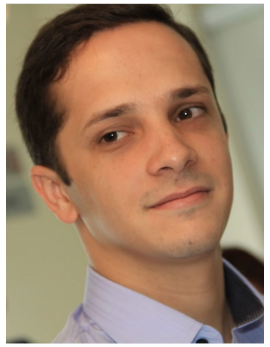
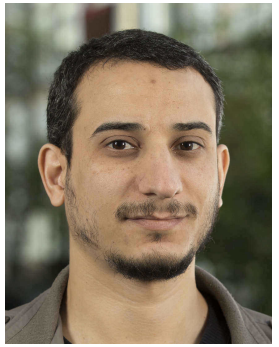
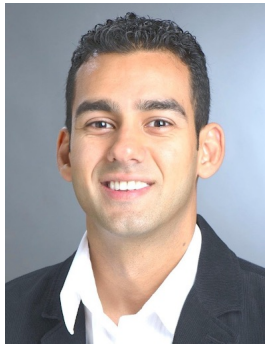
# Breaking Type Safety in Go:
## An empirical study on the use of the unsafe package



**Diego Elias Costa**, Suhaib Mujahid, Rabe Abdalkareem, Emad Shihab

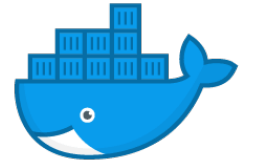
Data-driven Analysis of Software

Université Concordia University

# The Go programming language

- Major programming language
  - Clean syntax
  - C-like performance
  - Modern language features

kubernetes



docker

- Go has a **strong** and **static** type-system
  - Type-safe by design

**Go is memory-safe…**

**…unless you use the unsafe package**

# The unsafe package

- Step around the type-safety of Go programs

```
import "unsafe"

// Pointer arithmetic – (C-style)
p = unsafe.Pointer(uintptr(p) + offset)

// Convert between two types (without compiler checks)
func Float64bits(f float64) uint64 {
        return *(*uint64)(unsafe.Pointer(&f))
}
```

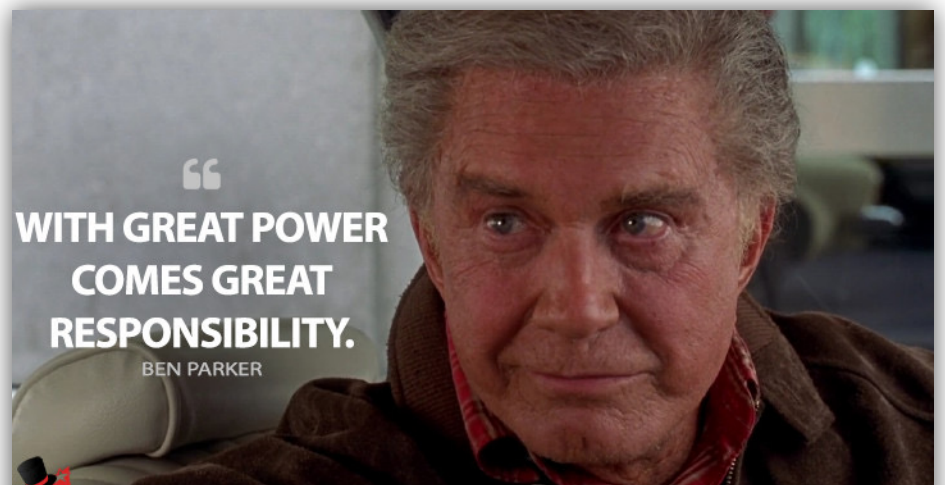
# The unsafe package

Pros

- Avoid compiler checks
- Low-level memory manipulation
- Interface with system calls

Cons

- Avoid compiler checks
- Risk of non-portability
- No guarantees of compatibility
- Easy to write bad code



# Beware of the unsafe package!

With the unsafe package there are no guarantees.

— "Go Proverbs" by Rob Pike

encoding/gob: can it avoid unsafe? #5159

Closed **robpike** opened this issue on Mar 29, 2013 · 5 comments

> ***Warning:*** *Avoid* `unsafe` *like the plague; if you can help it.*

**[go-nuts] Possible misuse of unsafe.Pointer**

Daniel Eloff
Jul 15, 2015 at 2:56 pm

Can someone please verify if my understanding around conversions between uintptr and unsafe.Pointer is correct?

Never use unsafe. Performance is never that critical. – Volker Nov 27 '15 at 10:31

6

First of all, unsafe is usually a bad idea. So is reflection, but unsafe is at least an order of magnitude worse.

Here is your example using pure reflection (http://play.golang.org/p/jTJ6Mhg8q9):

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Do Go developers use the unsafe package?

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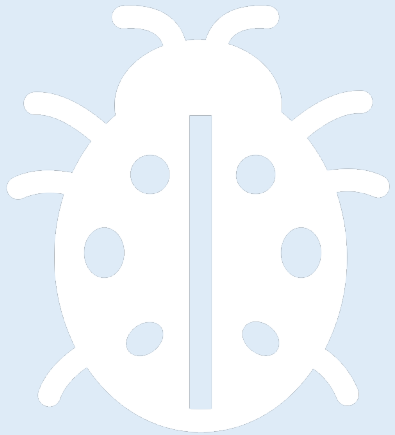
# Studying breaking type-safety in Go

Prevalence?



Why?

Consequences?



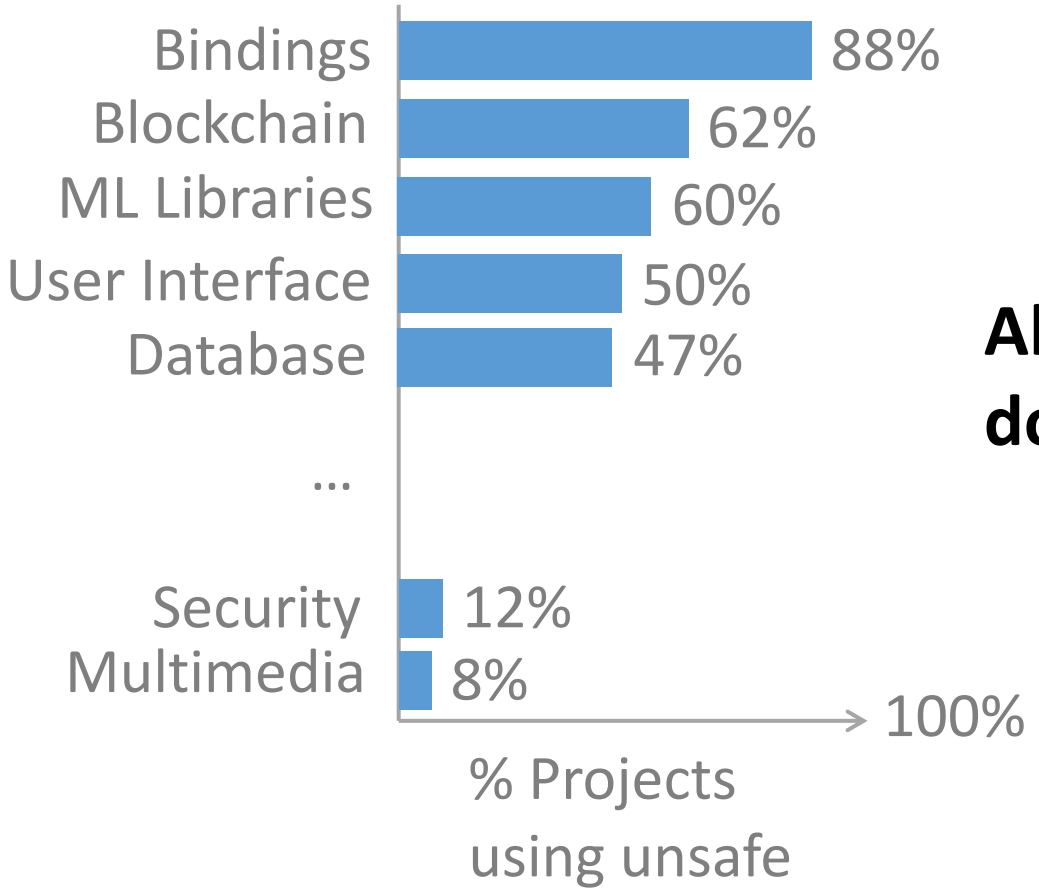
# Studied projects

**2590** most popular
Go software projects

GitHub

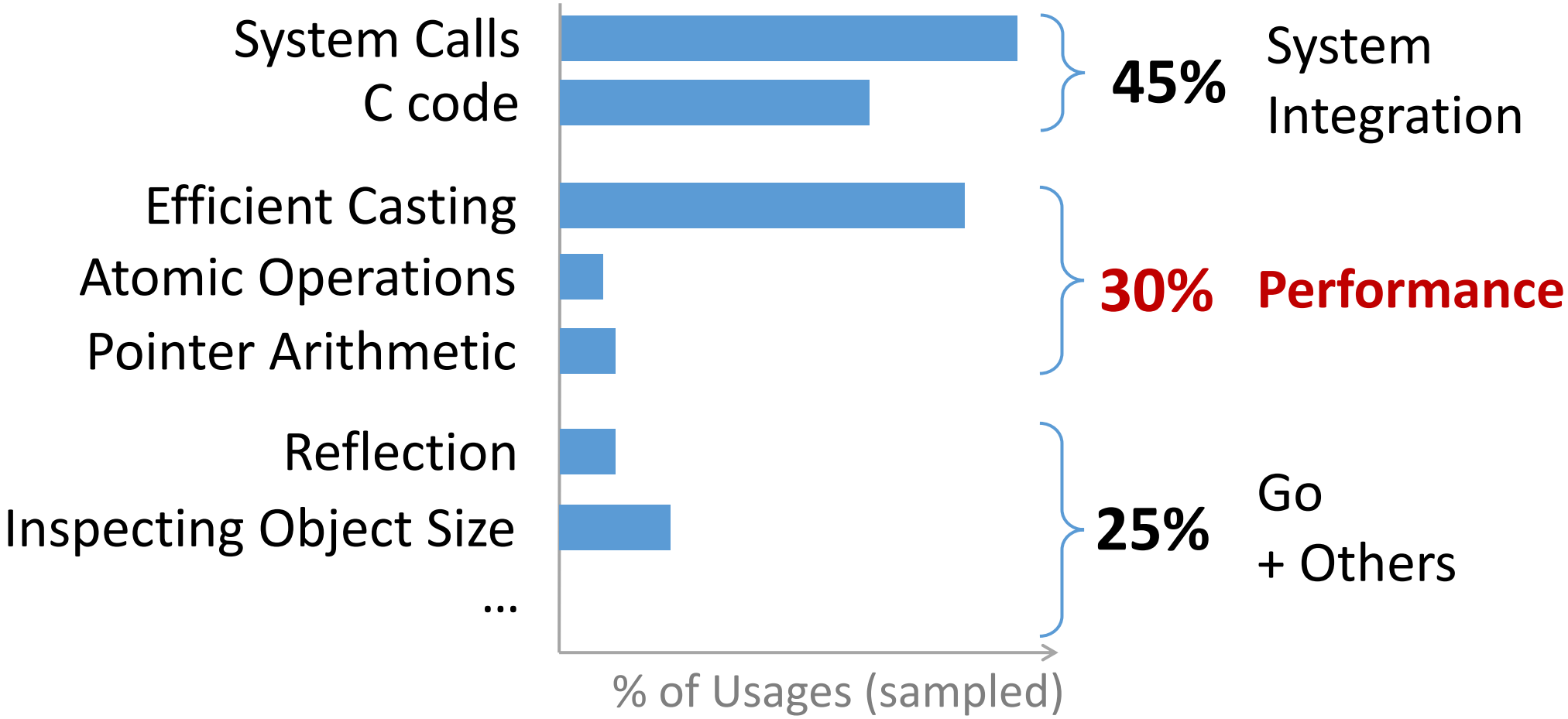
# Do developers use unsafe?

**24%** of projects use unsafe in their code




**All domains**

# Why developers use unsafe?



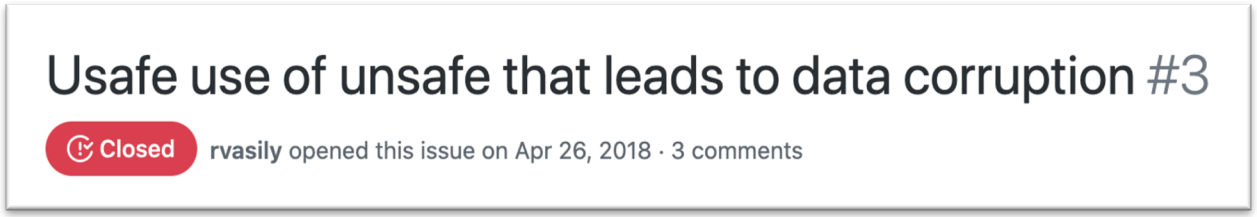
# Consequences of unsafe

Deployment restriction (20 projects)


> “I wanted to use this package within a Google App Engine project, and due to package ”unsafe” being used, it is **not compatible**”

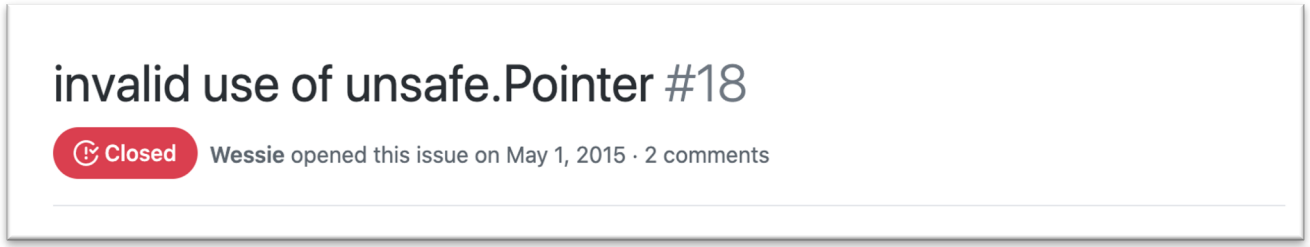
# Consequences of unsafe

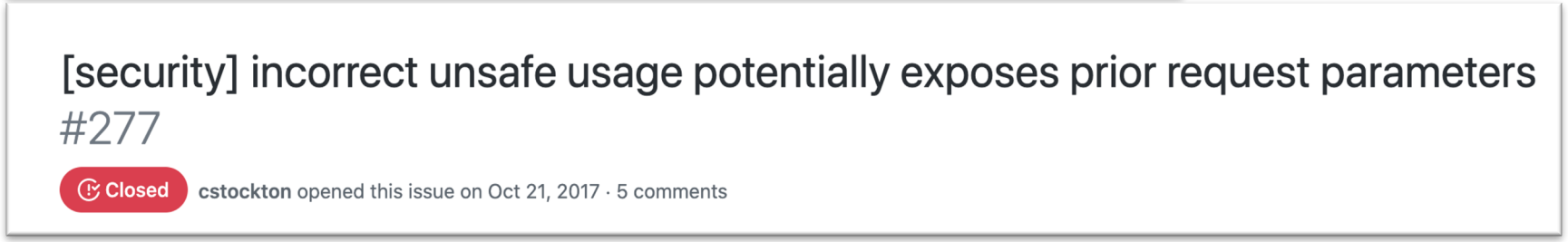
Deployment restriction (20 projects)
Runtime errors (16 projects)

# Consequences of unsafe

Deployment restriction (20 projects)
Runtime errors (16 projects)
Wrong API usage (13 projects)




…and the list goes on

# To summarize

## Prevalence?

**24%** of projects use unsafe

## Why?

System Integration

**Performance Optimization**

## Consequences?

**Higher risk** of

- Restrictions
- Runtime errors
- Bugs
- Breakages

# Feedback from the Go Team

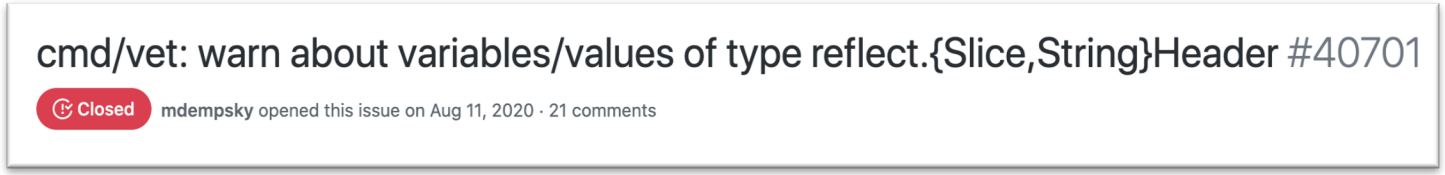
> “Other team members were more optimistic that developers would avoid or could implement their project without using package unsafe.
>
> I think this result will justify **spending more time on making package unsafe easier to use**.”

Matthew Dempsky, maintainer of the GO compiler

# Impact on the GO Language

**Wrong slice conversion**
is one of the most
common API misuses

New static analysis was released with Go 1.16




Language updates scheduled for Go 1.17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cmd/vet: warn about variables/values of type reflect.{Slice,String}Header #40701

Closed mdempsky opened this issue on Aug 11, 2020 · 21 comments

Language updates scheduled for Go 1.17

**Go 1.17**

unsafe: add Slice(ptr *T, len anyIntegerType) []T #19367

Open mdempsky opened this issue on Mar 2, 2017 · 105 comments

unsafe: add Add function #40481

Open rsc opened this issue on Jul 29, 2020 · 27 comments

@DiegoEliasCosta

diego.costa@concordia.ca