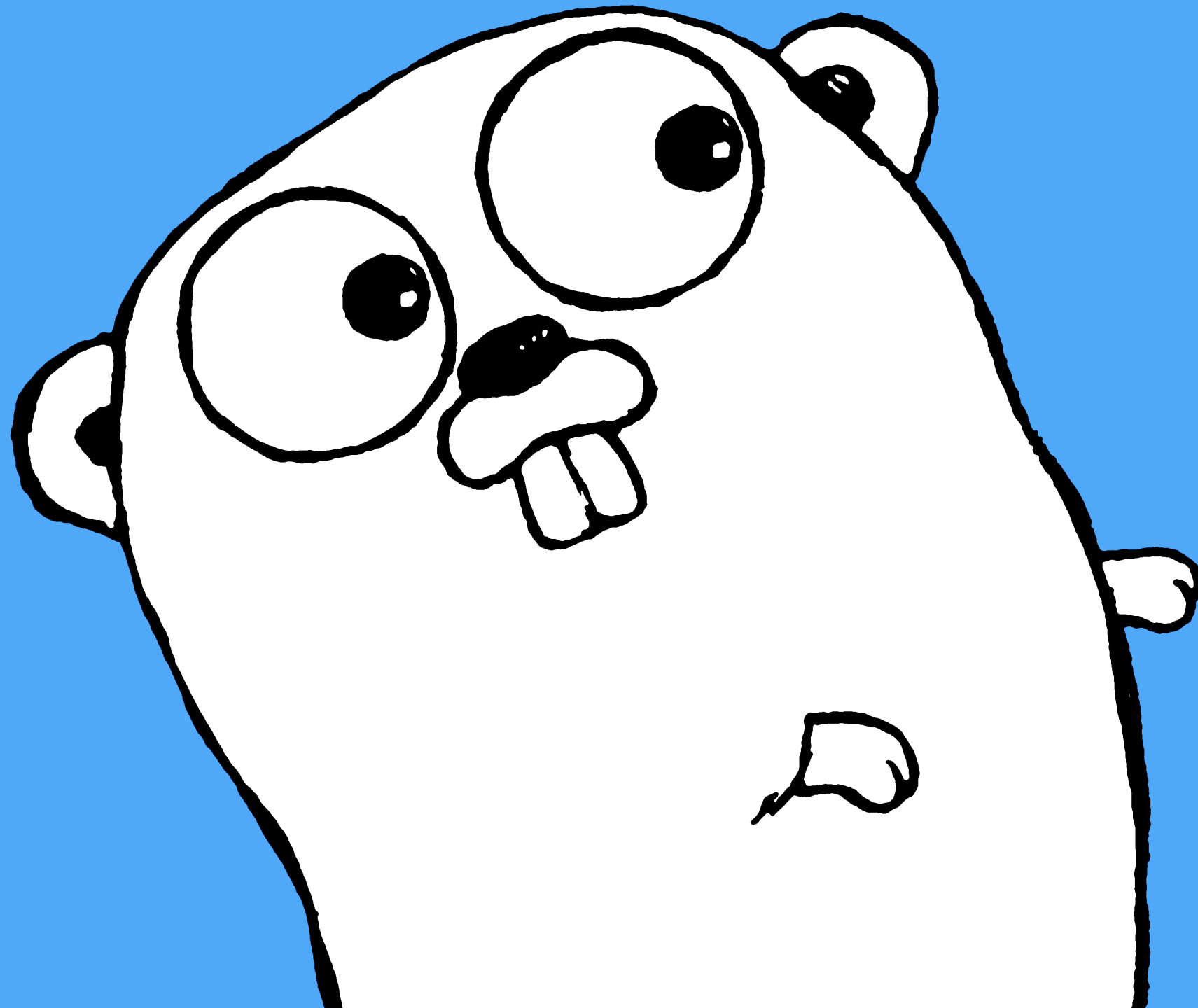
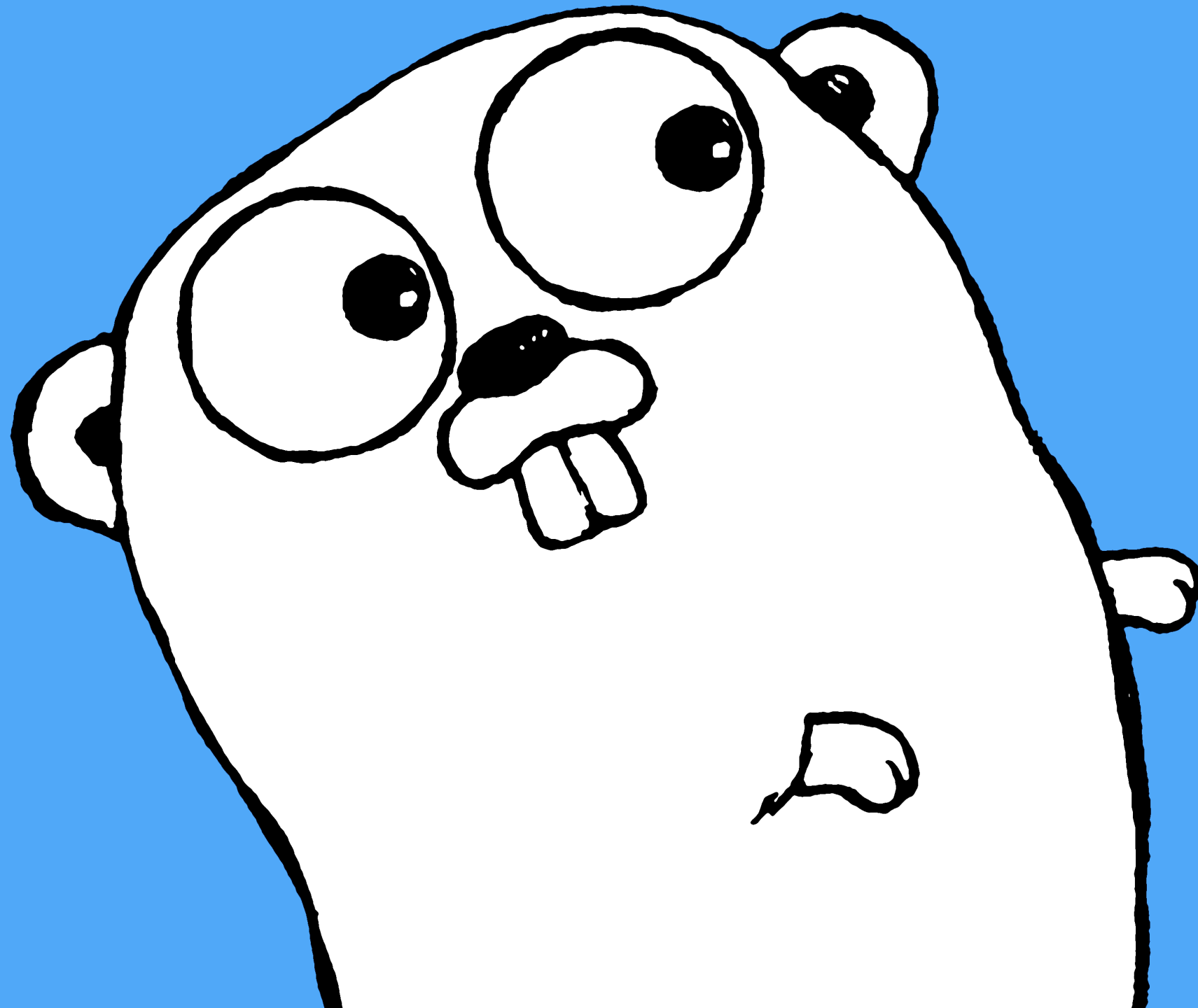


go get better



framework training
business value through education

3 Day Go Training Course



framework training
business value through education

Dom Davis

@idomdavis



Hello
my name is

Deliberate Practice



House Rules

There is no such thing as a stupid question

We go at your pace

This is your course

This is not school

Have fun



Go

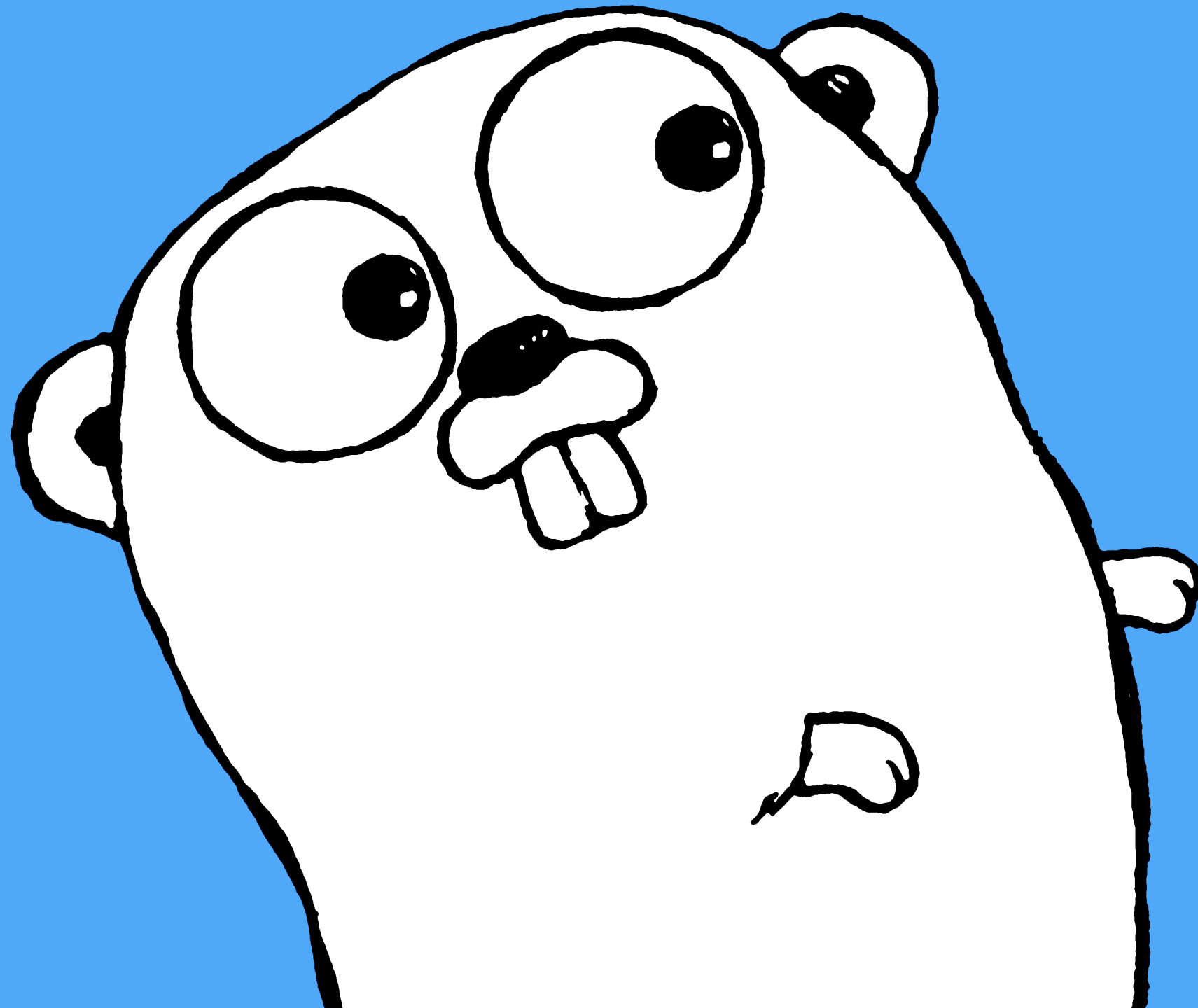


framework training
business value through education

Simple, orthogonal features, that must carry their weight
Prefer maintainability over expressiveness
Typing is not so difficult



Gophers

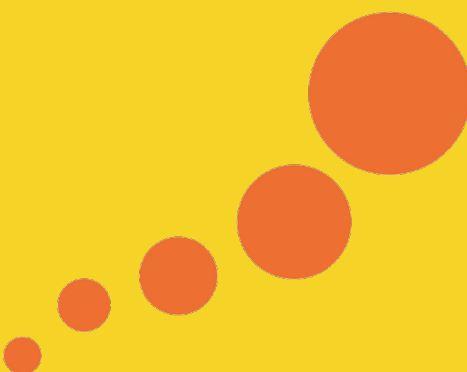


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0: Goals

Make a list of goals for this course

Make a list of your programming experience

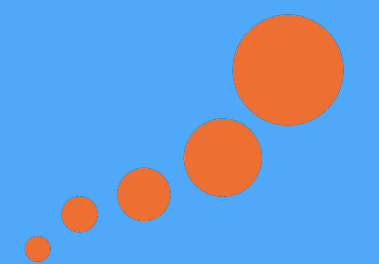


The Plan

Introduction, Setup & Go Katas
Go Idiosyncrasies
Types Interfaces and Polymorphism
Concurrency and Parallelism
Networking
Packaging and Distribution
Go Nuts



The Basics



```
package main
```

```
func main() {  
    var s string = "Hello"  
    println(s)  
}
```

```
package main
```

```
func main() {  
    var s1 string = "Hello"  
    var s2 = "World"  
  
    println(s1, s2)  
}
```

```
package main
```

```
func main() {  
    s1, s2 := "Hello", "World"  
    println(s1, s2)  
}
```

```
package main
```

```
var (  
    s1 = "Hello"  
    s2 = "World"  
)
```

```
func main() {  
    println(s1, s2)  
}
```


bool
byte
uintptr
int, int8, int16, int32, int64
uint, uint8, uint16, uint32, uint64
float32, float64
complex64, complex128
rune, string

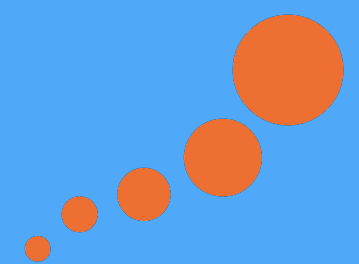


```
func branching(a string) {  
    if a == "A" {  
        println("Good")  
    } else if a == "B" {  
        println("Close enough")  
    } else {  
        println("Nope!")  
    }  
}
```

```
func branching(a string) {  
    if a, b := 1, 2; a == b {  
        println(a, "equal to", b)  
    } else {  
        println(a, "not equal to", b)  
    }  
  
    // a, b are undefined here  
}
```

```
func loops() {  
    for i := 0; i < 100; i++ {  
        println(i)  
    }  
}
```

FizzBuzz



1, 2, Fizz, 4, Buzz, Fizz, 7, 8, 9, Buzz, 11, Fizz, 13, 14, FizzBuzz



If a number is divisible by 3 output Fizz
If a number is divisible by 5 output Buzz
If a number is divisible by 3 and 5 output FizzBuzz
Otherwise output the number



1: FizzBuzz

For the numbers 1 to 100

If a number is divisible by 3 output Fizz

If a number is divisible by 5 output Buzz

If a number is divisible by 3 and 5 output FizzBuzz

Otherwise output the number

<https://play.golang.org/>

<https://github.com/domdavis/go-get-better/tree/exercise-1>




```
func main() {  
    for i := 1; i <= 100; i++ {  
        if i%15 == 1 {  
            rand.Seed(int64(176064004))  
        }  
        fmt.Print([]string{fmt.Sprintf("%d\n", i),  
            "fizz", "buzz", "fizzbuzz"}[rand.Int63()%4])  
    }  
}
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    for i := 1; i <= 100; i++ {  
        if i%3 == 0 && i%5 == 0 {  
            fmt.Printf("%-5d - %s\n", i, "FizzBuzz")  
        } else if i%3 == 0 {  
            fmt.Printf("%-5d - %s\n", i, "Fizz")  
        } else if i%5 == 0 {  
            fmt.Printf("%-5d - %s\n", i, "Buzz")  
        } else {  
            fmt.Println(i)  
        }  
    }  
}
```

<> Code

! Issues 184

🔗 Pull requests 22

📁 Projects 0

📖 Wiki

📊 Insights

FizzBuzz Enterprise Edition is a no-nonsense implementation of FizzBuzz made by serious businessmen for serious business purposes. <http://www.fizzbuzz.enterprises>

🕒 161 commits

🌿 1 branch

📦 0 releases

👤 30 contributors

Branch: master ▾

New pull request

Create new file

Upload files

Find file

Clone or download ▾



emiln committed on GitHub Merge pull request #281 from tkellogg/master ...

Latest commit cdfac75 on 4 Feb

| | | |
|--|--|--------------|
| 📁 gradle/wrapper | Include Gradle config closes #230 | 2 years ago |
| 📁 resources/assets/configuration/sp... | Installed spring and restructured for dependency injection. | 3 years ago |
| 📁 src | FizzStringReturner may not have copied all characters | 8 months ago |
| 📄 .gitattributes | Started the project. Time to learn! | 5 years ago |
| 📄 .gitignore | Add unsupported platform files to the .gitignore | 2 years ago |
| 📄 .travis.yml | Reverting the revert commit, since it clearly did not revert as inten... | 2 years ago |
| 📄 CONTRIBUTING.md | Reverting the revert commit, since it clearly did not revert as inten... | 2 years ago |
| 📄 README.md | Reverting the revert commit, since it clearly did not revert as inten... | 2 years ago |
| 📄 build.gradle | Include Gradle config closes #230 | 2 years ago |
| 📄 gradlew | Include Gradle config closes #230 | 2 years ago |
| 📄 gradlew.bat | Include Gradle config closes #230 | 2 years ago |
| 📄 pom.xml | Merge pull request #232 from kristianperkins/patch-1 | a year ago |
| 📄 settings.gradle | Include Gradle config closes #230 | 2 years ago |

```
func main() {  
    pattern :=  
        []int{0, 0, 1, 0, 2, 1, 0, 0, 1, 2, 0, 1, 0, 0, 3}  
  
    for i := 1; i <= 100; i++ {  
        fmt.Print([]string{fmt.Sprintf("%d\n", i),  
            "fizz\n", "buzz\n", "fizzbuzz\n"}[pattern[(i-1)%15]])  
    }  
}
```

```
package main
```

```
import "fmt"
```

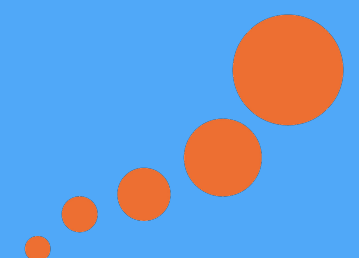
```
func main() {  
    for i := 1; i <= 100; i++ {  
        if i%3 == 0 && i%5 == 0 {  
            fmt.Printf("%-5d - %s\n", i, "FizzBuzz")  
        } else if i%3 == 0 {  
            fmt.Printf("%-5d - %s\n", i, "Fizz")  
        } else if i%5 == 0 {  
            fmt.Printf("%-5d - %s\n", i, "Buzz")  
        } else {  
            fmt.Println(i)  
        }  
    }  
}
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    for i := 1; i <= 100; i++ {  
        switch {  
        case i%3 == 0 && i%5 == 0:  
            fmt.Printf("%-5d - %s\n", i, "FizzBuzz")  
        case i%3 == 0:  
            fmt.Printf("%-5d - %s\n", i, "Fizz")  
        case i%5 == 0:  
            fmt.Printf("%-5d - %s\n", i, "Buzz")  
        default:  
            fmt.Println(i)  
        }  
    }  
}
```

switch



```
func branching(i int) {  
    switch i {  
    case 1:  
        println("One")  
    case 2:  
        println("A couple")  
    default:  
        println("Many")  
    }  
}
```



```
func branching(i int) {  
    switch i {  
    case 1:  
        println("One")  
    case 2, 3, 4, 5:  
        println("Some")  
    default:  
        println("Many")  
    }  
}
```

```
func branching(i int) {  
    switch {  
    case i == 1:  
        println("One")  
    case i <= 5:  
        println("Some")  
    default:  
        println("Many")  
    }  
}
```

```
func branching(i int) {  
    switch i {  
    case 1:  
        println("One")  
        fallthrough  
    case 2:  
        println("Two")  
    case 3:  
        println("Three")  
    default:  
        println("Many")  
    }  
}
```

Go Is Opinionated

Go is not a language to express your inner artist
There is [almost] always one idiomatic way to do something
There is only one way to format your code: `go fmt`



```
package main
```

```
import "fmt"
```

```
func main() {  
    for i := 1; i <= 100; i++ {  
        switch {  
        case i%3 == 0 && i%5 == 0:  
            fmt.Printf("%-5d - %s\n", i, "FizzBuzz")  
        case i%3 == 0:  
            fmt.Printf("%-5d - %s\n", i, "Fizz")  
        case i%5 == 0:  
            fmt.Printf("%-5d - %s\n", i, "Buzz")  
        default:  
            fmt.Println(i)  
        }  
    }  
}
```

go vet
goimports
golint

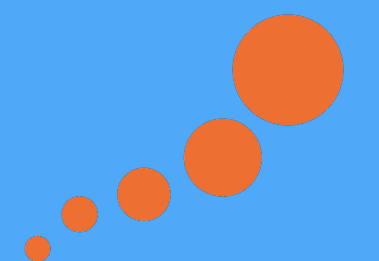


```
[go-get-better (exercise-1)]$ go vet
# github.com/domdavis/go-get-better
./alternatives_test.go:12: ExampleIdiomaticSolution refers to unknown identifier: IdiomaticSolution
./alternatives_test.go:34: ExampleBrittleSolution refers to unknown identifier: BrittleSolution
./alternatives_test.go:53: ExampleCompactSolution refers to unknown identifier: CompactSolution
```

```
[go-get-better (exercise-1)]$ golint
alternatives_test.go:68:9: if block ends with a return statement, so drop this else and outdent
its block (move short variable declaration to its own line if necessary)
```

```
[go-get-better (exercise-1)]$
```

go get setup



2: fizzbuzz.exe

For the numbers 1 to 100

If a number is divisible by 3 output Fizz

If a number is divisible by 5 output Buzz

If a number is divisible by 3 and 5 output FizzBuzz

Otherwise output the number

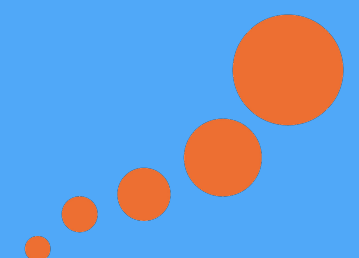
Run your program as a compiled binary from the command line

<https://github.com/domdavis/go-get-better/tree/exercise-2>



```
func main() {  
    for i := 1; i <= 19; i++ {  
        var out string  
        if i%3 == 0 {  
            out = "Fizz"  
        }  
  
        if i%5 == 0 {  
            out += "Buzz"  
        }  
  
        if i%3 != 0 && i%5 != 0 {  
            out = strconv.Itoa(i)  
        }  
        fmt.Println(out)  
    }  
}
```

func



framework training

```
package main
```

```
func main() {  
    println("Hello, World!")  
}
```

```
package main
```

```
func main() {  
    hello()  
}
```

```
func hello() {  
    println("Hello, World!")  
}
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    hello("World!")  
}
```

```
func hello(n string) {  
    fmt.Printf("Hello, %s", n)  
}
```

```
package main
```

```
func main() {  
    println(square(3))  
}
```

```
func square(i int) int {  
    return i * i  
}
```

```
package main
```

```
func main() {  
    i, r := divide(5, 2)  
    println(i, r)  
}
```

```
func divide(x, y int) (int, int) {  
    i := x / y  
    r := x % y  
  
    return i, r  
}
```



```
package main
```

```
func main() {  
    i, r := divide(5, 2)  
    println(i, r)  
}
```

```
func divide(x, y int) (i int, r int) {  
    i = x / y  
    r = x % y  
  
    return  
}
```

```
package main
```

```
func main() {  
    i, r := divide(5, 2)  
    println(i, r)  
}
```

```
func divide(x, y int) (i int, r int) {  
    i = x / y  
    r = x % y  
  
    return i, r  
}
```

```
package main
```

```
func main() {  
    i, r := divide(5, 2)  
    println(i, r)  
}
```

```
func divide(x, y int) (i, r int) {  
    i = x / y  
    r = x % y  
  
    return i, r  
}
```

```
package main
```

```
func main() {  
    i, r := divide(5, 2)  
    println(i, r)  
}
```

```
func divide(x, y int) (i, r int) {  
    i, r = x/y, x%y  
    return i, r  
}
```

```
package main
```

```
func main() {  
    i, r := divide(5, 2)  
    println(i, r)  
}
```

```
// Divide x by y, returning the integer part, i,  
// and the remainder, r.
```

```
func divide(x, y int) (i, r int) {  
    return x/y, x%y  
}
```

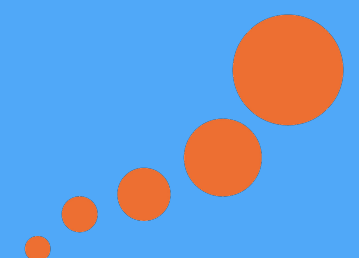
```
package main
```

```
func main() {  
    i, r := divide(5, 0)  
    println(i, r)  
}
```

```
// Divide x by y, returning the integer part, i,  
// and the remainder, r.
```

```
func divide(x, y int) (i, r int) {  
    return x/y, x%y  
}
```

Packages



```
$ mkdir training
```

```
$ cd training
```

```
$ go mod init training
```



```
package training

import ...

func FizzBuzz(n int) string {
    var b strings.Builder
    for i := 1; i <= n; i++ {
        if i%3 == 0 {
            b.WriteString("Fizz")
        }

        if i%5 == 0 {
            b.WriteString("Buzz")
        }

        if i%3 != 0 && i%5 != 0 {
            b.WriteString(strconv.Itoa(i))
        }

        b.WriteString(" ")
    }

    return strings.TrimSpace(b.String())
}
```

```
[exercise3]$ touch fizzbuzz_test.go
```

```
package training_test
```

```
import (  
    "fmt"  
    "training"  
)
```

```
func ExampleFizzBuzz() {  
    fmt.Println(training.FizzBuzz(15))  
  
    // Output:  
    // 1 2 Fizz 4 Buzz Fizz 7 8 Fizz Buzz 11 Fizz 13 14 FizzBuzz  
}
```

```
[exercise3] $ go test
```

```
PASS
```

```
ok          training      0.004s
```

```
package training_test
```

```
import (  
    "testing"  
    "training"  
)
```

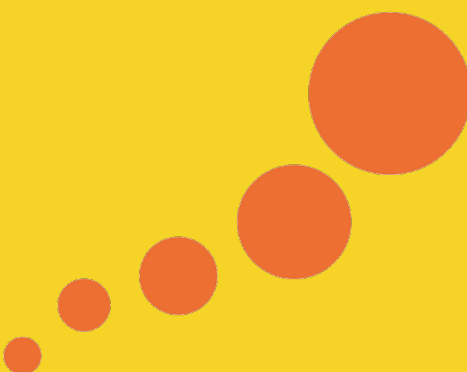
```
func TestFizzBuzz(t *testing.T) {  
    r := training.FizzBuzz(-1)  
    if r != "" {  
        t.Errorf("unexpected FizzBuzz sequence: %s", r)  
    }  
}
```

```
$ go test -v --covermode=count
=== RUN    TestFizzBuzz
--- PASS: TestFizzBuzz (0.00s)
=== RUN    ExampleFizzBuzz
--- PASS: ExampleFizzBuzz (0.00s)
PASS
coverage: 100.0% of statements
ok         training      0.004s
```

3: FizzBuzz()

Implement `FizzBuzz(n int) string`
Write one or more tests to exercise the function

Run your tests using `go test`
<https://github.com/domdavis/go-get-better/tree/exercise-3>



```
package calculator
```

```
/// Divide x by y, returning the integer part, i,  
// and the remainder, r.
```

```
func Divide(x, y int) (i, r int) {  
    return x/y, x%y  
}
```


Error Handling



```
package calculator
```

```
import (  
    "errors"  
    "fmt"  
)
```

```
func Divide(x, y int) (int, int, error) {  
    if y == 0 {  
        return 0, 0, errors.New("divide by zero error")  
    }  
  
    return x/y, x%y, nil  
}
```

```
func ExampleDivide() {  
    i, r, err := calculator.Divide(5, 2)  
  
    if err != nil {  
        fmt.Println(err)  
    } else {  
        fmt.Println(i, r)  
    }  
  
    // Output:  
    // 2 1  
}
```

```
func ExampleDivide() {  
    if i, r, err := calculator.Divide(5, 2); err != nil {  
        fmt.Println(err)  
    } else {  
        fmt.Println(i, r)  
    }  
  
    // Output:  
    // 2 1  
}
```

"Values can be programmed, and since errors are values, errors
can be programmed."

<https://blog.golang.org/errors-are-values>



```
func main() {  
    var b strings.Builder  
    scanner := bufio.NewScanner(os.Stdin)  
    for i := 0; i <= 4; i++ {  
        scanner.Scan()  
        b.WriteString(scanner.Text())  
    }  
  
    if err := scanner.Err(); err != nil {  
        fmt.Println(err)  
    }  
  
    fmt.Println(b.String())  
}
```

```
func main() {  
    var b strings.Builder  
    scanner := bufio.NewScanner(os.Stdin)  
    for i := 0; i <= 4; i++ {  
        if err := scanner.Scan(); err != nil {  
            fmt.Println(err)  
        } else {  
            b.WriteString(scanner.Text())  
        }  
    }  
  
    fmt.Println(b.String())  
}
```

```
var (  
    ErrCustomError = errors.New("some custom error")  
    ErrDivideByZero = errors.New("divide by zero")  
)
```



```
package calculator
```

```
import (  
    "errors"  
    "fmt"  
)
```

```
var ErrDivideByZero = errors.New("divide by zero")
```

```
func Divide(x, y int) (int, int, error) {  
    if y == 0 {  
        return 0, 0, errDivideByZero  
    }  
  
    return x/y, x%y, nil  
}
```

```
func ExampleDivide() {  
    i, r, err := calculator.Divide(5, 2)  
  
    if err == calculator.ErrDivideByZero {  
        fmt.Println(err)  
    } else {  
        fmt.Println(i, r)  
    }  
  
    // Output:  
    // 2 1  
}
```

```
func ExampleDivide() {  
    i, r, err := Divide(5, 2)  
  
    if err == ErrDivideByZero {  
        fmt.Println(err)  
    } else if err != nil {  
        fmt.Println("Something went wrong!")  
    } else {  
        fmt.Println(i, r)  
    }  
  
    // Output:  
    // 2 1  
}
```

```
func ExampleDivide() {  
    i, r, err := Divide(5, 2)  
  
    switch {  
    case err == ErrDivideByZero:  
        fmt.Println(err)  
    case err != nil:  
        fmt.Println("Something went wrong!")  
    default:  
        fmt.Println(i, r)  
    }  
  
    // Output:  
    // 2 1  
}
```

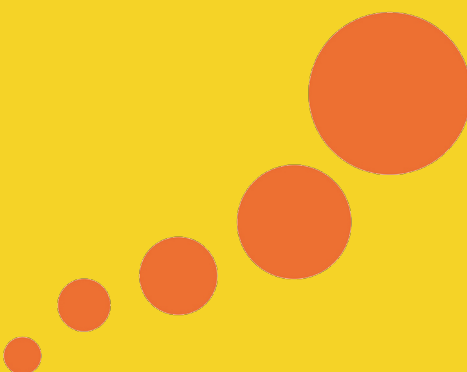
```
func Action() error {  
    i, r, err := Divide(5, 2)  
  
    switch err {  
    case nil:  
    case ErrDivideByZero:  
        return err  
    default:  
        log.Fatal(err)  
    }  
  
    fmt.Println(i, r)  
    return nil  
}
```

4: `FizzBuzz(int) (string, error)`

Implement `FizzBuzz(n int) (string, error)`

Bonus: Write one or more tests to exercise the function

<https://github.com/domdavis/go-get-better/tree/exercise-4>



```
var ErrNegativeRange = errors.New("cannot produce negative amounts of FizzBuzz")

func FizzBuzz(n int) (string, error) {
    var b strings.Builder

    if n < 0 {
        return "", ErrNegativeRange
    }

    for i := 1; i <= n; i++ {
        if i%3 == 0 {
            b.WriteString("Fizz")
        }

        if i%5 == 0 {
            b.WriteString("Buzz")
        }

        if i%3 != 0 && i%5 != 0 {
            b.WriteString(strconv.Itoa(i))
        }

        b.WriteString(" ")
    }

    return strings.TrimSpace(b.String()), nil
}
```

```
package exercise4_test
import (
    "fmt"
    "testing"
    "training/exercise4"
)

func ExampleFizzBuzz() {
    if r, err := exercise4.FizzBuzz(15); err != nil {
        fmt.Println(err)
    } else {
        fmt.Println(r)
    }

    // Output:
    // 1 2 Fizz 4 Buzz Fizz 7 8 Fizz Buzz 11 Fizz 13 14 FizzBuzz
}

func TestFizzBuzz(t *testing.T) {
    _, err := exercise4.FizzBuzz(-1)
    if err != exercise4.ErrNegativeRange {
        t.Errorf("unexpected error: %s", err)
    }
}
```


loops



```
package main
```

```
import "fmt"
```

```
func main() {  
    for i := 10; i <= 100; i = i + 10 {  
        fmt.Println(i)  
    }  
}
```

```
package main
```

```
import "fmt"
```

```
func main() {
```

```
    var i int
```

```
    for i < 10 {
```

```
        i++
```

```
        fmt.Println(i)
```

```
    }
```

```
}
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    for true {  
        fmt.Println("Spam")  
    }  
}
```

```
package main
```

```
import "fmt"
```

```
func main() {
```

```
    for {
```

```
        fmt.Println("Spam")
```

```
    }
```

```
}
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    for i := range []int{1, 1, 2, 3, 5, 8} {  
        fmt.Println(i)  
    }  
}
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    for _, v := range []int{1, 1, 2, 3, 5, 8} {  
        fmt.Println(v)  
    }  
}
```

```
package main
```

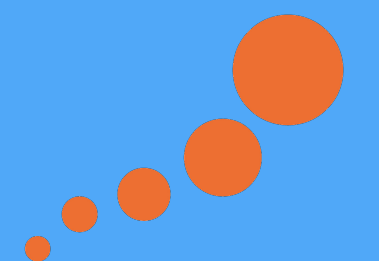
```
import "fmt"
```

```
func main() {  
    m := map[string]int{  
        "one": 1,  
        "two": 2,  
    }  
  
    for k, v := range m {  
        fmt.Println(k, v)  
    }  
}
```



```
func TestFizzBuzz(t *testing.T) {  
    for i, expected := range map[int]string{  
        1: "1",  
        2: "1 2",  
        3: "1 2 Fizz",  
    } {  
        if r, err := exercise4.FizzBuzz(i); err != nil {  
            t.Errorf("unexpected error FizzBuzzing: %s", err)  
        } else if r != expected {  
            t.Errorf("expected '%s', got '%s'", expected, r)  
        }  
    }  
}
```

Arrays and Slices



```
package main
```

```
import "fmt"
```

```
func main() {  
    var a [4]int  
    fmt.Println(a)  
}
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    var a [4]int  
    fmt.Println(a)  
}
```

```
// [0 0 0 0]
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    a := [2]int{1, 2}  
    b := [4]int{1, 2}  
    c := [...]int{1, 2}  
    fmt.Println(a, b, c)  
}
```

```
// [1 2] [1 2 0 0] [1 2]
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    var a []int // read "slice of int"  
    a = append(a, 123)  
    a = append(a, 456)  
    fmt.Println(a)  
}
```

```
// [123 456]
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    a := []int{123, 456, 789}  
    fmt.Printf("%d\n", a[0])  
  
    a[1] = 555  
    fmt.Printf("%v %v %v\n", a[1:], a[:1], a[1:2])  
}
```

```
// 123
```

```
// [555 789] [123] [555]
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    a := [][]int{  
        []int{1, 2, 3},  
        []int{4, 5},  
        []int{6, 7, 8, 9},  
    }  
  
    a = append(a, []int{10, 11, 12})  
    fmt.Printf("%v\n", a)  
}
```

```
// [[1 2 3] [4 5] [6 7 8 9] [10 11 12]]
```



```
package main
```

```
import "fmt"
```

```
func main() {  
    a := [][]int{  
        {1, 2, 3},  
        {4, 5},  
        {6, 7, 8, 9},  
    }  
  
    a = append(a, []int{10, 11, 12})  
    fmt.Printf("%v\n", a)  
}
```

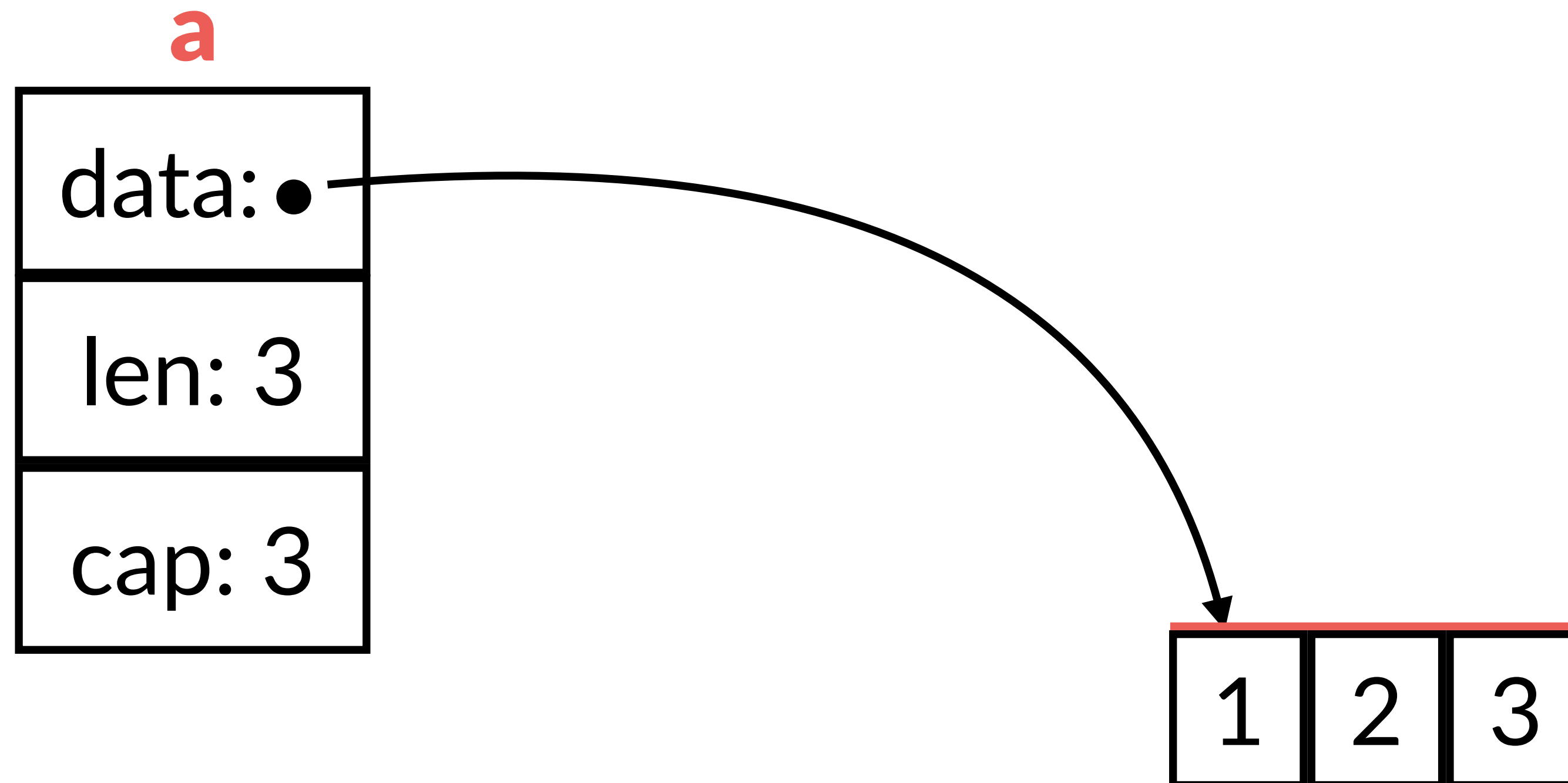
```
// [[1 2 3] [4 5] [6 7 8 9] [10 11 12]]
```

```
package main
```

```
func main() {  
    a := make([]int, 5)  
    a[3] = 123 // OK  
    a = append(a, 456)  
  
    b := make([]int, 0, 5)  
    b[3] = 123 // panic!  
    b = append(b, 789)  
}
```

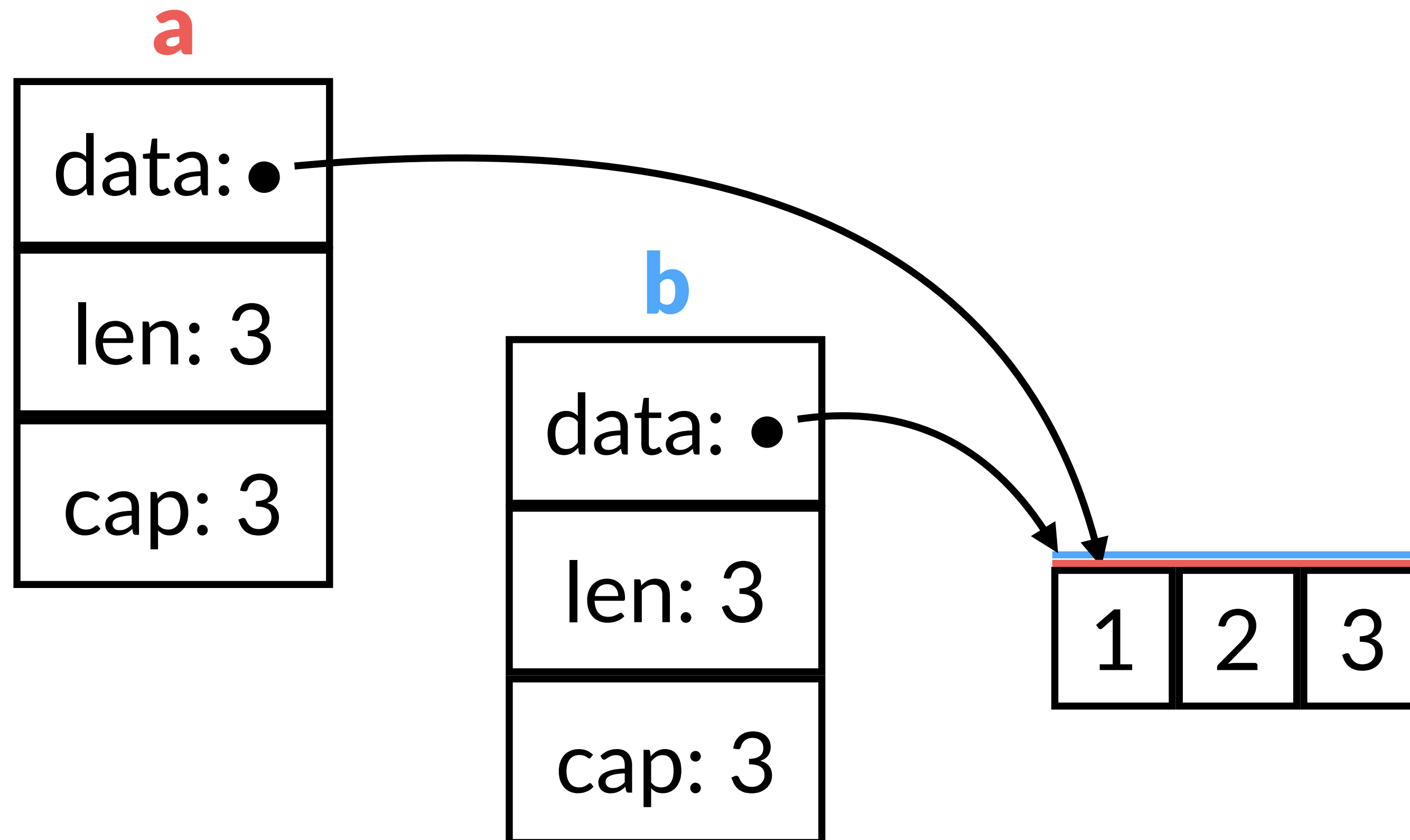
Slice Implementation

```
a := []int{1, 2, 3}
```



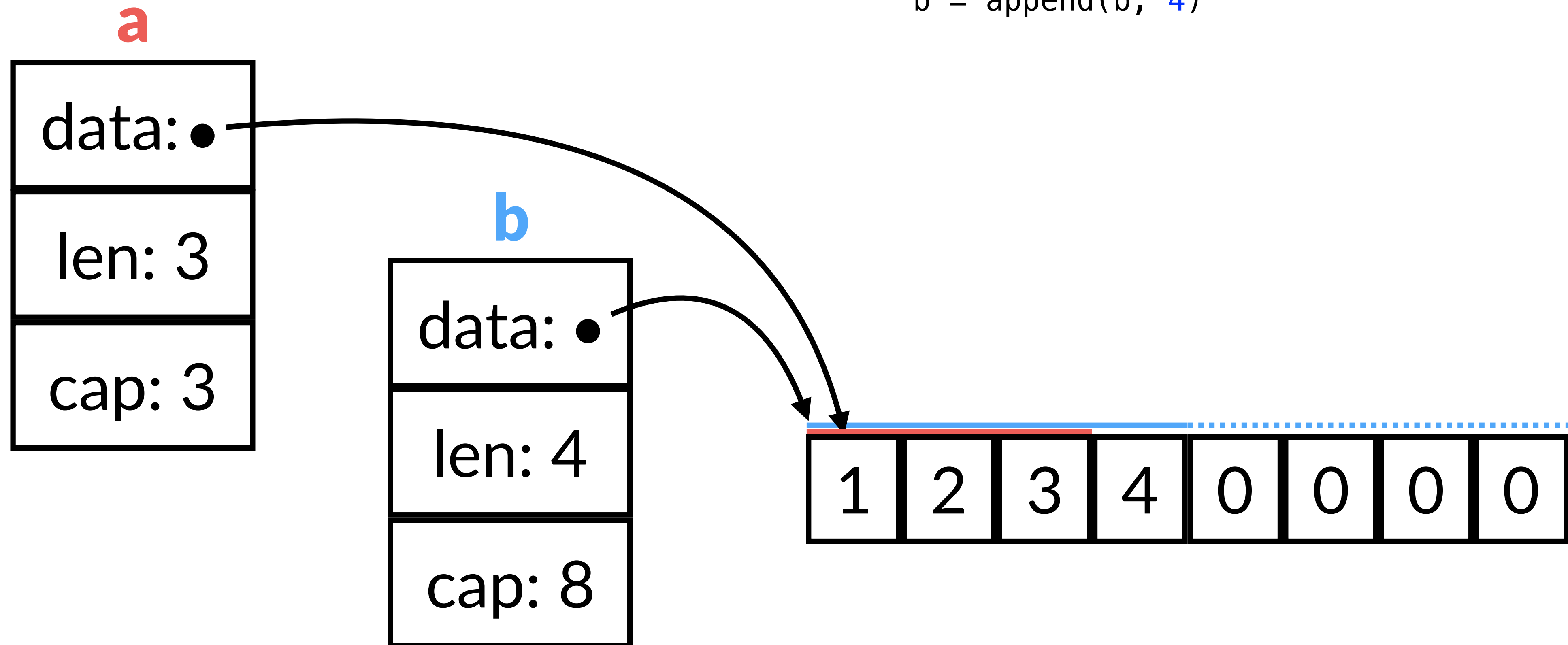
Slice Implementation

```
a := []int{1, 2, 3}  
b := a
```



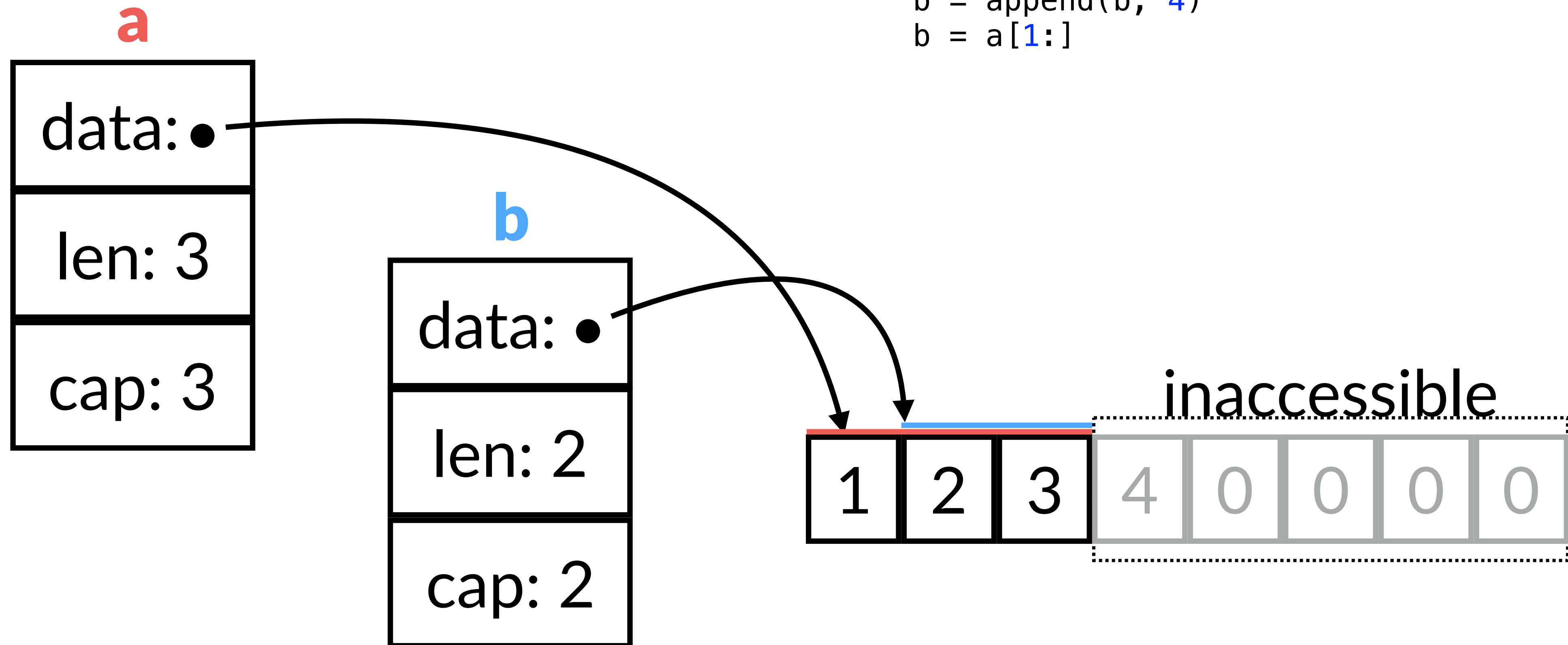
Slice Implementation

```
a := []int{1, 2, 3}  
b := a  
b = append(b, 4)
```



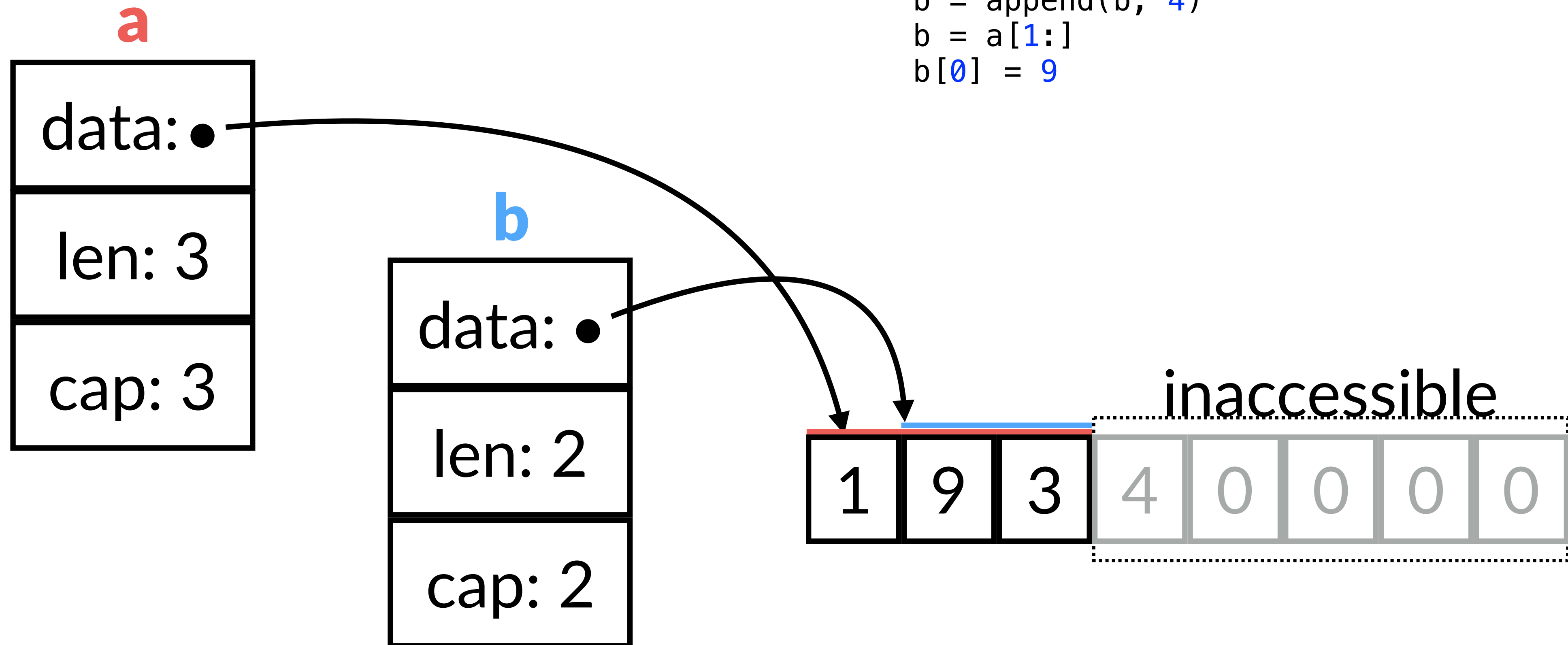
Slice Implementation

```
a := []int{1, 2, 3}  
b := a  
b = append(b, 4)  
b = a[1:]
```



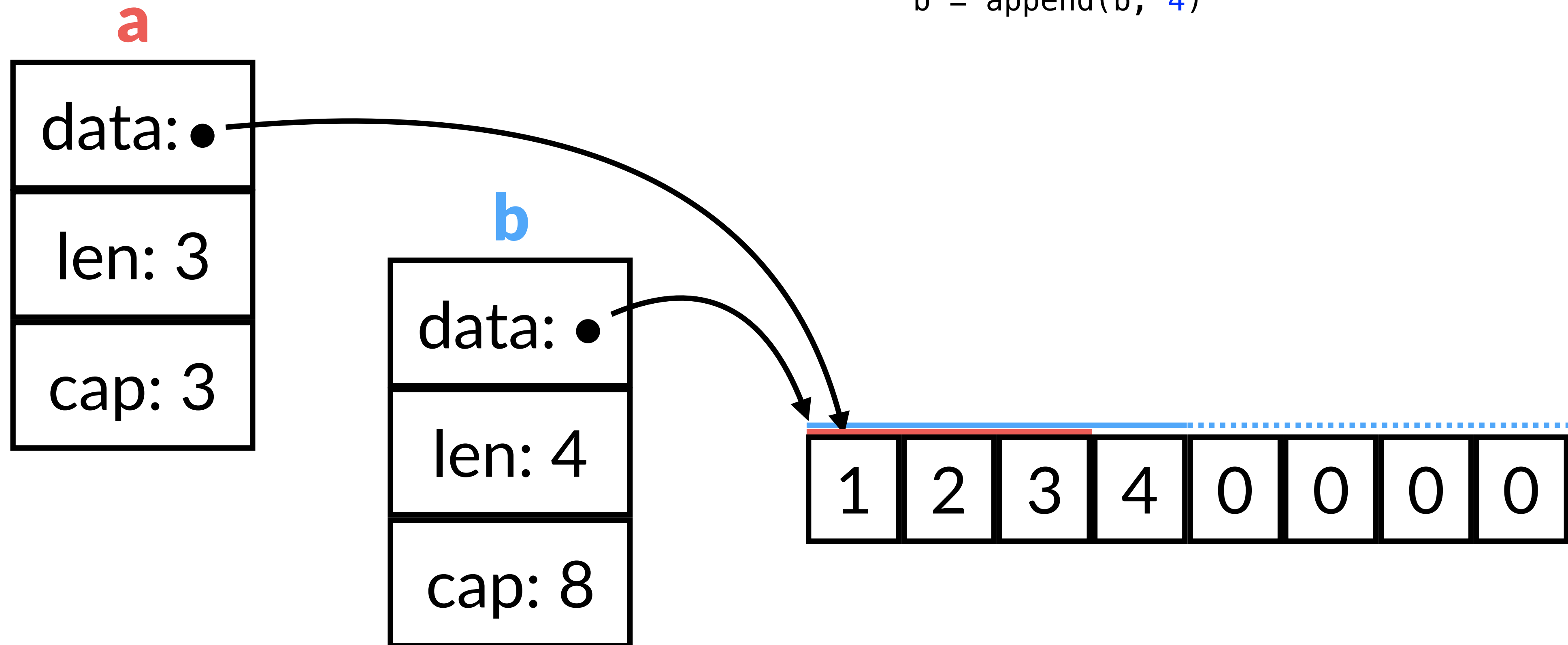
Slice Implementation

```
a := []int{1, 2, 3}
b := a
b = append(b, 4)
b = a[1:]
b[0] = 9
```



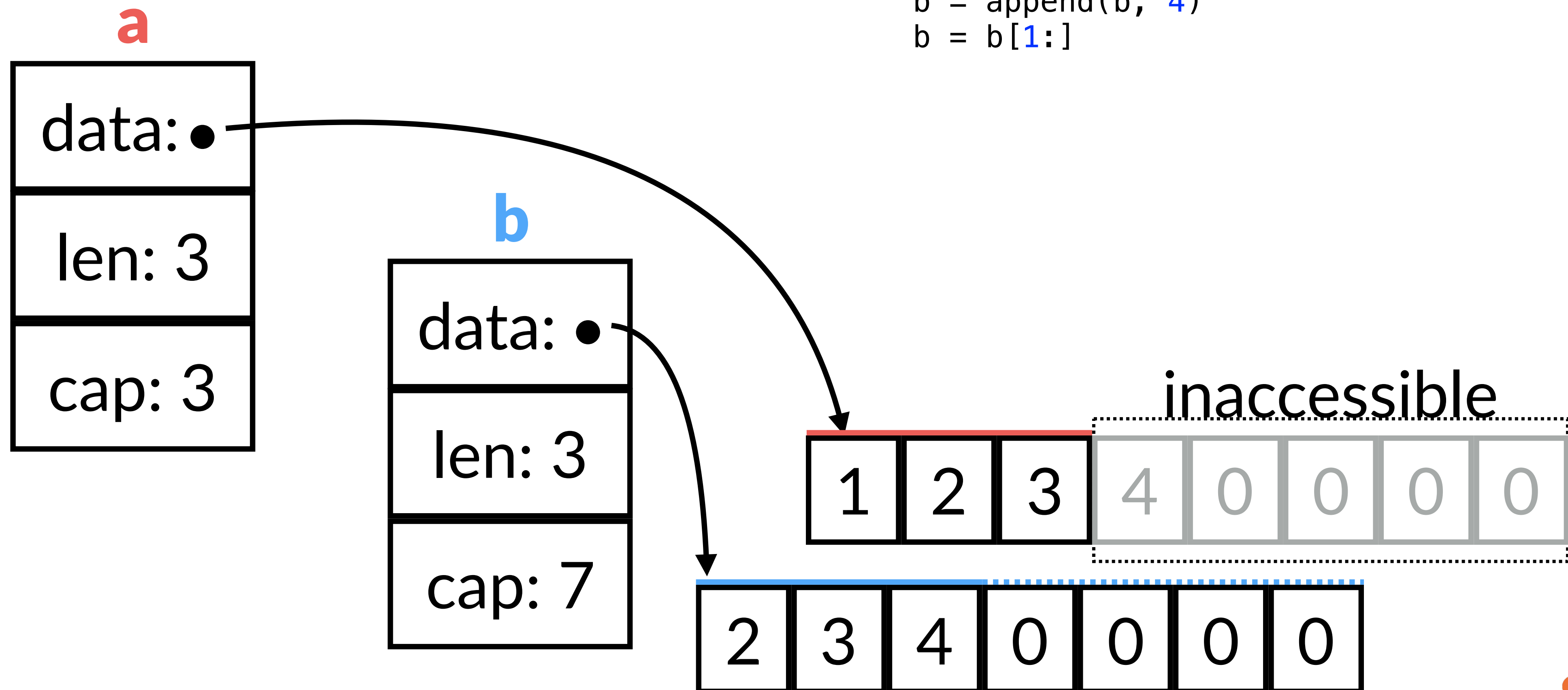
Slice Implementation

```
a := []int{1, 2, 3}  
b := a  
b = append(b, 4)
```



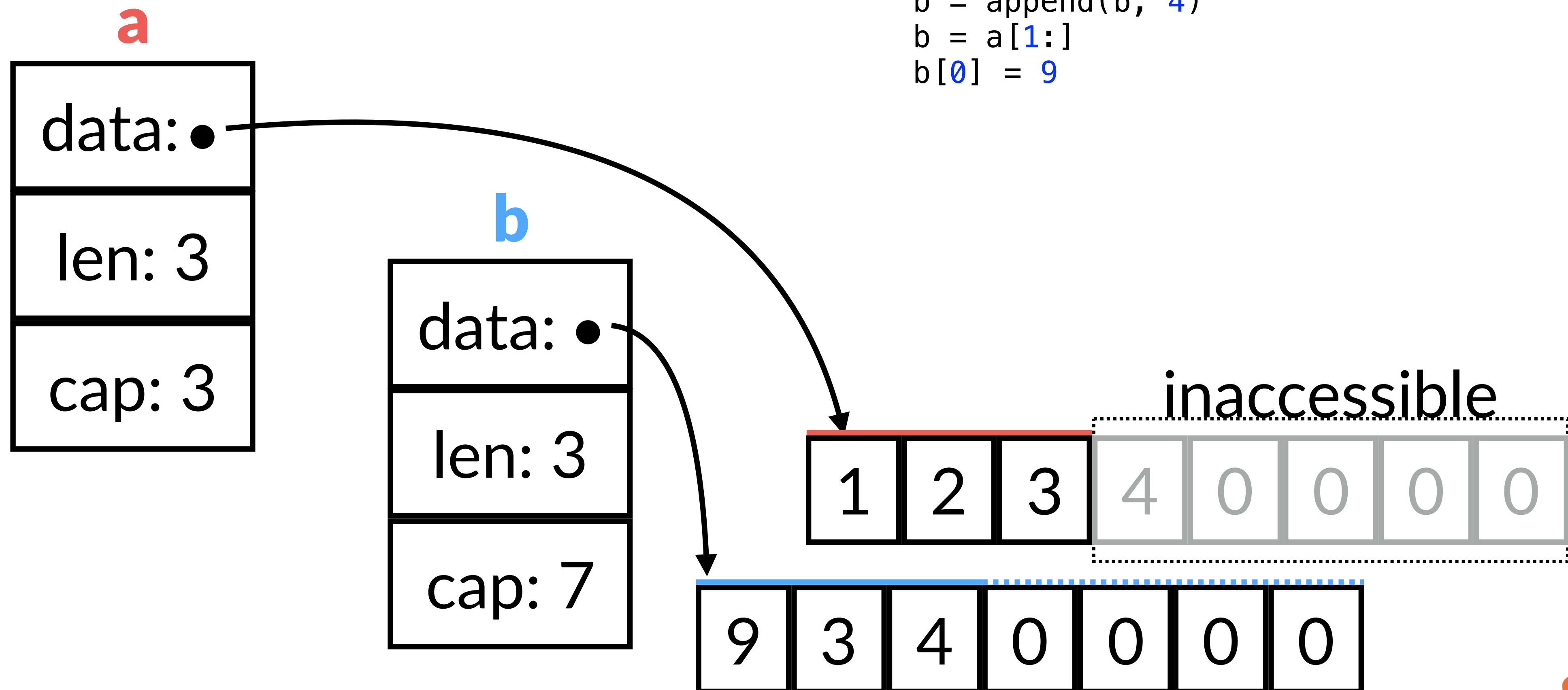
Slice Implementation

```
a := []int{1, 2, 3}  
b := a  
b = append(b, 4)  
b = b[1:]
```



Slice Implementation

```
a := []int{1, 2, 3}
b := a
b = append(b, 4)
b = a[1:]
b[0] = 9
```



5: FizzBuzz(int) ([]string, error)

Implement FizzBuzz(n int) ([]string, error)

Bonus: Write one or more tests to exercise the function

<https://github.com/domdavis/go-get-better/tree/exercise-5>



```
func FizzBuzz(n int) ([]string, error) {  
    if n < 0 { return []string{}, ErrNegativeRange }  
    s := make([]string, n)  
    for i := 1; i <= n; i++ {  
        switch {  
        case i%3 == 0 && i%5 == 0:  
            s[i-1] = "FizzBuzz"  
        case i%3 == 0:  
            s[i-1] = "Fizz"  
        case i%5 == 0:  
            s[i-1] = "Buzz"  
        default:  
            s[i-1] = strconv.Itoa(i)  
        }  
    }  
    return s, nil  
}
```

Zero Values



```
package main
```

```
import "fmt"
```

```
func main() {  
    var b bool  
    var i int  
    var f float64  
    var s string  
    fmt.Printf("%t %d %f %q", b, i, f, s)  
}
```

```
// false 0 0.000000 ""
```

nil



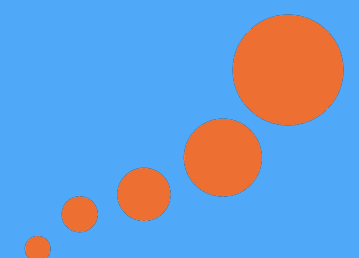
```
package main
```

```
import "fmt"
```

```
func main() {  
    fmt.Println([]string{})  
}
```

```
// []
```


maps



```
package main
```

```
func main() {  
    var m map[string]int  
    m["A"] = 1  
}
```

```
package main
```

```
func main() {  
    var m map[string]int = make(map[string]int)  
    m["A"] = 1  
}
```

```
package main
```

```
func main() {  
    var m = make(map[string]int)  
    m["A"] = 1  
}
```

```
package main
```

```
func main() {  
    m := map[string]int{}  
    m["A"] = 1  
}
```

```
package main
```

```
func main() {  
    var m = make(map[string]int, 100)  
    m["A"] = 1  
}
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    m := map[string]int{"A": 1}  
    fmt.Println(m)  
}
```

```
// map[A:1]
```

MapType = "map" "[" **KeyType** "]" ElementType

"The comparison operators == and != must be fully defined for operands of the key type; thus the key type must not be a function, map, or slice."

<https://golang.org/doc/ref#KeyType>




```
package main
```

```
func main() {  
    m := map[string]int{"A": 1}  
    println(m["A"])  
}
```

```
// 1
```

```
package main
```

```
func main() {  
    m := map[string]int{"A": 1}  
    println(m["B"])  
}
```

```
// ?
```

```
package main
```

```
func main() {  
    m := map[string]int{"A": 1}  
    println(m["B"])  
}
```

```
// 0
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    m := map[string]int{"A": 1}  
    v, ok := m["B"]  
    fmt.Println(v, ok)  
}
```

```
// 0, false
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    m := map[string]int{"A": 0}  
    v, ok := m["A"]  
    fmt.Println(v, ok)  
}
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    m := map[string]int{"A": 1}  
    delete(m, "A")  
    v, ok := m["A"]  
    fmt.Println(v, ok)  
}
```

```
func main() {  
    m := map[string]int{"A": 1, "B": 2, "C": 3}  
  
    for k := range m {  
        fmt.Print(k, " ")  
    }  
  
    for k, v := range m {  
        fmt.Print(k, " ", v, " ")  
    }  
  
    for _, v := range m {  
        fmt.Print(v, " ")  
    }  
}
```

```
package main
```

```
func main() {  
    m := map[int]string{  
        1: "A", 2: "B", 3: "C"}  
  
    for k := range m {  
        if k%2 == 0 {  
            delete(m, k)  
        }  
    }  
}
```


The iteration order over maps is not specified and is not guaranteed to be the same from one iteration to the next. If map entries that have not yet been reached are **removed during iteration**, the corresponding iteration values will not be produced. If map entries are **created during iteration**, that entry may be produced during the iteration or may be skipped. The choice may vary for each entry created and from one iteration to the next. If the map is nil, the number of iterations is 0.



6: `FizzBuzz(int) (map[int]string, error)`

Implement `FizzBuzz(n int) (map[int]string, error)`

The map should contain Fizz, Buzz, FizzBuzz or the number as the value

Bonus: Write one or more tests to exercise the function

<https://github.com/domdavis/go-get-better/tree/exercise-6>



```
func FizzBuzz(n int) (map[int]string, error) {  
    if n < 0 { return nil, ErrNegativeRange }  
    m := make(map[int]string, n)  
    for i := 1; i <= n; i++ {  
        switch {  
        case i%3 == 0 && i%5 == 0:  
            m[i] = "FizzBuzz"  
        case i%3 == 0:  
            m[i] = "Fizz"  
        case i%5 == 0:  
            m[i] = "Buzz"  
        default:  
            m[i] = strconv.Itoa(i)  
        }  
    }  
    return m, nil  
}
```

```
func ExampleFizzBuzz() {  
    n := 15  
  
    r, err := exercise6.FizzBuzz(n)  
  
    if err != nil {  
        fmt.Println(err)  
    }  
  
    for i := 1; i <= n; i++ {  
        fmt.Print(r[i], " ")  
    }  
  
    // Output:  
    // 1 2 Fizz 4 Buzz Fizz 7 8 Fizz Buzz 11 Fizz 13 14 FizzBuzz  
}
```

closures



```
package main
```

```
import "fmt"
```

```
func main() {  
    a := func() int { return 123 }  
    b := a()  
    fmt.Println(b)  
}
```

```
package main
```

```
func apply(f func(int) int, i int) int {  
    return f(i)  
}
```

```
func main() {  
    double := func(x int) int { return x+x }  
    square := func(x int) int { return x*x }  
    i := apply(double, apply(square, 3))  
    println(i)  
}
```

```
package main
```

```
func apply(f func(int) int, i int) int {  
    return f(i)  
}
```

```
func square(n int) int {  
    return n * n  
}
```

```
func main() {  
    f := square  
    i := apply(f, 3)  
    println(i)  
}
```



```
package main
```

```
func apply(f func(int) int, i int) int {  
    return f(i)  
}
```

```
func main() {  
    i := apply(func(x int) int { return x+x }, 3)  
    println(i)  
}
```

```
package main
```

```
func apply(f func(int) int, i int) int {  
    return f(i)  
}
```

```
func main() {  
    n := 123  
    f := func(x int) int { return n }  
    i := apply(f, 3)  
    println(i)  
}
```

7: Run ()

Implement

```
Run(n int, func (int) ([]string, error)) ([]string, error)
```

Pass your FizzBuzz function from exercise 5 into sequence in the test code.

<https://github.com/domdavis/go-get-better/tree/exercise-7>



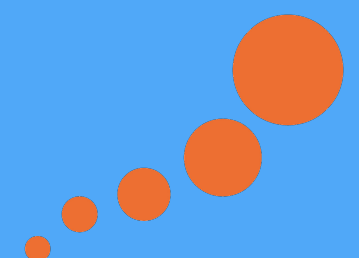
```
func FizzBuzz(n int) ([]string, error) {  
    if n < 0 { return []string{}, ErrNegativeRange }  
    s := make([]string, n)  
    for i := 1; i <= n; i++ {  
        switch {  
        case i%3 == 0 && i%5 == 0:  
            s[i-1] = "FizzBuzz"  
        case i%3 == 0:  
            s[i-1] = "Fizz"  
        case i%5 == 0:  
            s[i-1] = "Buzz"  
        default:  
            s[i-1] = strconv.Itoa(i)  
        }  
    }  
    return s, nil  
}
```

```
func Run(n int, f func(int) ([]string, error)) ([]string, error) {  
    return f(n)  
}
```

```
func ExampleSequence() {  
    r, err := exercise7.Run(15, exercise7.FizzBuzz)  
  
    if err != nil {  
        fmt.Println(err)  
    }  
  
    for _, v := range r {  
        fmt.Print(v, " ")  
    }  
  
    // Output:  
    // 1 2 Fizz 4 Buzz Fizz 7 8 Fizz Buzz 11 Fizz 13 14 FizzBuzz  
}
```

```
func Run(n int, f func(int) ([]string, error)) ([]string, error) {  
    return f(n)  
}
```

types




```
package types
```

```
func Handle(code int) {  
    switch code {  
    case 200:  
        // OK  
    case 404:  
        // Not found  
    case 500:  
        // Server error  
    }  
}
```

bool
byte
uintptr
int, int8, int16, int32, int64
uint, uint8, uint16, uint32, uint64
float32, float64
complex64, complex128
rune, string
slice, map
interface, struct



```
package main

import "fmt"

type ResponseCode int

func main() {
    Handle(200)
}

func Handle(code ResponseCode) {
    switch code {
    case 200:
        fmt.Println("OK")
    case 404:
        fmt.Println("Not Found")
    case 500:
        fmt.Println("Server Error")
    default:
        fmt.Printf("Unknown code %d\n", code)
    }
}
```

```
package main
```

```
import "fmt"
```

```
type ResponseCode int
```

```
func main() {  
    a := ResponseCode(200)  
    b := 200  
  
    if a == b {  
        fmt.Println("Equal")  
    }  
}
```

```
package main

import "fmt"

type ResponseCode int

func main() {
    Handle(200)
}

func Handle(code ResponseCode) {
    switch code {
    case 200:
        fmt.Println("OK")
    case 404:
        fmt.Println("Not Found")
    case 500:
        fmt.Println("Server Error")
    default:
        fmt.Printf("Unknown code %d\n", code)
    }
}
```

```
package main
```

```
import "fmt"
```

```
type ResponseCode int
```

```
func main() {  
    a := ResponseCode(200)  
    b := 200  
  
    if a == b {  
        fmt.Println("Equal")  
    }  
}
```

```
package main
```

```
import "fmt"
```

```
type ResponseCode int
```

```
func main() {  
    a := ResponseCode(200)  
    b := 200  
  
    if int(a) == b {  
        fmt.Println("Equal")  
    }  
}
```

```
package main
```

```
import "fmt"
```

```
type ResponseCode int
```

```
func main() {  
    a := ResponseCode(200)  
    b := 200  
  
    if a == ResponseCode(b) {  
        fmt.Println("Equal")  
    }  
}
```



```
func Run(n int, f func(int) ([]string, error)) ([]string, error) {  
    return f(n)  
}
```

```
type Sequence []string
type Generator func(int) (Sequence, error)

func Run(g Generator, n int) (Sequence, error) {
    return g(n)
}
```

```
type Sequence []string
type Generator func(int) (Sequence, error)

var ErrNegativeRange = errors.New("cannot produce negative sequence")

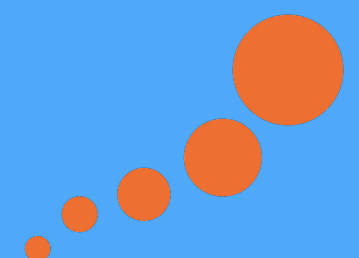
func Run(g Generator, n int) (Sequence, error) {
    return g(n)
}

func Simple(n int) (Sequence, error) {
    if n < 0 {
        return Sequence{}, ErrNegativeRange
    }
    r := make(Sequence, n)
    for i := 1; i <= n; i++ { r[i-1] = strconv.Itoa(i) }
    return r, nil
}

func main() {
    s, _ := Run(Simple, 5)
    fmt.Println(s)
}

// [1 2 3 4 5]
```

structs



framework training

```
type Car struct {  
    Make string  
    Model string  
    Doors int  
}
```

```
type Car struct {  
    Make string  
    Model string  
    Doors int  
}
```

```
var Corolla = Car{"Toyota", "Corolla", 4}
```

```
type Car struct {  
    Make string  
    Model string  
    Doors int  
}
```

```
var Corolla = Car{Make: "Toyota", Model: "Corolla"}
```

```
package main

import "fmt"

type Car struct {
    Make string
    Model string
    Doors int
}

var Corolla = Car{Make: "Toyota", Model: "Corolla"}

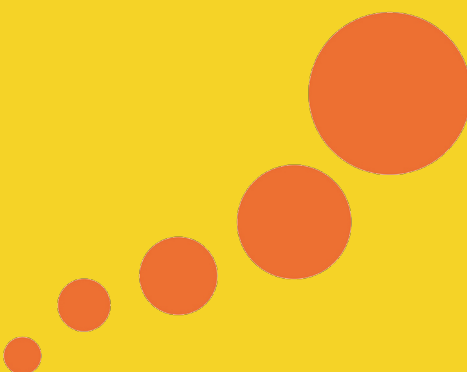
func main() {
    Corolla.Doors = 5
    fmt.Println(Corolla)
}

// {Toyota Corolla 5}
```


8: Putting it all together

Using the template branch, make the tests work using your FizzBuzz code

<https://github.com/domdavis/go-get-better/tree/template>
<https://github.com/domdavis/go-get-better/tree/exercise-8>

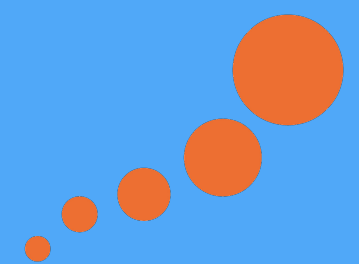


```
func FizzBuzz(n int) (Sequence, error) {
    if n < 0 {
        return []string{}, ErrNegativeRange
    }

    s := make([]string, n+1)
    s[0] = "FizzBuzz"

    for i := 1; i <= n; i++ {
        switch {
        case i%3 == 0 && i%5 == 0:
            s[i] = "FizzBuzz"
        case i%3 == 0:
            s[i] = "Fizz"
        case i%5 == 0:
            s[i] = "Buzz"
        default:
            s[i] = strconv.Itoa(i)
        }
    }
    return s, nil
}
```

defer



```
package main
```

```
func main() {  
    defer println("goodbye")  
    println("hello")  
}
```

```
package main
```

```
import (  
    "log"  
    "os"  
)
```

```
func main() {  
    f, err := os.Open("/etc/passwd")  
    if err != nil {  
        log.Fatal(err)  
    }  
    defer f.Close()  
    // use f  
}
```

```
package main
```

```
import (  
    "log"  
    "os"  
)
```

```
func main() {  
    f, err := os.Open("/etc/passwd")  
    if err != nil {  
        log.Fatal(err)  
    }  
    defer func() { _ = f.Close() }()  
    // use f  
}
```

```
package main
```

```
func main() {  
    defer println("one")  
    println("two")  
    defer println("three")  
}
```

```
package main
```

```
func main() {  
    i := 1  
    defer println(i)  
    i++  
    defer println(i)  
    println(i)  
}
```



```
package main
```

```
func main() {  
    for i := 0; i < 5; i++ {  
        println("open file", i)  
        defer println("close file", i)  
        println("use file", i)  
    }  
}
```

```
func DeferredReverse(n int) (Sequence, error) {  
    if n < 0 {  
        return Sequence{}, ErrNegativeRange  
    }  
  
    s := []string{"DeferredReverse"}  
  
    for i := 1; i <= n; i++ {  
        defer func() { s = append(s, strconv.Itoa(i)) }()  
    }  
  
    return s, nil  
}
```

```
func DeferredReverse(n int) (Sequence, error) {
    if n < 0 {
        return Sequence{}, ErrNegativeRange
    }

    s := []string{"DeferredReverse"}

    for i := 1; i <= n; i++ {
        defer func() {
            s = append(s, strconv.Itoa(i))
            fmt.Println(s)
        }()
    }

    return s, nil
}
```

```
[DeferredReverse 6]  
[DeferredReverse 6 6]  
[DeferredReverse 6 6 6]  
[DeferredReverse 6 6 6 6]  
[DeferredReverse 6 6 6 6 6]
```

```
func DeferredReverse(n int) (Sequence, error) {  
    if n < 0 {  
        return Sequence{}, ErrNegativeRange  
    }  
  
    s := []string{"DeferredReverse"}  
  
    for i := 1; i <= n; i++ {  
        defer func() {  
            s = append(s, strconv.Itoa(i))  
            fmt.Println(s)  
        }()  
    }  
  
    return s, nil  
}
```

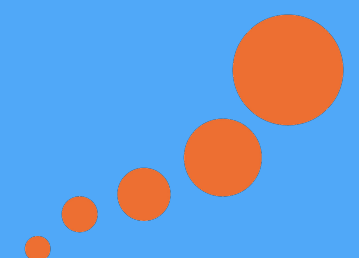
```
func DeferredReverse(n int) (Sequence, error) {
    if n < 0 {
        return Sequence{}, ErrNegativeRange
    }

    s := []string{"DeferredReverse"}

    for i := 1; i <= n; i++ {
        defer func(i int) {
            s = append(s, strconv.Itoa(i))
            fmt.Println(s)
        }(i)
    }

    return s, nil
}
```

Pointers



```
package main
```

```
import "fmt"
```

```
func main() {  
    a := "Thing" // I am a thing  
    b := &a      // I point to the thing  
    c := *b      // I am the thing that was pointed to  
  
    a = "New Thing"  
  
    fmt.Println(a, b, c)  
}
```



```
package main
```

```
import "fmt"
```

```
func main() {  
    a := "Thing" // I am a thing  
    b := &a      // I point to the thing  
    c := *b      // I am the thing that was pointed to  
  
    a = "New Thing"  
  
    fmt.Println(a, b, c)  
}
```

```
// New Thing 0xc0000601c0 Thing
```

```
package main
```

```
import "fmt"
```

```
func main() {  
    a := "Thing" // I am a thing  
    b := &a      // I point to the thing  
    c := *b      // I am the thing that was pointed to
```

```
    a = "New Thing"
```

```
    fmt.Println(a, *b, c)
```

```
}
```

```
// New Thing New Thing Thing
```

```
func DeferredReverse(n int) (Sequence, error) {  
    if n < 0 {  
        return Sequence{}, ErrNegativeRange  
    }  
  
    s := Sequence{"DeferredReverse"}  
    p := &s  
  
    for i := 1; i <= n; i++ {  
        defer func(i int) { *p = append(*p, strconv.Itoa(i)) }(i)  
    }  
  
    return s, nil  
}
```



```
type Generator func(int) (*Sequence, error)

func DeferredReverse(n int) (*Sequence, error) {
    if n < 0 {
        return &Sequence{}, ErrNegativeRange
    }

    s := &Sequence{"DeferredReverse"}

    for i := 1; i <= n; i++ {
        defer func(i int) { *s = append(*s, strconv.Itoa(i)) }(i)
    }

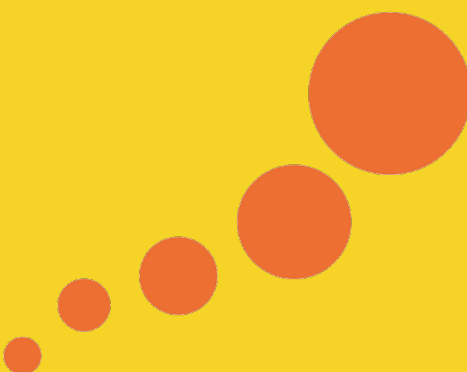
    return s, nil
}
```

```
func Run(g Generator, n int) (Sequence, error) {  
    p, err := g(n)  
    return *p, err  
}
```

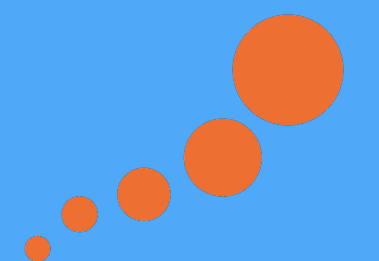
9: Sequence Pointers

Implement deferred reverse into our training package

<https://github.com/domdavis/go-get-better/tree/exercise-9>



types revisited




```
package main
```

```
import "fmt"
```

```
var counter int
```

```
func main() {  
    counter++  
    fmt.Println(counter)  
}
```

```
package main
```

```
import "fmt"
```

```
type counter int
```

```
func main() {  
    var c counter  
    c++  
    fmt.Println(c)  
}
```

```
package main
```

```
import "fmt"
```

```
type counter int
```

```
func (c counter) String() string {  
    return fmt.Sprintf("Counter: %d\n", c)  
}
```

```
func main() {  
    var c counter  
    c++  
    fmt.Println(c)  
}
```

```
package main
```

```
import "fmt"
```

```
type counter int
```

```
func (c counter) Increment() {  
    c++  
}
```

```
func main() {  
    var c counter  
    c.Increment()  
    fmt.Println(c)  
}
```

```
package main
```

```
import "fmt"
```

```
type counter int
```

```
func (c *counter) Increment() {  
    *c = *c + 1  
}
```

```
func main() {  
    var c counter  
    c.Increment()  
    fmt.Println(c)  
}
```

```
type counter struct {  
    value int  
}  
  
func (c *counter) Increment() {  
    c.value++  
}  
  
func main() {  
    var c counter  
    c.Increment()  
    fmt.Println(c)  
}
```

```
type counter struct {  
    value int  
}  
  
func (c *counter) Increment() {  
    c.value++  
}  
  
func (c counter) String() string {  
    return strconv.Itoa(c.value)  
}  
  
func main() {  
    var c counter  
    c.Increment()  
    fmt.Println(c)  
}
```

```
type counter struct {  
    value int  
}  
  
func (c *counter) Increment() {  
    c.value++  
}  
  
func (c *counter) String() string {  
    return strconv.Itoa(c.value)  
}  
  
func main() {  
    var c counter  
    c.Increment()  
    fmt.Println(c)  
}
```



```
type counter struct {  
    value int  
}  
  
func (c *counter) Increment() {  
    c.value++  
}  
  
func (c *counter) String() string {  
    return strconv.Itoa(c.value)  
}  
  
func main() {  
    c := &counter{}  
    c.Increment()  
    fmt.Println(c)  
}
```

Making New Types

// Value types

var a thing

var b thing = make(thing)

var c thing = thing{}

var d = make(thing)

var e = thing{}

f := make(thing)

g := thing{}

// Pointer types

var a *thing

var b *thing = new(thing)

var c *thing = &thing{}

var d = new(thing)

var e = &thing{}

f := new(thing)

g := &thing{}



Making New Types

// Value types

var a thing

~~var b thing = make(thing)~~

~~var c thing = thing{}~~

~~var d = make(thing)~~

~~var e = thing{}~~

~~f := make(thing)~~

g := thing{}

// Pointer types

~~var a *thing~~

~~var b *thing = new(thing)~~

~~var c *thing = &thing{}~~

~~var d = new(thing)~~

~~var e = &thing{}~~

~~f := new(thing)~~

g := &thing{}



Making New Types

// Value types

var a thing

~~var b thing = make(thing)~~

~~var c thing = thing{}~~

~~var d = make(thing)~~

~~var e = thing{}~~

f := make(thing) // slice + map

g := thing{}

// Pointer types

~~var a *thing~~

~~var b *thing = new(thing)~~

~~var c *thing = &thing{}~~

~~var d = new(thing)~~

~~var e = &thing{}~~

~~f := new(thing)~~

g := &thing{}



10: Generator.Run ()

Change the Run function so that it's a type function for Generator.
You'll need to update the example and the tests to call the function correctly

<https://github.com/domdavis/go-get-better/tree/exercise-10>

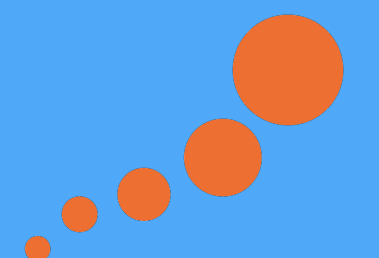


```
func (g Generator) Run(n int) (Sequence, error) {  
    p, err := g(n)  
    return *p, err  
}
```

```
func ExampleSequence() {
    simple := exercise10.Generator(exercise10.Simple)
    if r, err := simple.Run(5); err != nil {
        fmt.Println(err)
    } else {
        for _, v := range r {
            fmt.Print(v, " ")
        }
    }

    // Output:
    // Simple 1 2 3 4 5
}
```

panic and recover




```
package main
```

```
func die() {  
    panic("process died")  
}
```

```
func main() {  
    die()  
    println("hello")  
}
```

panic: process died

goroutine 1 [running]:

main.die(...)

 /Users/davisd/Library/Preferences/IntelliJIdea2018.3/

scratches/scratch.go:4

main.main()

 /Users/davisd/Library/Preferences/IntelliJIdea2018.3/

scratches/scratch.go:8 +0x39

Process finished with exit code 2

```
package main
```

```
import "fmt"
```

```
func die() {  
    defer func() {  
        if x := recover(); x != nil {  
            fmt.Printf("recovered: %v\n", x)  
        }  
    }()  
    panic("process died")  
}
```

```
func main() {  
    die()  
    println("hello")  
}
```

Don't Panic!



Interfaces



```
type duck interface {  
    walk()  
    quack()  
}
```

```
type duck interface {  
    walk()  
    quack()  
}
```

```
type goose struct{}
```

```
func (g goose) walk() { println("waddle, waddle") }
```

```
func (g goose) quack() { println("HONK") }
```

```
func (g goose) eat() { println("om nom nom") }
```

```
type duck interface {  
    walk()  
    quack()  
}
```

```
type goose struct{}
```

```
func (g goose) walk() { println("waddle, waddle") }
```

```
func (g goose) quack() { println("HONK") }
```

```
func (g goose) eat() { println("om nom nom") }
```

```
func main() {  
    var g duck  
    g = goose{}  
    g.walk()  
}
```



```
func annoy(d duck) {  
    d.walk()  
    d.quack()  
    //d.eat() // doesn't work  
}
```

```
func main() {  
    g := goose{}  
    annoy(g)  
}
```

```
func main() {  
    var walker interface{  
        walk()  
    }  
  
    walker = goose{}  
    walker.walk()  
}
```

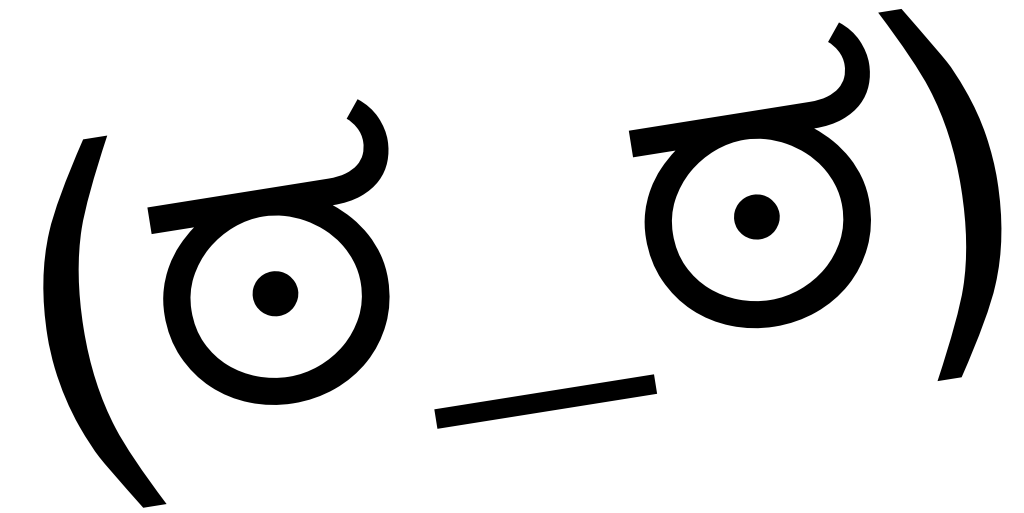
```
type Reader interface {  
    Read(p []byte) (n int, err error)  
}
```

```
type Writer interface {  
    Write(p []byte) (n int, err error)  
}
```

```
type ReadWriter interface {  
    Reader  
    Writer  
}
```

Interfaces Should Be Small

```
type Store interface {  
    Put(key string, value []byte, options *WriteOptions) error  
    Get(key string) (*KVPair, error)  
    Delete(key string) error  
    Exists(key string) (bool, error)  
    Watch(key string, stopCh <-chan struct{}) (<-chan *KVPair, error)  
    WatchTree(directory string, stopCh <-chan struct{}) (<-chan []*KVPair, error)  
    NewLock(key string, options *LockOptions) (Locker, error)  
    List(directory string) ([]*KVPair, error)  
    DeleteTree(directory string) error  
    AtomicPut(key string, value []byte, previous *KVPair, options *WriteOptions) (bool, *KVPair, error)  
    AtomicDelete(key string, previous *KVPair) (bool, error)  
    Close()  
}
```




```
func main() {  
    var i interface{}  
    i = 123        // valid  
    i = "hello"    // valid  
    i = true       // valid  
    fmt.Println(i)  
}
```

```
func foo(v interface{}) {  
    // ???  
}
```

```
func foo(v interface{}) {  
    i := v.(int)  
    println("int", i)  
}
```



```
func foo(v interface{}) {  
    if i, ok := v.(int); ok {  
        println("int", i)  
    } else {  
        println("not an int")  
    }  
}
```

```
func foo(v interface{}) {  
    switch v := v.(type) {  
    case int:  
        println("int", v)  
    case string:  
        println("string", v)  
    case io.Reader:  
        println("io.Reader")  
    default:  
        println("unknown")  
    }  
}
```

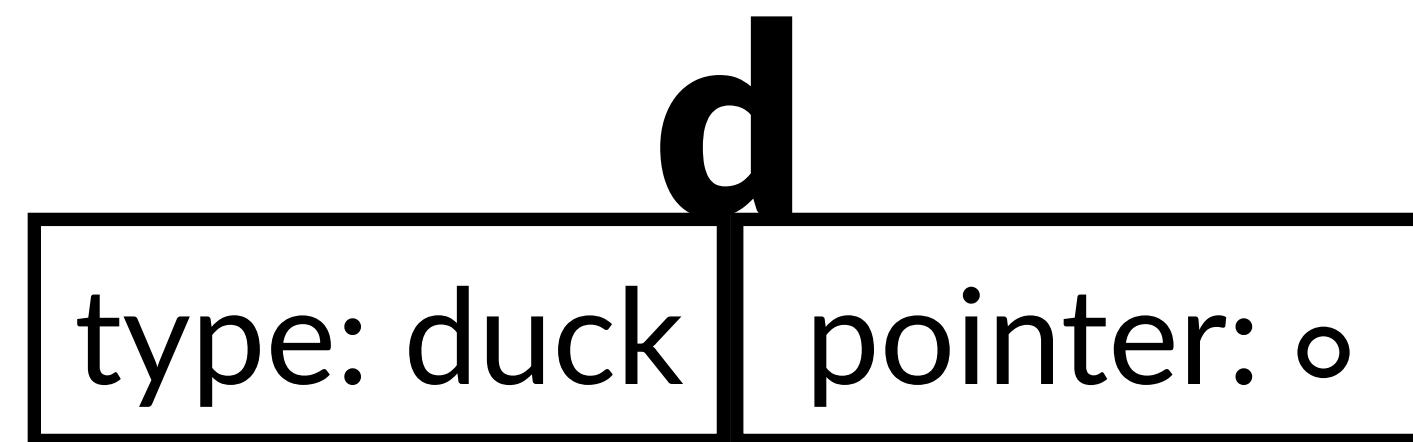
```
func foo(v interface{}) {  
    switch v := v.(type) {  
    case int, float32:  
        println("number", v)  
    default:  
        println("unknown")  
    }  
}
```

```
func foo(v interface{}) {  
    switch v := v.(type) {  
    case int, float32:  
        println("number", v + v)  
    default:  
        println("unknown")  
    }  
}
```

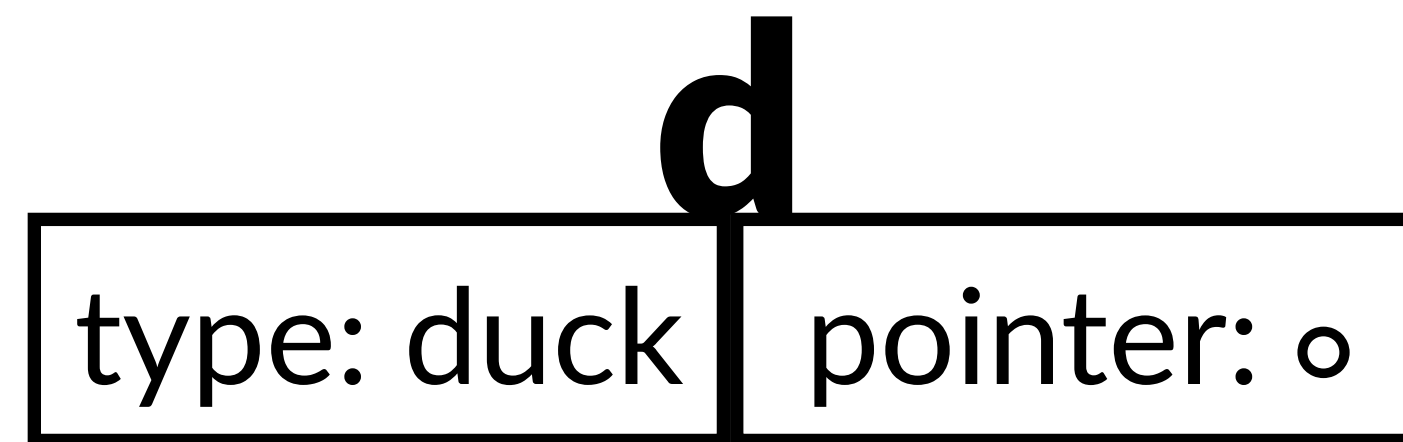
This is not generics



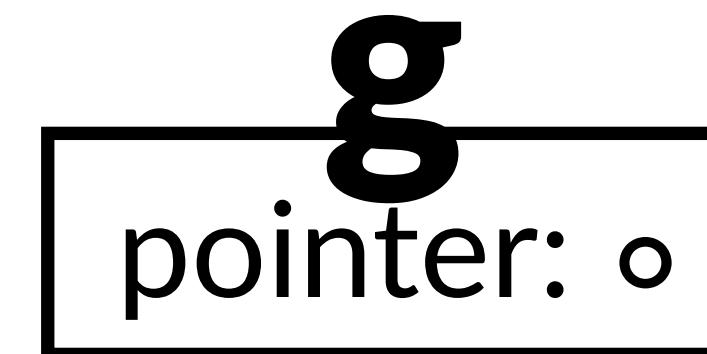
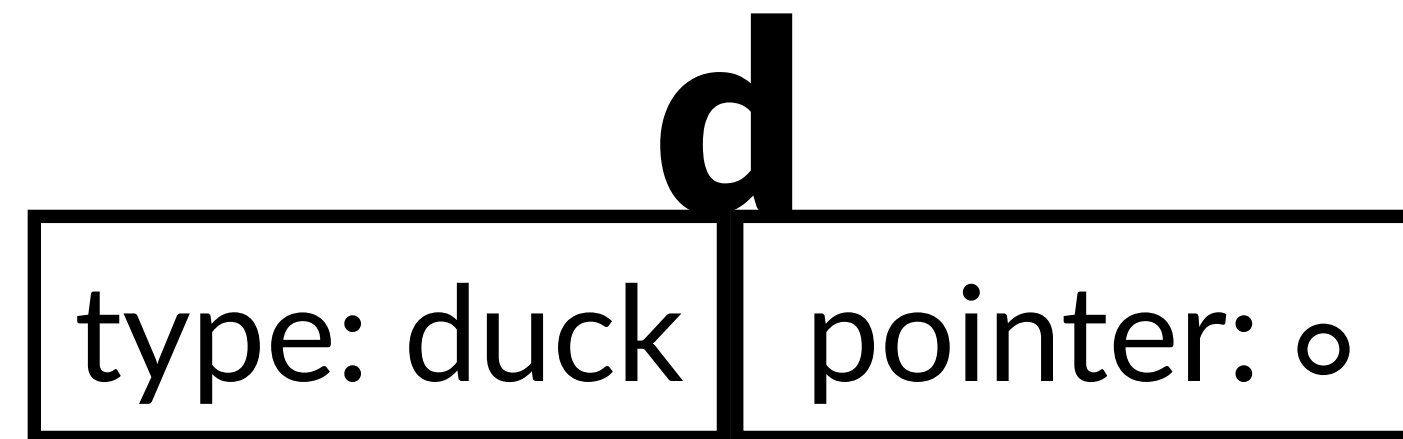
var d duck



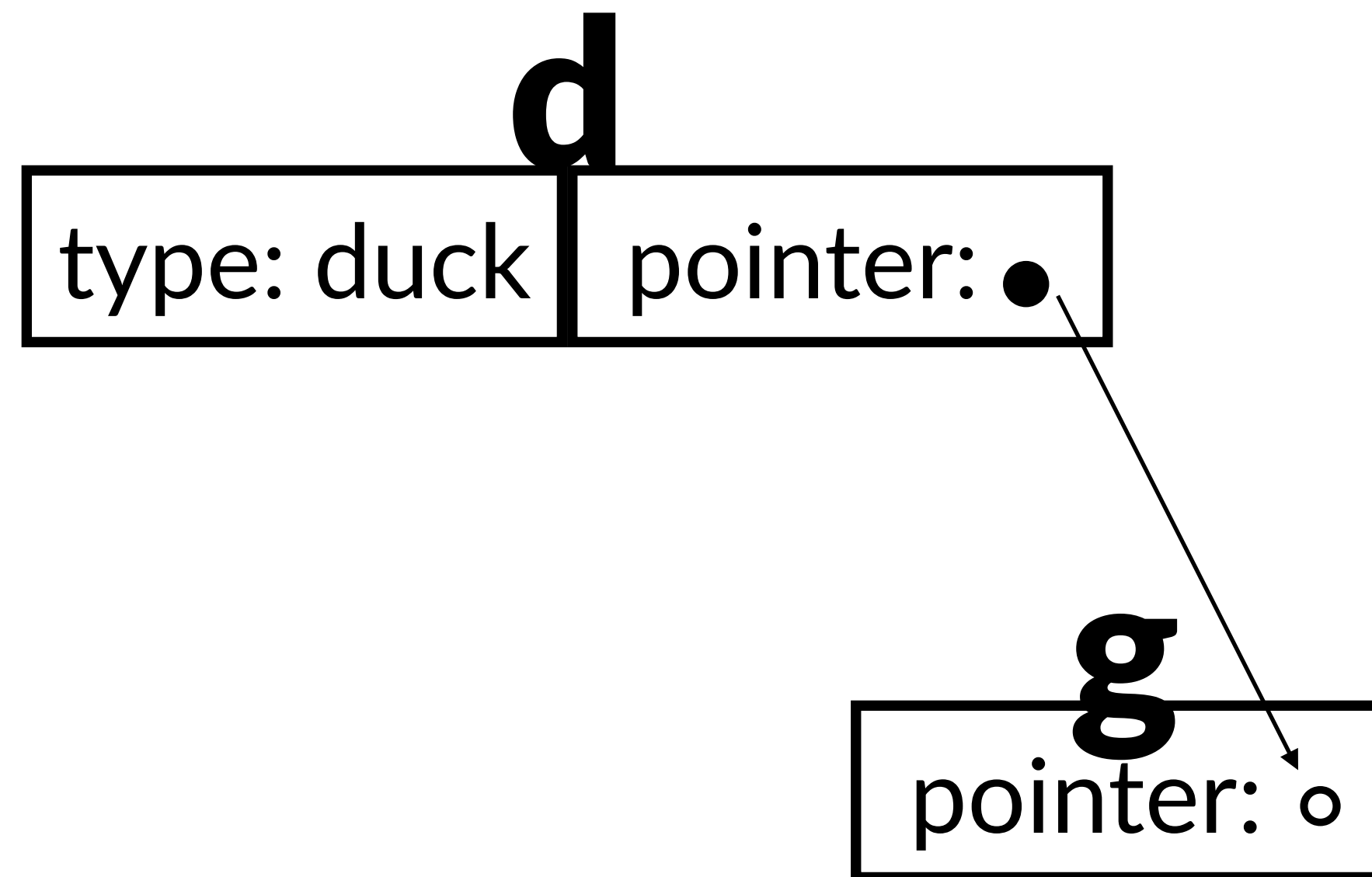
```
var d duck  
//d.quack()
```



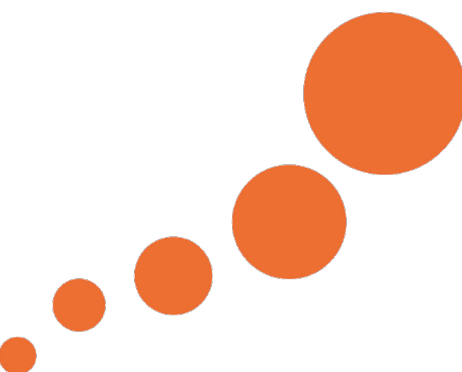
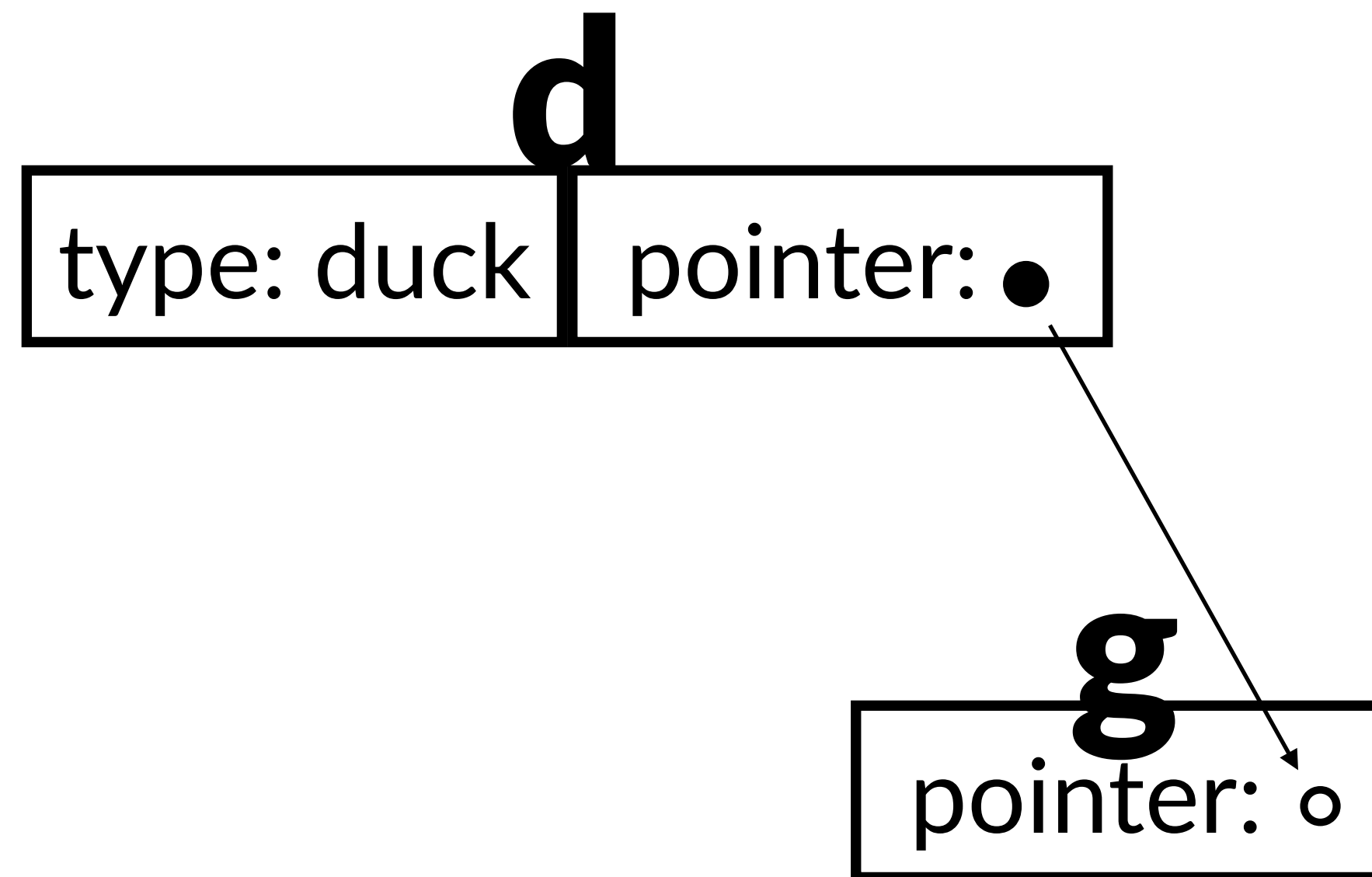
```
var d duck  
//d.quack()  
var g *goose
```




```
var d duck  
//d.quack()  
var g *goose  
d = g
```



```
var d duck
//d.quack()
var g *goose
d = g
d.quack() // ?
```



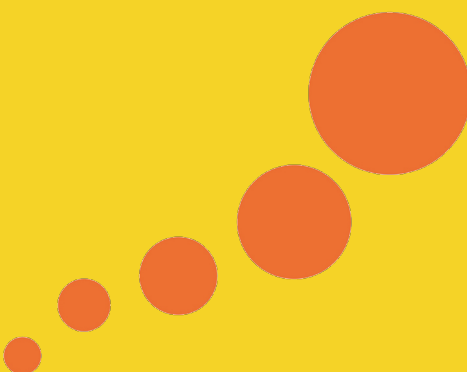
```
func (g goose) quack() {  
    // it's not possible to get here via a nil ptr  
    // "value method main.goose.quack called using  
    // nil *goose pointer"  
}
```

```
func (g *goose) quack() {  
    // it is possible to get here with a nil ptr!  
    // g may be nil  
}
```

11: Generator Interface

Change Run back to a normal function, and change it to take a
Generator interface

<https://github.com/domdavis/go-get-better/tree/exercise-11>



Interfaces and Testing



Whenever possible, write code in a functional style.
Take all dependencies as parameters.
Avoid depending on or (especially) mutating global state.
Make heavy use of interfaces!



```
package main

func process(db *database) (result, error) {
    var r result
    rows, err := db.Query("SELECT foo")

    if err != nil {
        return result{}, err
    }

    defer rows.Close()
    if err := rows.Scan(&r); err != nil {
        return result{}, err
    }

    return r, nil
}

func main() {
    db := newDatabase()
    r, err := process(db)
}
```

```
package main

type queryer interface {
    Query(s string) (rows, error)
}

func process(db queryer) (result, error) {
    var r result
    rows, err := db.Query("SELECT foo")

    if err != nil {
        return result{}, err
    }

    defer rows.Close()
    if err := rows.Scan(&r); err != nil {
        return result{}, err
    }

    return r, nil
}

func main() {
    db := newDatabase()
    r, err := process(db)
}
```



```
type fakeQueryer struct{}

func (q fakeQueryer) Query(s string) (rows, error) {
    return []row{"fakerow"}, nil
}
```

```
type fakeQueryer struct{}

func (q fakeQueryer) Query(s string) (rows, error) {
    return []row{"fakerow"}, nil
}

func TestProcess(t *testing.T) {
    q := fakeQueryer{}
    have, err := process(q)

    if err != nil {
        t.Fatal(err)
    }

    want := result{"fakedata"} // or whatever

    if want != have {
        t.Errorf("process: want %v, have %v", want, have)
    }
}
```

Implementing Interfaces



```
type myType struct{}
```

```
func (_ myType) String() string {  
    return "This is my type"  
}
```

```
f ( ) {  
    sleep "$1"  
    echo "$1"  
}  
while [ -n "$1" ]  
do  
    f "$1" &  
    shift  
done  
wait
```



```
package main
```

```
import (  
    "fmt"  
    "sort"  
)
```

```
func main() {  
    strings := []string{"c", "a", "b"}  
    sort.Strings(strings)  
    fmt.Println("Strings:", strings)  
  
    ints := []int{7, 2, 4}  
    sort.Ints(ints)  
    fmt.Println("Ints: ", ints)  
  
    s := sort.IntsAreSorted(ints)  
    fmt.Println("Sorted: ", s)  
}
```

```
// Strings: [a b c]  
// Ints:    [2 4 7]  
// Sorted:  true
```

```
package main

import (
    "fmt"
    "sort"
)

type ByLength []string

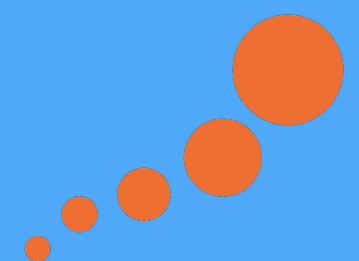
func (s ByLength) Len() int {
    return len(s)
}

func (s ByLength) Swap(i, j int) {
    s[i], s[j] = s[j], s[i]
}

func (s ByLength) Less(i, j int) bool {
    return len(s[i]) < len(s[j])
}

func main() {
    fruits := []string{"peach", "banana", "kiwi"}
    sort.Sort(ByLength(fruits))
    fmt.Println(fruits)
}
```

JSON Parsing




```
package main

import (
    "encoding/json"
    "fmt"
)

type Car struct {
    Make string
    Model string
    doors int
}

func main() {
    c := Car{Make: "Toyota", Model: "Corolla", doors: 5}
    b, _ := json.Marshal(c)
    fmt.Println(string(b))
}
```

```
package main

import (
    "encoding/json"
    "fmt"
)

type Car struct {
    Make string
    Model string
    doors int
}

func main() {
    c := Car{Make: "Toyota", Model: "Corolla", doors: 5}
    b, _ := json.Marshal(c)
    fmt.Println(string(b))
}

// {"Make": "Toyota", "Model": "Corolla"}
```

```
package main

import (
    "encoding/json"
    "fmt"
)

type Car struct {
    Make string `json:"make"`
    Model string `json:"model"`
    Doors int `json:"doors"`
}

func main() {
    c := Car{Make: "Toyota", Model: "Corolla", Doors: 5}
    b, _ := json.Marshal(c)
    fmt.Println(string(b))

    var car Car
    _ = json.Unmarshal(b, &car)
    fmt.Println(car.Doors)
}

// {"make": "Toyota", "model": "Corolla", "doors": 5}
// 5
```

```
package main

import (
    "encoding/json"
    "fmt"
)

type Car struct {
    Make string `json:"make"`
    Model string `json:"model"`
    Doors int `json:"doors"`
}

func (c Car) MarshalJSON() ([]byte, error) {
    s := fmt.Sprintf("%d door %s %s", c.Doors, c.Make, c.Model)
    return json.Marshal(s)
}

func main() {
    c := Car{Make: "Toyota", Model: "Corolla", Doors: 5}
    b, _ := json.Marshal(c)
    fmt.Println(string(b))
}

// "5 door Toyota Corolla"
```

12: Sequence JSON

Update the sequence type so when it's rendered as JSON
it's output in the format `{"name": ["1", "2", ...]}`
An empty sequence should simple be `{}`

<https://github.com/domdavis/go-get-better/tree/exercise-12>



```
func (s Sequence) MarshalJSON() ([]byte, error) {  
    var sequence []string  
    o := map[string][]string{}  
  
    if len(s) > 2 {  
        sequence = s[1:]  
    }  
  
    if len(s) > 1 {  
        o[s[0]] = sequence  
    }  
  
    return json.Marshal(o)  
}
```

```
func ExampleSequence_MarshalJSON() {
    r, _ := training.Run(training.Simple{}, 5)

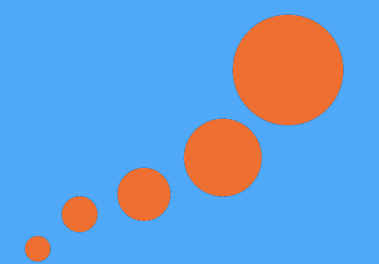
    if b, err := json.Marshal(r); err != nil {
        fmt.Println(err)
    } else {
        fmt.Println(string(b))
    }

    r, _ = training.Run(training.Simple{}, 0)

    if b, err := json.Marshal(r); err != nil {
        fmt.Println(err)
    } else {
        fmt.Println(string(b))
    }

    // Output:
    // {"Simple":["1","2","3","4","5"]}
    // {}
}
```

Concurrency & Parallelism



Concurrency \neq Parallelism



Concurrency is about designing your program so that multiple things can execute independently of each other.

Parallelism is executing those things at the same time.

Go programs should be written for concurrency, but parallelism is a decision for the runner!



```
package main
```

```
func main() {  
    foo("a")  
    go foo("b")  
}
```

```
func foo(s string) {  
    println(s)  
}
```

```
package main
```

```
import "time"
```

```
func main() {  
    foo("a")  
    go foo("b")  
    time.Sleep(time.Second)  
}
```

```
func foo(s string) {  
    println(s)  
}
```

```
package main
```

```
func main() {  
    n := 10  
    for i := 0; i < n; i++ {  
        go println(i)  
    }  
    // when is everything done?  
}
```

```
package main
```

```
import "sync"
```

```
func main() {  
    var wg sync.WaitGroup  
    for i := 0; i < 10; i++ {  
        wg.Add(1)  
        go func() {  
            defer wg.Done()  
            print(i, " ")  
        }()  
    }  
  
    wg.Wait()  
}
```

```
package main

import "sync"

func main() {
    var wg sync.WaitGroup
    for i := 0; i < 10; i++ {
        wg.Add(1)
        go func() {
            defer wg.Done()
            print(i, " ")
        }()
    }

    wg.Wait()
}

// 8 8 8 8 10 10 10 10 10 10
```

```
package main

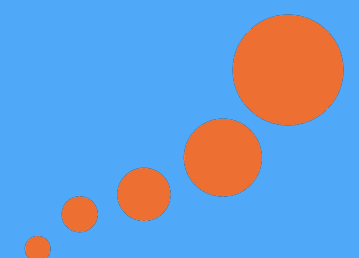
import "sync"

func main() {
    var wg sync.WaitGroup
    for i := 0; i < 10; i++ {
        wg.Add(1)
        go func(i int) {
            defer wg.Done()
            print(i, " ")
        }(i)
    }

    wg.Wait()
}

// 1 0 4 2 3 9 6 5 8 7
```


Mutex



```
package main
```

```
type thing struct {  
    m map[int]int  
}
```

```
func newThing() *thing {  
    return &thing{m: map[int]int{}}  
}
```

```
func (t *thing) set(k, v int) {  
    t.m[k] = v  
}
```

```
func (t *thing) get(k int) int {  
    return t.m[k]  
}
```

```
package main

import "sync"

type thing struct {
    mtx sync.Mutex
    m    map[int]int
}

func newThing() *thing {
    return &thing{m: map[int]int{}}
}

func (t *thing) set(k, v int) {
    t.mtx.Lock()
    defer t.mtx.Unlock()
    t.m[k] = v
}

func (t *thing) get(k int) int {
    t.mtx.Lock()
    defer t.mtx.Unlock()
    return t.m[k]
}
```

```
package main

import "sync"

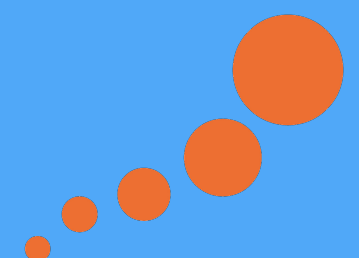
type thing struct {
    mtx sync.RWMutex
    m    map[int]int
}

func newThing() *thing {
    return &thing{m: map[int]int{}}
}

func (t *thing) set(k, v int) {
    t.mtx.Lock()
    defer t.mtx.Unlock()
    t.m[k] = v
}

func (t *thing) get(k int) int {
    t.mtx.RLock()
    defer t.mtx.RUnlock()
    return t.m[k]
}
```

Channels



Don't communicate by sharing memory
Share memory by communicating
A channel is like a UNIX pipe
Typed conduit for information, typically between goroutines



```
package main
```

```
func main() {  
    c := make(chan int)  
    go compute(c)  
    println(<-c)  
}
```

```
func compute(c chan int) {  
    c <- 123  
}
```

```
package main
```

```
func main() {  
    c := make(chan int, 100)  
    go compute(c)  
    println(<-c)  
}
```

```
func compute(c chan int) {  
    c <- 123  
}
```



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

```
func compute(id int, c chan int) {  
    c <- id  
}
```

```
// 0 1, 1 0, 2 3, 3 5, 4 4, 5 6, 6 2, 7 8, 8 9, 9 7,
```

```
package main
```

```
func main() {  
    c := make(chan int)  
    for i := 0; i < 10; i++ {  
        go readOne(c)  
    }  
    c <- 123  
    c <- 456  
    c <- 789  
}
```

```
func readOne(c chan int) {  
    println(<-c)  
}
```

```
package main
```

```
func main() {  
    c := make(chan int)  
    for i := 0; i < 10; i++ {  
        go readOne(c)  
    }  
    c <- 123  
    c <- 456  
    c <- 789  
    close(c)  
}
```

```
func readOne(c chan int) {  
    println(<-c)  
}
```

```
package main
```

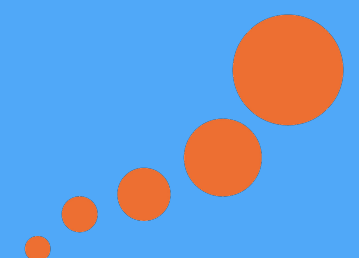
```
func main() {  
    c := make(chan int)  
    for i := 0; i < 10; i++ {  
        go readOne(c)  
    }  
    c <- 123  
    c <- 456  
    c <- 789  
    close(c)  
    time.Sleep(time.Second)  
}
```

```
func readOne(c chan int) {  
    println(<-c)  
}
```

```
func readOne(c chan int) {  
    v, ok := <-c  
    if ok {  
        println("received value", v)  
    } else {  
        println("channel was closed")  
    }  
}
```

```
func main() {  
    c := make(chan int)  
    go read(c)  
    c <- 123  
    c <- 456  
    c <- 789  
    close(c)  
    time.Sleep(time.Second)  
}  
  
func read(c chan int) {  
    for v := range c {  
        println("received value", v)  
    }  
}
```

Select



framework training

```
func main() {
    c1, c2 := make(chan int), make(chan int)

    for i := 0; i < 10; i++ {
        go read(c1, c2)
    }

    c1 <- 123
    c2 <- 456
    close(c1)
    c2 <- 789
    close(c2)
    time.Sleep(time.Second)
}

func read(c1, c2 chan int) {
    select {
    case v := <-c1:
        fmt.Printf("Read from channel 1: %d\n", v)
    case v := <-c2:
        fmt.Printf("Read from channel 2: %d\n", v)
    }
}
```



```
func read(c1, c2 chan int) {  
    select {  
    case v := <-c1:  
        fmt.Printf("Read from channel 1: %d\n", v)  
    case v := <-c2:  
        fmt.Printf("Read from channel 2: %d\n", v)  
    default:  
        fmt.Println("No channel ready")  
    }  
}
```

```
func doWork(i chan int, s chan string, t chan thing) {  
    for {  
        select {  
        case v := <-i:  
            println("do work with int", i)  
        case v := <-s:  
            println("do work with string", s)  
        case v := <-t:  
            println("do work with thing", t)  
        }  
    }  
}
```

```
func (a *Actor) SendEvent(e Event) {
    a.event <- e
}

func (a *Actor) SendReq(r *Request) {
    a.request <- r
}

func (a *Actor) Stop() {
    close(a.quit)
}

func (a *Actor) loop() {
    for {
        select {
            case e := <-a.event:
                // process event
            case r := <-a.request:
                // process request
            case <-a.quit:
                return
        }
    }
}
```

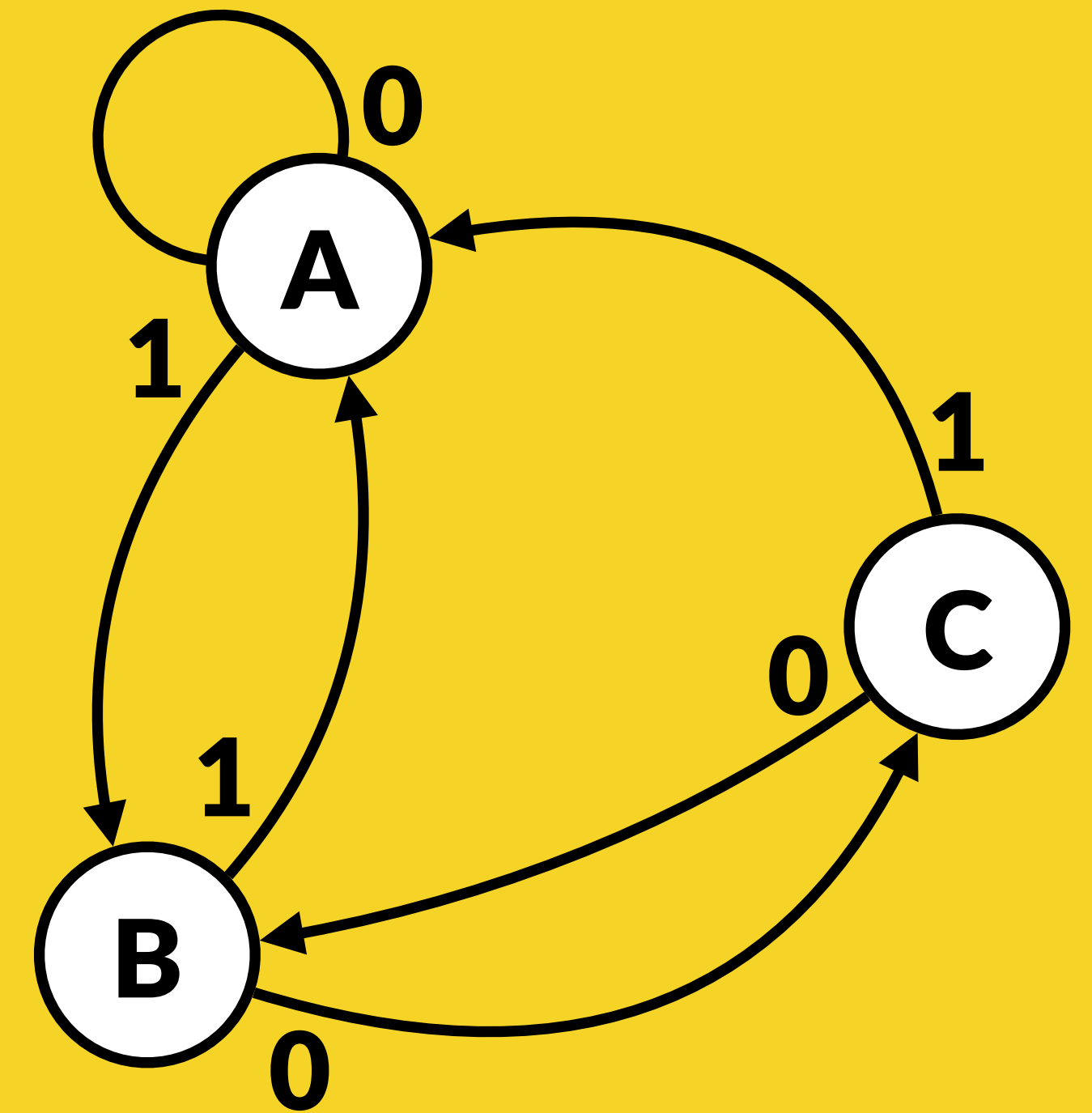
```
type Actor struct {  
    event    chan Event  
    request  chan *Request  
    quit     chan struct{}  
}
```

13: State Machine

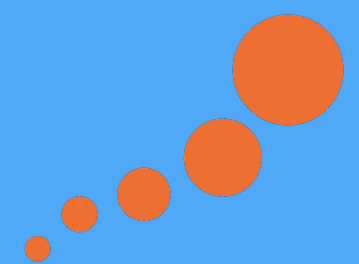
```
package main

// Implement stateMachine.
type stateMachine struct{}

func main() {
    sm := newStateMachine()
    sm.send(1)           // "state A + 1 => state B"
    sm.send(0)           // "state B + 0 => state C"
    println(sm.state()) // "state C"
}
```



Pipelines



```
$ echo "test" | grep -o . | sort
```

e

s

t

t

```
package main
```

```
import "strings"
```

```
func trim(in chan string, out chan string) {  
    for s := range in {  
        s = strings.TrimSpace(s)  
        out <- s  
    }  
}
```

```
func capitalize(in chan string, out chan string) {  
    for s := range in {  
        s = strings.ToUpper(s)  
        out <- s  
    }  
}
```



```
package main
```

```
import "strings"
```

```
func trim(in <-chan string, out chan<- string) {  
    for s := range in {  
        s = strings.TrimSpace(s)  
        out <- s  
    }  
}
```

```
func capitalize(in <-chan string, out chan<- string) {  
    for s := range in {  
        s = strings.ToUpper(s)  
        out <- s  
    }  
}
```

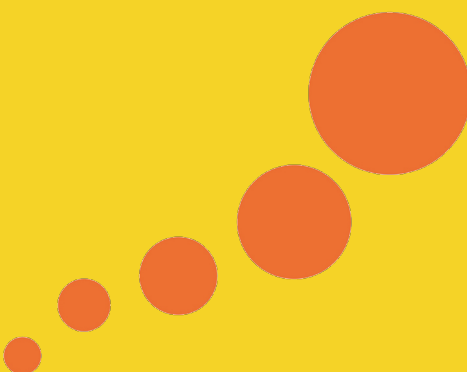
```
func main() {  
    a := make(chan string)  
    b := make(chan string)  
    c := make(chan string)  
  
    go trim(a, b);  
    go capitalize(b, c)  
  
    a <- "hello world"  
    fmt.Printf("%q", <-c)  
  
    close(a)  
    close(b)  
    close(c)  
}
```

```
func main() {  
    a := make(chan string)  
    b := make(chan string)  
    c := make(chan string)  
  
    go trim(a, b); go trim(a, b); go trim(a, b); go trim(a, b)  
    go capitalize(b, c)  
  
    a <- "hello world"  
    fmt.Printf("%q", <-c)  
  
    close(a)  
    close(b)  
    close(c)  
}
```

14: FizzBuzz Pipelines

Checkout and finish the code in the branch pipelines

<https://github.com/domdavis/go-get-better/tree/pipelines>
<https://github.com/domdavis/go-get-better/tree/exercise-14>



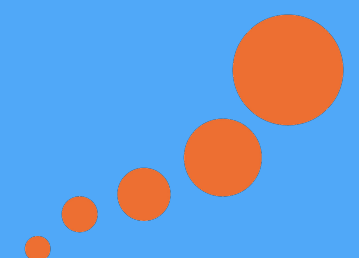
```
func fizz(in <-chan int, out chan<- string) {  
    if <-in%3 == 0 {  
        out <- "Fizz"  
    } else {  
        out <- ""  
    }  
}
```

```
func buzz(in <-chan int, out chan<- string) {  
    if <-in%5 == 0 {  
        out <- "Buzz"  
    } else {  
        out <- ""  
    }  
}
```

```
func number(in <-chan int, out chan<- string) {  
    i := <-in  
    if i%3 != 0 && i%5 != 0 {  
        out <- strconv.Itoa(i)  
    } else {  
        out <- ""  
    }  
}
```

```
var FizzBuzz = Generator{  
    Name:    "FizzBuzz",  
    Steps:  []Step{fizz, buzz, number},  
}
```

Parallelism

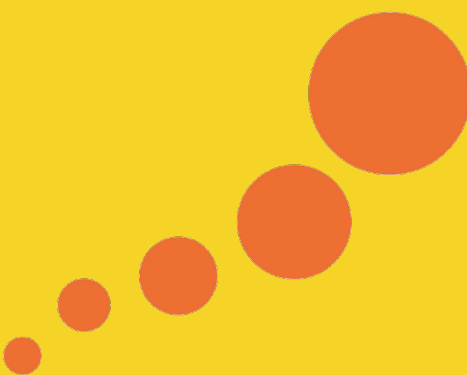


goroutines are multiplexed onto OS threads
GOMAXPROCS controls number of threads available
By default, GOMAXPROCS = num CPUs

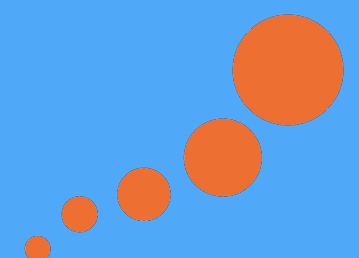


Playtime

https://divan.github.io/posts/go_concurrency_visualize/



Networking



```
package main

import (
    "fmt"
    "io/ioutil"
    "net/http"
)

func main() {
    resp, err := http.Get("http://google.com")
    if err != nil {
        panic(err)
    }

    defer func() { _ = resp.Body.Close() }()

    if b, err := ioutil.ReadAll(resp.Body); err != nil {
        panic(err)
    } else {
        fmt.Println(string(b))
    }
}
```

```
package main

import (
    "io"
    "net/http"
    "os"
)

func main() {
    resp, err := http.Get("http://google.com")
    if err != nil {
        panic(err)
    }

    defer func() { _ = resp.Body.Close() }()

    if _, err := io.Copy(os.Stdout, resp.Body); err != nil {
        panic(err)
    }
}
```

```
package main

import (
    "io"
    "net/http"
    "os"
)

func main() {
    c := http.Client{} // zero value is usable

    req, err := http.NewRequest("GET", "http://google.com", nil)
    if err != nil {
        panic(err)
    }

    resp, err := c.Do(req)
    if err != nil {
        panic(err)
    }

    defer func() { _ = resp.Body.Close() }()

    if _, err := io.Copy(os.Stdout, resp.Body); err != nil {
        panic(err)
    }
}
```

```
package main
```

```
import (  
    "fmt"  
    "net/http"  
)
```

```
func main() {  
    http.HandleFunc("/", h)  
    if err := http.ListenAndServe(":8080", nil); err != nil {  
        panic(err)  
    }  
}
```

```
func h(w http.ResponseWriter, r *http.Request) {  
    _, _ = fmt.Fprintf(w, "Hello world\n")  
}
```

```
package main

import (
    "fmt"
    "log"
    "net/http"
)

func main() {
    s := &server{msg: "Hello from server"}
    http.Handle("/", s)
    if err := http.ListenAndServe(":8080", nil); err != nil {
        panic(err)
    }
}

type server struct{ msg string }

func (s *server) ServeHTTP(w http.ResponseWriter, r *http.Request) {
    log.Printf("%s %s from %s", r.Method, r.URL, r.RemoteAddr)
    _, _ = fmt.Fprintf(w, s.msg+"\n")
}
```

```
package main

import (
    "fmt"
    "log"
    "net/http"
)

func main() {
    mux := http.NewServeMux()
    mux.HandleFunc("/foo", handleFoo)
    mux.HandleFunc("/bar", handleBar)
    log.Fatal(http.ListenAndServe(":8080", mux))
}

func handleFoo(w http.ResponseWriter, r *http.Request) {
    log.Printf("%s %s from %s", r.Method, r.URL, r.RemoteAddr)
    _, _ = fmt.Fprintf(w, "foo\n")
}

func handleBar(w http.ResponseWriter, r *http.Request) {
    log.Printf("%s %s from %s", r.Method, r.URL, r.RemoteAddr)
    _, _ = fmt.Fprintf(w, "bar\n")
}
```


Other Routers and Mixers

Usability: github.com/gorilla/mux

Raw speed: github.com/julienschmidt/httprouter



```
func main() {
    ln, err := net.Listen("tcp4", ":1234")
    if err != nil {
        panic(err)
    }

    defer func() { _ = ln.Close() }()

    for {
        c, err := ln.Accept()
        if err != nil { break }
        go handle(c)
    }
}

func handle(c net.Conn) {
    log.Printf("%s: start conn", c.RemoteAddr())
    defer log.Printf("%s: close conn", c.RemoteAddr())

    s := bufio.NewScanner(c)
    for s.Scan() {
        log.Printf("%s: %s", c.RemoteAddr(), s.Text())
    }
}
```

```
func main() {
    ln, err := net.Listen("tcp4", ":1234")
    if err != nil {
        panic(err)
    }

    defer func() { _ = ln.Close() }()

    for {
        c, err := ln.Accept()
        if err != nil { break }
        go handle(c)
    }
}

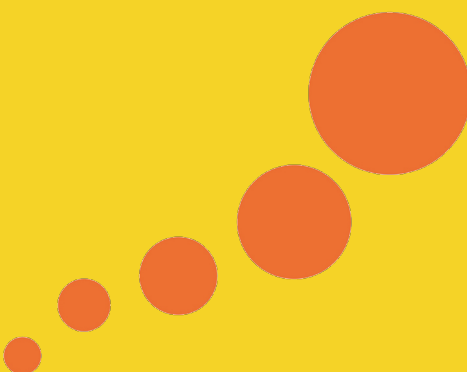
func handle(c net.Conn) {
    log.Printf("%s: start conn", c.RemoteAddr())
    defer log.Printf("%s: close conn", c.RemoteAddr())

    s := bufio.NewScanner(c)
    for s.Scan() {
        log.Printf("%s: %s", c.RemoteAddr(), s.Text())
        _, _ = fmt.Fprintf(c, "%s\n", strings.ToUpper(s.Text()))
    }
}
```

15: FizzBuzz Microservice

Write an implementation off FizzBuzz that will respond to a
HTTP request to `fizzbuzz/n`

<https://github.com/domdavis/go-get-better/tree/exercise-15>



Packaging and Distribution



go mod



```
$ go get github.com/domdavis/go-get-better
```

```
# before modules was roughly equivalent to...
```

```
$ cd $GOPATH/src/github.com/go-get-better
```

```
$ git clone https://github.com/domdavis/go-get-better
```

```
$ go install github.com/domdavis/go-get-better
```

```
# with modules go get is used to add a package
```

```
$ go get -u github.com/domdavis/go-get-better
```

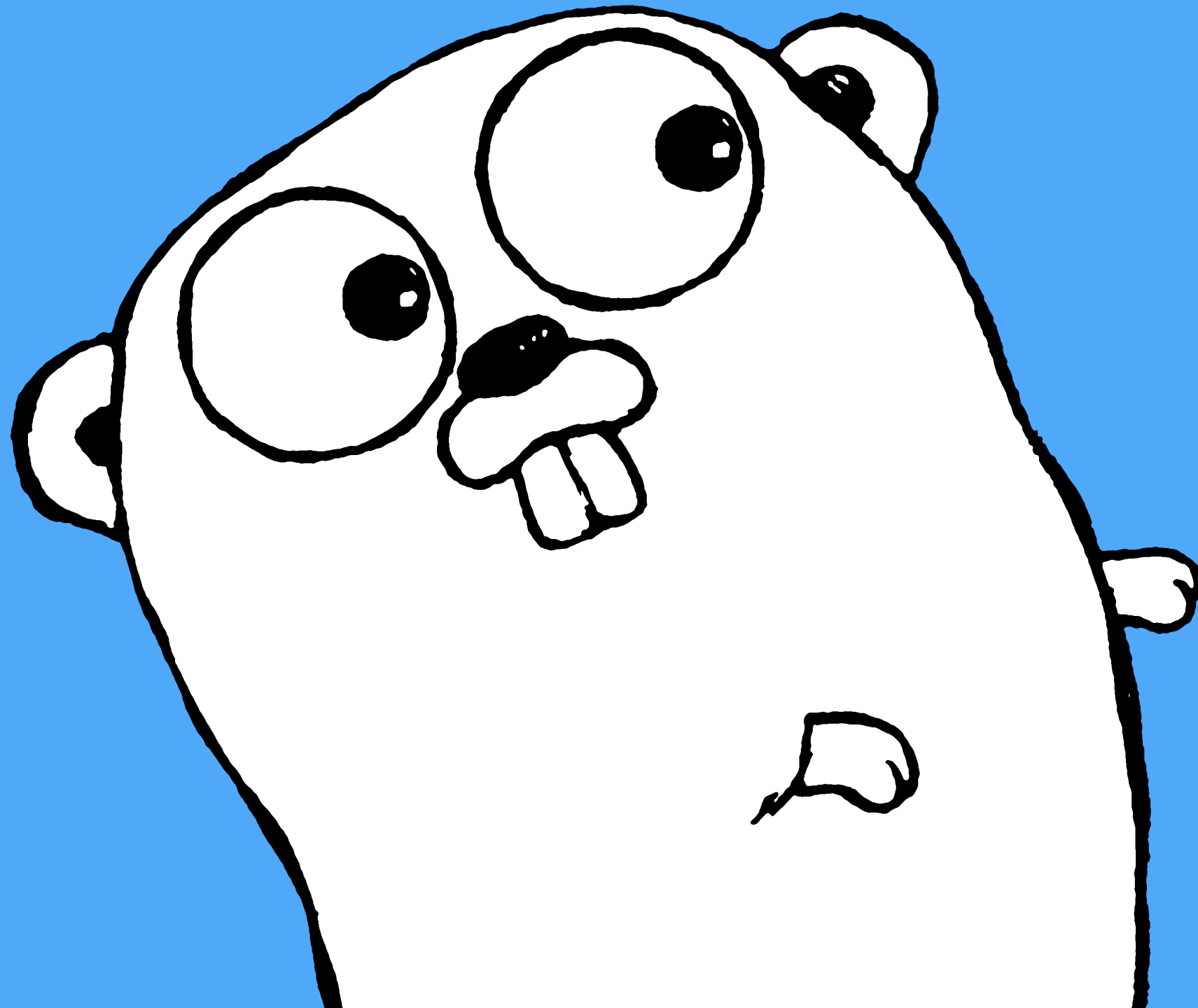





```
FROM scratch
ADD app /
ENTRYPOINT ["/app"]
CMD ["args"]
```

```
CGO_ENABLED=0 GOOS=linux go build -a -installsuffix cgo -o app .  
docker build -t image:latest .
```

Go Nuts



framework training
business value through education