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

• OpenDNS malware detection components

Information on Rust

- **Rust book** free online
  - **We will follow it in these lectures**

- **More references** via Rust site