Python at Twist Bioscience: Improving performance with Rust

Kieran Hervold, Bioinformatics
khervold@twistbioscience.com

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Getting Started

Install Rust

```
curl https://sh.rustup.rs -sSf | sh
```

Clone today's repo

```
https://github.com/Twistbioscience/pycon-rust
```

Making Python Faster

- numpy
- Pypy
- Cython
- C/C++ with SWIG or Boost

A New Option: Rust

Rust topped the list of most loved programming languages in Stack Overflow's 2016 developer survey

Mozilla's next-generation browser, code-named Servo, is being written in Rust

- https://github.com/servo/servo/tree/master/components

A “safe, concurrent, practical systems language”

Built on a modern type system (no NULL!)

- Algebraic data types similar to Haskell, ML, F#, Scala, etc

Polymorphism via Traits

Decent iterator library

Automatic memory management through the borrow-checker

- no garbage collection overhead
- stack allocation reduces cache misses (Java's missing "Value Types")
- borrow-checker prevents dangling pointers

Rust Ergonomics

Cargo build system

Built-in testing framework: #[test]

Automatic Trait implementation: #[derive(Debug)]

ex1-println.rs

```
#[derive(Debug)]
enum Sentence {
    Period,
    Word { text: String, count: usize }
}

fn main() {
    let sentence = vec![ Sentence::Word { text: "Simple".to_string(), count: 1 },
                         Sentence::Word { text: "Rust".to_string(), count: 2 },
                         Sentence::Word { text: "demo".to_string(), count: 1 },
                         Sentence::Period ];
    println!("{:?}", &sentence);
}
```

```
[Word { text: "Simple", count: 1 }, Word { text: "Rust", count: 2 },
 Word { text: "demo", count: 1 }, Period]
```

Rust bindings in Python, ex 1: Fast Inverse Sqrt

slides/src/lib.rs

```
#[no_mangle]
pub extern fn fast_inv_sqrt(x: f32) -> f32 {
    let i: u32 = unsafe { std::mem::transmute(x) };
    let j = 0x5f3759df - (i >> 1);
    let y: f32 = unsafe { std::mem::transmute(j) };
    y * (1.5 - 0.5 * x * y * y)
}
// credit to https://github.com/itchyny/fastinvsqrt
```

slides/example.py

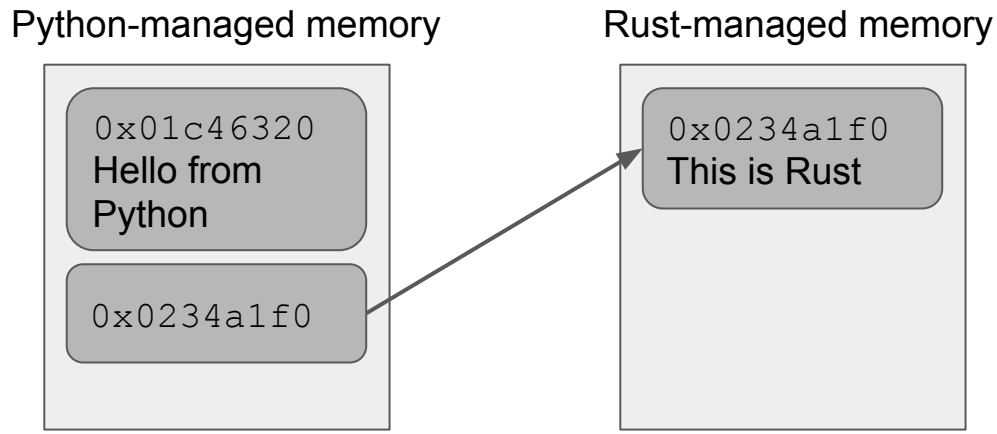
```
import ctypes

ex_lib = ctypes.CDLL("target/release/libtwist_pycon_slides.dylib")
ex_lib.fast_inv_sqrt.restype = ctypes.c_float
ex_lib.fast_inv_sqrt.argtypes = [ctypes.c_float]
print ex_lib.fast_inv_sqrt( 4.0 )
print ex_lib.fast_inv_sqrt( 9.0 )
```

```
0.499153584242
0.332953214645
```

FFI Bindings: Sharing Memory

The problem: Python and Rust maintain separate records of memory allocation



`ctypes`' default String handling is broken

➔ **`* char` wrapped in a Python string**

➔ **memory released when the string falls out of scope**

This is a problem for any C Foreign Function Interface library

Returning Pointers from Rust

simple_mc/python/simple_mc.py

```
import ctypes

lib = ctypes.CDLL("target/release/libsimple_mc.dylib")

lib.read_corpus_file.argtypes = [ctypes.c_char_p]
lib.read_corpus_file.restype = ctypes.c_void_p

lib.ext_generate_sentence.argtypes = [ctypes.c_void_p]
lib.ext_generate_sentence.restype = ctypes.c_void_p

# release really expects the char * from above, but we'll call it a void *
lib.release_str.argtypes = [ctypes.c_void_p]

...
p = lib.ext_generate_sentence( pointer )
sentence = ctypes.cast(p, ctypes.c_char_p).value
```

Example Algorithm: Markov Chains

Calculate word frequencies based on a corpus of text

```
defaultdict(lambda: defaultdict(int))
```

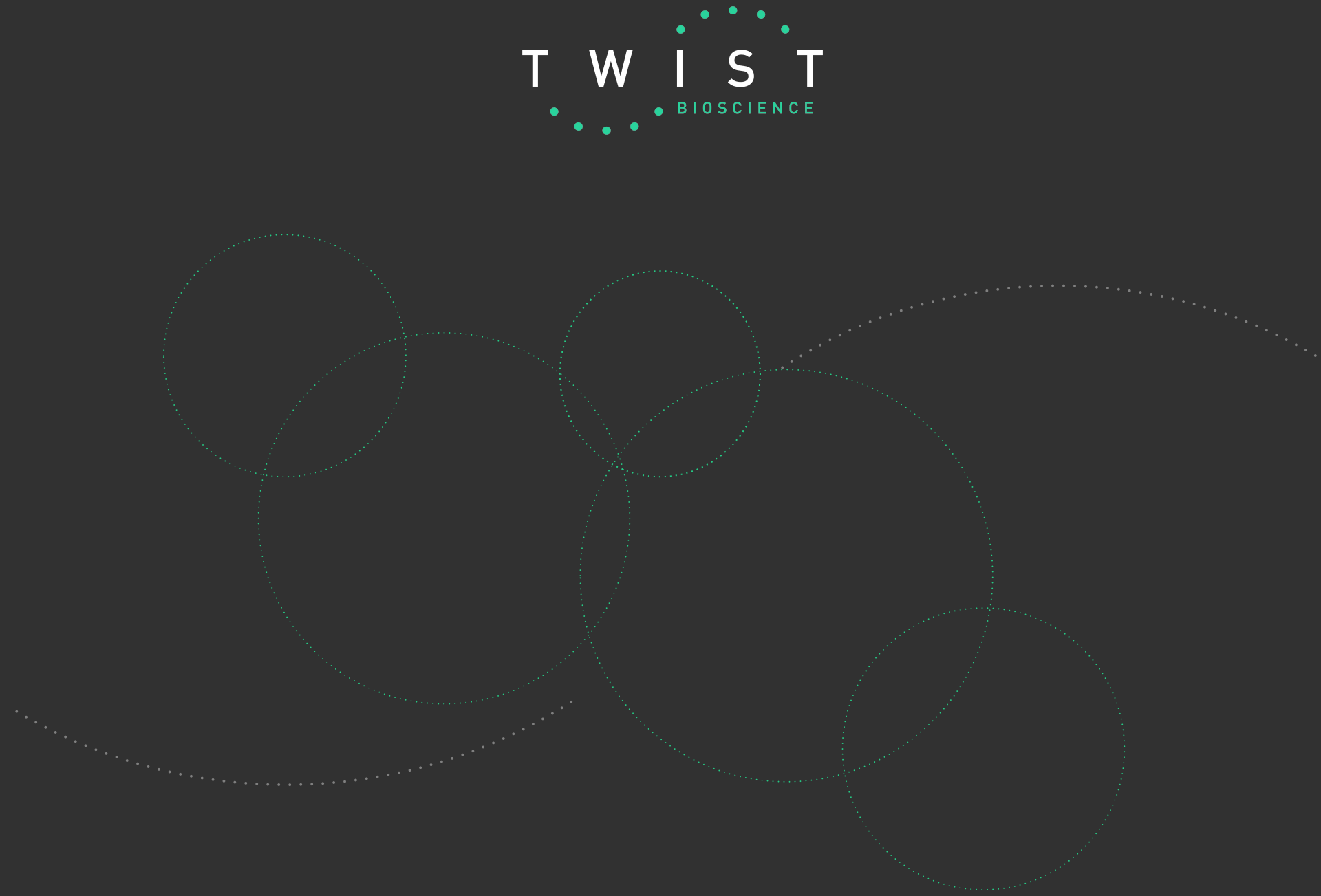
Example:

> it said it would continue to be the exclusive worldwide licensee of the technology for woodco

be	the	1
continue	to	1
exclusive	worldwide	1
for	woodco	1
it	said	1
	would	1

To the code ...

https://github.com/Twistbioscience/pycon-rust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