Go Get Them

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What are we **GO**ing to talk about?

- Why Go?
- Why Go is better than C
- Unused imports and variables
- Concurrency
- Defer, Panic and Recover
- ; Semicolon
- ++/-- operator
- Compilation
- Function & method calls
- Goto statements
- Types
- OOP
- Inheritance
- Interface
- Duck typing
- Pointers
- Memory allocation
- New vs make
- Garbage collector
- Tidbits

Why Go?

- Fast
  - Revolutionary build time
  - Extensive concurrency support
- Safe
  - Strong-type and memory managed
- Simple
  - i.e. `while` , `foreach` and `for` loops are spelled ‘`for`’
    - `for` loops have between 0 and 2 counters. no counters is a `while`, one counter is a `for`, two counters is a simultaneous `for` and `foreach`
- In short, a better C

Why better than C? – Here’s an example

- What is the meaning in C ?
- `void (*(*f[])())()`

Why better than C? – Here’s an example

- What is the meaning in C ?
- `void (*(*f[])())()`
- Defines `f` as an array of unspecified size of pointers to functions that return pointers to functions that return void

Why better than C? – Here’s an example

- The equivalent in Go is
- `f := [][]func() (func() ){}`

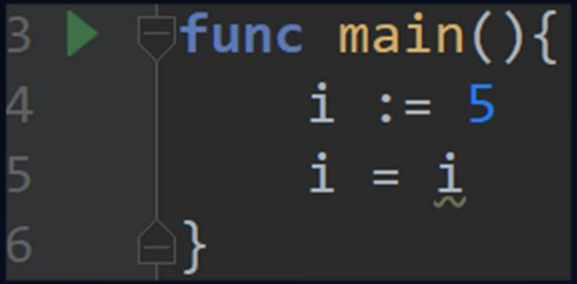
:=	[][]	func()	(func())	{}
Implicit definition and assignment	2d array	function without arguments that returns The next token	function without arguments that returns void	allocation

P.S. c++14 recommended function declaration syntax is similar to Go’s. Coincidence?

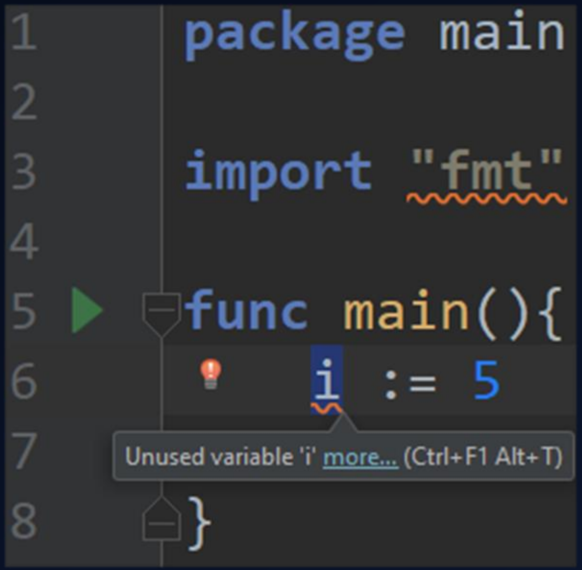
```
auto sunAtois(string s, string t) -> decltype({bool , int}) {…}
```

Unused import & variables

- Go won’t compile your code if there is an unused import or variable
- This restriction accelerates build time
- A way around this restriction is to assign a variable to itself



```
func main(){
        i := 5
        i = i
}
```



```
package main

import "fmt"

func main(){
        i := 5

}
```

Unused variable 'i' more... (Ctrl+F1 Alt+T)

Concurrency

- Its always good for a programming language to have support for concurrency
- In Go, running a function in parallel is as easy as adding the word ‘go’ before a function call. These functions are called routines, and are managed by Go’s scheduler
- Go also supports communication between routines using routes called channels
- This support means that Go is associated with the concurrent programming paradigm

Defer, Panic and Recover

- Defer is a function call that will occur when the program is about to exit
- If there are multiple defer calls, they will be executed in LIFO order
- The main use of defer function is to catch exceptions and release the resources that were being used when the exception occurred

Defer, Panic and Recover

- Panic is the equivalent of throw in C
- Recover is completely different from catch in C
  - It can appear only in a deferred function
  - All the deferred functions will run in LIFO order until a recover command is reached. The recovery section will execute and the program will resume from where the panic occurred

; Semicolon

- *“ semicolons are for parsers, not for developers ”*
- There are no terminating semicolons (;) in Go (in some rare cases there are, but mostly not)
- In reality, semicolons are injected during the build phase to every line that can be the end of a statement
- This forces the use of Java-style code formatting, but makes the code look more pleasant overall

++/-- operator

- Go avoids the confusion caused by the ++ and -- operators by treating them like statements
- In C, they were treated as expressions and so things like “a = a++ + ++a” were possible
- In Go, ++ and -- are always postfix and don't return a value, so they have to appear on their own
- This is much better than Python’s approach, which is to abolish the ++ operator entirely

Compilation

- Thanks to its simple syntax, it’s easy to build a compiler and an intelliSense (code-completion aid) for Go
- GCC standardization
- Optimization on assembly

Function & Method calls

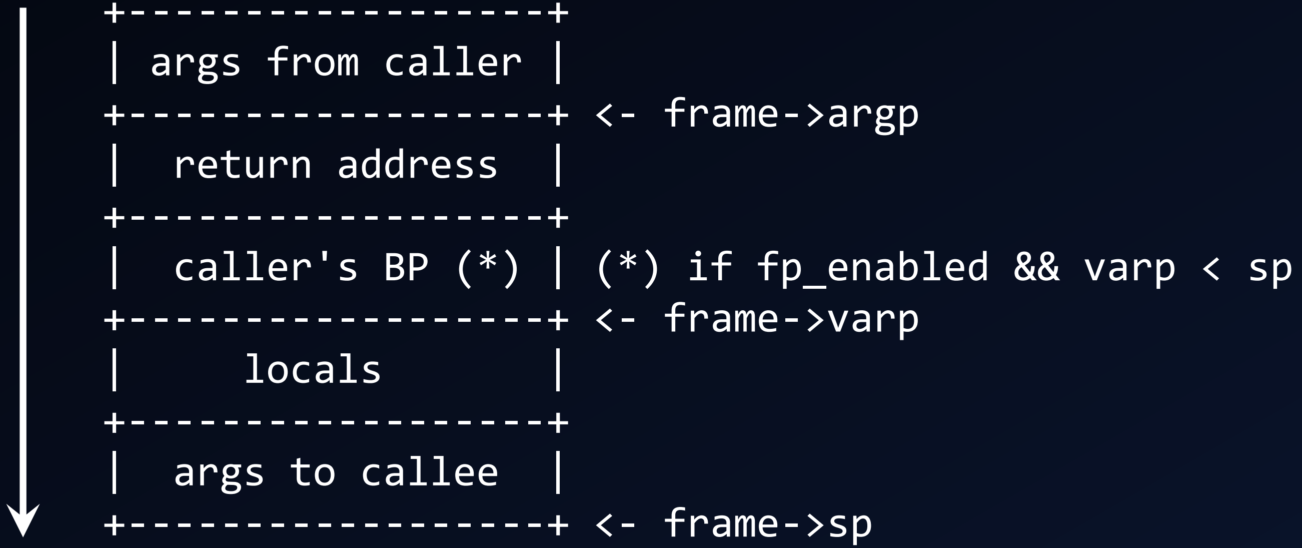
- No default arguments or overloading
  - Ambiguous function calls can’t happen because functions can have only one signature. Overloading isn’t an option
  - Why? Because the developers hate confusing code
- No nested function declaration
  - Anonymous functions are allowed
- Positional arguments
- Variadic support (unlimited passed arguments)
  - Watch me: https://stackoverflow.com/a/35092570
- Functions can return multiple values

Function & Method calls

- Go implements stack-dynamic activation record instances, and its stack frame is built as follows:

source: src/runtime/stack.go

Stack frame layout in x86 architecture



```
+------------------+
| args from caller |
+------------------+ <- frame->argp
|  return address  |
+------------------+
|  caller's BP (*) | (*) if fp_enabled && varp < sp
+------------------+ <- frame->varp
|     locals       |
+------------------+
|  args to callee  |
+------------------+ <- frame->sp
```

Goto

- Goto statements are allowed, but only in the same scope
- Hence, Go’s association with the structured programming paradigm

Types

- Static & Strong
- To avoid confusion and potentially disastrous mistakes, Go does not allow implied casting. all casting must be done explicitly

OOP

- Go is not object oriented
- This makes the objects "feel" lighter, and also allows for more abstract code due to Go's interesting implementation of interfaces

Inheritance

- Go provides two features to replace class inheritance:
- Embedding, which can be viewed as an automated form of composition or delegation
- Interfaces, which provide runtime polymorphism

Interface

- If a function returns an interface type, but that type was not instantiated, it will not be nil
- The type will always have some kind of instance, even if it contains nothing. the only way to return nil from a function is to explicitly return nil

Duck Typing

- Go doesn’t support duck typing
- Interfaces in Go take the form of "duck typing"
- If the object implements the functions of an interface, it can be referred to as that interface
- This means that every data-type implements the blank interface: `interface{}`

Pointers

- Pointers in Go are very similar to their C counterparts, but very different in several ways:
  - There is no pointer arithmetic. You can’t change the address a pointer points to, except to assign a new address to it.
  - In C, pointers and arrays are essentially the same thing. In Go, arrays are values, and the lack of pointer arithmetic makes pointers to arrays very limited.
  - In C, often a null pointer is used to signify that something went wrong in a function. In Go, it is possible to return multiple values, so there is no need for a null pointer to signify errors.

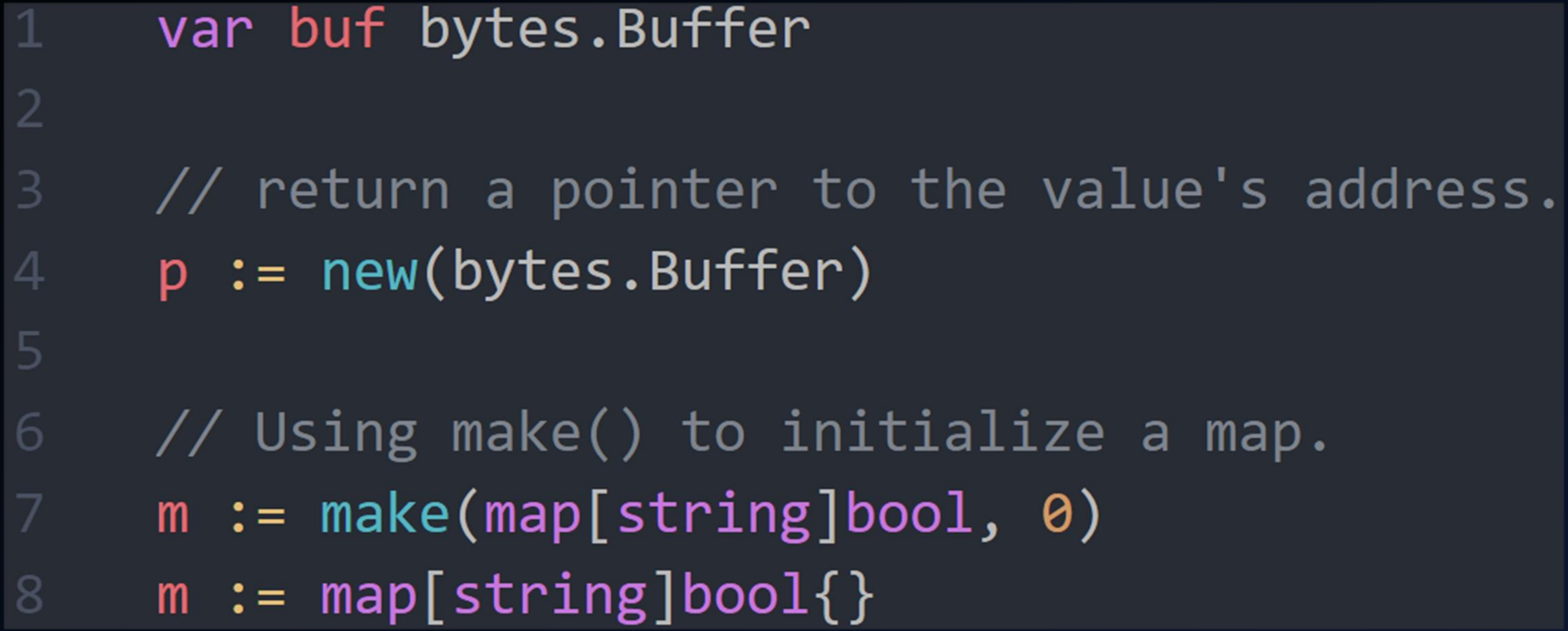
Memory Allocation

- Dynamic variables are allocated on the heap
- Static variables are allocated on the stack
  - If they aren’t too big
  - Big variables are allocated on the heap and are managed by the garbage collector

new vs make

- The `new(T)` function allocates zeroized storage for a new item of type T and returns its address, a value of type *T
- In Go terminology, it returns a pointer to a newly allocated zero value of type T
- The `make()` function, on the other hand, is a special built-in function that is used to initialize slices, maps, and channels
- `make()` can only be used to initialize, and that, unlike the `new()` function, does not return a pointer

new vs make



```go
var buf bytes.Buffer

// return a pointer to the value's address.
p := new(bytes.Buffer)

// Using make() to initialize a map.
m := make(map[string]bool, 0)
m := map[string]bool{}
```

Garbage Collector

- Go's garbage collector uses Dijkstra’s tri-color mark & sweep algorithm
- The collector starts at the roots (globals) and works its way toward the leaves (last in the reference chain)
- A write barrier runs in parallel, and watches for new allocations that connect to pointers on the heap, in case they occur during the mark phase
- Although this process is concurrent, there is a very short "Stop The World" phase to cover pointers on the stack.
  - usually under μ100 seconds, often around μ10 seconds

Tidbits

- Today, Go’s compiler is written in Go
  - The very first Go compiler was written in C
- The developers hate functional-programming.
  - even “ `(cond)? s1 : s2` ”
- Support for imports directly from GitHub repositories
- Mostly, `if-else-if`… is translated to `switch-case` during compilation

Questions?