RUSTBELT:

LOGICAL FOUNDATIONS FOR THE FUTURE OF SAFE SYSTEMS PROGRAMMING

Derek Dreyer
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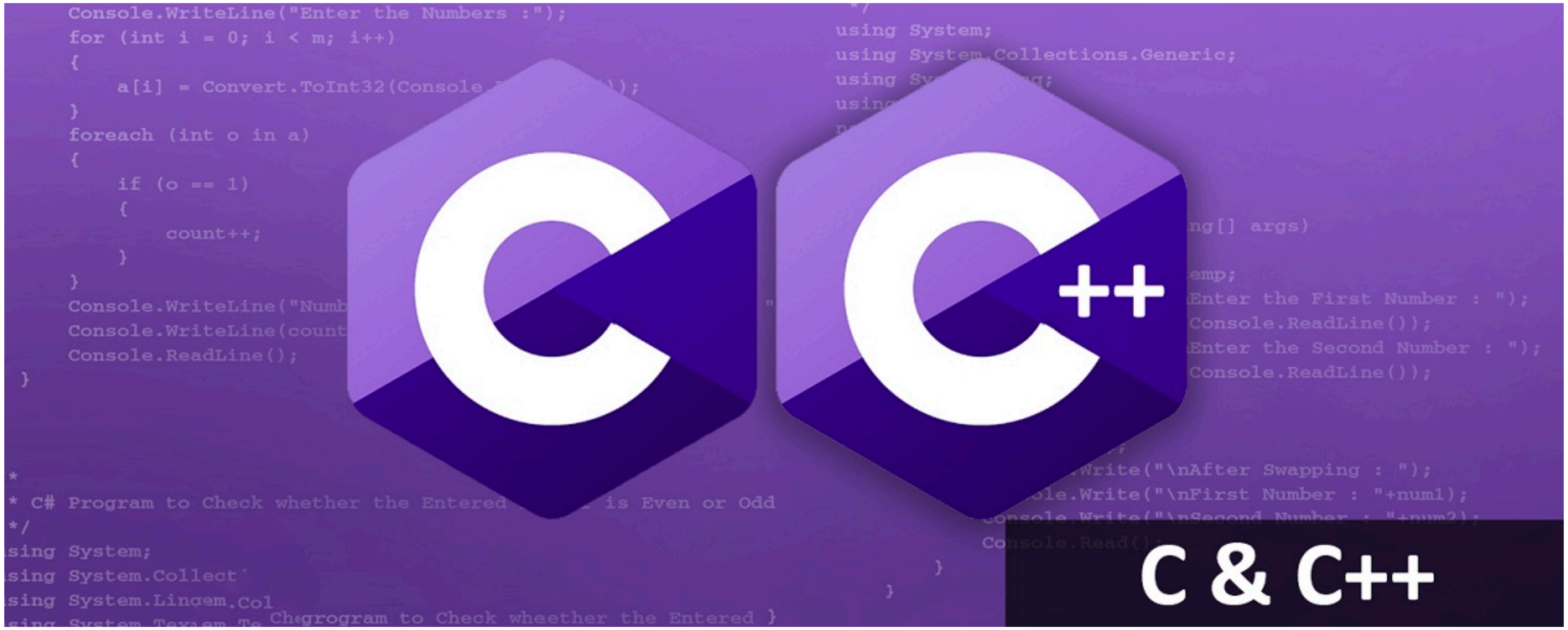
ENS Paris-Saclay Visit
November 2022

A Longstanding Problem

- Many core systems applications require low-level control over memory/resources
- Such applications are typically written in



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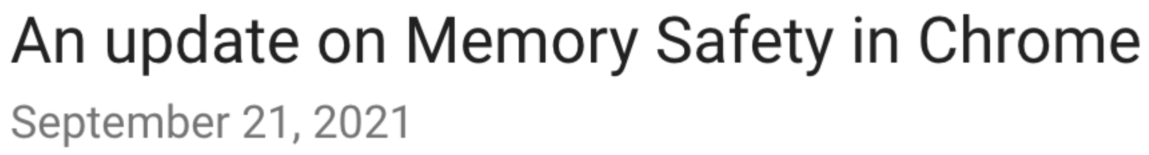
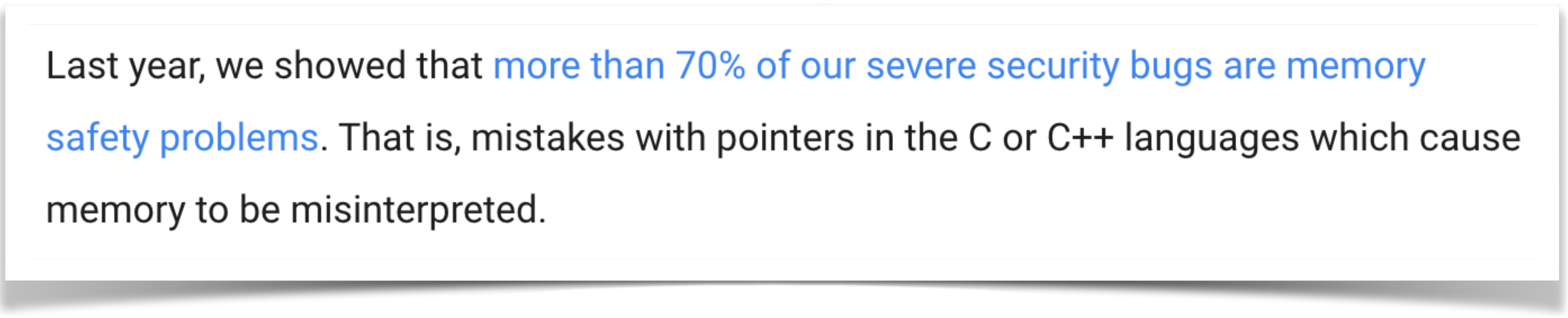
UNSAFE!

from Google Security Blog


An update on Memory Safety in Chrome

September 21, 2021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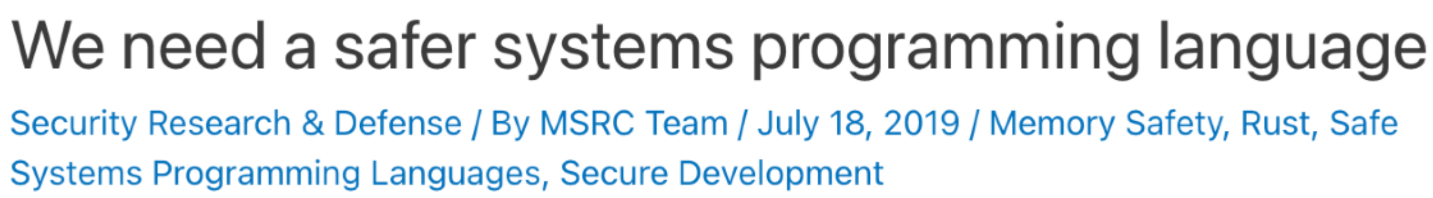
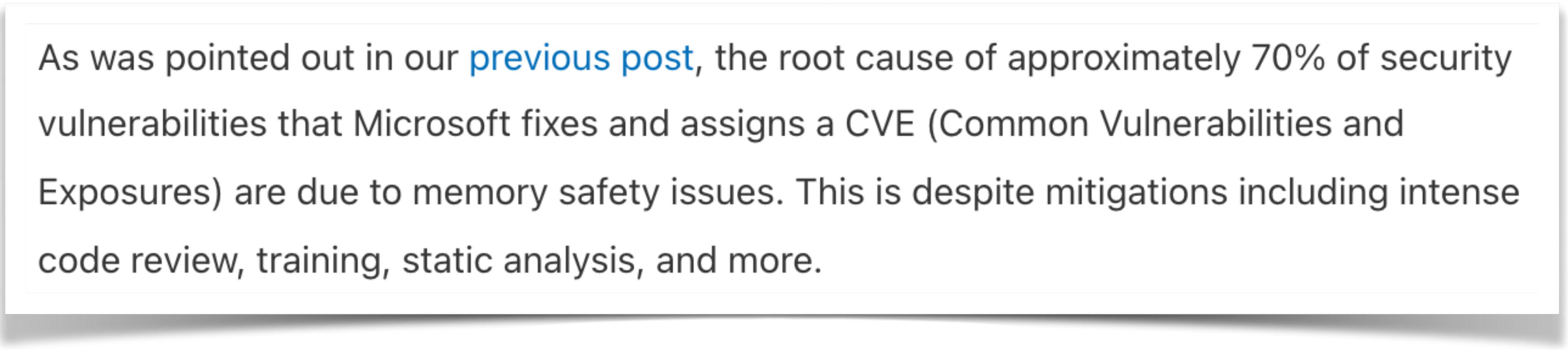
from Microsoft Security Response Center


We need a safer systems programming language

Security Research & Defense / By MSRC Team / July 18, 2019 / Memory Safety, Rust, Safe Systems Programming Languages, Secure Development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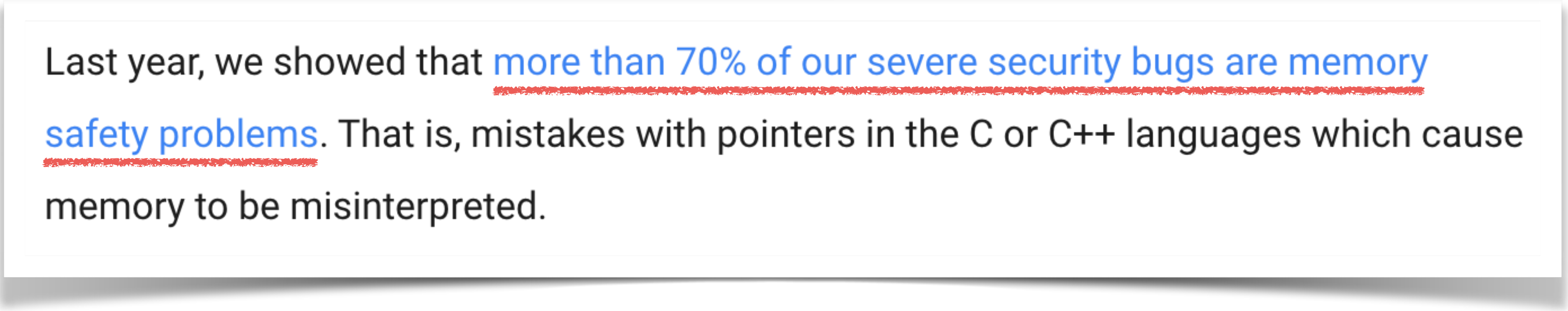

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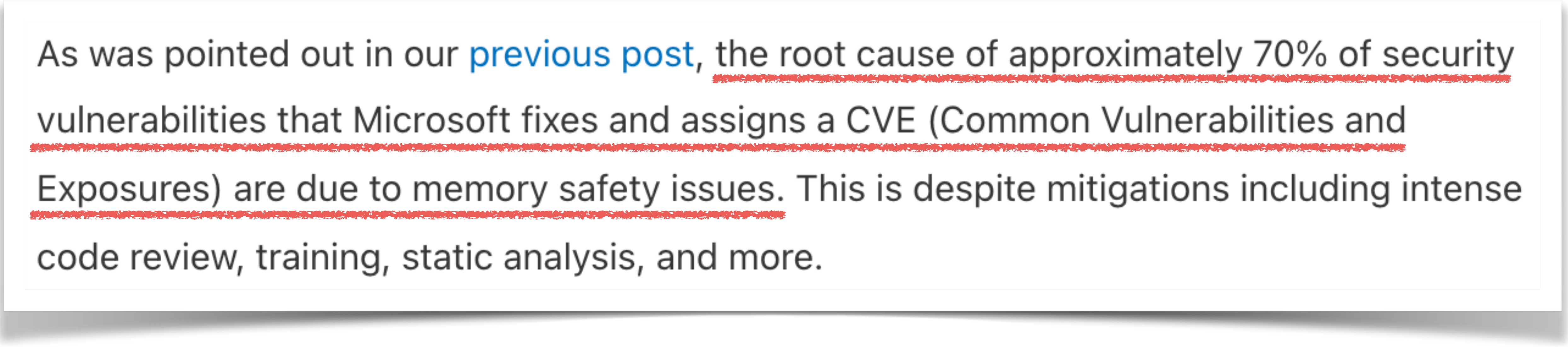

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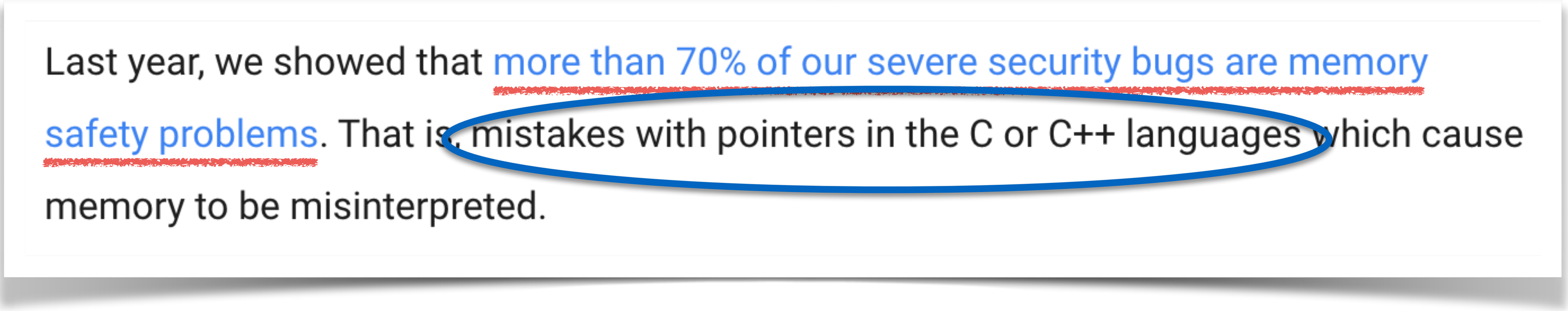

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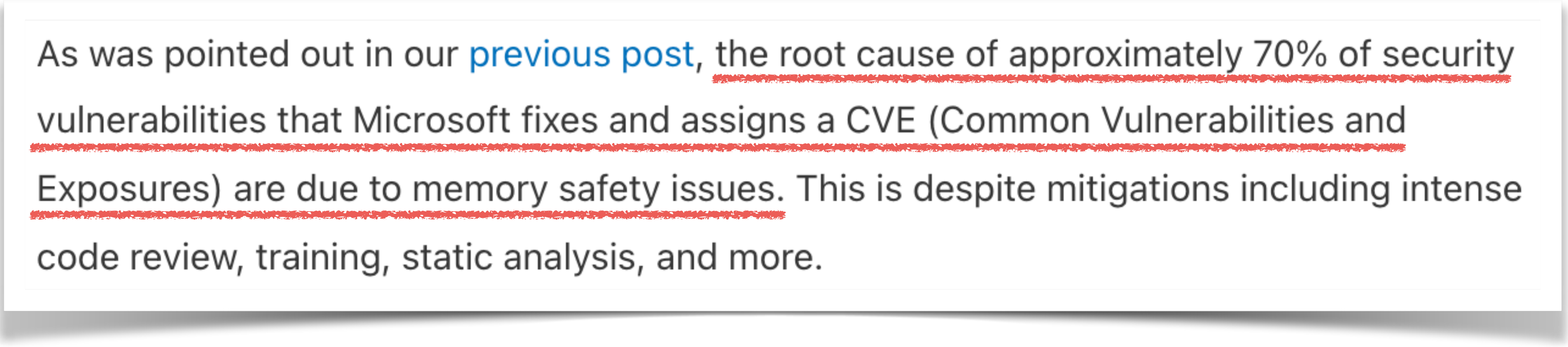

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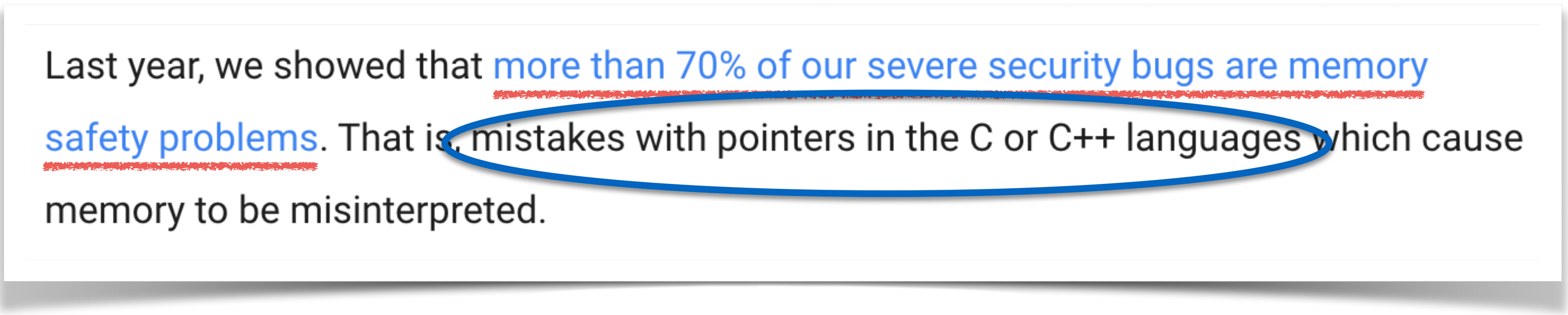

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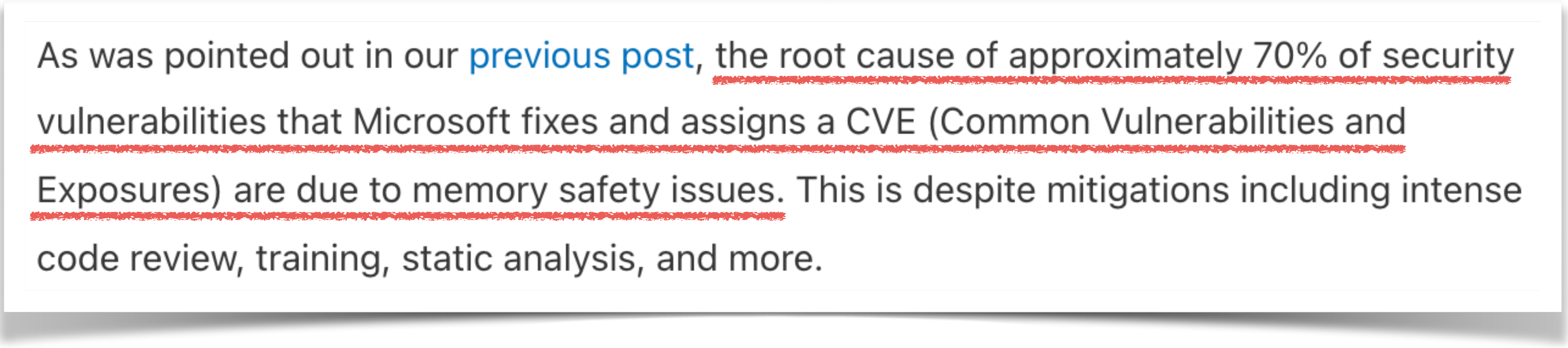

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Rust:

The Future of Safe Systems Programming?

In development since 2010, with 1.0 release in 2015

- Mozilla used Rust to build Servo, a next-gen browser engine, later incorporated into Firefox

Rust is the only "systems PL" to provide…

- Low-level control à la modern C++
- Strong safety guarantees
- Industrial development and backing

Many major companies using Rust in production

- In 2021, the **Rust Foundation** was formed, incl. Amazon, Google, Huawei, Meta, Microsoft, Mozilla

Rust:

The Future of Safe Systems Programming?

In development since 2010, with 1.0 release in 2015

- Mozilla used Rust to build Servo, a next-gen browser engine, later incorporated into Firefox

The "safety" of Rust is central to its promise.

But how do we know Rust is safe?

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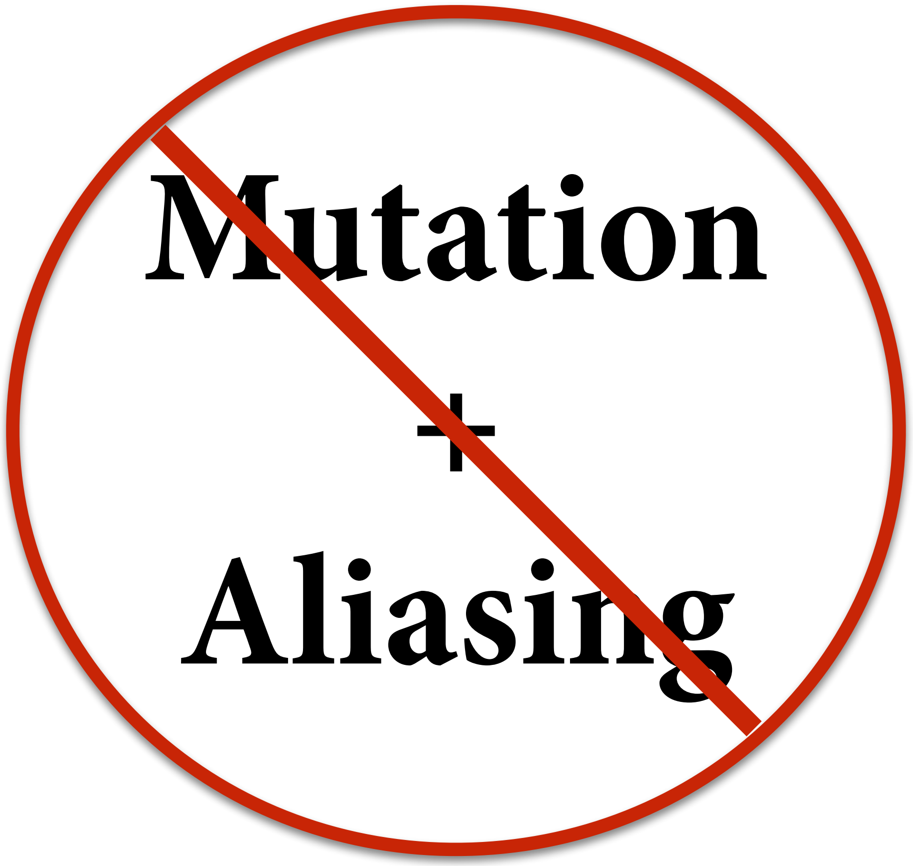
Core Idea of Rust

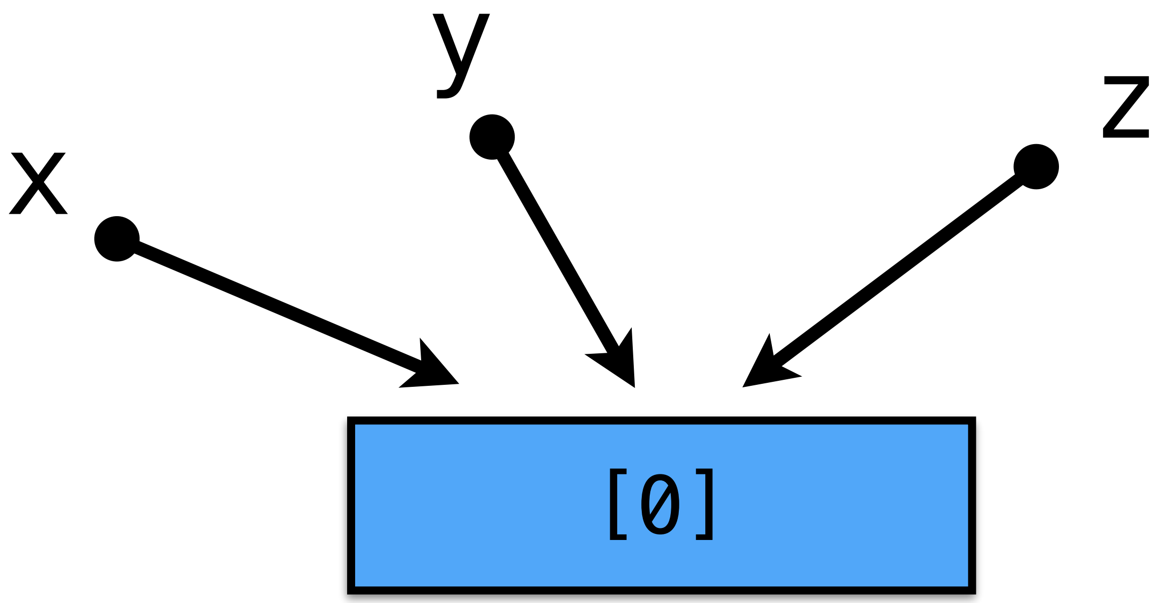


Mutation

+

Aliasing

Core Idea of Rust



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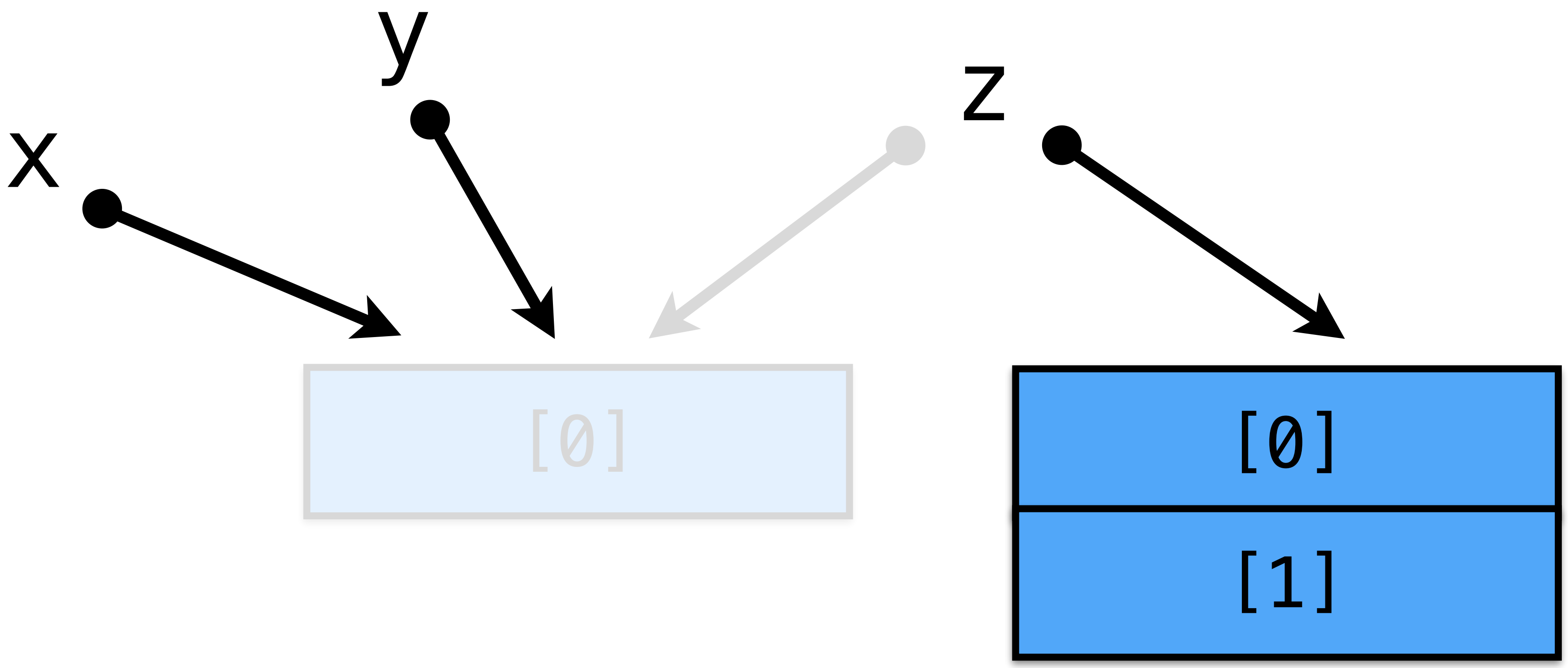

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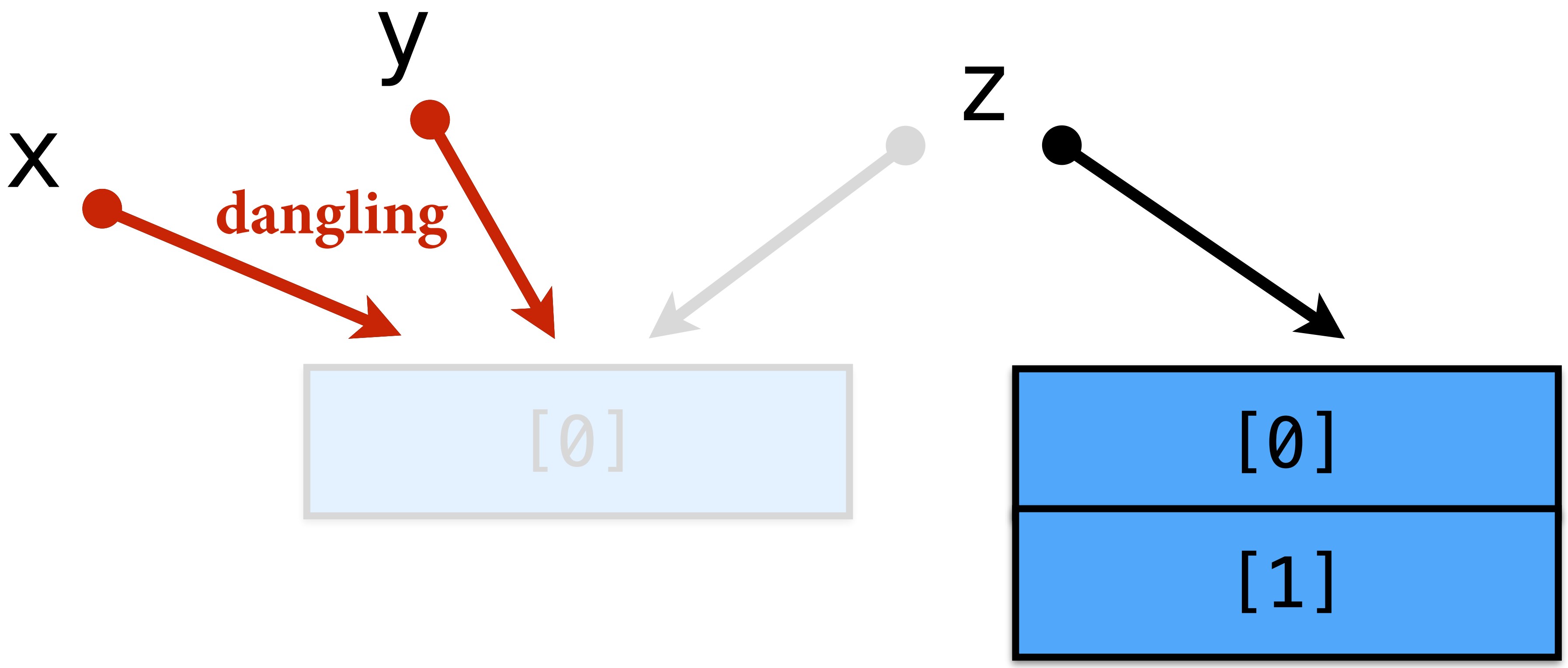

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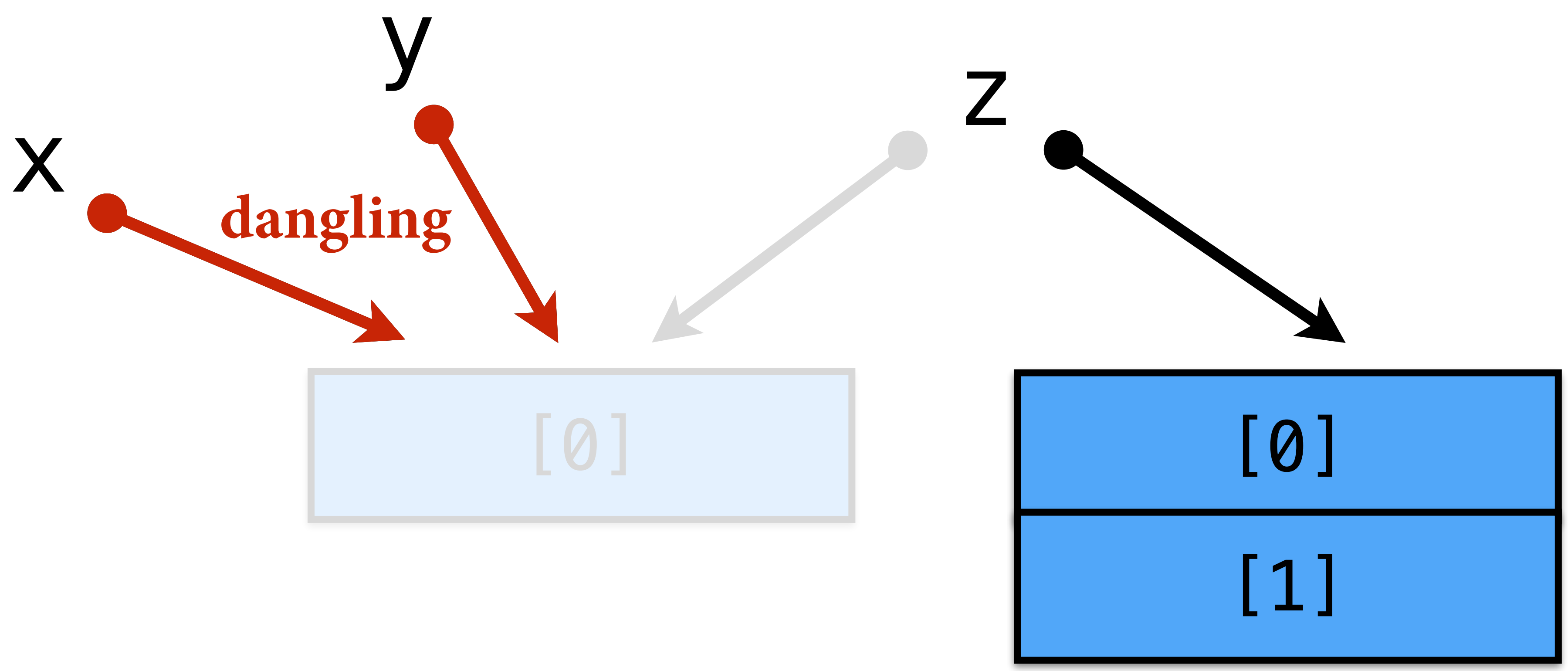
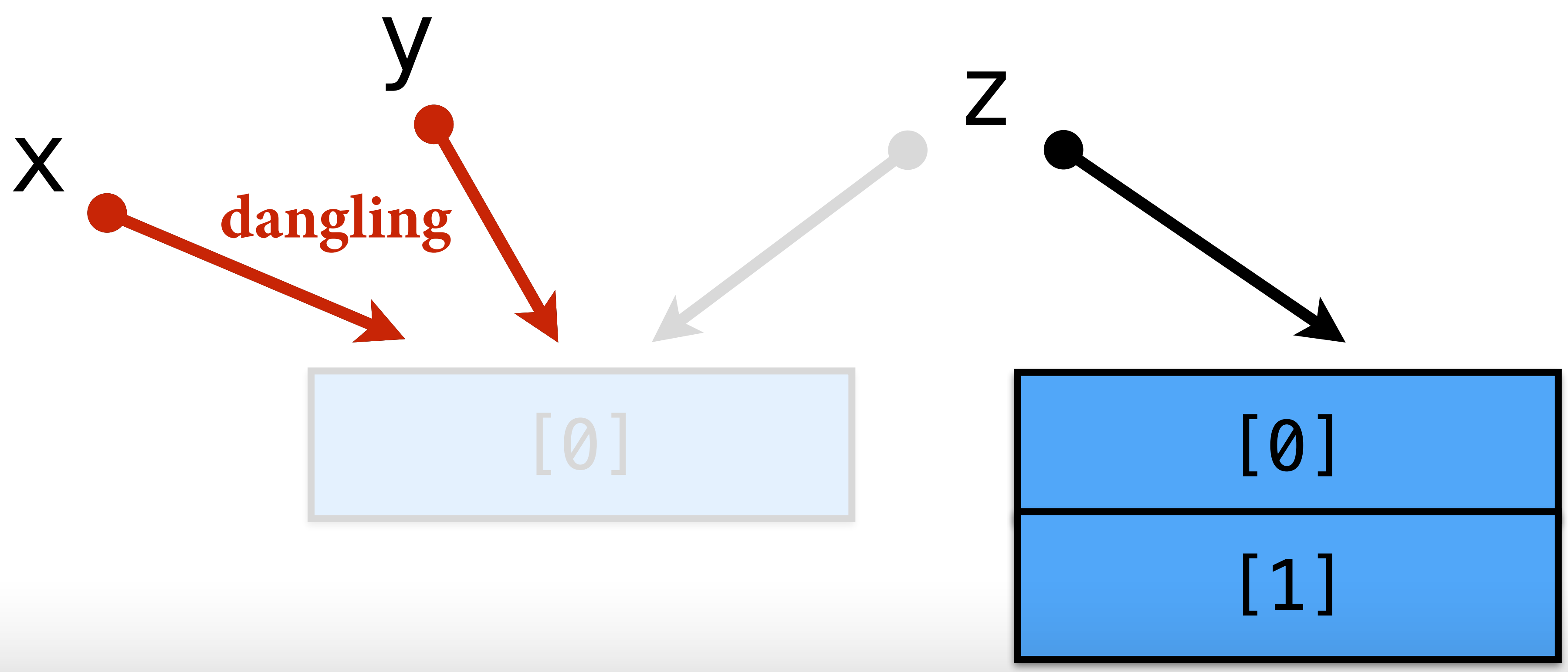


Unrestricted mutation and aliasing lead to:

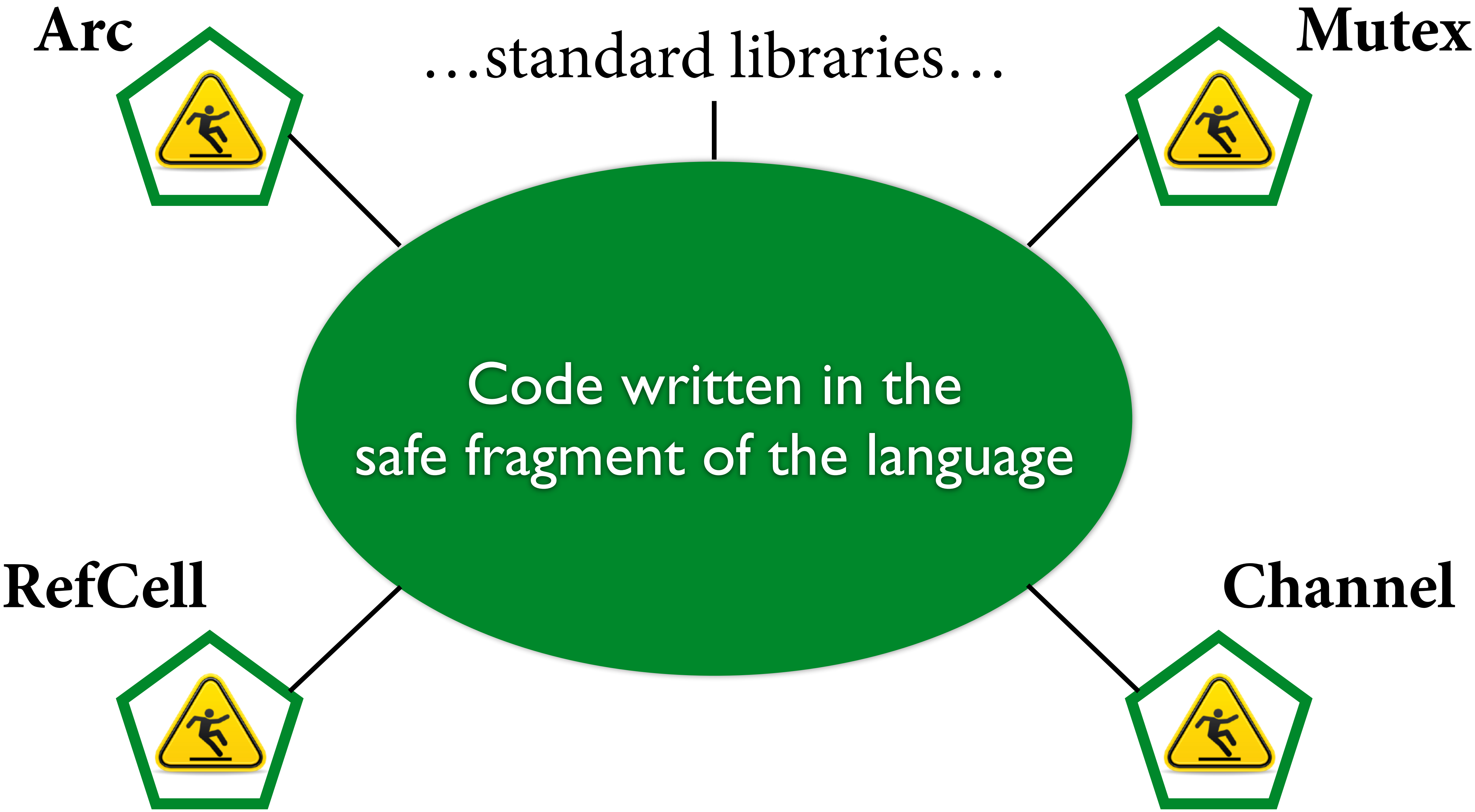
- use-after-free errors (dangling references)
- data races
- iterator invalidation

Core Idea of Rust



Rust prevents all these errors using a sophisticated “ownership” type system

The Reality of Rust



Arc

…standard libraries…

Mutex

Code written in the safe fragment of the language

RefCell

Channel

The Reality of Rust

Arc
Mutex
RefCell
nel

…standard libraries…

```
...
pub fn borrow(&self) -> Ref<T> {
  match BorrowRef::new(&self.borrow) {
    Some(b) => Ref {
      _value: unsafe { &*self.value.get() },
      _borrow: b,
    }, ...
  }
}
...
```

The Reality of Rust

Arc

…standard libraries…

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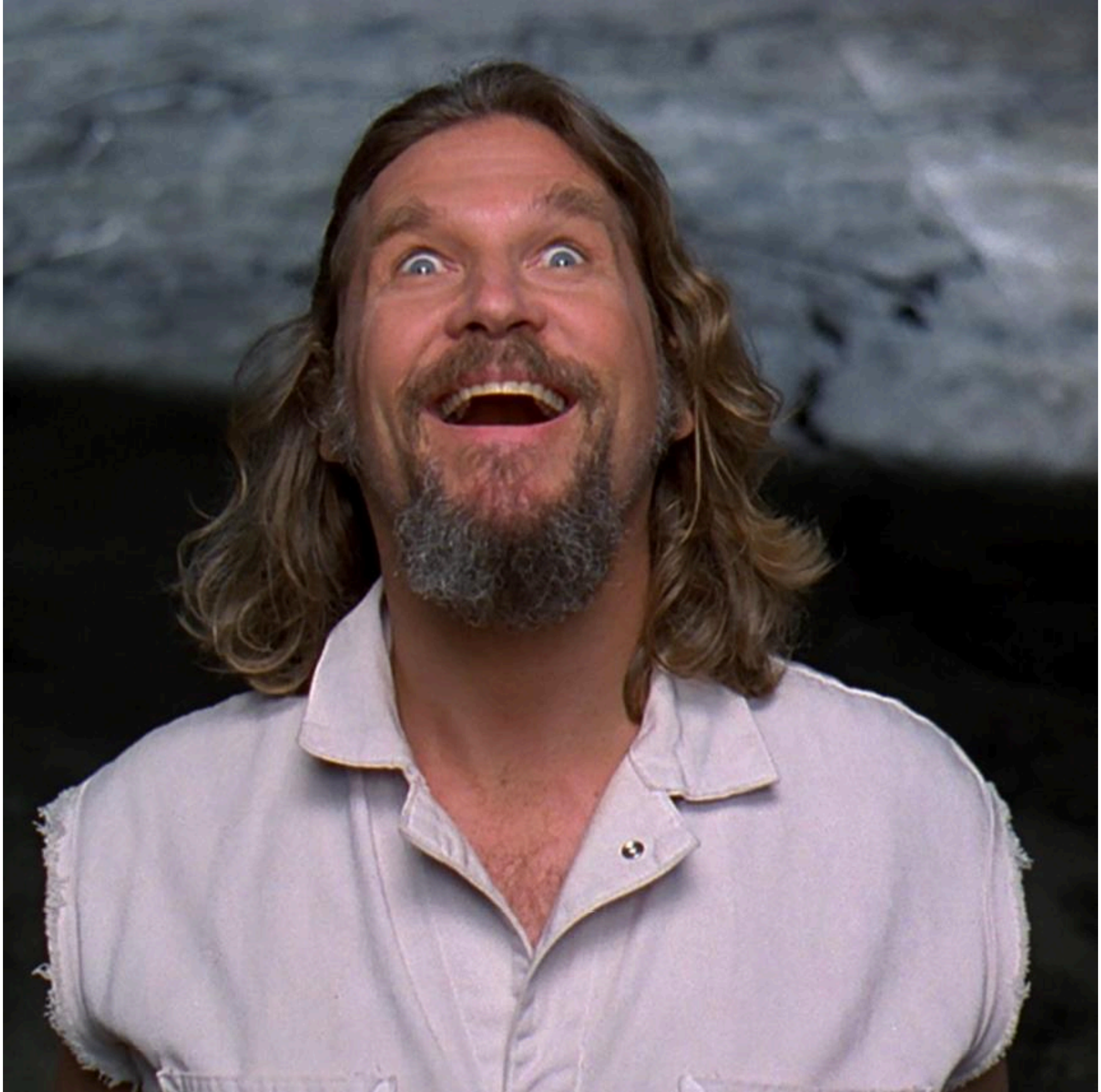
Claim library developers want to make:

Clients written in the safe fragment
will never observe any undefined behavior.



RUSTBELT

Goal: **Develop 1st logical foundations for Rust**

- Based on **Iris**, a new framework for higher-order concurrent separation logic in Coq
- Use these foundations to verify the safety of the Rust core type system and std libraries
- Give Rust developers the tools they need to safely evolve the language