

Programming in Go

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Composite Types

Composite types

string

a	r	e	a
---	---	---	---

[4]int

1	12	4	8
---	----	---	---

[]int

1	13	3	17
---	----	---	-----	-----	----

map[string]int

"to"	1
"from"	12
"into"	3
"above"	0

Arrays

Arrays are typed by size, which is *fixed* at compile time

// all these are equivalent

```
var a [3]int
```

```
var b [3]int{0, 0, 0}
```

```
var c [...]{0, 0, 0}    // sized by initializer
```

```
var d [3]int
```

```
d = b                  // elements copied
```

```
var m [...]int{1, 2, 3, 4}
```

```
c = m                  // TYPE MISMATCH
```

Arrays are passed *by value*, thus elements are copied

Slices

Slices have variable length, backed by some array; they are copied when they outgrow that array

```
var a []int           // nil, no storage
var b = []int{1, 2}   // initialized

a = append(a, 1)      // append to nil OK
b = append(b, 3)      // []int{1, 2, 3}

a = b                 // overwrites a

d := make([]int, 5)   // []int{0, 0, 0, 0, 0}
e := a                // same storage (alias)

e[0] == b[0]          // true
```

Slices are passed *by reference*; no copying, updating OK

The off-by-one bug

Slices are indexed like `[8:11]`

(read as the starting element and *one past* the ending element, so this way we have $11 - 8 = 3$ elements in our slice)

For loops work the same way in most cases:

```
for i := 8; i < 11; i++ { // in math written [8, 11)
    . . .
}
```



Read it on Wikipedia [OB1](#)

Slices

```
package main
import "fmt"

func main() {
    t := []byte("string") // 0:s 1:t 2:r 3:i 4:n 5:g
    fmt.Println(len(t))   // 6 bytes in t
    fmt.Println(t[2])     // 1 item
    fmt.Println(t[:2])    // 2 items
    fmt.Println(t[2:])    // 6-2 items
    fmt.Println(t[3:5])   // 5-3 items
}
```

```
6 [115 116 114 105 110 103]
114
[115 116]
[114 105 110 103]
[105 110]
```

Slices vs arrays

Most Go APIs take slices as inputs, not arrays

Slice	Array
Variable length	Length fixed at compile time
Passed by reference	Passed by value (copied)
Not comparable	Comparable (==)
Cannot be used as map key	Can be used as map key
Has copy & append helpers	—
Useful as function parameters	Useful as “pseudo” constants

Arrays as pseudo-constants

It can be useful to have fixed-size tables of values in some algorithms, treated as constant data

```
// from the file crypto/des/const.go in the DES package
```

```
// Used to perform an initial permutation of a 64-bit  
// input block.
```

```
var initialPermutation = [64]byte{  
    6, 14, 22, 30, 38, 46, 54, 62,  
    4, 12, 20, 28, 36, 44, 52, 60,  
    2, 10, 18, 26, 34, 42, 50, 58,  
    0,  8, 16, 24, 32, 40, 48, 56,  
    7, 15, 23, 31, 39, 47, 55, 63,  
    5, 13, 21, 29, 37, 45, 53, 61,  
    3, 11, 19, 27, 35, 43, 51, 59,  
    1,  9, 17, 25, 33, 41, 49, 57,  
}
```

Examples

```
var w = [...]int{1, 2, 3}    // array of len(3)
var x = []int{0, 0, 0}       // slice of len(3)

func do(a [3]int, b []int) []int {
    a = b                    // SYNTAX ERROR
    a[0] = 4                 // w unchanged
    b[0] = 3                 // x changed

    c := make([]int, 5)      // []int{0, 0, 0, 0, 0}
    c[4] = 42
    copy(c, b)               // copies only 3 elts

    return c
}

y := do(w, x)
fmt.Println(w, x, y)        // [1 2 3] [3 0 0] [3 0 0 0 42]
```

Maps

Maps are dictionaries: indexed by key, returning a value

You can read from a nil map, but inserting will panic

```
var m map[string]int    // nil, no storage
p := make(map[string]int) // non-nil but empty

a := p["the"]           // returns 0
b := m["the"]           // same thing
m["and"] = 1            // PANIC - nil map
m = p
m["and"]++              // OK, same map as p now
c := p["and"]           // returns 1
```

Maps are passed *by reference*; no copying, updating OK

The type used for the key must have `==` and `!=` defined (*not slices, maps, or funcs*)

Maps

Maps can't be compared to one another; maps can be compared only to `nil` as a special case

```
var m = map[string]int{  
    "and": 1,  
    "the": 1,  
    "or": 2,  
}
```

```
var n map[string]int
```

```
b := m == n           // SYNTAX ERROR  
c := n == nil         // true  
d := len(m)           // 3  
e := cap(m)           // TYPE MISMATCH
```

Maps

Maps have a special two-result lookup function

The second variable tells you if the key was there

```
p := map[string]int{}           // non-nil but empty

a := p["the"]                   // returns 0
b, ok := p["and"]               // 0, false

p["the"]++

c, ok := p["the"]               // 1, true

if w, ok := p["the"]; ok {
    // we know w is not the default value
    . . .
}
```

Each type has certain built-in functions

<code>len(s)</code>	string	string length
<code>len(a), cap(a)</code>	array	array length, capacity (constant)
<code>make(T, x)</code>	slice	slice of type T with length x and capacity x
<code>make(T, x, y)</code>	slice	slice of type T with length x and capacity y
<code>copy(c, d)</code>	slice	copy from d to c; # = min of the two lengths
<code>c=append(c, d)</code>	slice	append d to c and return a new slice result
<code>len(s), cap(s)</code>	slice	slice length and capacity
<code>make(T)</code>	map	map of type T
<code>make(T, x)</code>	map	map of type T with space hint for x elements
<code>delete(m, k)</code>	map	delete key k (if present, else no change)
<code>len(m)</code>	map	map length

Make nil useful

Nil is a type of zero: it indicates the absence of something

Many built-ins are safe: `len`, `cap`, `range`

```
var s []int
var m map[string]int

l := len(s)           // length of nil slice is 0

i, ok := m["int"]     // 0, false for any missing key

for _, v := range s { // skip if s is nil or empty
    . . .
}
```

“Make the zero value useful.” — Rob Pike

“Understanding nil”

See Francesc Campoy's video at

<https://www.youtube.com/watch?v=ynoY2xz-F8s>



GopherCon 2016: Francesc Campoy - Understanding nil

“Understanding nil”

♥ Dimitri Fontaine liked



Programming Wisdom @CodeWisdom · 13h



“A language that doesn't affect the way you think about programming is not worth knowing.” - Alan J. Perlis



7



167



627



```
package main

import (
    "bufio"
    "fmt"
    "os"
    "sort"
)

func main() {
    scan := bufio.NewScanner(os.Stdin)
    words := make(map[string]int)

    scan.Split(bufio.ScanWords)

    for scan.Scan() {
        words[scan.Text()]++
    }

    fmt.Println(len(words), "unique words")
}
```

```

type kv struct {
    key string
    val int
}

var ss []kv
for k, v := range words {
    ss = append(ss, kv{k, v})
}

sort.Slice(ss, func(i, j int) bool {
    return ss[i].val > ss[j].val
})

ss = ss[:3]

for _, s := range ss {
    fmt.Println(s.key, "appears", s.val, "times")
}

```