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

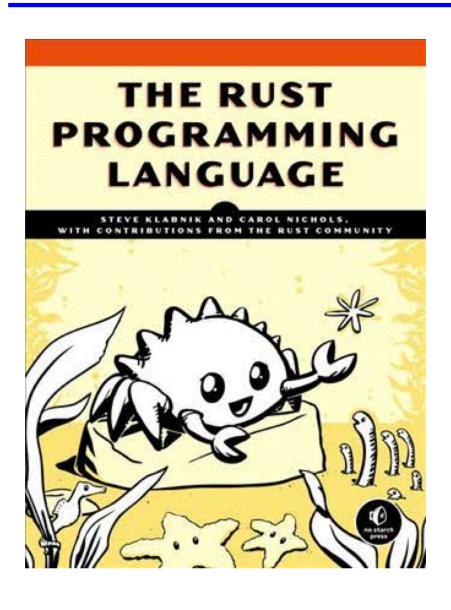
Features of Rust

- 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-dropboxsexodus-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.rustlang.org/en-US/documentation.html