What is Guix?

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Who could concisely describe what Guix can do?

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Make up your mind!

We'll focus on how Guix helps us achieve reproducibility.

But also some other nice Guix features along the way!

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[...]
$ agda MyCoolTheorem.agda

$ guix install ocaml
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$ ocamlopt simulation.ml
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It can run on top of any distribution and won't interfere with it.

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In Guix, packages are pure functions

$$\text{dependencies} + \text{source} \mapsto \text{build output}$$

i.e. if you give it the same dependencies and source, it should give you *exactly* the same result, bit-for-bit.

Guix achieves this by storing each build output in `/gnu/store`, under a directory

$$\mathrm{hash}(\mathrm{dependencies}, \mathrm{recipe}, \mathrm{source})\texttt{-name-version}$$

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- We can easily identify references to dependencies in a build output;
- We never modify state! You don't need to do a rebuild dance when a library is updated;
- We know the output store path beforehand, so we can download it from a substitute server instead!

How do we make package builds free of side-effects? What prevents other package managers/build systems from building reproducibly?

The Docker example

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```
FROM ubuntu@latest
RUN apt-get update && apt-get upgrade
```

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- Isolate builds from the rest of the system (not unlike Docker!);
- But also from the network (unlike Docker!);
- Only sources whose hash we know beforehand can be fetched from the network;
- Patch out unwanted behavior from underlying build tools: "Why does build system X embed the prime factors of the current date in the resulting binary???" and other fun things.

Making everything reproducible is a herculean effort. However, Guix has tools to help us along the way:

```
$ guix build --check --rounds=5 --no-substitutes
    --no-grafts libyaml
[...]
successfully built /gnu/store/6c6rs67wf0jwqnwqm821v
libyaml-0.2.5.drv
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```

You can also challenge substitute servers to reproducibility duels with `guix challenge`.

Guix QA: Reproducible builds

The following table gives an overview of packages that can be built reproducibly, as well as known issues. All data is from th

System	Package reproducibility			
	Matching	Not matching	Unknown	
aarch64-linux	17490	1748	12332	
armhf-linux	7057	696	18931	
i586-gnu	5	0	20683	
i686-linux	22750	1459	5202	
powerpc64le-linux	7648	168	19013	
riscv64-linux	0	0	26614	
x86_64-linux	28295	4094	1536	

Guix, unlike language-specific package managers, takes care of the *full* stack of dependencies.

Example: Stack claims that its main design point is reproducible builds[1]. It also manages your Haskell toolchain. But where do those Haskell toolchain binaries come from, and how do they work?

[1] `https://docs.haskellstack.org/en/stable/GUIDE/`

Stack 2.13.1 uses `ghc-build`:

- `musl` to indicate `libc.musl-x86_64.so.1` is present and Stack should use the GHC binary distribution for Alpine Linux.
- `tinfo6` to indicate `libgmp.so.10` and `libtinfo.so.6` are present and `libc6` is compatible with `libc6` 2.32.
- `tinfo6-libc6-pre232` to indicate `libgmp.so.10` and `libtinfo.so.6` are present and `libc6` is not compatible with `libc6` 2.32.
- `ncurses6` to indicate `libgmp.so.10` and `libncursesw.so.6` are present
- `gmp4` to indicate `libgmp.so.3` is present

By default, Stack associates:

- the `tinfo6` build with the 'Fedora 33' binary distribution of GHC 9.4.1 to 9.4.4. Those binary distributions require versions of `libc6` that are compatible with `libc6` 2.32; and
- the `tinfo6-libc6-pre232` build with the 'Debian 10' binary distribution of GHC 9.4.1 to 9.4.4. Those binary distributions require versions of `libc6` that are compatible with `libc6` 2.28.

The same can be said for external dependencies: what if you need bindings to a C library? You want *all* the software to be managed by one tool.

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- Guix can download sources from SWH if upstream's unavailable;
- Guix queues packages' sources for inclusion into SWH.

Development environments

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This also means we can do that temporarily! Suppose I want to build an OCaml program once, I can just do:

```
$ guix shell ocaml -- ocamlopt hello.ml -o hello
[...]
$ ./hello
```

For more serious projects, you can list the dependencies in a `manifest.scm` file, and run

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You can even distribute that file with your project for others to use!

Going back in time

Guix is rolling-release: packages are updated as we go along. How can we recover environments used in the past?

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```
$ guix describe
Generation 75 Oct 31 2023 10:25:56 (current)
  guix c089537
    repository URL: https://git.savannah.gnu.org/git/guix.git
    branch: master
    commit: c0895371c5759c7d9edb330774e90f192cc4cf2c
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```

Guix can describe itself, and you can also ask Guix to use an older version of itself to run some commands:

```
$ guix describe -f channels > channels.scm
[ some time later ]
$ guix time-machine -C channels.scm -- shell ocaml
```

Sharing the `channels.scm` and `manifest.scm` files lets anyone reproduce your environment with the magic

```
$ guix time-machine -C channels.scm
    -- shell -m manifest.scm
```

Exporting environments

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Alice can send a pack containing their whole computing environment with `guix pack`, for use on any other Linux system (even WSL!).

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```
$ guix pack -RR -S /bin=bin -S /etc=etc
    emacs emacs-agda2-mode agda agda-cubical
```

gives an archive with everything needed to Cubical Agda in Emacs, by extracting it anywhere!

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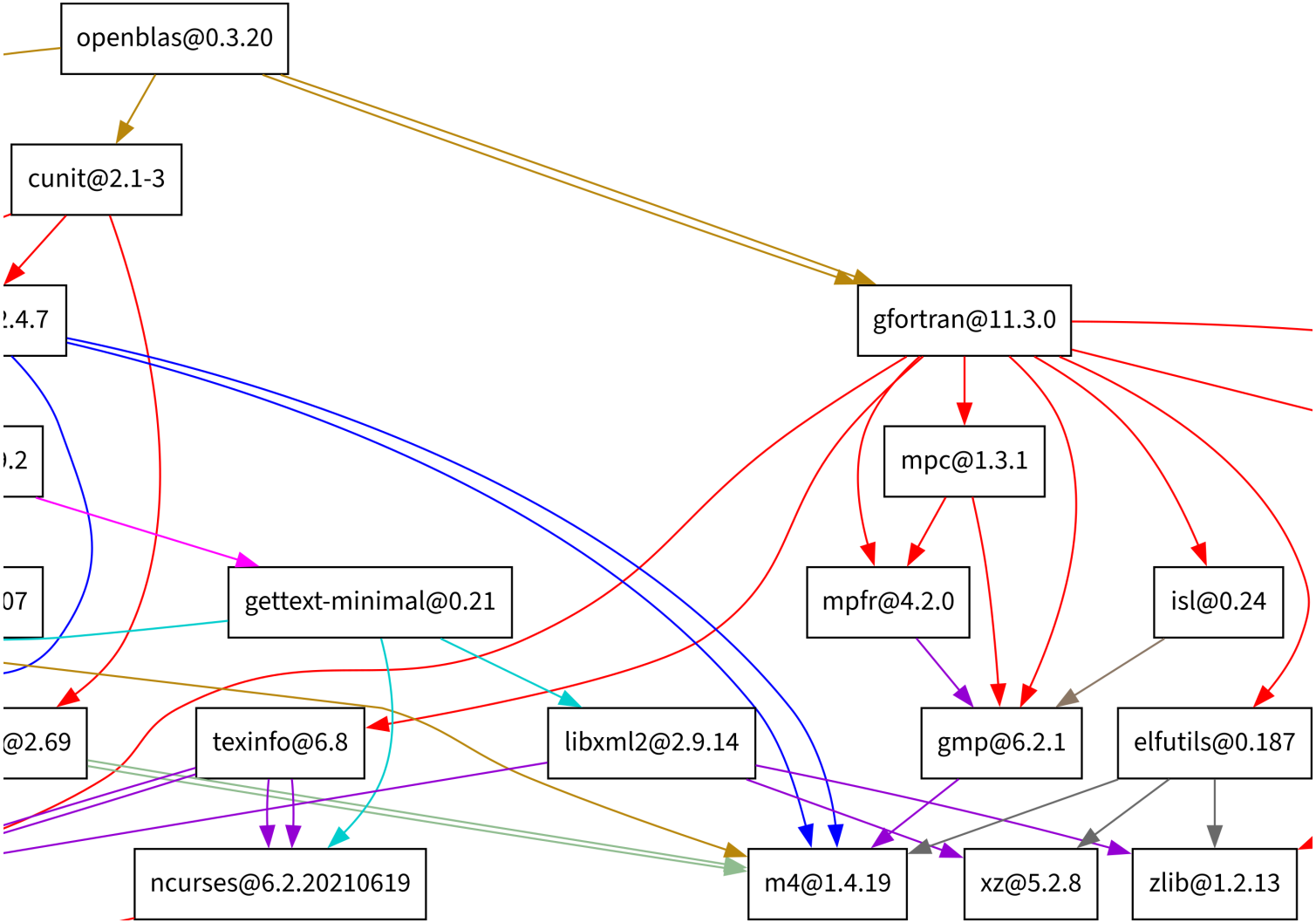
This lets you run Guix-built software on e.g. clusters without Guix.

One can also inspect dependency graphs with `guix graph`.



Optimizations and Reproducibility

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In Guix, optimizations are part of the recipe, thus a change of optimizations builds a different version of the package, in a separate store path.

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```

You can also replace some dependencies by optimized libraries with a simple package transformation:

```
$ guix build --with-input=gmp=my-faster-gmp openbla
```

Guix as a system

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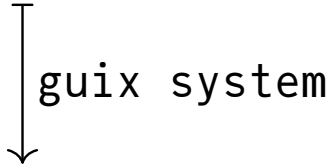
Guix System takes the functional POV to a whole new level: *declarative system configuration*.

```
(operating-system
  (host-name "komputilo")
  (timezone "Europe/Berlin")
  (locale "en_US.utf8")
  (bootloader ...)
  (file-systems ...)
  (users ...)
  (packages (cons screen %base-packages))
  (services ...))
```



system instantiation

Guix System can be used to configure:

- servers;
- personal machines;
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While this might be interesting for cluster administrators, once you get enamored with Guix you'll want to try it out!

Extensibility

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```

to writing a new package definition

```
(package/inherit flameshot
  (arguments
   (substitute-keyword-arguments (package-arguments flameshot)
     ((#:configure-flags flags #~('()))
      #~(cons* "-DUSE_WAYLAND_CLIPBOARD=ON"
               #$@flags))))
  (inputs
   (modify-inputs (package-inputs flameshot)
     (prepend qtwayland-5
              (@ (gnu packages kde-frameworks) kguiaddons)))))
```

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We have automatic importers!

```
$ guix import pypi b4
```

```
(package
  (name "python-b4")
  (version "0.12.4")
  (source
   (origin
     (method url-fetch)
     (uri (pypi-uri "b4" version))
     (sha256
      (base32 "03gxjnch08kzi33kqarr9a43pmzqaykk69kb09pdsk3dv2v8nycz"))))
  (build-system pyproject-build-system)
  (propagated-inputs (list python-dkimpy python-dnspython
                           python-git-filter-repo python-patatt
                           python-requests))
  (home-page "https://git.kernel.org/pub/scm/utils/b4/b4.git/tree/README.rst")
  (synopsis "A tool to work with public-inbox and patch archives")
  (description
   "This package provides a tool to work with public-inbox and patch archives")
  (license #f))
```

The chicken-and-egg problem

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Example: Rust

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We need to break the cycle! We use `mrustc` for an old version of Rust.

Guix now features the full-source bootstrap for the x86_64 architecture, which is the same problem but for the base C compiler.

See Janneke's blog post *The Full-Source Bootstrap: Building from source all the way down*, as well as the Bootstrappable Builds project!

Guix is also an excellent manual, available both in HTML and Info formats, and cozy CLI!

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Last but not least, Guix is also an incredibly nice and welcoming community, which you can meet over on IRC, over mails or here (for those who could attend)!

Thank you for your attention. Any questions?

Guix