COMP-520 – GoLite project

Vincent Foley-Bourgon

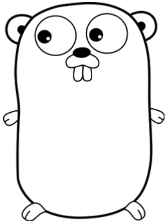
Sable Lab
McGill University

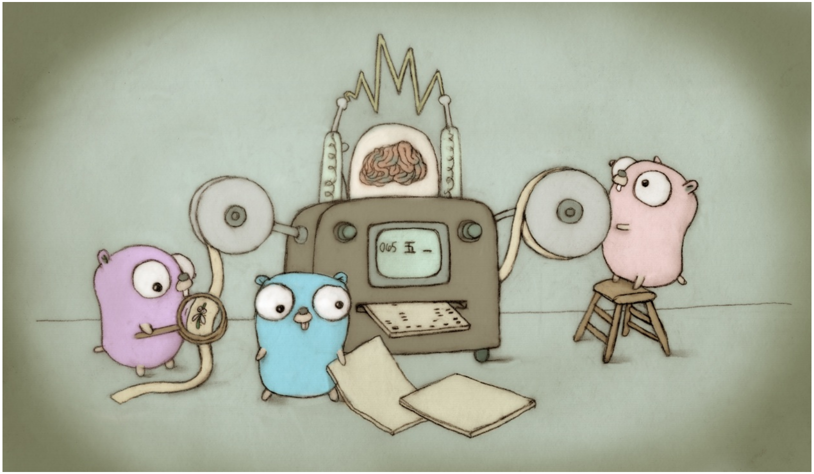
Winter 2019

Agenda

- Overview of Go
- Why Go for a compiler class?
- GoLite

Feel free to ask questions at any time.





Renee French, licensed under CC 3.0 Attributions

Go

- Created by Rob Pike, Ken Thompson and Robert Griesemer
- Google employees
- Not a Google project like Gmail; open source
- Initial release in 2009
- 1.0 release in 2012

Motivation

- Simplify development

Motivation

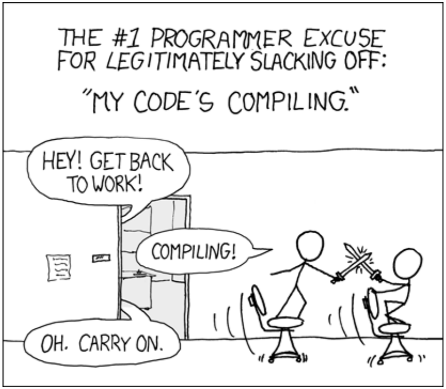
- Simplify development
  `class AbstractSingletonProxyFactoryBean { ... }`

Motivation

- Simplify development
  `class AbstractSingletonProxyFactoryBean { ... }`
- Built-in concurrency support

Motivation

- Simplify development
  `class AbstractSingletonProxyFactoryBean { ... }`
- Built-in concurrency support
- Faster compilation



Features

- Imperative
- Goroutines and channels
- Interfaces and methods
- Closures
- `defer`
- Maps and slices
- Multiple return values
- Module system
- Garbage collection
- Optional semi-colons (tricky scanner!)

Notable missing features

- User-defined parametrized types (source of 95% of all Go arguments online)
- Exceptions
- Classes and inheritance
- Operator overloading

Example Go program

```
package main

import "fmt"

func fib(n int) int {
  a, b := 0, 1
  for i := 0; i < n; i++ {
    a, b = b, a+b
  }
  return a
}

func main() {
  var f int = fib(42)
  fmt.Println(f)
}
```

Who uses Go?

- Google
- Github
- Bitbucket
- CloudFlare
- Dropbox
- New York Times
- Many others [1]

Extremely quick adoption!

[1] `https://github.com/golang/go/wiki/GoUsers`

Who uses Go?

The authors expected Java and C++ programmers to be the primary Go audience.

In actual fact, Go is more popular with Python, Ruby and other dynamically typed languages programmers.

Why?

Who uses Go?

The authors expected Java and C++ programmers to be the primary Go audience.

In actual fact, Go is more popular with Python, Ruby and other dynamically typed languages programmers.

Why?

- Better performance
- Static typing
- Good concurrency support
- Good libraries and tools
- Can deploy a single binary file

Useful addresses

- `http://golang.org`
- `http://play.golang.org`
- `http://golang.org/ref/spec`

Why Go for a compiler class?

Why use Go for a compiler class?

Useful and popular

It is more fun to write a compiler for a language that is alive and kicking than for a made-up language (minilang) or for a dead language (Pascal).

Writing a compiler forces you to really learn the language, a nice addition on your C.V.!

Why use Go for a compiler class?
Simple language

Go is simpler than a lot of other popular languages such as Java or C++.

Go is surprisingly quick to learn.

Not nearly as tricky as MATLAB, JavaScript or PHP.

Why use Go for a compiler class?

Detailed online specification

You can find pretty much everything you need to know about Go on a single page: `http://golang.org/ref/spec`

The syntax is described in EBNF notation.
(Warning! Ambiguous!)

Less specification work for the T.A. ;-)

Why use Go for a compiler class?

Encompasses all the classical compiler phases

The things you learn in class and from reading the textbook apply to writing a Go compiler. It doesn't have specialized phases like pre-processing or macro expansion.

Why use Go for a compiler class?

Go is open source

Parser used to be written with bison (now hand-written)

The old sources of the parser can be found on Github (e.g. 1.2 release tag)

You can look, **do not copy/paste!**

Why use Go for a compiler class?

Your work is publishable!

Not only will you learn some Go for this class, but you can publish the complete compiler on GitHub after the class and include it on your C.V.!

Why use Go for a compiler class?

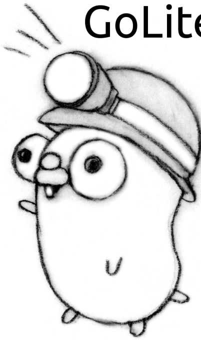
Your work is publishable!

Not only will you learn some Go for this class, but you can publish the complete compiler on GitHub after the class and include it on your C.V.!

Note: We know that previous year's submissions are available online. We have 2 requirements for this class:

1. *You must come up with your own solutions; any inspiration that comes from other sources must be reported.*
2. *No grading material may be used at any point, under any circumstance, nor may it be published.*

GoLite



Features

- Imperative
- Goroutines and channels
- Interfaces and methods
- Closures
- `defer`
- Maps and slices
- Multiple return values
- Module system
- Garbage collection
- Optional semi-colons

Features

- Imperative
- ~~Goroutines and channels~~
- ~~Interfaces and methods~~
- ~~Closures~~
- ~~`defer`~~
- ~~Maps~~ and slices
- ~~Multiple return values~~
- ~~Module system~~
- ~~Garbage collection~~
- Optional semi-colons

Is this still Go?

- You have a few weeks to build the compiler (took 2 years before first Go release)
- It still is a lot of work (likely more than you ever put in a class)
- You can add more features when the course is finished :)

Lexical syntax

	Go	GoLite
Encoding	UTF-8	ASCII
Number precision	Arbitrary	Fixed
Integers	255, 0377, 0xff	255, 0377, 0xff
Floats	0.12, .12, 12.	0.12, .12, 12.
Imaginary	3i	No thanks
Strings	“Chrono\n”	“Marle\n”
Raw strings	‘Lucca\n‘	‘Ayla\n‘
Keywords	Bunch of ’em	Slighlty more
Line comments	// Sabin	// Edgar
Block comments	/* Celes */	/* Locke */
Semicolons	Optional	Optional

Basic types

int
float64
bool
rune (char)
string
uint8
uint16
uint32
uint64
int8
int16
int32
int64
float32
complex64
complex128
byte

General structure

```
// Go structure

// package declaration

// import statements

// vars, consts, types, functions
```

General structure

```
// GoLite structure

// package declaration


// vars, types, functions
```

Declarations

In Go, top-level declarations can be in any order

In GoLite, declarations must come before their first use

```
// Valid in Go; invalid in GoLite
var x int = max(y, 32)
var y = 42

func max(a, b int) int {
  if a > b {
    return a
  } else {
    return b
  }
}
```

Variable declarations

```
var x1, x2 int          // implicitly initialized to 0
var y int = 12
var z = 24
```

Variable declarations

```
var x1, x2 int        // implicitly initialized to 0
var y int = 12
var z = 24
```

```
var (
        x1, x2 int
        y int = 12
        z = 24
)
```

GoLite should support all of these.

Constant declarations

GoLite won’t support constant declarations.

Type declarations

```
type natural int
type real float64

type (
        point struct {
                x, y, z real
        }
)
```

Function declarations

```
// Allowed in GoLite
func f(a int, b int) int {
  ...
}

// Allowed in GoLite
func f(a, b int) int {
  ...
}

// Not allowed in GoLite
func f(int, int) int {
  ...
}
```

- GoLite functions should always have a body.
- We'll allow zero or one return value.

Statements

Declarations

- Variables and types can be declared within functions.
- Short variable declaration allowed within functions.

```
func demo() {
  type number int
  var x int = 12

  best_ff := 6
}
```

Statements

Loops

- All loops use the `for` keyword
- No parentheses, mandatory braces
- GoLite should not support *for/range* loops

```
// Infinite loop
for {
  ...
}

// ``While'' loop
for x < 10 {
  ...
}

// ``For'' loop
for i := 0; i < 10; i++ {
  ...
}
```

Statements

Loops

We'll support unlabelled `break` and `continue` in loops

Statements

If

- No parentheses, mandatory braces

```
if x == 0 {
  ...
}

if x < 0 {
  ...
} else {
  ...
}

if x < 0 {
  ...
} else if x > 0 {
  ...
} else {
  ...
}
```

Statements
Switch

- Allows expressions in cases
- No explicit `break` (although it may be used)

```
switch x {
  case 0, 1, 2: println("Small")
  default: println("Other")
}

switch {    // Same as switch true
  case x < 0: println("Negative")
  case x > 0: println("Positive")
  default: println("Zero")
}
```

Expressions

Literals	`42, 3.14, "Go", 'H'`
Identifiers	`x, my_dog, Alakazou`
Unary expressions	`!x, +y, -(a*b), ^0`
Binary expressions	`a || b, 3 + x, 1 << 12`
Function calls	`fib(42), max(0, 1)`
Casts	`int(3.4), mytype(x)`
Indexing	`slice[0], point.x`

Built-ins

In Go:

- Look like function calls
- Not reserved keywords
- Can accept a type as a first parameter (`make([]int, 4)`)
- Can be polymorphic (`append()`)

Real tricky to parse function calls, casts and builtins nicely

Built-ins

In GoLite:

- Reserved keywords to make parsing easier
- Only a subset (`print, println, append, len, cap`)
- Limited functionality

References

- Go presentation: `http://www.youtube.com/watch?v=rKnDgT73v8s`
- Gopher: `http://golang.org/doc/gopher/frontpage.png`
- Gopher + helmet: `http://golang.org/doc/gopher/pencil/gopherhelmet.jpg`
- Xkcd, compiling: `http://xkcd.com/303/`

Advice

- This is a project that takes a lot of time: start milestones early!
- Pick an implementation language that you know well enough to not get painted into a corner.
- Be careful with your AST design, it's extremely important.
- Don't be afraid of asking questions and using the Facebook group.

Gophers!

Thanks Google :)