Preserving source code in Software Heritage

a foundation for reproducibility

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RRPR 2020

Software Heritage

THE GREAT LIBRARY OF SOURCE CODE

Outline

Short Bio: Roberto Di Cosmo

Computer Science professor in Paris, now working at INRIA

- *30 years* of research (Theor. CS, Programming, Software Engineering, Erdos #: 3)
- *20 years* of Free and Open Source Software
- *10 years* building and directing structures for the common good

1999 *DemoLinux* – first live GNU/Linux distro

2007 *Free Software Thematic Group*
150 members 40 projects 200Me

2008 *Mancoosi project* www.mancoosi.org

2010 *IRILL* www.irill.org

2015 *Software Heritage* at INRIA

2018 *National Committee for Open Science*, France

Outline

Software source code: *human readable* and *executable knowledge*

Harold Abelson, Structure and Interpretation of Computer Programs (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)

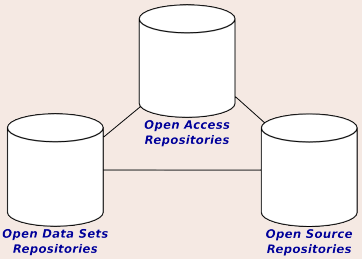
```
float Q_rsqrt( float number )
{
    long i;
    float x2, y;
    const float threehalfs = 1.5F;

    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."

Software Source code: pillar of Open Science

Three pillars of Open Science



A plurality of needs

Researcher

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

Laboratory/team track software contributions

- produce reports / web page

Research Organization know its software assets

- technology transfer
- impact metrics

What is at stake — 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*!)

We need an infrastructure *designed for* software source code — *now we have it!*

Outline

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

find and reference all software source code

Universal archive

preserve all software source code

Research infrastructure

enable analysis of all software source code

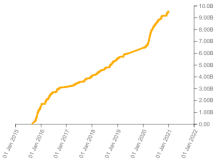
The largest software archive, a shared infrastructure

Cultural Heritage | **Industry** | **Research** | **Education**

Software Heritage

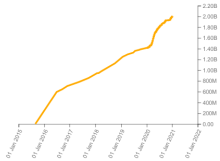
Source files

9,537,638,393



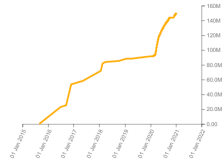
Commits

2,005,941,580



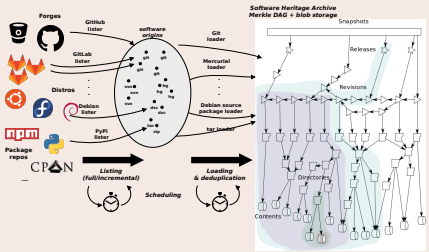
Projects

150,108,503



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

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

A walkthrough

- Browse the archive
- Trigger archival of your preferred software in a breeze
- Get and use SWHIDs (full specification available online)
- Cite software with the biblatex-software style from CTAN
- 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
- 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

Outline

Sharing the vision

United Nations Educational, Scientific and Cultural Organization

And many more ...

www.softwareheritage.org/support/testimonials

Donors, members, sponsors

Inria — INVENTEURS DU MONDE NUMÉRIQUE

Platinum sponsors

Gold sponsors

Silver sponsors

Bronze sponsors

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

IPOL (image processing)

- archive (deposit)
- reference
- BibLaTeX

eLife (life sciences)

- archive (save code now)
- reference

JTCAM (Mechanics)

- instructions for authors
- biblatex-software in journal LaTeX class

Policy: France

National Plan Open Science

Policy: Europe

EOSC SIRS report

- SWHIDs
- archive

Guidelines

- summary
- ICMS 2020

Breaking news, and a lesson to be learned

Saving 250.000 endangered repositories…

- summer 2019: BitBucket announce Mercurial VCS phase out
- fall 2019: Software Heritage teams up with Octobus (funded by NLNet, thanks!)
- july 2020: BitBucket erases *250.000* repositories
- august 2020: bitbucket-archive.softwareheritage.org is live

… preserving the web of knowledge (Tweet is here)

Bottomline

explicit deposit is important, …

… and we must promote it…

… but will never be enough.

(think also of all software dependencies!)

Conclusion

Software Heritage

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

You can help improve science!

- *adopt* SWH: conferences, journals, AEC
- *save* relevant source code
- *contribute* to SWH: *it is open source*
- help build the SWH *community*

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)

P. Alliez, R. Di Cosmo, B. Guedj, A. Girault, M.-S. Hacid, A. Legrand and N. Rougier
Attributing and referencing (research) software: Best practices and outlook from Inria,
CiSE 2020 (10.1109/MCSE.2019.2949413) (hal-02135891)

Roberto Di Cosmo, Marco Danelutto
[Rp] Reproducing and replicating the OCamlP3l experiment. ReScience C, 6(1), 2.