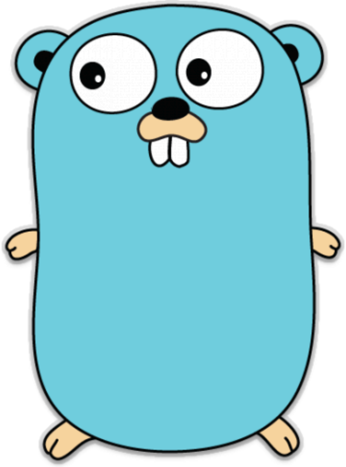
Go Tutorial

To do …

- ❑ Today
  - A brief, gentle intro to Go

- ❑ Next
  - Networking



About Go

- Developed by Google
  - Webpage: https://golang.org/

- Concurrency was a priority in the language design

- A bit of a mix between high- and low-level programming language features

Go Features

- Go is a bit similar to C
  - Visually similar to C
  - Compiled
  - Fixed-size int, float, and complex types
  - Strong, static typing
  - Uses return codes instead of exceptions
  - No classes/inheritance (uses structs/interfaces)
  - Has pointers

Go Features

- Also… kind of similar to Python
  - No pointer arithmetic
  - Has garbage collection
  - Key, value maps are part of the language
  - Can return multiple values (useful for error codes)
  - Lots of “batteries-included” libraries
    - net/http, net/rpc, encoding/json, encoding/gob

Go Features

- Well-suited for designing concurrent, distributed systems
  - goroutines
  - channels
  - defer
  - RPC library

  - (more on these later)

Installing Go (it’s easy)

- Available in most package managers
  - Macports & Homebrew: install “go”
  - Ubuntu & Fedora: “golang”
  - Arch: “go”
- Binary distributions available for most Oses
  - https://golang.org/doc/install
- I’ll be using the latest version of Go (1.6) to grade
  - T-Lab and Wilkinson have v1.3
  - v1.6 is backwards compatible with v1.3

Hello, 世界

```go
// This is a comment

package main
// Programs start running in package "main"

import "fmt"

func main() {
    // strings support Unicode!
    fmt.Println("Hello, EECS 345! (あいうえお)")
}
```

```
Hello, EECS 345! (あいうえお)

Program exited.
```

http://play.golang.org/p/pL_36Jnu7m

Note on network I/O

- Go’s “net” package uses byte slices ([]byte)
  - Can convert string to []byte
    - []byte(str)
  - And []bytes to string
    - string(byte_slice)

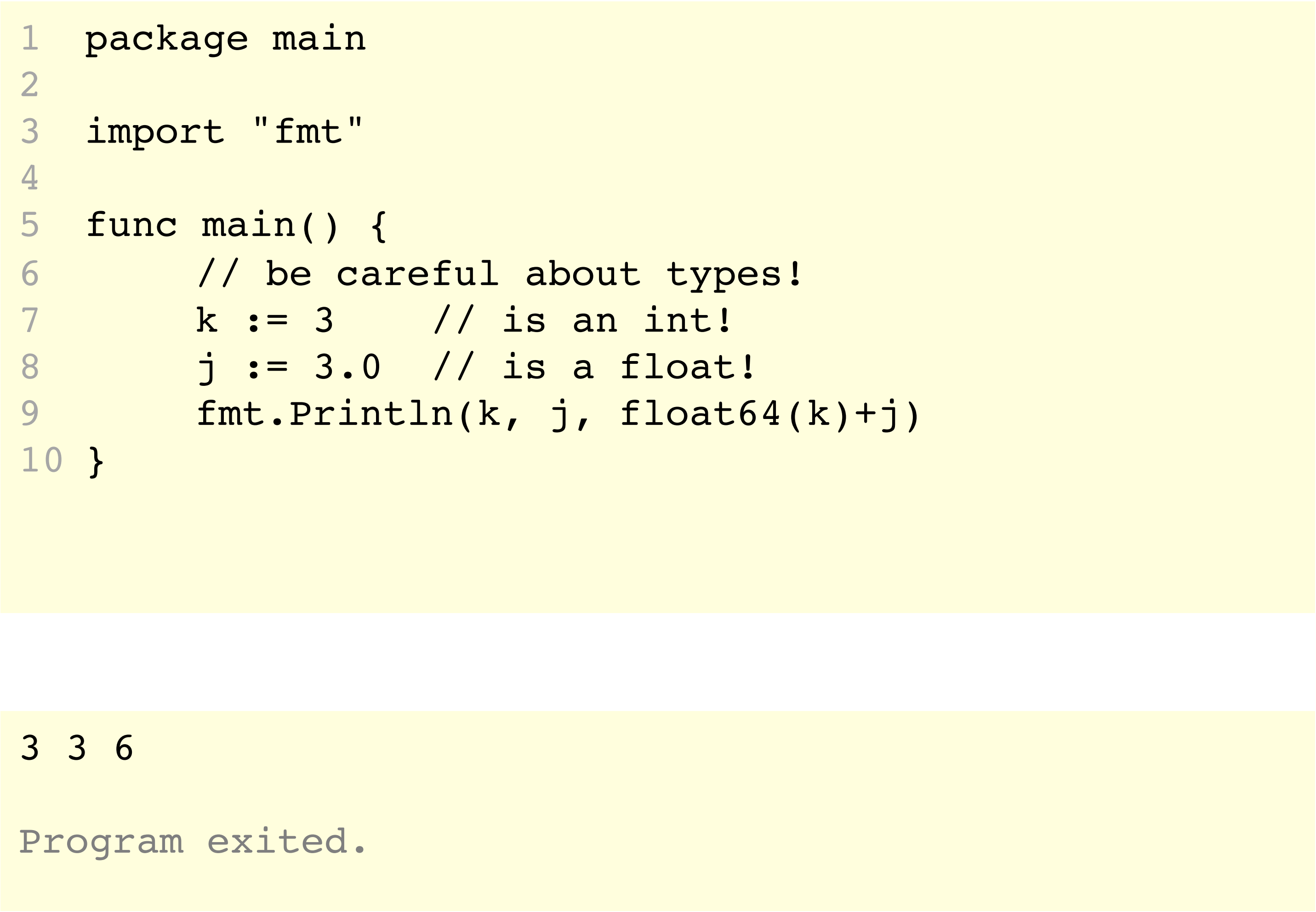
Declaring variables

```
package main

import "fmt"

func main() {
         // the type goes last!
        var i int
        // or is implied with a colon
        j := 1
        fmt.Println(i, j)
}
```

```
0 1

Program exited.
```

http://play.golang.org/p/OLZMGtsnw0

More declaring and types

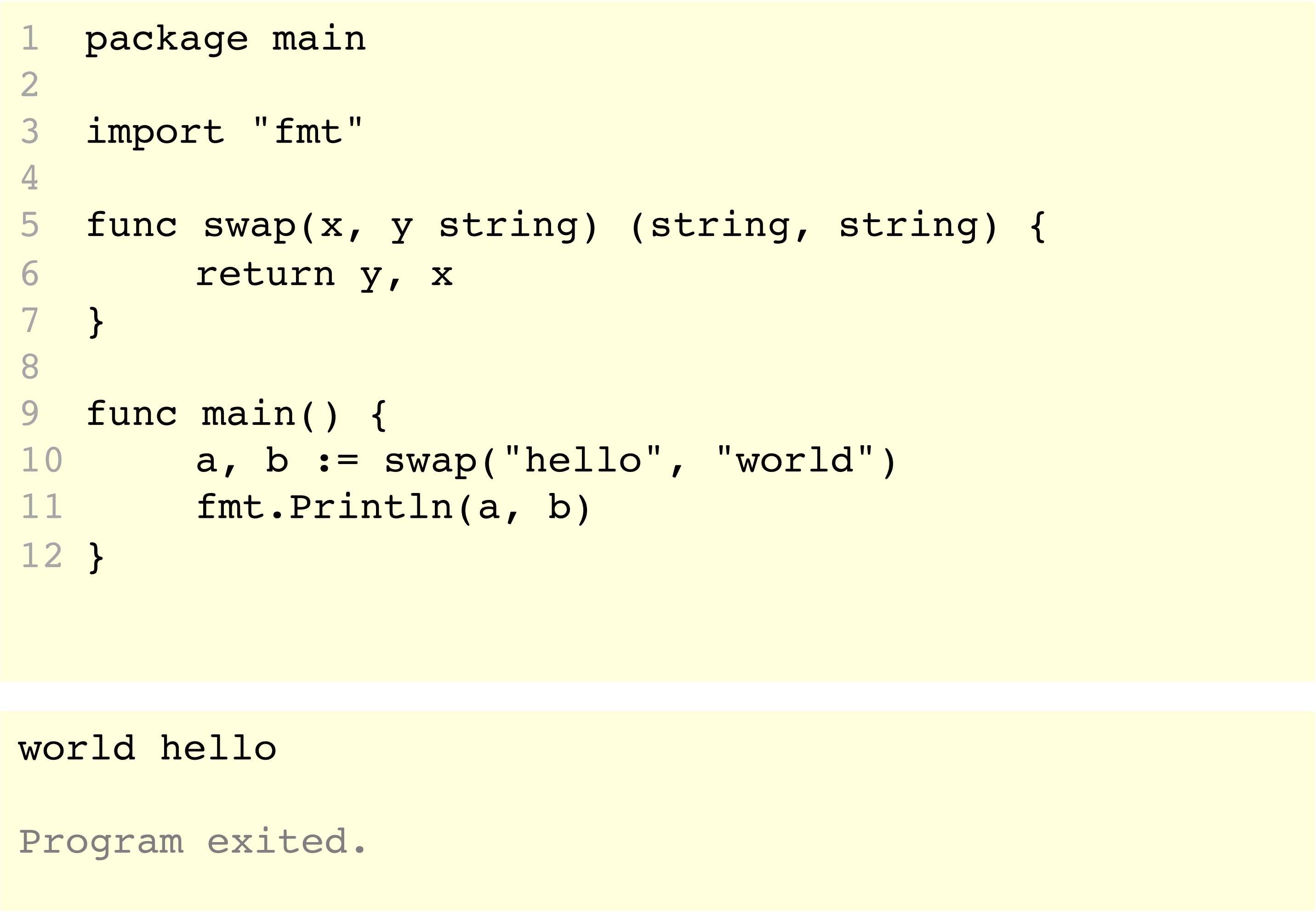


```go
package main

import "fmt"

func main() {
	// be careful about types!
	k := 3    // is an int!
	j := 3.0  // is a float!
	fmt.Println(k, j, float64(k)+j)
}
```

```
3 3 6

Program exited.
```

http://play.golang.org/p/hW_3xJp7dF

Multiple return values

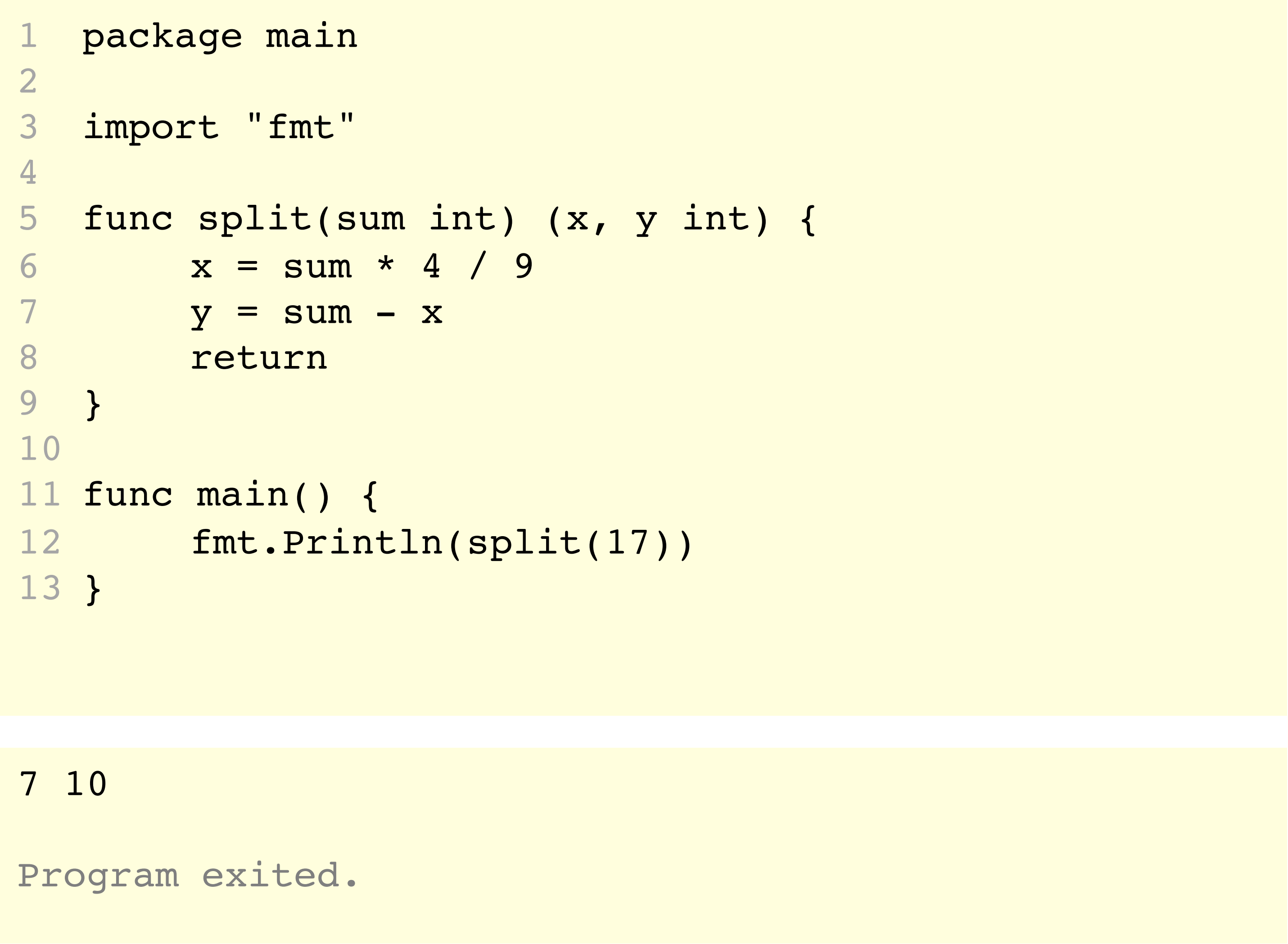


```go
package main

import "fmt"

func swap(x, y string) (string, string) {
	return y, x
}

func main() {
	a, b := swap("hello", "world")
	fmt.Println(a, b)
}
```

```
world hello

Program exited.
```

http://play.golang.org/p/7Luh22gb9T

Named return values

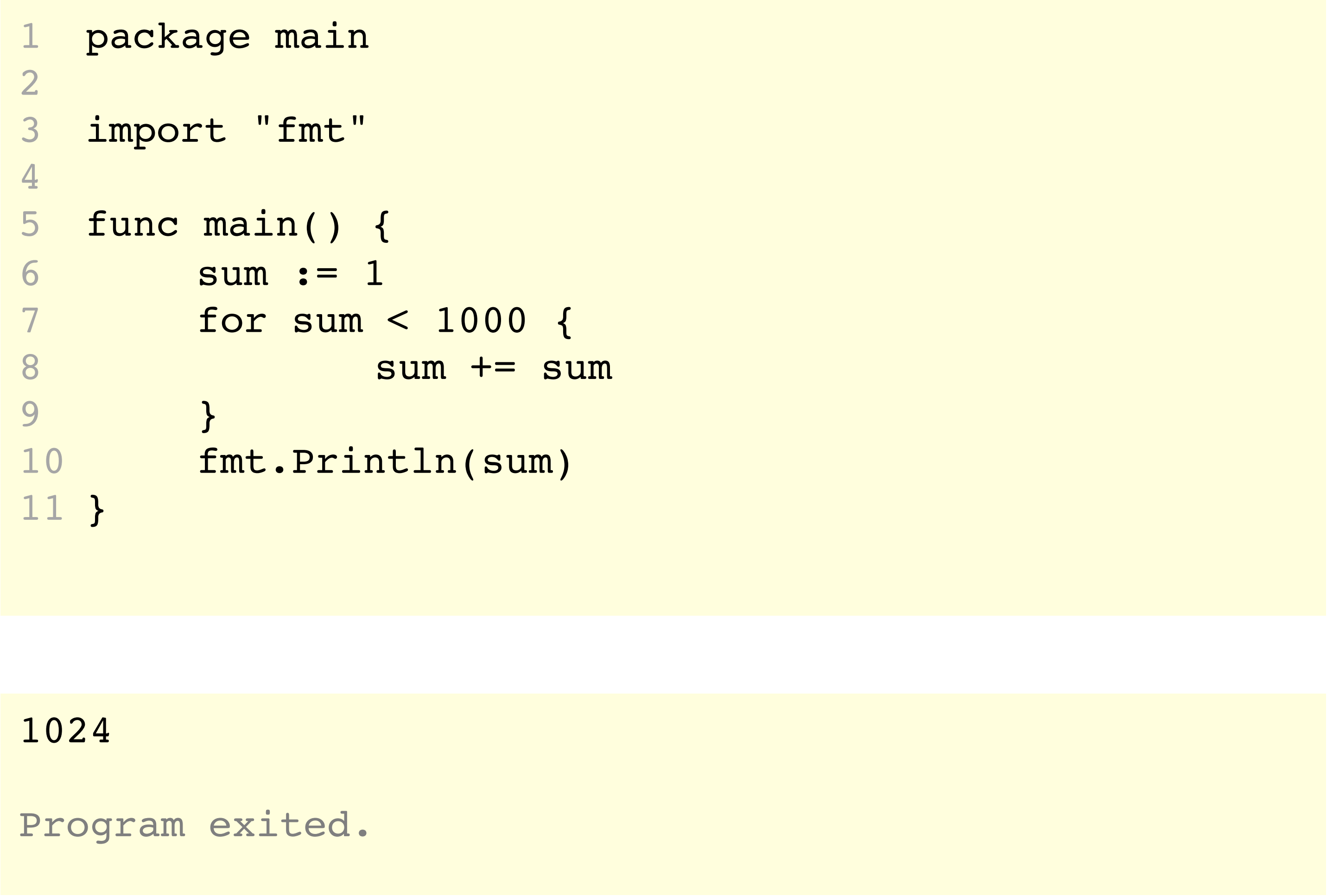


```go
package main

import "fmt"

func split(sum int) (x, y int) {
	x = sum * 4 / 9
	y = sum - x
	return
}

func main() {
	fmt.Println(split(17))
}
```

```
7 10

Program exited.
```

http://play.golang.org/p/7VpZG0mfG7

There can be only one … looping construct

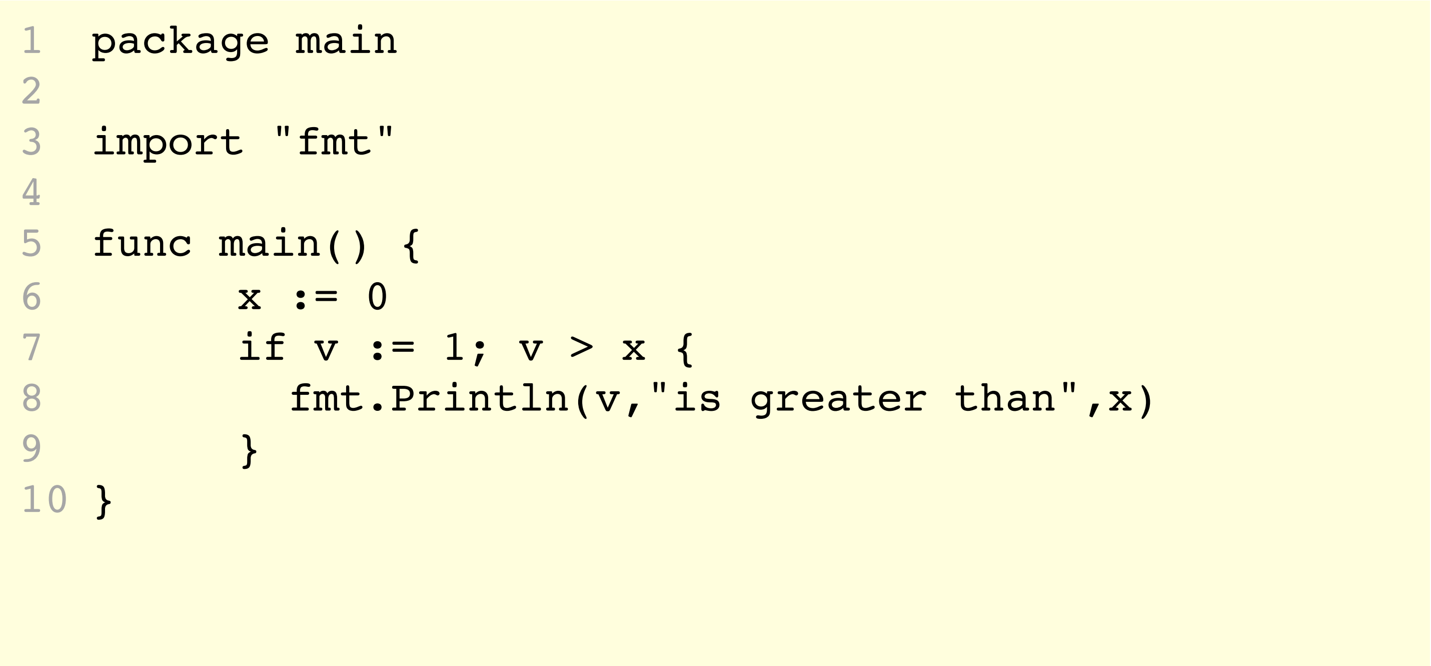


```go
package main

import "fmt"

func main() {
    sum := 1
    for sum < 1000 {
        sum += sum
    }
    fmt.Println(sum)
}
```

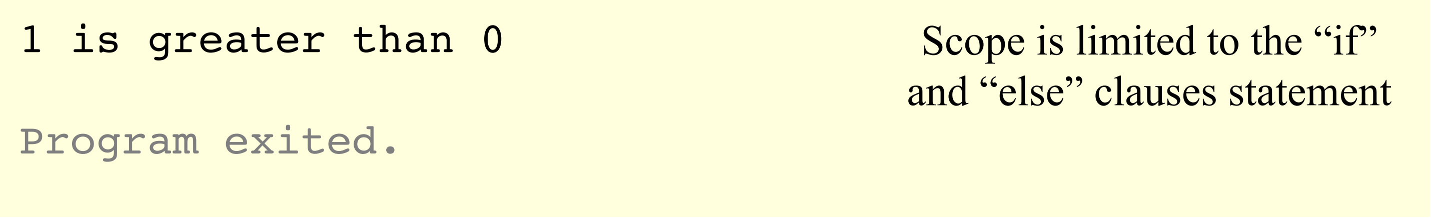
```
1024

Program exited.
```

http://play.golang.org/p/8c5bGBbLcq

If statements



```go
package main

import "fmt"

func main() {
	x := 0
	if v := 1; v > x {
	  fmt.Println(v,"is greater than",x)
	}
}
```

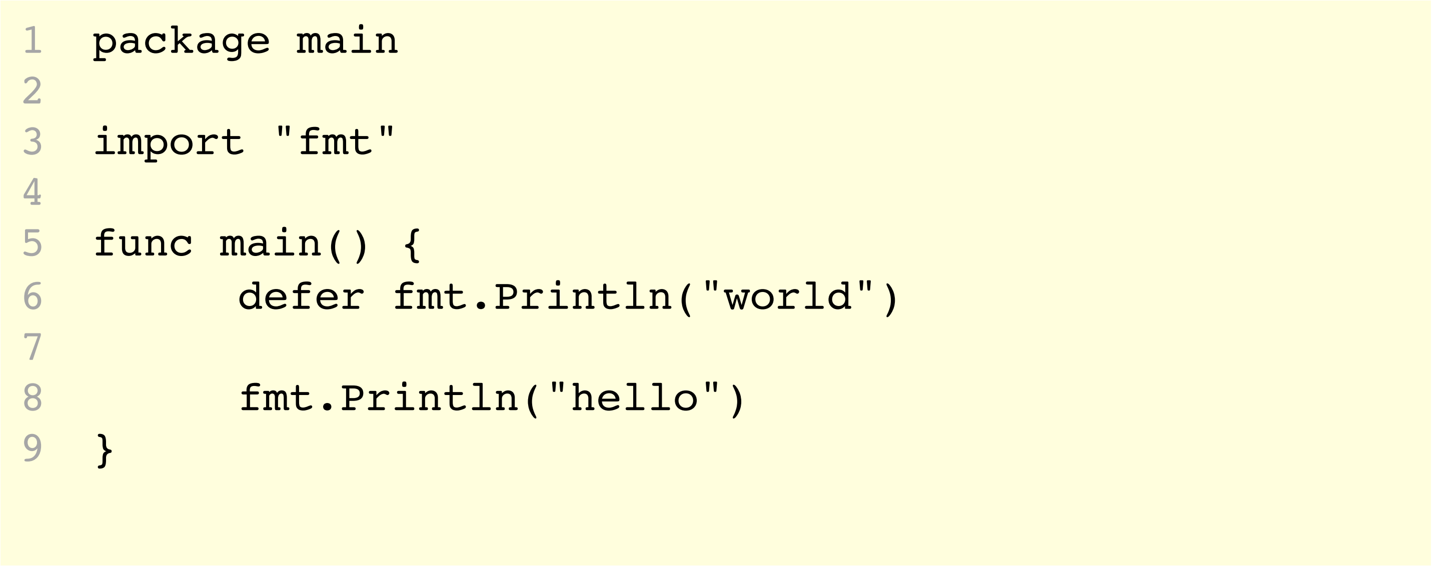


```
1 is greater than 0

Program exited.
```

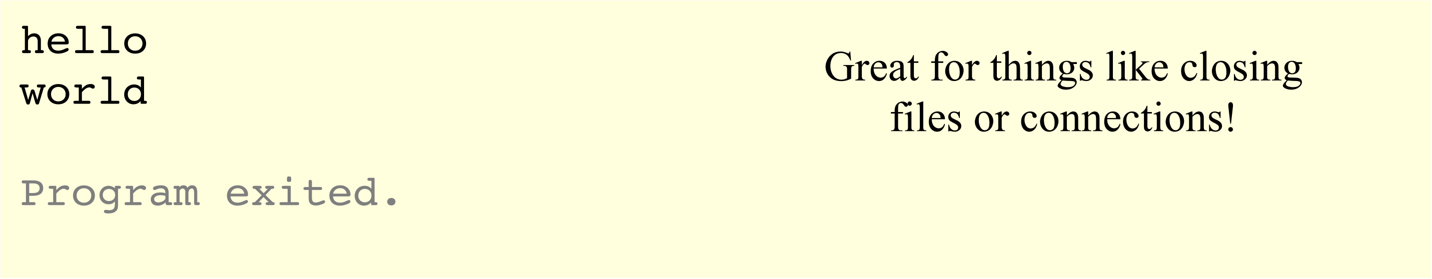
Scope is limited to the “if” and “else” clauses statement

http://play.golang.org/p/UcE46slAeK

Defers



```go
package main

import "fmt"

func main() {
	defer fmt.Println("world")

	fmt.Println("hello")
}
```



```
hello
world

Program exited.
```

Great for things like closing files or connections!

http://play.golang.org/p/tYcMMTOwFa

Structs (not classes)

```go
package main

import (
	"fmt"
	"math"
)

type Vertex struct {
	X, Y float64
}

func (v *Vertex) Abs() float64 {
	return math.Sqrt(v.X*v.X + v.Y*v.Y)
}

func main() {
	v := Vertex{3, 4}
	fmt.Println(v.Abs())
}
```

http://play.golang.org/p/_LBuBRWC_M

Interfaces

- An interface type is basically a set of required methods

- Any type (struct) that implements the required methods, implements that interface

- A type is not explicitly declared to be of a certain interface, it is implicit
  - Just implement the required methods

Interface example

```
type Abser interface {
        Abs() float64
}

type Vertex struct {
        X, Y float64
}

func (v *Vertex) Abs() float64 {
        return math.Sqrt(v.X*v.X + v.Y*v.Y)
}
```

Type Vertex meets the requirements of Abser interface

http://play.golang.org/p/KbyhiM29tQ

Error handling

```
package main

import (
     "fmt"
     "strconv"
)

func main() {
      i, err := strconv.Atoi("42")
      if err != nil {
         fmt.Printf("couldn't convert: %v\n", err)
      }
  fmt.Println("Converted integer:", i)
}
```

Unused variables raise errors!

If “err” not checked or used, compile error

http://play.golang.org/p/3n25h6roQd

Listening for connections

```go
package main
import (
    "net"
)
func handleConnection(conn net.Conn) {
    // do something
}
func main() {
    ln, err := net.Listen("tcp", ":8080")
    if err != nil {
        // handle error
    }
    for {
        conn, err := ln.Accept()
        if err != nil {
            // handle error
        }
        handleConnection(conn)
    }
}
```

Make it concurrent

```go
package main
import (
	"net"
)
func handleConnection(conn net.Conn) {
	// do something
}
func main() {
	ln, err := net.Listen("tcp", ":8080")
	if err != nil {
		// handle error
	}
	for {
		conn, err := ln.Accept()
		if err != nil {
			// handle error
		}
		go handleConnection(conn)
	}
}
```

Concurrency and shared memory

- Locks are a pain
  - Must have global lock ordering
  - Error-prone
  - Extremely difficult to debug

- Message passing
  - Have to explicitly say what you’re sharing
  - But easier to maintain in large, complicated programs
  - Go uses “channels” to pass data

Using channels

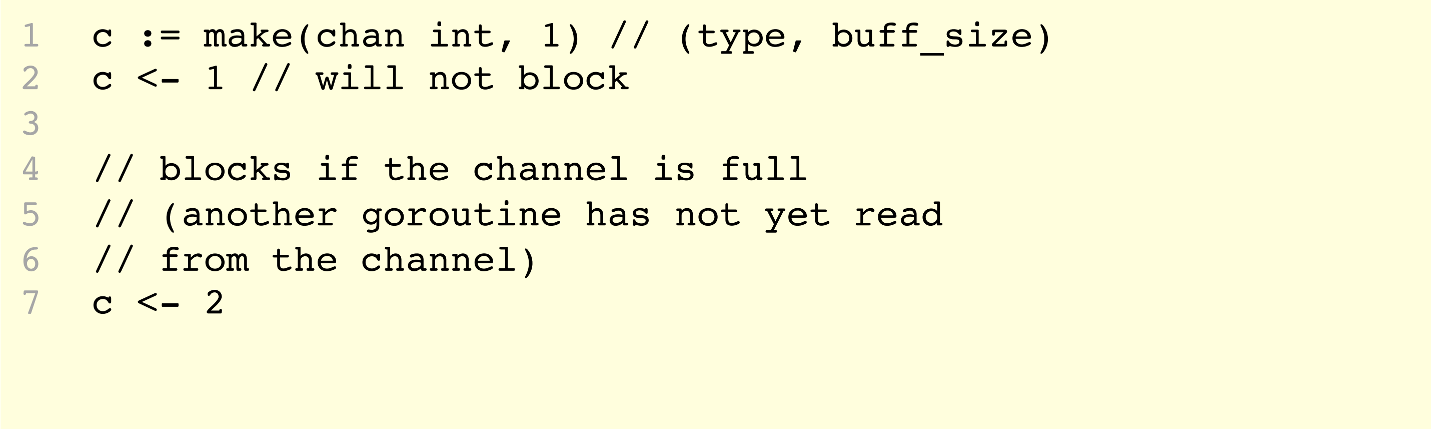
```
package main

import "fmt"

func fib(c chan int) {
  i, j := 0, 1
  for {
    i, j = i + j, i
    c <- i
  }
}

func main() {
      c := make(chan int)
      go fib(c)
      for i := 0; i < 10; i++{
            fmt.Println(<-c)
      }
}
```

Data goes in the direction of the arrow

http://play.golang.org/p/ozAf6hJXQt

More on channels

- By default, channel operations block
- Buffered channels do not block if they are not full



```
c := make(chan int, 1) // (type, buff_size)
c <- 1 // will not block

// blocks if the channel is full
// (another goroutine has not yet read
// from the channel)
c <- 2
```

Using select

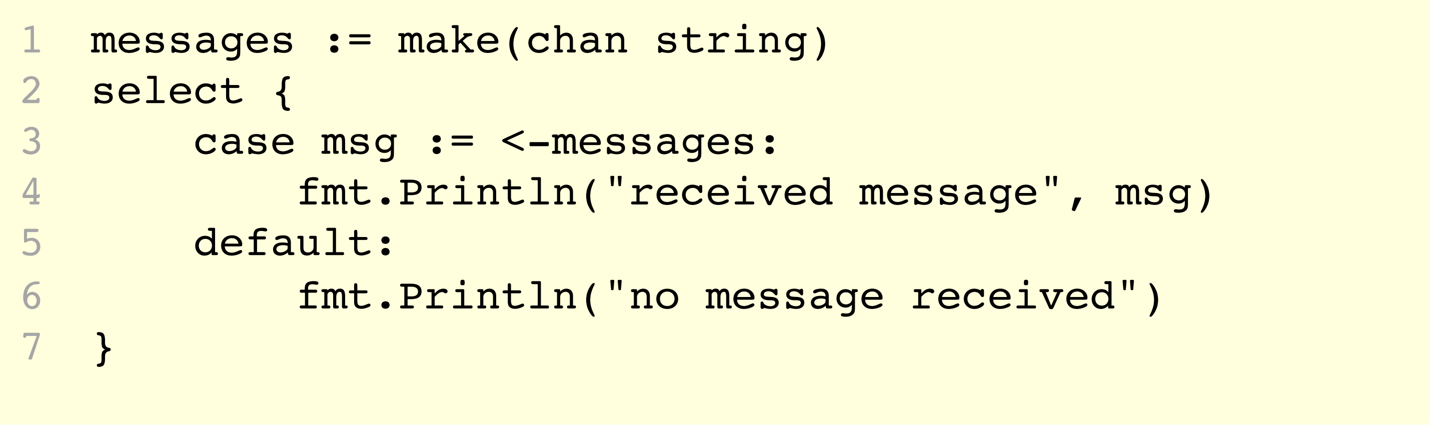
```
…
func fibonacci(c, quit chan int) {
      x, y := 0, 1
      for {
      select {
        case c <- x:
             x, y = y, x+y
        case <-quit:
           fmt.Println("quit")
           return
        }
     }
}
…
```

http://play.golang.org/p/e8xP0_99S0

Back to channels

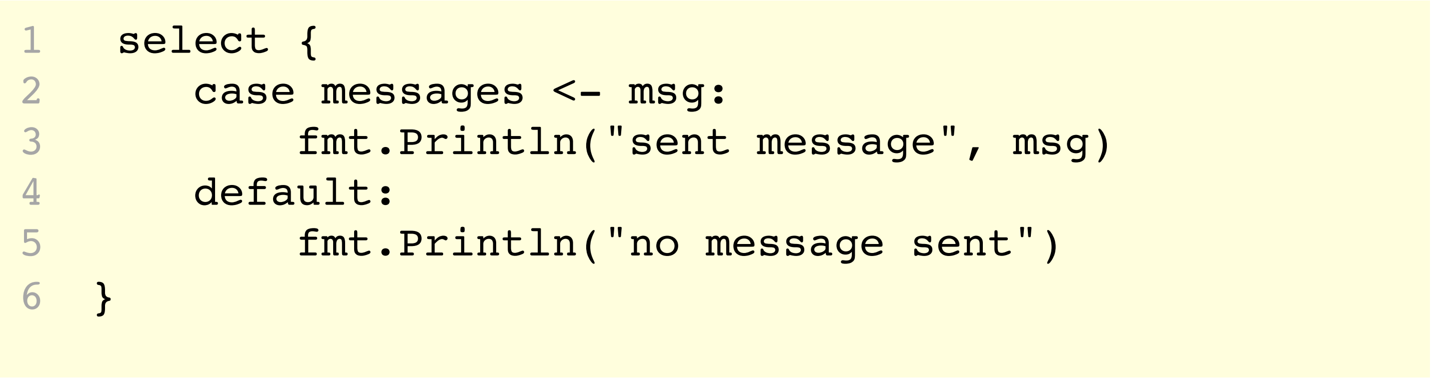
- Select statement also does non-blocking channel I/O

Reading



```
messages := make(chan string)
select {
    case msg := <-messages:
        fmt.Println("received message", msg)
    default:
        fmt.Println("no message received")
}
```

Writing



```
 select {
    case messages <- msg:
        fmt.Println("sent message", msg)
    default:
        fmt.Println("no message sent")
}
```

A few more things…

- Go can be somewhat picky
  - Unused variables raise errors, not warnings
    - Use "_" for variables you don't care about
  - Unused imports raise errors
    - "goimports" is a project to automatically add/remove imports (use at your own risk)
  - "go fmt" can auto-indent your code
  - } else if {
    - "} else" must be on the same line