COS418 Precept 1

Go Resources

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

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

Go standard docs: https://pkg.go.dev/

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

```go
// 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()
}
```

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A basic Go program contains

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- ❏ Import other packages
- ❏ Package-level declarations: var, func, const, type

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Variables

```go
// 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)
}
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Variables

Variable Declaration
- General form: *var name type = expression*
  - *var name type* (sans *= expression*) initializes to default value.
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Note: Keep in mind := is a declaration, whereas = is an assignment

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an int
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// 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

```go
// 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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Loops

- In Go, while loops are represented via for loops

```go
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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  - Array: fixed-length, elements of same type

```go
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

}
```

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    - Array: fixed-length, elements of same type
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    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))
}
```

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  - Array: fixed-length, elements of same type
  - Slice: variable-length, elements of same type
  - Map: hash table of key value pairs

```go
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

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  - 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. We can view:
  - 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

```go
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
}
```

Exercise Time

Sharks and Their Methods

```go
// 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
}
```

```go
// 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)
}
```

Go Routines

```go
// 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")
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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

```go
// 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)
    }
}
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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

```go
// 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)
    }
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Output:

Consuming 1 from channel
Consuming 2 from channel
Consuming 3 from channel