

CMSC 330: Organization of Programming Languages

Safe, Low-level Programming with **Rust**

The C programming language

- Was invented in the 70s but is still among the most popular languages. Why?
 - Low-level control, careful memory management
 - Despite serious risks
- Why not a type-safe language?
 - GC de-facto requirement of type safety
 - Increases memory footprint
 - Adds unpredictable pauses
 - Also: important limitations on concurrency patterns
- Can't we do better?

Type safety and low-level control

- Several research projects in the 90s and 2000s on type safety without GC
 - MLKit, Vault (Microsoft), Cyclone (Cornell, AT&T, UMD, UW) – see <http://cyclone.thelanguage.org>
- Likewise, lots of work on safe concurrency
 - Cyclone (in principle), Java dialects, software transactions (language add-on)
- Big challenge: Sufficient expressiveness
 - Cyclone made it the furthest, but fizzled
 - Finding the right tradeoffs and balance is a big task



- Begun in 2006 by Graydon Hoare
- Sponsored as full-scale project and announced by Mozilla in 2010
 - Changed a lot since then; source of frustration
 - But now: **most loved programming language** in Stack Overflow annual surveys of **2016**, **2017**, and **2018**
- Takes ideas from **functional** and **OO** languages, and **recent research**
- Key properties: **Type safety** despite use of **concurrency** and **manual memory management**
 - And: **No data races**

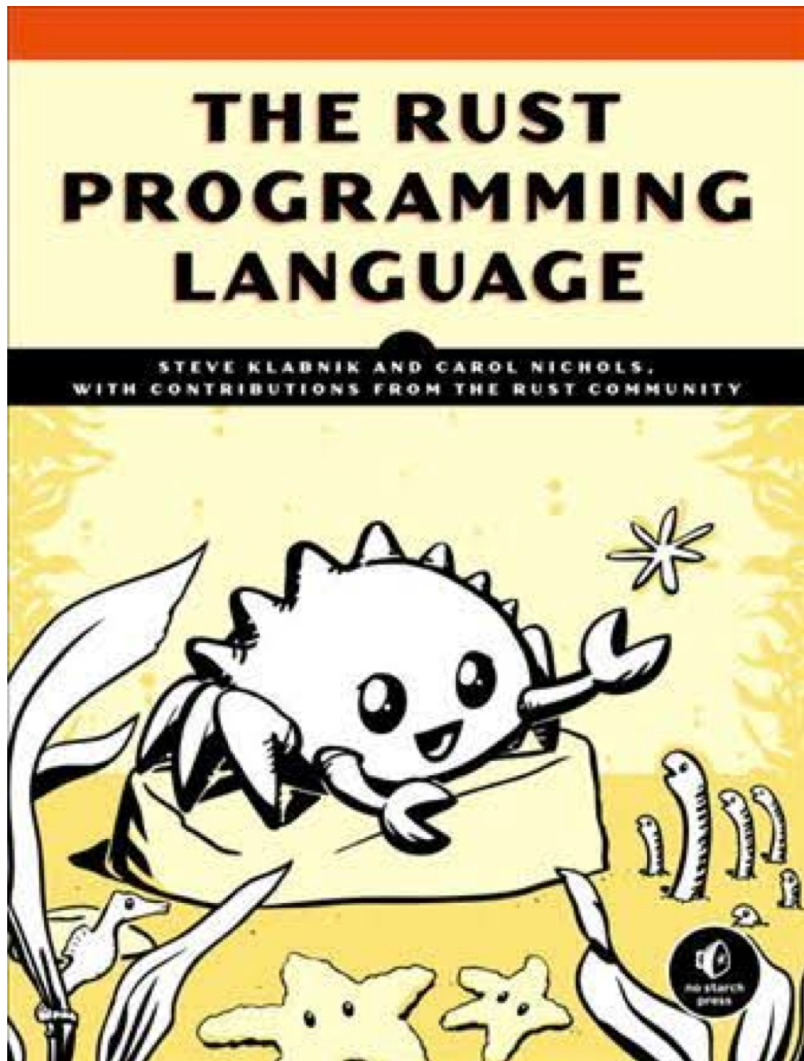
Features of Rust

- Lifetimes and Ownership
 - Key feature for ensuring safety
- Traits as core of object system
- Variable default is immutability
- Data types and pattern matching
- Type inference
 - No need to write types for local variables
- Generics (aka parametric polymorphism)
- First-class functions
- Efficient C bindings

Rust in the real world

- Firefox Quantum and Servo components
 - <https://servo.org>
- REmacs port of Emacs to Rust
 - <https://github.com/Wilfred/remacs>
- Amethyst game engine
 - <https://www.amethyst.rs/>
- Magic Pocket filesystem from Dropbox
 - <https://www.wired.com/2016/03/epic-story-dropboxs-exodus-amazon-cloud-empire/>
- OpenDNS malware detection components
- <https://www.rust-lang.org/en-US/friends.html>

Information on Rust



- **Rust book** free online
 - <https://doc.rust-lang.org/book/>
 - **We will follow it in these lectures**
- More references via Rust site
 - <https://www.rust-lang.org/en-US/documentation.html>