# 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

# Rust

- 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
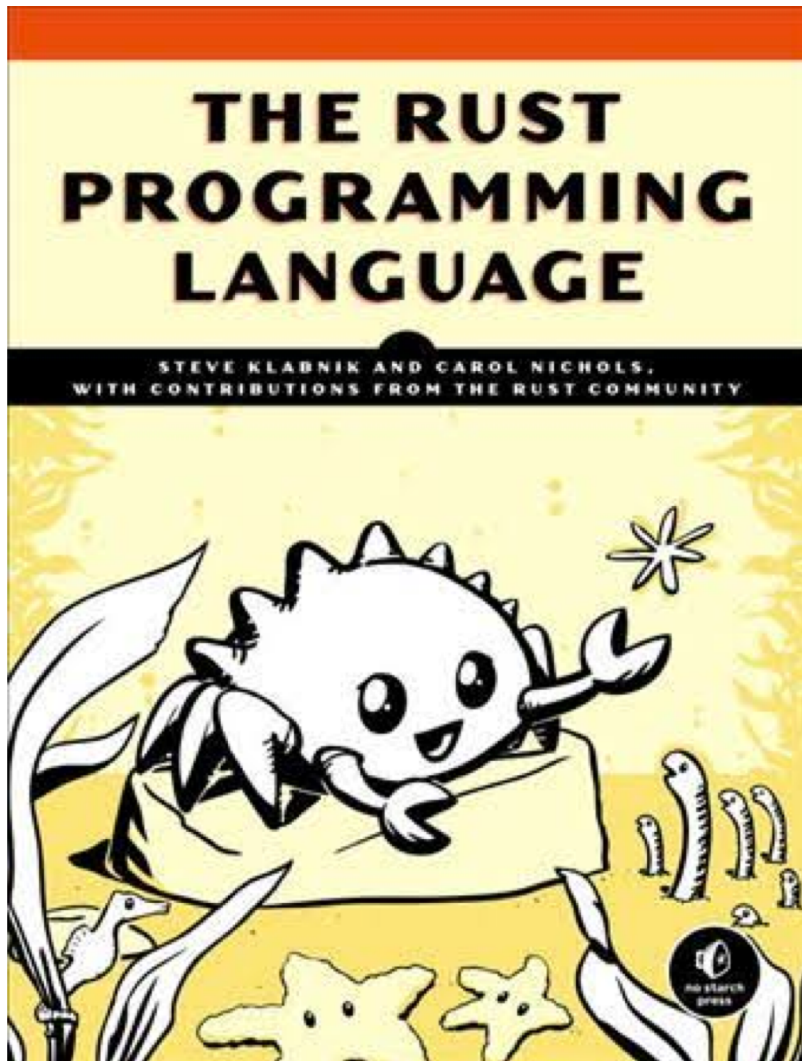  - And: No data races

# 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