

A detailed oil painting of a scene featuring a window with green shutters. A ginger and white cat is sitting on the windowsill, yawning with its mouth wide open. The window is framed by a dense arrangement of yellow flowers and green leaves. To the left, a vine with green leaves hangs down the wall. Below the window, a brick wall is visible, with a small potted plant and some white and pink flowers in the foreground. The overall style is soft and painterly, with warm lighting.

# Python Incompatible Changes

Victor  
Stinner



# Victor STINNER

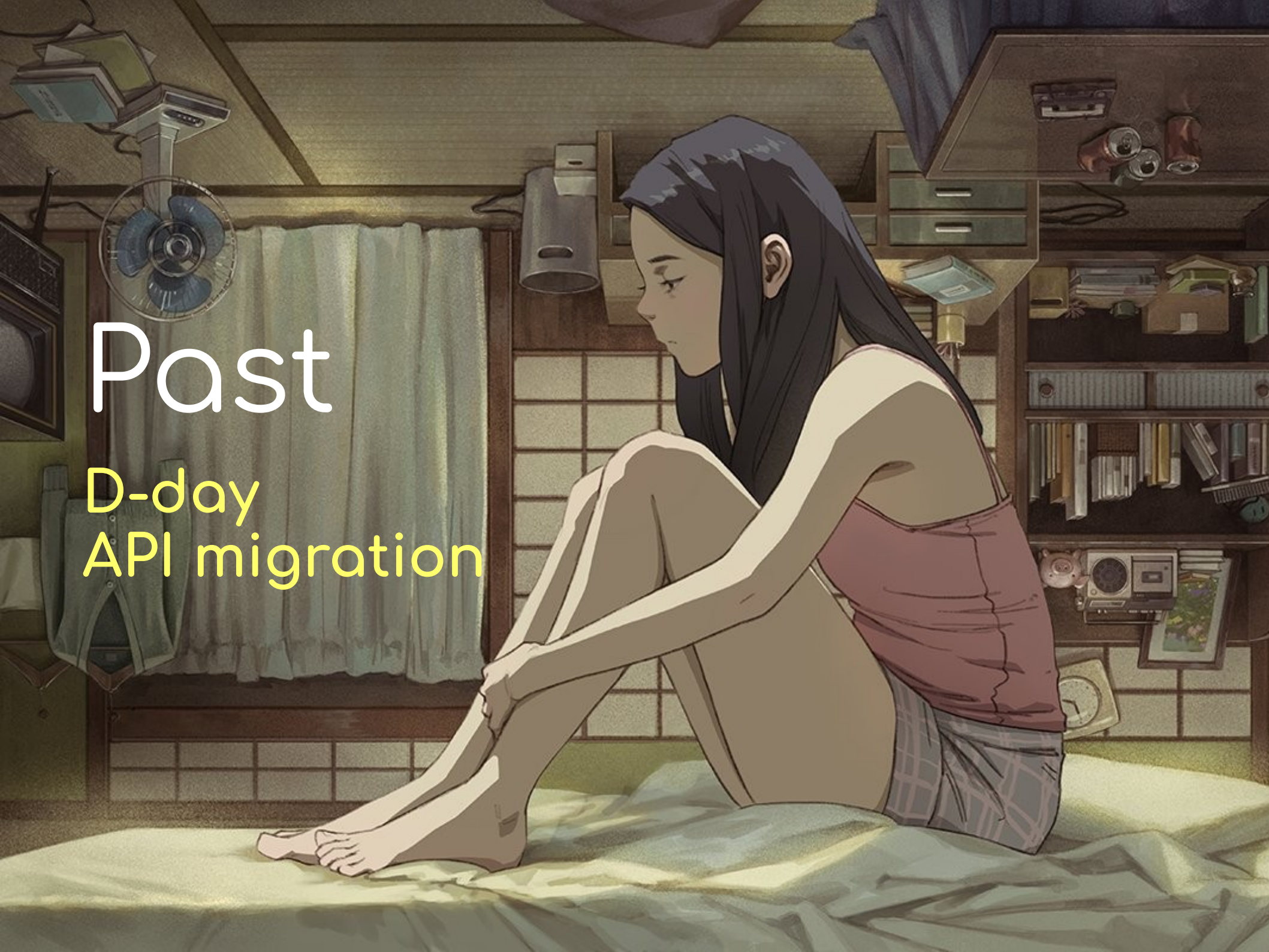
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- Maintain Python **upstream** (python.org) and **downstream** (Fedora and RHEL) for Red Hat
- Python core developer since 2010
- Happy **Fedora** and **vim** user!
- Went through many Python incompatible changes since 2010..
- <https://twitter.com/VictorStinner>



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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

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- 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.



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# Python 2: bytes vs Unicode

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



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# Python 3 uses Unicode

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- 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**



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# Iterators and generators

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- 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



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# Python 3 uses generators

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- 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

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



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# 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

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- 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**



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# Högertrafikomläggningen

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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.



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# 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

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- 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 pycopg2, etc.



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# Python 3.11 C API changes

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Python 3.11 optimizations changes multiple core C structures

- Py**Code**Object
- Py**Frame**Object
- Py**Thread**State

Problem: some C extensions directly access members of these structures



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# Update C extensions

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- `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

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- 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!



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# 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**



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# 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)



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# PEP 387

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- 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)



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# 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



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# 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



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# Code search

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- `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

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- **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



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# 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**



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# Hidden projects

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- Projects **behind closed doors**
- From short scripts to large applications
- Old projects no longer maintained
- Turnover
- **pyupgrade** and **upgrade\_pythoncap1.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>



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# 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



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# C API guidelines

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- 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



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# C API headers

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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

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- 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



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# What's new?

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- **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



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Future  
Better API



# Stable ABI

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- 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



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# HPy project

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- **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

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- 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



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Q & A





# Sources

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- Drawing by **Djamila Knopf**
- Python and Red Hat are registered trademarks



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