

Golang Basics

Materials are generously shared by Prof. Michael J.
Freedman and Wyatt Lloyd from Princeton

Go Resources

Go tutorial: <https://tour.golang.org/list>

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

Go standard docs: <http://go.dev/doc/>

Basic syntax code in playground: <https://tinyurl.com/y7rdgqj3>

Agenda for Today

- Go Basics
 - Program Structure
 - Variables
 - Functions
 - Loops
 - Composite Data Types
 - OOP in Go
- Exercise Time

Program Structure

```
// All files start with a package declaration  
package main  
  
// Import statements, one package on each line  
import (  
    "errors"  
    "fmt"  
)  
  
// Main method will be called when the Go  
executable is run  
func main() {  
    fmt.Println("Hello world!")  
    basic()  
    add(1, 2)  
    divide(3, 4)  
    loops()  
    slices()  
    maps()  
    sharks()  
}
```

Program Structure

A basic Go program contains

- ❑ Package specification: serves as a separate namespace, like modules or libraries in other languages



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- ❑ Package specification: serves as a separate namespace, like modules or libraries in other languages
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Program Structure

A basic Go program contains

- ❑ Package specification: serves as a separate namespace, like modules or libraries in other languages
- ❑ Import other packages
- ❑ Package-level declarations: var, func, const, type

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 add(1, 2)
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}

Variables

```
// Declare a package-level variable
var msg string = "Hello World"

// Function declaration
func basic() {
    // Declare x as a variable, initialized to 0
    var x int
    // Declare y as a variable, initialized to 2
    var y int = 2
    // Declare z as a variable, initialized to 4
    // This syntax can only be used in a function
    z := 4

    // Assign values to variables
    x = 1
    y = 2
    z = x + 2 * y + 3

    // Print the variables; just use %v for most types
    fmt.Printf("x = %v, y = %v, z = %v\n", x, y, z)
    // Print the package-level string variable
    fmt.Println(msg)
}
```

Variables

Variable Declaration

- General form: *var name type = expression*
 - *var name type* (sans *= expression*) initializes to default value.
 - 0 for int
 - false for bool
 - "" for strings
 - nil for pointers

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- Short Variable Declaration
 - *name := expression*
 - Only for local variables within a function

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// Function declaration
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    fmt.Printf("x = %v, y = %v, z = %v\n", x, y, z)
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}
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Note: Keep in mind **:=** is a declaration, whereas **=** is an assignment

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var msg string = "Hello World"
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// Function declaration
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}
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x = 1  
y = 2  
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// Print the package-level string variable  
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Functions

- Function Declaration

- The General Form:

```
func name (parameter-list) (result-list)  
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    body  
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an int
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func add(x, y int) int {  
    return x + y  
}
```

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    body  
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// Function declaration; takes in 2 ints and outputs  
an int
```

```
func add(x, y int) int {  
    return x + y  
}
```

```
// Function that returns two things; error is nil if  
successful
```

```
func divide(x, y int) (float64, error) {  
    if y == 0 {  
        return 0.0, errors.New("Divide by zero")  
    }  
    // Cast x and y to float64 before dividing  
    return float64(x) / float64(y), nil  
}
```

Functions

- Anonymous Functions
 - Define such a function at its point of use
 - Declare without a name following the *func* keyword

*// squares() returns an anonymous function
// that itself returns the next square number each
time it is called*

```
func squares() func() int {  
    var x int  
    return func() int {  
        x++  
        return x*x  
    }  
}
```

```
func main() {  
    // Assign a function variable to func squares()  
    f := squares()  
    fmt.Println(f()) // "1"  
    fmt.Println(f()) // "4"  
    fmt.Println(f()) // "9"  
}
```

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    return func() int {  
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func main() {  
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}
```

Loops

- In Go, while loops are represented via for loops

```
func loops() {  
    // For loop  
    for i := 0; i < 10; i++ {  
        fmt.Print(".")  
    }  
    // While loop  
    sum := 1  
    for sum < 1000 {  
        sum *= 2  
    }  
    fmt.Printf("The sum is %v\n", sum)  
}
```

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    sum := 1  
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    }  
    fmt.Printf("The sum is %v\n", sum)  
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Composite Data Types

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 - Array: fixed-length, elements of same type

```
func slicesAndArrays() {  
    var array = [8]int{1, 2, 3, 4, 5, 6, 7, 8}  
    fmt.Println(array)  
    fmt.Println(array[2:5]) // 3, 4, 5  
    fmt.Println(array[5:]) // 6, 7, 8  
    fmt.Println(array[:3]) // 1, 2, 3  
}
```

Composite Data Types

- Composite types are based on basic data types (e.g integers, floating point numbers, strings, and booleans). In Go, some common composite types are:
 - Array: fixed-length, elements of same type
 - Slice: variable-length, elements of same type

```
func slicesAndArrays() {  
    var array = [...]int{1, 2, 3, 4, 5, 6, 7, 8}  
    fmt.Println(array)  
    fmt.Println(array[2:5]) // 3, 4, 5 [type slice]  
    fmt.Println(array[5:]) // 6, 7, 8  
    fmt.Println(array[:3]) // 1, 2, 3  
  
    slice := make([]string, 3)  
    slice[0] = "tic"  
    slice[1] = "tac"  
    slice[2] = "toe"  
    fmt.Println(slice)  
    slice = append(slice, "tom")  
    slice = append(slice, "radar")  
    fmt.Println(slice)  
    for index, value := range slice {  
        fmt.Printf("%v: %v\n", index, value)  
    }  
    fmt.Printf("Slice length = %v\n", len(slice))  
}
```

Composite Data Types

- Composite types are based on basic data types (e.g integers, floating point numbers, strings, and booleans). In Go, some common composite types are:
 - Array: fixed-length, elements of same type
 - Slice: variable-length, elements of same type
 - Map: hash table of key value pairs

```
func maps() {  
    // Declare a map whose keys have type string, and values have type int  
    myMap := make(map[string]int)  
    myMap["yellow"] = 1  
    myMap["magic"] = 2  
    myMap["amsterdam"] = 3  
    fmt.Println(myMap)  
    myMap["magic"] = 100  
    delete(myMap, "amsterdam")  
    fmt.Println(myMap)  
    fmt.Printf("Map size = %v\n",  
len(myMap))  
}
```

Composite Data Types

- Composite types are based on basic data types (e.g integers, floating point numbers, strings, and booleans). In Go, some common composite types are:
 - Array: fixed-length, elements of same type
 - Slice: variable-length, elements of same type
 - Map: hash table of key value pairs
 - Struct: contain arbitrary fields and types

```
type Shark struct {  
    Name string  
    Age int  
}
```

Object-Oriented Programming (OOP) in Go

- Go also provides programmers with an OOP paradigm.
 - Object: a value or variable that has methods
 - Method: a function associated with a particular type
- Methods in Go
 - Method Declaration
Similar to function declaration, but add an extra parameter between *func* and *name*. This will attach the function to the type of the parameter.
 - Example

```
import "math"
// Declare a struct named Point with x, y positions
type Point struct { X, Y float64}

// Implement a method that find Hypotenuse distance
between one Point and another
func (p Point) Distance(q Point) float64 {
    return math.Hypot(q.X - p.X, q.Y - p.Y)
}

// standard function
func Distance(p Point, q Point) float64 {
    return math.Hypot(q.X - p.X, q.Y - p.Y)
}

func main() {
    p := Point{1, 2}
    q := Point{4, 6}
    fmt.Println(p.Distance(q)) // "5" method call
    fmt.Println(Distance(p, q)) // "5" function call
}
```

Go Routines

// Launch n goroutines, each printing a number

// Note how the numbers are not printed in order

```
func goroutines() {  
    for i := 0; i < 10; i++ {  
        // Print the number asynchronously  
        go fmt.Printf("Printing %v in a goroutine\n", i)  
    }  
    // At this point the numbers may not have been printed yet  
    fmt.Println("Launched the goroutines")  
}
```

Go Routines

```
// Launch n goroutines, each printing a number  
// Note how the numbers are not printed in order  
func goroutines() {  
    for i := 0; i < 10; i++ {  
        // Print the number asynchronously  
        go fmt.Printf("Printing %v in a goroutine\n", i)  
    }  
    // At this point the numbers may not have been printed yet  
    fmt.Println("Launched the goroutines")  
}
```

Possible Output:

Printing 4 in a goroutine
Printing 8 in a goroutine
Printing 9 in a goroutine
Printing 0 in a goroutine
Printing 1 in a goroutine
Printing 6 in a goroutine
Printing 2 in a goroutine
Printing 3 in a goroutine
Launched the goroutines

(Unbuffered) Channels

// Channels are a way to pass messages across goroutines

```
func channels() {  
    ch := make(chan int)  
    // Launch a goroutine using an anonymous function  
    go func() {  
        i := 1  
        for {  
            // This line blocks until someone  
            // consumes from the channel  
            ch <- i * i  
            i++  
        }  
    }()  
    // Extract first 10 squared numbers from the channel  
    for j := 0; j < 10; j++ {  
        // This line blocks until someone sends into the channel  
        fmt.Printf("The next squared number is %v\n", <-ch)  
    }  
}
```

(Unbuffered) Channels

// Channels are a way to pass messages across goroutines

```
func channels() {
```

```
    ch := make(chan int)
```

// Launch a goroutine using an anonymous function

```
    go func() {
```

```
        i := 1
```

```
        for {
```

```
            // This line blocks until someone  
            // consumes from the channel
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```
            ch <- i * i
```

```
            i++
```

```
        }
```

```
    }()
```

// Extract first 10 squared numbers from the channel

```
    for j := 0; i < 10; i++ {
```

```
        // This line blocks until someone sends into the channel  
        fmt.Printf("The next squared number is %v\n", <-ch)
```

```
    }
```

```
}
```

```
ch <- v    // Send v to channel ch  
v := <-ch  // Receive from ch, and  
           // assign value to v
```

(Unbuffered) Channels

// Channels are a way to pass messages across goroutines

```
func channels() {
```

```
    ch := make(chan int)
```

// Launch a goroutine using an anonymous function

```
    go func() {
```

```
        i := 1
```

```
        for {
```

```
            // This line blocks until someone
```

```
            // consumes from the channel
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            ch <- i * i
```

```
            i++
```

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        }
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```
    }()
```

// Extract first 10 squared numbers from the channel

```
    for j := 0; j < 10; j++ {
```

```
        // This line blocks until someone sends into the channel
```

```
        fmt.Printf("The next squared number is %v\n", <-ch)
```

```
    }
```

```
}
```

Output:

The next squared number is 1

The next squared number is 4

The next squared number is 9

The next squared number is 16

The next squared number is 25

The next squared number is 36

The next squared number is 49

The next squared number is 64

The next squared number is 81

The next squared number is 100

Buffered Channels

```
// Buffered channels are like channels except:  
// 1. Sending only blocks when the channel is full  
// 2. Receiving only blocks when the channel is empty  
func bufferedChannels() {  
    ch := make(chan int, 3)  
    ch <- 1  
    ch <- 2  
    ch <- 3  
    // Buffer is now full; sending any new messages will block  
    // Instead let's just consume from the channel  
    for i := 0; i < 3; i++ {  
        fmt.Printf("Consuming %v from channel\n", <-ch)  
    }  
    // Buffer is now empty; consuming from channel will block  
}
```

Buffered Channels

*// Buffered channels are like channels except:
// 1. Sending only blocks when the channel is full
// 2. Receiving only blocks when the channel is empty*

func bufferedChannels() {

ch := make(**chan** int, 3)

ch <- 1

ch <- 2

ch <- 3

// Buffer is now full; sending any new messages will block

// Instead let's just consume from the channel

for i := 0; i < 3; i++ {

fmt.Printf(**"Consuming %v from channel\n"**, <-ch)

}

// Buffer is now empty; consuming from channel will block

}

Output:

Consuming 1 from channel

Consuming 2 from channel

Consuming 3 from channel

Exercise Time

Sharks and Their Methods

// Object oriented programming
// Convention: capitalize first letter of public fields

```
type Shark struct {  
    Name string  
    Age int  
}
```

// Declare a public method
// This is called a receiver method

```
func (s *Shark) Bite() {  
    fmt.Printf("%v says CHOMP!\n", s.Name)  
}
```

// Because functions in Go are pass by value
// (as opposed to pass by reference), receiver
// methods generally take in pointers to the
// object instead of the object itself.

```
func (s *Shark) ChangeName(newName string) {  
    s.Name = newName  
}
```

Output:
Bruce says CHOMP!
Lee says your majesty
Sharkira says yo what's up Lee

// Receiver methods can take in other objects as well

```
func (s *Shark) Greet(s2 *Shark) {  
    if (s.Age < s2.Age) {  
        fmt.Printf("%v says your majesty!\n",  
s.Name)  
    } else {  
        fmt.Printf("%v says yo what's up %v!\n",  
s.Name, s2.Name)  
    }  
}
```

```
func sharks() {  
    shark1 := Shark{"Bruce", 32}  
    shark2 := Shark{"Sharkira", 40}  
    shark1.Bite()  
    shark1.ChangeName("Lee")  
    shark1.Greet(&shark2) // pass in pointer  
    shark2.Greet(&shark1)  
}
```