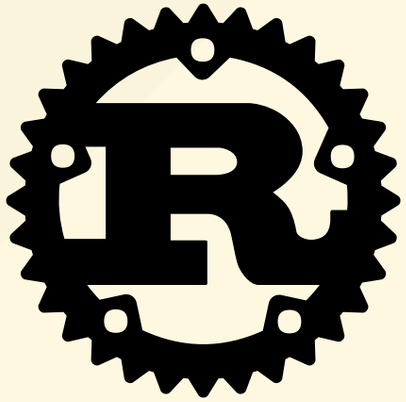
Rust

A safe systems programming language



Features

Some of Rust's selling points:

- **guaranteed memory safety** (current research topic)
- **threads without data races**
- generics
- pattern matching
- zero-cost abstractions ("What you don’t use, you don’t pay for.")
- Rust balances control (unmanaged) and safety (memory managed languages

Quick Comparison

Rust	Python
compiled	interpreted (GIL)
static strong typing with *type inference*	*dynamic* and *strongly* typed
automatic[1] /wo GC ➡ real time capable	garbage collected
{ curly brace language }	indentation based

[1] you have to think about variable scopes

History

- in development since 2010
- first stable release (1.0) on May 15, 2015
- since then about every 6 weeks a new minor versions
  - 1.10 at the time of writing
- open source project backed by Mozilla, Samsung and others

Competition

Similar languages in order of common features:

- nim
- C++
- D
- Swift

Companies that use Rust

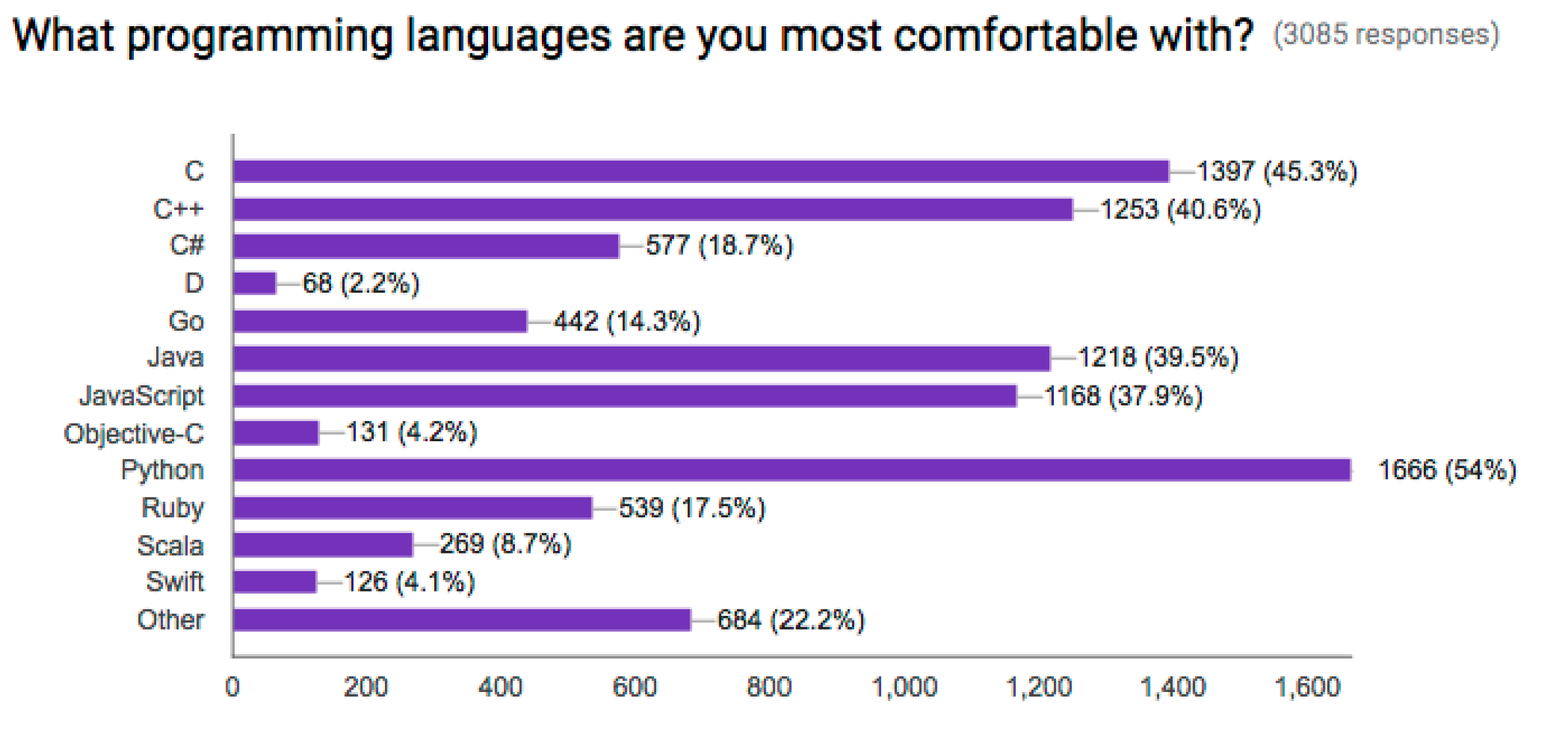
- Servo, Mozilla's next generation parallel browser engine
- Brotli decompressor from Dropbox
- ... many more

Rust is often used as a replacement for C to write safe and performant external modules for Ruby (RoR) or Python applications.

Trivia

- Rust programmers are called *rustaceans* (like pythonistas)
- the language is named after a fungus
- idiomatic Rust code is called *rusty* or *rustic*
- Ferris the Crab

Rust 👭 Python


What programming languages are you most comfortable with? (3085 responses)
C
C++
C#
D
Go
Java
JavaScript
Objective-C
Python
Ruby
Scala
Swift
Other
1397 (45.3%)
1253 (40.6%)
577 (18.7%)
68 (2.2%)
442 (14.3%)
1218 (39.5%)
1168 (37.9%)
131 (4.2%)
1666 (54%)
539 (17.5%)
269 (8.7%)
126 (4.1%)
684 (22.2%)
0
200
400
600
800
1,000
1,200
1,400
1,600

Compiled Language

- Python is interpreted (at runtime)
- Rust's compilation steps (MIR since 1.9):

Source ➡ (HIR ➡ MIR ➡ LLVM IR ➡) Machine Code

- [C]Python: source (.py) ➡ bytecode (.pyc) ➡ runtime
- LLVM intermediate representation (IR) is used by many compilers for a lot of different languages: clang (C), Swift, D, Haskell, **Pyston**, ...
- Rust benefits from improvements of LLVM's optimization steps

Hello World

```
fn main() {
    let words = ["Hello", "pythonistas"];
    for word in words.iter() {
        print!("{} ", word);
    }
    println!("!");
}
```

Compile & Run

```
$ rustc hello.rs -o hello && ./hello
Hello pythonistas !
```

Installation

- Linux, Win (e.g. cygwin bash), OSX:

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

- Rust comes in different flavours: *stable, beta, nightly*
- `rustup` (former multirust) lets you install different Rust versions side-by-side
- `rustup` also manages target platforms for cross-compilation
- Rust's package manager called `cargo` is also part of the bundle

Cargo

- Rust's package manager and build tool
- Packages are called *crates*
- ~5.6k crates on crates.io
- **No** batteries included but there is a crate for everything
- test runner, dependency managament (pip), documentation generator, ...
- additional features through plugins

```
$ cargo --list
Installed Commands:
    bench
    build
    check
    clean
    clippy
    doc
    fetch
    fmt
    generate-lockfile
    git-checkout
    graph
    help
    init
    install
    locate-project
    login
    ...
```

Setup a new project (`--bin` application, default is library):

```
$ cargo new --bin example
$ tree example
example
├── Cargo.toml // ~requirements.txt && setup.py
└── src/
    └── main.rs
```

```
$ cargo run
   Compiling example v0.1.0 (file:///home/andreas/personal/presentations/lpug-R
     Running `target/debug/example`
Hello, world!
```

Variables

- immutable by default
- create a variable binding: `let name: type = value;`
- mutable binding: `let mut x: type = value;`
- must be initialized with some value
- `type` can often be inferred

Ownership

- variable *bindings have ownership*
- if a binding goes out of scope its resources are freed
- Rust ensures that there is only **one** binding to any resource

Borrowing

- *borrowing* is lending a reference `&T` to a resource

```
sum(&[1,2,3,4,5]);
```

- resource is not freed when reference gets out of scope
- **borrowing rules**:
  1. one or more references `&T` to a resource (shared borrow)
  2. exactly one (even across threads) mutable reference `&mut T` (mutable borrow)

Lifetimes

- references have lifetimes
- a reference can't outlive the resource it is pointing at
- if the compiler can't infer the lifetime then it must be declared

```
// implicit
fn foo(x: &i32) {
}

// explicit
fn bar<'a>(x: &'a i32) {
}
```

Enums

- Rust's enums are *algebraic datatypes*
  - **algebraic**: build from product types (tuples, structs) and sum types (only one variant at any one time, e.g. enum variants)

```
enum Message {
    Quit, // variant /wo data
    ChangeColor(i32, i32, i32), // tuple variant
    Move { x: i32, y: i32 }, // struct (≈dict) variant
    Write(String), // single value variant
}
```

Pattern Matching 📝

```
enum E {
    A,
    B(i32)
}

fn main() {
    let e = E::B(4);
    match e {
        E::A => println!("I'm an A!"),
        E::B(x) => println!("I'm an B with value: {}!",x),
    }
}
```

Iterators 📝

- list/dict comprehensions on stereoids
- lazy evaluated, must be consumed to get the value
- get a vector with values from 0 to 9:
  ```
  let v = (0..10).collect::<Vec<_>>::();
  ```
- iterator cheat sheet

Traits 

- defines functionality an implementing type must provide

```
use std::ops::Add;

struct Pair { a: f64, b: f64 }

impl Add for Pair {
    type Output = Pair;

    fn add(self, other: Pair) -> Pair {
        Pair {
            a: self.a + other.a,
            b: self.b + other.b,
        }
    }
}
```

Generics 📝

- parameterized type

```
use std::ops::Add;

// looks a bit strange, but
// the output can be different from the input
// type.
fn add<T: Add<T>>(x: T, y: T) -> T::Output {
    x + y
}

fn main() {
    println!("{}", add(3.0, 0.14159265359));
    println!("{}", add(30_000u64, 40_000));
}
```

Error Handling

- **no exceptions**, errors are values (like in Go)

```
fn read_file(path: Into<String>) -> Result<Vec<u8>,IOError> { ... }

let data = match read_file("./some.file")  {
    Ok(data) => data,
    Err(error) => panic!(err),
}
```

- there are certain macros and methods to avoid explicit matching of common `Option` and `Result` types (`try!`)

```
// shorter version from above
let data = read_file("./some.file").expect("could not read file");
```

Macros

- end with an `!`: `println!`
- expandend at compile time
- hygienic macros: expand always to valid code at compile time (unlike C's text based preprocessor macros)

Tools

rustfmt

- `cargo install rustfmt`
- de-facto standard for code formatting, like go's `gofmt` but a bit less opionated
- `autopep8` □ `rustfmt`
- the rusti project aims to provide a REPL for Rust

clippy

- sophisticated linter
- `> 160` lints
- really nice for beginners to see antipatterns (index based loops instead of iterators, etc.)
- requires Rust nightly build (`rustup` 🎉) because the compiler plugin API is not stable yet

Pros

- very friendly and helpful community - code of conduct
- incredibly good documentation
- great tooling
- transparent language development, core team that decides about RFCs, internals.rust-lang.org
- play.rust-lang.org

Cons

- infrastructure too immature for productive use (depends)
- steep learning curve (fight against the borrow checker)
  - (+) learning Rust will give you a new perspective on how your code is executed
- debugger support could be better

Resources

- The Rust Programming Language - The official Rust book
- users.rust-lang.org
- rustplatz
- /r/rust
- #rust-beginners IRC
- community overview or rustaceans.org

width: 300%

See you @ Rustfest?

First european Rust conference

September, 17th and 18th in Berlin

Questions?

Thank you for listening!

Made with ❤ and marp editor

klingt.net

Andreas Linz - 2016