Rust @ Code4Fun

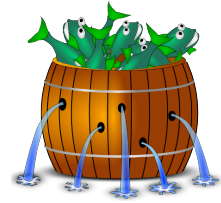
Stefan Kaestle

June 19, 2019

About me

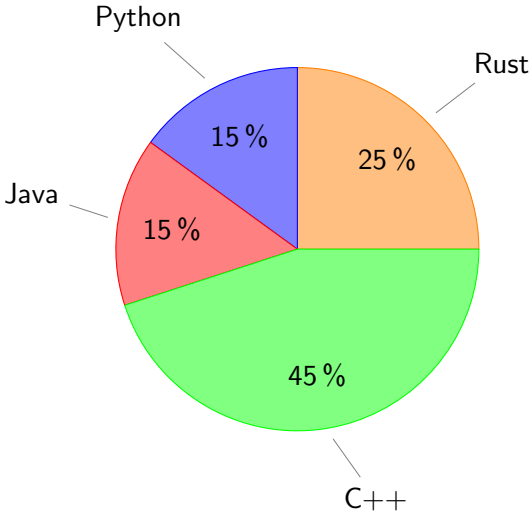
- Stefan
- Since 2016: Oracle Labs, Distributed Graph Processing
- Background: ETH Systems Group, Barrelfish OS
- Rust since ∼9 months
  - So absolutely no expert :-)

ETH zürich

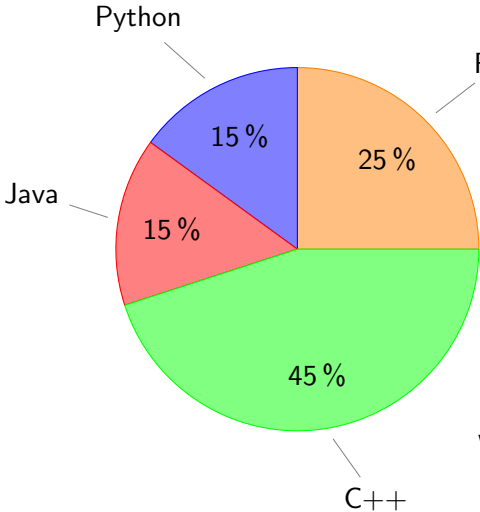


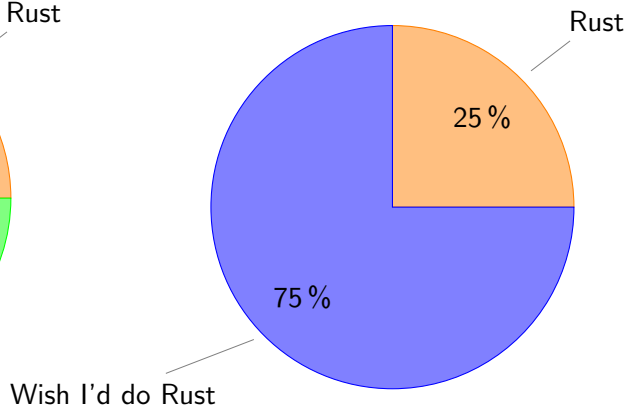
ORACLE

About me: Programming languages



About me: Programming languages



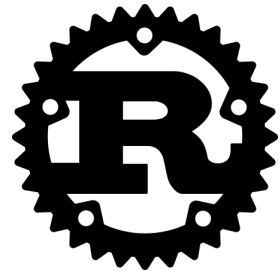


Section 1

Intro to Rust

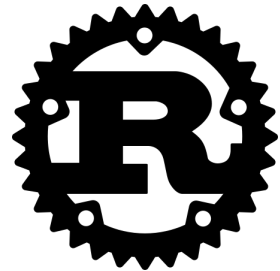
Short history of Rust

- Developed by Mozilla Research
- Goal: better memory safety, but retain high-performance
- Announced in 2010
- 2011: First successfully compiled `rustc`



Short history of Rust

Ohh, and there's this little fella
Meet ferries, the crab



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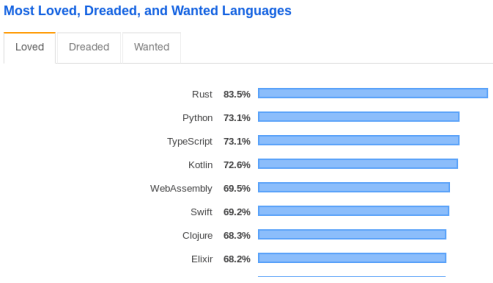

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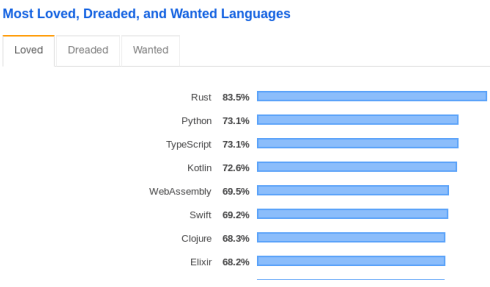
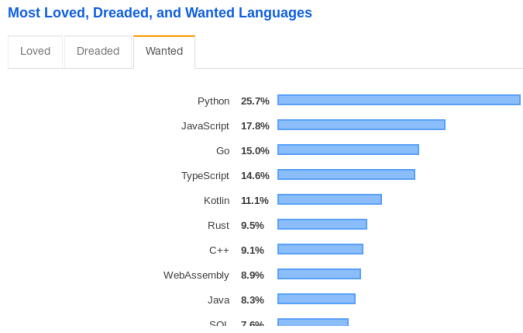
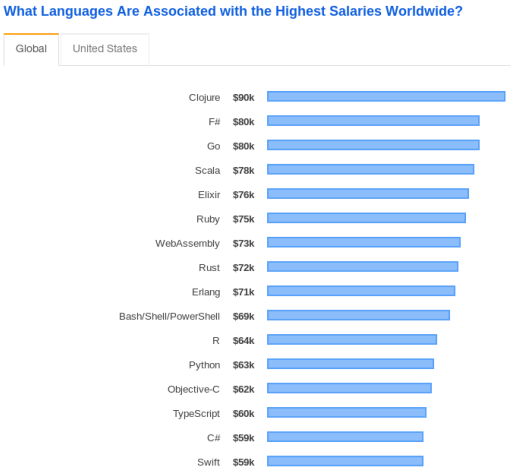




- People love it
- Interest to learn it

Why Rust?



- Rustaceans get paid well

Why now?

Industry puts Rust to production

- Mozilla: sytlo, soon WebRender
- Dropbox: storage system
- Facebook: Mercurial rewrite
- Google: Fuschia OS
- Amazon: Firecracker VMM
- Microsoft: Azure
- Oracle: railcar

Why Rust - better programs

- Robustness + Reliability
  - Memory safety
  - Thread safety
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- Robustness + Reliability
  - Memory safety
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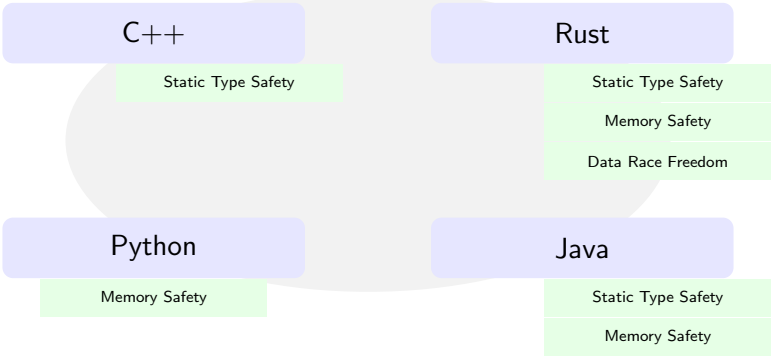
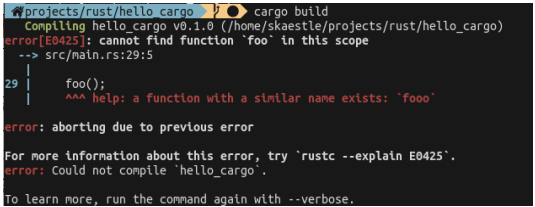
  - Result error types (`Result<T, E>`)
- Performance
  - Compiled language
  - *No garbage collection*
  - Lightweight standard lib

Overview: Safety in programming languages

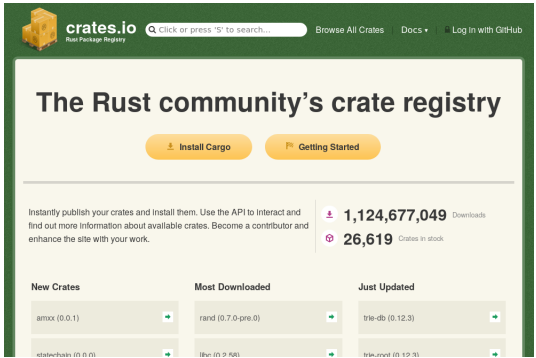


Why Rust - benefits for programmers



- Extremely helpful compiler messages
- Push complexity to compilation, rather than runtime
- Very good tooling
- Good IDE integration
- Good documentation: `rustup doc`

Dependency management



- Large selection of external modules (called *crates*)
- Generally very good code quality

more later

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- Goal today: help you get over the initial fear
- Plus: Rust community generally very helpful

Section 2

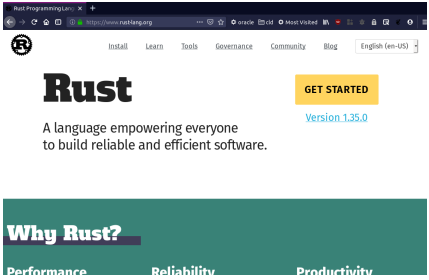
Okay, let's get started

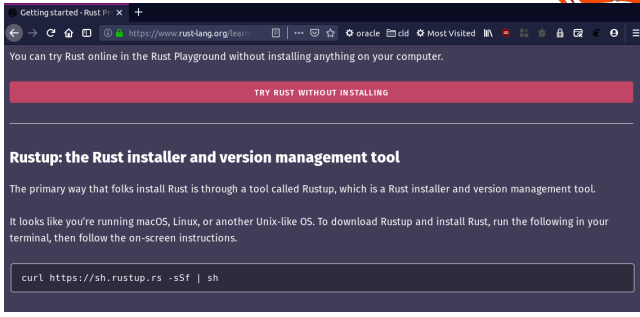
Let's get started

- `fn` keyword for functions
- Relatively similar to C/C++

```
fn main() {
  println!("Hello world");
}
```

Installing Rust





- Download from rust-lang.org → Get started
- Also: online editor: play.rust-lang.org
- Default settings in installer work well
- User installation works, no root needed
- Need `build-essentials`

Rust tooling

`rustc`

- The Rust compiler
- Normally not used directly

`rustup`

- Used to manage and update tool-chains
- Documentation and help with error handling

`cargo`

- Rust's build system
- Used to create projects
- Dependency management
- Compile your programs `cargo build`
- Run your programs `cargo run`

More in Rust book

Meet cargo

```
> which cargo
> which rustc

> cargo new hello_world
> cd hello_world
> ls -R
.:
Cargo.toml  src

./src:
main.rs
```

- Creates an empty project
- Creates a git repository
- Two files
  - `Cargo.toml`: Dependency management and project info
  - `main.rs`: Main Rust file

Lets run it

```
cargo run
```

```
/tmp/hello_world ❯ ● cargo run
   Compiling hello_world v0.1.0 (/tmp/hello_world)
    Finished dev [unoptimized + debuginfo] target(s) in 0.40s
     Running `target/debug/hello_world`
Hello, world!
```

- That wasn't all too hard!
- Also:
  - `cargo run --release`
  - `cargo build [--release]`
  - Compiled binaries are in `target/{release,debug}/{app}`
  - Rust compiler uses `clang`

Section 3

Playtime

Playtime — recap

- Functions
- Error handling
- Variables, default: immutable
- Typed w/ inference

```
fn hello(s: String) {
  println!(s);
}

fn main() {
  let mut s = "Hello".to_string();
  s += " world";
  hello(s);
}
```

Section 4

Memory safety

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- Like Java:
  - Automatic memory dealloc
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- Like Java:
  - Automatic memory dealloc
  - Checks index out of bound
- *But:* No garbage collection (GC) needed
  - $\rightarrow$ No overhead from running GC
- Instead: ownership + borrow checker
- Sharing: wrap data in synchronization primitives, checked by compiler

Garbage collection: memory management in Java

Short review of garbage collected languages, here: Java
Slides from: RustConf17

```
void main() {
  Vector name = …;
  helper(name);
  helper(name);
}
```

```
void helper(Vector name) {
  …
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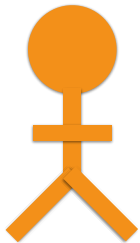

“Ownership” in Java

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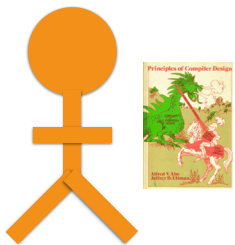

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Take **reference** to Vector

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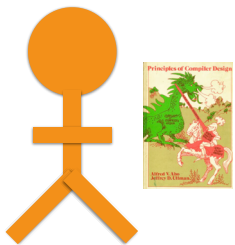

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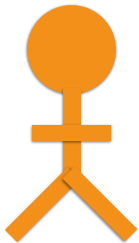

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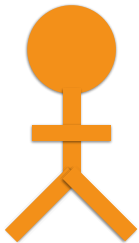

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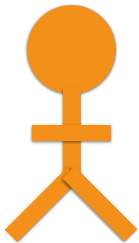

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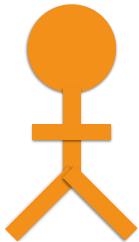
“Ownership” in Java

Ownership in Rust

Hold on tight: this is going to be a bit more tricky (but perhaps easier than GC).
Slides from: RustConf17




Principles of Compiler Design
Alfred V. Aho
Jeffrey D. Ullman

Ownership

```
fn main() {
  let name = format!("…");
  helper(name);
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}
```

```
fn helper(name: String) {
  println!(..);
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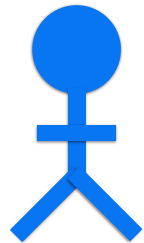

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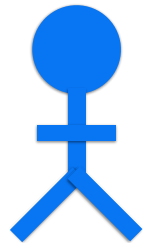
Take ownership of a String



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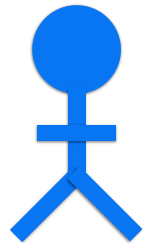

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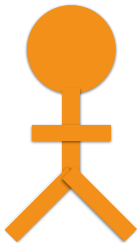

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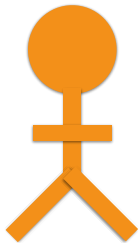

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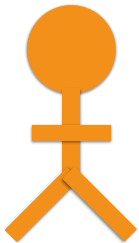

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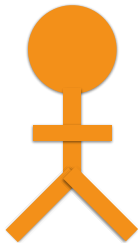

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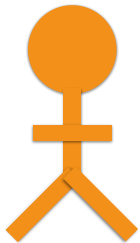

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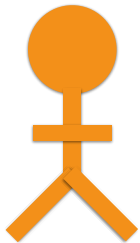
Error: use of moved value: `name`



Ownership

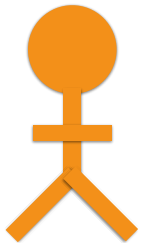
Ownership in Rust: Borrowing

What about references?
Slides from: RustConf17

Borrowing: Shared Borrows

```
fn main() {
  let name = format!("…");
  let reference = &name;
  helper(reference);
  helper(reference);
}
```

```
fn helper(name: &String) {
  println!(..);
}
```



Shared borrow

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  let name = format!("…");
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  helper(reference);
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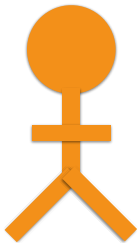

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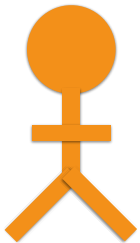
Lend the string,
creating a reference



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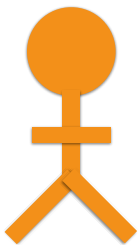

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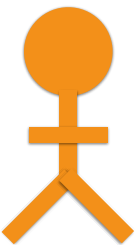

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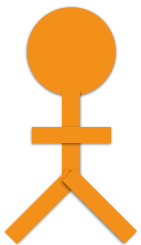

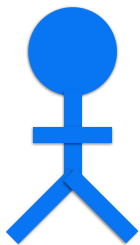

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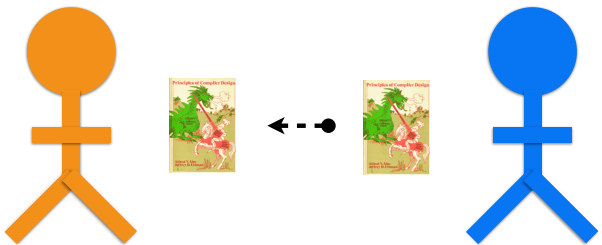

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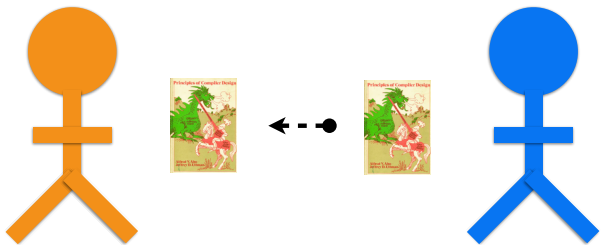

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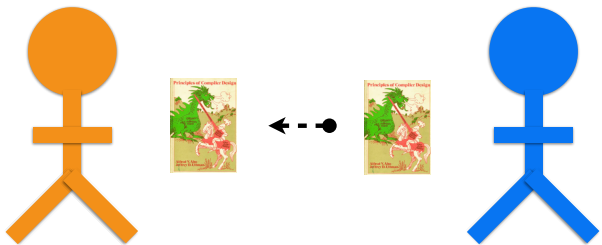

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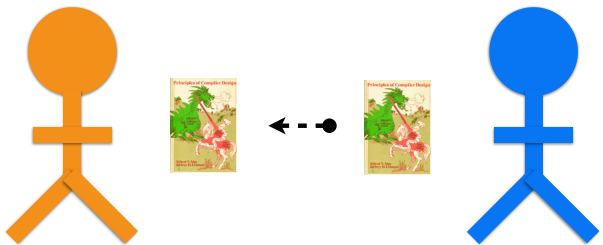

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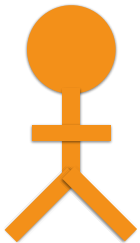

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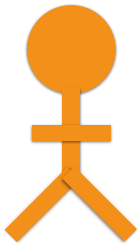

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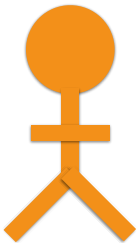

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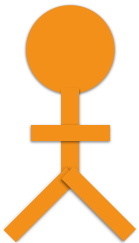

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```

Shared borrow

Shared == Immutable

```
fn helper(name: &String) {
  println!(“{}”, name);
}

fn helper(name: &String) {
  name.push(‘x’);
}
```

Shared == Immutable

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fn helper(name: &String) {
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OK. Just reads.

```
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Error. Writes.

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error: cannot borrow immutable borrowed content `*name`
       as mutable
    name.push_str(“s”);
    ^^^^
```

Shared == Immutable*

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* **Actually:** mutation only in **controlled circumstances**.

Section 5

Thread safety

Thread safety

- Sharing possible by means of reference, as with C/C++ and Java
- One writable reference to data only
- *Or* arbitrarily many read-only references

Section 6

A proper example: ORM + webserver

Setup dependencies

Diesel: ORM for Rust

- `cargo install diesel_cli --no-default-features --features mysql`
- `echo DATABASE_URL="mysql://rustuser:\%23Code4Fun@130.61.92.85/"\`
  `"rustdemo" > .env`
- diesel setup
- diesel print-schema

Where to go from here?

- Look at the Rust book
- Join meetup “Rust Zurich”