# Google Go!

## Seminar aus Informatik

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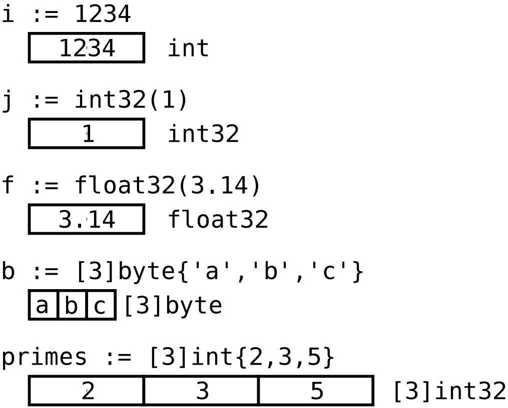
# Data Allocation and Runtime Representation

1. Basic Types
2. Arrays and Strings
3. Slices
4. Maps
5. New and Make

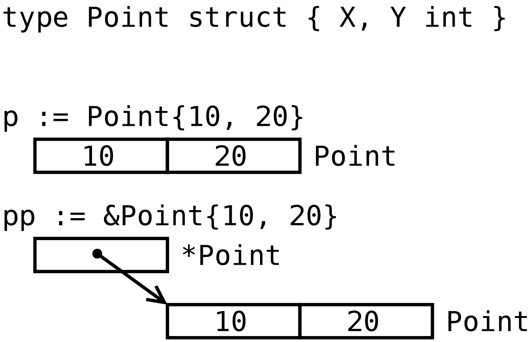
# Basic Types



```
i := 1234
  1234  int

j := int32(1)
  1  int32

f := float32(3.14)
  3.14  float32

b := [3]byte{'a','b','c'}
  a b c [3]byte

primes := [3]int{2,3,5}
  2 3 5  [3]int32
```

Figure: Memory Layout of basic types

# Struct Type

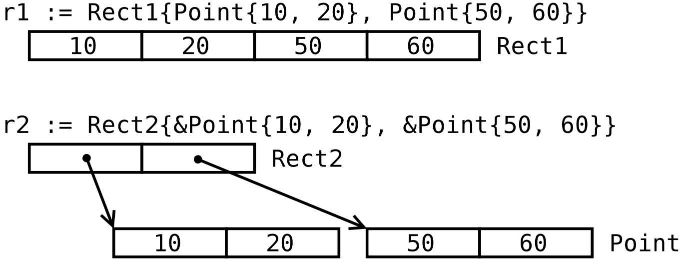


```
type Point struct { X, Y int }

p := Point{10, 20}

pp := &Point{10, 20}
```

Figure: Memory Layout of structs

# Struct Type

```
type Rect1 struct { Min, Max Point }
type Rect2 struct { Min, Max *Point }
```



```
r1 := Rect1{Point{10, 20}, Point{50, 60}}

r2 := Rect2{&Point{10, 20}, &Point{50, 60}}
```

Figure: Memory Layout of composite structs

# Arrays and Strings

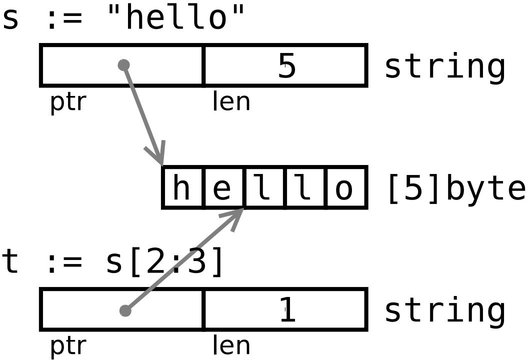
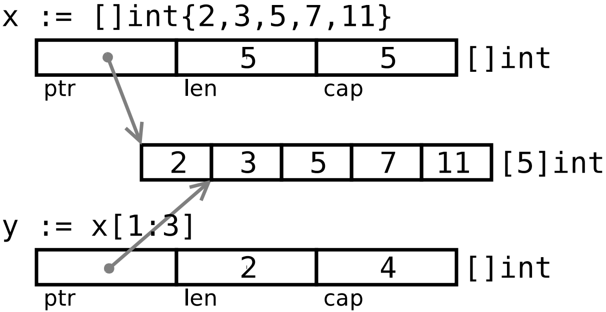


Figure: Memory Layout of a string

# Slices



```
x := []int{2,3,5,7,11}
```

```
y := x[1:3]
```

Figure: Slicing an array of integers

# Maps

## Maps are...

... built-in data structures to associate values of different types. Keys can be any type for which the equality operator is defined.

- integers
- floats
- strings
- pointer
- interfaces (if the dynamic type supports equality)

# Maps

## Example

```
//composite literal construction
var timeZone = map[string] int {
    "UTC":  0*60*60,
    "EST": -5*60*60,
    // and so on
}
//accessing map values
offset := timeZone["EST"]

//checking 0 v.s. non-existanve
var seconds int
var ok bool
seconds, ok = timeZone[tz] //comma ok idiom
```

# New and Make

## New

- new(T) returns a *T, a pointer to zeroed storage
- ready to use
- works transitively

## Make

- make(T, args) returns a value of type T, not a pointer
- used for slices, maps and channels only
- initialized complex datastructure

# Examples for New

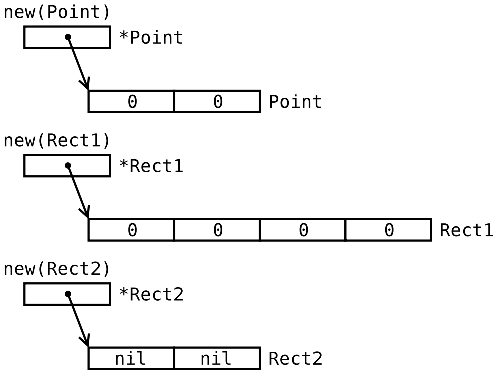


Figure: Allocation with new

# Examples for Make

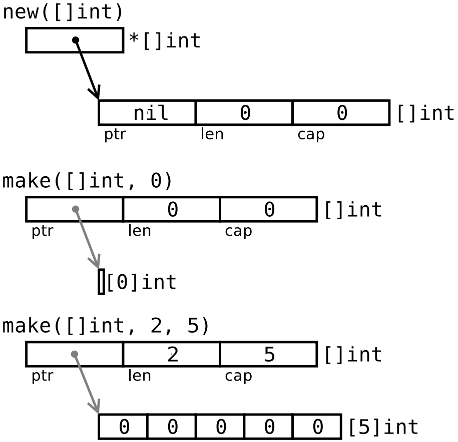


Figure: Allocation with make

# Concurrency

6. Share by communicating
7. Goroutines
8. Channels
9. Parallelization
10. Example

# Share by communicating

**Slogan**

Do not communicate by sharing memory; instead, share memory by communicating

- Shared values are passed around on channels
- Only one goroutine has access to the value at any given time
- Using channels to control access makes it easier to write clear, correct programs
- It can also be seen as a type-safe generalization of Unix pipes

For reference counts there is no need to put a mutex around the integer variable

# Goroutines

**Goroutines are...**

...functions executing in parallel with other goroutines in the same address space

- Prefix a function or method call with the go keyword to run the call in a new goroutine
- Hides many of the complexities of thread creation and management
- Goroutines are multiplexed onto multiple OS threads
- When the call completes, the goroutine exits, silently

```
func main() {
    go expensiveComputation(x, y, z)
    anotherExpensiveComputation(a, b, c)
}
```

# Channels I

**Channels combine...**

...communication with synchronization

- Shared values are passed around on channels
- Like maps, channels are a reference type and are allocated with make
- Channels can be buffered
- With a channel you can make one goroutine wait for an other
  - Receivers always block until there is data to receive
  - If the channel is unbuffered, the sender blocks until the receiver has received the value
  - If the channel has a buffer, the sender blocks if the buffer is full

```
ci := make(chan int) // unbuffered channel of integers
cs := make(chan *os.File, 100) // buffered channel of pointers to Files
```

# Channels II

**Channels combine...**

...communication with synchronization

```
c := make(chan int) // Allocate a channel.
// Start the sort in a goroutine; when it completes, signal on the channel.
go func() {
   list.Sort()
   c <- 1 // Send a signal; value does not matter.
}()
doSomethingForAWhile()
<- c // Wait for sort to finish; discard sent value.
```

# Parallelization

**If the calculation can be broken into separate pieces,...**

...it can be parallelized, with a channel to signal when each piece completes.

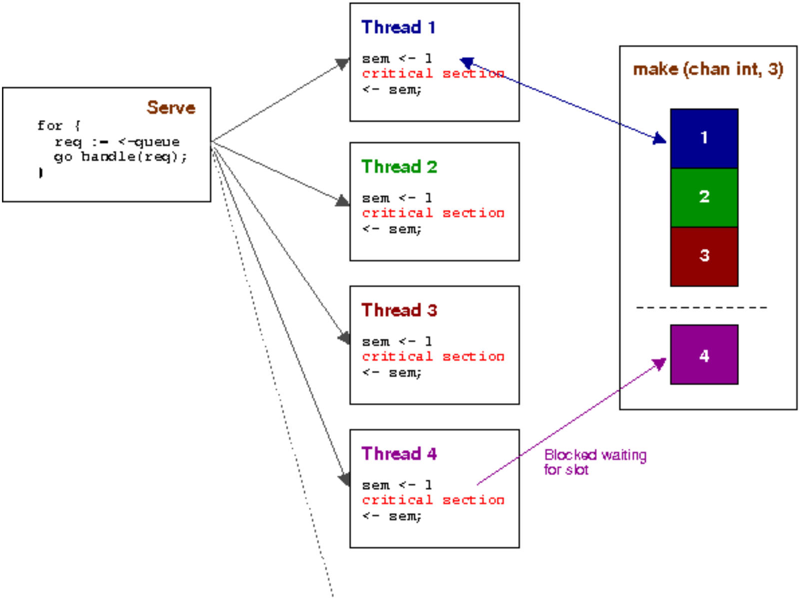
- Current compilerimplementations will not parallelize code by default
- Environment variable GOMAXPROCS sets the number of cores to use
- Or call runtime.GOMAXPROCS(NCPU) from your code

A good example for parallelization is a request-broker.
We handle a defined number of requests in parallel and block incoming requests if the maximum number is reached.

# Semaphore using a channel I (Code)

```
var sem = make(chan int, MaxOutstanding)
func handle(r *Request) {
    sem <- 1; // Wait for active queue to drain.
    process(r); // May take a long time.
    <-sem; // Done; enable next request to run.
}
func Serve(queue chan *Request) {
    for {
       req := <-queue;
       go handle(req); // Don't wait for handle to finish.
    }
}
```

# Semaphore using a channel II (Figure)



```
for {
  req := <-queue
  go handle(req);
}
```

```
sem <- 1
critical section
<- sem;
```

```
sem <- 1
critical section
<- sem;
```

```
sem <- 1
critical section
<- sem;
```

```
sem <- 1
critical section
<- sem;
```

# The End

Thank You!

# References

[1] The go programming language, 2010. URL `http://golang.org`.

[2] Go l4, 2010. URL `http://www.technovelty.org/code/go-l4.html`.

[3] The go programming language blog, 2010. URL `http://blog.golang.org/2010/05/new-talk-and-tutorials.html`.

[4] Russ Cox. research!rsc, 2010. URL `http://research.swtch.com/2009/11/go-data-structures.html`.

[5] golang-nuts, 2010. URL `http://groups.google.com/group/golang-nuts`.