Software Heritage: why and how we preserve our Software Commons

Roberto Di Cosmo
Director, Software Heritage
Inria and Université de Paris

29/10/2020, *49 JAIIO*

Software Heritage
THE GREAT LIBRARY OF SOURCE CODE

Outline

1. Introduction
2. Meet Software Heritage
3. The archive in action
4. Preserving knowledge all around
5. Conclusion

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

2015 *Software Heritage* at INRIA

2018 *National Committee for Open Science*, France

Software source code: a precious part of our heritage

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

“Source code provides a view into the mind of the designer.”

Software Commons, Open Science

Yuval Noah Harari (on COVID 19)

"The real antidote [to epidemic] is scientific knowledge *and* global cooperation."

Definition (Software Commons)

The software commons consists of all computer software which is available at little or no cost and which can be altered and reused with few restrictions. Thus *all open source software and all free software are part of the [software] commons.* [...]

https://en.wikipedia.org/wiki/Software_Commons

Source code: part of our commons ... pillar of Open Science! *(would require another talk)*

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

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

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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

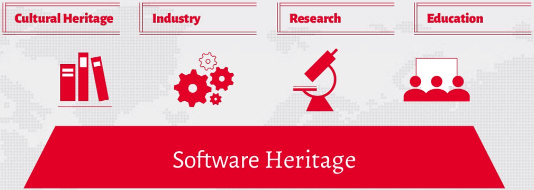
Universal archive

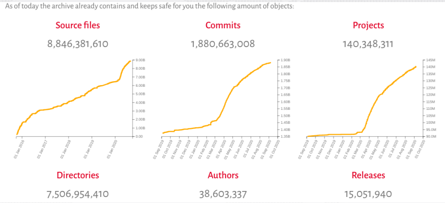
preserve all software source code

Research infrastructure

enable analysis of all software source code

Largest software archive, principled http://bit.ly/swhpaper




As of today the archive already contains and keeps safe for you the following amount of objects:

Source files

8,846,381,610

Commits

1,880,663,008

Projects

140,348,311

Directories

7,506,954,410

Authors

38,603,337

Releases

15,051,940

Technology

- transparency and FOSS
- replicas all the way down

Content (billions!)

- intrinsic identifiers
- facts and provenance

Organization

- non-profit
- multi-stakeholder

An international, non profit initiative…

Sharing the vision

UNESCO
United Nations
Educational, Scientific and
Cultural Organization

IEEE Software
GitLab
ENGINEERING
eclipse
OW2
fsfe
nlnet FOUNDATION
SIGSOFT SPECIAL INTEREST GROUP ON SOFTWARE ENGINEERING
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

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INVENTEURS DU MONDE NUMÉRIQUE

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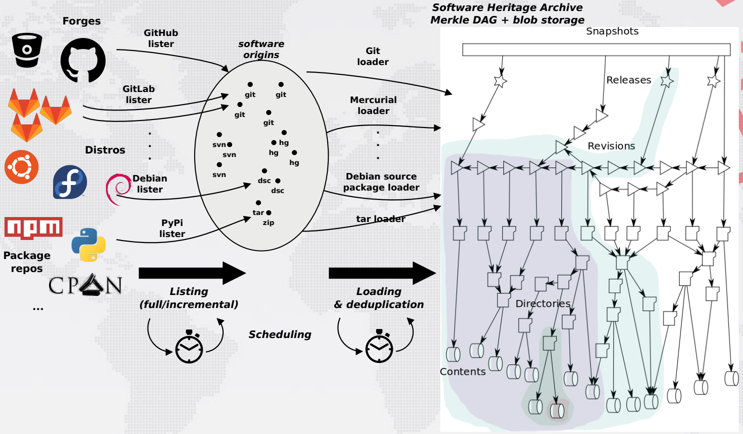
DANS Data Archiving and Networked Services
FOSSID
ALMA MATER STUDIORUM A.D. 1088

A peek under the hood

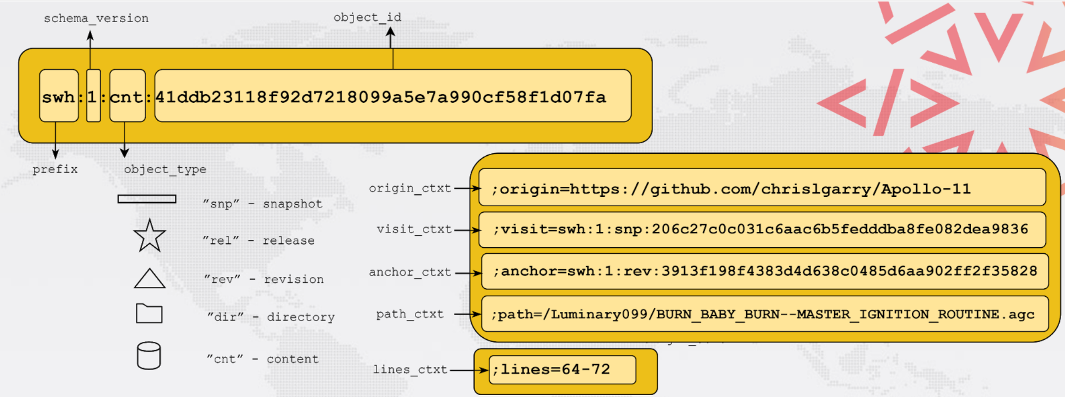


Global development history permanently archived in a *unique* git-like Merkle DAG

- ~400 TB (uncompressed) blobs, ~20 B nodes, ~280 B edges

Software Heritage Identifiers (SWHID)

link to full docs



schema_version

object_id

swh:1:cnt:41ddb23118f92d7218099a5e7a990cf58f1d07fa

prefix

object_type

"snp" - snapshot

"rel" - release

"rev" - revision

"dir" - directory

"cnt" - content

origin_ctxt → ;origin=https://github.com/chrislgarry/Apollo-11

visit_ctxt → ;visit=swh:1:snp:206c27c0c031c6aac6b5fedddba8fe082dea9836

anchor_ctxt → ;anchor=swh:1:rev:3913f198f4383d4d638c0485d6aa902ff2f35828

path_ctxt → ;path=/Luminary099/BURN_BABY_BURN--MASTER_IGNITION_ROUTINE.agc

lines_ctxt → ;lines=64-72

An emerging standard

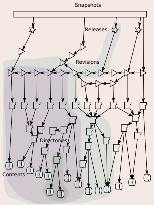
- in Linux Foundation's SPDX 2.2
- IANA-registered "swh:" URI prefix
- WikiData property P6138

Examples

- Apollo 11 AGC excerpt
- Quake III rsqrt

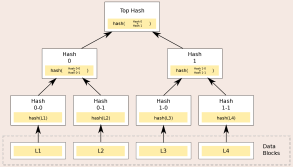
A revolutionary infrastructure for software source code

The *graph* of Software Development



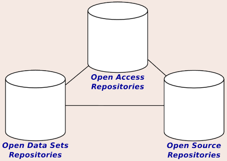
All software development with its history, in a single graph …

The *blockchain* of Software Development



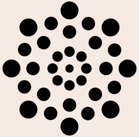
… a single Merkle graph, with *intrinsic ids* for traceability

A *pillar* of Open Science



Reference archive of Research Software

Reference platform for *Big Code*



One uniform data structure enables *massive* machine learning for quality, cybersecurity, etc.

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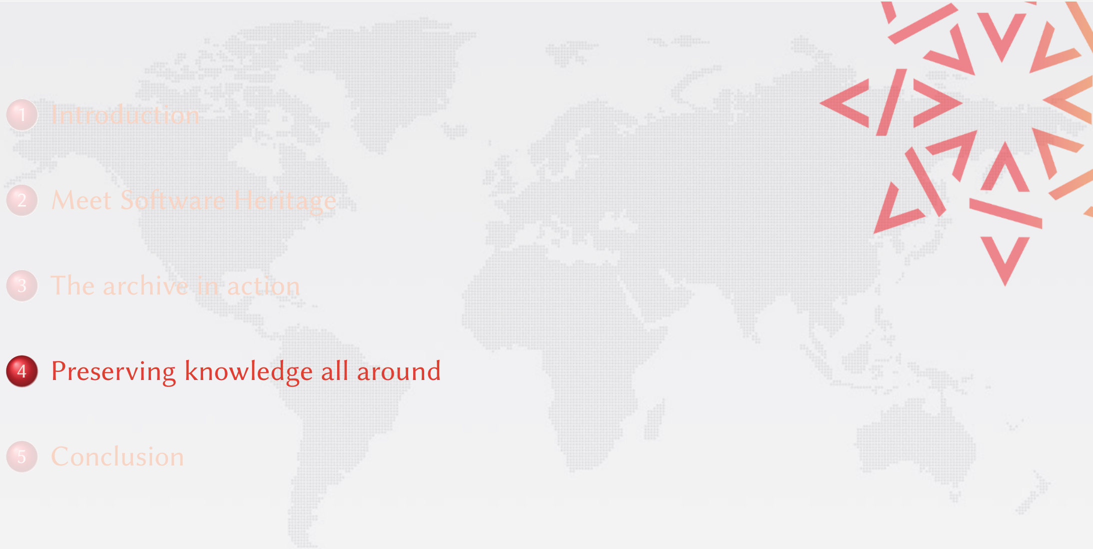
An example is worth a thousand words

- Browse the archive
- Trigger archival of your preferred software in a breeze
- Get and use SWHIDs (full specification available online)
- curated deposit in SWH via HAL, see for example: LinBox, SLALOM, Givaro, NS2DDV, SumGra, Coq proof, . . .
- 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

Outline



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Paris Call on Software Source Code

Experts call for greater recognition of software source code as heritage for sustainable development

.6 November 2018

At UNESCO, Inria, and Software Heritage invitation,

40 international experts meet in Paris ...

United Nations Educational, Scientific and Cultural Organization

Memory of the World

Inria inventors for the digital world

PARIS CALL

SOFTWARE SOURCE CODE

AS HERITAGE FOR SUSTAINABLE DEVELOPMENT

Software Heritage

Their call is published on Feb 2019

it's open for signatures!

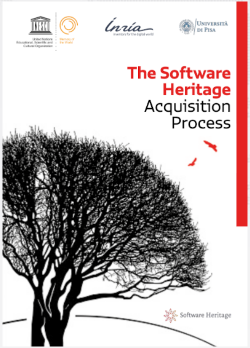
Rescuing landmark legacy software…

SWHAP

Paris Call on Software Source Code

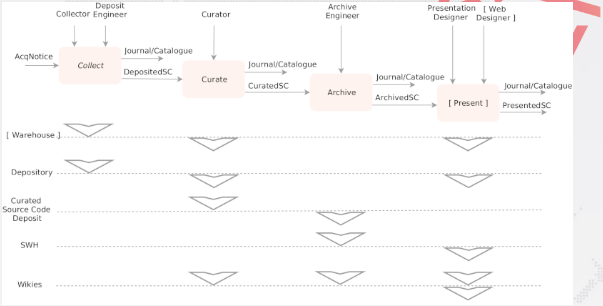
“[We call to] support efforts to gather and preserve the artifacts and narratives of the history of computing, while the earlier creators are still alive”

Rescue Legacy Software, Curate the code, Archive it



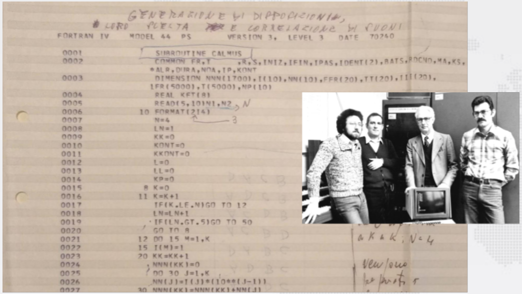
The Software Heritage Acquisition Process

Software Heritage



UNESCO, UniPi and Software Heritage collaboration worldwide scope

An example: TAUmus, from Pisa (70's)



GENERAZIONE DI DISPOSIZIONI, LORO SCELTA E CORRELAZIONE DI SUONI

```
FORTRAN IV    MODEL 44  PS        VERSION 3,  LEVEL 3   DATE  70240

       SUBROUTINE CALMUS
       COMMON FR,T      ,R,S,INIZ,IFIN,IPAS,IDENT(2),BATS,RDCND,MA,KS,
      *ALR,DURA,NOA,IP,KONT
       DIMENSION NNN(1700),I(10),NN(10),FFR(20),TT(20),III(20),
      1FR(5000),T(5000),NP(10)
       REAL KFT(8)
       READ(5,10)N1,N2
    10 FORMAT(2I4)
       N=4
       LN=1
       KK=0
       KONT=0
       KKONT=0
       L=0
       LL=0
       KP=0
     8 K=0
    11 K=K+1
       IF(K.LE.N)GO TO 12
       LN=LN+1
       IF(LN.GT.5)GO TO 50
       GO TO 8
    12 DO 15 M=1,K
    15 I(M)=1
    20 KK=KK+1
       NNN(KK)=0
       DO 30 J=1,K
       NN(J)=I(J)*(10**(J-1))
    30 NNN(KK)=NNN(KK)+NN(J)
```

N

3

a K a K ; V=4

- The control code for the music synthesizer TAU2
- FORTRAN II and TAUmus command language
- Istituto di Elaborazione dell'Informazione CNR
- Group led by the late M° P. Grossi
  - Le Sacre du Printemps (ABSTRACT)

… and massive amounts of present source code!

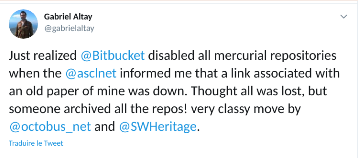
Paris Call on Software Source Code

"[We call to] support a universal archive, as part of a broad effort at digital preservation, that will ensure persistence of and universal access to software source code"

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)



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

Bottomline

explicit deposit is important, …

… and we must promote it…

… but will never be enough.

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Come in, we're open!

Software Heritage

www.softwareheritage.org @swheritage

Everybody is concerned, everybody can help build

The Library of Alexandria of code

- recover the past
- structure the future

A CERN for Software

- build better software
  - for industry
  - for society as a whole

Appendix

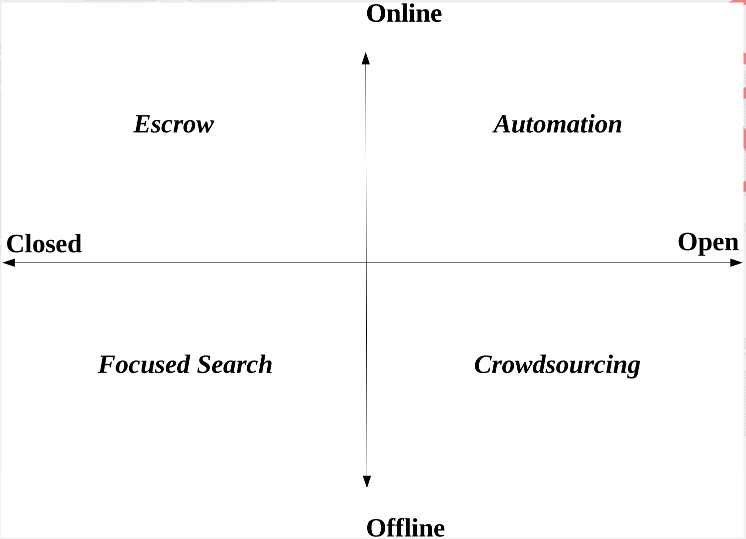
Outline

6 Strategies

7 SWHIDs by the example

8 News

All the source code: strategy



Online

Escrow

Automation

Closed

Open

Focused Search

Crowdsourcing

Offline

Outline

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7 SWHIDs by the example

8 News

A word on the trust model for systems of identifiers

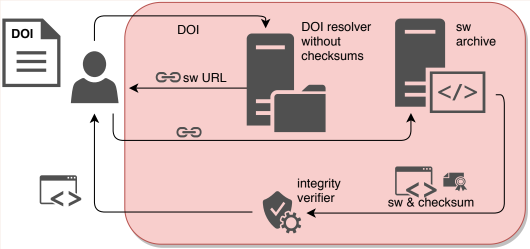
Two general classes of systems of identifiers

intrinsic *computed* from the object *(no registry required, fully decentralised)*
(e.g.: chemical notation, music notation, hashes, SWHIDs)

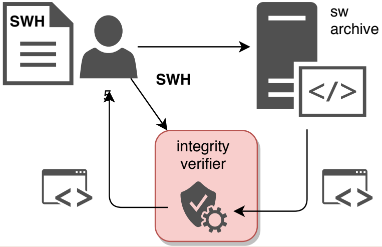
extrinsic *assigned* by an authority *(need a registry)*
(e.g.: passport number, DOI, ARK, RRID, etc.)

See the dedicated blog post for more details

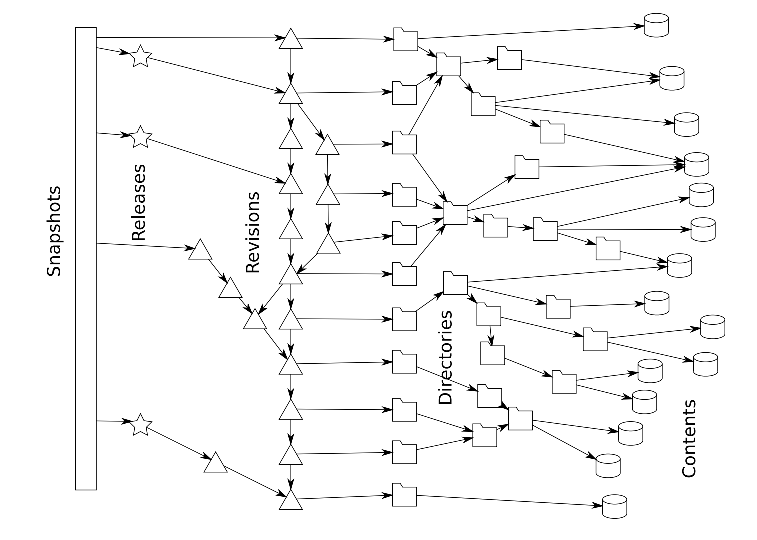
Trust model, extrinsic (e.g. DOIs)



Trust model, intrinsic (e.g. SWHIDs)

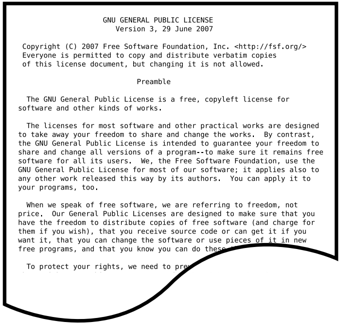


A worked example



A worked example

Contents



```
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                            Version 3, 29 June 2007

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```
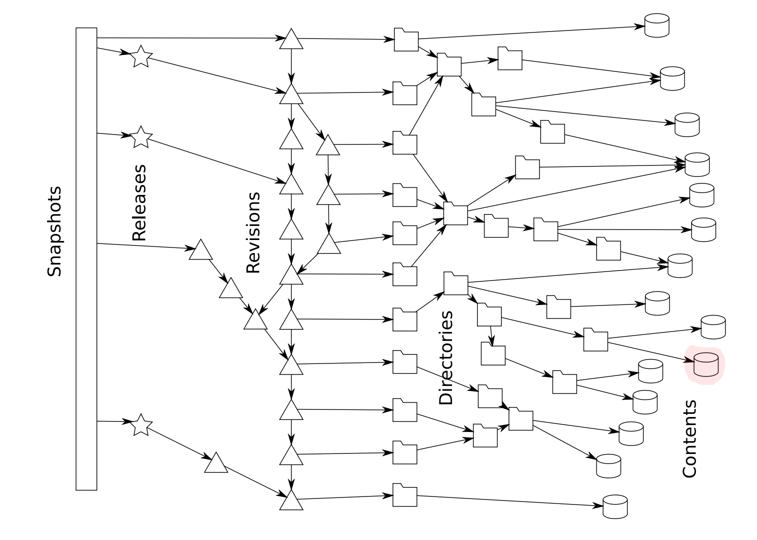
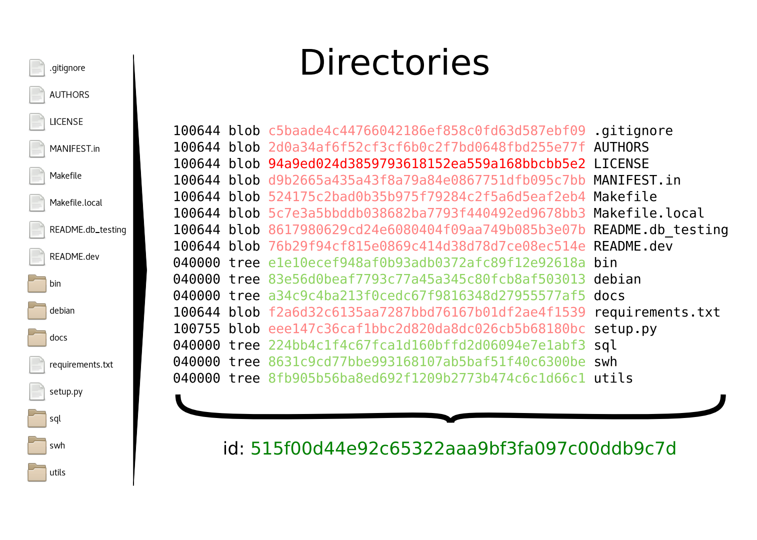

sha1: 8624bcdae55baeef...
sha256: 8ceb4b9ee5aded...
sha1_git: 94a9ed024d385...
length: 35147

A worked example



A worked example

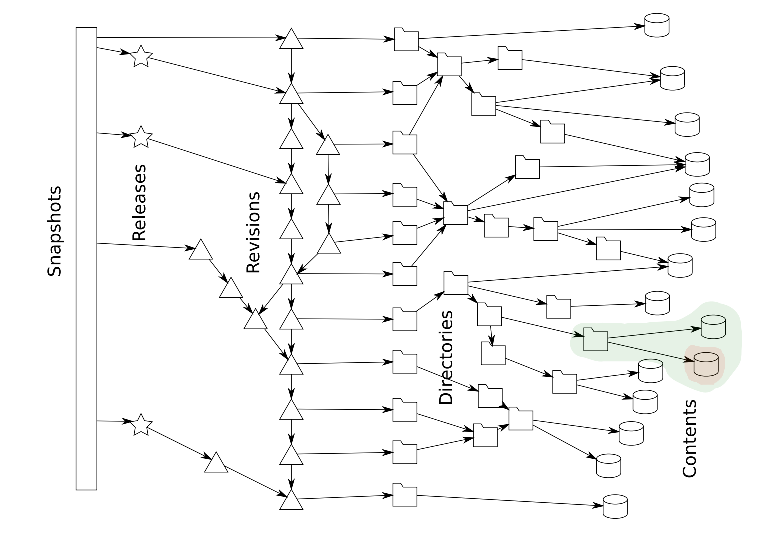


Directories

```
100644 blob c5baade4c44766042186ef858c0fd63d587ebf09 .gitignore
100644 blob 2d0a34af6f52cf3cf6b0c2f7bd0648fbd255e77f AUTHORS
100644 blob 94a9ed024d3859793618152ea559a168bbcbb5e2 LICENSE
100644 blob d9b2665a435a43f8a79a84e0867751dfb095c7bb MANIFEST.in
100644 blob 524175c2bad0b35b975f79284c2f5a6d5eaf2eb4 Makefile
100644 blob 5c7e3a5bbddb038682ba7793f440492ed9678bb3 Makefile.local
100644 blob 8617980629cd24e6080404f09aa749b085b3e07b README.db_testing
100644 blob 76b29f94cf815e0869c414d38d78d7ce08ec514e README.dev
040000 tree e1e10ecef948af0b93adb0372afc89f12e92618a bin
040000 tree 83e56d0beaf7793c77a45a345c80fcb8af503013 debian
040000 tree a34c9c4ba213f0cedc67f9816348d27955577af5 docs
100644 blob f2a6d32c6135aa7287bbd76167b01df2ae4f1539 requirements.txt
100755 blob eee147c36caf1bbc2d820da8dc026cb5b68180bc setup.py
040000 tree 224bb4c1f4c67fca1d160bffd2d06094e7e1abf3 sql
040000 tree 8631c9cd77bbe993168107ab5baf51f40c6300be swh
040000 tree 8fb905b56ba8ed692f1209b2773b474c6c1d66c1 utils
```

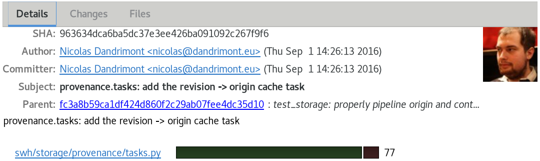
id: 515f00d44e92c65322aaa9bf3fa097c00ddb9c7d

A worked example



A worked example

Revisions



Details | Changes | Files

SHA: 963634dca6ba5dc37e3ee426ba091092c267f9f6

Author: Nicolas Dandrimont <nicolas@dandrimont.eu> (Thu Sep 1 14:26:13 2016)

Committer: Nicolas Dandrimont <nicolas@dandrimont.eu> (Thu Sep 1 14:26:13 2016)

Subject: **provenance.tasks: add the revision -> origin cache task**

Parent: fc3a8b59ca1df424d860f2c29ab07fee4dc35d10 : *test_storage: properly pipeline origin and cont...*

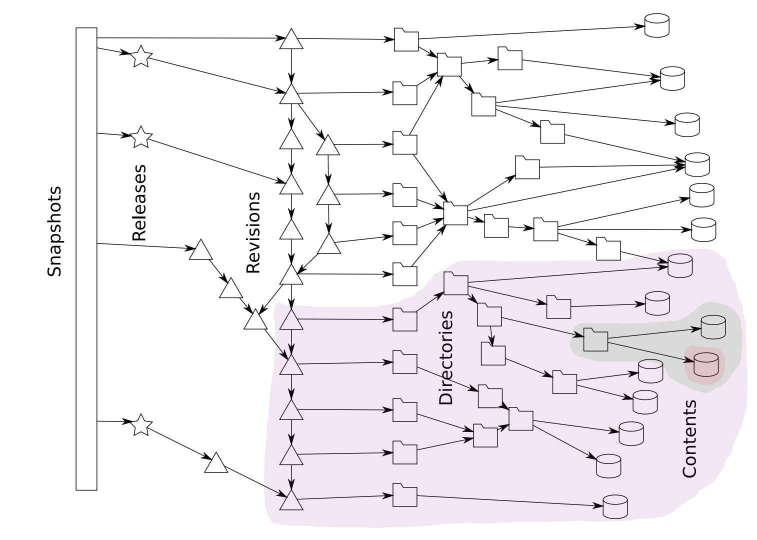
provenance.tasks: add the revision -> origin cache task

swh/storage/provenance/tasks.py 77

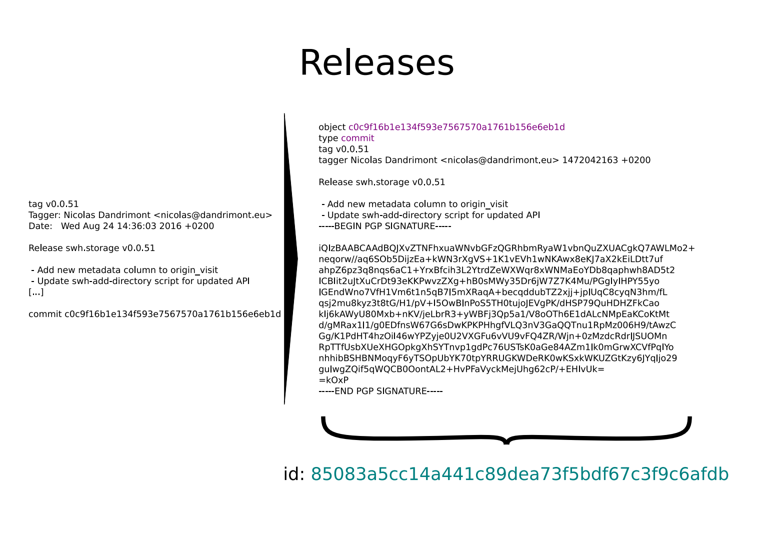
```
tree 515f00d44e92c65322aaa9bf3fa097c00ddb9c7d
parent fc3a8b59ca1df424d860f2c29ab07fee4dc35d10
author Nicolas Dandrimont <nicolas@dandrimont.eu> 1472732773 +0200
committer Nicolas Dandrimont <nicolas@dandrimont.eu> 1472732773 +0200

provenance.tasks: add the revision -> origin cache task
```

id: 963634dca6ba5dc37e3ee426ba091092c267f9f6

A worked example



A worked example



Releases

```
tag v0.0.51
Tagger: Nicolas Dandrimont <nicolas@dandrimont.eu>
Date:   Wed Aug 24 14:36:03 2016 +0200

Release swh.storage v0.0.51

 - Add new metadata column to origin_visit
 - Update swh-add-directory script for updated API
[...]

commit c0c9f16b1e134f593e7567570a1761b156e6eb1d
```

```
object c0c9f16b1e134f593e7567570a1761b156e6eb1d
type commit
tag v0.0.51
tagger Nicolas Dandrimont <nicolas@dandrimont.eu> 1472042163 +0200

Release swh.storage v0.0.51

 - Add new metadata column to origin_visit
 - Update swh-add-directory script for updated API
-----BEGIN PGP SIGNATURE-----

iQIzBAABCAAdBQJXvZTNFhxuaWNvbGFzQGRhbmRyaW1vbnQuZXUACgkQ7AWLMo2+
neqorw//aq6SOb5DijzEa+kWN3rXgVS+1K1vEVh1wNKAwx8eKJ7aX2kEiLDtt7uf
ahpZ6pz3q8nqs6aC1+YrxBfcih3L2YtrdZeWXWqr8xWNMaEoYDb8qaphwh8AD5t2
lCBIit2uJtXuCrDt93eKKPwvzZXg+hB0sMWy35Dr6jW7Z7K4Mu/PGgIyIHPY55yo
lGEndWno7VfH1Vm6t1n5qB7I5mXRaqA+becqddubTZ2xjj+jpIUqC8cyqN3hm/fL
qsj2mu8kyz3t8tG/H1/pV+I5OwBInPoS5TH0tujoJEVgPK/dHSP79QuHDHZFkCao
kIj6kAWyU80Mxb+nKV/jeLbrR3+yWBFj3Qp5a1/V8oOTh6E1dALcNMpEaKCoKtMt
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=kOxP
-----END PGP SIGNATURE-----
```
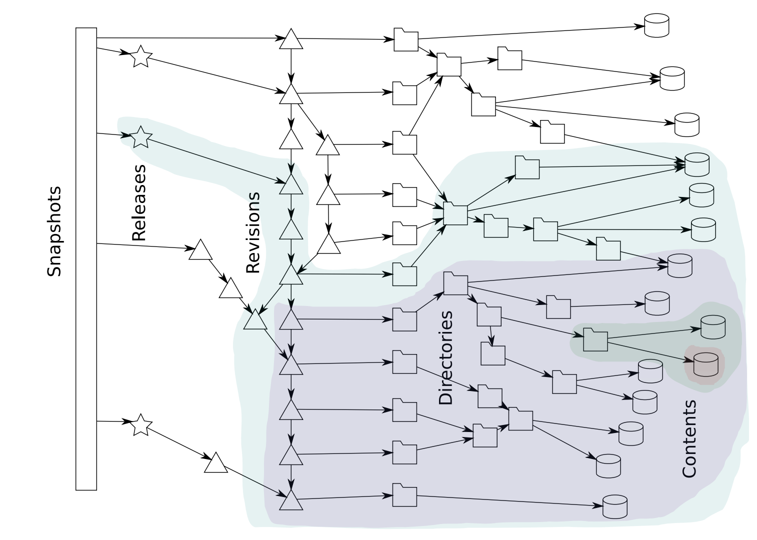
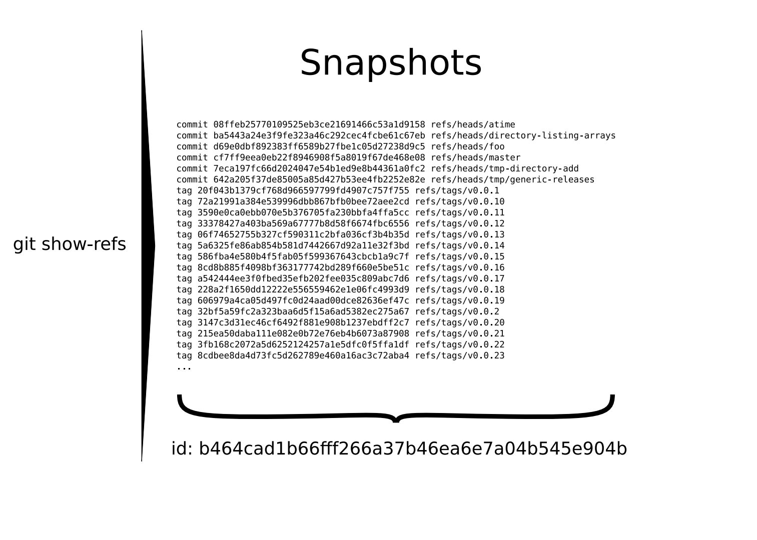

id: 85083a5cc14a441c89dea73f5bdf67c3f9c6afdb

A worked example



A worked example



Snapshots

git show-refs

```
commit 08ffeb25770109525eb3ce21691466c53a1d9158 refs/heads/atime
commit ba5443a24e3f9fe323a46c292cec4fcbe61c67eb refs/heads/directory-listing-arrays
commit d69e0dbf892383ff6589b27fbe1c05d27238d9c5 refs/heads/foo
commit cf7ff9eea0eb22f8946908f5a8019f67de468e08 refs/heads/master
commit 7eca197fc66d2024047e54b1ed9e8b44361a0fc2 refs/heads/tmp-directory-add
commit 642a205f37de85005a85d427b53ee4fb2252e82e refs/heads/tmp/generic-releases
tag 20f043b1379cf768d966597799fd4907c757f755 refs/tags/v0.0.1
tag 72a21991a384e539996dbb867bfb0bee72aee2cd refs/tags/v0.0.10
tag 3590e0ca0ebb070e5b376705fa230bbfa4ffa5cc refs/tags/v0.0.11
tag 33378427a403ba569a67777b8d58f6674fbc6556 refs/tags/v0.0.12
tag 06f74652755b327cf590311c2bfa036cf3b4b35d refs/tags/v0.0.13
tag 5a6325fe86ab854b581d7442667d92a11e32f3bd refs/tags/v0.0.14
tag 586fba4e580b4f5fab05f599367643cbcb1a9c7f refs/tags/v0.0.15
tag 8cd8b885f4098bf363177742bd289f660e5be51c refs/tags/v0.0.16
tag a542444ee3f0fbed35efb202fee035c809abc7d6 refs/tags/v0.0.17
tag 228a2f1650dd12222e556559462e1e06fc4993d9 refs/tags/v0.0.18
tag 606979a4ca05d497fc0d24aad00dce82636ef47c refs/tags/v0.0.19
tag 32bf5a59fc2a323baa6d5f15a6ad5382ec275a67 refs/tags/v0.0.2
tag 3147c3d31ec46cf6492f881e908b1237ebdff2c7 refs/tags/v0.0.20
tag 215ea50daba111e082e0b72e76eb4b6073a87908 refs/tags/v0.0.21
tag 3fb168c2072a5d6252124257a1e5dfc0f5ffa1df refs/tags/v0.0.22
tag 8cdbee8da4d73fc5d262789e460a16ac3c72aba4 refs/tags/v0.0.23
...
```

id: b464cad1b66fff266a37b46ea6e7a04b545e904b

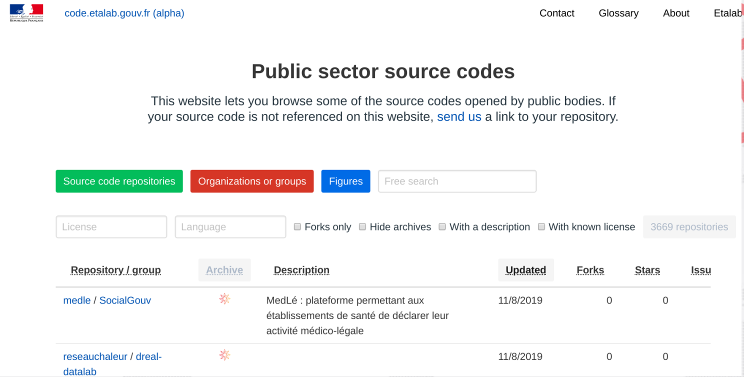
Outline

6 Strategies

7 SWHIDs by the example

8 News

News : archiving *public* code



code.etalab.gouv.fr (alpha)

Public sector source codes

This website lets you browse some of the source codes opened by public bodies. If your source code is not referenced on this website, send us a link to your repository.

□ Forks only □ Hide archives □ With a description □ With known license 3669 repositories

Repository / group	Archive	Description	Updated	Forks	Stars	Issu
medle / SocialGouv	✻	MedLé : plateforme permettant aux établissements de santé de déclarer leur activité médico-légale	11/8/2019	0	0	
reseauchaleur / dreal-datalab	✻		11/8/2019	0	0	

https://code.etalab.gouv.fr