Starting, and stopping, things

GopherConSG 2025

https://dave.cheney.net/

Hello!

Section 1

The problem

Memory is a resource

If you obtain a resource, its on you to release it

Memory is finite because address space is finite

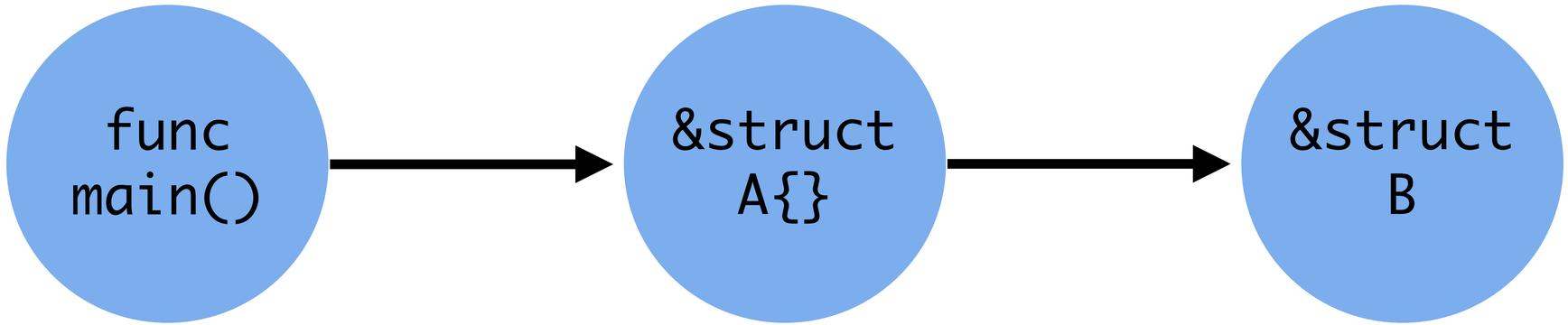
If your program allocates memory, is it on you to release it?

Garbage collection frees the programmer from the burden of matching each allocation with a free

“Garbage collection provides the illusion of infinite memory using only finite memory.”

https://go.dev/doc/gc-guide

Reachability



All allocated memory must be reachable from a root

Each goroutine is a GC root

* Package level variables are also GC roots, but we'll ignore them for this discussion

Goroutines are a resource, because they are GC roots

You can close a file, or a unlock a lock, but how can you stop a goroutine?

Section 2

There’s a go keyword, but no stop keyword

If a goroutine could be stopped at any time, what do we do with the resources that it's holding?

Option 1

Stopping a goroutine releases all the resources it owns

Java Thread Primitive Deprecation

Why is `Thread.stop` deprecated?

Because it is inherently unsafe. Stopping a thread causes it to unlock all the monitors that it has locked. (The monitors are unlocked as the `ThreadDeath` exception propagates up the stack.) If any of the objects previously protected by these monitors were in an inconsistent state, other threads may now view these objects in an inconsistent state. Such objects are said

Option 2

Ask the goroutine, politely, to stop

Stop vs stopping

```
func loop[T any](work chan T, stop chan struct{}) {
    for {
        select {
        case <-stop:
            return
        case w := <-work:
            // process work
        }
    }
}
```

Stop, demo time

cmd/stop-work

* Hint: https://go.dev/ref/spec#Select_statements

Implicit goroutine lifetime management

Stop, demo time

cmd/http-server

Goroutine lifetimes

Goroutine management is a problem for middle aged Go programs

Section 3

History

gopkg.in/tomb.v2

```
func main() {
        var t tomb.Tomb

        t.Go(func() error {
                for {
                        select {
                        case <-t.Dying():
                                fmt.Println("shutting down because of", t.Err())
                                return t.Err()
                        default:
                                // do something
                        }
                }
        })

        t.Go(func() error {
                time.AfterFunc(2*time.Second, func() {
                        t.Kill(fmt.Errorf("timeout"))
                })
                return nil
        })

        fmt.Println("waiting for goroutines to finish")
        t.Wait()
        fmt.Println("all goroutines finished")
}
```

golang.org/x/sync/errgroup

```
func main() {

        // Create a new errgroup
        var g errgroup.Group

        // Add a new goroutine to the errgroup
        g.Go(func() error {
                // Do some work
                return nil
        })

        // Add a new goroutine to the errgroup
        g.Go(func() error {
                // Do some work
                return fmt.Errorf("oops, failed")
        })

        // Wait for all goroutines to finish
        if err := g.Wait(); err != nil {
                fmt.Println("At least one goroutine failed:", err)
        }
}
```

Use a group

Link

SCAN ME

```
var g group.Group
{
    ctx, cancel := context.WithCancel(context.Background())
    g.Add(func() error {
        return sm.Run(ctx)
    }, func(error) {
        cancel()
    })
}
```

There is no one correct solution

(But probably quite a few *incorrect* solutions)

Managing goroutines is the Jazz standard of Go programming

Section 4

A solution

```
package group // import "github.com/pkg/group"


type G struct {
        // Has unexported fields.
}
```

G manages the lifetime of a set of goroutines from a common context. The first goroutine in the group to return will cause the context to be canceled, terminating the remaining goroutines.

```
func New(opts ...Option) *G
func (g *G) Add(fn func(context.Context) error)
func (g *G) Wait() error
```

Stop, demo time

Group/example_test.go

```
package main

import (
        "context"
        "fmt"
        "os"
        "time"

        "github.com/pkg/group"
)

func main() {
        if err := run(); err != nil {
                fmt.Fprintln(os.Stderr, err)
                os.Exit(1)
        }
}

func run() error {
        ctx, _ := signal.NotifyContext(context.Background(), syscall.SIGTERM, os.Interrupt)
        g := group.New(group.WithContext(ctx))
        g.Add(newHTTPService().Run)
        g.Add(newRPCService().Run)
        g.Add(newMetricsService().Run)
        return g.Wait()
}
```

```
type Service struct{}

func newService() *Service { return &Service{} }

func (svc *Service) Run(ctx context.Context) error {
        if err := svc.start(ctx); err != nil {
                return fmt.Errorf("failed to start: %w", err)
        }
        // run returns when context is done or on error
        return svc.run(ctx)
}

func (svc *Service) start(ctx context.Context) error {
        // initialise
        return nil
}

func (svc *Service) run(ctx context.Context) error {
        for {
                select {
                case <-ctx.Done():
                        return ctx.Err()
                default:
                        // do work
                        time.Sleep(100 * time.Millisecond)
                }
        }
}
```

Conclusion

Goroutines are resources

Never start a goroutine without knowing when it will stop

You cannot make a goroutine stop, you have to ask politely

A goroutine's raison d'état is work

Leave concurrency to the caller

That's it!

Go write some code that makes you proud!

Sample code

Slides