliOs
CTAN
GitLab
CRAN
GoogleCode
Adullact

find and reference all software source code

Universal archive

damage
disaster
malicious
obsolete
attack
dependencies
aging
media
tear
reference
storage
deletion
dangling
wear
corruption
encryption
format

preserve all software source code

Research infrastructure

enable analysis of all software source code

An international, non profit initiative built for the long term

Sharing the vision

UNESCO

United Nations
Educational, Scientific and
Cultural Organization

Software
GitLab
ENGINEERING
eclipse
OW2
fsfe
nlnet FOUNDATION
SIGSOFT
Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
INAPI
THE LINUX FOUNDATION
ADULLACT
INFORMATICS EUROPE
Computer History Museum
software freedom conservancy
Software Freedom Law Center
AdaCore The GNAT Pro Company
gandi.net
TDF
FREE SOFTWARE FOUNDATION
creative commons
SIF Société Informatique de France
open source initiative
openinventionnetwork

And many more ...
www.softwareheritage.org/support/testimonials

Donors, members, sponsors

Inria
INVENTEURS DU MONDE NUMÉRIQUE

Platinum sponsors

Microsoft
intel
SOCIETE GENERALE
MINISTÈRE DE L'ENSEIGNEMENT SUPÉRIEUR, DE LA RECHERCHE ET DE L'INNOVATION
HUAWEI

Gold sponsors

openinventionnetwork
Université de Paris
SORBONNE UNIVERSITÉ

Silver sponsors

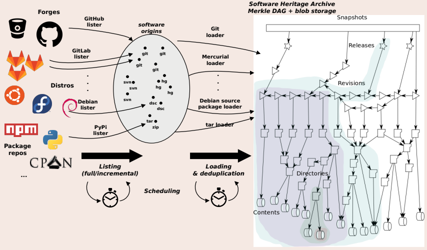
CAST Software Intelligence for Digital Leaders
Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
GitHub
Google
UNIVERSITÀ DI PISA
vmware

Bronze sponsors

DANS Data Archiving and Networked Services
FOSSID

Addressing the four ARDC needs (see ICMS 2020 for details)

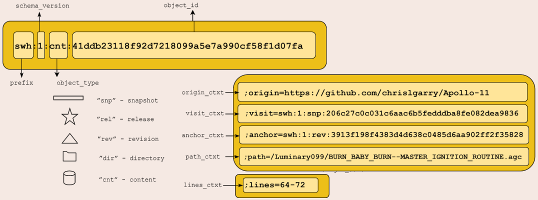
Archive (8B+ files, 140M+ projects)



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

Reference (20 billion SWHIDs)

Intrinsic, decentralised, cryptographically strong identifiers, SWHIDs


```
swh:1:cnt:41ddb23118f92d7218099a5e7a990cf58f1d07fa
;origin=https://github.com/chrislgarry/Apollo-11
;visit=swh:1:snp:206c27c0c031c6aac6b5fedddba8fe082dea9836
;anchor=swh:1:rev:3913f198f4383d4d638c0485d6aa902ff2f35828
;path=/Luminary099/BURN_BABY_BURN--MASTER_IGNITION_ROUTINE.agc
;lines=64-72
```

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

Outline

1. Software Source Code is knowledge
2. Software Heritage
3. Demo time!
4. The way forward
5. Conclusion

A walkthrough

Archive

- Trigger archival of your preferred software in a breeze
- curated deposit in SWH via HAL, see for example: LinBox, SLALOM, Givaro, NS2DDV, SumGra, Coq proof, …
- rescue landmark legacy software, see the SWHAP process with UNESCO

Reference

- Browse the archive
- Get and use SWHIDs (full specification available online)
- cite software using the biblatex-software style

Cite/Credit

- Example use in a research article: compare Fig. 1 and conclusions
  - in the 2012 version
  - in the updated version using SWHIDs and Software Heritage

Outline

1. Software Source Code is knowledge
2. Software Heritage
3. Demo time!
4. The way forward
5. Conclusion

Adoption is coming

HAL software curated deposit workflow

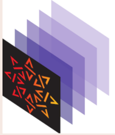
Curated Archiving of Research Software Artifacts
International Journal of Digical Curation, 2020

Reference archive for swmath.org

swMATH
an information service for mathematical software

See *code* links, e.g. SemiPar package

Image Processing On Line (IPOL)



- archives
- reference
- cite: see BibLaTeX example

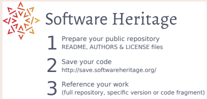
JTCAM (Theor. Comp. and Appl. Mech)

- instructions for authors recommend archival in Software Heritage
- biblatex-software in journal LaTeX class

Policy

now officially in the *French National Plan for Open Science*

Self archival guidelines



Software Heritage

1 Prepare your public repository
README, AUTHORS & LICENSE files

2 Save your code
http://save.softwareheritage.org/

3 Reference your work
(full repository, specific version or code fragment)

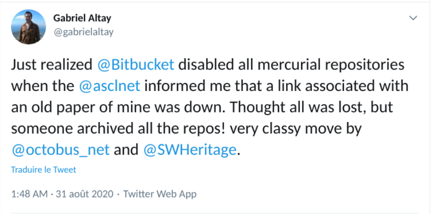
- online summary
- full ICMS 2020 paper

Breaking news: saving 250.000 endangered repositories

Bitbucket phase out of Mercurial VCS

- summer 2019: official announcement
- fall 2019: Software Heritage teams up with Octobus (funded by NLNet, thanks!)
- july 2020: *250.000* repositories unplugged
- august 2020: bitbucket-archive.softwareheritage.org is live

… preserving the web of knowledge (Tweet is here)



Gabriel Altay
@gabrielaltay

Just realized @Bitbucket disabled all mercurial repositories when the @asclnet informed me that a link associated with an old paper of mine was down. Thought all was lost, but someone archived all the repos! very classy move by @octobus_net and @SWHeritage.

Traduire le Tweet

1:48 AM · 31 août 2020 · Twitter Web App

Bottomline

explicit deposit is important, …

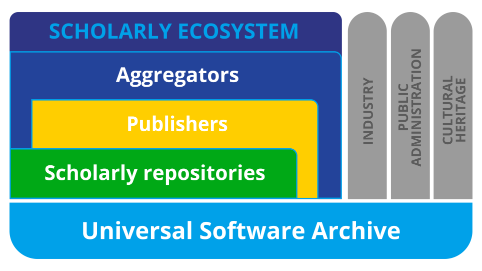
… and we must promote it…

… but will never be enough.

(think also of all software dependencies!)

Breaking news: a roadmap for software in the EOSC

Infrastructures in the architecture



universal software archive *Software Heritage* connects with the global software ecosystem

scholarly repositories *HAL, Zenodo, . . .*

publishers *Dagstuhl, eLife, IPOL, . . .*

aggregators *OpenAire, ScanR, swMath, . . .*

Towards interconnection and interoperability

metadata standard proposal to adopt *CodeMeta*

intrinsic identifiers proposal to adopt *SWHID*

extrinsic identifiers take into account what exists

EOSC SIRS TF report: community review until 10/11/2020

Outline

1. Software Source Code is knowledge
2. Software Heritage
3. Demo time!
4. The way forward
5. Conclusion

The way forward

Software Heritage

- *universal* archive of source code
- *intrinsic* identifiers (SWHIDS)
- *non profit*, long term, multistakeholder
- *infrastructure* for Open Science

Your help is needed!

adopt	*use* SWH in your work
save	relevant source code
contribute	SWH is open source
advocate	spread the word

Roberto Di Cosmo
Archiving and Referencing Source Code with Software Heritage
International Congress on Mathematical Software (ICMS), 2020

Jean-François Abramatic, Roberto Di Cosmo, Stefano Zacchiroli
Building the Universal Archive of Source Code, CACM, October 2018 (10.1145/3183558)

Pierre Alliez, Roberto Di Cosmo, Benjamin Guedj, Alain Girault, Mohand-Said Hacid, Arnaud Legrand and Nicolas Rougier
Attributing and referencing (research) software: Best practices and outlook from Inria,
CiSE 2020 (10.1109/MCSE.2019.2949413) (hal-02135891)