Golang Programming

Modules and dependency management using go mod

Where to Find The Code and Materials?

https://github.com/iproduct/coursego

Agenda for This Session

- Modules in Go
- go.mod file
- Version selection
- Semantic import versioning
- Installing and activating module support
- Defining a module
- Upgrading and downgrading dependencies
- Main go mod commands
- Daily workflow.
- Hands-on: RESTful service using gorilla/mux, go-playground/validator.v10, jwt-go, and MySQL (go-sql-driver/mysql)
- Projects mentoring.

Modules in Go

Modules in Go

- Go projects use a wide variety of dependency management strategies:
  - Some projects store their entire GOPATH directory in a single Git repository.
  - Others simply rely on go get and expect fairly recent versions of dependencies to be installed in GOPATH.
  - Vendoring tools such as **dep**, **godep**, **govendor**, and **glide** are popular, but they have wide differences in behavior and don't always work well together.
- **Go's module system**, introduced in Go 1.11, provides an official dependency management solution built into the **go** command.

Go Code Organization (1)

- Go programs are organized into packages - collection of source files in the same directory that are compiled together.
- A repository contains one or more modules
- A module is a collection of related Go packages that are released together.
- Go repository typically contains only one module, located at the root of the repository. A file named **go.mod** there declares the **module path**: the import path prefix for all packages within the module.
- The module contains the packages in the directory containing its **go.mod** file as well as subdirectories of that directory, up to the next subdirectory containing another go.mod file (if any).

Go Code Organization (2)

- You don't need to publish your code to a remote repository. A module can be defined locally without belonging to a repository. However, it's a good habit to organize your code as if you will publish it someday.
- Each module's path not only serves as an import path prefix for its packages, but also indicates where the go command should look to download it. For example, in order to download the module golang.org/x/tools, the go command would consult the repository indicated by https://golang.org/x/tools.
- A package's import path is its module path joined with its subdirectory within the module. E.g. the module github.com/google/go-cmp contains a package in the directory cmp/. That package's import path is github.com/google/go-cmp/cmp. Packages in the standard library do not have a module path prefix.

go.mod file

```
module github.com/iproduct/coursego/modules

go 1.13

require (
	github.com/dgrijalva/jwt-go v3.2.0+incompatible
	github.com/go-playground/locales v0.13.0
	github.com/go-playground/universal-translator v0.17.0
	github.com/go-playground/validator/v10 v10.1.0
	github.com/go-sql-driver/mysql v1.5.0
	github.com/gorilla/mux v1.7.3
	golang.org/x/crypto v0.0.0-20200208060501-ecb85df21340
)
```

go.sum file

```
github.com/leodido/go-urn v1.2.0 h1:hpXL4XnriNwQ/ABnpepYM/1vCLWNDfUNts8dX3xTG6Y=
github.com/leodido/go-urn v1.2.0/go.mod h1:+8+nEpDfqqsY+g338gtMEUOtuK+4dEMhiQEgxpxOKII=
github.com/pmezard/go-difflib v1.0.0 h1:4DBwDE0NGyQoBHbLQYPwSUPoCMWR5BEzIk/f1lZbAQM=
github.com/pmezard/go-difflib v1.0.0/go.mod h1:iKH77koFhYxTK1pcRnkKkqfTogsbg7gZNVY4sRDYZ/4=
github.com/stretchr/objx v0.1.0/go.mod h1:HFkY916IF+rwdDfMAkV7OtwuqBVzrE8GR6GFx+wExME=
github.com/stretchr/testify v1.4.0 h1:2E4SXV/wtOkTonXsotYi4li6zVWxYlZuYNCXe9XRJyk=
github.com/stretchr/testify v1.4.0/go.mod h1:j7eGeouHqKxXV5pUuKE4zz7dFj8WfuZ+81PSLYec5m4=
golang.org/x/crypto v0.0.0-20190308221718-c2843e01d9a2/go.mod h1:djNgcEr1/C05ACkg1iLfiJU5Ep61QUkGW8qpdssI0+w=
golang.org/x/crypto v0.0.0-20200208060501-ecb85df21340 h1:KOcEaR10tFr7gdJV2GCKw8Os5yED1u1aOqHjOAb6d2Y=
golang.org/x/crypto v0.0.0-20200208060501-ecb85df21340/go.mod h1:LzIPMQfyMNhhGPhUkYOs5KpL4U8rLKemX1yGLhDgUto=
golang.org/x/net v0.0.0-20190404232315-eb5bcb51f2a3/go.mod h1:t9HGtf8HONx5eT2rtn7q6eTqICYqUVnKs3thJo3Qplg=
golang.org/x/sys v0.0.0-20190215142949-d0b11bdaac8a/go.mod h1:STP8DvDyc/dI5b8T5hshtkjS+E42TnysNCUPdjciGhY=
golang.org/x/sys v0.0.0-20190412213103-97732733099d/go.mod h1:h1NjWce9XRLGQEsW7wpKNCjG9DtNlClVuFLEZdDNbEs=
golang.org/x/text v0.3.0/go.mod h1:NqM8EUOU14njkJ3fqMW+pc6Ldnwhi/IjpwHt7yyuwOQ=
golang.org/x/text v0.3.2/go.mod h1:bEr9sfX3Q8Zfm5fL9x+3itogRgK3+ptLWKqgva+5dAk=
golang.org/x/tools v0.0.0-20180917221912-90fa682c2a6e/go.mod h1:n7NCudcB/nEzxVGmLbDWY5pfWTLqBcC2KZ6jyYvM4mQ=
gopkg.in/check.v1 v0.0.0-20161208181325-20d25e280405 h1:yhCVgyC4o1eVCa2tZl7eS0r+SDo693bJlVdllGtEeKM=
gopkg.in/check.v1 v0.0.0-20161208181325-20d25e280405/go.mod h1:Co6ibVJAznAaIkqp8huTwlJQCZ016jof/cbN4VW5Yz0=
gopkg.in/yaml.v2 v2.2.2 h1:ZCJp+EgiOT7lHqUV2J862kp8Qj64Jo6az82+3Td9dZw=
gopkg.in/yaml.v2 v2.2.2/go.mod h1:hI93XBmqTisBFMUTm0b8Fm+jr3Dg1NNxqwp+5A1VGuI=
```

go.mod file

- Module version is defined by source files tree, with a **go.mod** file in its root.
- When the **go** command is run, it looks in the current directory and then successive parent directories to find the **go.mod** marking the root of the main (current) module.
- The go.mod file itself is line-oriented, with // comments but no /* */ comments. Each line holds a single directive, made up of a verb followed by arguments. For example:

```
module my/thing
go 1.15
require other/thing v1.0.2
require new/thing/v2 v2.3.4
exclude old/thing v1.2.3
replace bad/thing v1.4.5 => good/thing v1.4.5
```

Verbs in go.mod

- **module**, to define the module path;
- **go**, to set the expected language version;
- **require**, to require a particular module at a given version or later;
- **exclude**, to exclude a particular module version from use; and
- **replace**, to replace a module version with a different module version.

Sematic Versioning – e.g. **v1.2.3**

- **Major Versions** - All the versions within a particular major version should be backwards compatible with other minor and patch versions. Incrementing this typically tells other developers using your package that you have made some breaking changes to how your package works.

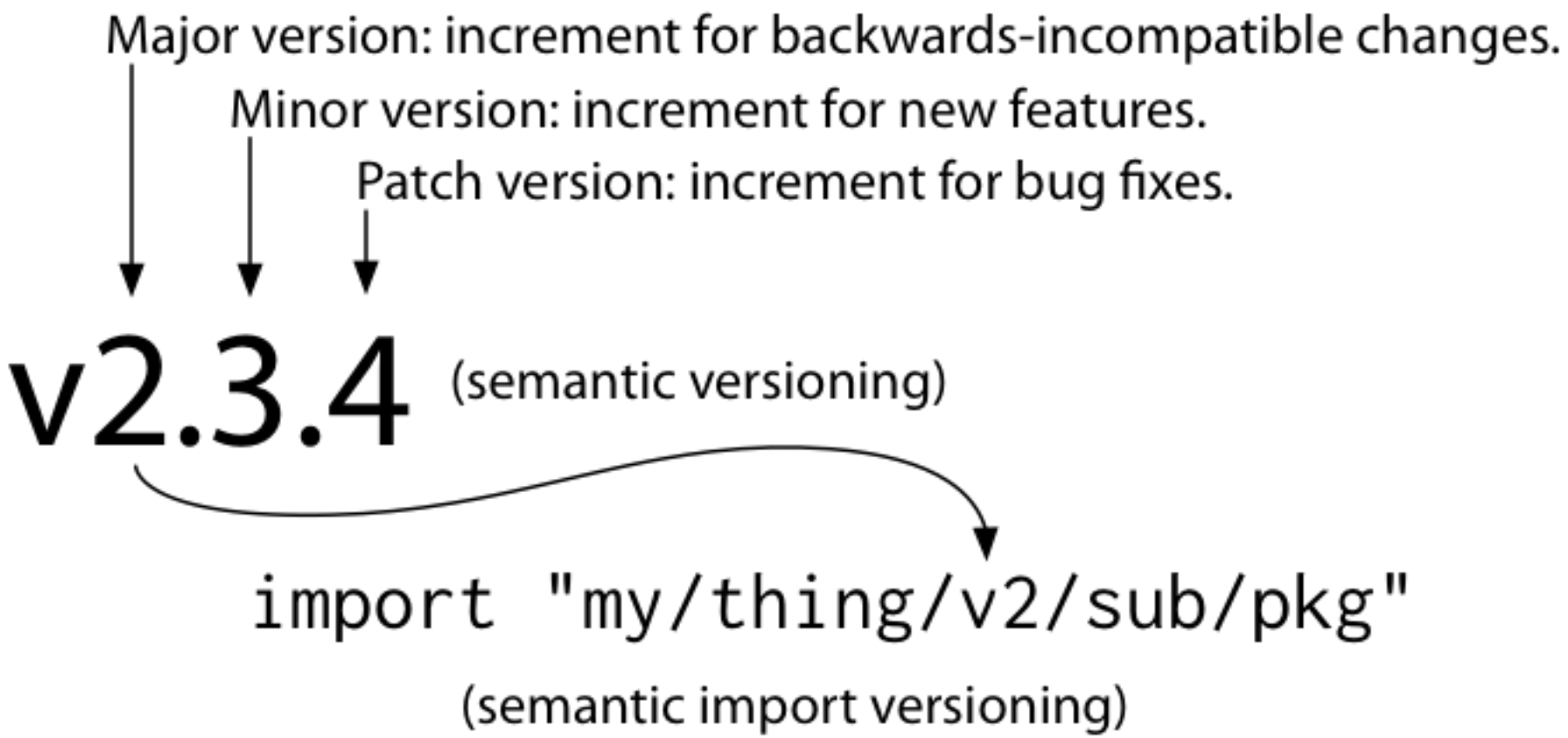
- **Minor Versions** - Developers tend to increment minor versions of their package or application when they have added new functionality, or new features to the package whilst maintaining backwards compatibility within the rest of the application.

- **Patch Versions** - Patch versions are typically used for general bug-fixes. If a developer notices a slight issue or bug within their application, they can fix the issue whilst again ensuring backwards compatibility and then increment the patch version by one to indicate new bug fixes.

Import Compatibility Rule in Go

If an old package and a new package have the **same import path**, the new package must be backwards compatible with the old package.

Version selection – Sematic Import Versioning



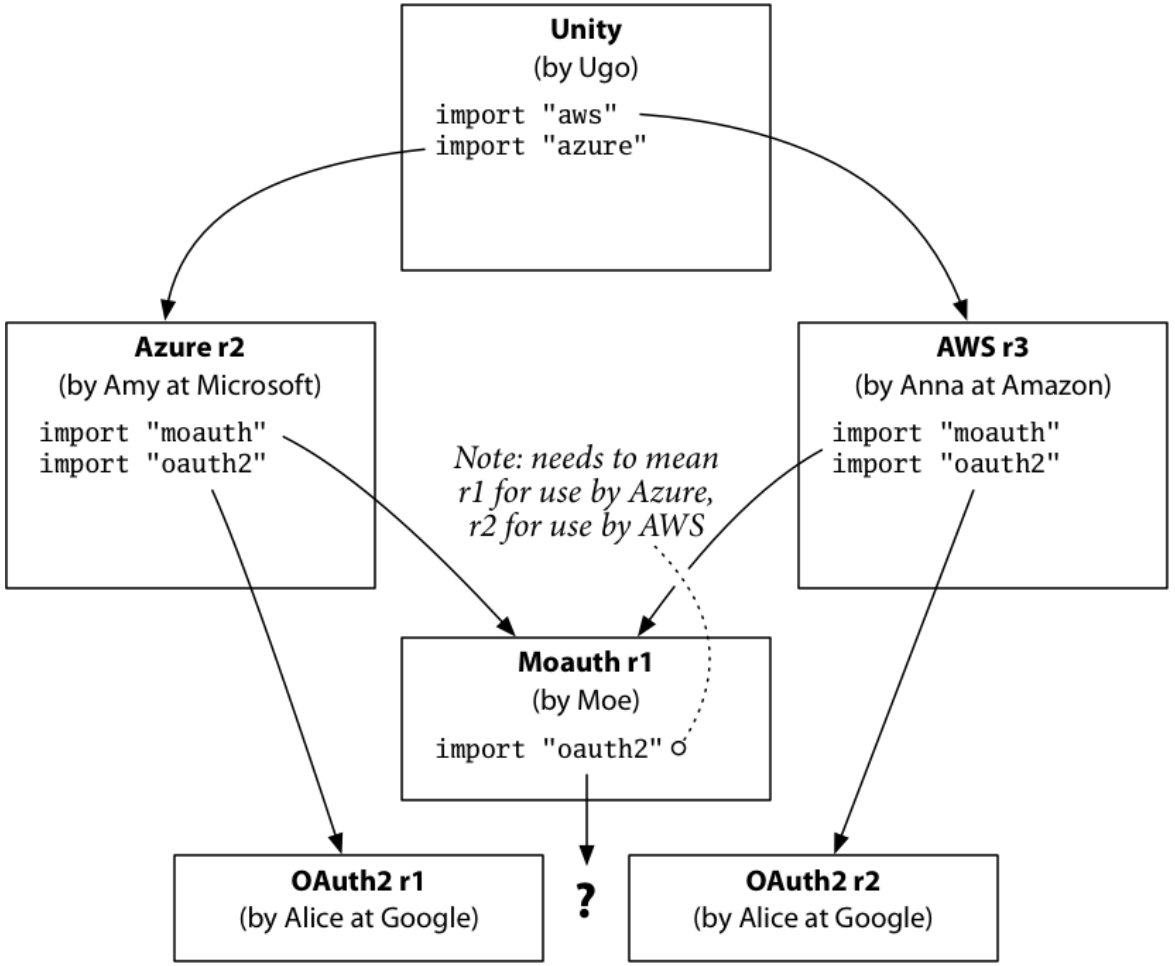
Semantic import versioning (1)

https://research.swtch.com/vgo-import

- A module **my/thing** is imported as:
- **my/thing** for **v0** – the incompatibility period when breaking changes are expected and not protected against
- **my/thing** during **v1** – the first stable major version
- **my/thing/v2** for **v2** – we give it a new name, instead of redefining the meaning of the now-stable my/thing.

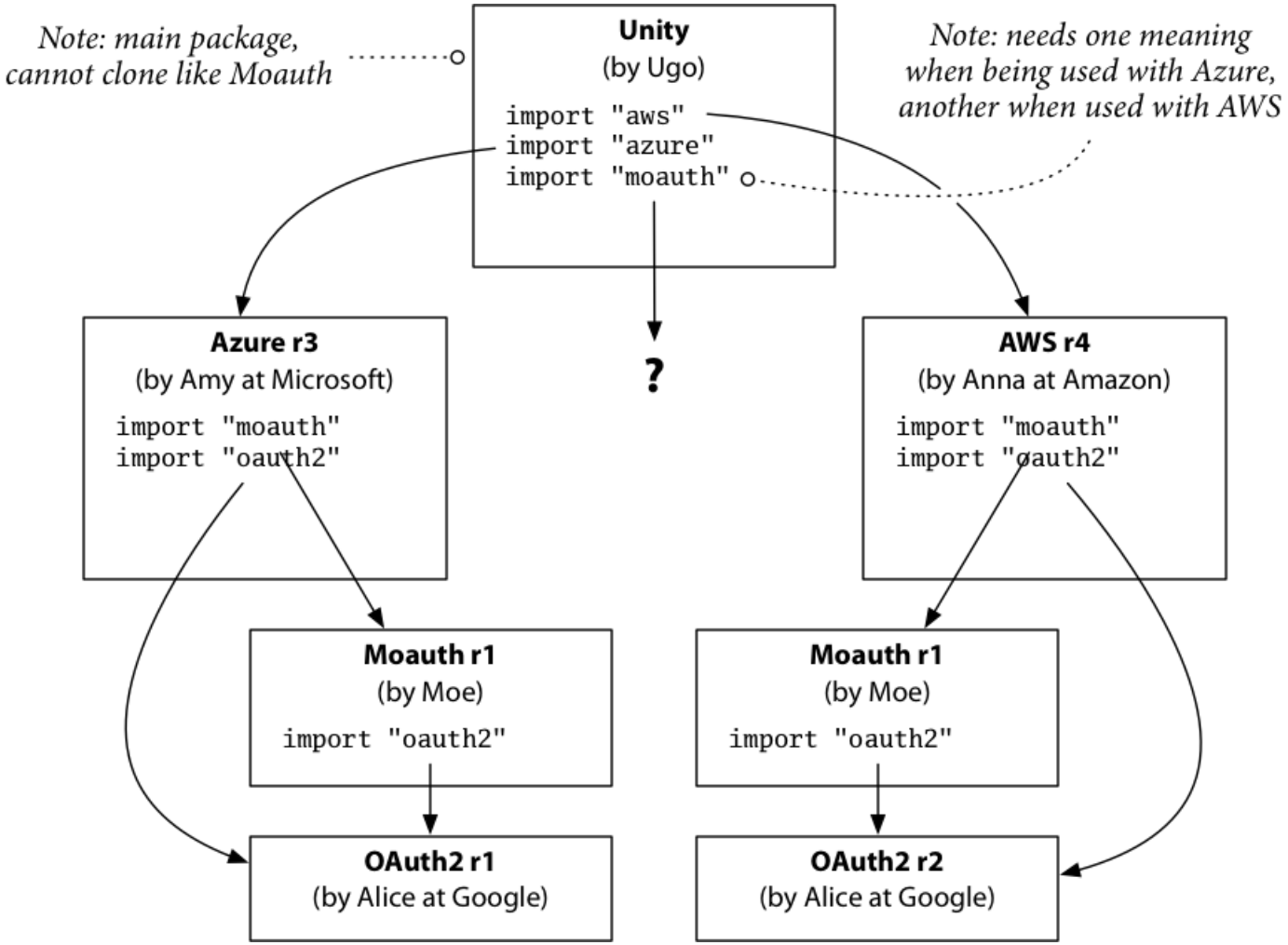
Semantic import versioning (2)

https://research.swtch.com/vgo-import



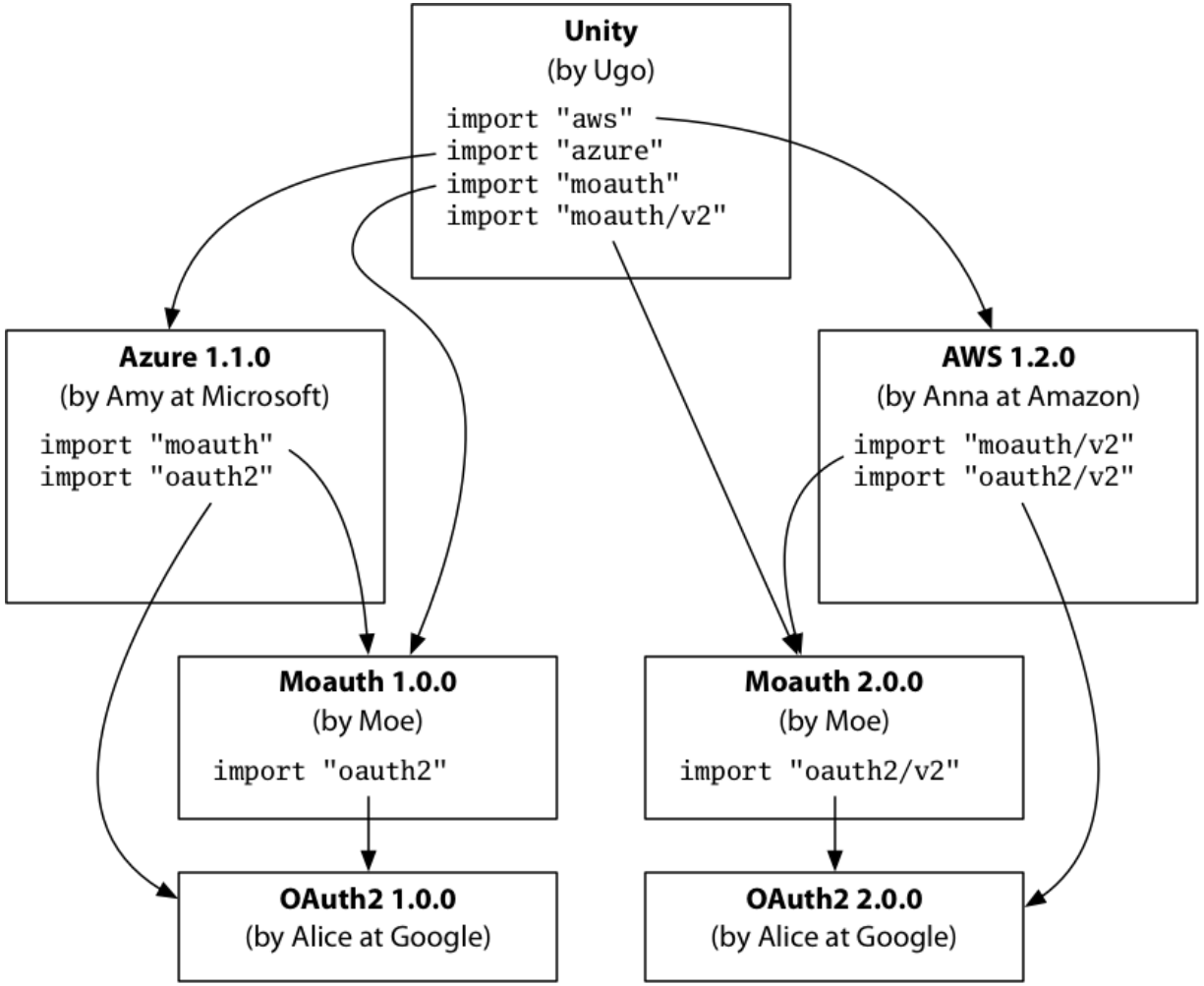
Semantic import versioning (3)

https://research.swtch.com/vgo-import



Semantic import versioning (4)

https://research.swtch.com/vgo-import



go.mod file versions

```
module M

        require (
                A v1
                B v1.0.0
                C v1.0.0
                D v1.2.3
                E dev
        )

        exclude D v1.2.3
```

Installing and activating module support

- Go in some directory outside of GOPATH (e.g. home directory) and create a folder for our app called **module-demo** and set up my app there (instead of inside GOPATH we did before). Cache is in **$GOPATH/pkg/mod**

- Add dependency – e.g.:

```
package main
import (
	"fmt"
	"github.com/Pallinder/go-randomdata"
)
func main(){
	fmt.Println("Running the TestApp")
	fmt.Println(randomdata.SillyName())
}
```

- `go mod init /root/TestApp` → creates go.mod file
- `go mod tidy` → fetches and cleans-up the dependencies

More go commands using module graph

- Because the module graph defines the meaning of import statements, any commands that load packages also use and therefore update **go.mod**, including:

- go build
- go get
- go install
- go list
- go verify
- go test
- go mod graph,
- go mod tidy,
- go mod why

- Examples: `go mod why -m <module>`, `go mod vendor`, `go list -m all`, `go list -f='{{.Dir}}' -m all` – lists module directories

Upgrading and downgrading dependencies

```
$ go get golang.org/x/text
go: golang.org/x/text upgrade => v0.3.5
go: downloading golang.org/x/text v0.3.5
$ go test
PASS
ok      example.com/hello    0.013s
$
```

- The **golang.org/x/text** package has been upgraded to the latest tagged version (v0.3.5).
- The **go.mod** file has been updated to specify v0.3.5 too.
- The indirect comment indicates a dependency is not used directly by this module, only indirectly by other module dependencies.
- See **go help modules** for details.

Most used go mod commands

- **go mod init** – creates a new module, initializing the go.mod file that describes it.
- **go build** – go test, and other package-building commands add new dependencies to go.mod as needed.
- **go list -m all** – prints the current module's dependencies.
- **go get** – changes the required version of a dependency (or adds a new dependency).
- **go mod tidy** – removes unused dependencies.

Hands-on: RESTful Service with Modules, TDD, Persistence, Validation & Security

- Projects @Github:
  - https://github.com/iproduct/coursego/tree/master/modules-lab
  - https://github.com/iproduct/coursego/tree/master/modules-auth
- Used modules:
  - gorilla/mux
  - go-playground/validator.v10
  - jwt-go
  - MySQL: go-sql-driver/mysql

gorilla/mux

- It implements the http.Handler interface so it is compatible with the standard http.ServeMux.
- Requests can be matched based on URL host, path, path prefix, schemes, header and query values, HTTP methods or using custom matchers.
- URL hosts, paths and query values can have variables with an optional regular expression.
- Registered URLs can be built, or "reversed", which helps maintaining references to resources.
- Routes can be used as subrouters: nested routes are only tested if the parent route matches. This is useful to define groups of routes that share common conditions like a host, a path prefix or other repeated attributes. As a bonus, this optimizes request matching.

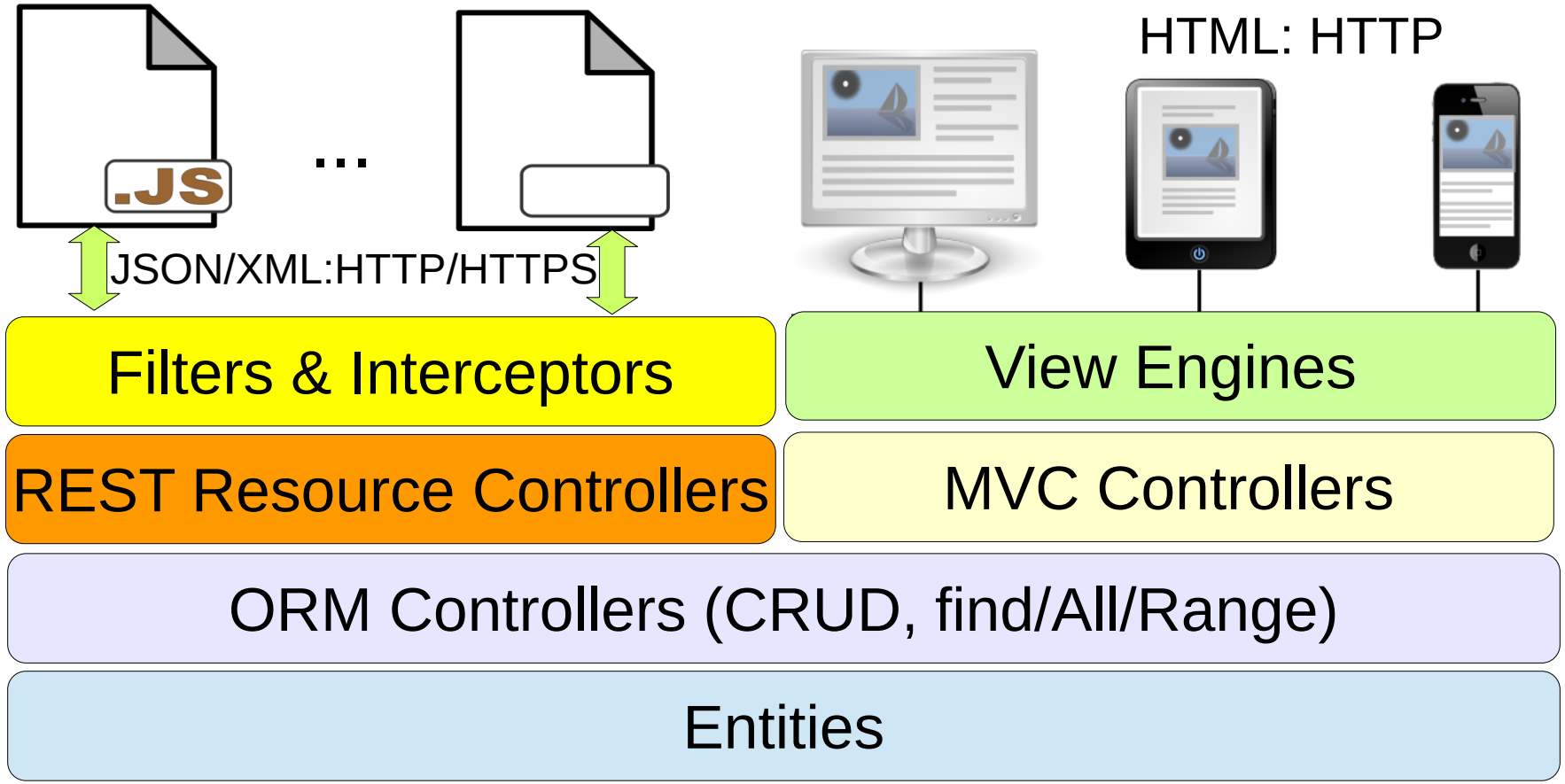
gorilla/mux routing example:

```
func main() {
        r := mux.NewRouter()
        r.HandleFunc("/products/{key}", ProductHandler)
        r.HandleFunc("/products", ProductsHandler2).
                Host("www.example.com").
                Methods("GET").
                Schemes("http")
        r.HandleFunc("/articles/{category}/", ArticlesCategoryHandler)
        r.HandleFunc("/articles/{category}/", ArticlesCategoryPostHandler).
                Methods(http.MethodPost)
        r.HandleFunc("/articles/{category}/{id:[0-9]+}", ArticleHandler)
        r.PathPrefix("/").Handler(catchAllHandler)
        http.Handle("/", r)
}
```

Web Service Architectures

Coping with the Complexity – Domain Driven Design

N-Tier Web Architectures



Domain Driven Design (DDD)

We need tools to cope with the complexity inherent in most real-world design problems.

Simple solutions are needed – cope with problems through divide and concur on different levels of abstraction:

Domain Driven Design (DDD) – back to basics: domain objects, data and logic.

Described by Eric Evans in his book:
Domain Driven Design: Tackling Complexity in the Heart of Software, 2004

Domain Driven Design (DDD)

Main concepts:

- Entities, value objects and modules
- Aggregates and Aggregate Roots [Haywood]:
  value < entity < aggregate < module < BC
- Repositories, Factories and Services:
  application services <-> **domain services**
- Separating interface from implementation

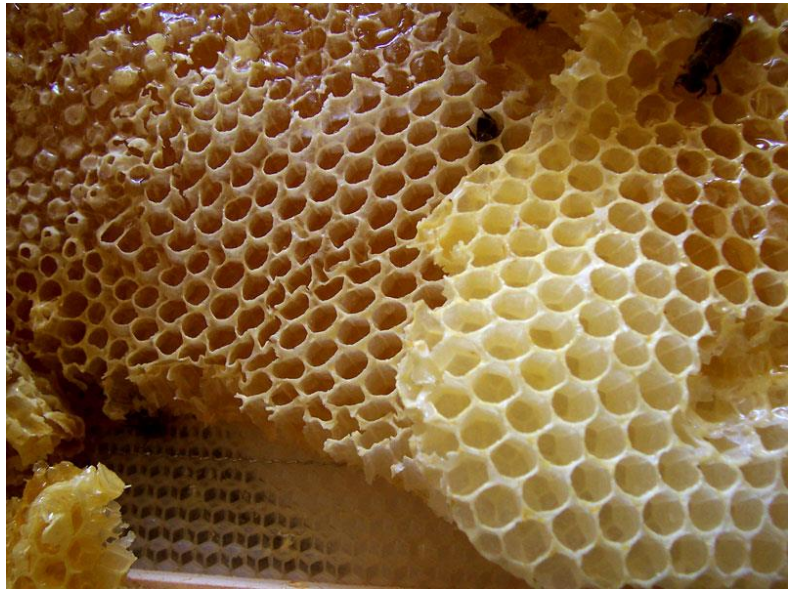
Domain Driven Design (DDD) & Microservices

- Ubiquitous language and Bounded Contexts
- DDD Application Layers:
- Infrastructure, Domain, Application, Presentation
- Hexagonal architecture :

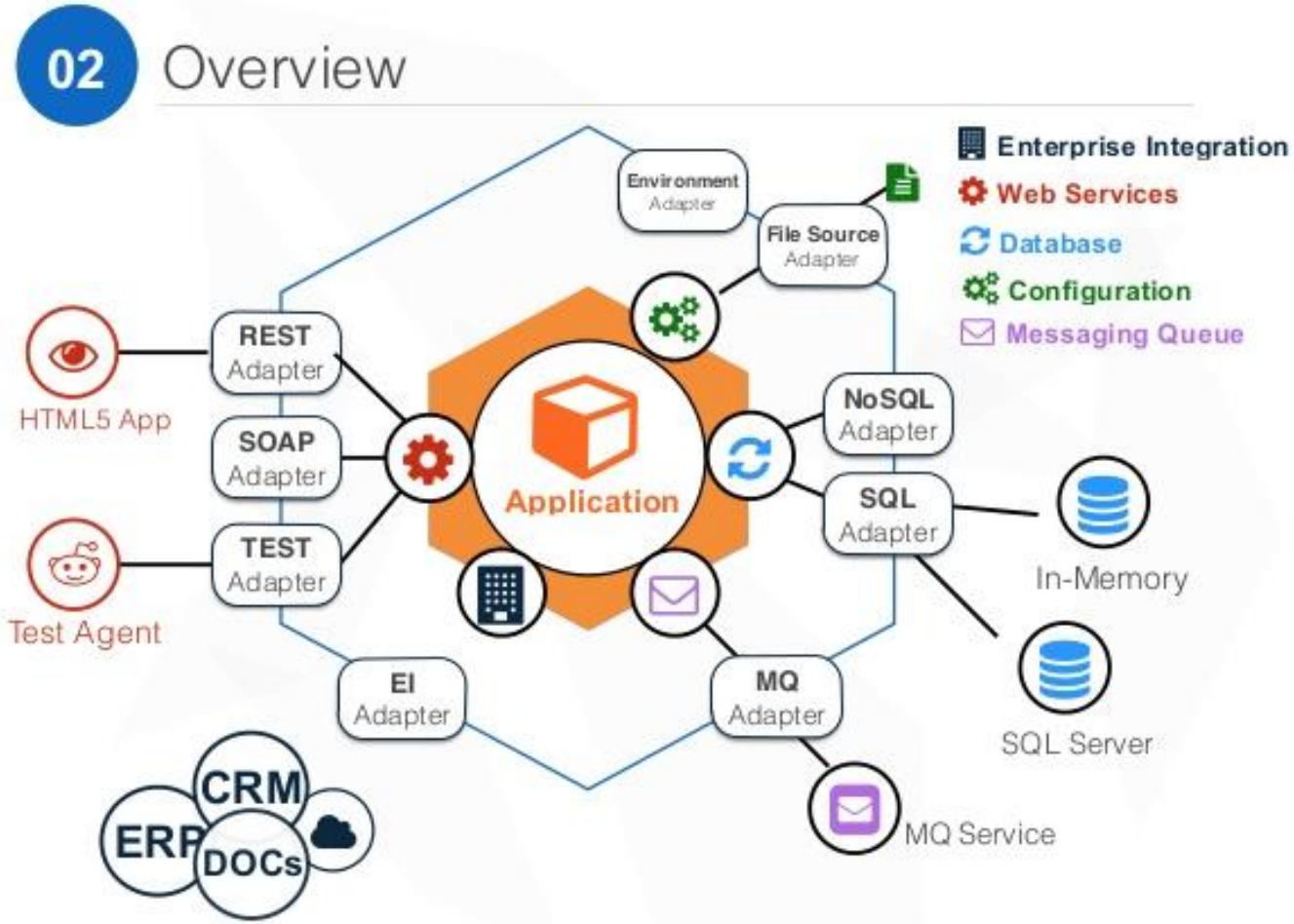
  OUTSIDE <-> transformer <->

  (application <-> domain)

  [A. Cockburn]



Hexagonal Architecture



Source: https://www.slideshare.net/fabricioepa/hexagonal-architecture-for-java-applications

Hexagonal Architecture Design Principles

- Allows an application to equally be driven by users, programs, automated test or batch scripts, and to be developed and tested in isolation from its eventual run-time devices and databases.
- As events arrive from the outside world at a port, a technology-specific adapter converts it into a procedure call or message and passes it to the application
- Application sends messages through ports to adapters, which signal data to the receiver (human or automated)
- The application has a semantically sound interaction with all the adapters, without actually knowing the nature of the things on the other side of the adapters

Source: http://alistair.cockburn.us/Hexagonal+architecture

Recommended Literature

- The Go Documentation - https://golang.org/doc/
- The Go Bible: Effective Go - https://golang.org/doc/effective_go.html
- David Chisnall, *The Go Programming Language Phrasebook*, Addison Wesley, 2012
- Alan A. A. Donovan, Brian W. Kernighan, *The Go Programming Language*, Addison Wesley, 2016
- Nathan Youngman, Roger Peppé, *Get Programming with Go*, Manning, 2018
- Naren Yellavula, *Building RESTful Web Services with Go*, Packt, 2017

Thank's for Your Attention!

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