

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 profusion of bright yellow flowers, possibly roses, which spill over the top and sides. To the left, green ivy leaves climb up the wall. A small brass wind chime hangs from the top of the window frame. The wall is made of light-colored stone or plaster, with some visible texture and shadows. In the bottom right corner, there are more flowers, including white and pink ones. The overall style is soft and painterly, with visible brushstrokes and a warm, sunlit atmosphere.

Python C API

Victor
Stinner

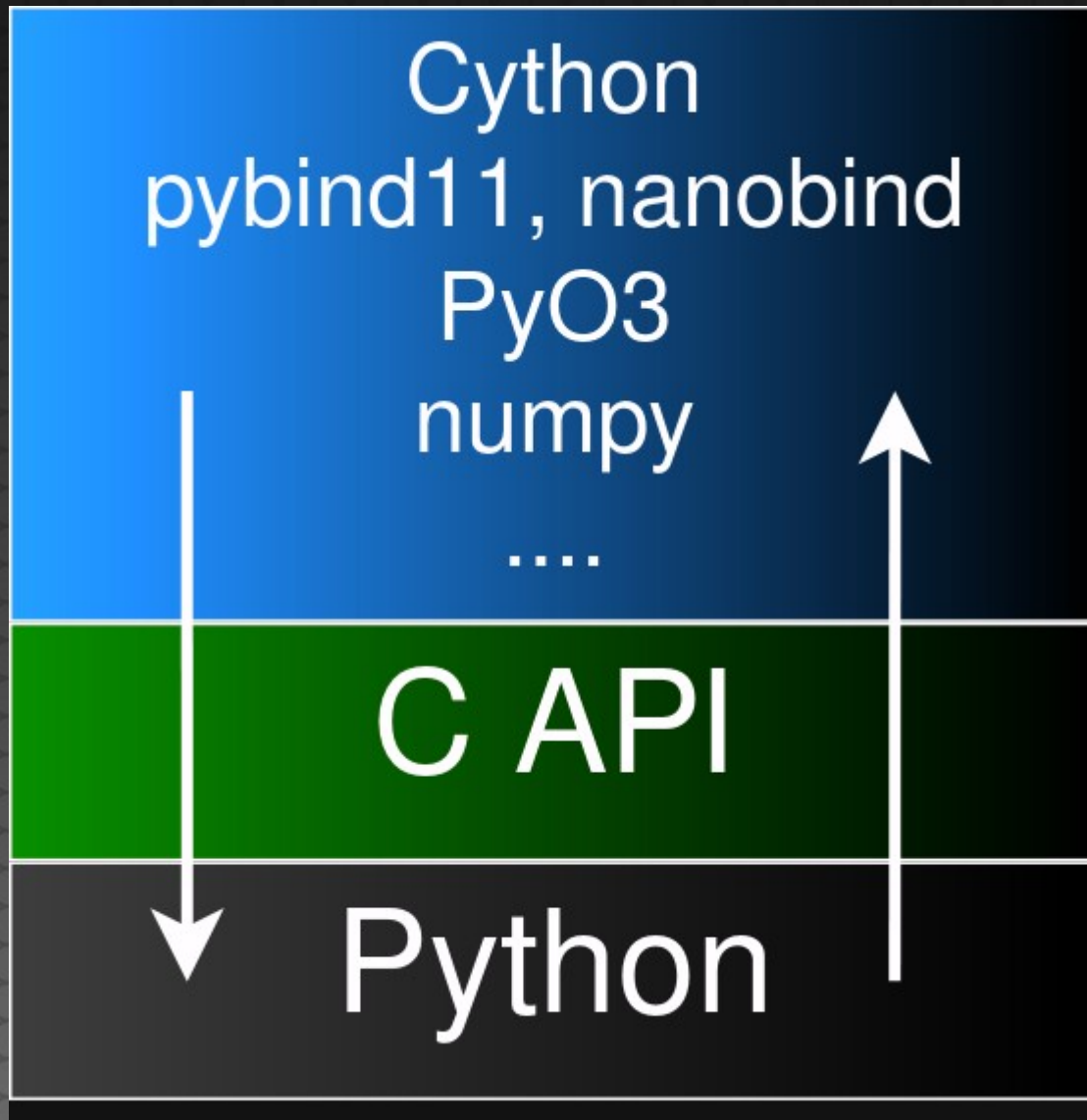
Victor Stinner



- CPython **core developer** for 14 years
- Maintain **Python CI** (GitHub Actions, buildbots), fix regressions, memory leaks, race conditions
- Work for **Red Hat**: backport fixes up to Python 3.6 and fix security vulnerabilities
- Happy **vim** and **Fedora** user!



C API



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My C API long term goals



Limited C API by default!
Stable ABI for all!

It's a long term goal,
not the exact purpose of this talk



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Stable ABI



- **Build once**, work on all Python versions
- Less wheel packages to distribute (one per "platform")
- Platform: {OS, CPU, libc}
- Added to **Python 3.2** (2011) but is incomplete
- Used by **500+** C extensions on PyPI: PySide6, cryptography, ...



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MarkupSafe: 60 wheel pkgs



Built Distributions

- [MarkupSafe-2.1.5-cp312-cp312-win_amd64.whl](#) (17.1 kB [view hashes](#))
Uploaded Feb 2, 2024 | CPython 3.12 | Windows x86-64
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- [MarkupSafe-2.1.5-cp38-cp38-win_amd64.whl](#) (17.2 kB [view hashes](#))
Uploaded Feb 2, 2024 | CPython 3.8 | Windows x86-64
- [MarkupSafe-2.1.5-cp38-cp38-win32.whl](#) (16.7 kB [view hashes](#))
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- [MarkupSafe-2.1.5-cp37-cp37m-win_amd64.whl](#) (17.2 kB [view hashes](#))
Uploaded Feb 2, 2024 | CPython 3.7m | Windows x86-64
- [MarkupSafe-2.1.5-cp37-cp37m-win32.whl](#) (16.6 kB [view hashes](#))



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PySide6: 4 wheel packages



Source Distributions

! No source distribution files available for this release. See tutorial on [generating distribution archives](#).

Built Distributions

-  [PySide6-6.7.2-cp39-abi3-win_amd64.whl](#) (538.0 kB [view hashes](#))
Uploaded Jun 18, 2024 CPython 3.9+ Windows x86-64
-  [PySide6-6.7.2-cp39-abi3-manylinux_2_31_aarch64.whl](#) (530.7 kB [view hashes](#))
Uploaded Jun 18, 2024 CPython 3.9+ manylinux: glibc 2.31+ ARM64
-  [PySide6-6.7.2-cp39-abi3-manylinux_2_28_x86_64.whl](#) (530.8 kB [view hashes](#))
Uploaded Jun 18, 2024 CPython 3.9+ manylinux: glibc 2.28+ x86-64
-  [PySide6-6.7.2-cp39-abi3-macosx_11_0_universal2.whl](#) (530.2 kB [view hashes](#))
Uploaded Jun 18, 2024 CPython 3.9+ macOS 11.0+ universal2 (ARM64, x86-64)



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My C API long term goals



- More **freedom** to change Python **internals**
- Reduce 3rd party **maintenance burden** when updating Python (goal: no change)
- Reduce **friction/stress** related to the C API, on the Python side, and on the 3rd party side
- Get C extensions ready since Python **alpha1** release: no need to request release



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Challenges



- **Need to change** some 3rd party code to reach this long term goal
- Usually **1-10 lines** per Python release in the few **impacted projects**
- **Unknown number** of impacted projects per change



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Python 3.13

C API Working Group



- **PEP 731** "C API Working Group Charter"
- Created in November 2023
- New C API must be approved by the WG
- 6 members: **Erlend** Aasland, **Michael** Droettboom, **Petr** Viktorin, **Serhiy** Storchaka, **Steve** Dower, **Victor** Stinner
- **PEP 733** "An Evaluation of Python's Public C API"



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C API WG projects



- **decisions**: decide on an API
- **api-evolution**: list small API changes
- **api-revolution**: list disruptive API changes

<https://github.com/capi-workgroup/>



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Remove private funcs



- No **doc**, no **test**
- No **backward compatibility** support
- Private functions are not part of the **limited C API**
- Replace them with **public functions**



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Remove private funcs

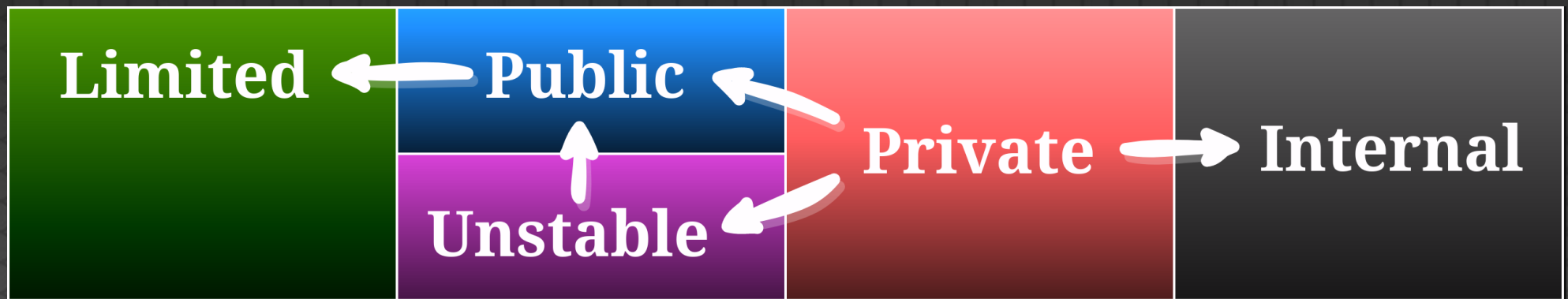


- Removed 300+ **private** functions in Python 3.13 alpha1
- Some removals impacted **5-30 projects**
- As planned, removals causing most trouble have been **reverted** (mostly in alpha2)
- 3.13 beta1: **264** functions removed



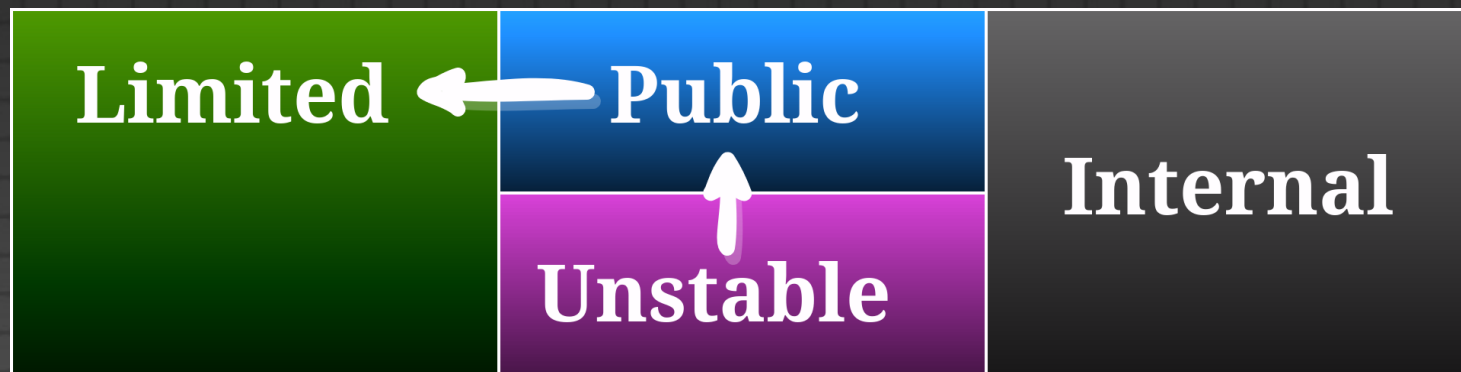
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Remove private funcs



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Remove private funcs



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Better public functions



- Promote private to **public** functions
- Add **backward compatibility warranty**
- Add **documentation** and **tests**
- C API Working Group designs a **better** API
- Enforce error checking
- Avoid inefficient `PyErr_Occurred()` check



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PyDict_Pop() example



- 3.12: **PyObject*** _PyDict_Pop(PyObject *dict, PyObject *key, PyObject *deflt)
→ NULL means "not found" **or** error
- 3.13: **int** PyDict_Pop(PyObject *op, PyObject *key, **PyObject **result**)
 - Return **-1** on **error** and set an exception
 - Return **0** if **not found** (NULL result)
 - Return **1** if **found** (non-NULL result)



And Python \leq 3.12 ?



pythoncapi-compat provides new Python 3.13 functions on Python 3.12 and older

- `PyDict_GetItemRef()`
- `PyLong_AsInt()`
- `PyUnicode_EqualToUTF8()`
- ...



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Python 3.13 Limited C API



Argument Clinic Limited API



- Use limited C API if code uses **#define Py_LIMITED_API** ...
- Only use **public** functions of the limited C API
- **Inline code** to avoid calling private/internal functions



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AC: fcntl.fcntl() clinic input



```
fd: files  
cmd as code: int  
arg: object(c_default='NULL') = 0  
/
```



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AC:fcntl.fcntl() code in 3.12



```
if (!_PyArg_CheckPositional(  
    "fcntl", nargs, 2, 3)) ...  
if (!_PyLong_FileDescriptor_Converter(  
    args[0], &fd)) ...  
code = _PyLong_AsInt(args[1]);
```



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AC:fcntl.fcntl() code in 3.13



```
if (nargs < 2) { PyErr_Format(...)... }
if (nargs > 3) { PyErr_Format(...)... }
fd = PyObject_AsFileDescriptor(args[0]);
if (fd < 0) ...
code = PyLong_AsInt(args[1]);
```



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Build stdlib ext with limited



- Limited C API was not really used/tested by Python itself
- **Test** the limited C API
- Make sure that it **works** with non trivial code
- "Eating your own dog food"



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Build stdlib ext with limited



- **Build** 16 stdlib extensions with the **limited C API**
- errno, md5, resource, _uuid, ...
- PEP 737 "Unify type formatting" adds **%T** and **%N** formats for error messages



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Future
(3.14)

HPy



- New C API which looks like the Python C API
- **More efficient** on PyPy
- **"Universal mode"** which is a stable ABI working any CPython version and any PyPy version
- **numpy** is being porting to HPy



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Limited C API & stakeholders



- Cython: **opt-in** build mode
- PyO3 (Rust): **opt-in** build mode; consider making it the default!
- pybind11 (C++11): **not** supported
- nanobind (C++11): **opt-in** build mode, 100% feature complete
- cffi: **not** supported



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Use the Limited C API



- Define **Py_LIMITED_API** macro to a Python "hex" version.
Example: 0x0**3080000** for Python **3.8**.
- **Cython**: define **CYTHON_LIMITED_API** macro to **1**



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abi3audit



- Test if a binary uses the stable ABI or not
- <https://github.com/trailofbits/abi3audit>



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Q & A

