
Python
Incompatible
Changes
Victor
Stinner

Victor STINNER

- Maintain Python **upstream** (`python.org`) and **downstream** (Fedora and RHEL) for Red Hat
- Python core developer since 2010
- Happy **Fedora** and **vim** user!
- Went through many Python incompatible changes since 2010..
- `https://twitter.com/`**`VictorStinner`**

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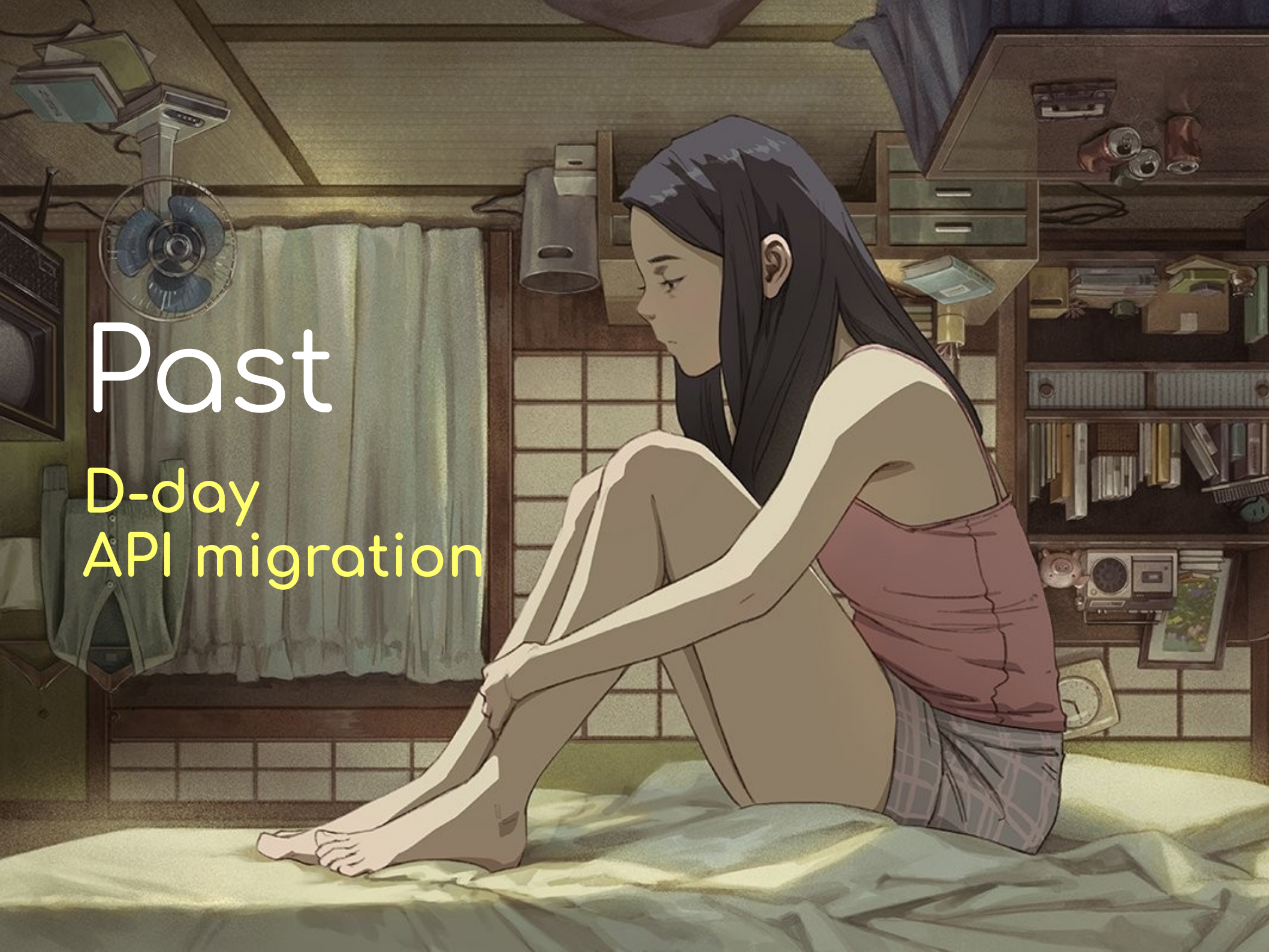
Past
D-day
API migration

A long time ago...
in a galaxy far, far away
There was Python 2.

Let's travel 14 years in the past, before Python 3...

Python 2 Unicode errors

- In the Python 2 era, Django started to become a real competitor of PHP frameworks and Ruby on Rails.
- One common issue in Django was handling non-ASCII characters
- You might have heard about them in Taiwan
- In Python in general, handling Unicode errors was a frequently asked question.

Python 2: bytes vs Unicode

- **`"abc"`** is a **bytes** string
- `"é"+u"ç"` raises a Unicode error
- Getting Unicode correctly is complicated in Python 2.

Python 3 uses Unicode

- Python 3 fix the root issue: Unicode becomes a **first class citizen**
- **"abc"** is now a **Unicode** string
- Migrating Python 2 to Python 3 is painful: you have to handle **all** bytes vs Unicode **issues at once**

Iterators and generators

- Python 2.2 introduces **iterators** (PEP 234) and **generators** (PEP 255)
- Python 2 **`map()`** and **`zip()`** return a **list**: consume more memory than a generator
- `itertools` **`imap()`** and **`izip()`** have to be used explicitly

  `dict.`**`items()`** returns a list,
  `dict.`**`iteritems()`** creates a generator

Python 3 uses generators

- Python 3 `map()` and `zip()` create a generator
- `dict.items()` creates a generator
- Just use `list(dict.items())` to get a list

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Python 3

- Python evolved as Python 3 to get a **sane default behavior**
- Use Unicode
- Create generators
- Python 3 is “consistent” again
- .. but is **backward incompatible**

Why incompatible changes?

PEP 20: “There should be **one** –and preferably only one– **obvious way** to do it.”

- **Consistent** coding style
- Easier to **teach**
- Easier to **review**

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Python 3 D-Day

- Python 3 initial plan was simple
- Everybody has to run 2to3 on their code at once to make it compatible with Python 3
- Problem: dependencies
- Problem: maintainers wanted to keep Python 2 support
- Problem: the migration took 10 years

Högertrafikomläggningen

At 3 September 1967, Sweden switched from driving on the left-hand side of the road to the right: “Dagen H”

- Decided in 1963: 4 years to prepare the change
- 350,000 signs had to be removed or replaced (Stockholm: 20,000)
- Bus with right-hand side, bus stop, trams, etc.

Logo

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Underwear and socks

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Keep to the right, Svensson

"Håll dig till höger, Svensson" song

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Then comes the C API

- The C API is used by many third party C extensions to **extend Python**
- It's a big **part of Python success**
- Without C API, there is no Cython, **no numpy**, no psycopg2, etc.

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Python 3.11 C API changes

Python 3.11 optimizations changes multiple core C structures

- `PyCodeObject`
- `PyFrameObject`
- `PyThreadState`

Problem: some C extensions directly access members of these structures

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Update C extensions

- `code->f_code`
  → **`PyCode_GetCode`**`(code)`
- `frame->f_back`
  → **`PyFrame_GetBack`**`(frame)`
- `tstate->frame`
  → **`PyThreadState_GetFrame`**`(tstate)`
- Problem: These functions requires Python 3.11 or `#ifdef`

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Present
Smoother
API updates

Python 3: six module

- six allows writing a **single code base** working with old and new Python
- **Add support** for the **new** Python 3, rather than removing support for the old Python 2
- New migration approach: **port incrementally** the code
- **D-day** approach **abandoned**: we learnt!

Revert 3.10 changes

- Python 2.7 support just ended upstream, many projects still supported Python 2.7
- Revert **open()** “U” mode removal
- Revert **collections** ABC aliases removal
- → Removed again in Python 3.11
- These changes affected too many packages: give **more time to update**

Revert 3.11 changes

- Revert unittest aliases removal
- Revert configparser removals
- Revert asyncore removal
- Changes postponed to Python 3.12
- Affected too many packages, it takes time to update them (fix, release)

PEP 387

- Since 2020 (Python 3.9), one Python release per year (PEP 602)
- Backward compatibility policy (PEP 387) updated to deprecate for 2 years: 2 Python releases
- Example: deprecate in 3.11 and 3.12, remove in 3.13 (3 years)

DeprecationWarning

- Python 2.7 (2010) hides them by default
- Python 3.7 shows them in the __main__ module (PEP 565)
- `python -W default`: display once
- `python -W error`: raise an exception
- `python -X dev`: Python development mode

Smooth deprecation

- **Add** new API
- Deprecate only in the **documentation**
- Emit **DeprecationWarning**
- Explain how to update existing code **without losing support** for old Python versions (**NEW!**)
- **Remove** the old API

Code search

- `download_pypi_top.py`: Download source code of the PyPI top 5,000 projects
- `search_pypi_top.py`: Search for code pattern with a regex
- Help updating affected projects

  `https://github.com/vstinner/misc/tree/main/cpython/`

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Ideal migration

- **Add** new API
- **Doc** and/or **tool** to update
- Identify and **update** affected projects
- Wait for **releases** of affected projects
- **Deprecate** old API
- **Remove** old API
- Take ~3-5 years

Unmaintained projects

- Some core Python dependencies have a **single unavailable maintainer**
- Busy with work, life duties, get bored, sick, etc. (it's not only about bus)
- How to update projects when the maintainer doesn't reply?
- Problem of **funding** maintenance of these projects
- **Thankless work**

Hidden projects

- Projects **behind closed doors**
- From short scripts to large applications
- Old projects no longer maintained
- Turnover
- **`pyupgrade`** and **`upgrade_pythoncapi.py`**
- or: **keep** an **old Python** (security!)

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pythoncapi-compat

- C API: Provide new functions to old Python
- 2020: Project created
- upgrade_pythoncapi.py script
- 2021: Python 2.7 support for Mercurial
- 2022: Python 3.11 functions
- 10 projects are using it
- `https://pythoncapi-compat.readthedocs.io`

pythoncapi-compat

- Update your C extensions to use new Python 3.11 functions
- Copy pythoncapi_compat.h file to get these functions on Python 3.10 and older
- Keep support with Python 2.7
- No need to update pythoncapi_compat.h until you need a new function

C API guidelines

- New functions must **not return borrowed references** but strong references
- New functions must **not steal references**
- Well define **ownership** rules and **lifetimes** of arguments and structure members
- It should ease supporting the C API on Python implementations other than CPython

C API headers

C API now splitted in 3 categories (3 directories):

- Limited C API (stable ABI)
- Public C API
- Internal C API

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Fedora COPR

- My team tests **Python 3.11** since alpha1 to detect issues as soon as possible
- **Rebuild** Fedora Python **packages** (5500+) with Python 3.11
- Lot of work to **identify the root cause**, report issue to **upstream**, propose a fix
- **Collaboration** to get the fix merged and get a release

What's new?

- Proactively search for affected projects
- Document how to update code without losing support with old Python versions
- Helping to update affected projects give a better insight on how to update code
- Fedora provides early feedback
- pythoncapi-compat for C API


Future
Better API

Stable ABI

- Python 3.2 implements **Stable ABI** (PEP 384): the **limited C API**
- **Build once**, works all Python versions
- Python 3.10: Maintaining the Stable ABI (PEP 652), **tests** the ABI, better doc
- 2021: **CI** now fails on any ABI changes (not just the stable ABI)
- **Cryptography** and **PySide** binaries on PyPI use the stable ABI

HPy project

- New C API designed in 2019 to be efficient on PyPy (and CPython)
- ujson made 3x faster on PyPy with HPy
- Universal ABI: build one, work on all CPython and PyPy versions
- numpy WIP port to HPy
- https://hpyproject.org/

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Test next Python

- Test Python **nightly build** in your CI
- Bugs discovered earlier are easier to fix
- **Report** issues to CPython bug tracker
- If possible, start by testing Python **alpha** versions


Q & A

Sources

- Drawing by **Djamila Knopf**
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