The Robustness of Go

A study of Go and its ecosystem

Agenda

- What does it mean to be robust?
- Robust features of Go
- Fragile features of Go
- Giving up
- Well, actually: Erlang
- A new hope

About me

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- VP of Developer Relations at source{d} (#MLonCode)
- Previously:
  - Developer Advocate at Google Cloud Platform
  - Go team
  - Machine Learning (tensorflow)
- justforfunc.com!

What does it mean to be Robust?


Robustness


Error Error
An error occurred while displaying the previous error.
OK

Fragility

Robust features of Go

Memory safety

- Pointers for convenience, but no pointers arithmetics.
- Escape analysis for automated allocation on heap/stack.
- Garbage collection: no dangling pointers.
- Automatic bound checks for slices and arrays.
  - Negative indices are forbidden, avoiding a whole class of errors.
  - No buffer overflow (unless bug in the language ...)

This makes memory corruption **basically** impossible.

Stack allocation (important for performance)

```
func value() *int {
    v := new(int)   // allocated on the stack,
                    // because v doesn't escape.
    return v
}

func main() {  fmt.Println(*value()) }
```

Heap allocation (important for correctness)

```
func value() *int {
    v := 42          // allocated on the heap,
                     // because v escapes
    return &v
}

func main() {  fmt.Println(*value()) }
```

Bound checks (important for correctness)

```
func main() {
    a := make([]int, 256)
    a[512] = 42 // panic: runtime error: index out of range
}
```

Type safety

- Static typing
- Explicit type conversion for numeric types

```
int64 + int32 // mismatched types int32 and int64
```

- No unsafe implicit conversions, no automatic type coercion

```
42 + “hello”   // mismatched types int and string
               // not “42hello”
```

Type safety

- Compile-time but implicit interface satisfaction

```
v := 42
fmt.Fprintln(v, “hello”)
    // cannot use v (type int) as type io.Writer in argument to fmt.Fprintln:
    //   int does not implement io.Writer (missing Write method)
```

- Interfaces keep the type of the stored value

```
var i interface{} = v
i.(string) // panic: interface conversion: interface {} is int, not string
```

Unused variables; the compilation error

Seems surprising, but it has caught more than one bug!

```
for i, row := range s {
    for j, cell := range row { // cell declared and not used
        cell = i * j
    }
}
```

Errors are not exceptional

- Go doesn’t have exceptions
- Exceptions are banned in C++ code at Google
- The main reason is that exceptions break the linear flow of a program, causing subtle bugs.

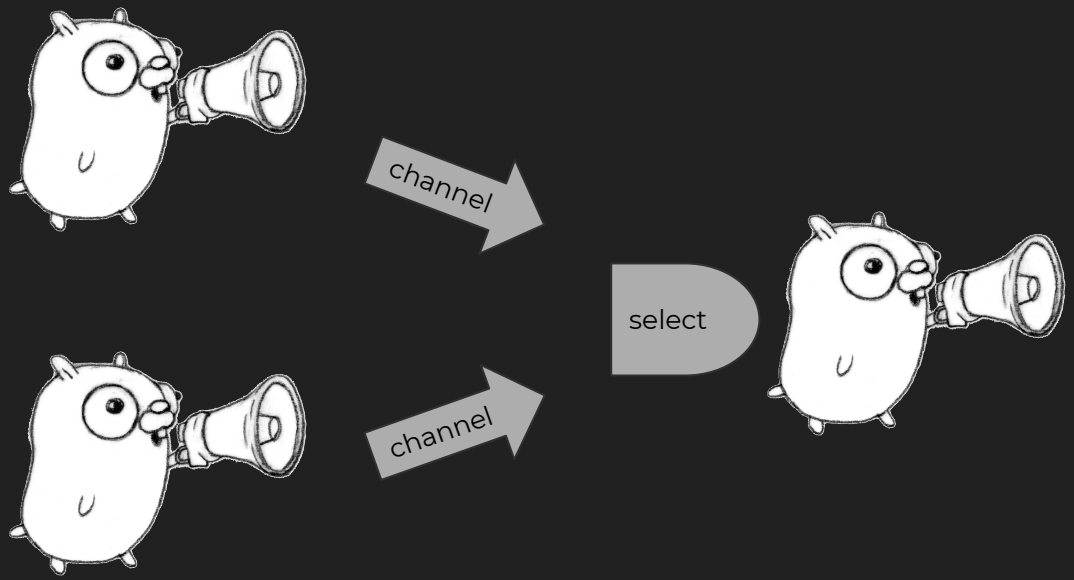
A subtle bug

```
var mutex sync.Mutex

func withMutex(f func()) {
    mutex.Lock()
    f()
    mutex.Unlock()
}
```

Channels

A simpler concurrency model makes it easier to implement correct patterns.



Fragile features of Go

Mutable shared state

```
var counter int

func ticker() {
  for range time.Tick(time.Second) {
      log.Printf("counter is %d\n", counter)
  }
}

func count(w http.ResponseWriter, r *http.Request) {
  counter++
}
```

Mutable shared state

```
func main() {
  go ticker()
  http.HandleFunc("/count", count)
  log.Fatal(http.ListenAndServe(":8080", nil))
}
```

```
$ go run main.go
2018/04/26 07:01:13 counter is 0
2018/04/26 07:01:14 counter is 1
…
```

Mutable shared state: tooling

Data race detector to the rescue!

```
$ go run -race main.go
2018/04/26 07:00:59 counter is 0
==================
WARNING: DATA RACE
Read at 0x000001581488 by goroutine 6:
  main.ticker()
Previous write at 0x000001581488 by goroutine 8:
  main.count()
```

Nil pointers!

Technically not that bad … but still a source of problems

Nil receivers, nil slices … but also nil maps

Lack of generics (yes I went there)

Monads are a great way to manage error

But without generics they’re quite hard to implement

Panic; then recover

Similar to exceptions, but used only “exceptionally”

```
func main() {
        defer func() {
                if err := recover(); err != nil {
                        // handle err
                }
        }()
    doStuff()
}
```

panic

```
func main() {
    http.HandleFunc("/", handler)
    log.Fatal(http.ListenAndServe(":8080", nil))
}

func handler(w http.ResponseWriter, r *http.Request) {
    panic("boo!")
}
```

$ go run server.go

```
2018/04/18 11:37:40 http: panic serving [::1]:56732: boo!

goroutine 5 [running ]:
net/http.(*conn).serve.func1(0xc420098820)
        /Users/francesc/go/src/net/http/server.go:1726 +0xd0
panic(0x12387a0, 0x12cdb70)
        /Users/francesc/go/src/runtime/panic.go:505 +0x229
main.handler(0x12d1800, 0xc420134000, 0xc42011e000)
        /Users/francesc/src/github.com/campoy/samples/recover/server.go:14 +0x39
net/http.HandlerFunc.ServeHTTP(0x12b0220, 0x12d1800, 0xc420134000, 0xc42011e000)
        /Users/francesc/go/src/net/http/server.go:1947 +0x44
net/http.(*ServeMux).ServeHTTP(0x140a3e0, 0x12d1800, 0xc420134000, 0xc42011e000)
        /Users/francesc/go/src/net/http/server.go:2337 +0x130
net/http.serverHandler.ServeHTTP(0xc42008b2b0, 0x12d1800, 0xc420134000, 0xc42011e000)
        /Users/francesc/go/src/net/http/server.go:2694 +0xbc
net/http.(*conn).serve(0xc420098820, 0x12d1a00, 0xc42010a040)
        /Users/francesc/go/src/net/http/server.go:1830 +0x651
created by net/http.(*Server).Serve
        /Users/francesc/go/src/net/http/server.go:2795 +0x27b
```

panic

```
func main() {
    http.HandleFunc("/", handler)
    log.Fatal(http.ListenAndServe(":8080", nil))
}

func handler(w http.ResponseWriter, r *http.Request) {
    go panic("boo!")
}
```

$ go run server.go

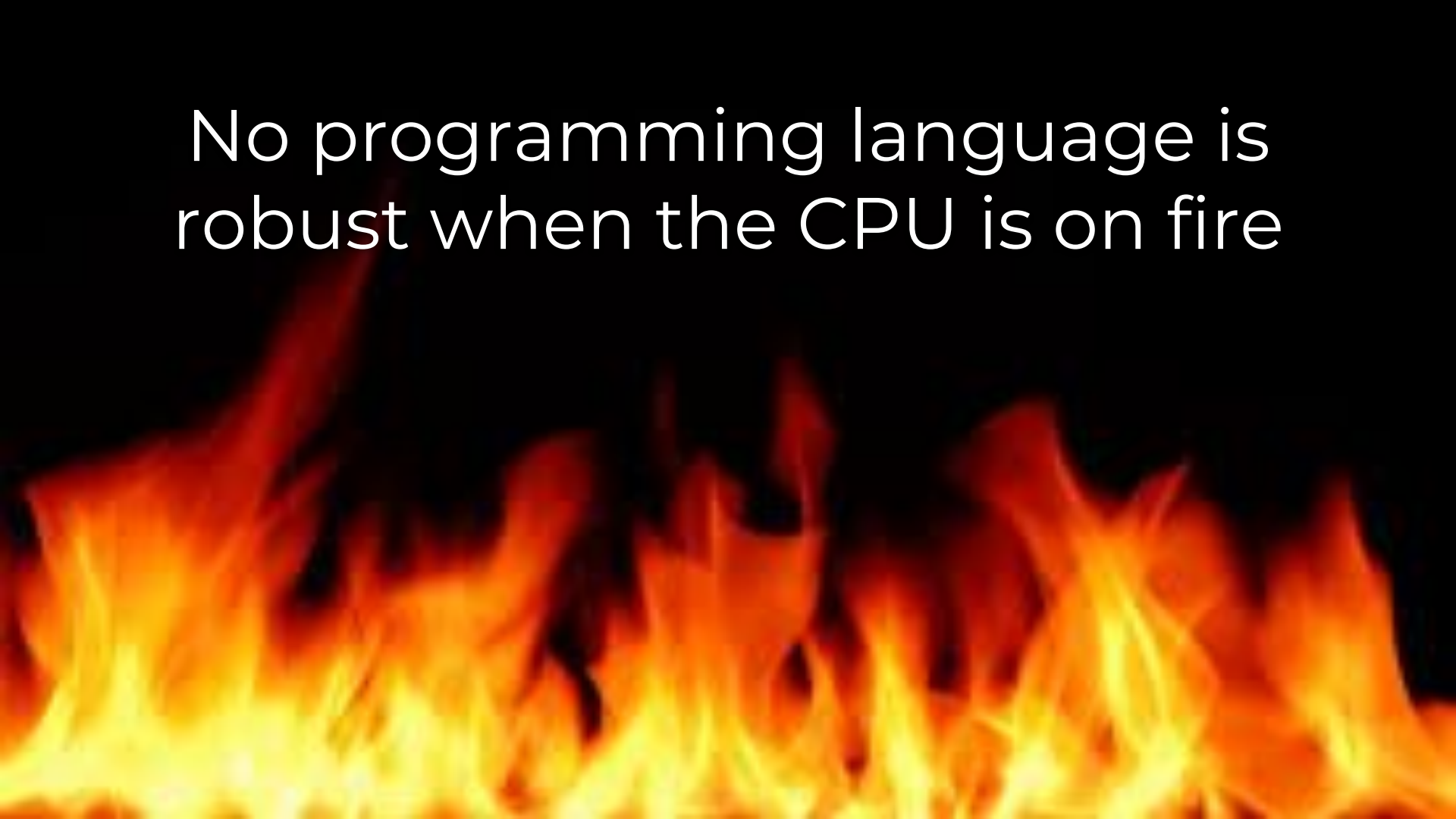
```
panic: boo!

goroutine 8 [running]:
panic(0x12387e0, 0xc420010b90)
        /Users/francesc/go/src/runtime/panic.go:554 +0x3c1
runtime.goexit()
        /Users/francesc/go/src/runtime/asm_amd64.s:2361 +0x1
created by main.handler
        /Users/francesc/src/github.com/campoy/samples/recover/server.go:14 +0x64

exit status 2
```


Giving up on Robustness

No programming language is robust when the CPU is on fire



Well, actually: Erlang

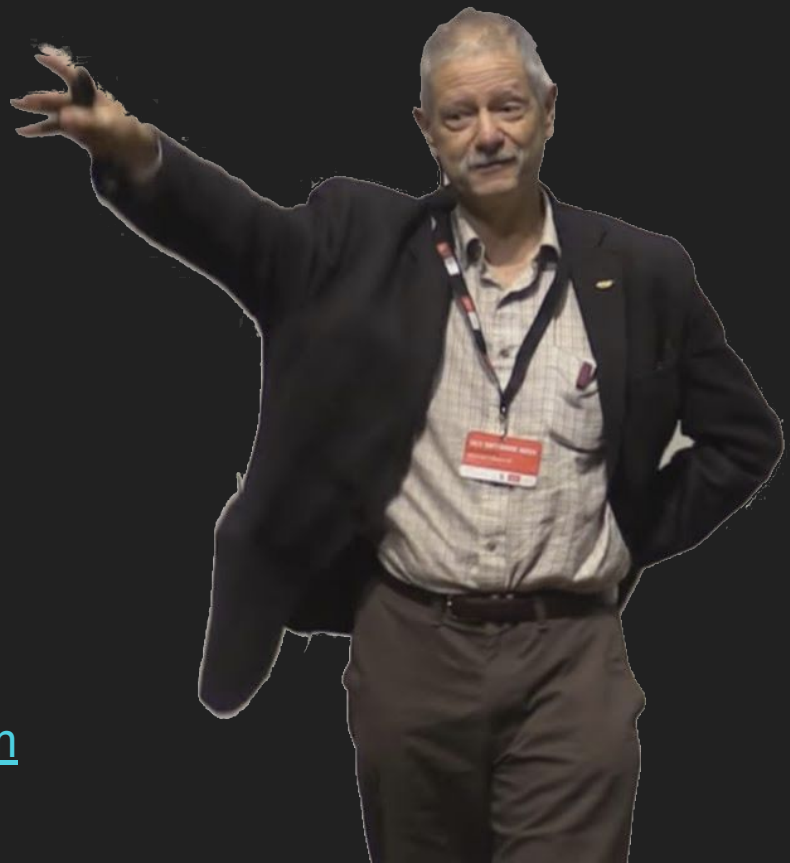
ERLANG

Systems that Run Forever Self-heal and Scale

Six rules:

1. Isolation
2. Concurrency
3. Failure detection
4. Fault Identification
5. Live Code Upgrade
6. Stable Storage

infoq.com/presentations/self-heal-scalable-system



I - Isolation

II - Concurrency

III - Failure Detection

IV - Fault Identification

V - Live Code Upgrade

VI - Stable Storage


“Let it crash”

Erlang vs. Go

	Erlang	Go
Isolation	✓	✗
Concurrency	✓	✓
Failure Detection	✓	✓
Fault Identification	✓	✗
Live Code Upgrade	✓	✗
Stable Storage	✓	✓

A new hope

kubernetes

I - Isolation

- Containers
- Namespaces
- Multiple nodes
- Multiple clusters / federation

II - Concurrency

- Go’s concurrency is great
- Extra Parallelism via replication
    - Replica controllers

III - Failure Detection

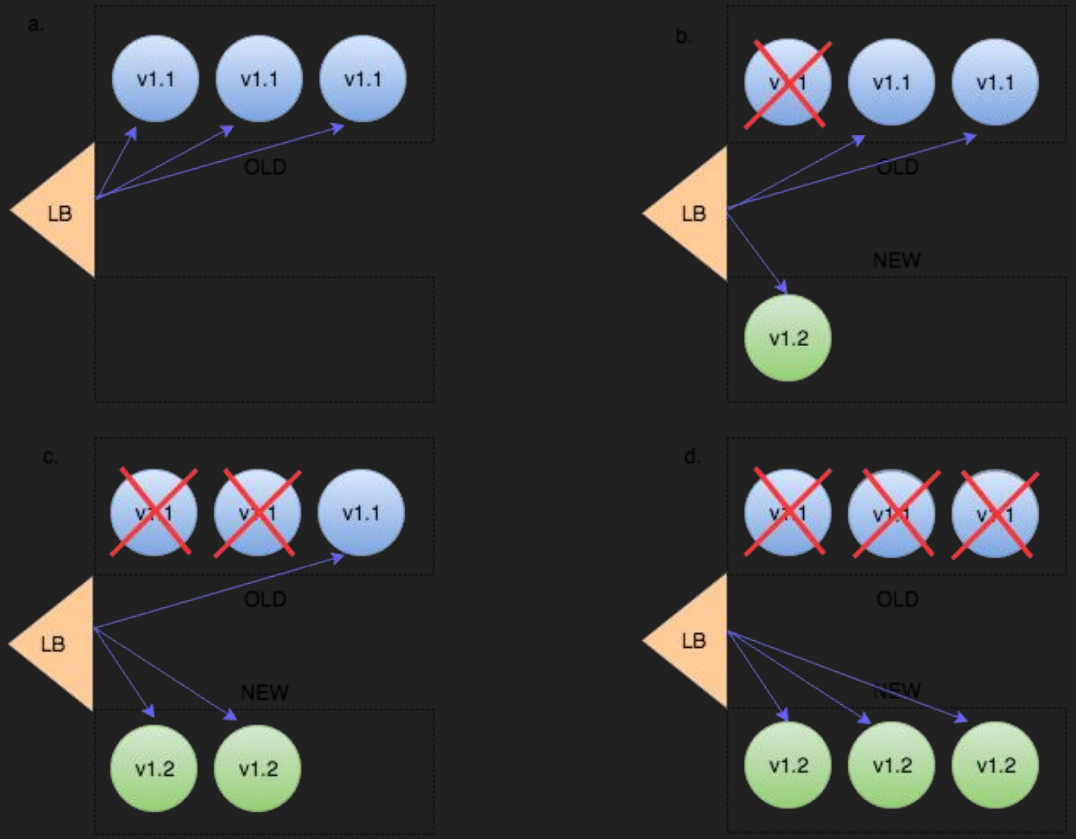
- Heartbeats (probes)
- Automated Monitoring
- Restart Policies

IV - Fault Identification

- Logs (but who reads them)
- /dev/termination-log

V - Live Code Upgrade

- Liveness Probes
- Readiness Probes
- Live Rolling Update



Kubernetes Rolling Update

VI - Stable Storage

- Not necessarily part of the system
  - Etcd
  - SQL databases
  - etc

Conclusion

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- A new hope

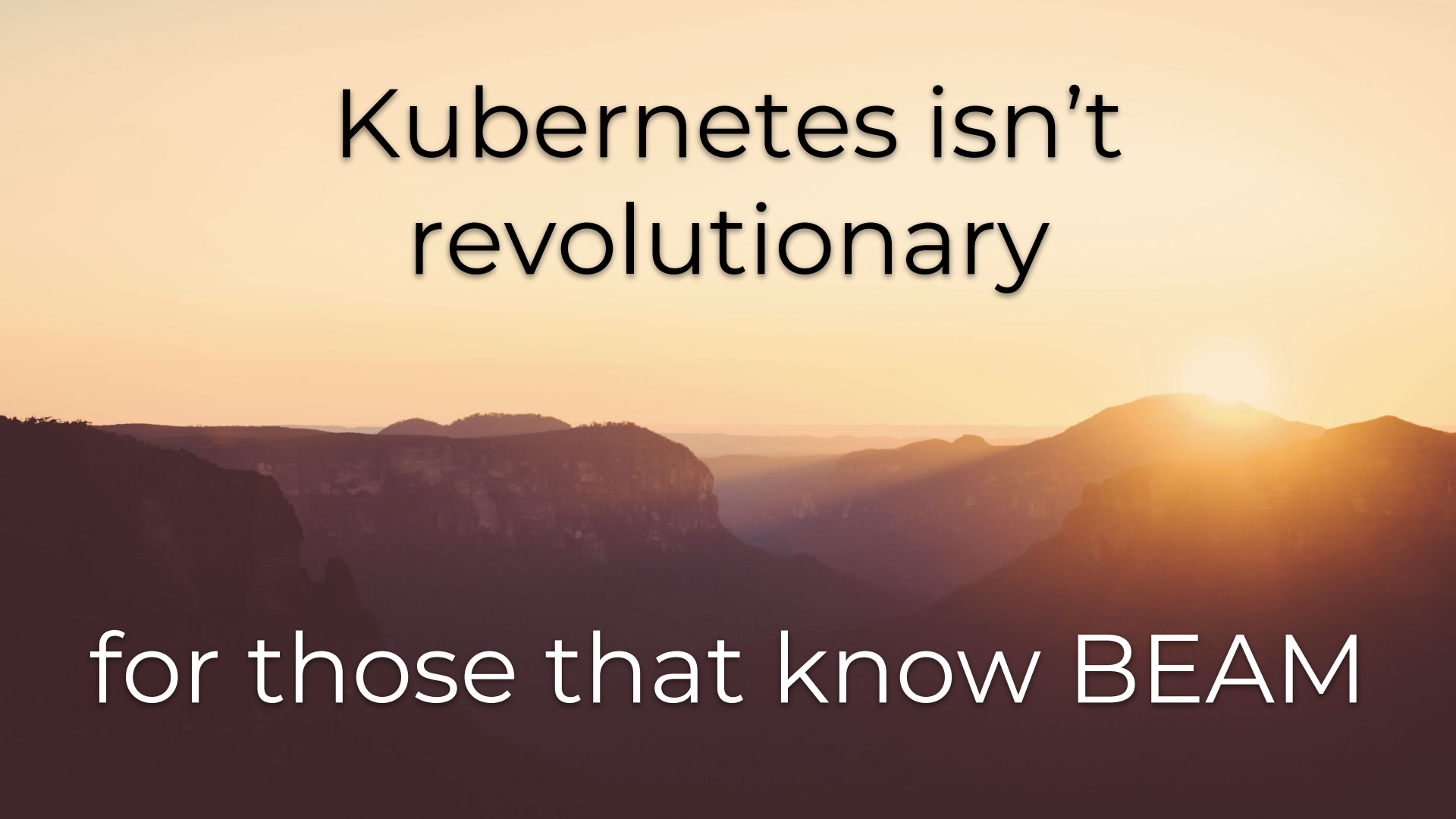
Erlang vs. Go

	Erlang	Go
Isolation	✓	✗
Concurrency	✓	✓
Failure Detection	✓	✓
Fault Identification	✓	✗
Live Code Upgrade	✓	✗
Stable Storage	✓	✓

Erlang vs. Go

	Erlang+BEAM	Go+K8s
Isolation	✓	✓
Concurrency	✓	✓
Failure Detection	✓	✓
Fault Identification	✓	✓
Live Code Upgrade	✓	✓
Stable Storage	✓	✓

Kubernetes isn’t revolutionary


Kubernetes isn’t
revolutionary
for those that know BEAM

Thanks!

@maria_fibonacci

@miriampena

Thanks!

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