

An Introduction to Nix

Reproducible builds and deployments

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I designed the Rust/Haskell interoperability tools suite `cargo-cabal` and `hs-bindgen`, the Nix contracts library, and am maintaining the `Cabal`, `devx` and `haskell.nix` build infrastructures.

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What's on the menu?

1. **Reproducible:** no more *"but it worked on my machine"* ;
2. **Declarative:** *"one configuration that rules all"*, set up a new machine is just one `Ctrl+C/Ctrl+V` (or rather `git clone && nixos-rebuild switch`) away ;
3. **Immutable:** an evil program couldn't any more change your system without you even notice... Also, your system doesn't *"get old"* because of partially uninstalled programs, so you need to reinstall it...
4. **Atomic transitions:** no more *"my system is broken because power got cut while the update"*! And, if your system is broken, you can always *"restore a previous version"* in one command!

0. What's the Nix?

- The Nix **language**
- The Nix **package manager**
- The NixOS **linux distribution**
- The `nixpkgs`¹ (Nix packages) **monorepo**

¹`nixpkgs.lib` is the standard library of Nix language.

Interlude: The Nix language

I don't have the time to teach the Nix language here... but it could be learned in 1-hour of your time. It's really a small language, you can think about it as “*JSON + functions*”. Here's an example:

```
with (import <nixpkgs> {});  
mkShell {  
  buildInputs = [  
    pandoc  
    texlive.combined.scheme-full  
  ];  
}
```

Advice: Learn² the Nix syntax and semantics before starting to copy-paste others NixOS configurations.

²Read <https://code.tvl.fyi/about/nix/nix-1p> ;)

1. Reproducible: *Beyond the bash script...*

Consider this script:

```
#!/usr/bin/env bash  
apt update  
apt install python3  
python3 ./myserver.py
```

What could go wrong?

- Having not the exact same python3 version...
- Having a different PATH (with a custom python3 binary)...
- Having python3 dynamically linked against a different glibc...

Interlude: But Docker is already fine! right?

With Docker, **what you distribute is the image** (what docker push/pull does) not the Dockerfile, and it's a big binary.
Building the image is not reproducible³.

³A workaround would be to use Alpine Linux and to pin the version of the system used.

2. Declarative: *I can build whatever I want with Nix!*

Nix let's you describe **derivations** (*recipes*), that can be anything:

- A binary⁴, a script ;
- A developer environment ;
- A Docker or KVM image ;
- The content of `/etc/`⁵ or `$XDG_CONFIG_HOME` on my machine, e.g.:

```
programs.git = {  
  enable = true;  
  userName = "Yvan Sraka";  
  userEmail = "yvan@sraka.xyz";  
  signing.key = "370B823A2A0C7478";  
  signing.signByDefault = true;  
}
```

⁴Where to download it or its sources and how to build it.

⁵That's what NixOS options does!

Interlude: nixpkgs (Nix packages)

The real value of Nix lives in `nixpkgs` (more than 100 000 package⁶, 10 000 contributors and 500 000 commits):

- `nixpkgs` contains package definitions, but also NixOS options, that are indexed here <https://search.nixos.org> ;
- `home-manager` isn't part of `nixpkgs` but let you populate `$XDG_CONFIG_HOME`⁷.

The idea here is to write all your configurations in one same language (Nix).

⁶NixOS is actually the Linux distribution with the most packages availables.

⁷Which is set to `$HOME/.config` on most systems.

Interlude: extract of my
/etc/nixos/configuration.nix:

```
programs.zsh = {  
  enable = true;  
  enableCompletion = true;  
  promptInit = ''  
    # Best defaults are https://grml.org/zsh/  
    source ${pkgs.grml-zsh-config}/etc/zsh/zshrc  
  '';  
};  
  
programs.tmux = {  
  enable = true;  
  extraConfig = builtins.fetchurl {  
    url = "https://git.grml.org/f/grml-etc-core/etc/tmux.conf";  
    sha256 = "1ysb9jzhhpz160kwcf4iafw7qngs90k3rgblp04qhz5f8...";  
  };  
};
```

3. Immutable: */nix/store/everything*

- Everything is symbolic linking that point to the `/nix/store/` (Nix store) ;
- Only the `nix-daemon` can write the `/nix/store/` ;
- A `/nix/store/` object is called a **derivation** ;
- Derivations are garbage-collected when no symbolic link points to them ;
- What about dynamic linking? `patchelf`⁸ to the rescue!

⁸A small utility to modify the dynamic linker and RPATH of ELF executables <https://github.com/NixOS/patchelf>

Interlude: How does that even work?

In previous example, `${pkgs.grml-zsh-config}` is
`/nix/store/bn226m74zgwdpdpnp12lq01z89wh0mzn0-grml-zsh-config`

NixOS expression can only reference `/nix/store/` objects or external resources locked with a checksum hash (e.g. with `builtins.fetchurl`). That means that we control the **complete dependencies closure of our derivation** (*recipe*), so we control also all systems dependency it rely on⁹.

Finally, **derivations are realized in a sandbox**, or in other words, recipes are built in an environment where there is no access to network, or to environment variables or to your home directory. This ensure that those builds are **fully-reproducible**.

⁹What, e.g., `package-lock.json` does not.

4. Atomic transitions: *It's magic!*

- Upgrade system, install a program is just a change in symbolic linking ;
- Grub offers you to choose at boot the generation of your system you want to use and NixOS just has to change a few symbolic links ;
- That means you can have several versions of `node` or `glibc` on your system without any conflict ;
- That allows throwable developer environment (or per-directory, e.g. with `direnv` automation)!

DEMO

Drawbacks

- The macOS¹⁰ support isn't that great.
- Flakes experimental feature, that constrains the hermeticity¹¹, is controversial and fragments the ecosystem.
- Complexity... there are a lot more Nix features I don't mentioned yet, like **remote builders** or **binary caches**, and a lot of concepts to grasp to build a right mental model on Nix, but arguably that's also because it's full of great features!

¹⁰e.g. there is no sandbox on macOS...

¹¹Nix expressions could no longer read ENV variables.

Q/A