Unleash the power of C++ in Python

A guide through the bindings generation process

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Source and slides

github.com/cmaureir/unleash_cpp

C++

- General purpose
- Multi paradigm
- Statically typed
- Compiled
- Provides low-level memory manipulation
- Code readability ???

Python

- General purpose
- Multi paradigm
- Dynamically typed
- Interpreted
- Automatic memory management
- Code readability

```python
if __name__ == "__main__":

    print("Hello EuroPython 2019")
```

```cpp
#include <iostream>

int main() {

    std::cout << "Hello EuroPython 2019";
    return 0;
}
```

```
template <bool C, typename TR, typename FR>
class if_;
template <typename TR, typename FR>
struct if_<true, TR, FR>{ typedef TR result;};
template <typename TR, typename FR>
struct if_<false, TR, FR> { typedef FR result;};
int main() {
  typename if_<true, int, void*>::result n(3);
  typename if_<false, int, void*>::result p(&n);
  typedef typename if_<(sizeof(void *) > sizeof(uint32_t)),
        uint64_t, uint32_t>::result i_ptr_t;
  i_ptr_t c_p = reinterpret_cast<i_ptr_t>(p);
}
```

Compile-time if Template Meta Programming (Wikibooks)

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C++11: auto and decltype

```
const std::vector v(1);
auto a = v[0];        // a: type int
auto c = 0;           // c: type int
auto d = c;           // d: type int
decltype(c) e;        // e: type int, from c
decltype((c)) f = c;  // f: type int&, (c) is an lvalue
decltype(0) g;        // g: type int, 0 is an rvalue
```

https://gcc.gnu.org/projects/cxx-status.html#cxx11

C++11: for loops

```
std::vector<int> v {1, 2, 3, 4, 5};

// Old way
for (int i = 0; i < v.size(); i++)
    x += v[i];
// or with an iterator...
```

```
// getting ints from v
for (int &i : v)
    x += i;
```

```
// using type inference
for (auto &i : v)
    x += i;
```

https://gcc.gnu.org/projects/cxx-status.html#cxx11

C++11: lambda functions

```
// [](int x, int y) -> int { return x + y; }
// [&x](int i) -> int { x += i; }

std::vector<int> v{ 1, 2, 3, 4, 5 };
int x = 0;
std::for_each(begin(v),
              end(v),
              [&x](int i) {
   x += i;
});
```

https://gcc.gnu.org/projects/cxx-status.html#cxx11

C++20 and Python: for

```
// ranges-v3
#include <range/v3/all.hpp>
using namespace std;
namespace v = ranges::view;

for (auto i : v::ints(0, 5))
    cout << i << endl;
```

```
for i in range(0, 5):
    print(i)
```

https://gcc.gnu.org/projects/cxx-status.html#cxx2a

C++20 and Python: palindrome

```cpp
#include <range/v3/all.hpp>
namespace r = ranges;
namespace v = r::view;

bool is_palindrome(std::string_view word)
{
   return r::equal(word, v::reverse(word));
}
```

```python
def is_palindrome(word):
   #return word == word[::-1]
   return word == "".join(reversed(word))
```

Extending Python with C++

Looking under Python

```
// Include/object.h
typedef struct _object {
    _PyObject_HEAD_EXTRA
    Py_ssize_t ob_refcnt;
    struct _typeobject *ob_type;
} PyObject;
```

WHY DOES PYTHON LIVE ON LAND
BECAUSE IT'S ABOVE C-LEVEL
imgflip.com

Creating a module

Let's look at the code.

so...

What is Qt?

Qt /kjut/

Cross platform C++ framework, for UI and more.

...but what about Python?

It's around 2007...

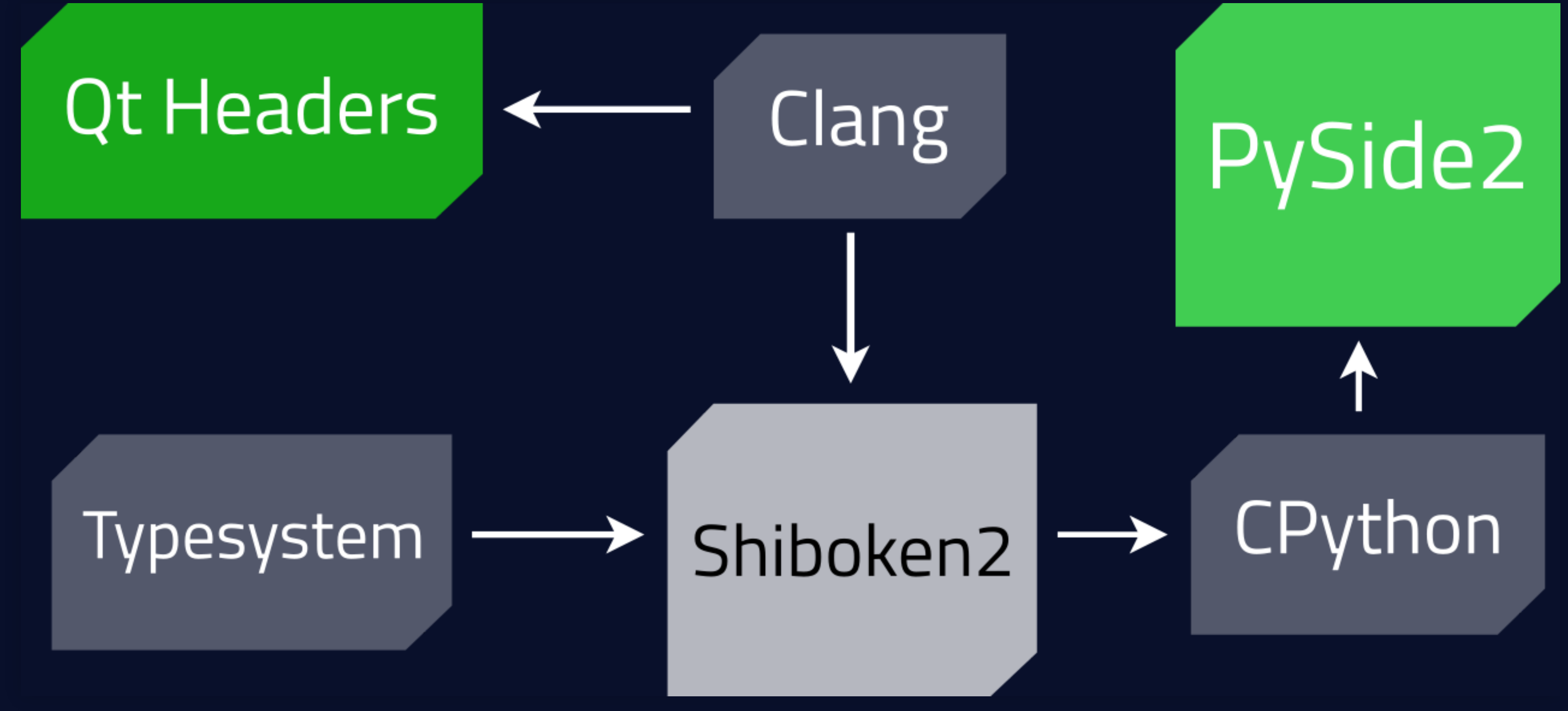
Which options do we have?

- Raw CPython
- SWIG - swig.org
- Boost::Python - boost.org

The story of PySide

2008	2015	2016	2018
Qt4 Development (PySide)	Qt5 Port (PySide2)	Back to the Qt Project	Released (Qt for Python)

How do we do it?



Shiboken

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doc.qt.io/qtforpython/shiboken2

Other nice options

- pybind11 - pybind11.readthedocs.io
- cffi - cffi.readthedocs.io
- cppyy - cppyy.readthedocs.io
- sip - riverbankcomputing.com/software/sip

Creating a more useful module

Let's look at the code.

Summary

	Type	C++	Python	License	Support
boost::python	Interface	C++11+	2.7, 3.0	BSL-1	Boost
SWIG	Code gen	C++11+	1.5+	GPL3	-
shiboken	Code gen	C++11 (*)	2.7, 3.5+	LGPLv3	Qt
sip	Code gen	C++11 (*)	3.5+	GPLv3	Riverbank
pyBind11	Interface	C++11 (*)	2.7, 3.x	BSD-3	-
cffi	Interface	C89, C99 (*)	2.6+, 3.0+	MIT	PyPy
cppyy	Interface	C++11+	2 and 3	UC	-

Q&A

Qt for Python
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