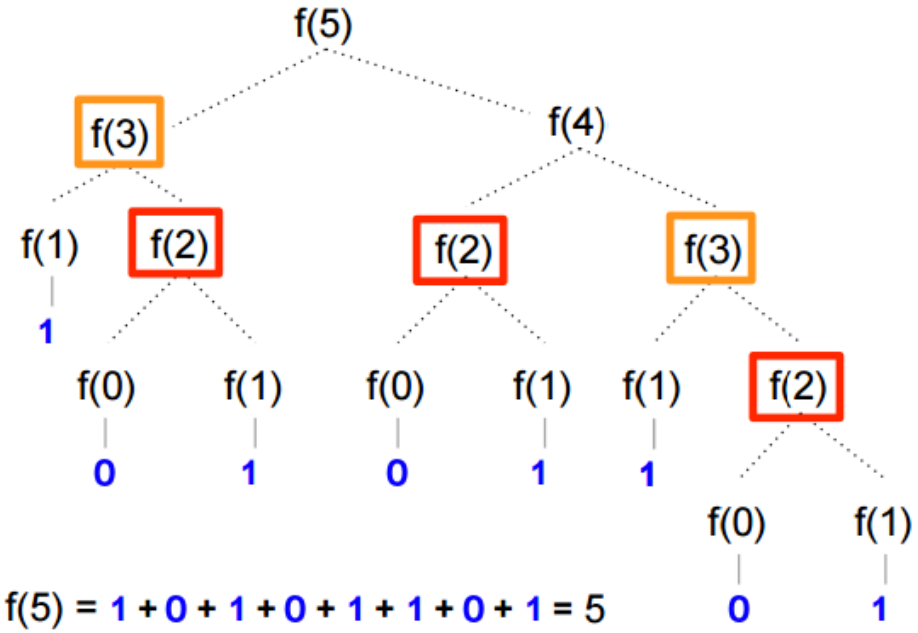
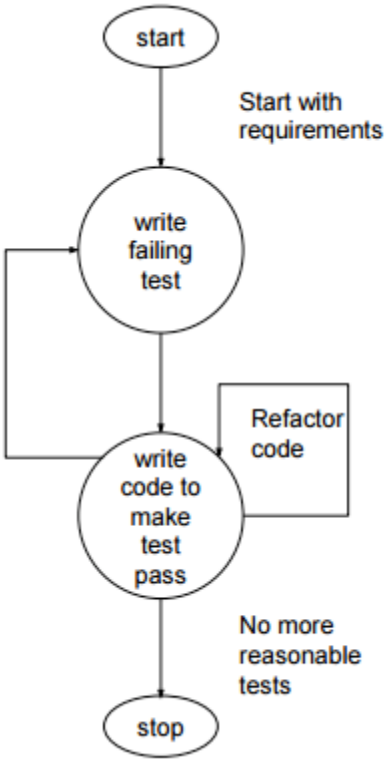
Chapter 1: Pure Functional Programming in Go

```
~/myprojects/fp-go $ tree -C -d -L 2
.
├── 1-functional-fundamentals
│   ├── ch01-pure-fp
│   ├── ch02-collections
│   └── ch03-hof
├── 2-design-patterns
│   ├── ch04-solid
│   ├── ch05-decoration
│   └── ch06-onion-arch
├── 3-functional-techniques
│   ├── ch07-func-param
│   ├── ch08-pipelining
│   └── ch09-refx-futr-lazy
├── 4-purely-functional
│   ├── ch10-category-thery-that-applies
│   ├── ch11-functor-monoid-tclass
│   └── ch12-monads
└── 5-appendix
```

```
~/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/01_oop $ go version
go version go1.9 darwin/amd64
~/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/01_oop $ export GOPATH=$(pwd)
~/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/01_oop $ go run cars.go
Found &{Highlander} ~/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/01_oop $
```



f(5) = 1 + 0 + 1 + 0 + 1 + 1 + 0 + 1 = 5




```
~/clients/packt/dev/fp-go/1-functional-fundamentals/ch01-pure-fp/02_fib $ go test -bench=. ./...
goos: darwin
goarch: amd64
BenchmarkFibSimple-8            10000000               213 ns/op
BenchmarkFibSimple1-8           500000000                3.94 ns/op
BenchmarkFibSimple2-8           200000000                8.85 ns/op
BenchmarkFibSimple3-8           100000000               15.6 ns/op
BenchmarkFibSimple10-8          50000000                28.9 ns/op
BenchmarkFibSimple20-8             20000             64558 ns/op
BenchmarkFibSimple40-8                 1        2509110502 ns/op
BenchmarkFibMemoized-8          1000000              1302 ns/op
BenchmarkFibMemoized1-8         5000000               372 ns/op
BenchmarkFibMemoized2-8         3000000               469 ns/op
BenchmarkFibMemoized3-8         3000000               502 ns/op
BenchmarkFibMemoized10-8        3000000               549 ns/op
BenchmarkFibMemoized20-8         500000              3568 ns/op
BenchmarkFibMemoized40-8         200000              7920 ns/op
BenchmarkFibChanneled-8          500000              3334 ns/op
BenchmarkFibChanneled1-8        1000000              1189 ns/op
BenchmarkFibChanneled2-8        1000000              1822 ns/op
BenchmarkFibChanneled3-8        1000000              1699 ns/op
BenchmarkFibChanneled10-8       1000000              2121 ns/op
BenchmarkFibChanneled20-8        200000              6245 ns/op
BenchmarkFibChanneled40-8        100000             12223 ns/op
PASS
ok      _/Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch01-pure-fp/01_fib       41.935s
```

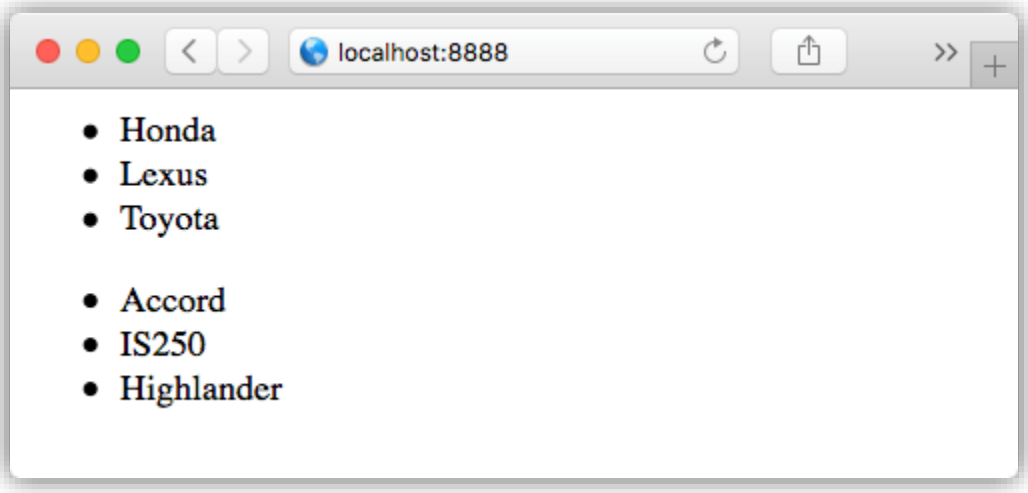
recursive: 2509110502 ns

memoized: 7920 ns

channeled: 12223 ns

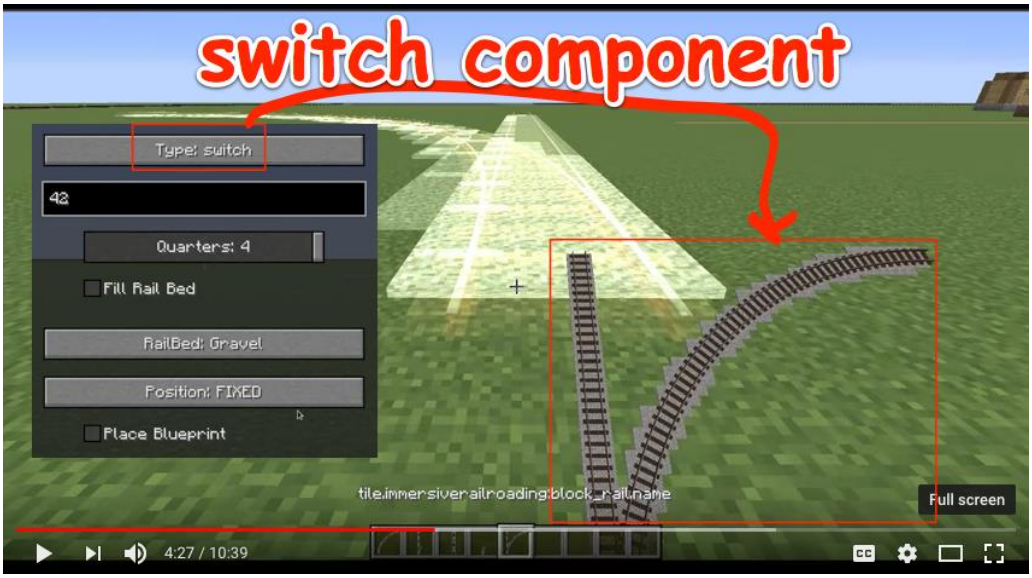
Chapter 2: Manipulating Collections

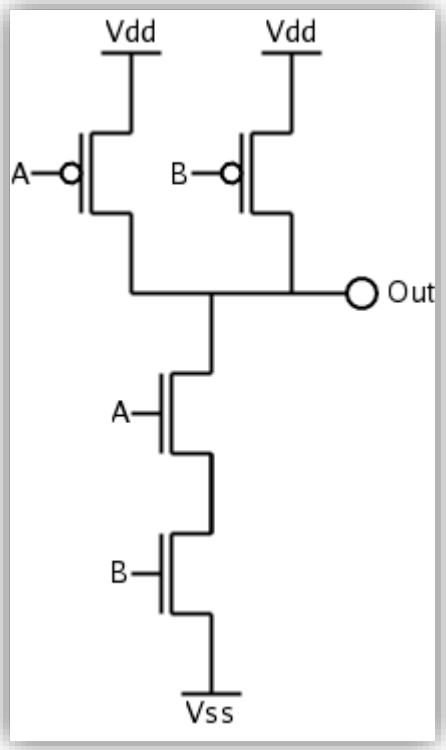
```
 ~ $ cd /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch02-collections/01_iterator
 ~/clients/packt/dev/fp-go/1-functional-fundamentals/ch02-collections/01_iterator $ . init
+++ basename /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch02-collections/01_iterator
++ PROJECT_DIR_LINK=/Users/lex/dev/01_iterator
++ ln -s /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch02-collections/01_iterator /Users/lex/
dev/01_iterator
Installed Go version: go version go1.9 darwin/amd64
Switching Go to version 1.9 ...
Exported GOBIN=/Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch02-collections/01_iterator/bin
You should only need to run this init script once.
Add Go source code files under the src directory.
After updating dependencies, i.e., adding a new import statement, run: glide-update
To build and run your app, run: go-run
 ~/dev/01_iterator $ go-run
CRV
IS250
Blazer
 ~/dev/01_iterator $
```

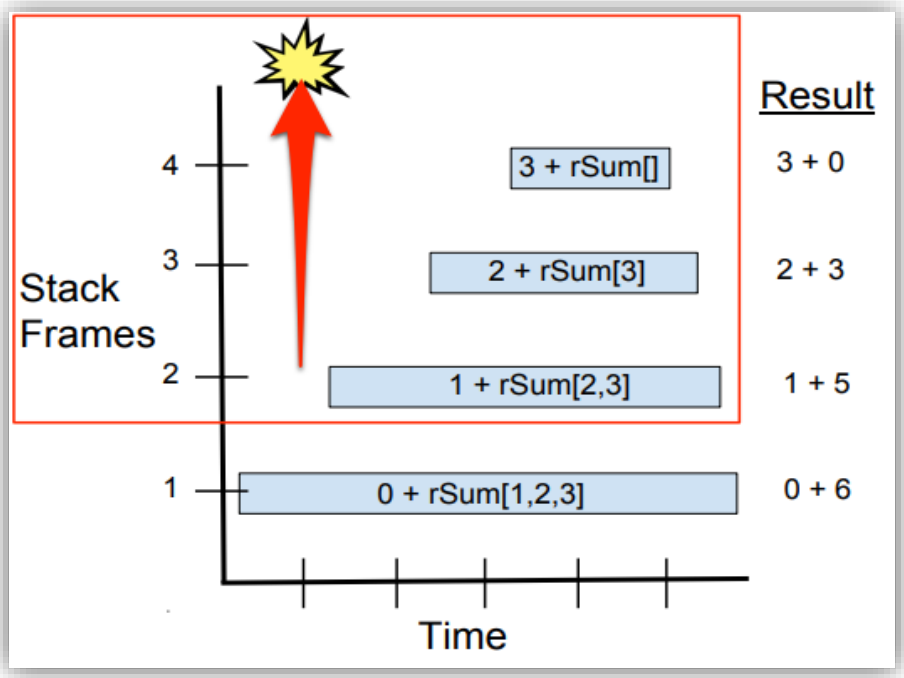


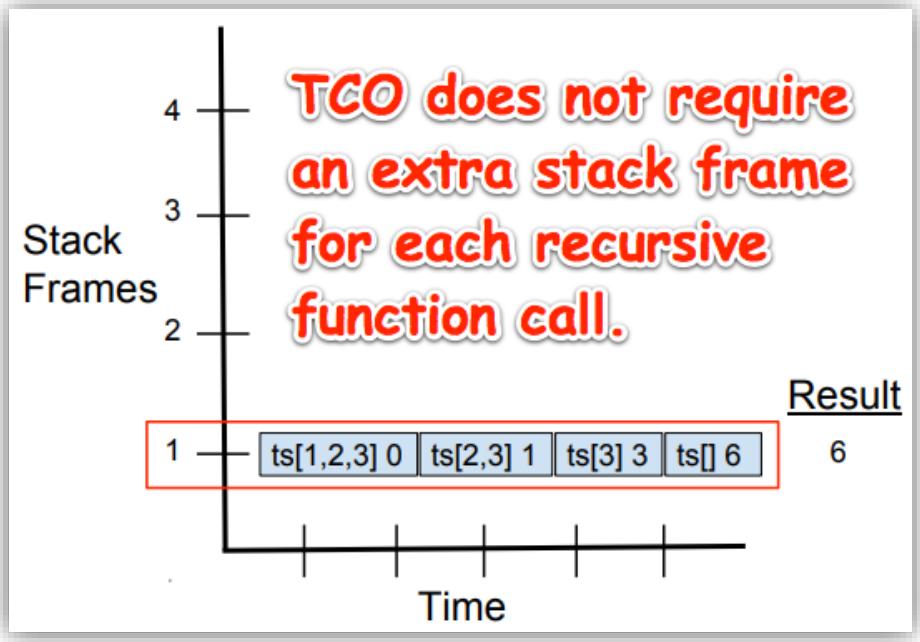

Full screen
1:04 / 10:39

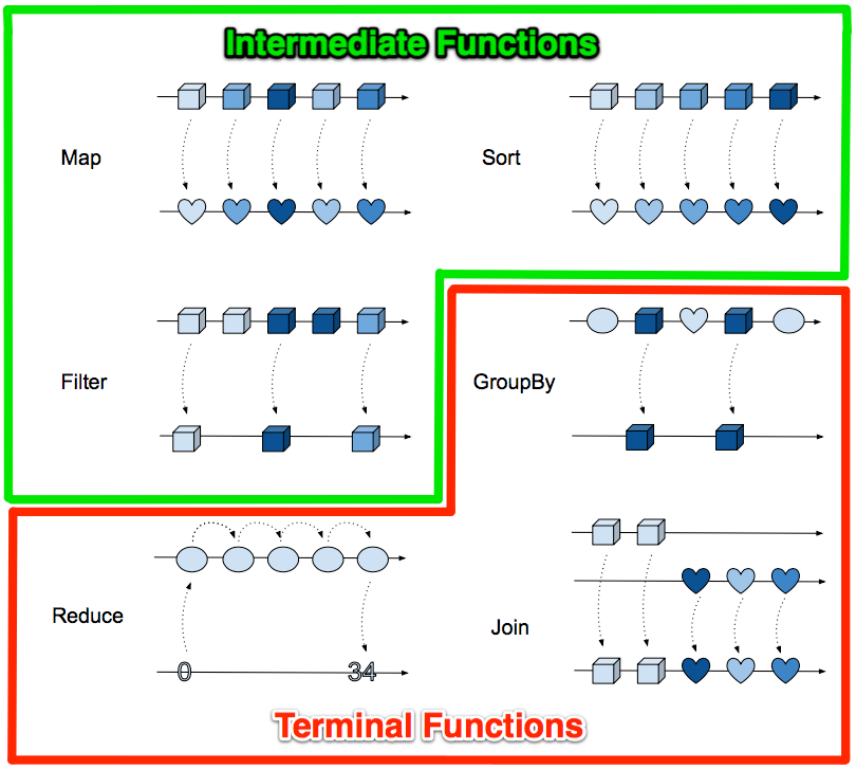

1 / 2
Transportation
Transportation


switch component
Type: switch
42
Quarters: 4
Fill Rail Bed
RailBed: Gravel
Position: FIXED
Place Blueprint
tile.immersiverailroading:block_rail.name
Full screen
4:27 / 10:39

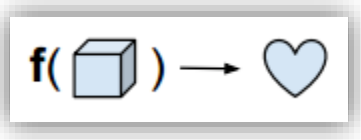

Vdd
Vdd
A
B
Out
A
B
Vss


Result
4
3 + rSum[]
3 + 0
3
2 + rSum[3]
2 + 3
Stack
Frames
2
1 + rSum[2,3]
1 + 5
1
0 + rSum[1,2,3]
0 + 6
Time

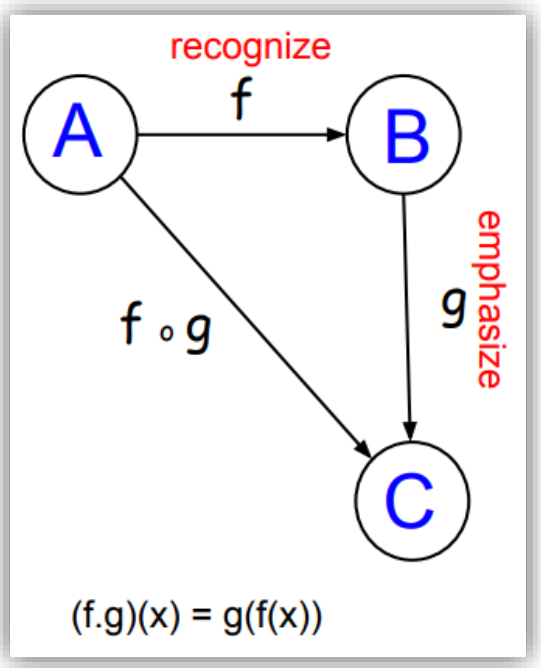

TCO does not require
an extra stack frame
for each recursive
function call.
4
3
Stack
Frames
2
Result
1
ts[1,2,3] 0
ts[2,3] 1
ts[3] 3
ts[] 6
6
Time

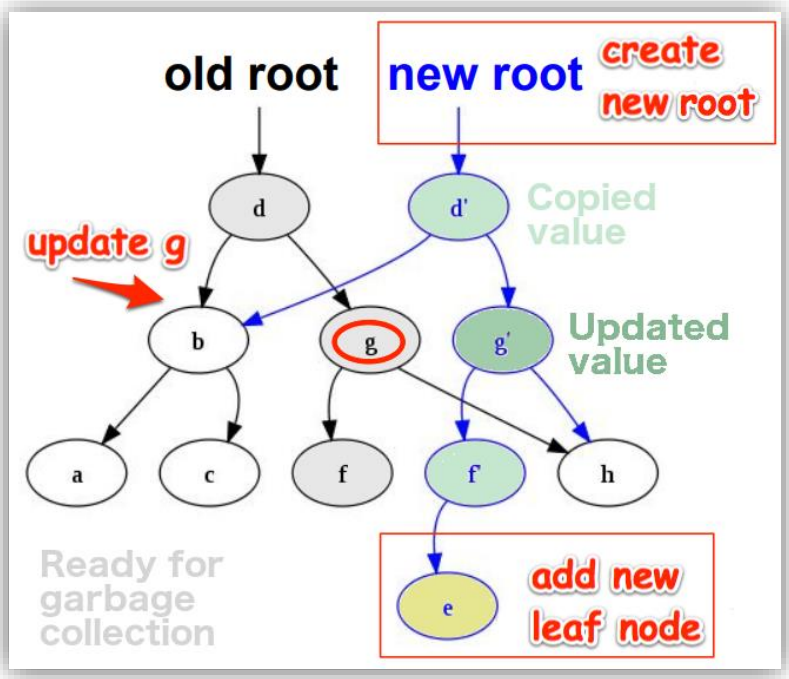

Intermediate Functions
Map
Sort
Filter
GroupBy
Reduce
0
34
Join
Terminal Functions

```
1. bash
~/clients/packt/dev/fp-go/1-functional-fundamentals/ch02-collections/02_chainlink $ . init
++ ln -s /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch02-collections/02_chainlink /Users/lex/dev/02_chainlink
Installed Go version: go version go1.9.2 darwin/amd64
Switching Go to version 1.9.2 ...
GOVERSION: go version go1.9.2 darwin/amd64
CURRENT_GOVERSION: go1.9.2
You should only need to run this init script once.
Add Go source code files under the src directory.
After updating dependencies, i.e., adding a new import statement, run: glide-update
To build and run your app, run: go-run
~/dev/02_chainlink $ go-run

** Constants ***
ZERO: 0
SMALL: 6
MEDIUM: 12
LARGE: 18
XLARGE: 24
XXLARGE: 50
unfiltered: []string{"tiny", "marathon", "philanthropinist", "supercalifragilisticexpialidocious"}
filtered: &main.ChainLink{Data:[]string{"tiny"}}
filtered and mapped (<= SMALL sized words): []string{"TINY"}
filtered and mapped (<= Up to MEDIUM sized words): []string{"TINY", "MARATHON"}
filtered twice and mapped (<= Up to LARGE sized words): []string{"TINY", "MARATHON", "PHILANTHROPINIST"}
mapped and filtered (<= Up to XXLARGE sized words): []string{"TINY", "MARATHON", "PHILANTHROPINIST", "SUPERCALIFRAGILISTICEXPIALIDOCIOUS"}
~/dev/02_chainlink $
```

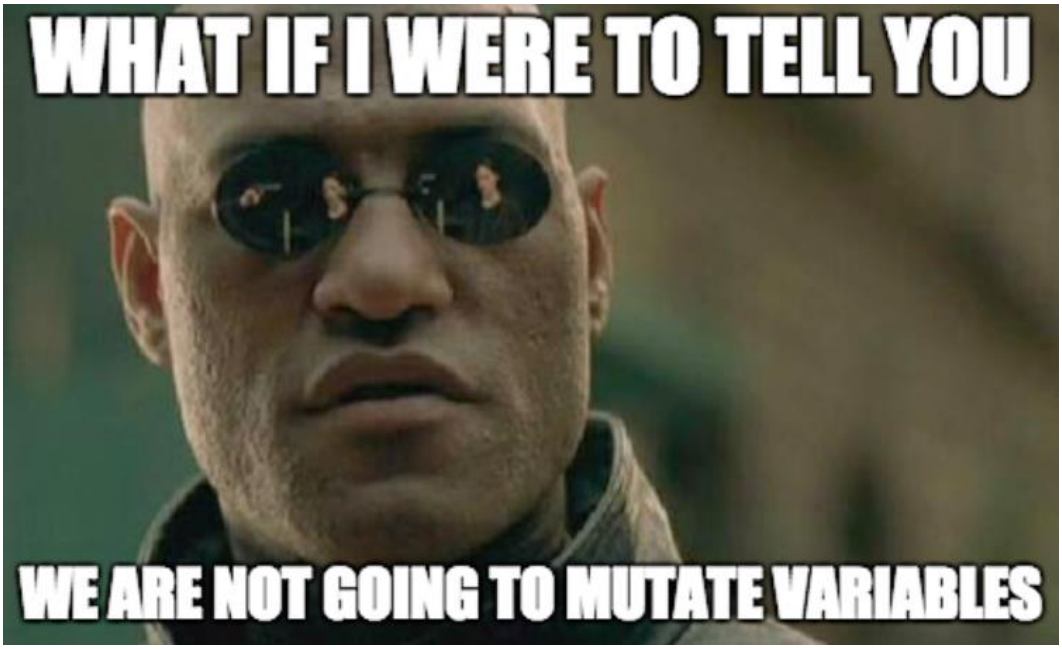


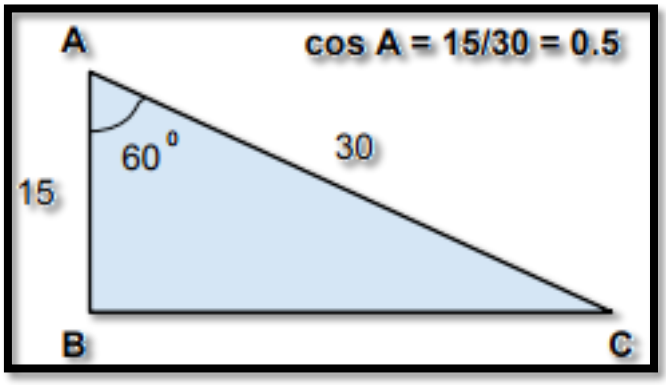
Chapter 3: Using High-Order Functions



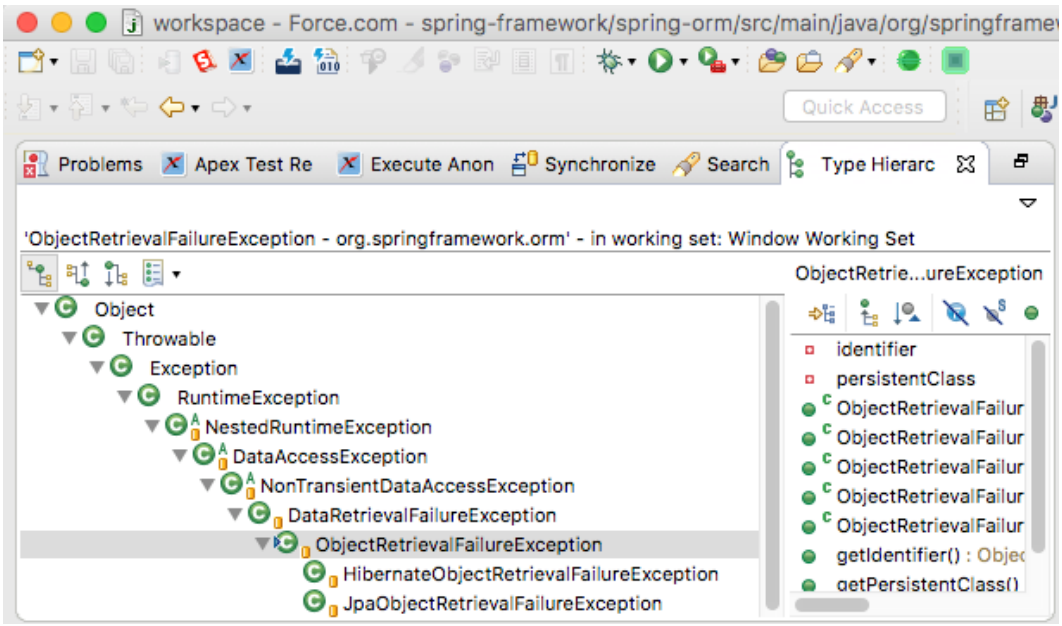

old root
new root
create new root
d
d'
Copied value
update g
b
g
g'
Updated value
a
c
f
f'
h
Ready for garbage collection
e
add new leaf node

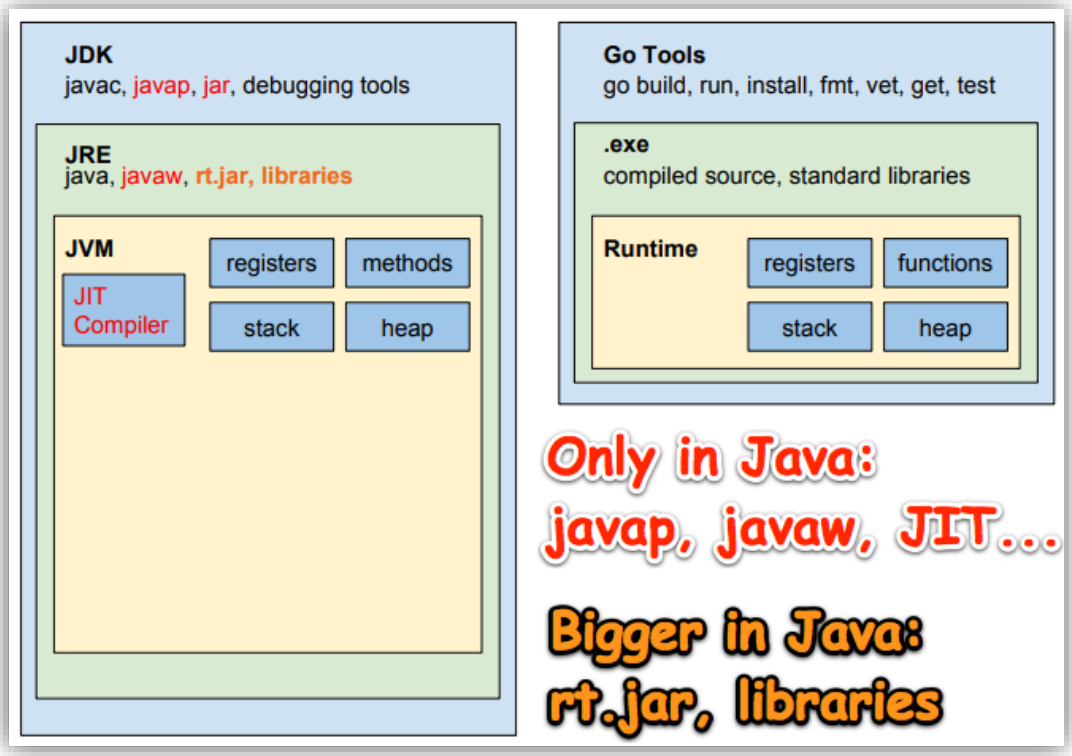

localhost:8000/cars
{
"IndexedCars": [
{
"index": 0,
"car": "Honda Accord"
},
{
"index": 1,
"car": "Honda Accord ES2"
},
{
"index": 2,
"car": "Lexus IS250"
},
{
"index": 3,
"car": "Honda CRV"
},
{
"index": 4,
"car": "Lexus SC 430"
},
{
"index": 5,
"car": "Ford F-150"
},
{
"index": 6,
"car": "GM Hummer H2"
},
{
"index": 7,
"car": "GM Hummer H3"
},
{
"index": 8,
"car": "Chrysler 200"
},
{
"index": 9,
"car": "Chrysler Pacifica"
},
{
"index": 10,
"car": "Toyota 86"
},
{
"index": 11,
"car": "Toyota Highlander"
},
{
"index": 12,
"car": "Toyota RAV4"
},
{
"index": 13,
"car": "Dodge Charger"
},
{
"index": 14,
"car": "Dodge 330"
},
{
"index": 15,
"car": "GM Oldsmobile Cutlass Supreme"
},
{
"index": 16,
"car": "GM Oldsmobile Delta 88"
},
{
"index": 17,
"car": "GM Oldsmobile 442"
}
]


WHAT IF I WERE TO TELL YOU
WE ARE NOT GOING TO MUTATE VARIABLES

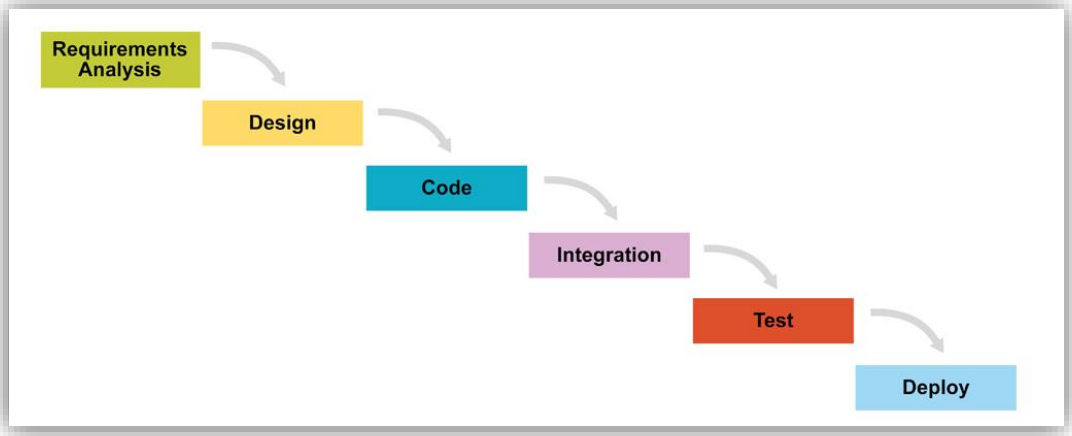

A
cos A = 15/30 = 0.5
60°
30
15
B
C

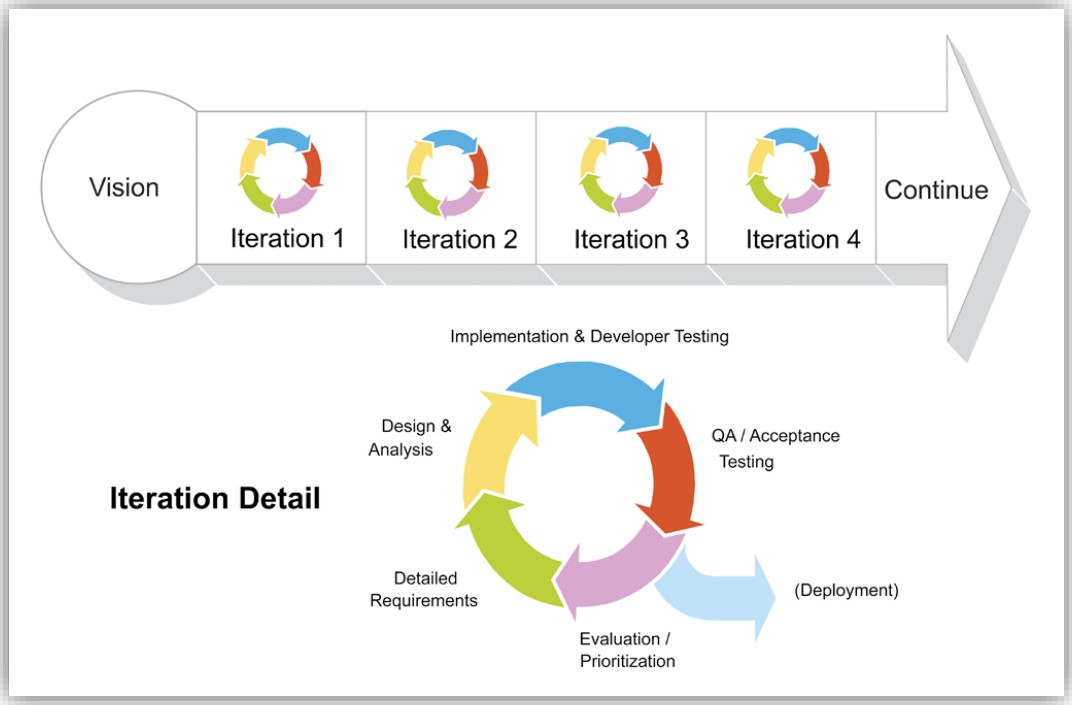
Chapter 4: SOLID Design in Go

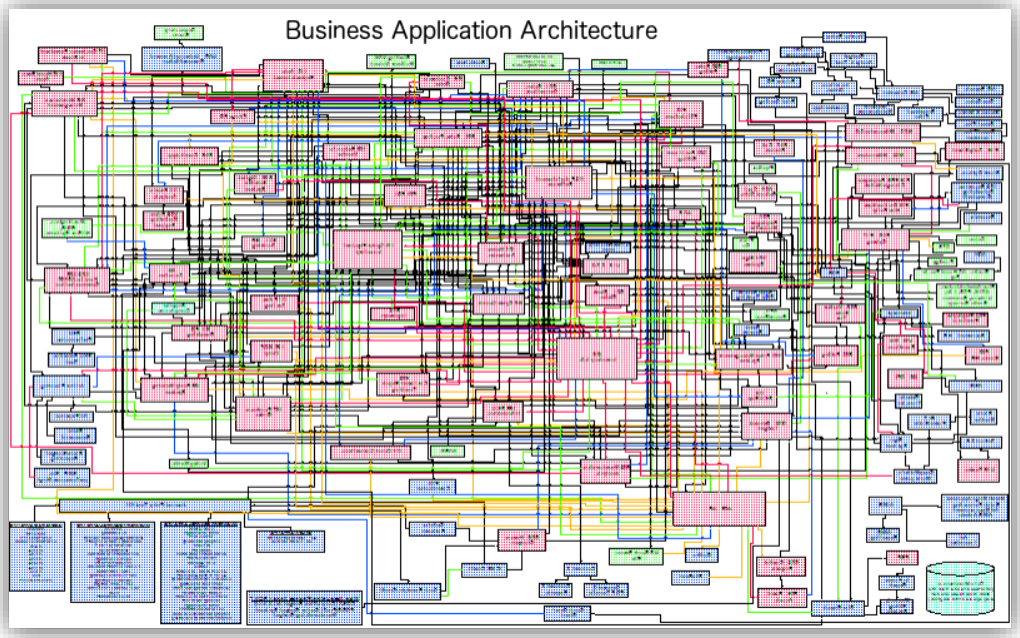


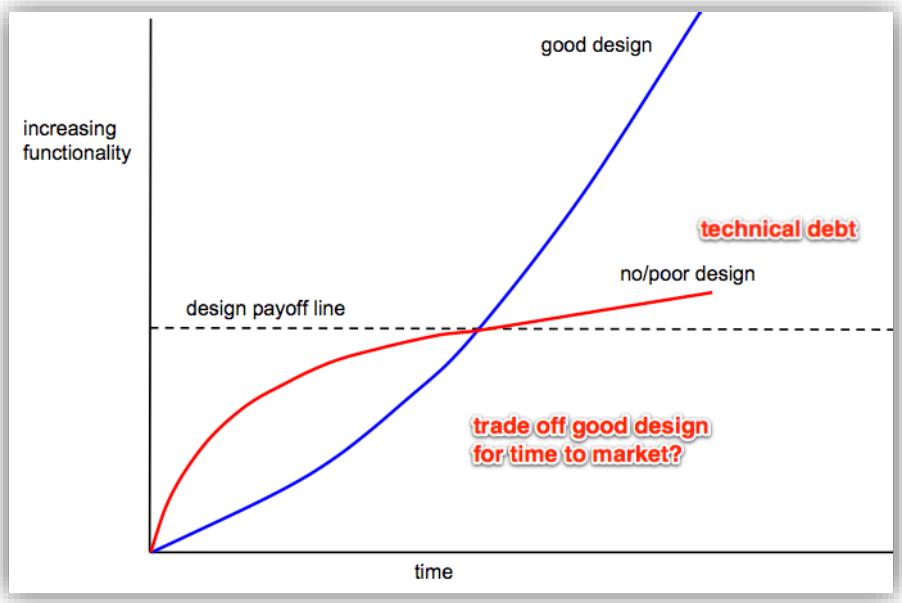

JDK
javac, javap, jar, debugging tools
JRE
java, javaw, rt.jar, libraries
JVM
JIT Compiler
registers
methods
stack
heap
Go Tools
go build, run, install, fmt, vet, get, test
.exe
compiled source, standard libraries
Runtime
registers
functions
stack
heap
Only in Java:
javap, javaw, JIT...
Bigger in Java:
rt.jar, libraries


with Exception Handling
with if err != nil scaffolding
UNION STATION
UNION STATION

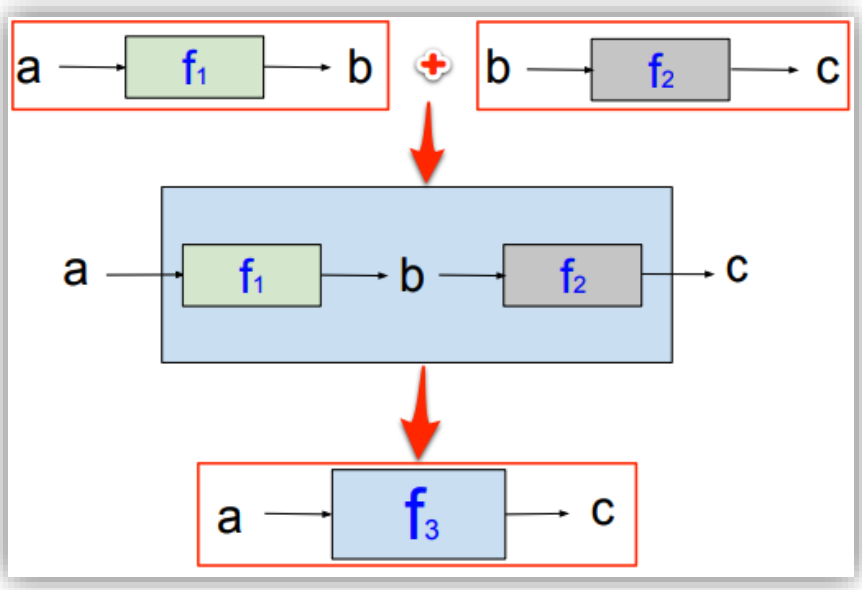

Requirements Analysis
Design
Code
Integration
Test
Deploy


Vision
Iteration 1
Iteration 2
Iteration 3
Iteration 4
Continue
Iteration Detail
Implementation & Developer Testing
Design & Analysis
QA / Acceptance Testing
Detailed Requirements
(Deployment)
Evaluation / Prioritization


Business Application Architecture



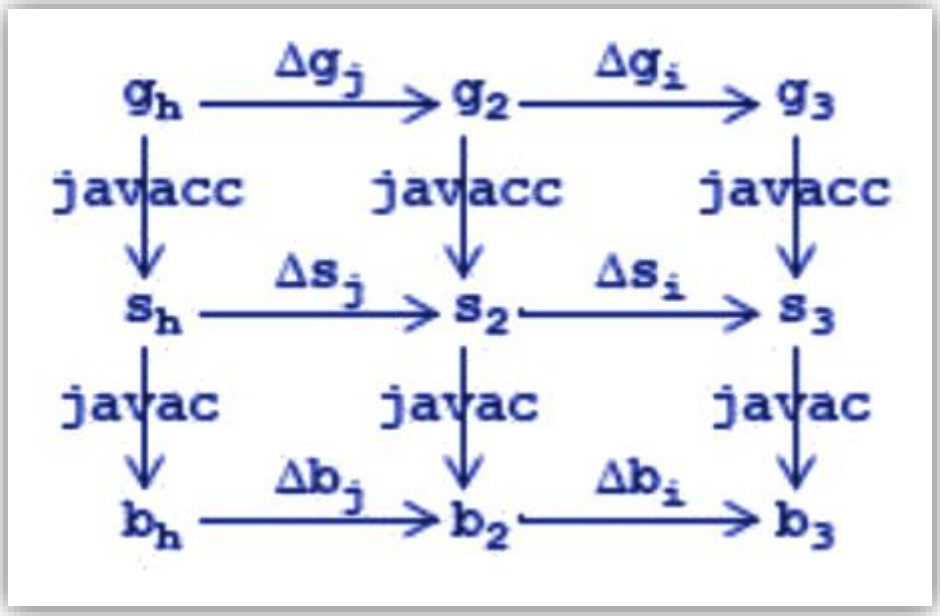

```
├── compress
│   ├── bzip2
│   ├── flate
│   ├── gzip
│   ├── lzw
│   ├── testdata
│   └── zlib
├── database
│   └── sql
│       └── driver
├── crypto
│   ├── aes
│   ├── cipher
│   ├── des
│   ├── dsa
│   ├── ecdsa
│   ├── elliptic
│   ├── hmac
│   ├── md5
│   ├── rand
│   ├── rc4
│   └── rsa
├── encoding
│   ├── ascii85
│   ├── asn1
│   ├── base32
│   ├── base64
│   ├── binary
│   ├── csv
│   ├── gob
│   ├── hex
│   ├── json
│   ├── pem
│   └── xml
└── net
    ├── http
    │   ├── cgi
    │   ├── cookiejar
    │   ├── fcgi
    │   ├── httptest
    │   ├── httptrace
    │   └── httputil
    ├── mail
    ├── rpc
    │   └── jsonrpc
    ├── smtp
    └── url
```

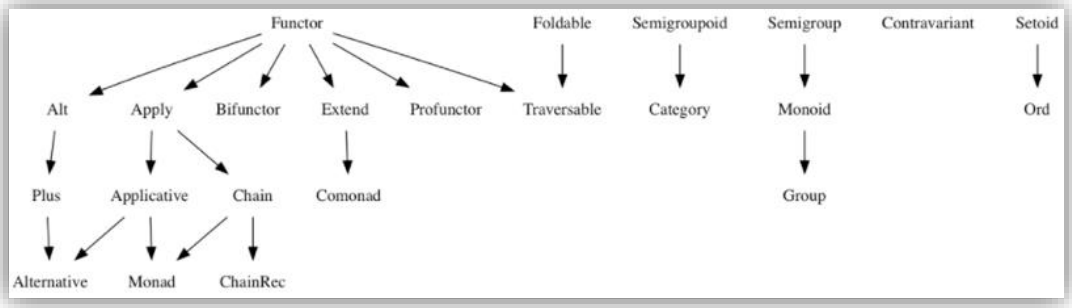


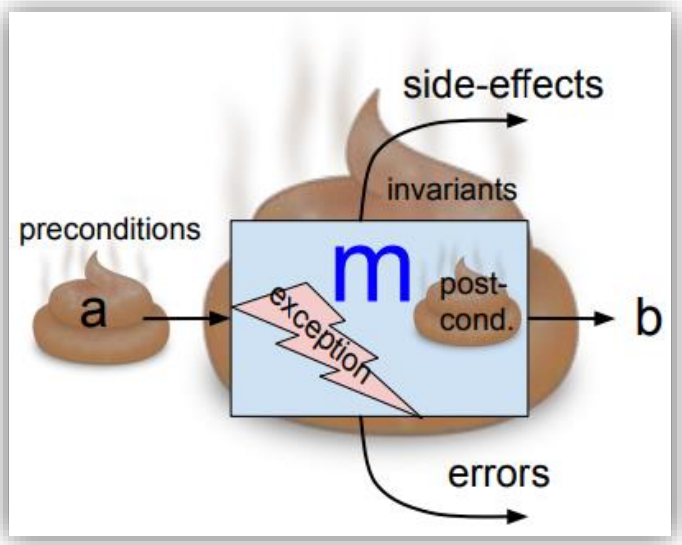

```go
func (c CarWithSpare) PrintInfo() {
    fmt.Printf("%v has %d tires\n", c, c.Tires())
}
func (c CarWithSpare) PrintInfo(upCase bool) {
    if upCase {
        fmt.Printf("%v HAS %d TIRES\n", c, c.Tires())
    } else {
        fmt.Printf("%v has %d tires\n", c, c.Tires())
    }
}
```

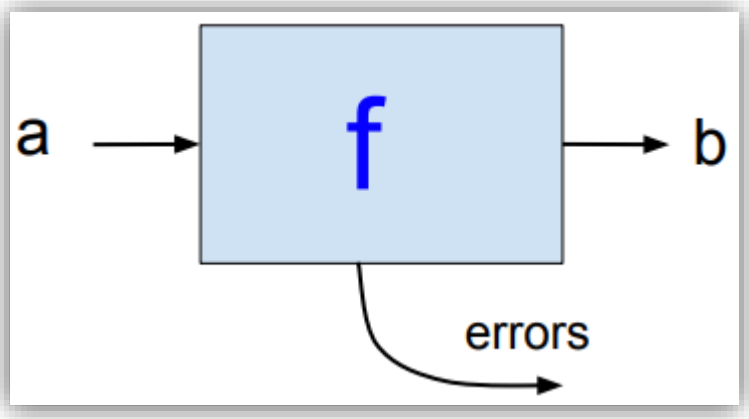
0 parameters

1 parameter

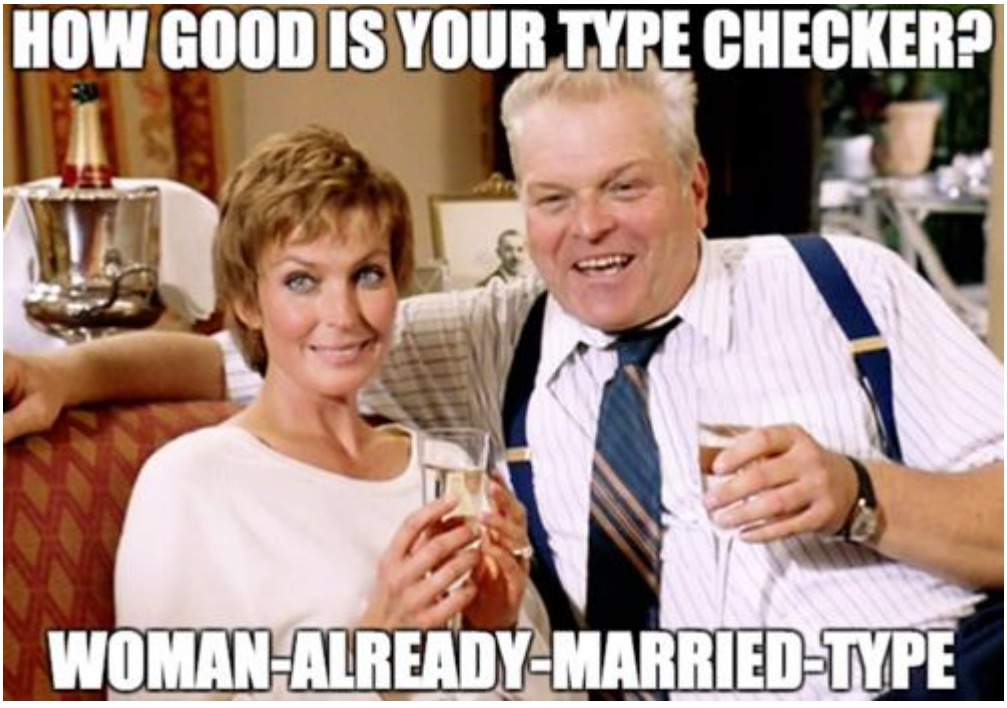

g_h
Δg_j
g_2
Δg_i
g_3
javacc
javacc
javacc
s_h
Δs_j
s_2
Δs_i
s_3
javac
javac
javac
b_h
Δb_j
b_2
Δb_i
b_3

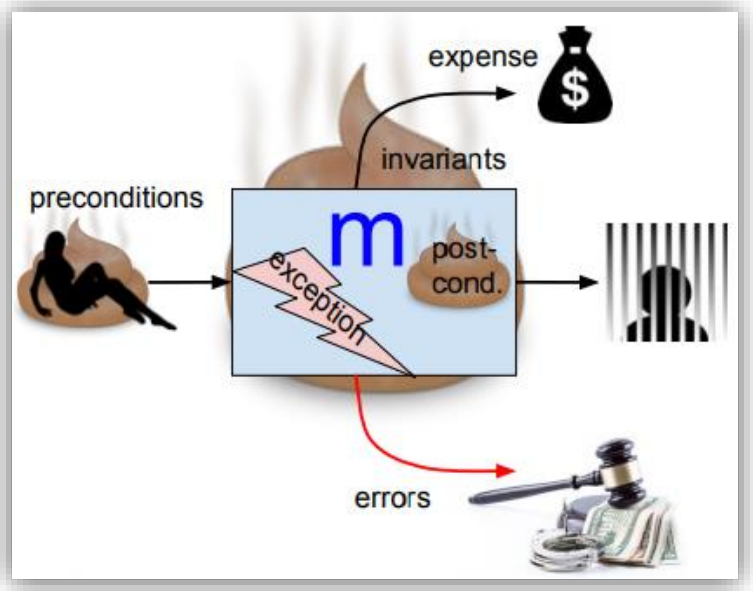

Functor
Foldable
Semigroupoid
Semigroup
Contravariant
Setoid
Alt
Apply
Bifunctor
Extend
Profunctor
Traversable
Category
Monoid
Ord
Plus
Applicative
Chain
Comonad
Group
Alternative
Monad
ChainRec

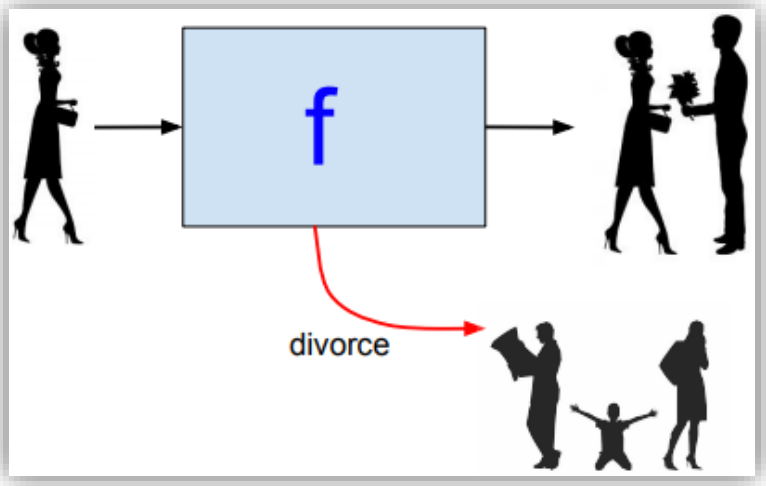

side-effects
invariants
preconditions
m
a
post-
cond.
b
exception
errors


a
f
b
errors


GIVE ME TWO INTS ...
AND I'LL GIVE YOU AN INT

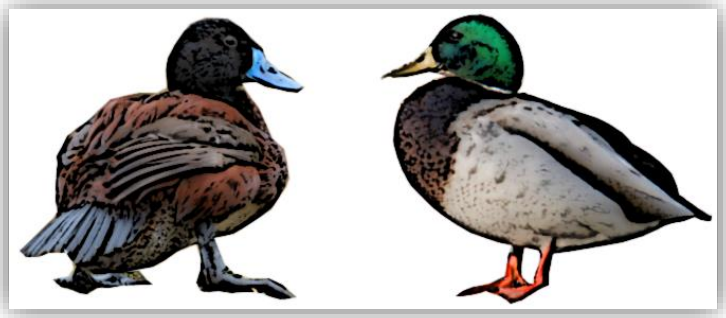

HOW GOOD IS YOUR TYPE CHECKER?
WOMAN-ALREADY-MARRIED-TYPE

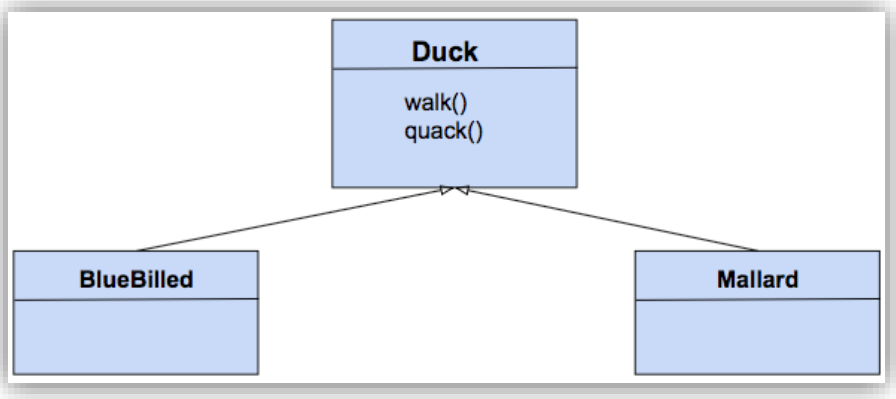

expense
invariants
preconditions
m
post-
cond.
exception
errors

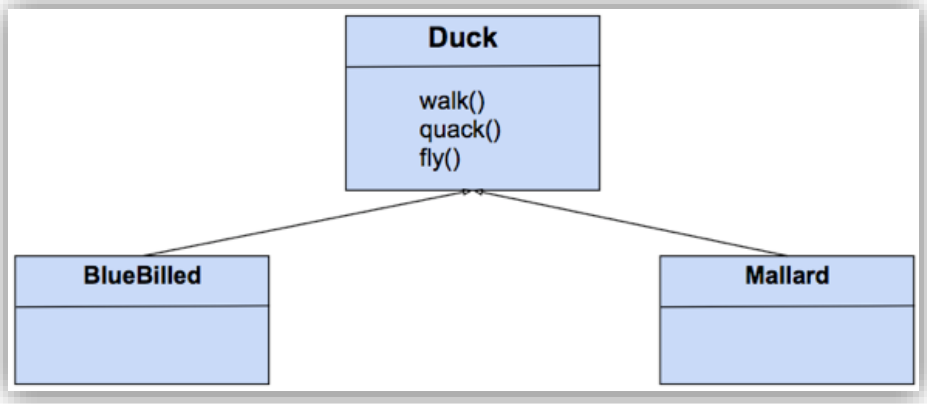

f
divorce

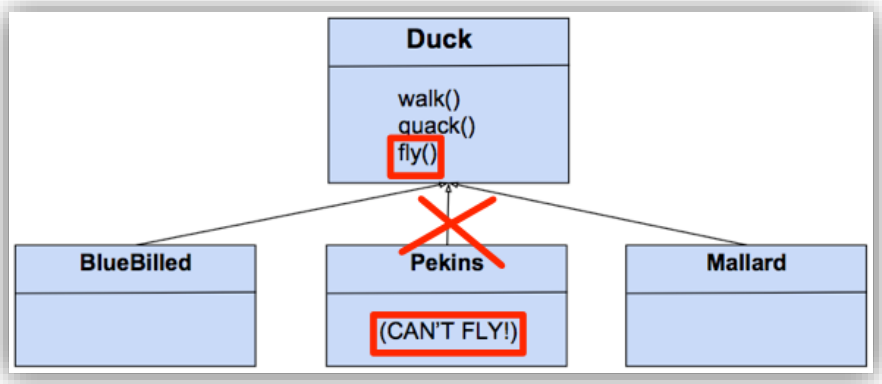
in-laws

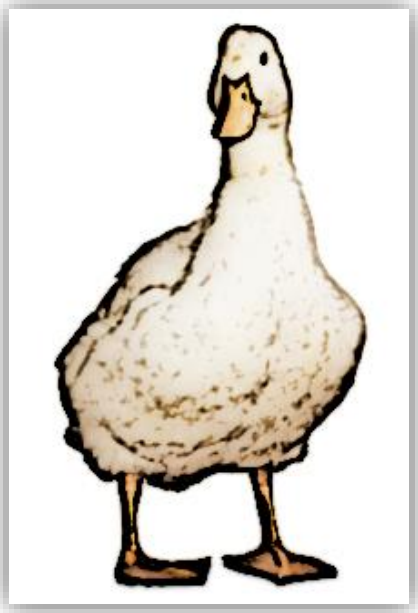
children

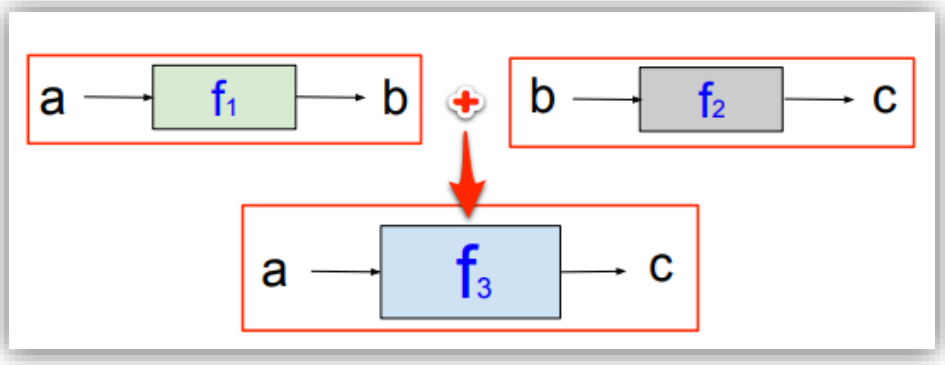



Duck
walk()
quack()
BlueBilled
Mallard


Duck
walk()
quack()
fly()
BlueBilled
Mallard

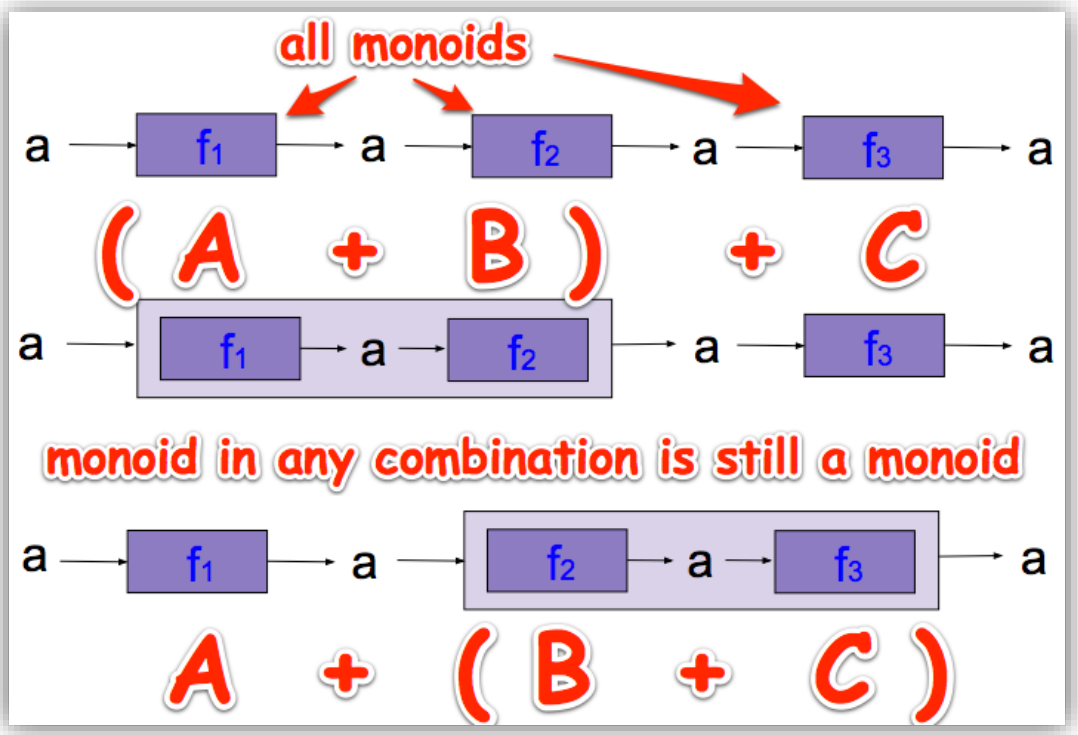

Duck
walk()
quack()
fly()
BlueBilled
Pekins
(CAN'T FLY!)
Mallard

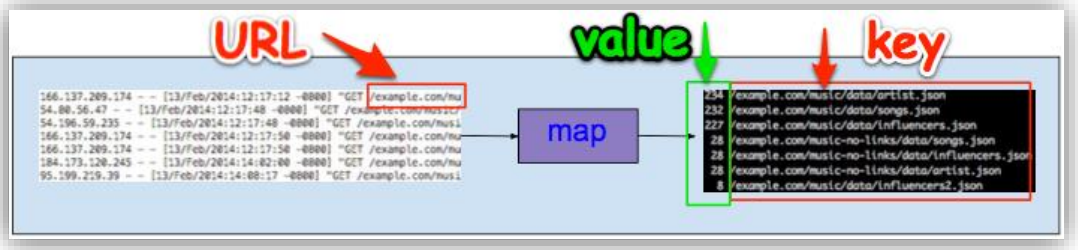


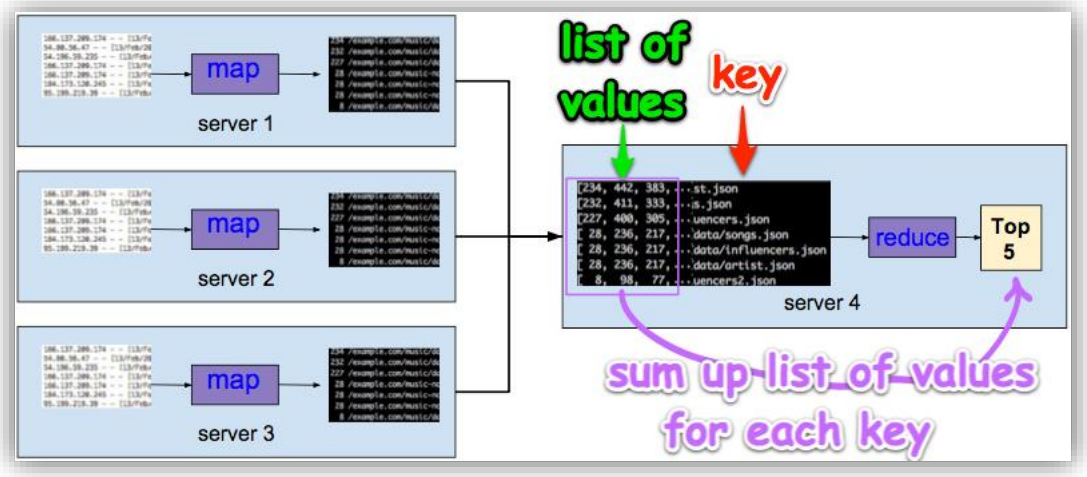

a
f1
b
b
f2
c
a
f3
c

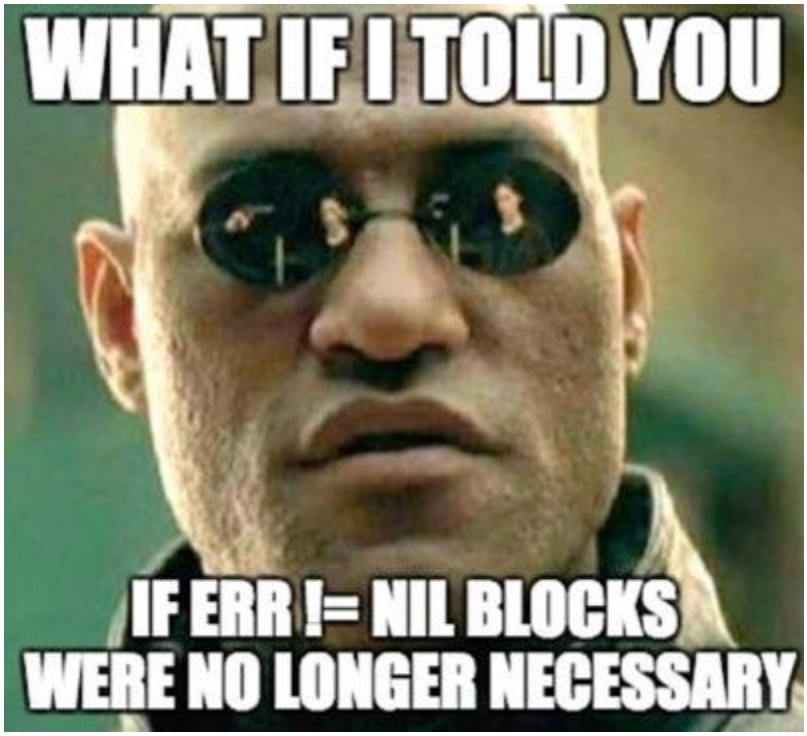

a
f
a


a
f
a
f
a
f
a


all monoids
a
f1
a
f2
a
f3
a
(A + B) + C
monoid in any combination is still a monoid
A + (B + C)

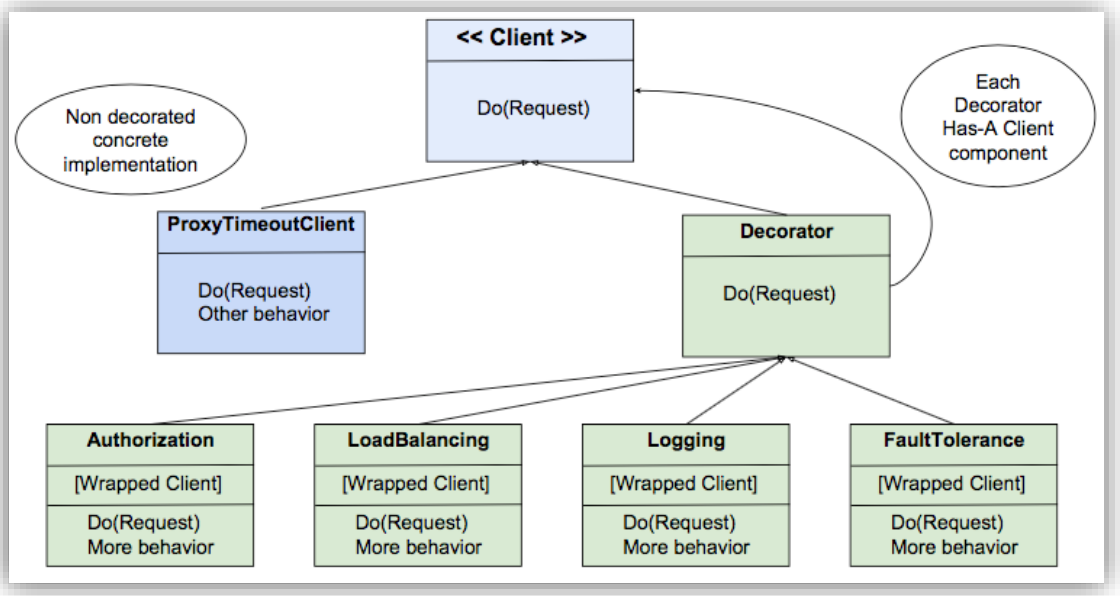

URL
value
key
map

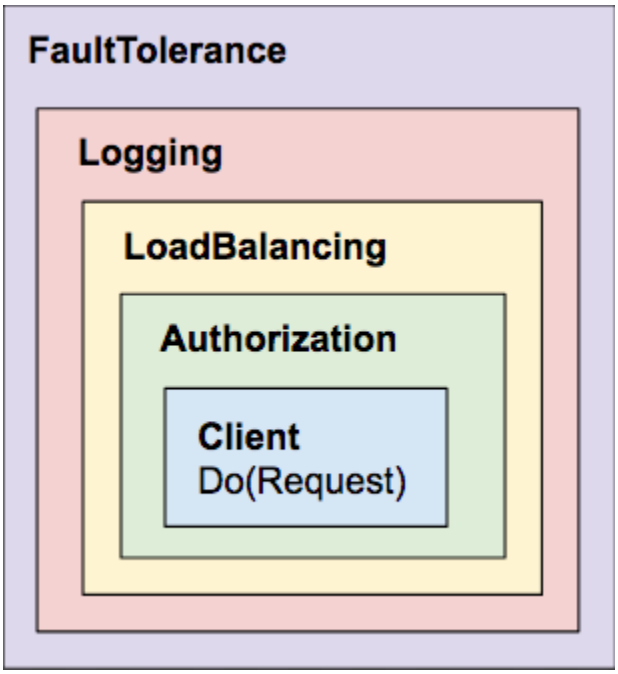

map
server 1
map
server 2
map
server 3
list of values
key
reduce
Top 5
server 4
sum up list of values for each key

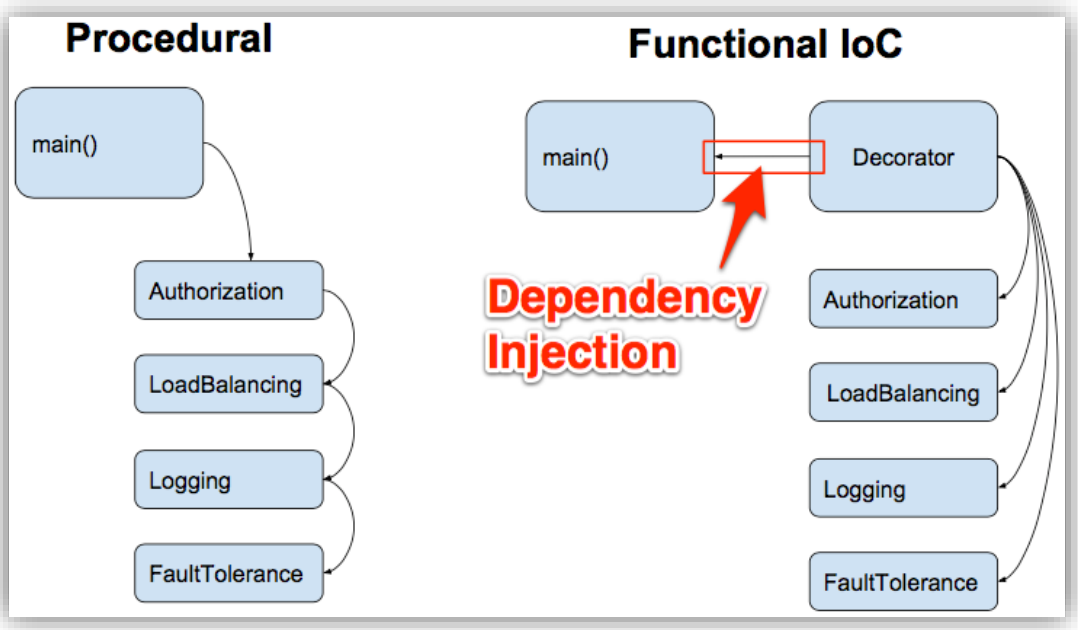

WHAT IF I TOLD YOU
IF ERR != NIL BLOCKS WERE NO LONGER NECESSARY

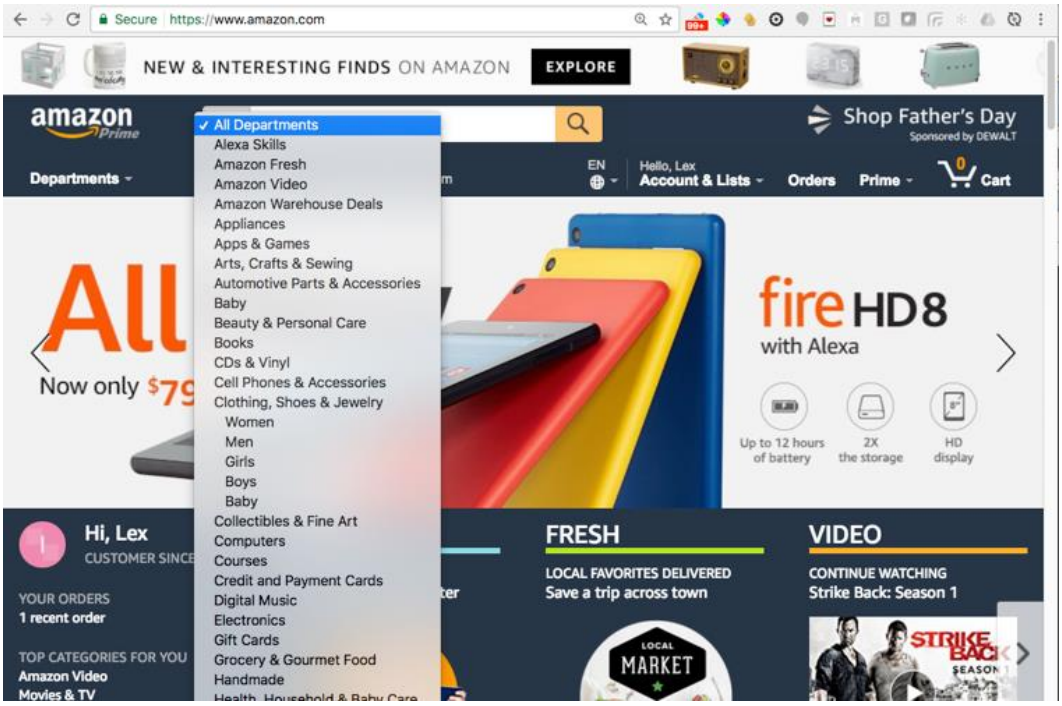

ITS MAGIC
memegen.com

Chapter 5: Adding Functionality with Decoration

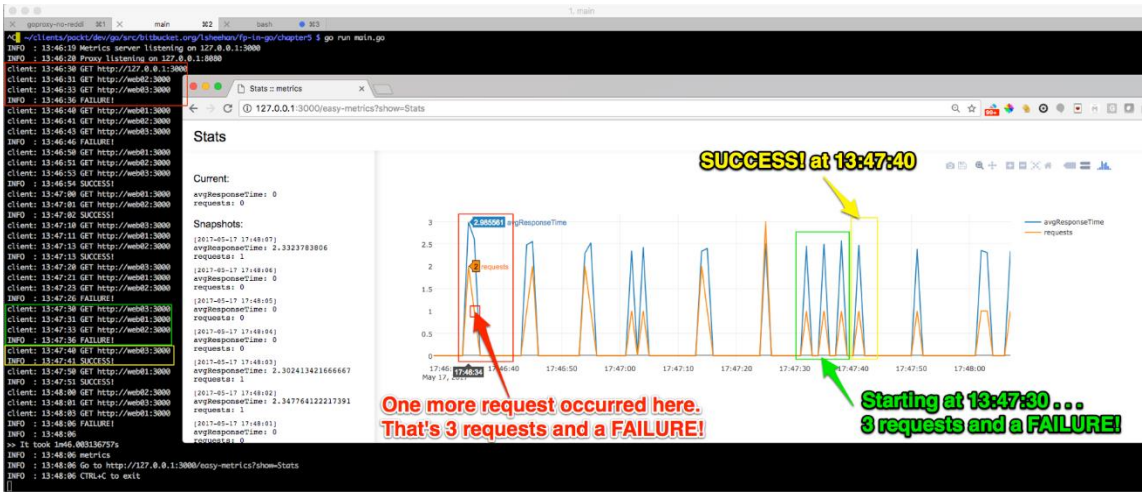

<< Client >>
Do(Request)
Non decorated concrete implementation
Each Decorator Has-A Client component
ProxyTimeoutClient
Do(Request)
Other behavior
Decorator
Do(Request)
Authorization
[Wrapped Client]
Do(Request)
More behavior
LoadBalancing
[Wrapped Client]
Do(Request)
More behavior
Logging
[Wrapped Client]
Do(Request)
More behavior
FaultTolerance
[Wrapped Client]
Do(Request)
More behavior


FaultTolerance
Logging
LoadBalancing
Authorization
Client
Do(Request)

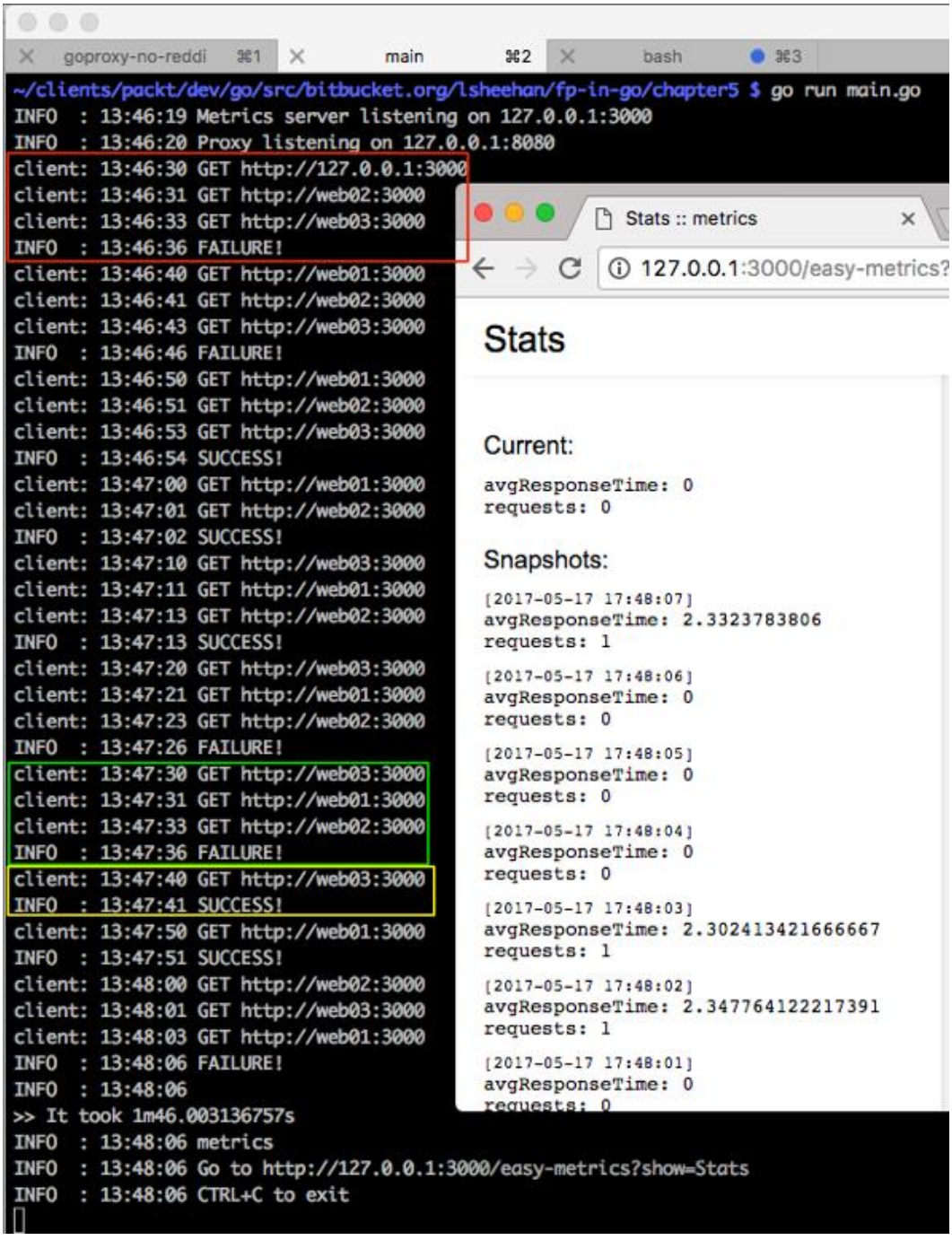

Procedural
main()
Authorization
LoadBalancing
Logging
FaultTolerance
Functional IoC
main()
Decorator
Dependency Injection
Authorization
LoadBalancing
Logging
FaultTolerance

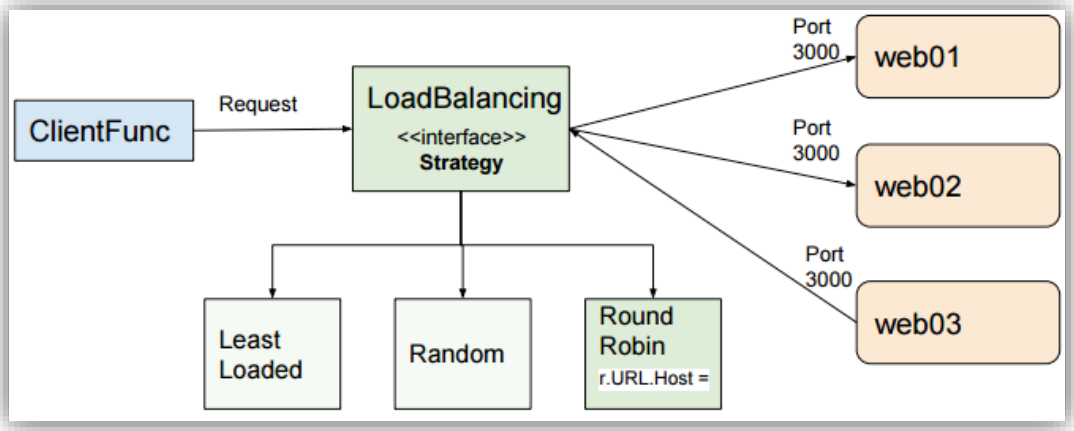



```
~/dev/02_decorator $ go-run --help
Usage of 02_decorator:
  -proxyPort int
        Server Port (default 8080)
  -serverPort int
        Server Port (default 3000)
```

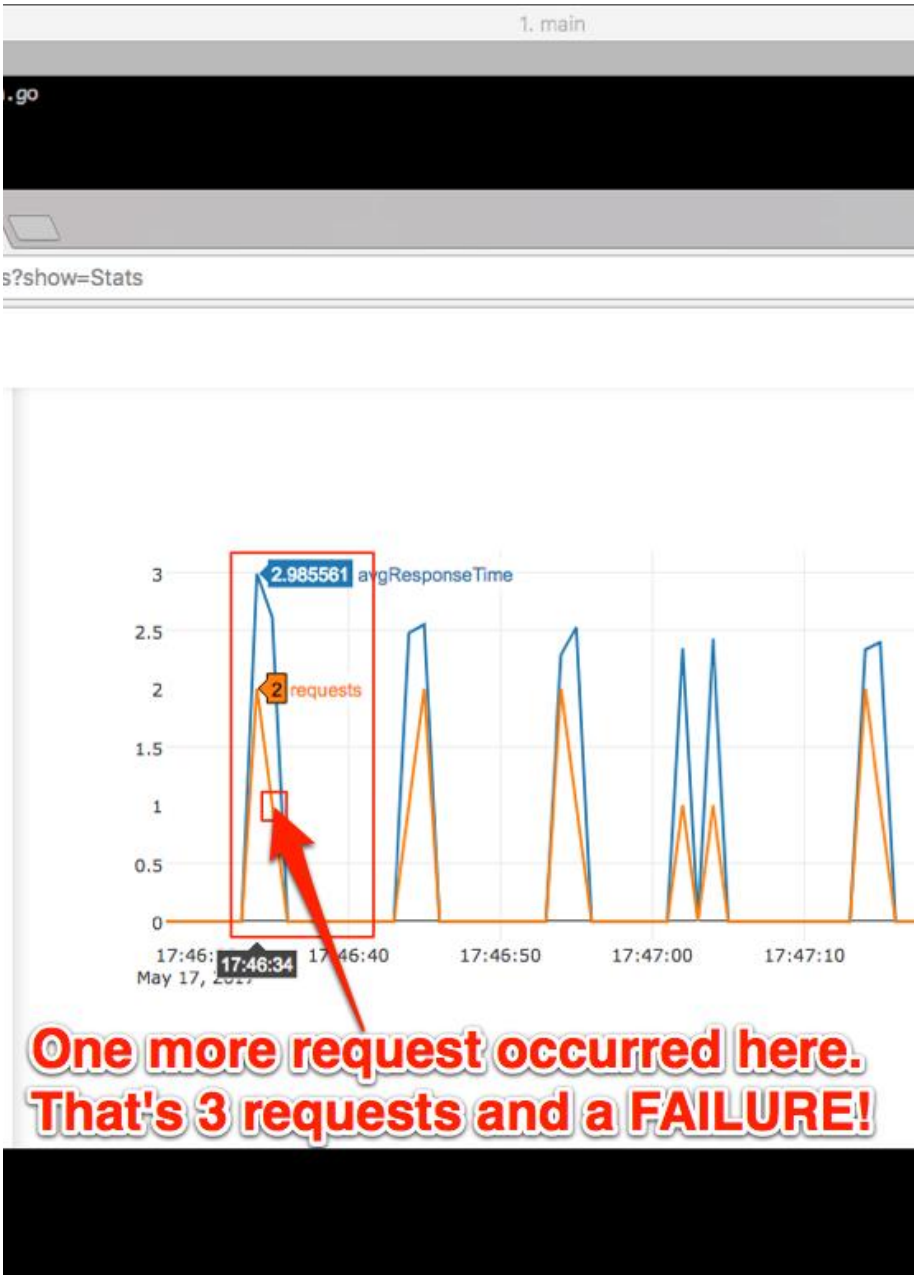

SUCCESS! at 13:47:40
One more request occurred here.
That's 3 requests and a FAILURE!
Starting at 13:47:30 . . .
3 requests and a FAILURE!

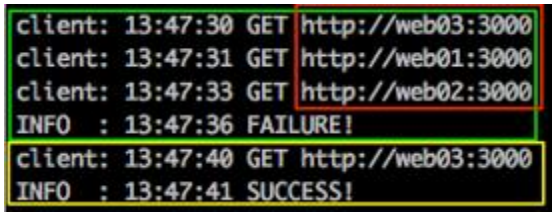

1. 02_decorator
~/dev/02_decorator $ go-run
INFO : 14:12: trics serve stening on 127.0.0.1:3000
INFO : 14:12:2 xy listening 27.0.0.1:8080
client: 14:12:36 GE tp://127.0.0.1:
client: 14:12:37 GET ht //web02:3000
client: 14:12:39 GET http: eb03:3000
INFO : 14:12:42 FAILURE!
client: 14:12:46 GET http://web01: 000
client: 14:12:47 GET http://web02:30
client: 14:12:49 GET http://web03:3000
INFO : 14:12:52 FAILURE!
client: 14:12:56 GET http://web01:3000
client: 14:12:57 GET http://web02:3000
client: 14:12:59 GET http://web03:3000
INFO : 14:13:00 SUCCESS!
client: 14:13:06 GET http://web01:3000
client: 14:13:07 GET http://web02:3000
INFO : 14:13:08 SUCCESS!
client: 14:13:16 GET http://web03:3000
client: 14:13:17 GET http://web01:3000
client: 14:13:19 GET http://web02:3000
INFO : 14:13:19 SUCCESS!
client: 14:13:26 GET http://web03:3000
client: 14:13:27 GET http://web01:3000
client: 14:13:29 GET http://web02:3000
INFO : 14:13:32 FAILURE!
client: 14:13:36 GET http://web03:3000
client: 14:13:37 GET http://web01:3000
client: 14:13:39 GET http://web02:3000
INFO : 14:13:42 FAILURE!
client: 14:13:46 GET http://web03:3000
INFO : 14:13:47 SUCCESS!
client: 14:13:56 GET http://web01:3000
INFO : 14:13:57 SUCCESS!
client: 14:14:06 GET http://web02:3000
client: 14:14:07 GET http://web03:3000
client: 14:14:09 GET http://web01:3000
INFO : 14:14:12 FAILURE!
INFO : 14:14:12
>> It took 1m46.002261682s
INFO : 14:14:12 metrics
INFO : 14:14:12 Go to http://127.0.0.1:3000/easy-metrics?show=Stats
INFO : 14:14:12 CTRL+C to exit
simpler
shorter

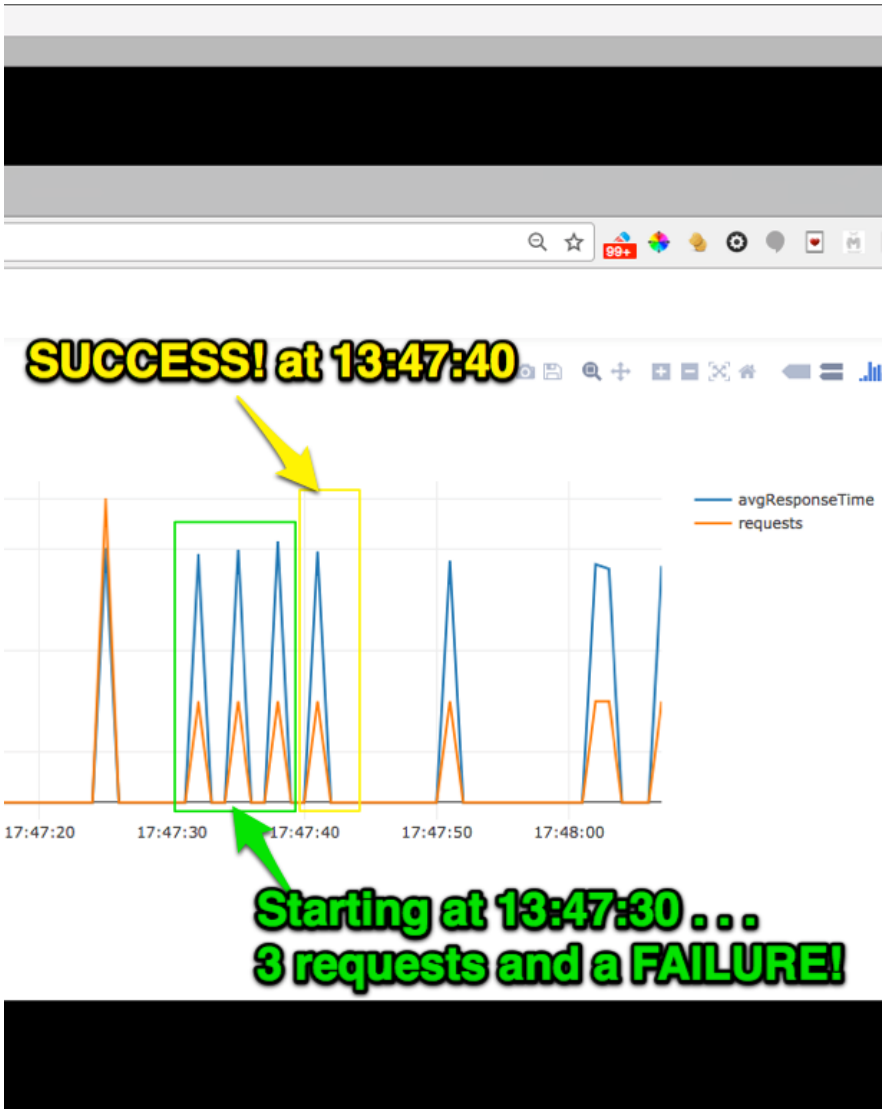

goproxy-no-reddi ⌘1
main ⌘2
bash ⌘3
~/clients/packt/dev/go/src/bitbucket.org/lsheehan/fp-in-go/chapter5 $ go run main.go
INFO : 13:46:19 Metrics server listening on 127.0.0.1:3000
INFO : 13:46:20 Proxy listening on 127.0.0.1:8080
client: 13:46:30 GET http://127.0.0.1:3000
client: 13:46:31 GET http://web02:3000
client: 13:46:33 GET http://web03:3000
INFO : 13:46:36 FAILURE!
client: 13:46:40 GET http://web01:3000
client: 13:46:41 GET http://web02:3000
client: 13:46:43 GET http://web03:3000
INFO : 13:46:46 FAILURE!
client: 13:46:50 GET http://web01:3000
client: 13:46:51 GET http://web02:3000
client: 13:46:53 GET http://web03:3000
INFO : 13:46:54 SUCCESS!
client: 13:47:00 GET http://web01:3000
client: 13:47:01 GET http://web02:3000
INFO : 13:47:02 SUCCESS!
client: 13:47:10 GET http://web03:3000
client: 13:47:11 GET http://web01:3000
client: 13:47:13 GET http://web02:3000
INFO : 13:47:13 SUCCESS!
client: 13:47:20 GET http://web03:3000
client: 13:47:21 GET http://web01:3000
client: 13:47:23 GET http://web02:3000
INFO : 13:47:26 FAILURE!
client: 13:47:30 GET http://web03:3000
client: 13:47:31 GET http://web01:3000
client: 13:47:33 GET http://web02:3000
INFO : 13:47:36 FAILURE!
client: 13:47:40 GET http://web03:3000
INFO : 13:47:41 SUCCESS!
client: 13:47:50 GET http://web01:3000
INFO : 13:47:51 SUCCESS!
client: 13:48:00 GET http://web02:3000
client: 13:48:01 GET http://web03:3000
client: 13:48:03 GET http://web01:3000
INFO : 13:48:06 FAILURE!
INFO : 13:48:06
>> It took 1m46.003136757s
INFO : 13:48:06 metrics
INFO : 13:48:06 Go to http://127.0.0.1:3000/easy-metrics?show=Stats
INFO : 13:48:06 CTRL+C to exit
Stats :: metrics
127.0.0.1:3000/easy-metrics?
Stats
Current:
avgResponseTime: 0
requests: 0
Snapshots:
[2017-05-17 17:48:07]
avgResponseTime: 2.3323783806
requests: 1
[2017-05-17 17:48:06]
avgResponseTime: 0
requests: 0
[2017-05-17 17:48:05]
avgResponseTime: 0
requests: 0
[2017-05-17 17:48:04]
avgResponseTime: 0
requests: 0
[2017-05-17 17:48:03]
avgResponseTime: 2.302413421666667
requests: 1
[2017-05-17 17:48:02]
avgResponseTime: 2.347764122217391
requests: 1
[2017-05-17 17:48:01]
avgResponseTime: 0
requests: 0




```
client: 13:46:30 GET http://127.0.0.1:3000
client: 13:46:31 GET http://web02:3000
client: 13:46:33 GET http://web03:3000
INFO  : 13:46:36 FAILURE!
```

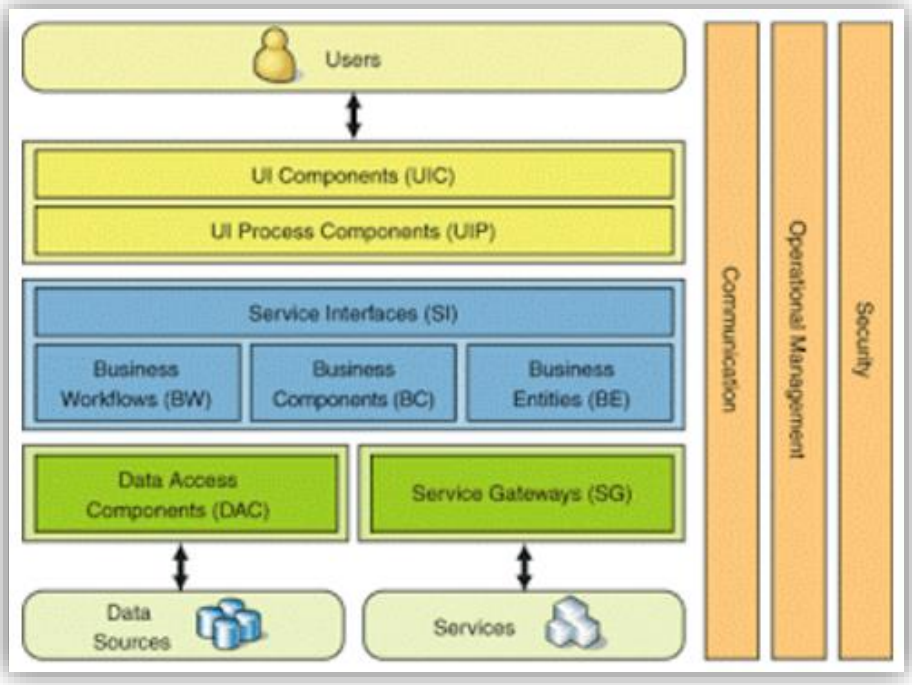

1. main
.go
s?show=Stats
2.985561 avgResponseTime
2 requests
3
2.5
2
1.5
1
0.5
0
17:46:34
17:46:40
17:46:50
17:47:00
17:47:10
One more request occurred here.
That's 3 requests and a FAILURE!

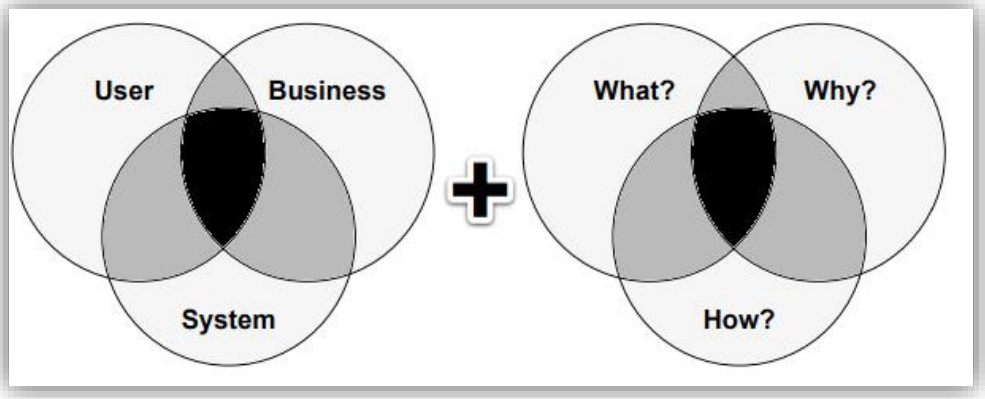

client: 13:47:30 GET http://web03:3000
client: 13:47:31 GET http://web01:3000
client: 13:47:33 GET http://web02:3000
INFO : 13:47:36 FAILURE!
client: 13:47:40 GET http://web03:3000
INFO : 13:47:41 SUCCESS!

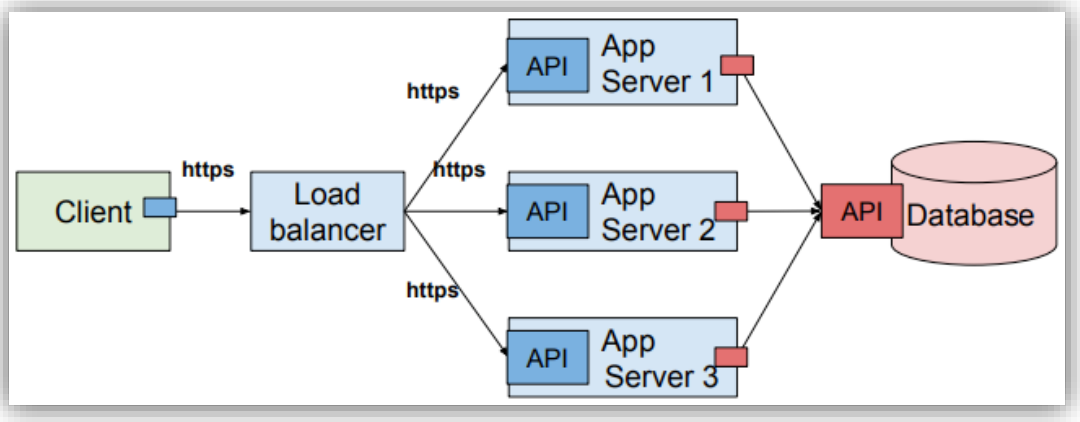

SUCCESS! at 13:47:40
avgResponseTime
requests
17:47:20
17:47:30
17:47:40
17:47:50
17:48:00
Starting at 13:47:30 . . .
3 requests and a FAILURE!

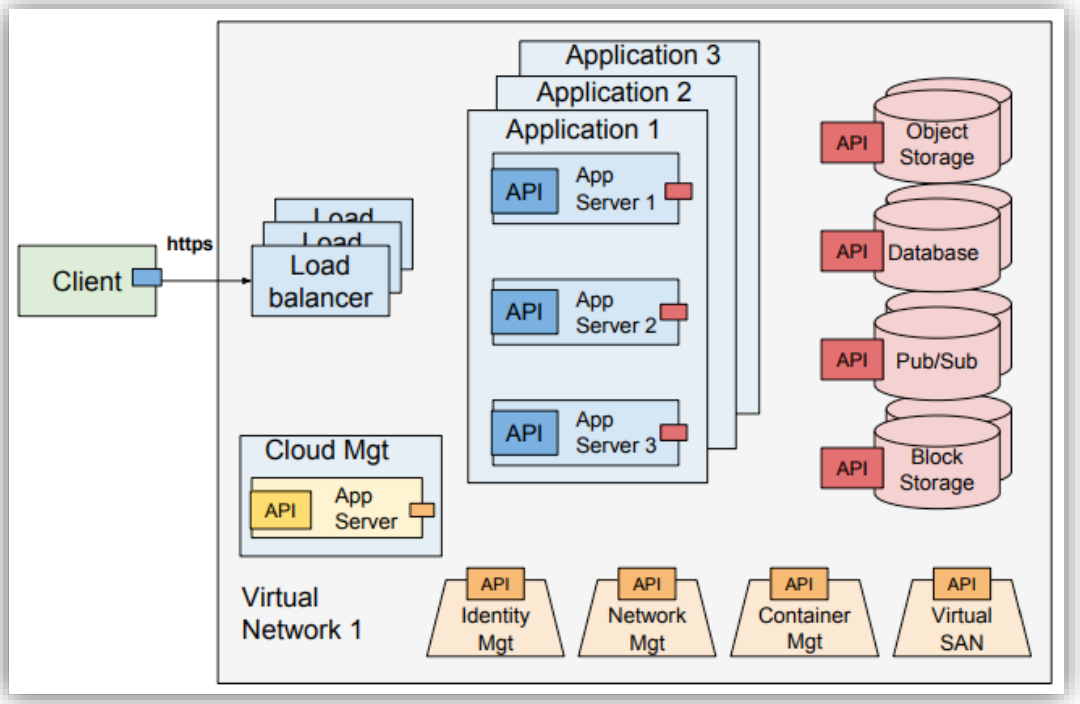

MIND BLOWN
quickmeme.com

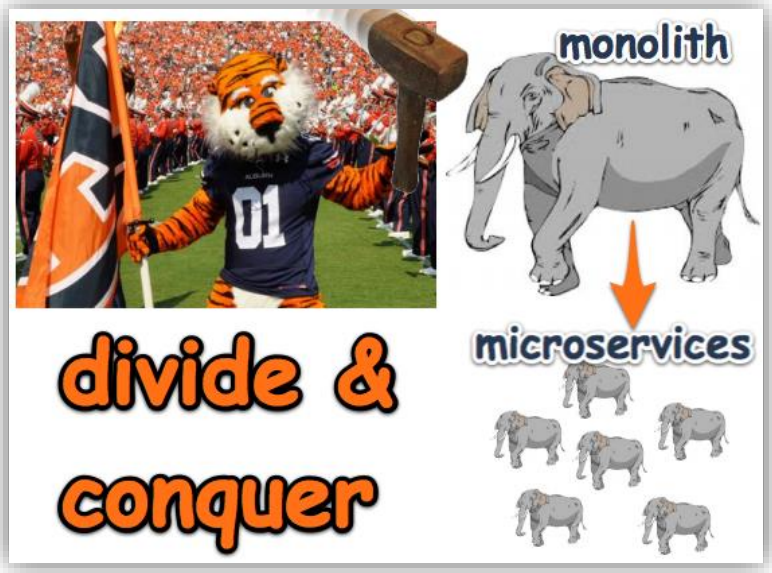
Chapter 6: Applying FP at the Architectural Level

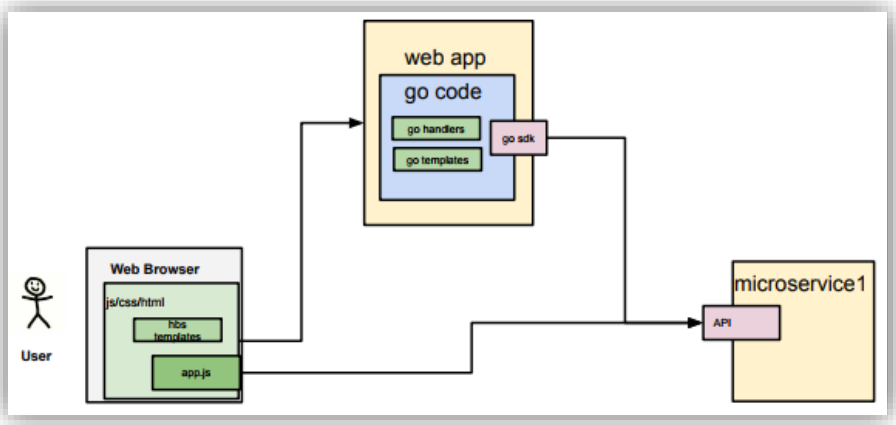


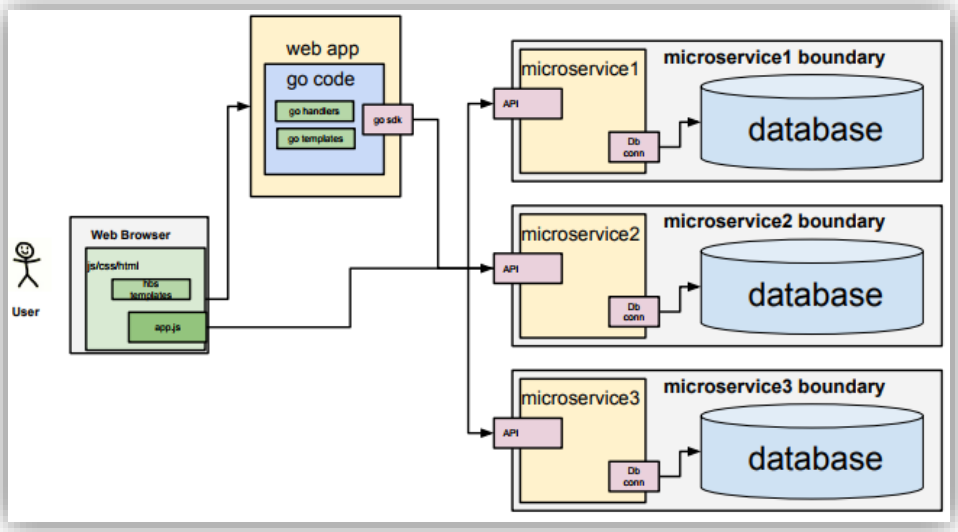


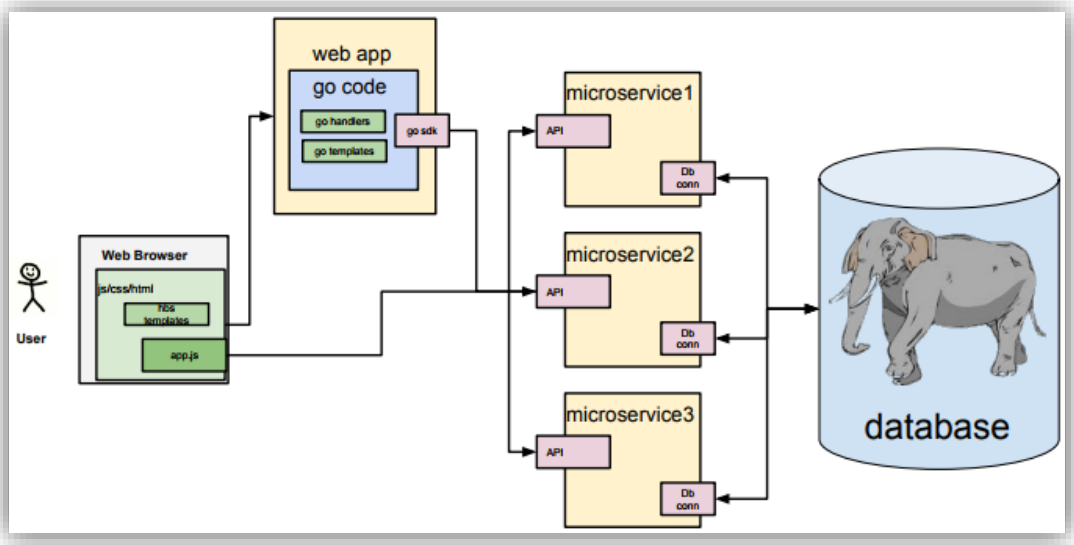

Client
https
Load balancer
https
https
https
API
App Server 1
API
App Server 2
API
App Server 3
API
Database

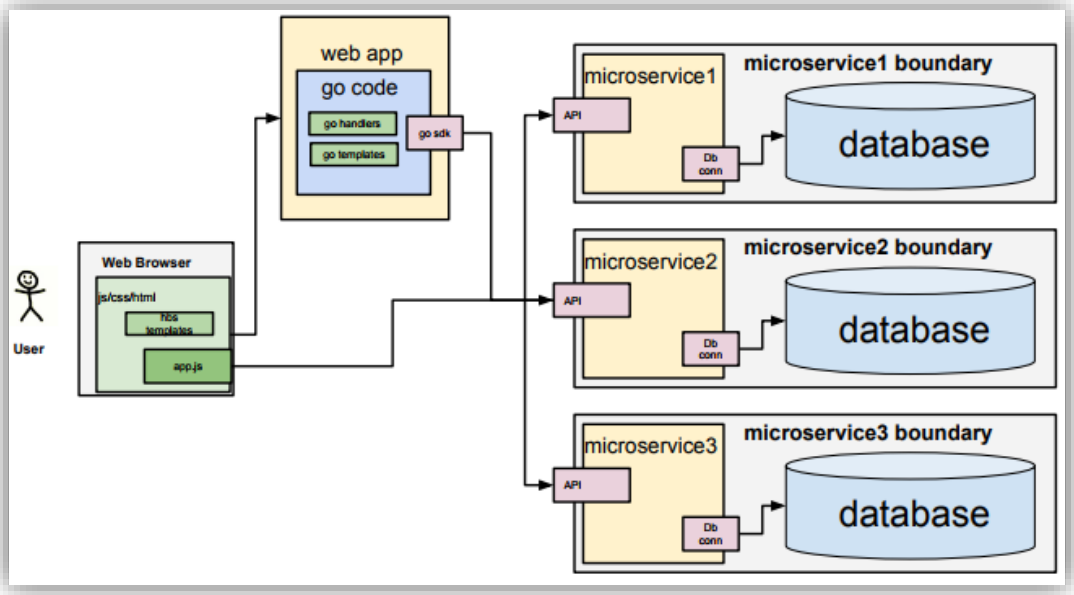

Client
https
Load balancer
Application 3
Application 2
Application 1
API
App Server 1
API
App Server 2
API
App Server 3
Cloud Mgt
API
App Server
Virtual Network 1
API
Identity Mgt
API
Network Mgt
API
Container Mgt
API
Virtual SAN
API
Object Storage
API
Database
API
Pub/Sub
API
Block Storage


monolith
microservices
divide &
conquer

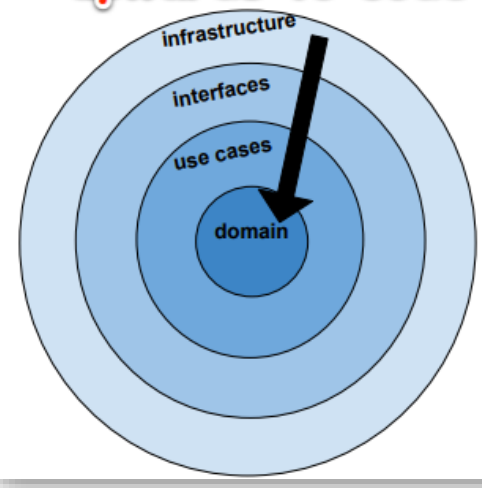

web app
go code
go handlers
go templates
go sdk
Web Browser
js/css/html
hbs templates
app.js
User
microservice1
API

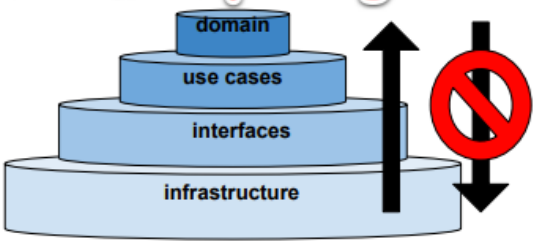

web app
go code
go handlers
go templates
go sdk
Web Browser
js/css/html
hbs templates
app.js
User
microservice1
API
Db conn
microservice1 boundary
database
microservice2
API
Db conn
microservice2 boundary
database
microservice3
API
Db conn
microservice3 boundary
database


web app
go code
go handlers
go templates
go sdk
microservice1
API
Db conn
microservice2
API
Db conn
microservice3
API
Db conn
database
Web Browser
js/css/html
hbs templates
app.js
User


web app
go code
go handlers
go templates
go sdk
microservice1
microservice1 boundary
API
Db conn
database
microservice2
microservice2 boundary
API
Db conn
database
microservice3
microservice3 boundary
API
Db conn
database
Web Browser
js/css/html
hbs templates
app.js
User

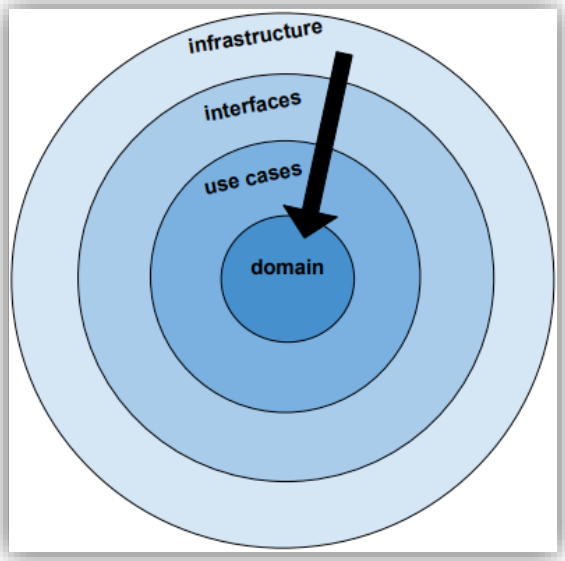
code in infrastructure can reference upwards to code in domain package

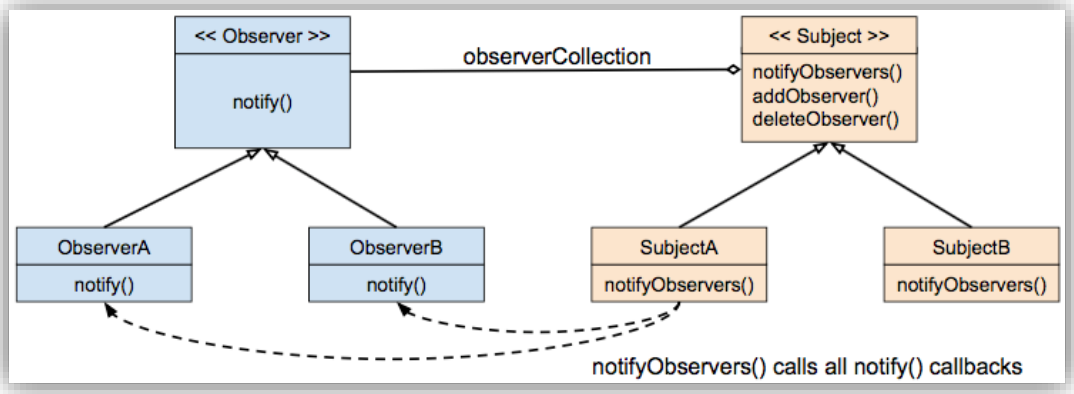


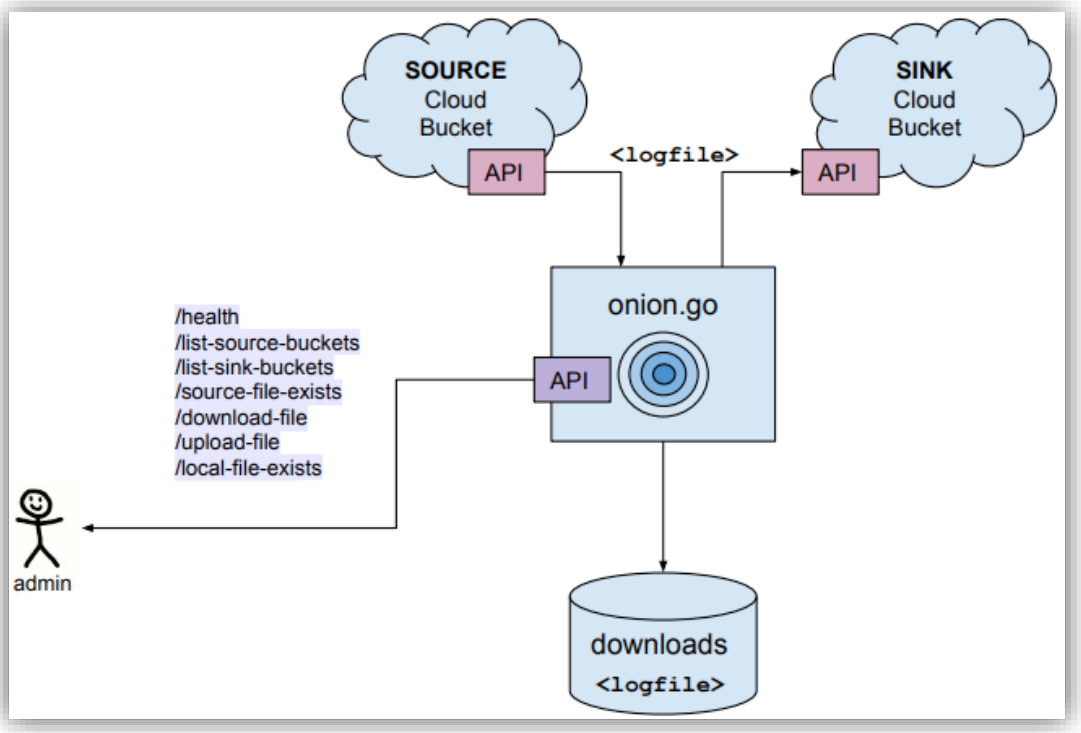


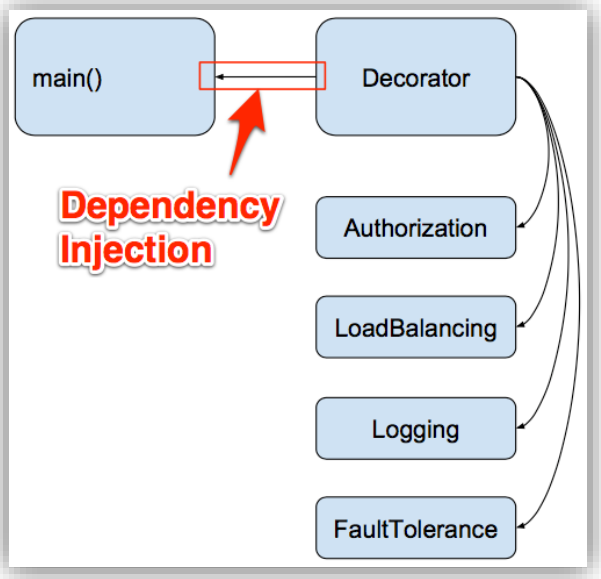
04_onion/src/infrastructure/gcphandler.go

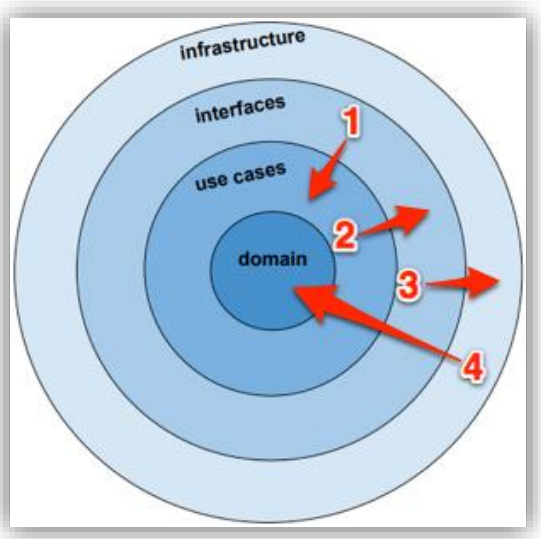
```
func (handler *GcpHandler) FileExists(fileName string) (fileExists bo
    ctx := context.Background()
    bucketName := Config.SourceBucketName
    newFile := domain.NewFile(fileName)
    fullPath := newFile.FullHostPath(Config.GcpSourceDir)
    Debug.Printf("fullPath: %s", fullPath)
```

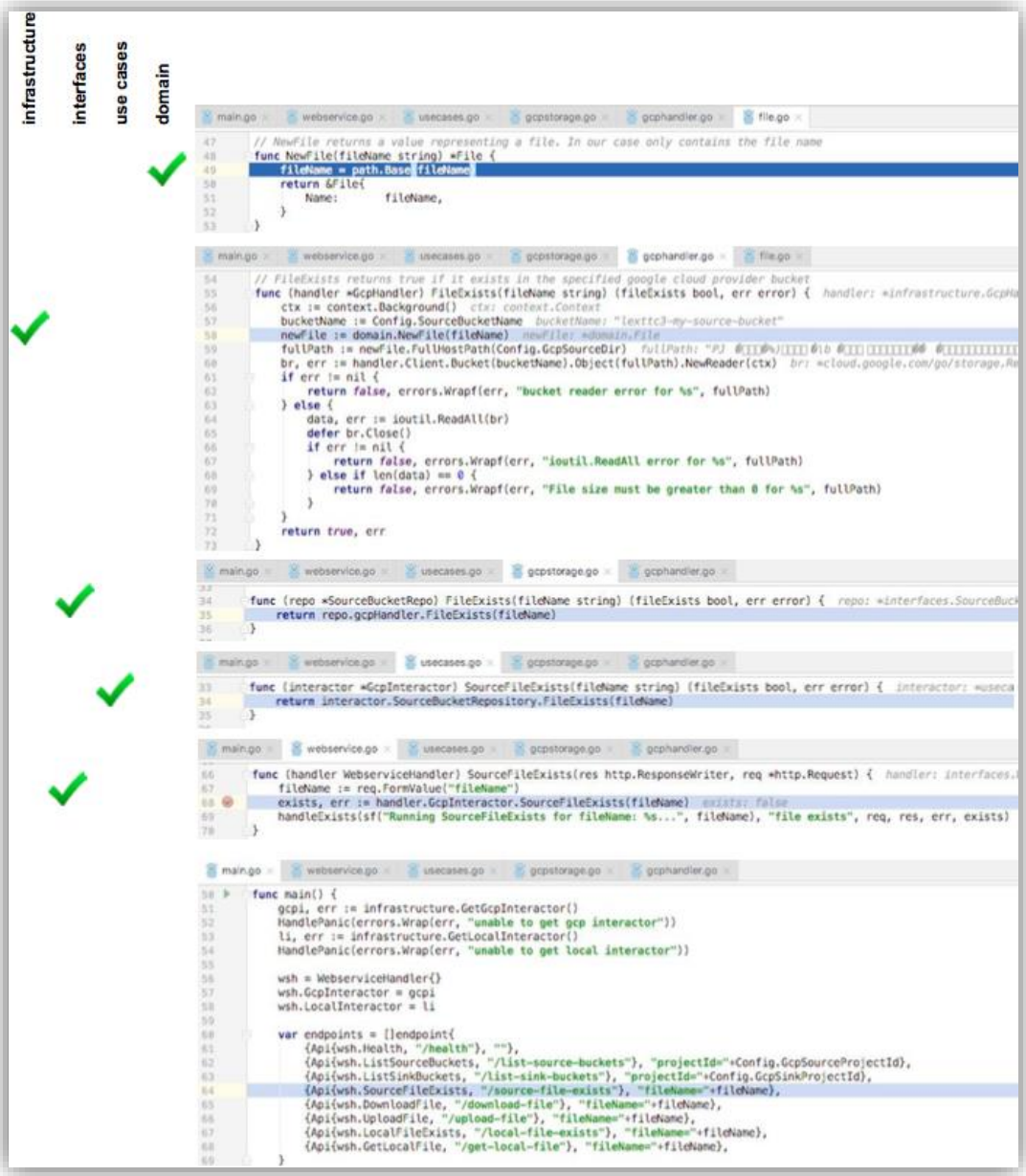


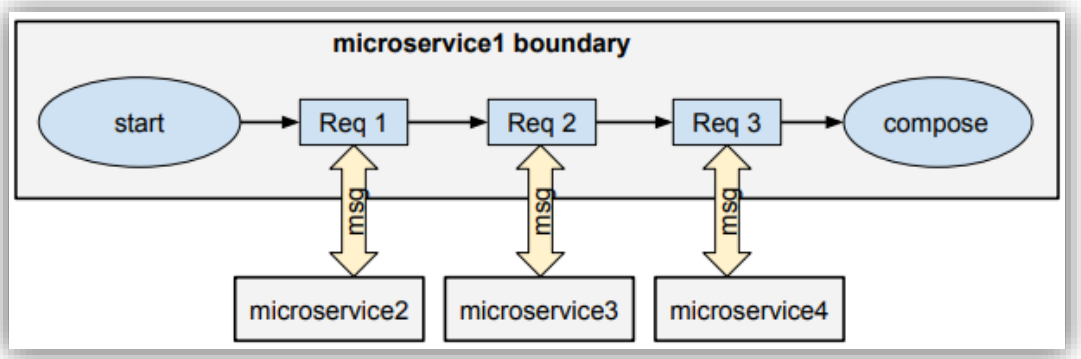

<< Observer >>
notify()
observerCollection
<< Subject >>
notifyObservers()
addObserver()
deleteObserver()
ObserverA
notify()
ObserverB
notify()
SubjectA
notifyObservers()
SubjectB
notifyObservers()
notifyObservers() calls all notify() callbacks

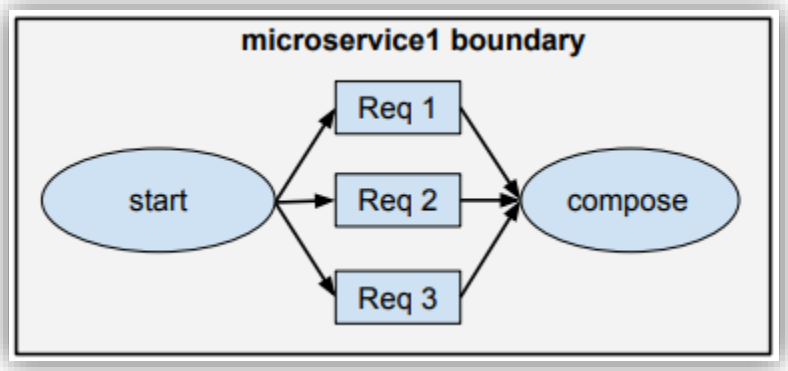

SOURCE
Cloud
Bucket
API
<logfile>
SINK
Cloud
Bucket
API
onion.go
API
/health
/list-source-buckets
/list-sink-buckets
/source-file-exists
/download-file
/upload-file
/local-file-exists
admin
downloads
<logfile>

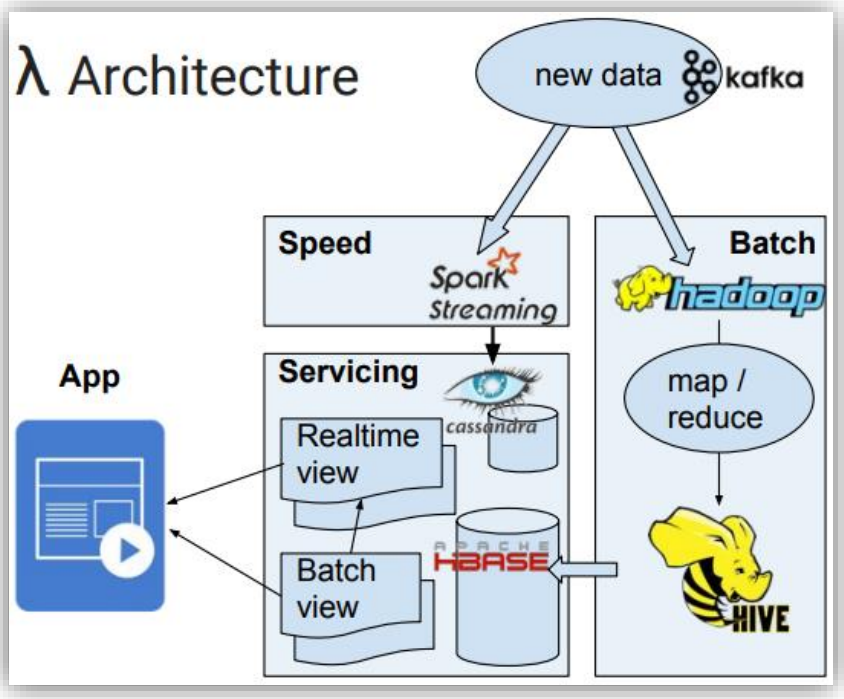

main()
Decorator
Dependency
Injection
Authorization
LoadBalancing
Logging
FaultTolerance

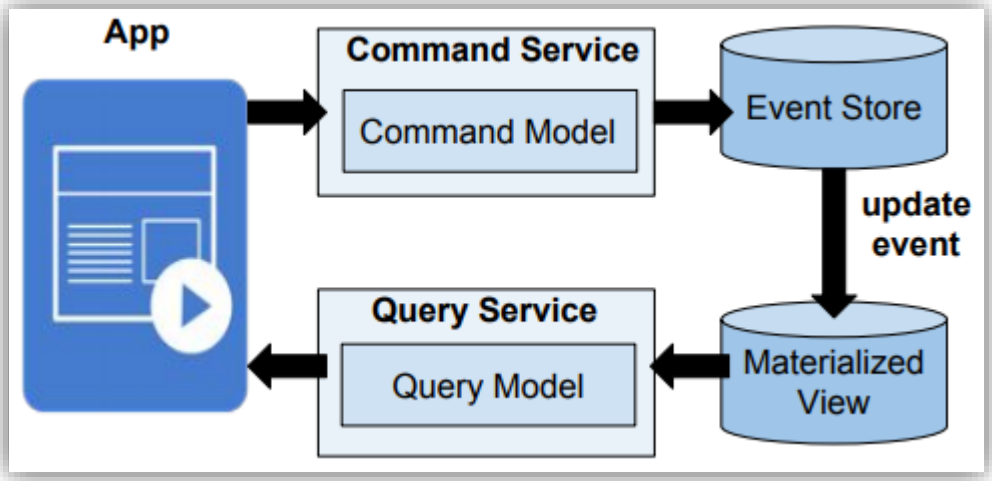

infrastructure
interfaces
use cases
domain
1
2
3
4

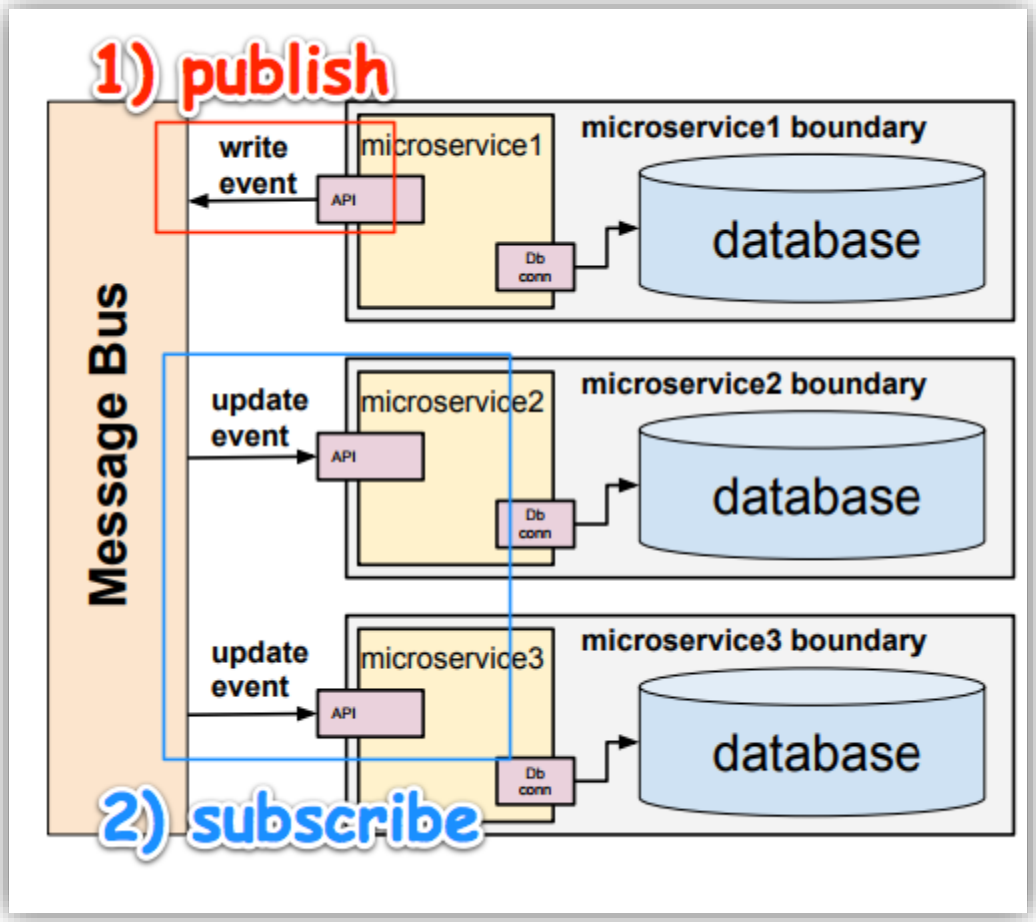

infrastructure
interfaces
use cases
domain
main.go
webservice.go
usecases.go
gcpstorage.go
gcphandler.go
file.go
// NewFile returns a value representing a file. In our case only contains the file name
func NewFile(fileName string) *File {
fileName = path.Base(fileName)
return &File{
Name: fileName,
}
}
// FileExists returns true if it exists in the specified google cloud provider bucket
func (handler *GcpHandler) FileExists(fileName string) (fileExists bool, err error) {
ctx := context.Background()
bucketName := Config.SourceBucketName
newFile := domain.NewFile(fileName)
fullPath := newFile.FullHostPath(Config.GcpSourceDir)
br, err := handler.Client.Bucket(bucketName).Object(fullPath).NewReader(ctx)
if err != nil {
return false, errors.Wrapf(err, "bucket reader error for %s", fullPath)
} else {
data, err := ioutil.ReadAll(br)
defer br.Close()
if err != nil {
return false, errors.Wrapf(err, "ioutil.ReadAll error for %s", fullPath)
} else if len(data) == 0 {
return false, errors.Wrapf(err, "File size must be greater than 0 for %s", fullPath)
}
}
return true, err
}
func (repo *SourceBucketRepo) FileExists(fileName string) (fileExists bool, err error) {
return repo.gcpHandler.FileExists(fileName)
}
func (interactor *GcpInteractor) SourceFileExists(fileName string) (fileExists bool, err error) {
return interactor.SourceBucketRepository.FileExists(fileName)
}
func (handler WebserviceHandler) SourceFileExists(res http.ResponseWriter, req *http.Request) {
fileName := req.FormValue("fileName")
exists, err := handler.GcpInteractor.SourceFileExists(fileName)
handleExists(sf("Running SourceFileExists for fileName: %s...", fileName), "file exists", req, res, err, exists)
}
func main() {
gcpi, err := infrastructure.GetGcpInteractor()
HandlePanic(errors.Wrap(err, "unable to get gcp interactor"))
li, err := infrastructure.GetLocalInteractor()
HandlePanic(errors.Wrap(err, "unable to get local interactor"))
wsh = WebserviceHandler{}
wsh.GcpInteractor = gcpi
wsh.LocalInteractor = li
var endpoints = []endpoint{
{Api{wsh.Health, "/health"}, ""},
{Api{wsh.ListSourceBuckets, "/list-source-buckets"}, "projectId="+Config.GcpSourceProjectId},
{Api{wsh.ListSinkBuckets, "/list-sink-buckets"}, "projectId="+Config.GcpSinkProjectId},
{Api{wsh.SourceFileExists, "/source-file-exists"}, "fileName="+fileName},
{Api{wsh.DownloadFile, "/download-file"}, "fileName="+fileName},
{Api{wsh.UploadFile, "/upload-file"}, "fileName="+fileName},
{Api{wsh.LocalFileExists, "/local-file-exists"}, "fileName="+fileName},
{Api{wsh.GetLocalFile, "/get-local-file"}, "fileName="+fileName},
}

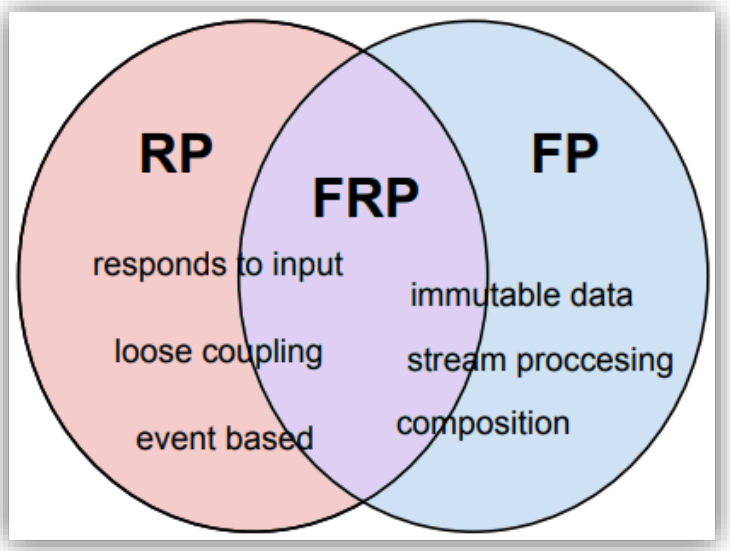

microservice1 boundary
start
Req 1
Req 2
Req 3
compose
msg
msg
msg
microservice2
microservice3
microservice4

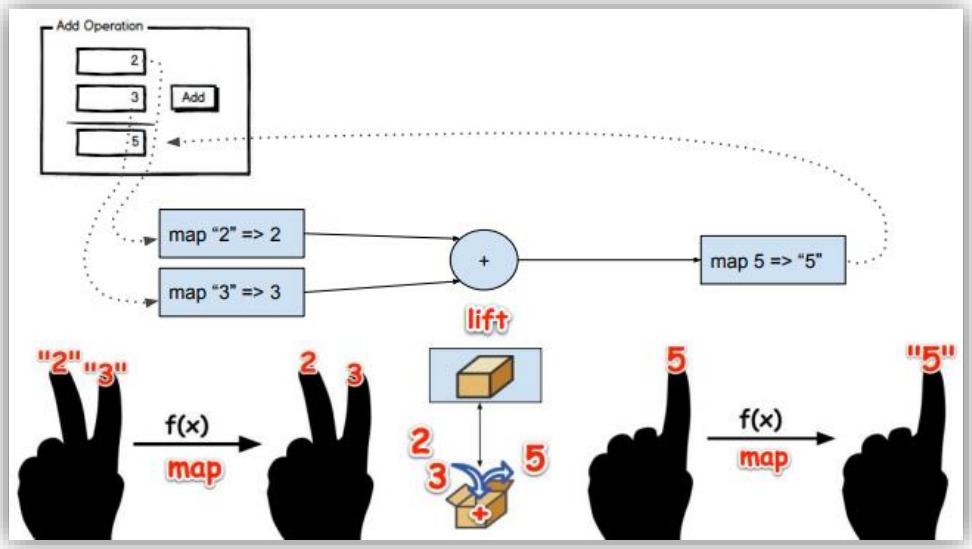

microservice1 boundary
start
Req 1
Req 2
Req 3
compose

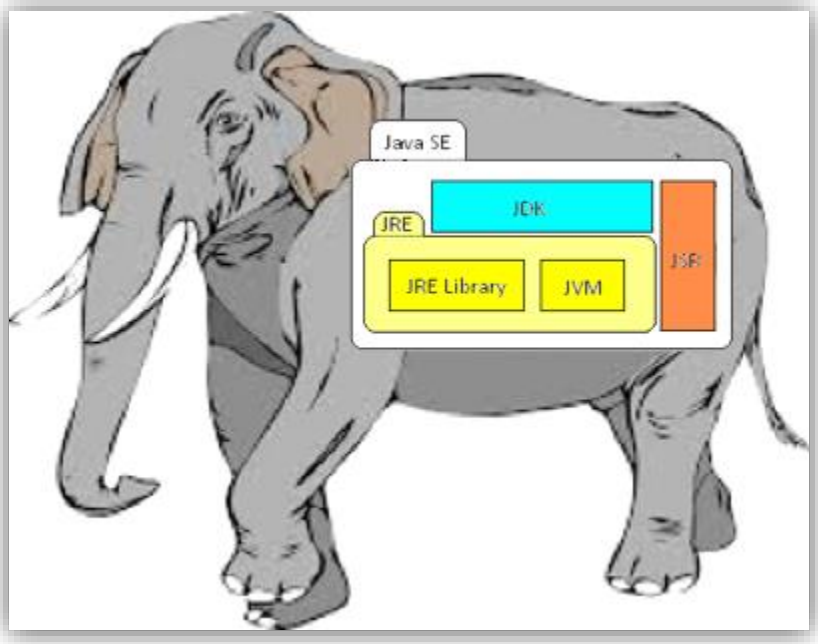

λ Architecture
new data
kafka
Speed
Spark Streaming
Batch
hadoop
App
Servicing
cassandra
map / reduce
Realtime view
Batch view
APACHE HBASE
HIVE


App
Command Service
Command Model
Event Store
update event
Query Service
Query Model
Materialized View

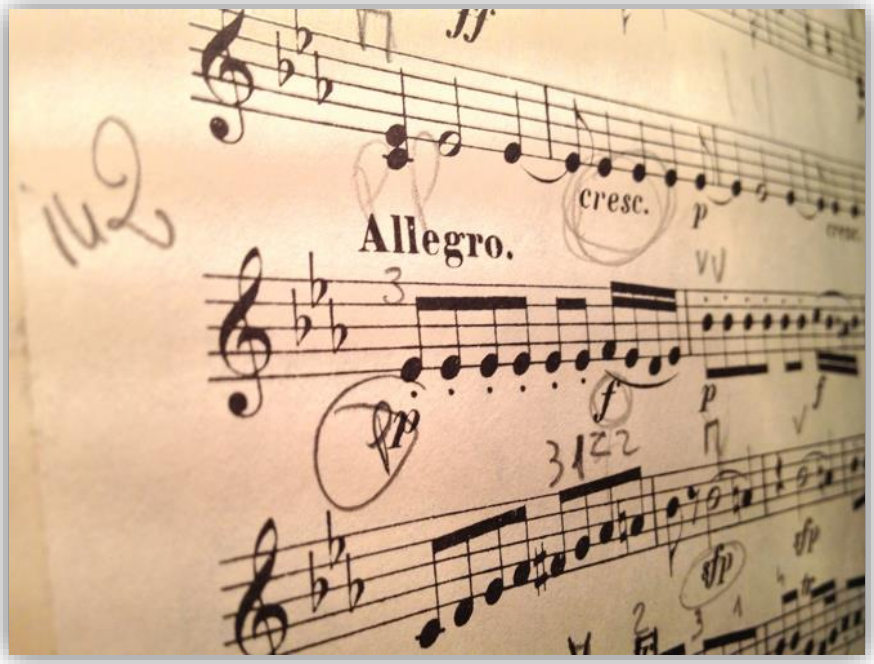

1) publish
Message Bus
write
event
API
microservice1
microservice1 boundary
Db
conn
database
update
event
API
microservice2
microservice2 boundary
Db
conn
database
update
event
API
microservice3
microservice3 boundary
Db
conn
database
2) subscribe

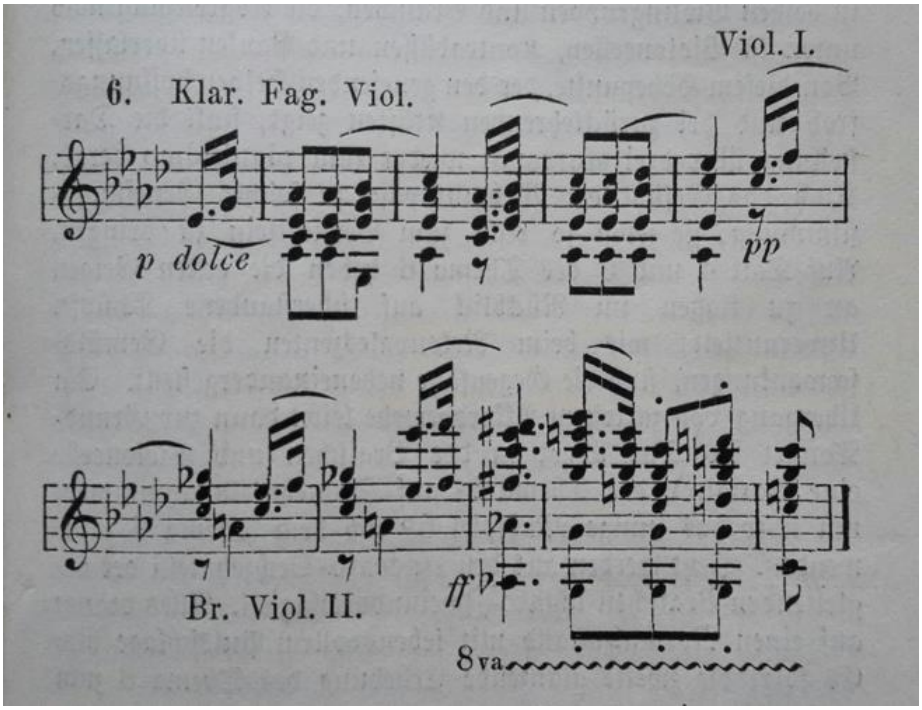

RP
FRP
FP
responds to input
loose coupling
event based
immutable data
stream proccesing
composition


Add Operation
2
3
Add
5
map "2" => 2
map "3" => 3
+
map 5 => "5"
lift
"2" "3"
f(x)
map
2 3
2
3
5
5
f(x)
map
"5"

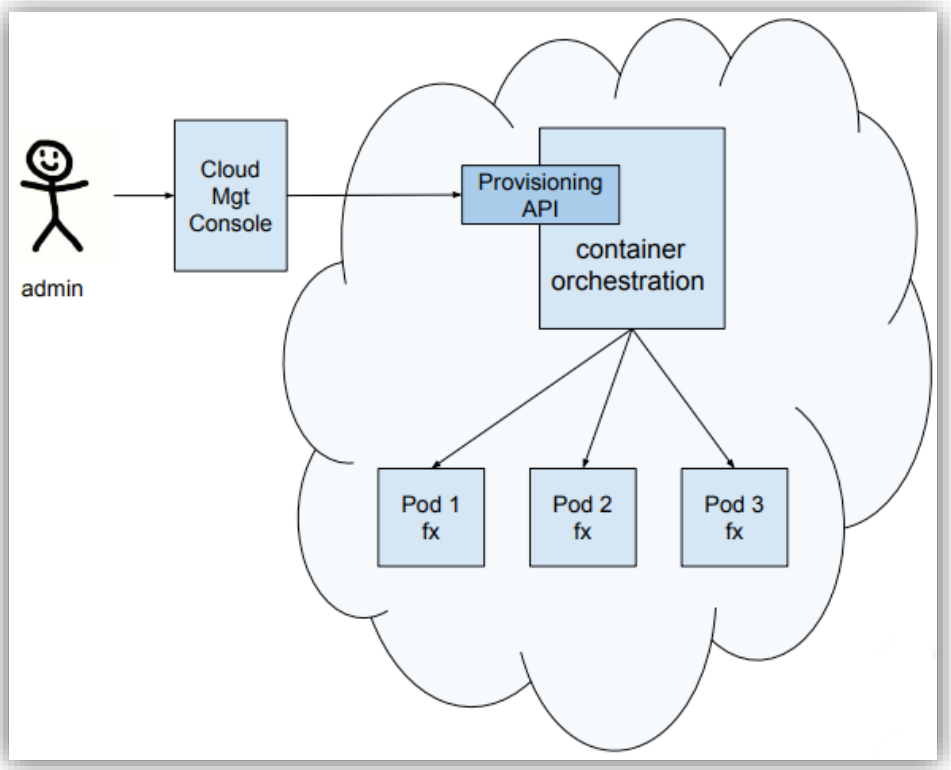

Java SE
JDK
JRE
JRE Library
JVM
JSR

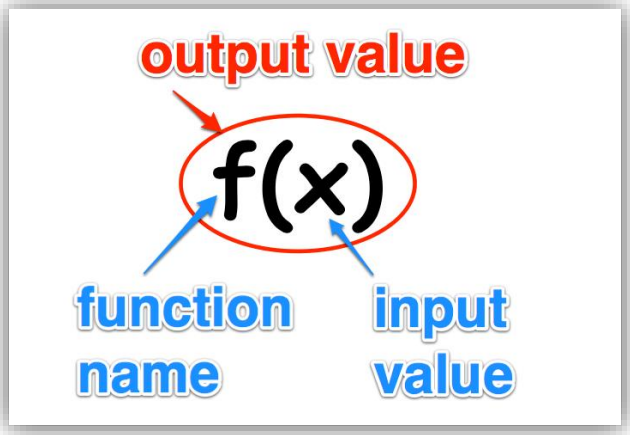
Chapter 7: Functional Parameters

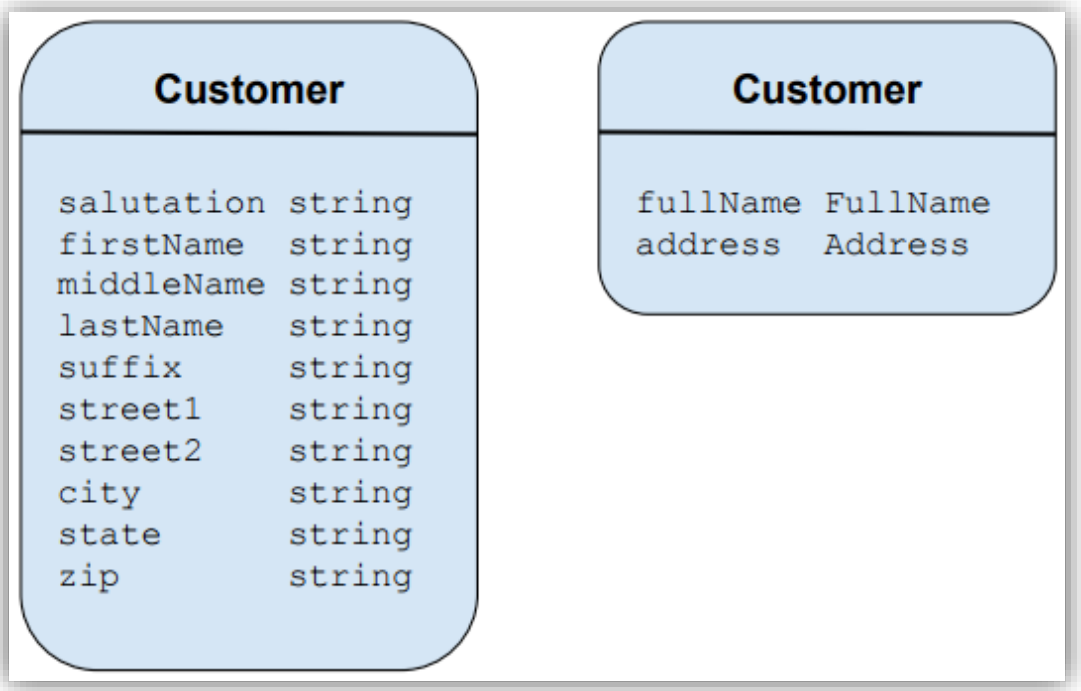



Viol. I.
6. Klar. Fag. Viol.
p dolce
pp
Br. Viol. II.
ff
8va


P3 R1 I1 D2 E1

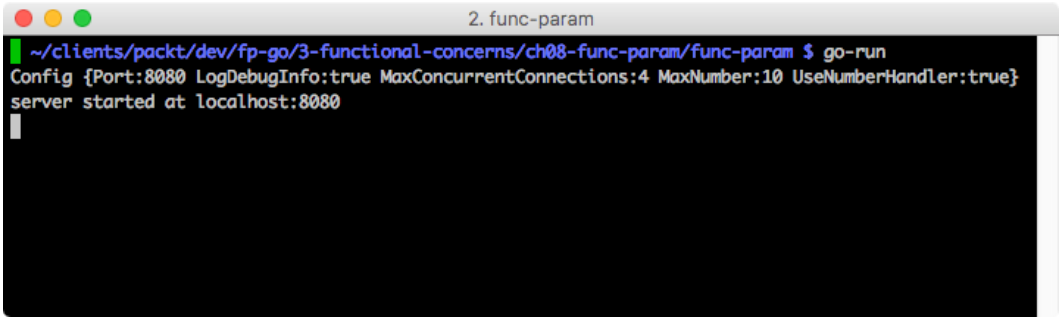

admin
Cloud
Mgt
Console
Provisioning
API
container
orchestration
Pod 1
fx
Pod 2
fx
Pod 3
fx

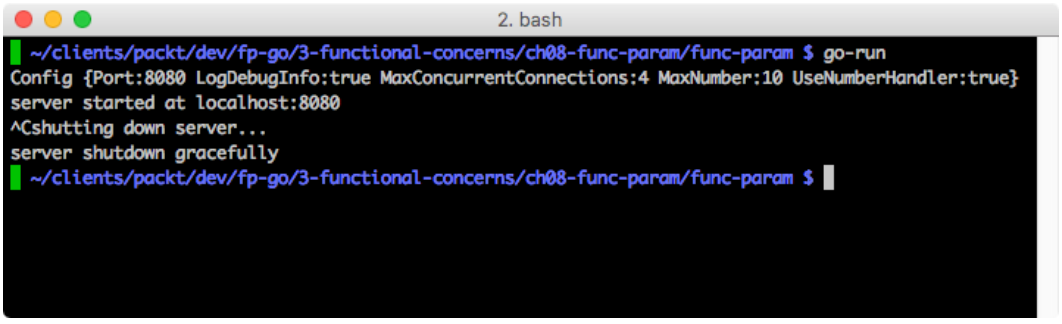

output value
f(x)
function
name
input
value

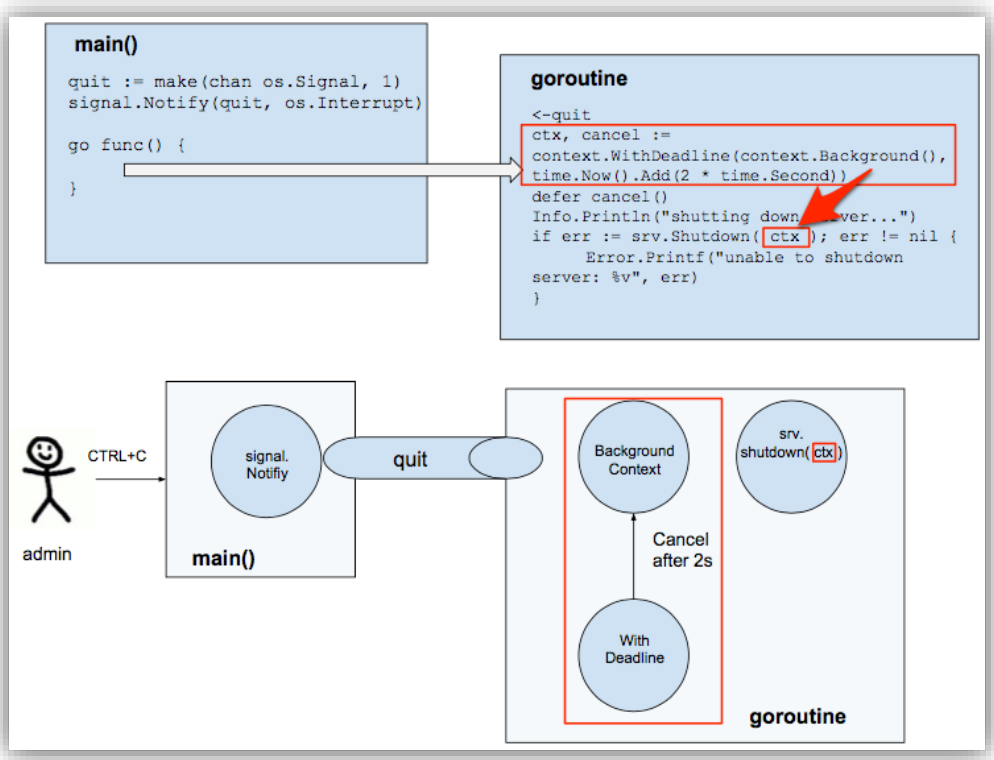

Customer
salutation string
firstName string
middleName string
lastName string
suffix string
street1 string
street2 string
city string
state string
zip string
Customer
fullName FullName
address Address

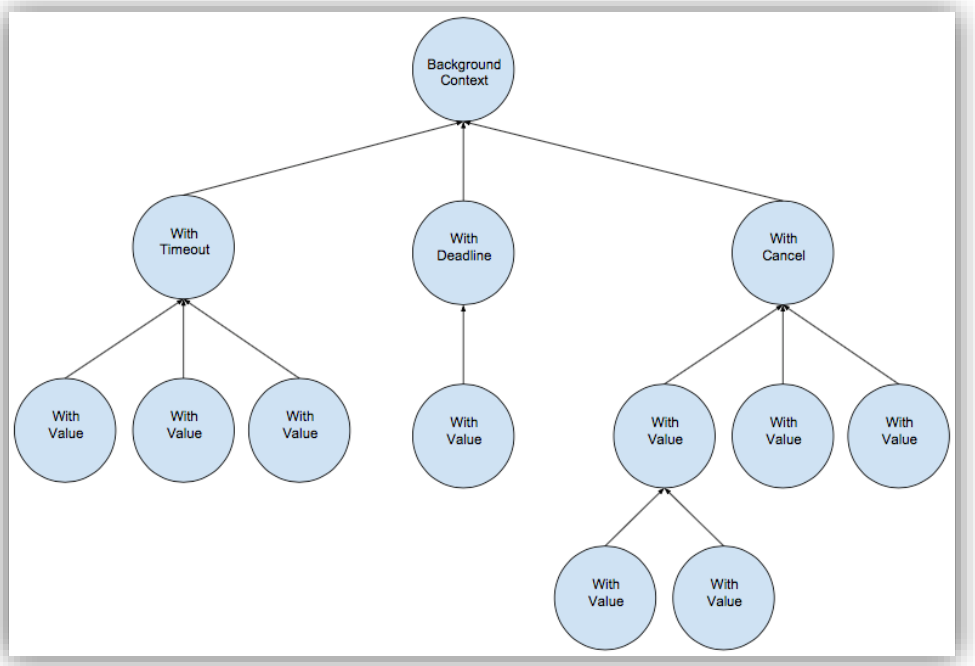

L
E
A
R
N


localhost:8080/?number=2
{"displayNumber":"10"}

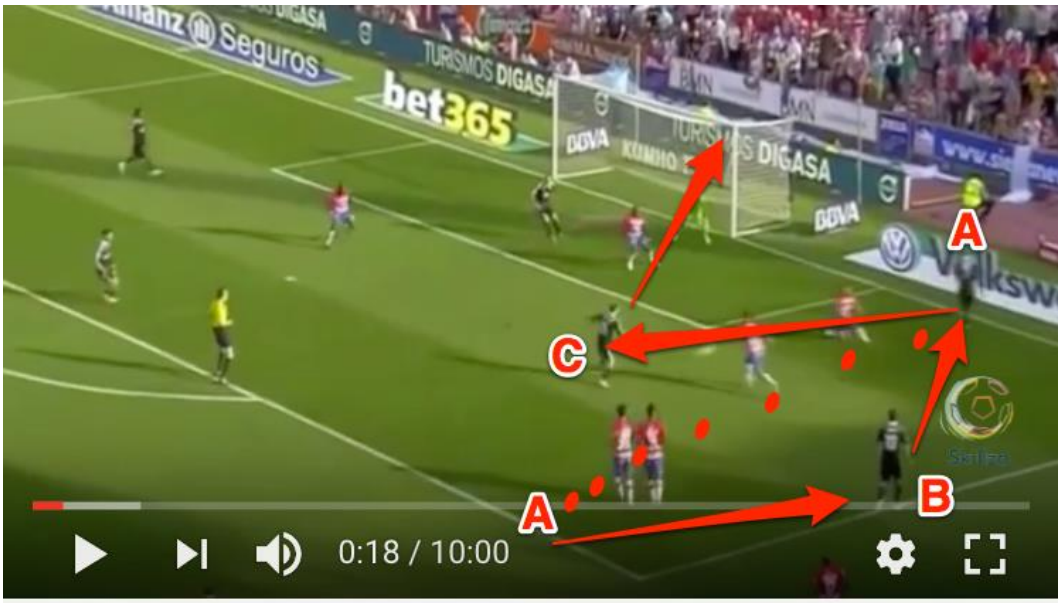

2. func-param
~/clients/packt/dev/fp-go/3-functional-concerns/ch08-func-param/func-param $ go-run
Config {Port:8080 LogDebugInfo:true MaxConcurrentConnections:4 MaxNumber:10 UseNumberHandler:true}
server started at localhost:8080


2. bash
~/clients/packt/dev/fp-go/3-functional-concerns/ch08-func-param/func-param $ go-run
Config {Port:8080 LogDebugInfo:true MaxConcurrentConnections:4 MaxNumber:10 UseNumberHandler:true}
server started at localhost:8080
^Cshutting down server...
server shutdown gracefully
~/clients/packt/dev/fp-go/3-functional-concerns/ch08-func-param/func-param $


main()
quit := make(chan os.Signal, 1)
signal.Notify(quit, os.Interrupt)
go func() {
}
goroutine
<-quit
ctx, cancel :=
context.WithDeadline(context.Background(),
time.Now().Add(2 * time.Second))
defer cancel()
Info.Println("shutting down server...")
if err := srv.Shutdown(ctx); err != nil {
Error.Printf("unable to shutdown
server: %v", err)
}
admin
CTRL+C
signal.
Notifiy
main()
quit
Background
Context
srv.
shutdown(ctx)
Cancel
after 2s
With
Deadline
goroutine


Background Context
With Timeout
With Deadline
With Cancel
With Value
With Value
With Value
With Value
With Value
With Value
With Value
With Value


COPA ORO
49:07
FASE DE GRUPOS
USA
0:0
PAN
SNICKERS
GRUPO B
NISSAN
telcel
0:02 / 1:09
CC
HD



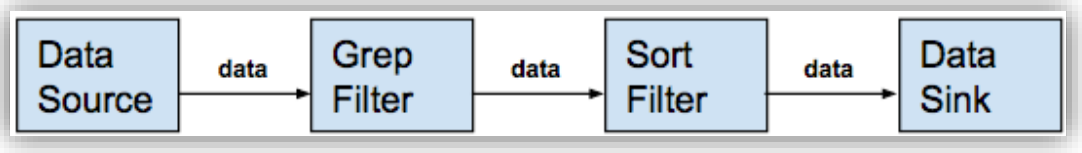
Real Madrid Amazing Team Plays Combinations And Passing.

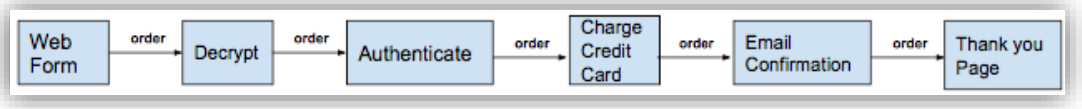
short passes

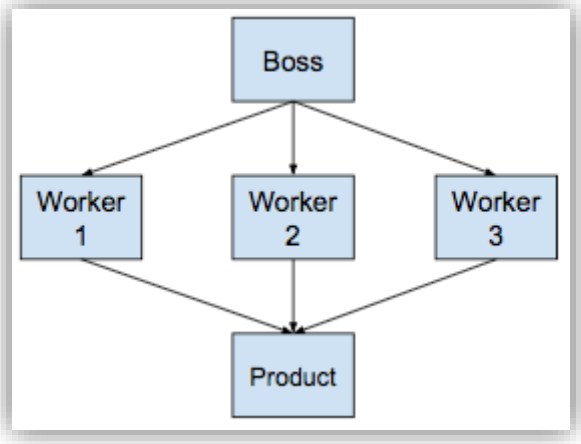

localhost:8080/?number=255
{"displayNumber":"255"}

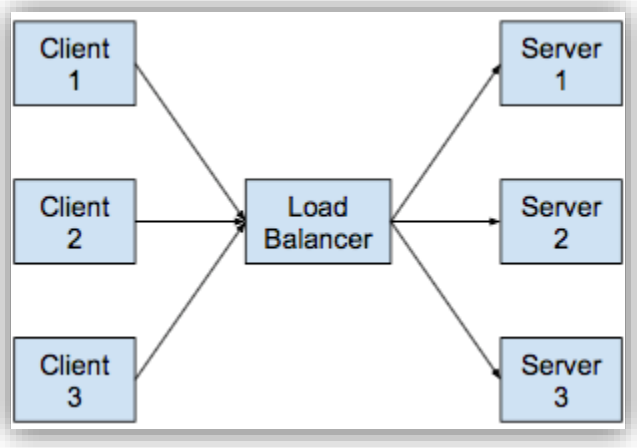

localhost:8080/?number=255
{"displayNumber":"11111111"}

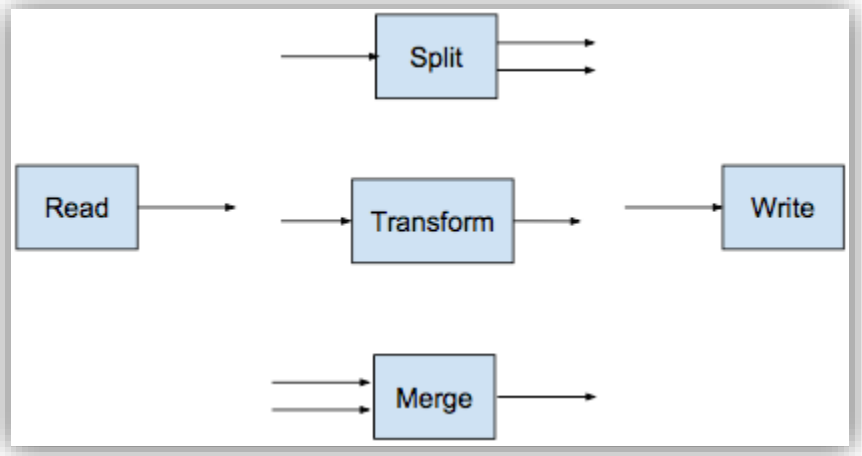
Chapter 8: Increasing Performance Using Pipelining

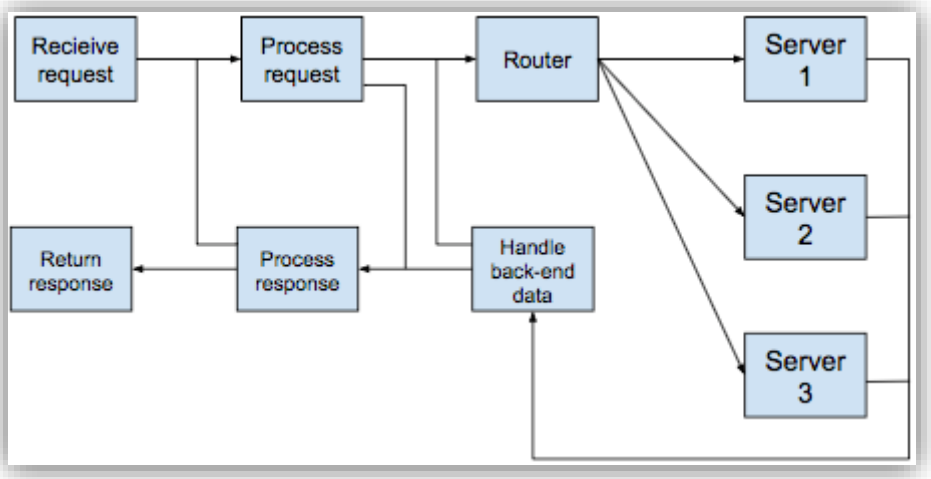


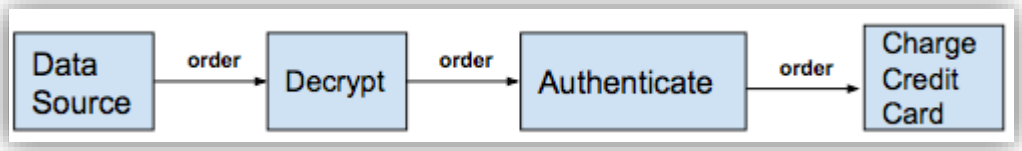


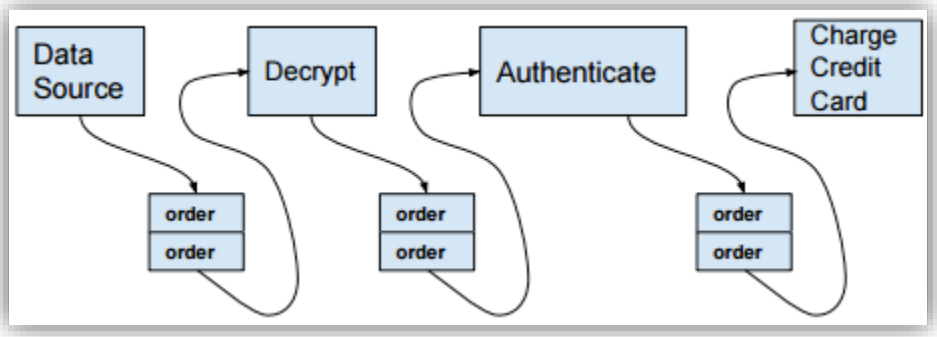


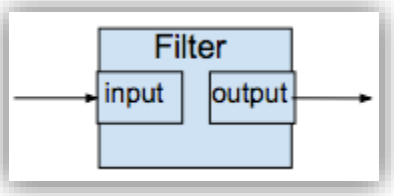

Client 1
Client 2
Client 3
Load Balancer
Server 1
Server 2
Server 3


Split
Read
Transform
Write
Merge

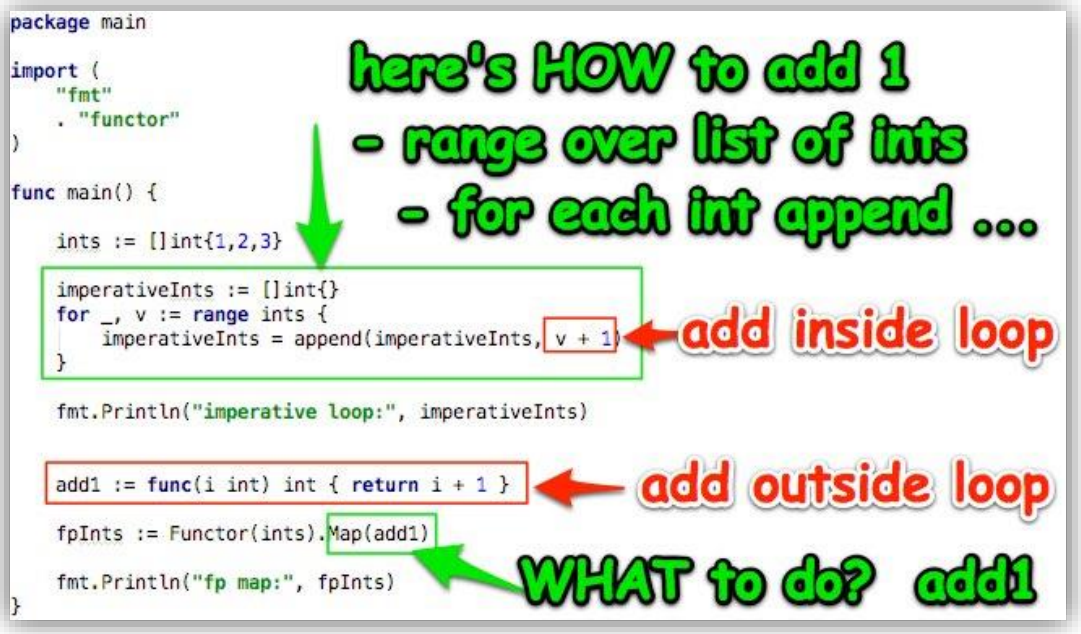

Recieive request
Process request
Router
Server 1
Server 2
Server 3
Return response
Process response
Handle back-end data

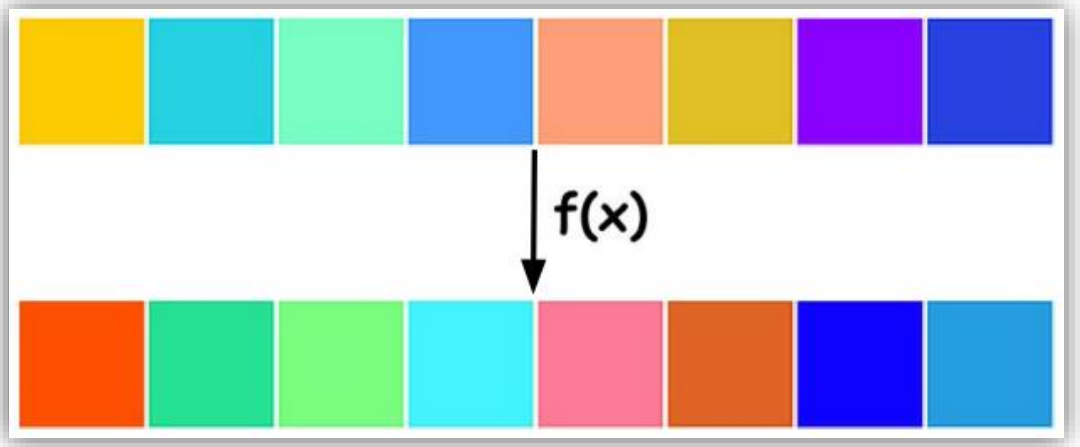

Data Source
order
Decrypt
order
Authenticate
order
Charge Credit Card

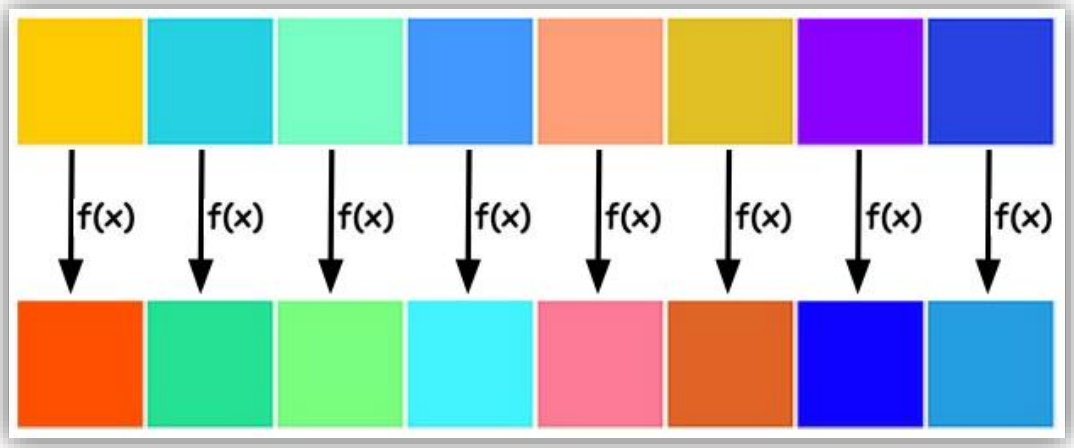

Data Source
Decrypt
Authenticate
Charge Credit Card
order
order
order
order
order
order

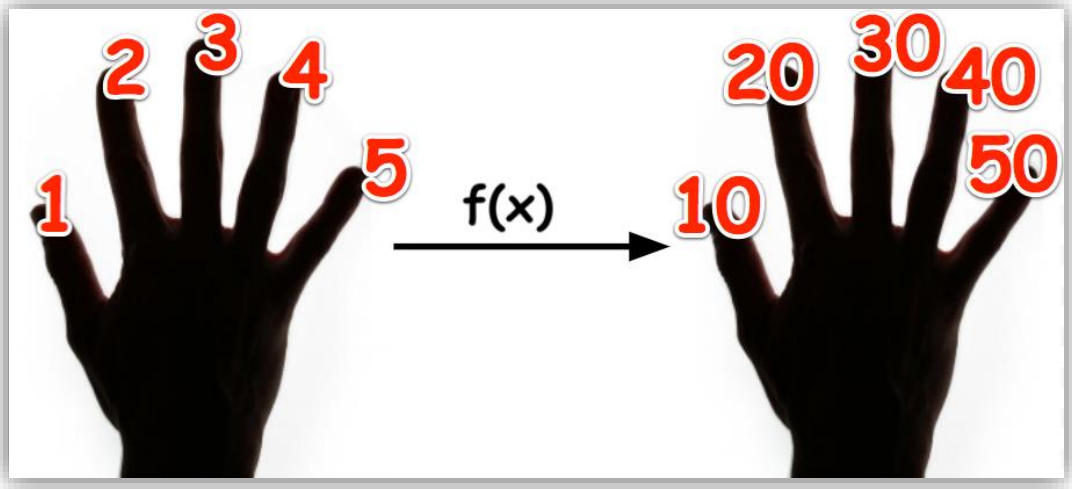

Filter
input
output

Chapter 9: Functors, Monoids, and Generics

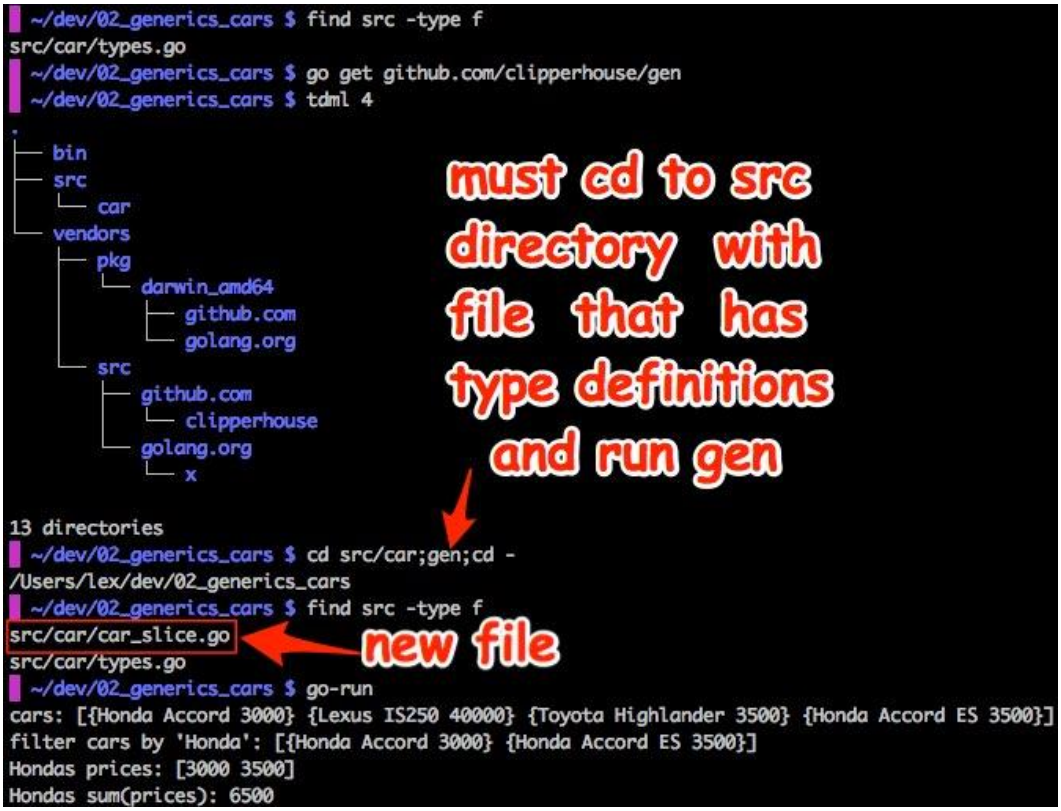


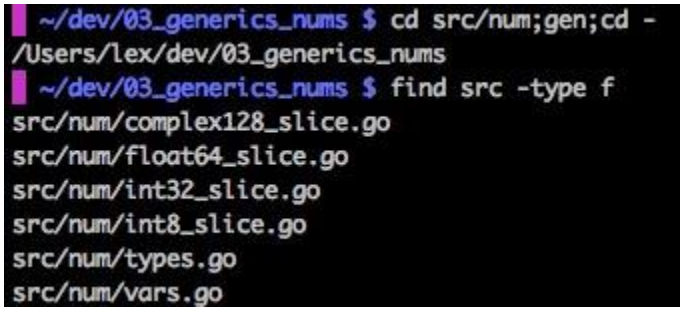


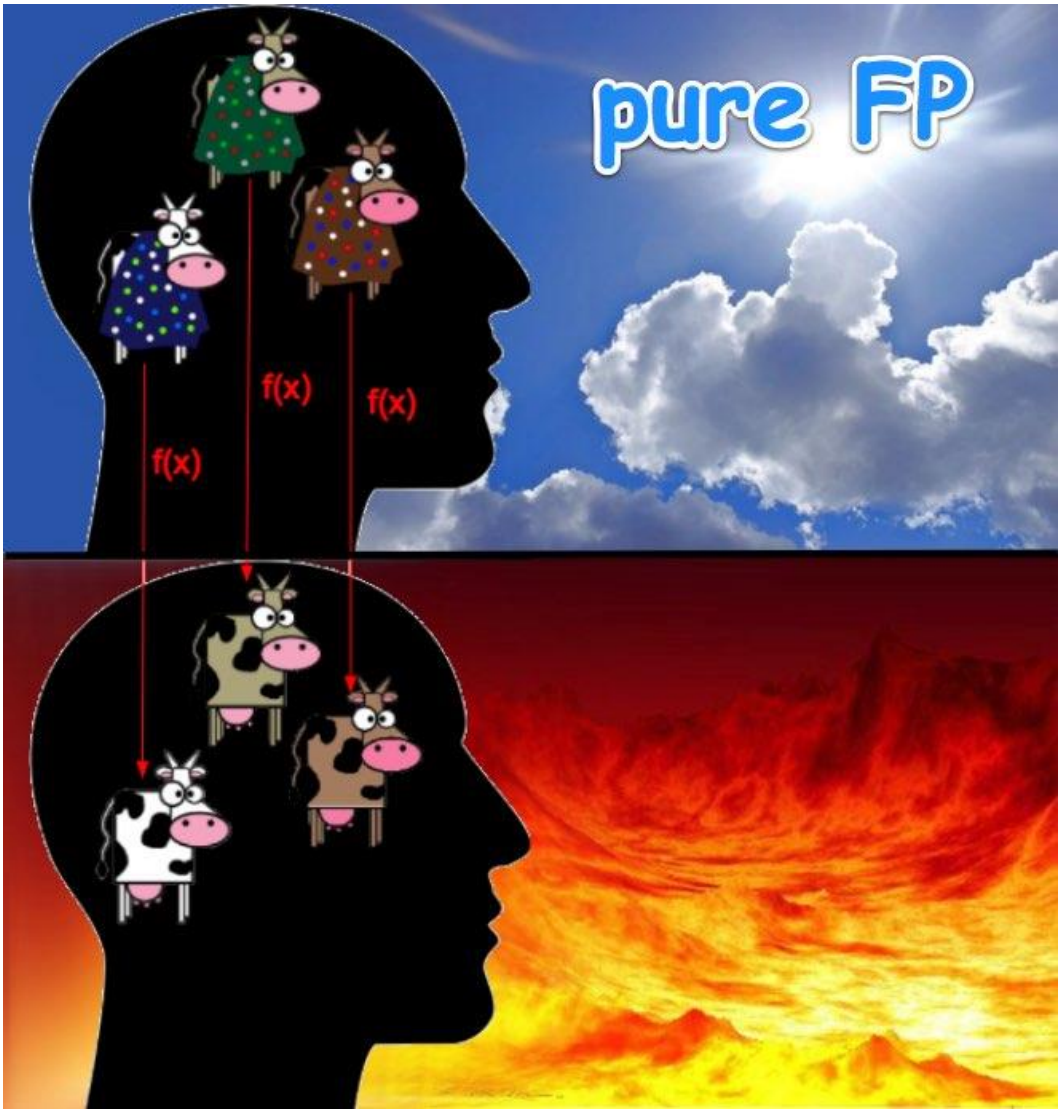

f(x)
f(x)
f(x)
f(x)
f(x)
f(x)
f(x)
f(x)

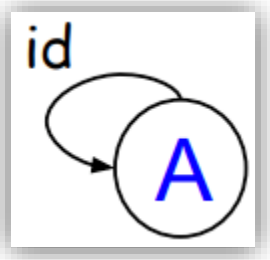

1
2
3
4
5
f(x)
10
20
30
40
50

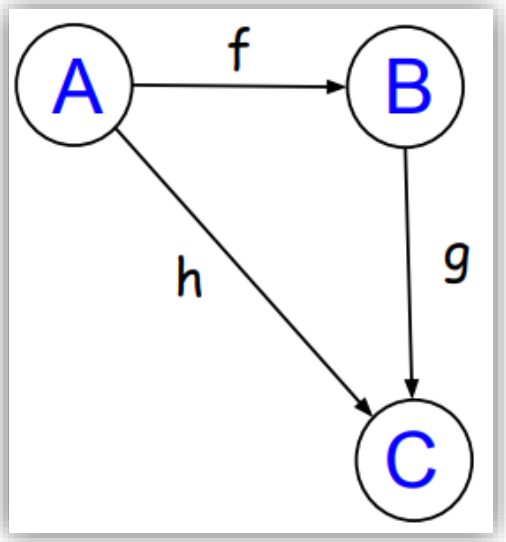

1. bash
~/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/02_generics_cars $. init
++ ln -s /Users/lex/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/02_generics_cars /Users/lex/dev/02_generics_cars
Installed Go version: go version go1.9.2 darwin/amd64
Switching Go to version 1.9.2 ...
GOVERSION: go version go1.9.2 darwin/amd64
CURRENT_GOVERSION: go1.9.2
You should only need to run this init script once.
Add Go source code files under the src directory.
After updating dependencies, i.e., adding a new import statement, run: glide-update
To build and run your app, run: go-run
~/dev/02_generics_cars $ tdml 4
.
├── bin
└── src
    ├── car
    └── mypackage
4 directories
~/dev/02_generics_cars $ glide-update
~/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/02_generics_cars ~/dev/02_generics_cars
[INFO] Generating a YAML configuration file and guessing the dependencies
[INFO] Attempting to import from other package managers (use --skip-import to skip)
[INFO] Scanning code to look for dependencies
[INFO] Writing configuration file (glide.yaml)
[INFO] You can now edit the glide.yaml file. Consider:
[INFO] --> Using versions and ranges. See https://glide.sh/docs/versions/
[INFO] --> Adding additional metadata. See https://glide.sh/docs/glide.yaml/
[INFO] --> Running the config-wizard command to improve the versions in your configuration
[INFO] Downloading dependencies. Please wait...
[INFO] No references set.
[INFO] Resolving imports
[INFO] Downloading dependencies. Please wait...
[INFO] Setting references for remaining imports
[INFO] No references set.
[INFO] Exporting resolved dependencies...
[INFO] Replacing existing vendor dependencies
[INFO] Project relies on 0 dependencies.
vendor packages have been moved to /Users/lex/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/02_generics_cars/vendors and your GOPATH: /Users/lex/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/02_generics_cars/vendors:/Users/lex/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/02_generics_cars
~/dev/02_generics_cars
~/dev/02_generics_cars $ tdml 4
.
├── bin
├── src
│   ├── car
│   └── mypackage
└── vendors
    └── src
6 directories
~/dev/02_generics_cars $

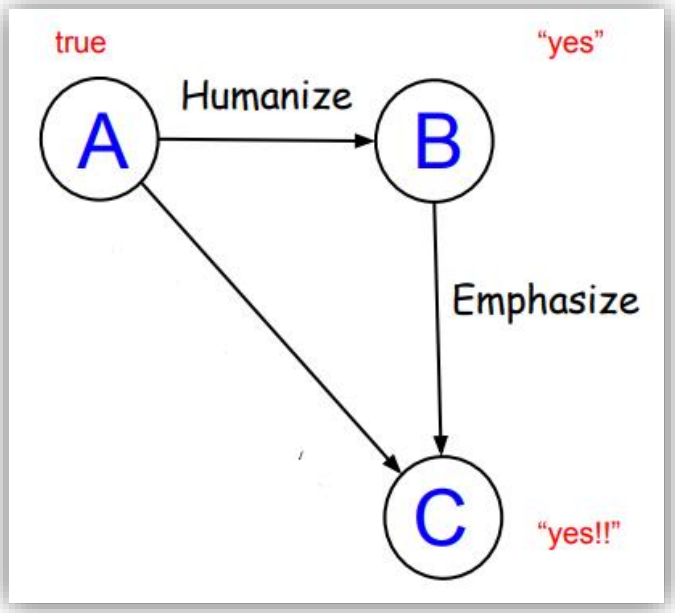

~/dev/02_generics_cars $ find src -type f
src/car/types.go
~/dev/02_generics_cars $ go get github.com/clipperhouse/gen
~/dev/02_generics_cars $ tdml 4
.
bin
src
car
vendors
pkg
darwin_amd64
github.com
golang.org
src
github.com
clipperhouse
golang.org
x
13 directories
~/dev/02_generics_cars $ cd src/car;gen;cd -
/Users/lex/dev/02_generics_cars
~/dev/02_generics_cars $ find src -type f
src/car/car_slice.go
src/car/types.go
~/dev/02_generics_cars $ go-run
cars: [{Honda Accord 3000} {Lexus IS250 40000} {Toyota Highlander 3500} {Honda Accord ES 3500}]
filter cars by 'Honda': [{Honda Accord 3000} {Honda Accord ES 3500}]
Hondas prices: [3000 3500]
Hondas sum(prices): 6500
must cd to src directory with file that has type definitions and run gen
new file


~/dev/03_generics_nums $ cd src/num;gen;cd -
/Users/lex/dev/03_generics_nums
~/dev/03_generics_nums $ find src -type f
src/num/complex128_slice.go
src/num/float64_slice.go
src/num/int32_slice.go
src/num/int8_slice.go
src/num/types.go
src/num/vars.go

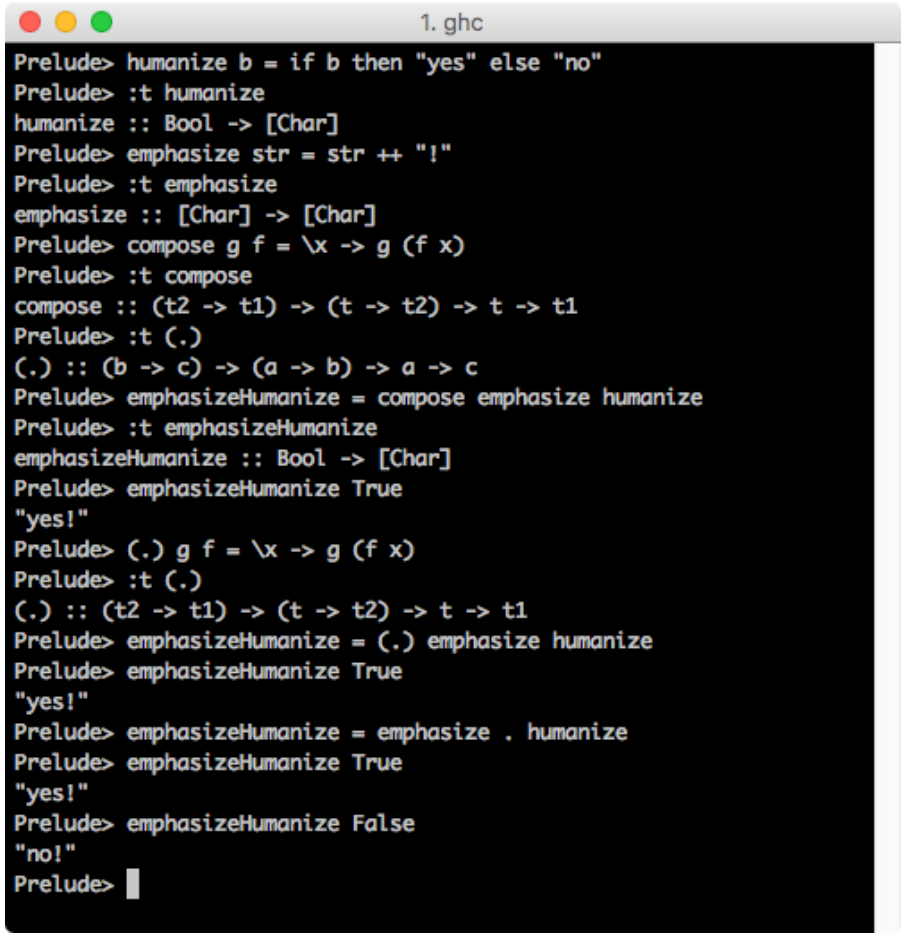

pure FP
f(x)
f(x)
f(x)

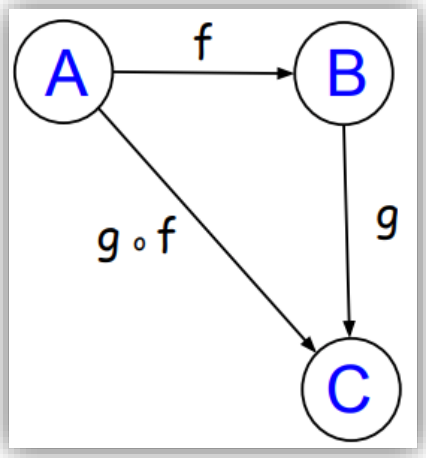

id
A

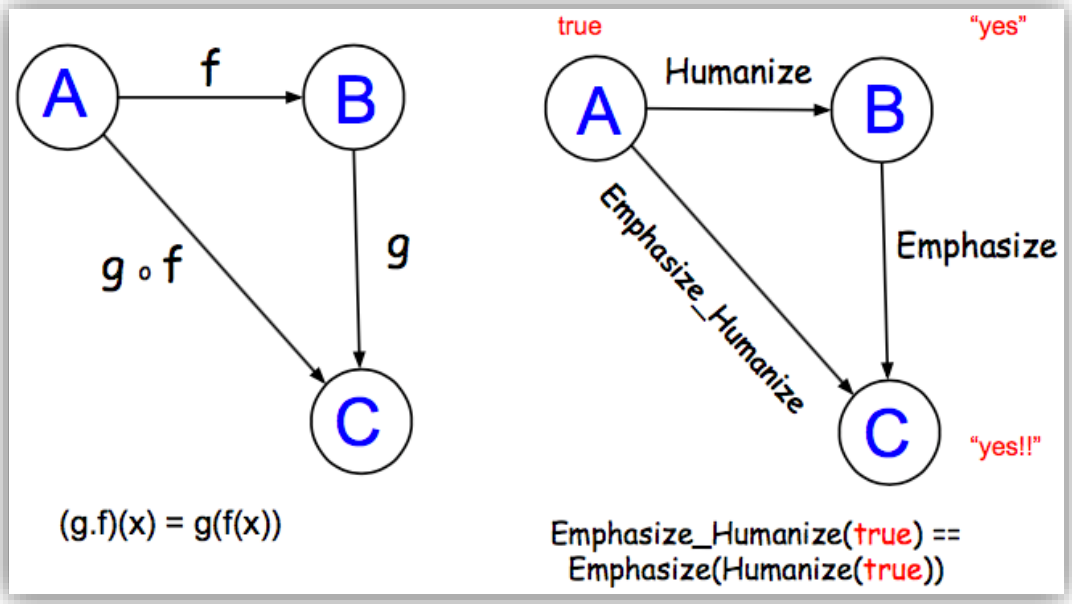

A
f
B
h
g
C




```
1. bash
~/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/09_clock_functor $ . init
++ ln -s /Users/lex/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/09_clock_functor
/Users/lex/dev/09_clock_functor
Installed Go version: go version go1.9.2 darwin/amd64
Switching Go to version 1.9.2 ...
GOVERSION: go version go1.9.2 darwin/amd64
CURRENT_GOVERSION: go1.9.2
You should only need to run this init script once.
Add Go source code files under the src directory.
After updating dependencies, i.e., adding a new import statement, run: glide-update
To build and run your app, run: go-run
~/dev/09_clock_functor $ go-run
Initial state     : [1 2 3 4 5 6 7 8 9 10 11 12]
Zero application  : [1 2 3 4 5 6 7 8 9 10 11 12]
1st application   : [13 14 15 16 17 18 19 20 21 22 23 0]
Chain applications: [1 2 3 4 5 6 7 8 9 10 11 12]
Chain applications: [13 14 15 16 17 18 19 20 21 22 23 0]
~/dev/09_clock_functor $
```

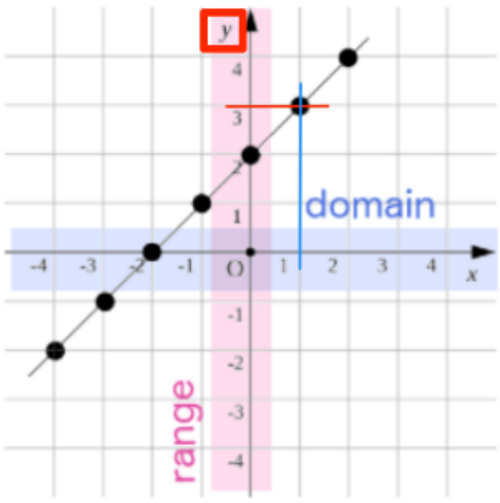

1. ghc
Prelude> humanize b = if b then "yes" else "no"
Prelude> :t humanize
humanize :: Bool -> [Char]
Prelude> emphasize str = str ++ "!"
Prelude> :t emphasize
emphasize :: [Char] -> [Char]
Prelude> compose g f = \x -> g (f x)
Prelude> :t compose
compose :: (t2 -> t1) -> (t -> t2) -> t -> t1
Prelude> :t (.)
(.) :: (b -> c) -> (a -> b) -> a -> c
Prelude> emphasizeHumanize = compose emphasize humanize
Prelude> :t emphasizeHumanize
emphasizeHumanize :: Bool -> [Char]
Prelude> emphasizeHumanize True
"yes!"
Prelude> (.) g f = \x -> g (f x)
Prelude> :t (.)
(.) :: (t2 -> t1) -> (t -> t2) -> t -> t1
Prelude> emphasizeHumanize = (.) emphasize humanize
Prelude> emphasizeHumanize True
"yes!"
Prelude> emphasizeHumanize = emphasize . humanize
Prelude> emphasizeHumanize True
"yes!"
Prelude> emphasizeHumanize False
"no!"
Prelude>


A
f
B
g ∘ f
g
C

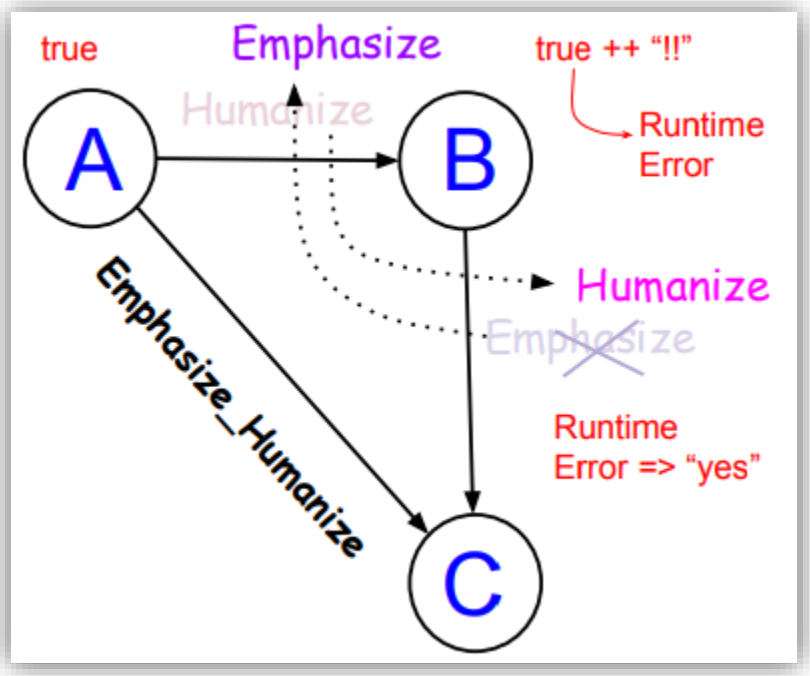

A
f
B
g ∘ f
g
C
(g.f)(x) = g(f(x))
true
"yes"
A
Humanize
B
Emphasize_Humanize
Emphasize
C
"yes!!"
Emphasize_Humanize(true) ==
Emphasize(Humanize(true))

```
1. bash
~/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/07_compose_gof $ . init
++ ln -s /Users/lex/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/07_compose_gof
/Users/lex/dev/07_compose_gof
Installed Go version: go version go1.9.2 darwin/amd64
Switching Go to version 1.9.2 ...
GOVERSION: go version go1.9.2 darwin/amd64
CURRENT_GOVERSION: go1.9.2
You should only need to run this init script once.
Add Go source code files under the src directory.
After updating dependencies, i.e., adding a new import statement, run: glide-update
To build and run your app, run: go-run
~/dev/07_compose_gof $ go-run
A to B - Humanize(true): yes
B to C - Emphasize("yes"): yes!!
A to C - EmphasizeHumanize(true): yes!!
A to C - Emphasize_Humanize(true): yes!!
~/dev/07_compose_gof $
```

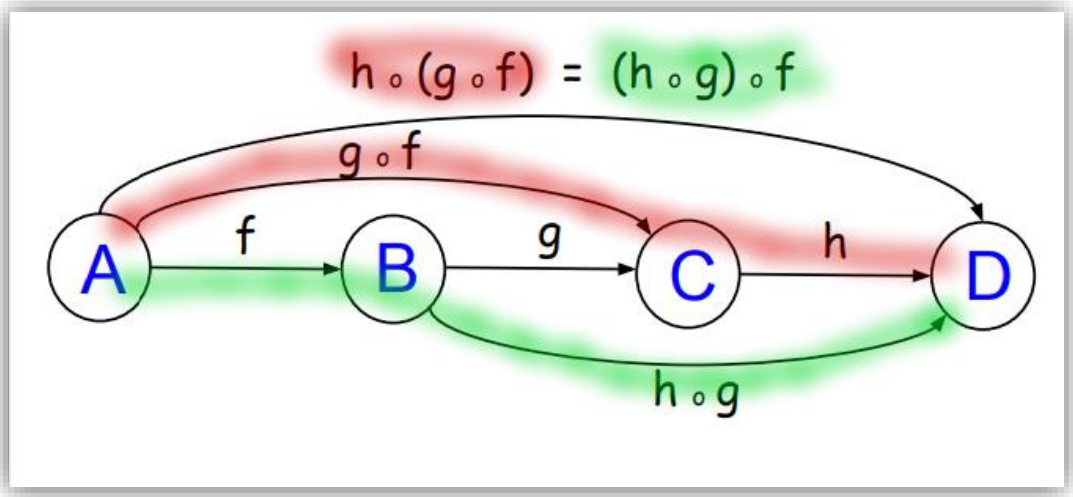
x	y = f(x)	
-4	-2	
-3	-1	
-2	0	
-1	1	
0	2	
1	3	
2	4	

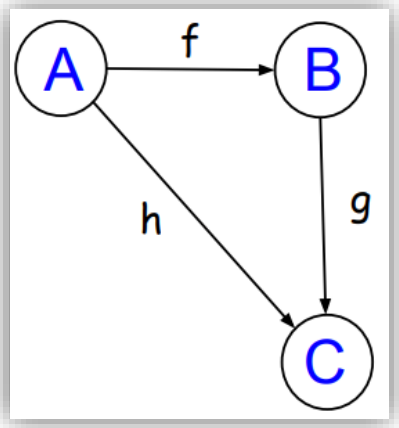


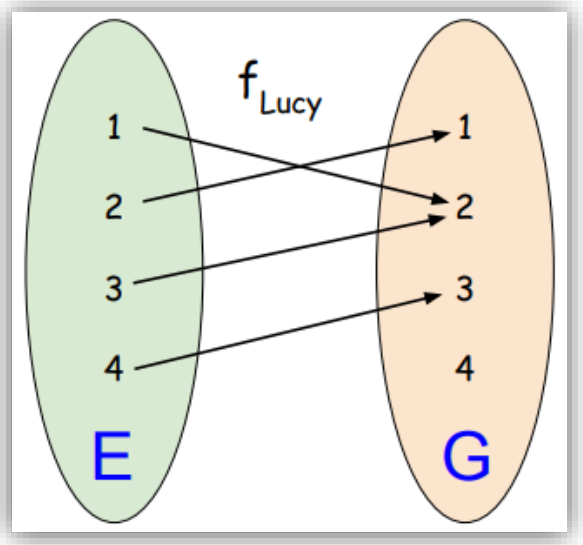
1 → f → 3 → ~~f(1)~~ → g → 10 → ~~g(3)~~

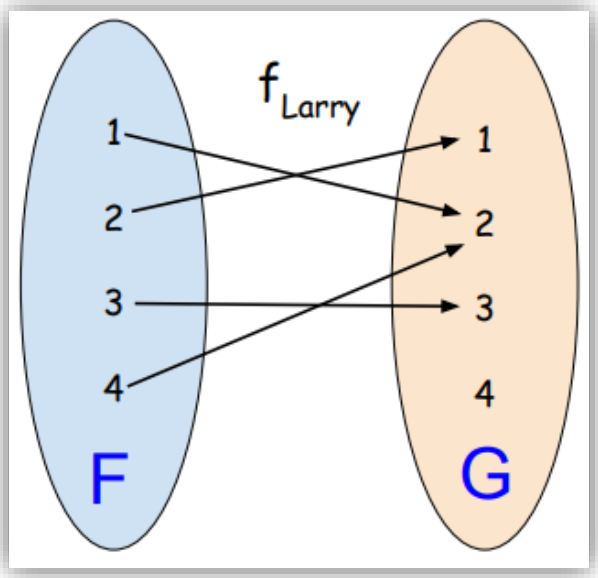


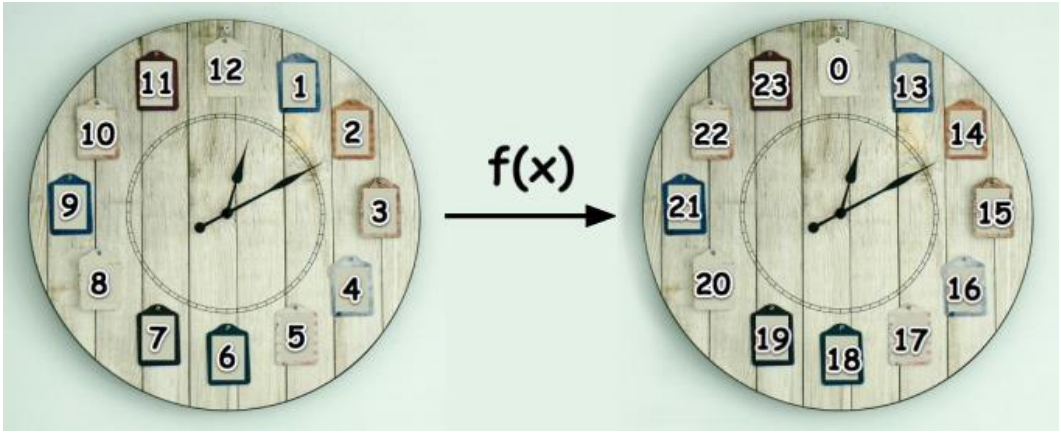

```
1. bash
~/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/08_compose_fog $ . init
++ ln -s /Users/lex/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/08_compose_fog /Users/lex/dev/08_compose_fog
Installed Go version: go version go1.9.2 darwin/amd64
Switching Go to version 1.9.2 ...
GOVERSION: go version go1.9.2 darwin/amd64
CURRENT_GOVERSION: go1.9.2
# compose
../../clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/08_compose_fog/src/compose/compose.go:25:35: cannot use Emphasize
 (type func(string) string) as type Fbs in argument to Compose
../../clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/08_compose_fog/src/compose/compose.go:25:35: cannot use Humanize
(type func(bool) string) as type Fss in argument to Compose
You should only need to run this init script once.
Add Go source code files under the src directory.
After updating dependencies, i.e., adding a new import statement, run: glide-update
To build and run your app, run: go-run
~/dev/08_compose_fog $ go-run
# compose
../../clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/08_compose_fog/src/compose/compose.go:25:35: cannot use Emphasize
 (type func(string) string) as type Fbs in argument to Compose
../../clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/08_compose_fog/src/compose/compose.go:25:35: cannot use Humanize
(type func(bool) string) as type Fss in argument to Compose
~/dev/08_compose_fog $
```


h ∘ (g ∘ f) = (h ∘ g) ∘ f
g ∘ f
A
f
B
g
C
h
D
h ∘ g

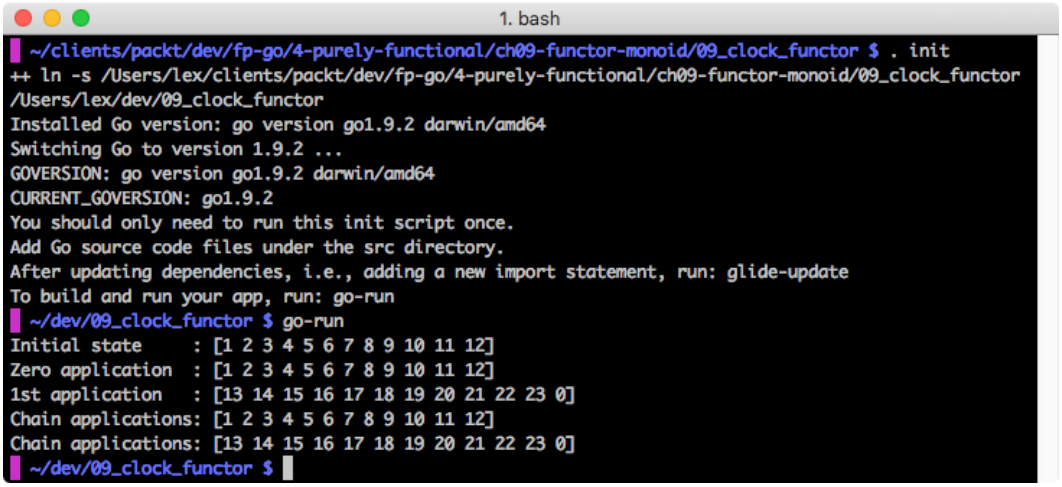

A
f
B
h
g
C

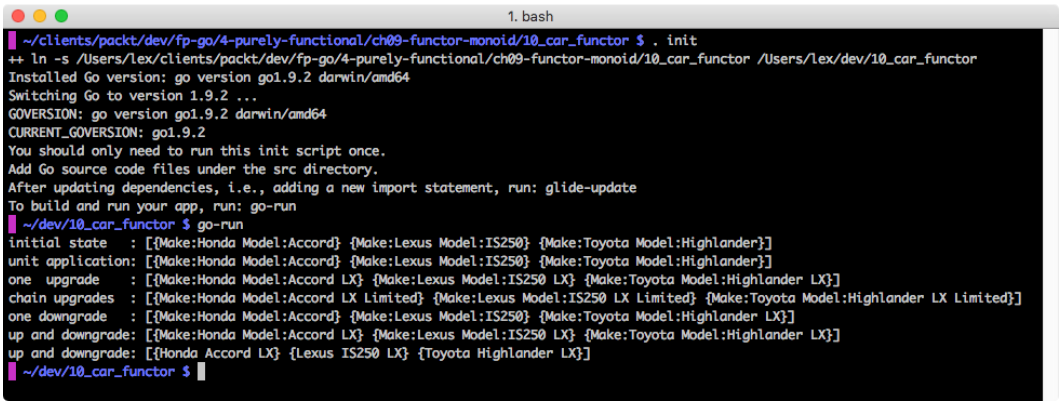

f Lucy
1
2
3
4
E
1
2
3
4
G


f Larry
1
2
3
4
F
1
2
3
4
G


f(x)


CHAINING FUNCTORS
AWESOME!


1. bash
~/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/09_clock_functor $. init
++ ln -s /Users/lex/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/09_clock_functor /Users/lex/dev/09_clock_functor
Installed Go version: go version go1.9.2 darwin/amd64
Switching Go to version 1.9.2 ...
GOVERSION: go version go1.9.2 darwin/amd64
CURRENT_GOVERSION: go1.9.2
You should only need to run this init script once.
Add Go source code files under the src directory.
After updating dependencies, i.e., adding a new import statement, run: glide-update
To build and run your app, run: go-run
~/dev/09_clock_functor $ go-run
Initial state : [1 2 3 4 5 6 7 8 9 10 11 12]
Zero application : [1 2 3 4 5 6 7 8 9 10 11 12]
1st application : [13 14 15 16 17 18 19 20 21 22 23 0]
Chain applications: [1 2 3 4 5 6 7 8 9 10 11 12]
Chain applications: [13 14 15 16 17 18 19 20 21 22 23 0]
~/dev/09_clock_functor $


1. bash
~/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/10_car_functor $. init
++ ln -s /Users/lex/clients/packt/dev/fp-go/4-purely-functional/ch09-functor-monoid/10_car_functor /Users/lex/dev/10_car_functor
Installed Go version: go version go1.9.2 darwin/amd64
Switching Go to version 1.9.2 ...
GOVERSION: go version go1.9.2 darwin/amd64
CURRENT_GOVERSION: go1.9.2
You should only need to run this init script once.
Add Go source code files under the src directory.
After updating dependencies, i.e., adding a new import statement, run: glide-update
To build and run your app, run: go-run
~/dev/10_car_functor $ go-run
initial state : [{Make:Honda Model:Accord} {Make:Lexus Model:IS250} {Make:Toyota Model:Highlander}]
unit application: [{Make:Honda Model:Accord} {Make:Lexus Model:IS250} {Make:Toyota Model:Highlander}]
one upgrade : [{Make:Honda Model:Accord LX} {Make:Lexus Model:IS250 LX} {Make:Toyota Model:Highlander LX}]
chain upgrades : [{Make:Honda Model:Accord LX Limited} {Make:Lexus Model:IS250 LX Limited} {Make:Toyota Model:Highlander LX Limited}]
one downgrade : [{Make:Honda Model:Accord} {Make:Lexus Model:IS250} {Make:Toyota Model:Highlander LX}]
up and downgrade: [{Make:Honda Model:Accord LX} {Make:Lexus Model:IS250 LX} {Make:Toyota Model:Highlander LX}]
up and downgrade: [{Honda Accord LX} {Lexus IS250 LX} {Toyota Highlander LX}]
~/dev/10_car_functor $

Garage Name

AUTO REPAIR WORK ORDER

Address

city,state, zip, phone

W.O. # **1000**

NAME
ADDRESS
CITY,STATE

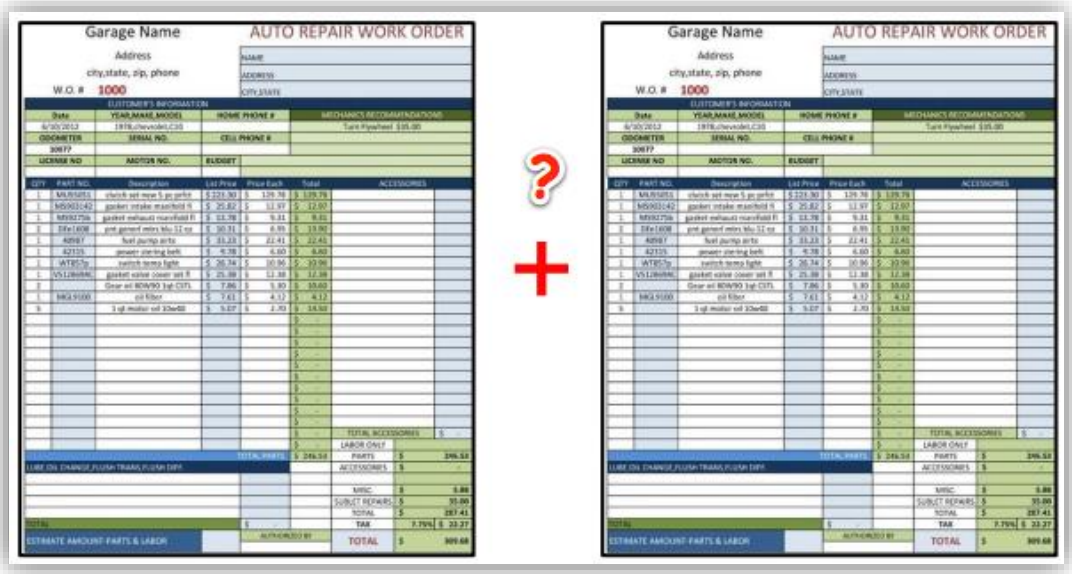
CUSTOMER'S INFORMATION			
Date	**YEAR,MAKE,MODEL**	**HOME PHONE #**	MECHANICS RECOMMENDATIONS
6/10/2012	1978,chevrolet,C10		Turn Flywheel $35.00
ODOMETER	**SERIAL NO.**	**CELL PHONE #**	
10077			
LICENSE NO	**MOTOR NO.**	**BUDGET**	

QTY	PART NO.	Description	List Price	Price Each	Total
1	MU55051	clutch set new 5 pc prfct	$ 223.30	$ 129.78	$ 129.78
1	MS903142	gasket intake manifold fl	$ 25.82	$ 12.97	$ 12.97
1	MS9275b	gasket exhaust manifold fl	$ 13.78	$ 9.31	$ 9.31
2	DEe1608	pnt generl mtrs blu 12 oz	$ 10.31	$ 6.95	$ 13.90
1	40987	fuel pump airtx	$ 33.23	$ 22.41	$ 22.41
1	42315	power stering belt	$ 9.78	$ 6.60	$ 6.60
1	WT857p	switch temp light	$ 26.74	$ 10.96	$ 10.96
1	VS12869AC	gasket valve cover set fl	$ 25.38	$ 12.38	$ 12.38
2		Gear oil 80W90 1qt CSTL	$ 7.86	$ 5.30	$ 10.60
1	MGL9100	oil filter	$ 7.61	$ 4.12	$ 4.12
5		1 qt motor oil 10w40	$ 5.07	$ 2.70	$ 13.50
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -
					$ -

ACCESSORIES	
TOTAL ACCESSORIES	$ -

LABOR ONLY	
PARTS	$ 246.53
ACCESSORIES	$ -
MISC.	$ 5.88
SUBLET REPAIRS	$ 35.00
TOTAL	$ 287.41
TAX	7.75% $ 22.27
TOTAL	$ 309.68

		TOTAL PARTS	$ 246.53
LUBE,OIL CHANGE,FLUSH TRANS,FLUSH DIFF.			
TOTAL		$ -	
ESTIMATE AMOUNT-PARTS & LABOR		AUTHORIZED BY	

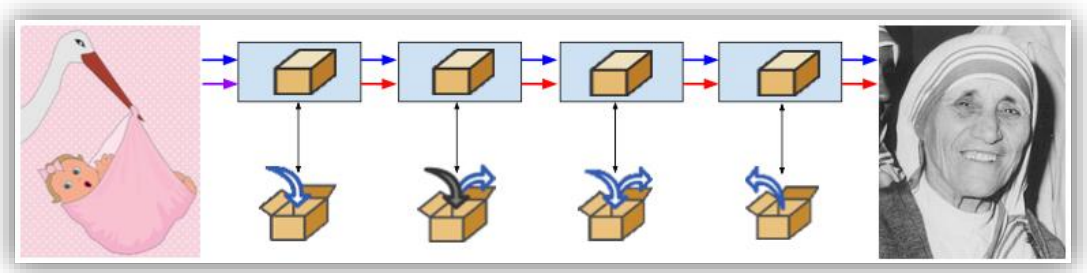


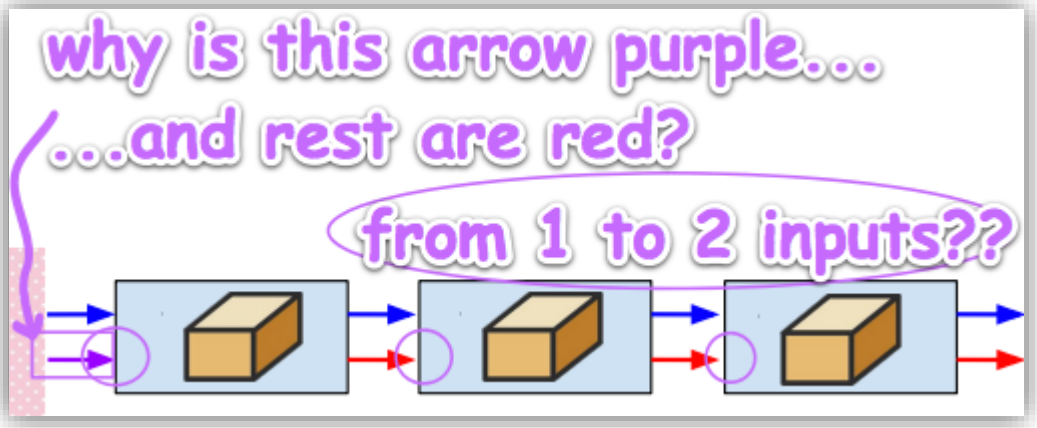

```
~/dev/11_monoid $ go-run
NameMonoid
Initial state: Alice
Zero:
1st application: AliceAlice
Chain applications: AliceAliceAlice
```

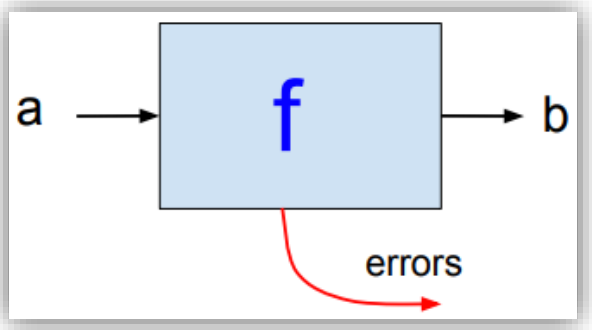
```
IntMonoid
Initial state: {[1 2 3]}
Zero: []
1st application: {[1 2 3 1 2 3]}
Chain applications: {[1 2 3 1 2 3 1 2 3]}
Reduce chain: 18
```

```
LineItemMonoid
Initial state: {[{1 12978 22330} {2 530 786} {5 270 507}]}
Zero: []
1st application: {[{1 12978 22330} {2 530 786} {5 270 507} {1 12978 22330} {2 530 786} {5 270 507}]}
Chain applications: {[{1 12978 22330} {2 530 786} {5 270 507} {1 12978 22330} {2 530 786} {5 270 507} {1 12978 22330} {2 530 786} {5 270 507}]}
Reduce chain: {24 41334 70869}
```

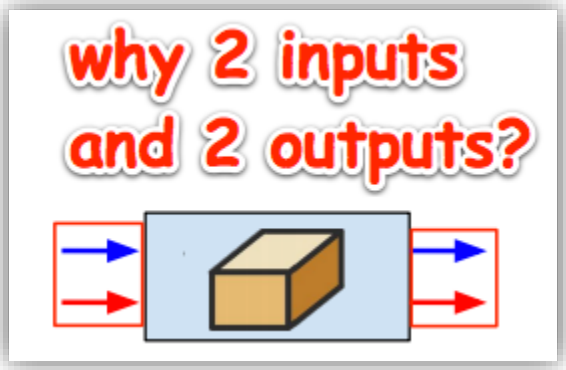
Chapter 10: Monads, Type Classes, and Generics

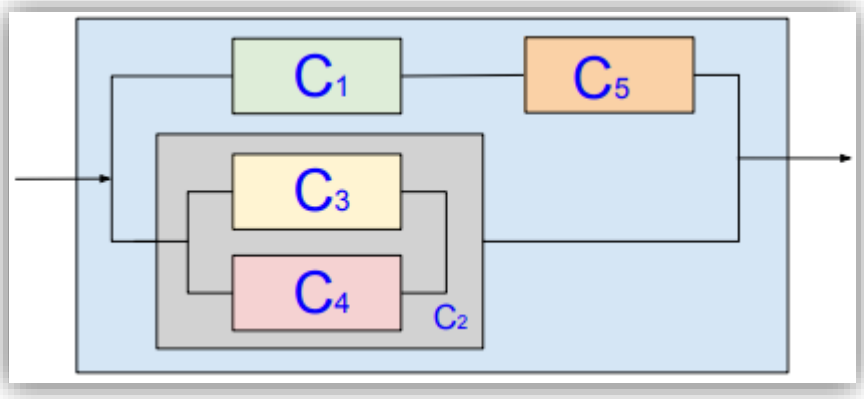


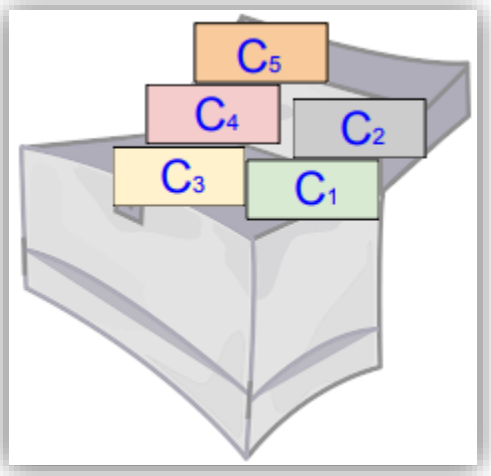


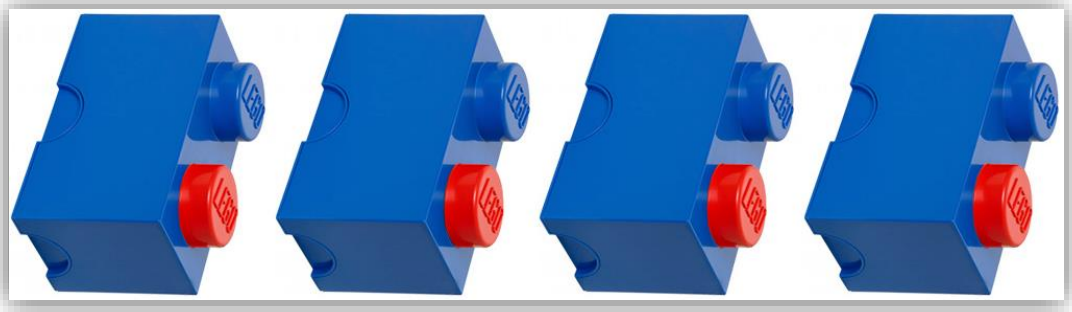

a
f
b
errors


a
f
b
errors

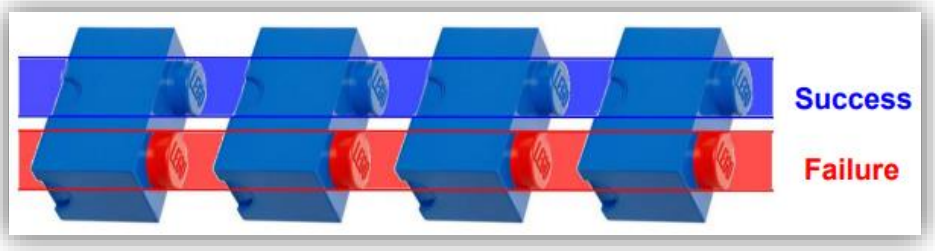

why 2 inputs
and 2 outputs?

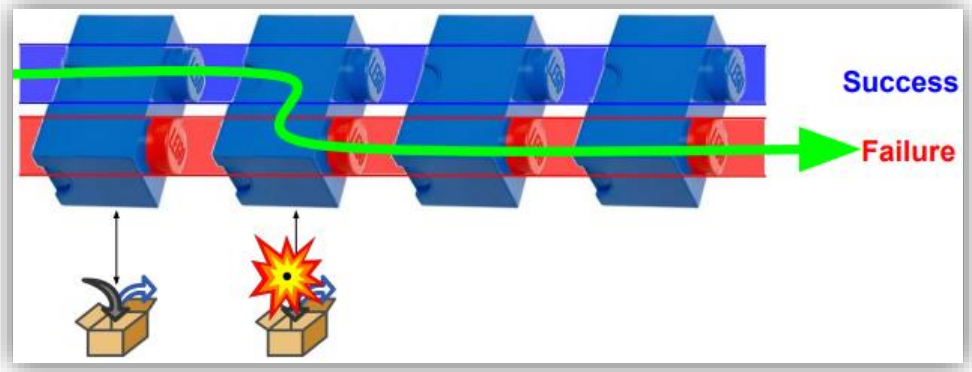

C1
C5
C3
C4
C2


C5
C4
C2
C3
C1

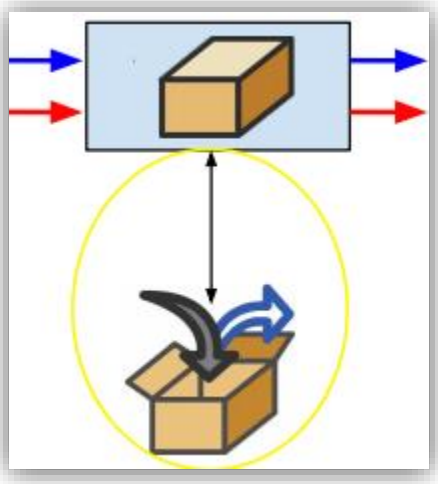



bind operation
>>=

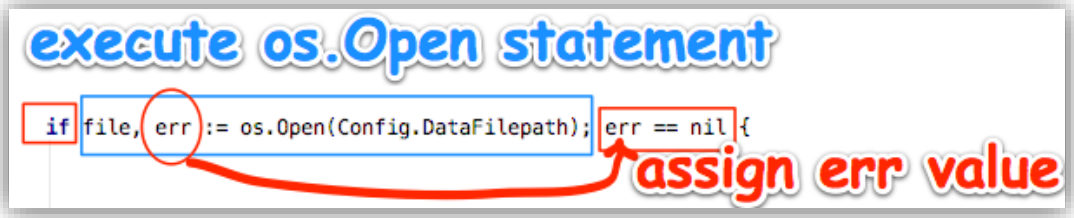


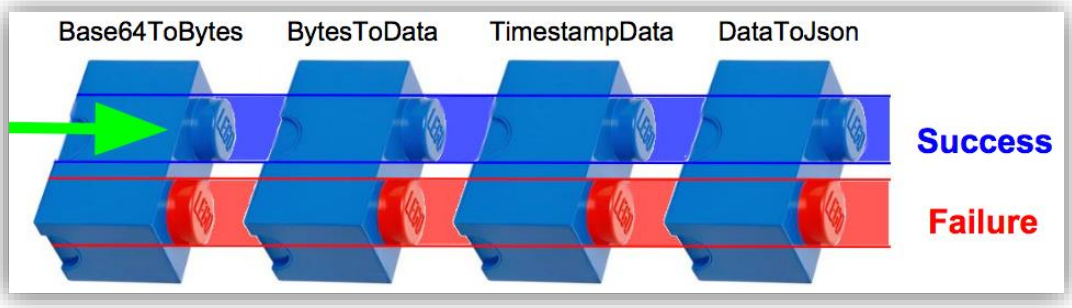


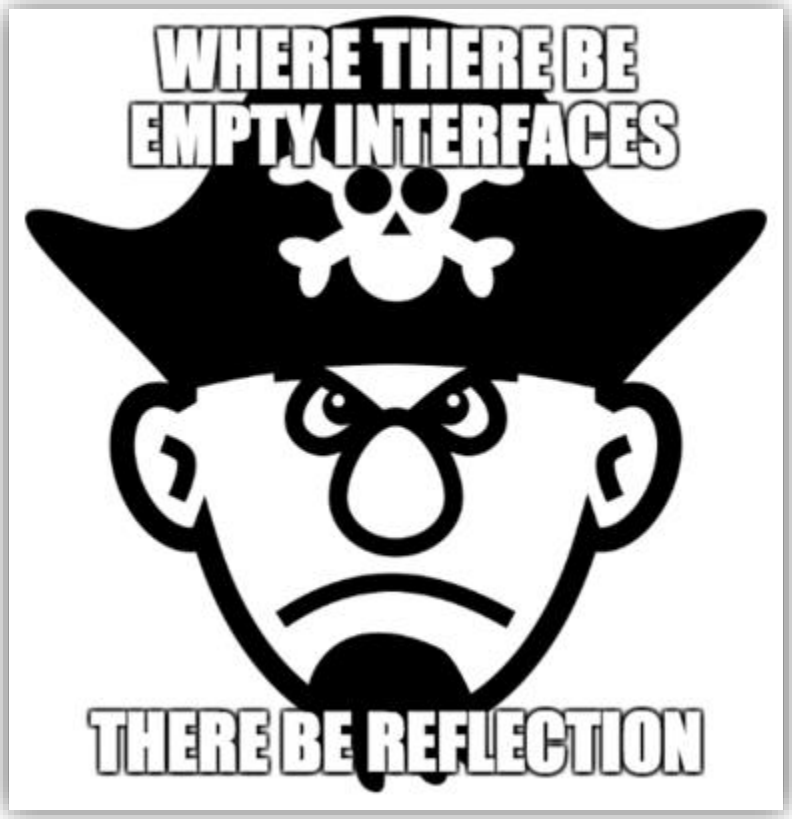

```
1. ghci
~/clients/packt/dev/haskell/ghci $ ghci
GHCi, version 8.2.1: http://www.haskell.org/ghc/  :? for help
Prelude> replicate 2 "A"
["A","A"]
Prelude> :t replicate
replicate :: Int -> a -> [a]
Prelude> import Control.Applicative
Prelude Control.Applicative> :t liftA2
liftA2 :: Applicative f => (a -> b -> c) -> f a -> f b -> f c
Prelude Control.Applicative> (liftA2 replicate) [1,2] ["A", "B", "C"]
[["A"],["B"],["C"],["A","A"],["B","B"],["C","C"]]
Prelude Control.Applicative> :t liftA2
liftA2 :: Applicative f => (a -> b -> c) -> f a -> f b -> f c
Prelude Control.Applicative>
```

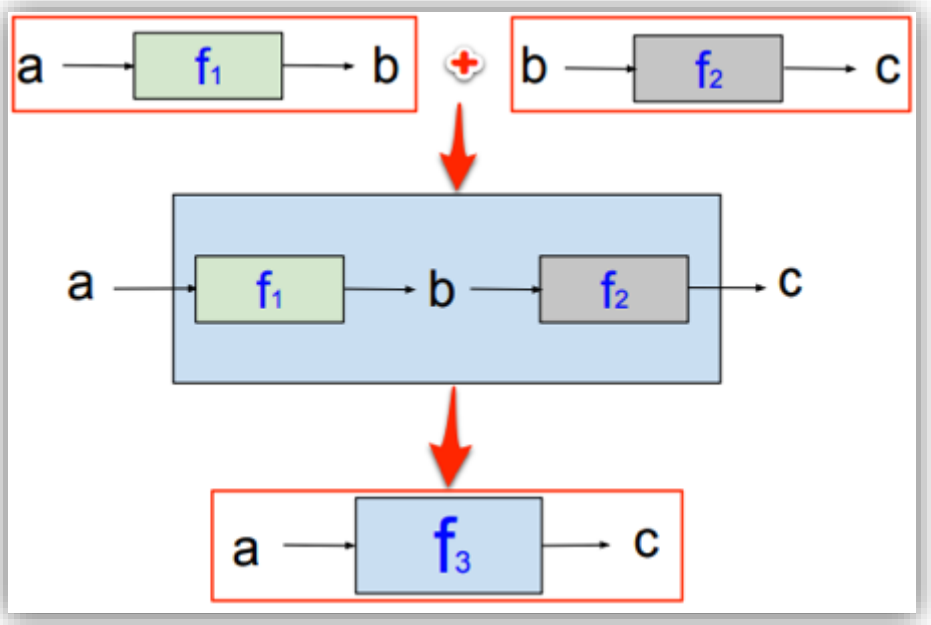



what happens
in the box?

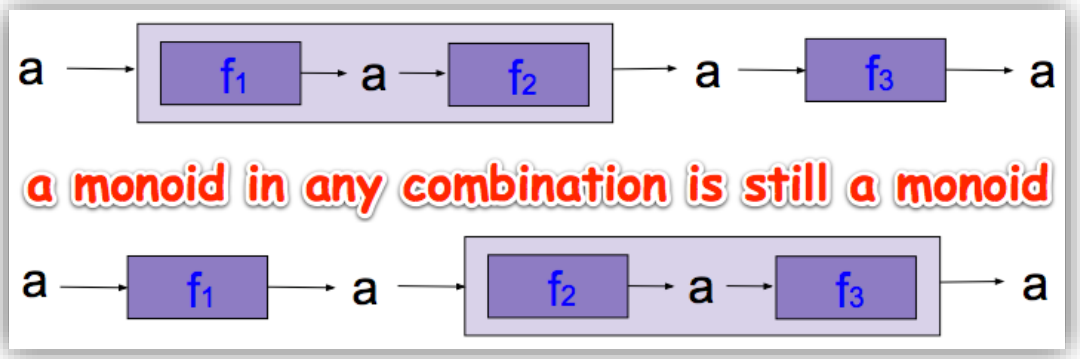

execute os.Open statement
if file, err := os.Open(Config.DataFilepath); err == nil {
assign err value

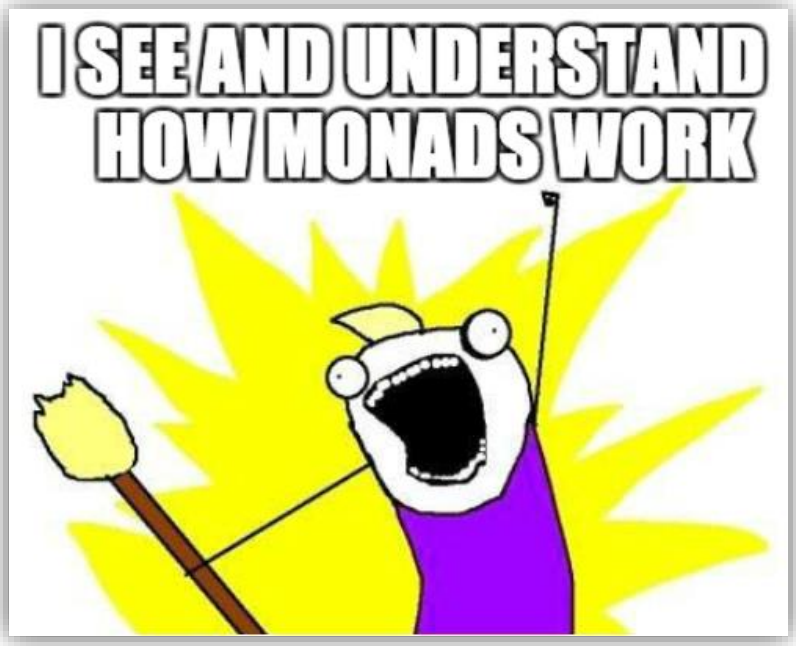

Base64ToBytes
BytesToData
TimestampData
DataToJson
Success
Failure

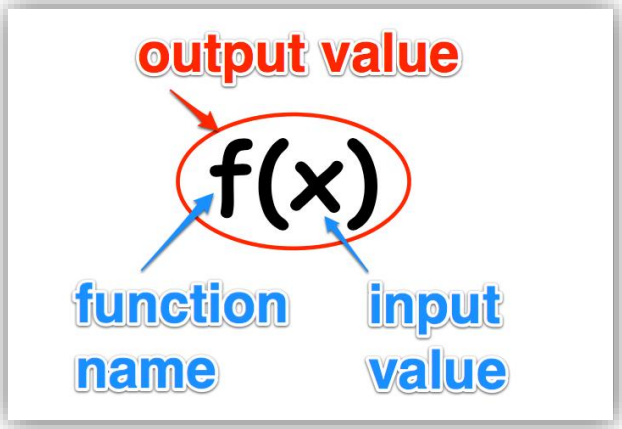

WHERE THERE BE
EMPTY INTERFACES
THERE BE REFLECTION

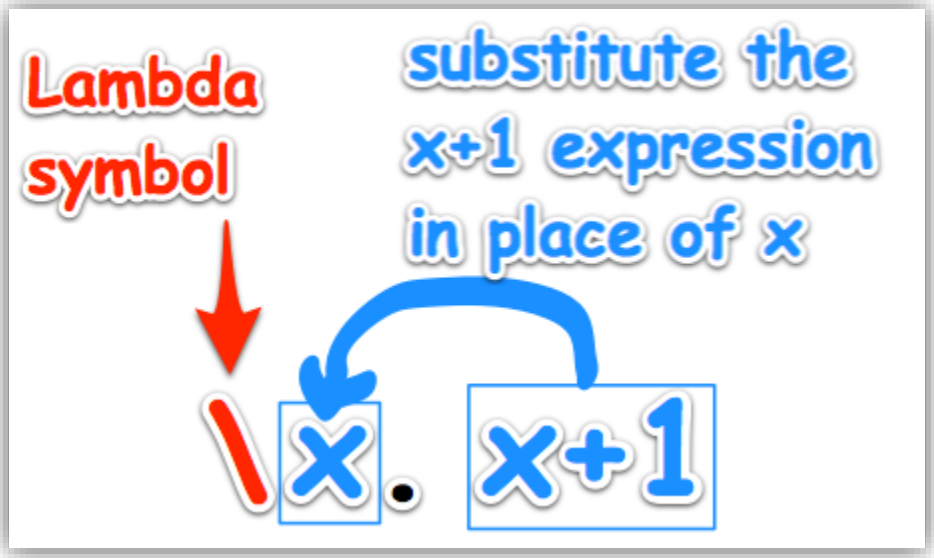

a
f1
b
b
f2
c
a
f1
b
f2
c
a
f3
c

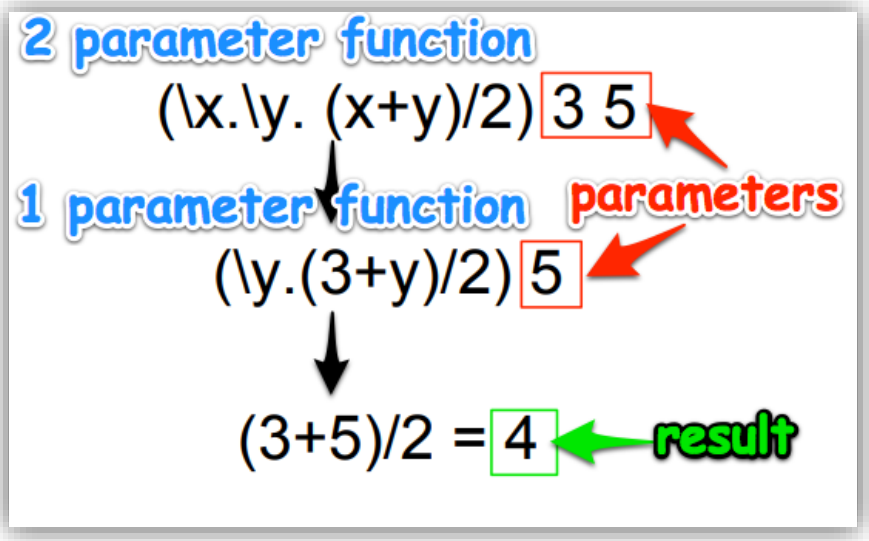

a
f
a

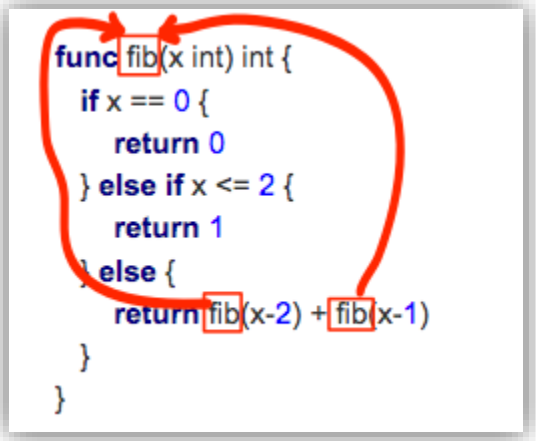

a
f1
a
f2
a
f3
a
a monoid in any combination is still a monoid
a
f1
a
f2
a
f3
a

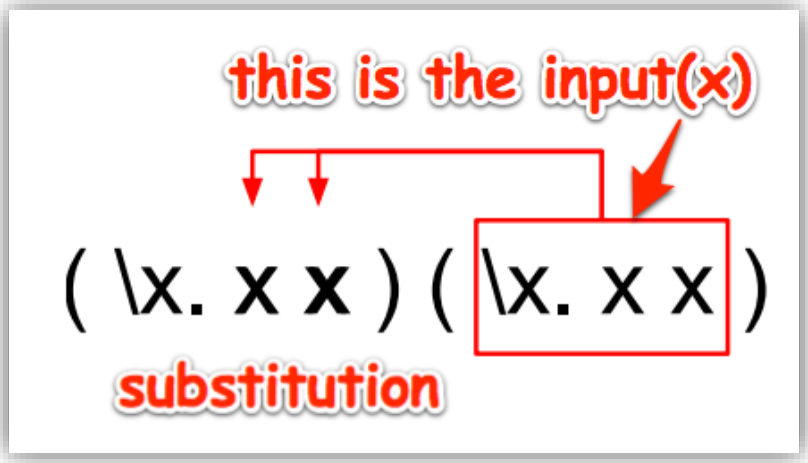

I SEE AND UNDERSTAND
HOW MONADS WORK

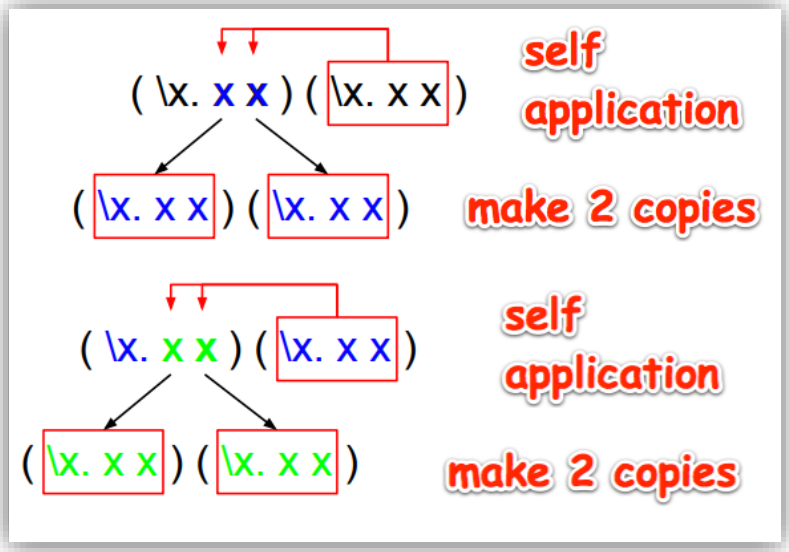

output value
f(x)
function name
input value

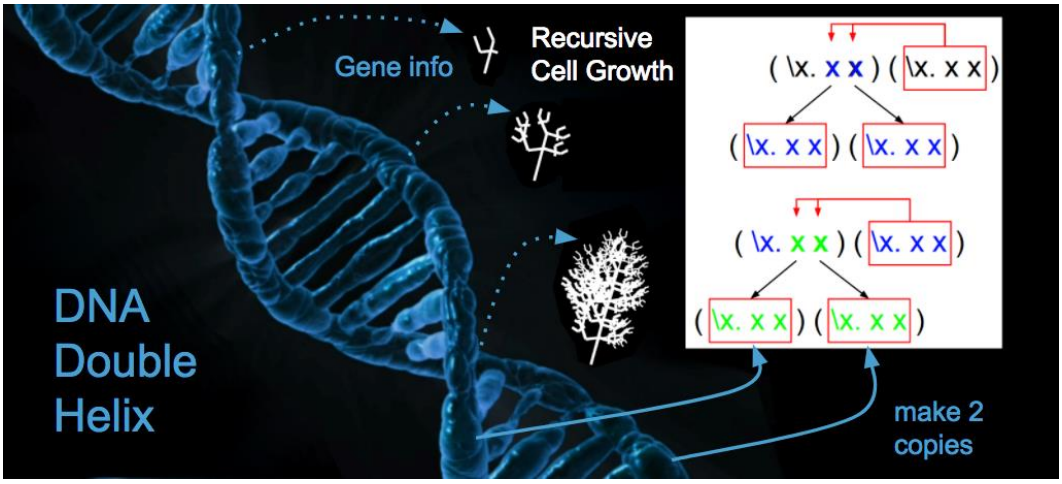

Lambda symbol
substitute the x+1 expression in place of x
\x. x+1

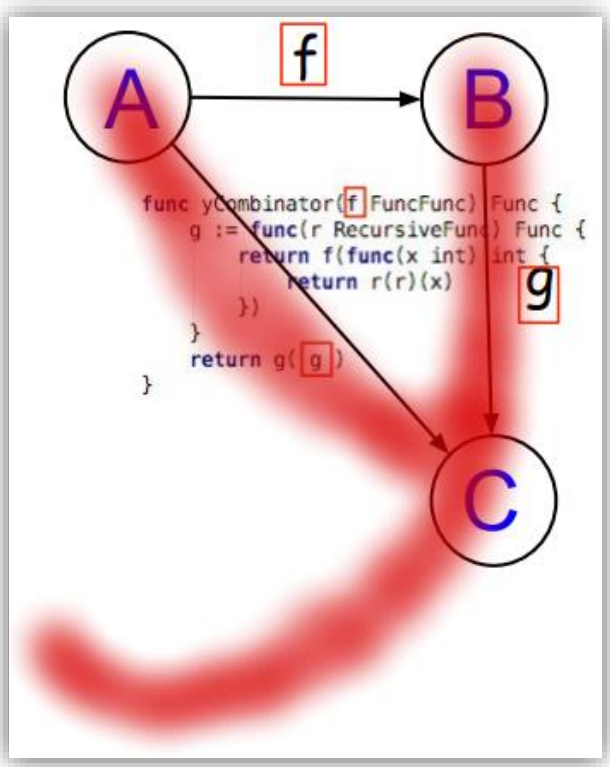

2 parameter function
(\x.\y. (x+y)/2) 3 5
1 parameter function
parameters
(\y.(3+y)/2) 5
(3+5)/2 = 4
result

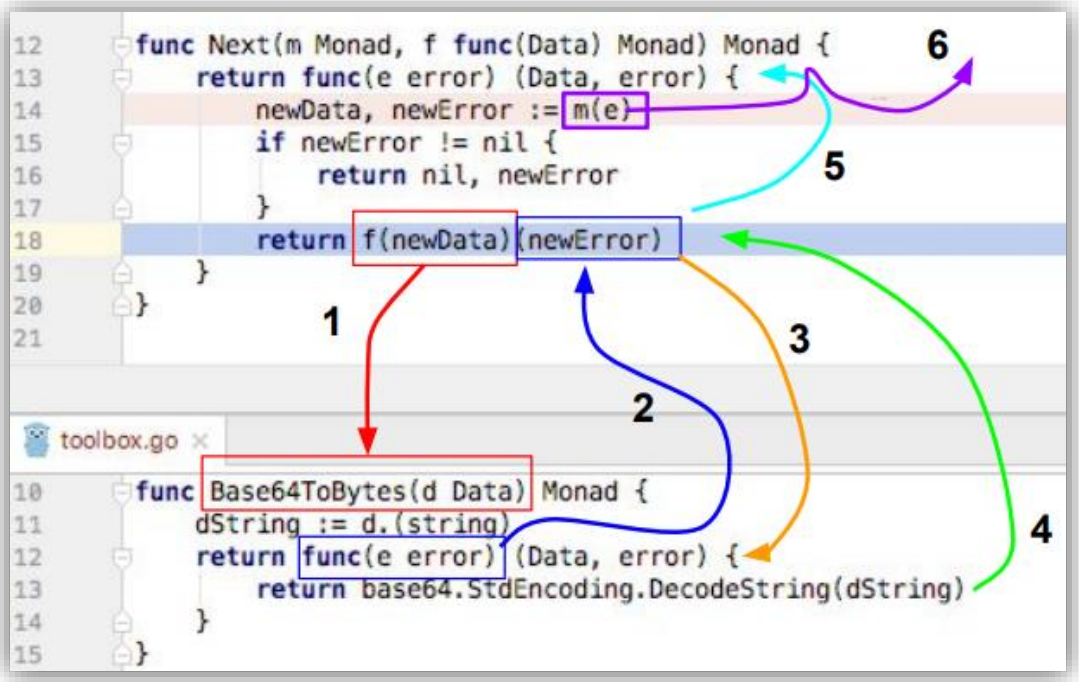

func fib(x int) int {
if x == 0 {
return 0
} else if x <= 2 {
return 1
} else {
return fib(x-2) + fib(x-1)
}
}


this is the input(x)
(\x. x x) (\x. x x)
substitution


(\x. x x) (\x. x x)
self application
(\x. x x) (\x. x x)
make 2 copies
(\x. x x) (\x. x x)
self application
(\x. x x) (\x. x x)
make 2 copies


Gene info
Recursive
Cell Growth
(\x. x x) (\x. x x)
(\x. x x) (\x. x x)
(\x. x x) (\x. x x)
(\x. x x) (\x. x x)
DNA
Double
Helix
make 2
copies


A
f
B
g
C
func yCombinator(f FuncFunc) Func {
g := func(r RecursiveFunc) Func {
return f(func(x int) int {
return r(r)(x)
})
}
return g(g)
}



Business Requirements

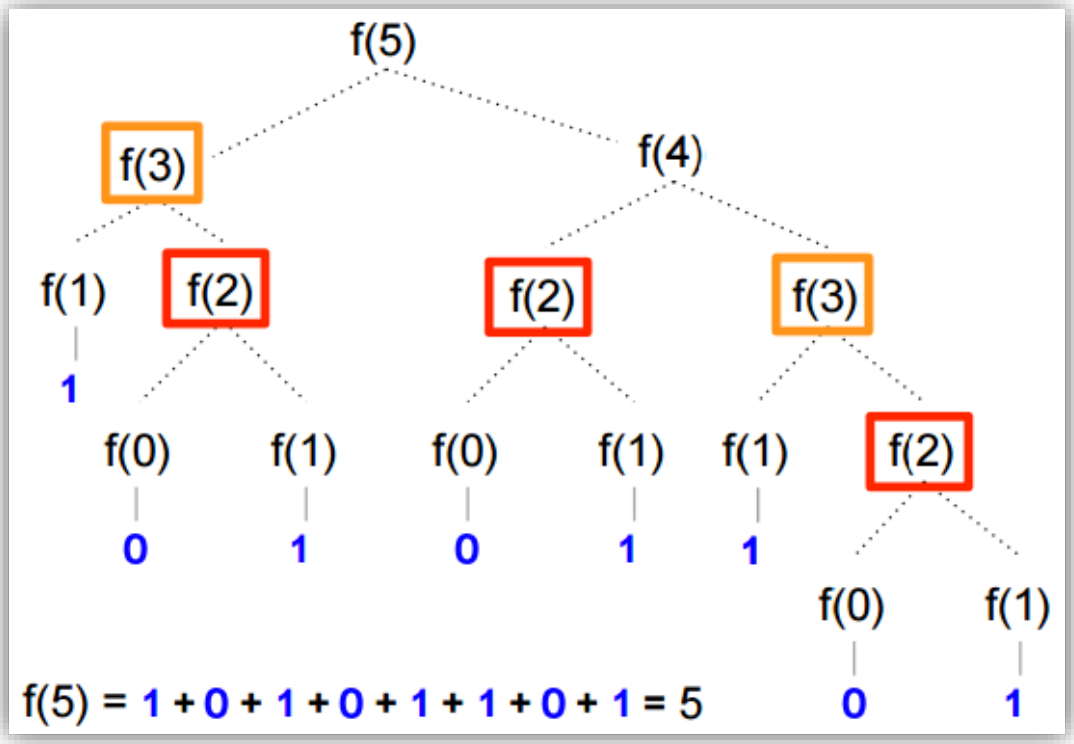
1. Normalize Data
2. Remove Samples
3. Change Timestamp Format
4. Filter by Demographics
5. Match Populations

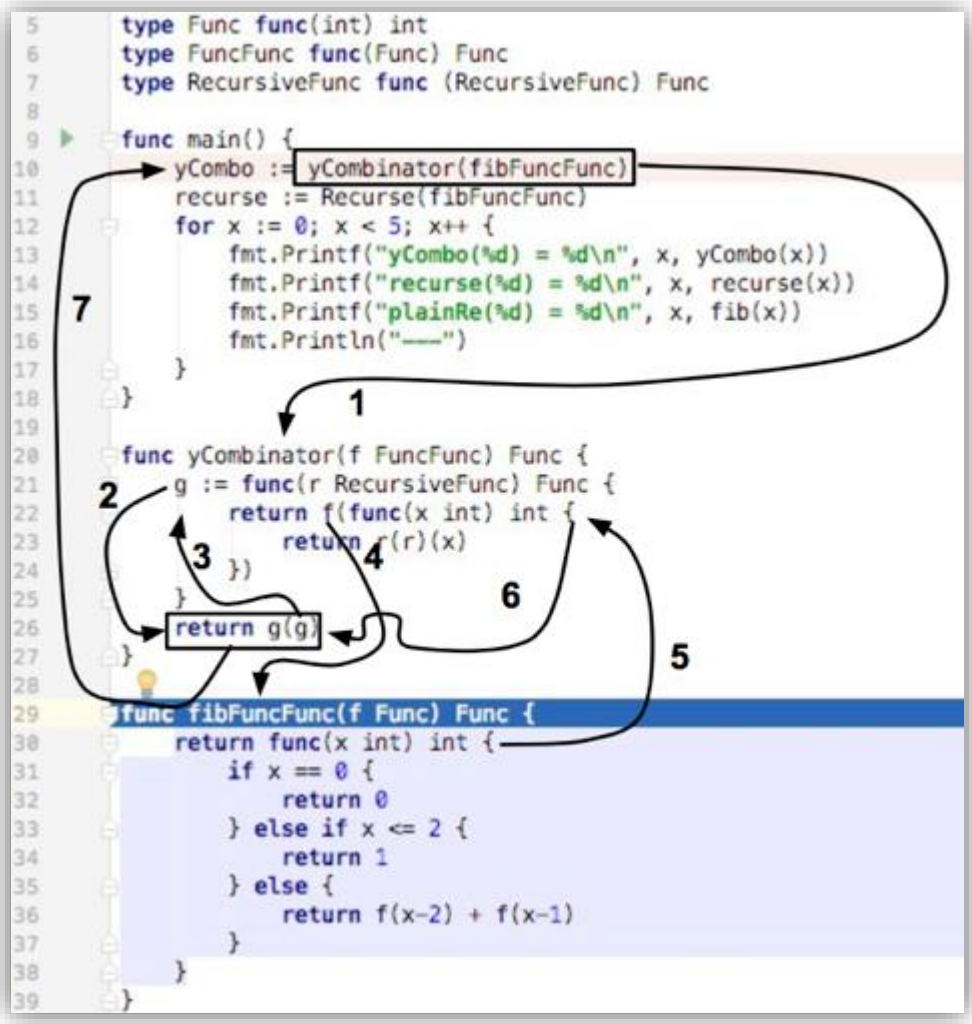
Lexical (Monadic) Workflow

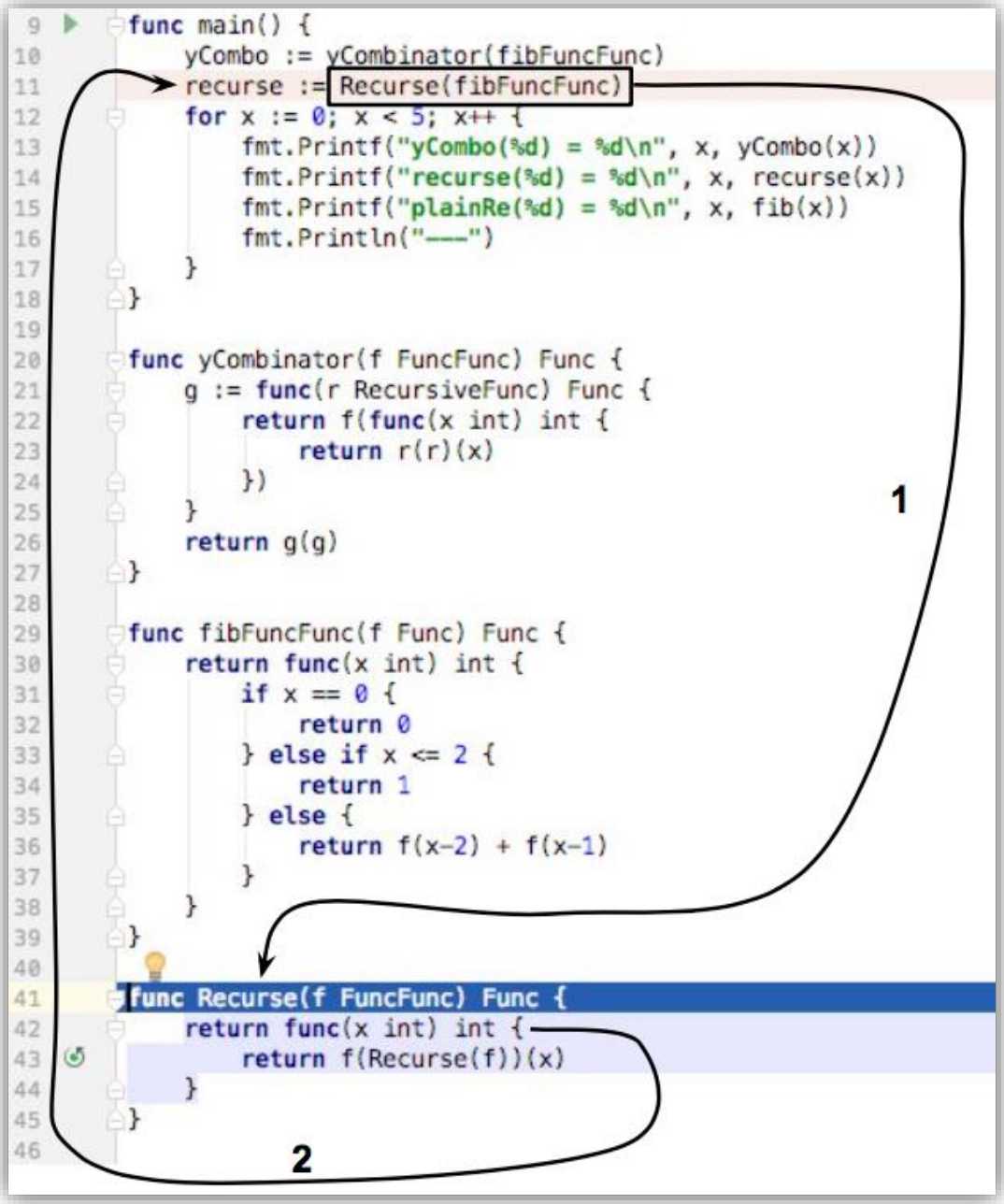
```
step := Get(data)
step = Next(step, NormalizeData)
step = Next(step, RemoveSamples)
step = Next(step, ChangeTimestamp)
step = Next(step, FilterByDemographics)
step = Next(step, MatchPopulations)
if err != nil {
        // handle errors
} else {
        // handle success
}
```

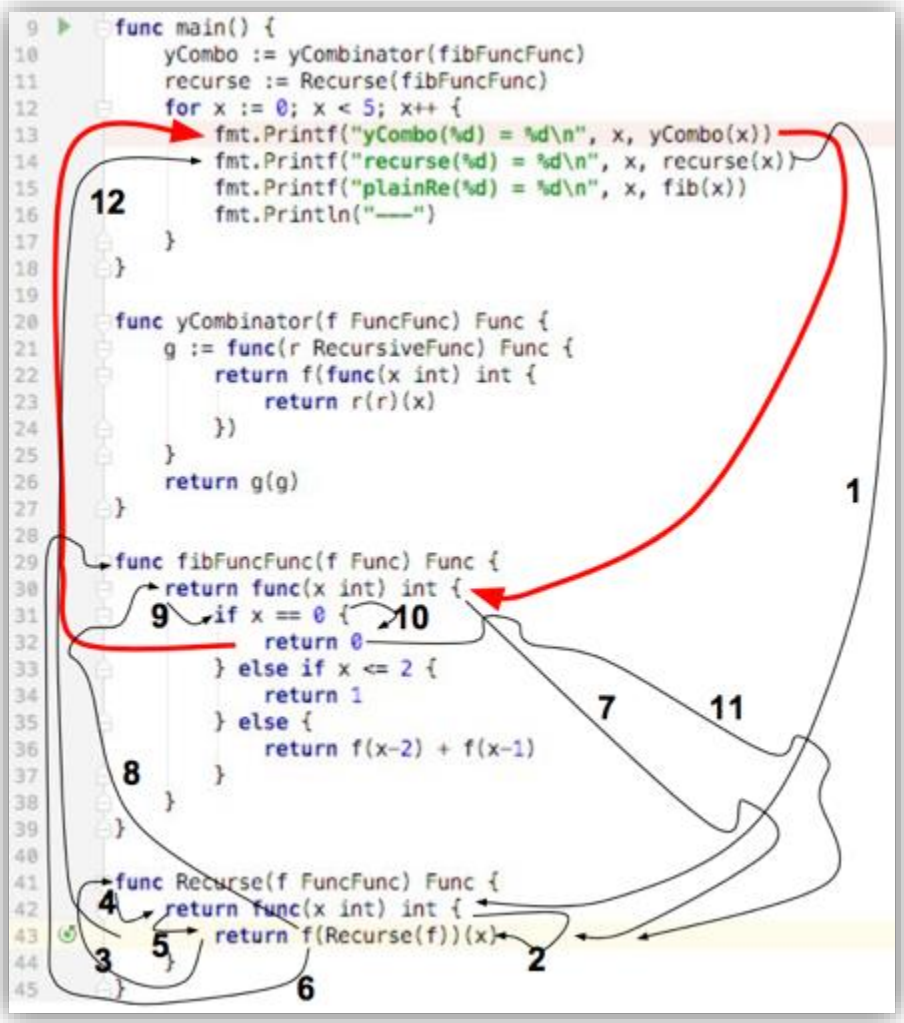
Test Script

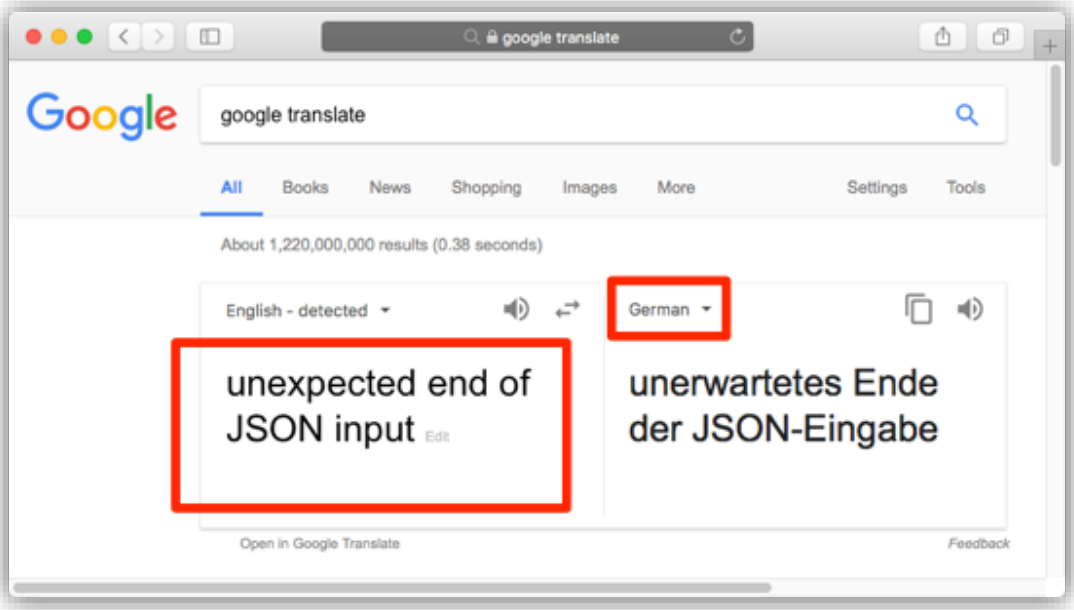
1. Test_NormalizeData
2. Test_RemoveSamples
3. Test_ChangeTimestamp
4. Test_FilterByDemographics
5. Test_MatchPopulations

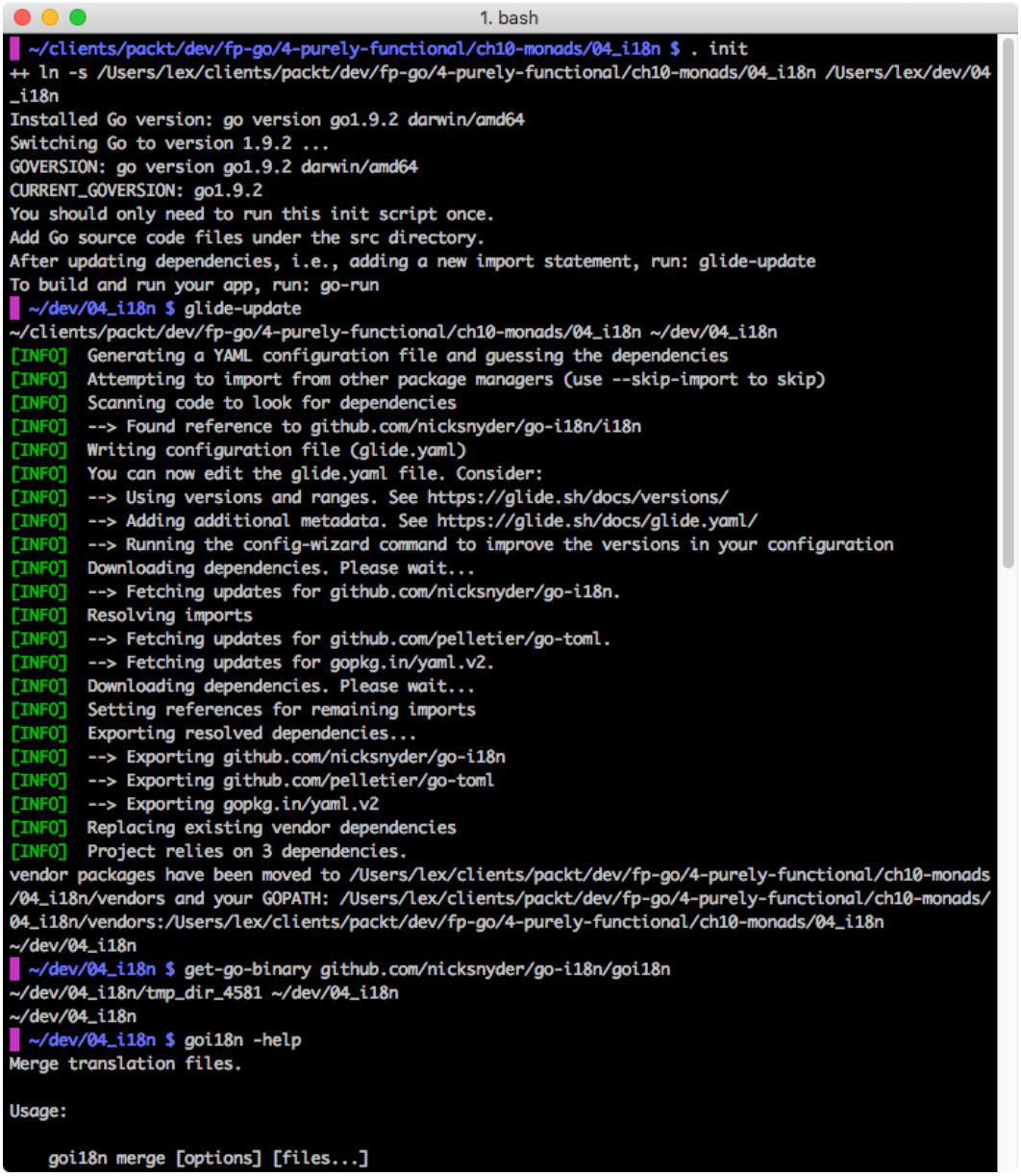

f(5)
f(3)
f(4)
f(1)
f(2)
f(2)
f(3)
1
f(0)
f(1)
f(0)
f(1)
f(1)
f(2)
0
1
0
1
1
f(0)
f(1)
0
1
f(5) = 1 + 0 + 1 + 0 + 1 + 1 + 0 + 1 = 5


type Func func(int) int
type FuncFunc func(Func) Func
type RecursiveFunc func (RecursiveFunc) Func
func main() {
yCombo := yCombinator(fibFuncFunc)
recurse := Recurse(fibFuncFunc)
for x := 0; x < 5; x++ {
fmt.Printf("yCombo(%d) = %d\n", x, yCombo(x))
fmt.Printf("recurse(%d) = %d\n", x, recurse(x))
fmt.Printf("plainRe(%d) = %d\n", x, fib(x))
fmt.Println("---")
}
}
func yCombinator(f FuncFunc) Func {
g := func(r RecursiveFunc) Func {
return f(func(x int) int {
return r(r)(x)
})
}
return g(g)
}
func fibFuncFunc(f Func) Func {
return func(x int) int {
if x == 0 {
return 0
} else if x <= 2 {
return 1
} else {
return f(x-2) + f(x-1)
}
}
}
1
2
3
4
5
6
7

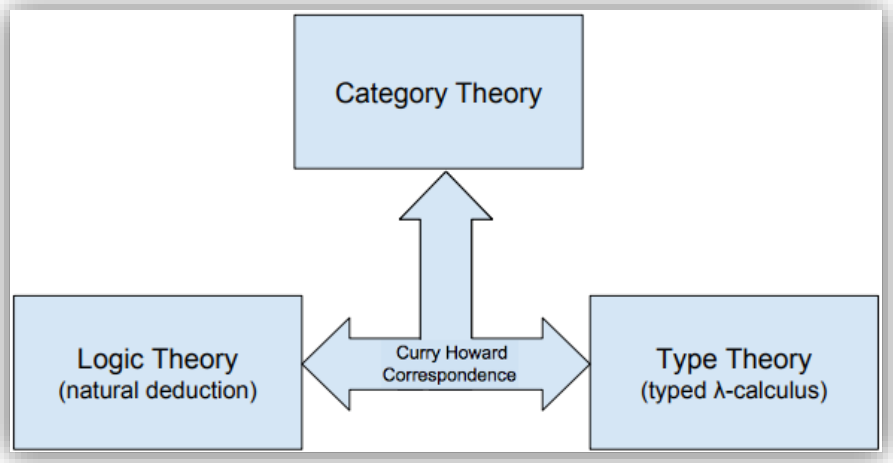

func main() {
yCombo := yCombinator(fibFuncFunc)
recurse := Recurse(fibFuncFunc)
for x := 0; x < 5; x++ {
fmt.Printf("yCombo(%d) = %d\n", x, yCombo(x))
fmt.Printf("recurse(%d) = %d\n", x, recurse(x))
fmt.Printf("plainRe(%d) = %d\n", x, fib(x))
fmt.Println("---")
}
}
func yCombinator(f FuncFunc) Func {
g := func(r RecursiveFunc) Func {
return f(func(x int) int {
return r(r)(x)
})
}
return g(g)
}
func fibFuncFunc(f Func) Func {
return func(x int) int {
if x == 0 {
return 0
} else if x <= 2 {
return 1
} else {
return f(x-2) + f(x-1)
}
}
}
func Recurse(f FuncFunc) Func {
return func(x int) int {
return f(Recurse(f))(x)
}
}
1
2

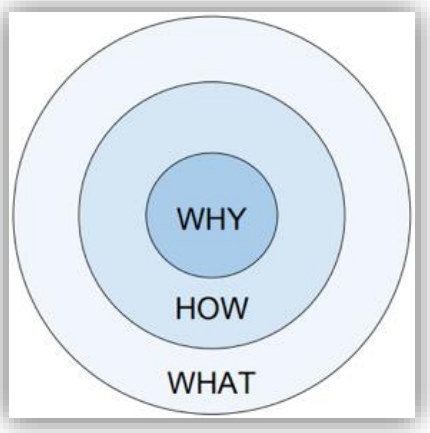

func main() {
yCombo := yCombinator(fibFuncFunc)
recurse := Recurse(fibFuncFunc)
for x := 0; x < 5; x++ {
fmt.Printf("yCombo(%d) = %d\n", x, yCombo(x))
fmt.Printf("recurse(%d) = %d\n", x, recurse(x))
fmt.Printf("plainRe(%d) = %d\n", x, fib(x))
fmt.Println("---")
}
}
func yCombinator(f FuncFunc) Func {
g := func(r RecursiveFunc) Func {
return f(func(x int) int {
return r(r)(x)
})
}
return g(g)
}
func fibFuncFunc(f Func) Func {
return func(x int) int {
if x == 0 {
return 0
} else if x <= 2 {
return 1
} else {
return f(x-2) + f(x-1)
}
}
}
func Recurse(f FuncFunc) Func {
return func(x int) int {
return f(Recurse(f))(x)
}
}
1
2
3
4
5
6
7
8
9
10
11
12

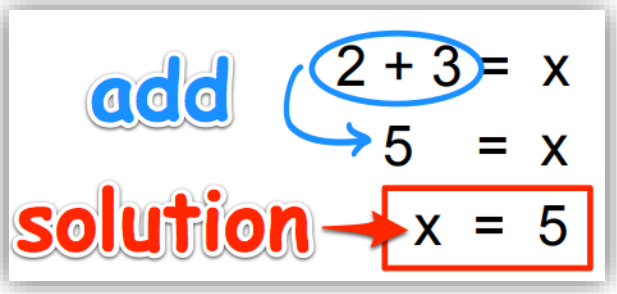

google translate
Google
google translate
All
Books
News
Shopping
Images
More
Settings
Tools
About 1,220,000,000 results (0.38 seconds)
English - detected
German
unexpected end of JSON input
Edit
unerwartetes Ende der JSON-Eingabe
Open in Google Translate
Feedback

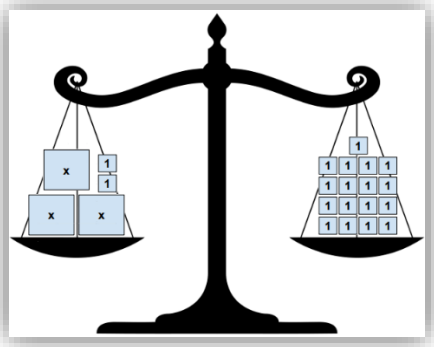

1. bash
~/clients/packt/dev/fp-go/4-purely-functional/ch10-monads/04_i18n $. init
++ ln -s /Users/lex/clients/packt/dev/fp-go/4-purely-functional/ch10-monads/04_i18n /Users/lex/dev/04_i18n
Installed Go version: go version go1.9.2 darwin/amd64
Switching Go to version 1.9.2 ...
GOVERSION: go version go1.9.2 darwin/amd64
CURRENT_GOVERSION: go1.9.2
You should only need to run this init script once.
Add Go source code files under the src directory.
After updating dependencies, i.e., adding a new import statement, run: glide-update
To build and run your app, run: go-run
~/dev/04_i18n $ glide-update
~/clients/packt/dev/fp-go/4-purely-functional/ch10-monads/04_i18n ~/dev/04_i18n
[INFO] Generating a YAML configuration file and guessing the dependencies
[INFO] Attempting to import from other package managers (use --skip-import to skip)
[INFO] Scanning code to look for dependencies
[INFO] --> Found reference to github.com/nicksnyder/go-i18n/i18n
[INFO] Writing configuration file (glide.yaml)
[INFO] You can now edit the glide.yaml file. Consider:
[INFO] --> Using versions and ranges. See https://glide.sh/docs/versions/
[INFO] --> Adding additional metadata. See https://glide.sh/docs/glide.yaml/
[INFO] --> Running the config-wizard command to improve the versions in your configuration
[INFO] Downloading dependencies. Please wait...
[INFO] --> Fetching updates for github.com/nicksnyder/go-i18n.
[INFO] Resolving imports
[INFO] --> Fetching updates for github.com/pelletier/go-toml.
[INFO] --> Fetching updates for gopkg.in/yaml.v2.
[INFO] Downloading dependencies. Please wait...
[INFO] Setting references for remaining imports
[INFO] Exporting resolved dependencies...
[INFO] --> Exporting github.com/nicksnyder/go-i18n
[INFO] --> Exporting github.com/pelletier/go-toml
[INFO] --> Exporting gopkg.in/yaml.v2
[INFO] Replacing existing vendor dependencies
[INFO] Project relies on 3 dependencies.
vendor packages have been moved to /Users/lex/clients/packt/dev/fp-go/4-purely-functional/ch10-monads/04_i18n/vendors and your GOPATH: /Users/lex/clients/packt/dev/fp-go/4-purely-functional/ch10-monads/04_i18n/vendors:/Users/lex/clients/packt/dev/fp-go/4-purely-functional/ch10-monads/04_i18n
~/dev/04_i18n
~/dev/04_i18n $ get-go-binary github.com/nicksnyder/go-i18n/goi18n
~/dev/04_i18n/tmp_dir_4581 ~/dev/04_i18n
~/dev/04_i18n
~/dev/04_i18n $ goi18n -help
Merge translation files.
Usage:
goi18n merge [options] [files...]

Chapter 11: Category Theory That Applies



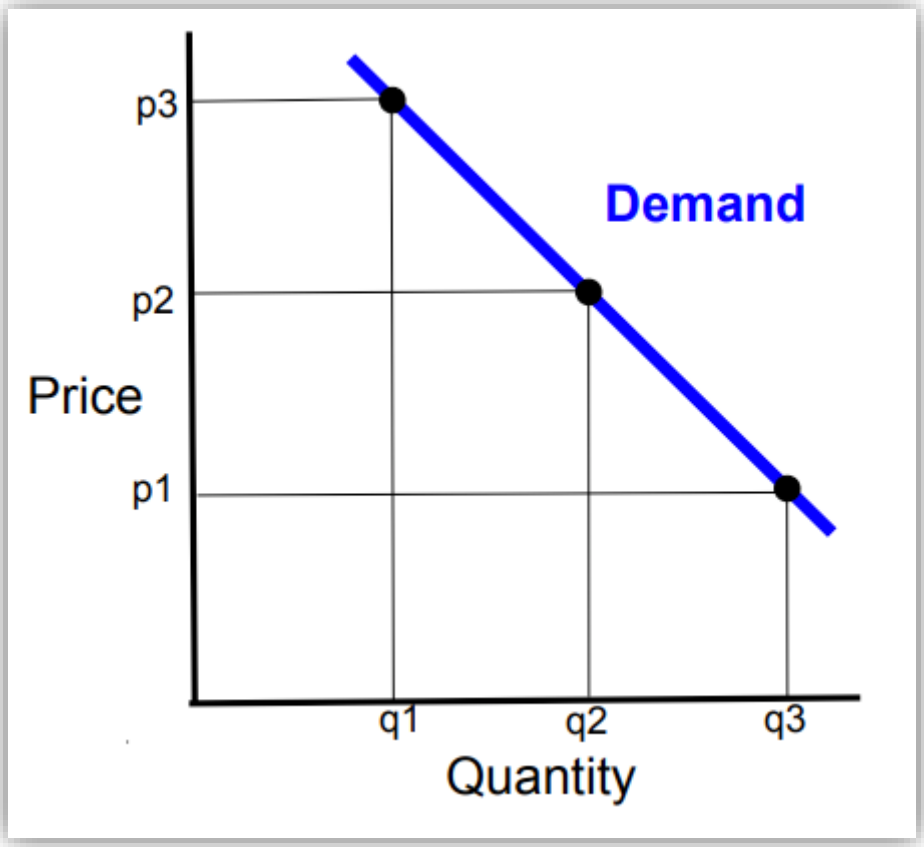

WHY
HOW
WHAT

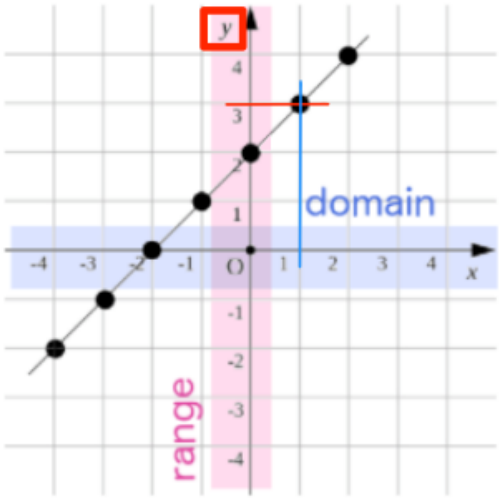

add
2 + 3 = x
5 = x
solution
x = 5


x
1
1
x
x
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1

$$3x + 2 = 17$$
$$-2 = -2$$
$$\left(\tfrac{1}{3}\right) \quad 3x = 15 \quad \left(\tfrac{1}{3}\right)$$

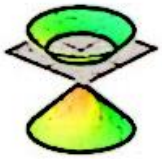
solution $\boxed{x = 5}$

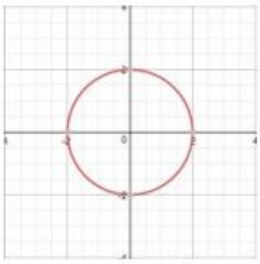


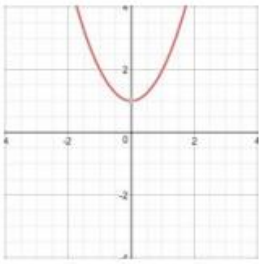
x	y = g(x)	
-4	-2	
-3	-1	
-2	0	
-1	1	
0	2	
1	3	
2	4	

circle

$x^2 + y^2 = 1$







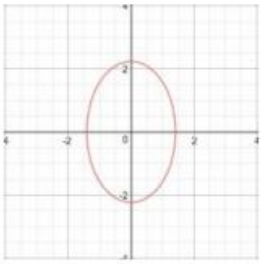
parabola

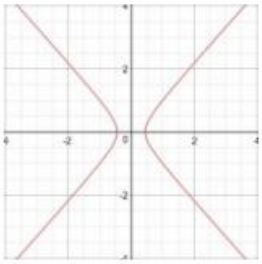
$ax^2 = 1$

eclipse

$ax^2 + by^2 = 1$

{a:0.5, b:0.2}

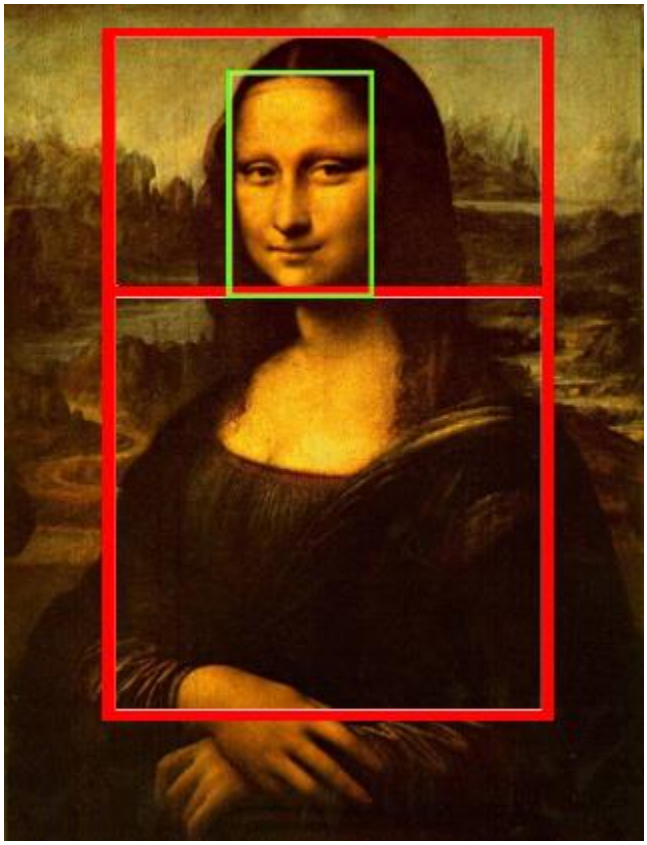


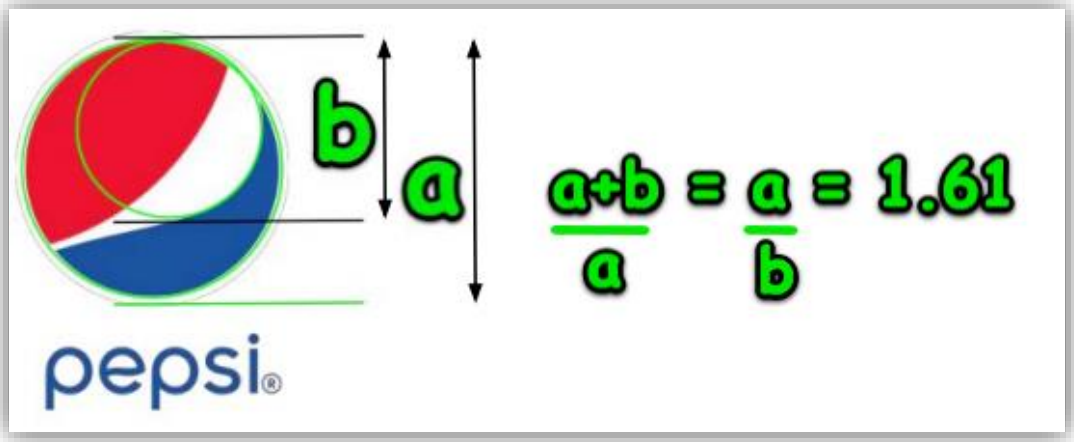


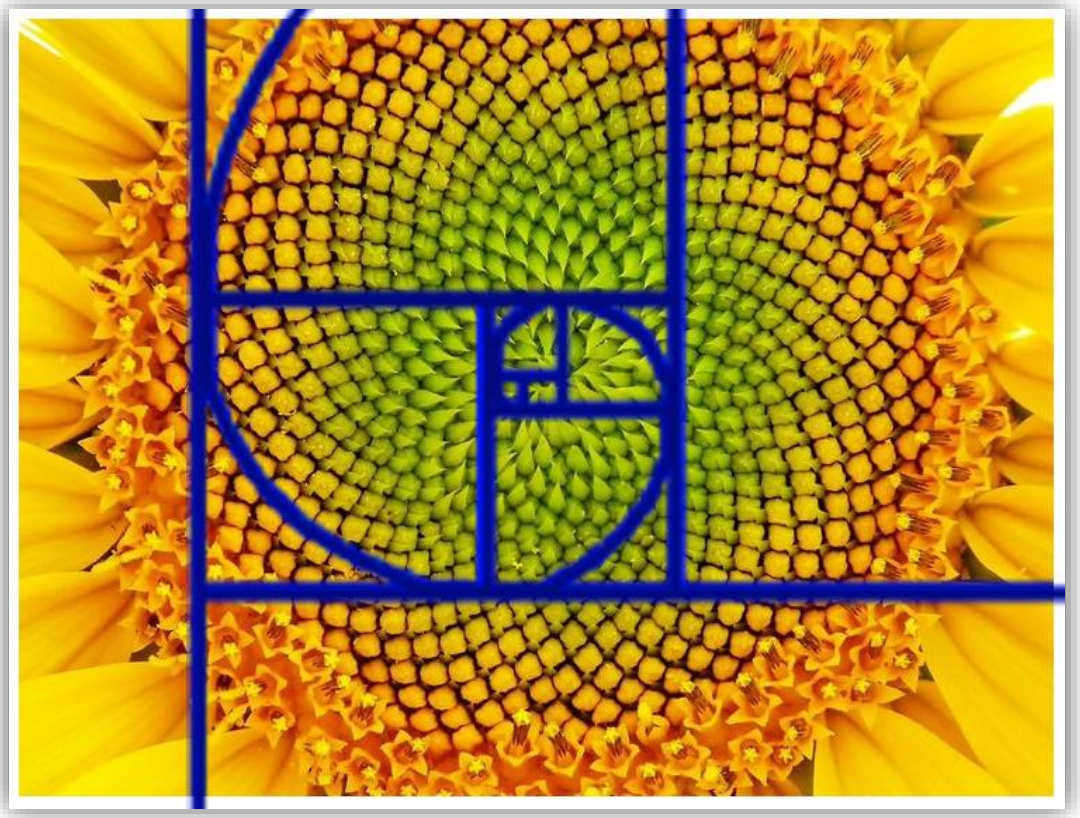
hyperbola

$ax^2 - by^2 = 1$

{a: 5, b: 4}




b
a
a+b / a = a / b = 1.61
pepsi



Identity Property

Fingerprints revealed the culprit's identity.

Addition	Multiplication
5 + 0 = 5	5 * 1 = 5

Commutative Property

Marty commutes to and from work by train.

Addition	Multiplication
2 + 3 = 5	2 * 3 = 6
3 + 2 = 5	3 * 2 = 6

Associative Property

Marty associates more with CocoPuff at school.

Marty associates more with Ryan after school.

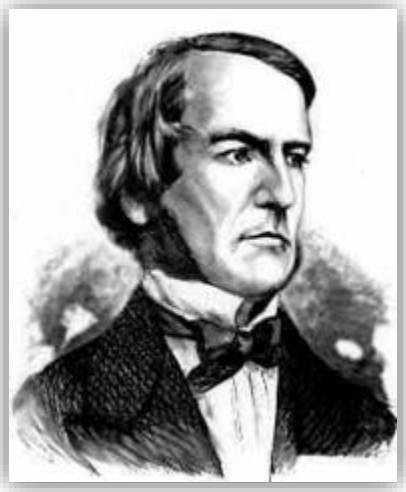
Addition	Multiplication
5+(2+4) = 11	5*(2*4) = 40
(5+2)+4 = 11	(5*2)*4 = 40

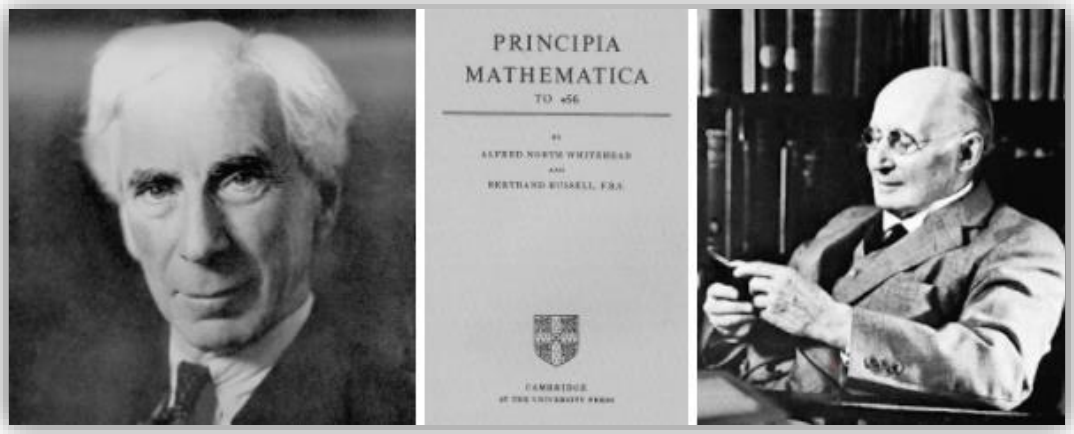
Distributive Property

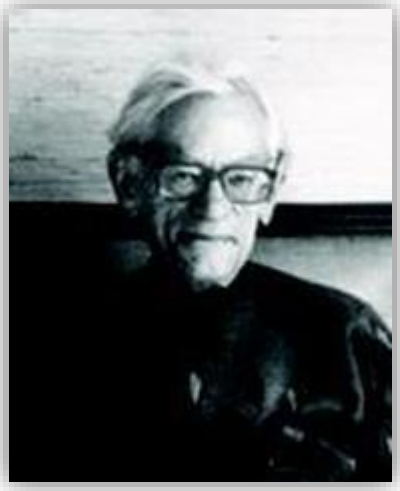
Grandma distributes gifts to each grandchild.

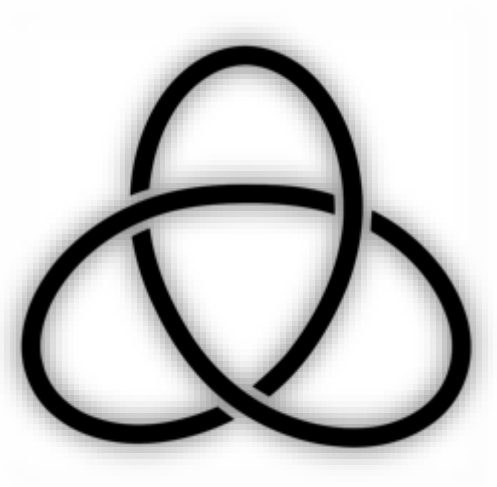
10 15

5 * (2 + 3) = 25




PRINCIPIA
MATHEMATICA
TO *56
BY
ALFRED NORTH WHITEHEAD
AND
BERTRAND RUSSELL, F.R.S.
CAMBRIDGE



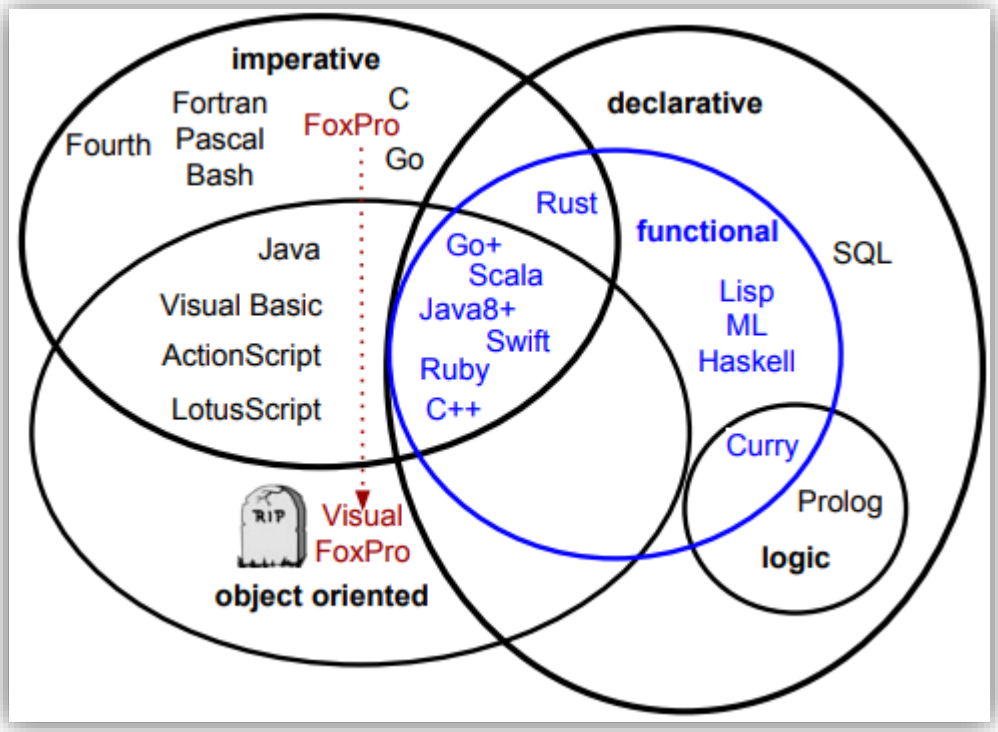


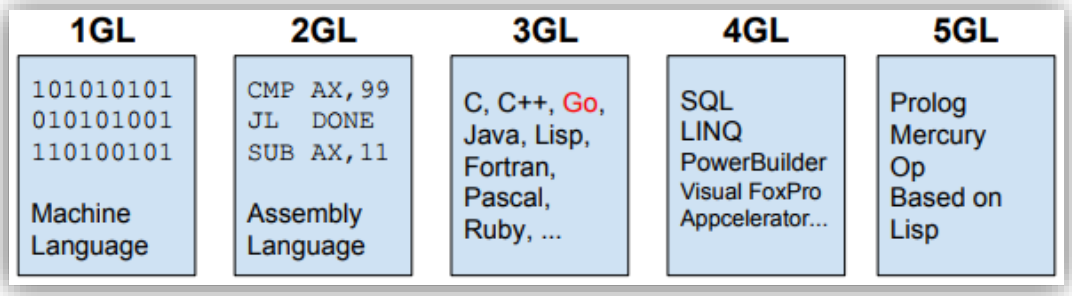
```
is250 := &Car{"Lexus", "IS250"}
accord := &Car{"Honda", "Accord"}
cars := []*Car{is250, accord}
upgradedCars := []*Car{}
count := 0
for _, car := range cars {
    upgradedCars = append(upgradedCars, car.Upgrade())
    count ++
}
```

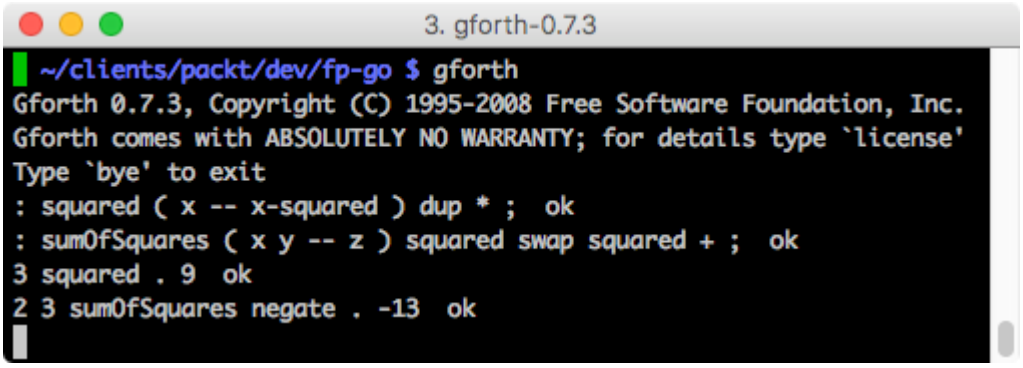
same shape

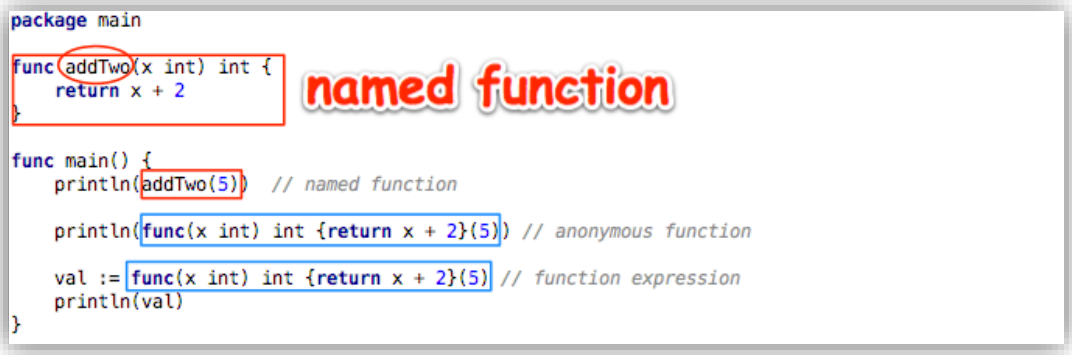
map

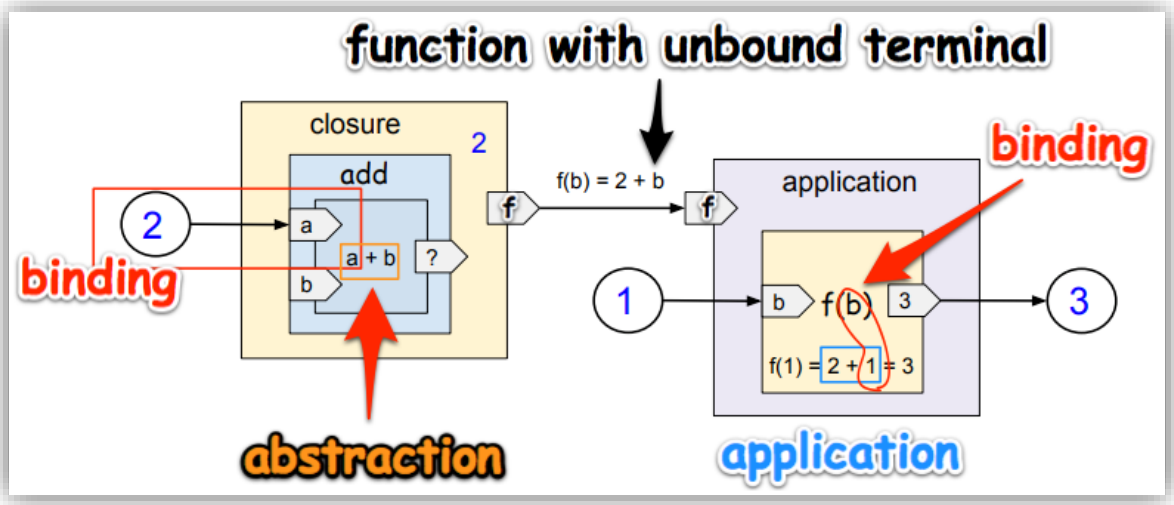
accumulate


imperative
Fortran
C
FoxPro
Fourth
Pascal
Bash
Go
declarative
Rust
functional
SQL
Java
Go+
Scala
Visual Basic
Java8+
Lisp
ML
Swift
ActionScript
Ruby
Haskell
LotusScript
C++
Curry
Prolog
RIP
Visual
FoxPro
logic
object oriented


1GL
101010101
010101001
110100101
Machine Language
2GL
CMP AX,99
JL DONE
SUB AX,11
Assembly Language
3GL
C, C++, Go, Java, Lisp, Fortran, Pascal, Ruby, ...
4GL
SQL
LINQ
PowerBuilder
Visual FoxPro
Appcelerator...
5GL
Prolog
Mercury
Op
Based on Lisp


3. gforth-0.7.3
~/clients/packt/dev/fp-go $ gforth
Gforth 0.7.3, Copyright (C) 1995-2008 Free Software Foundation, Inc.
Gforth comes with ABSOLUTELY NO WARRANTY; for details type `license'
Type `bye' to exit
: squared (x -- x-squared) dup * ; ok
: sumOfSquares (x y -- z) squared swap squared + ; ok
3 squared . 9 ok
2 3 sumOfSquares negate . -13 ok


package main
func addTwo(x int) int {
return x + 2
}
named function
func main() {
println(addTwo(5)) // named function
println(func(x int) int {return x + 2}(5)) // anonymous function
val := func(x int) int {return x + 2}(5) // function expression
println(val)
}



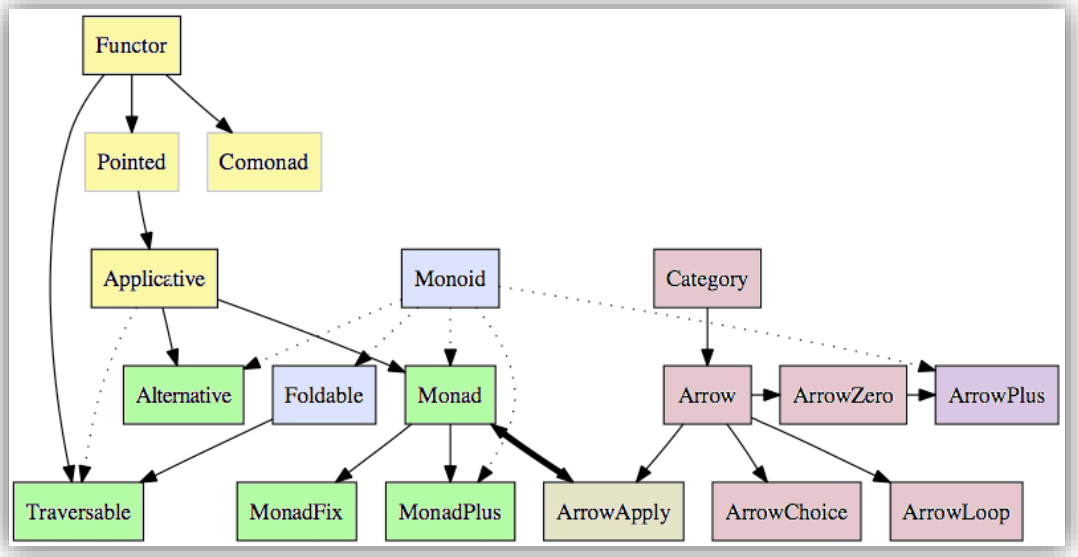

```
package main

type lambda func(int) int

func add(a int) lambda {
    return func(free int) int {
        return func(b int) int {
            return a + b
        }(free)
    }
}

func main() {
    add2 := add(2)
    three := add2(1)
    println("Pass 1 to to add2 expression to get:", three)
    four := add2(2)
    println("Pass 2 to to add2 expression to get:", four)
}
```

1) define function

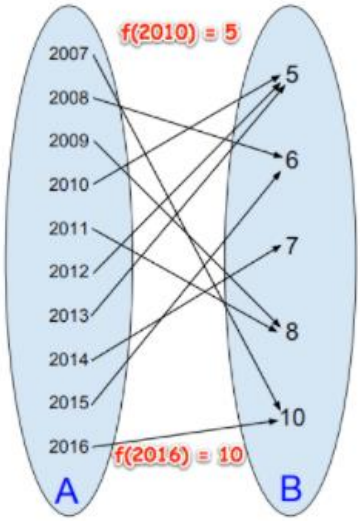
2) bind to variable

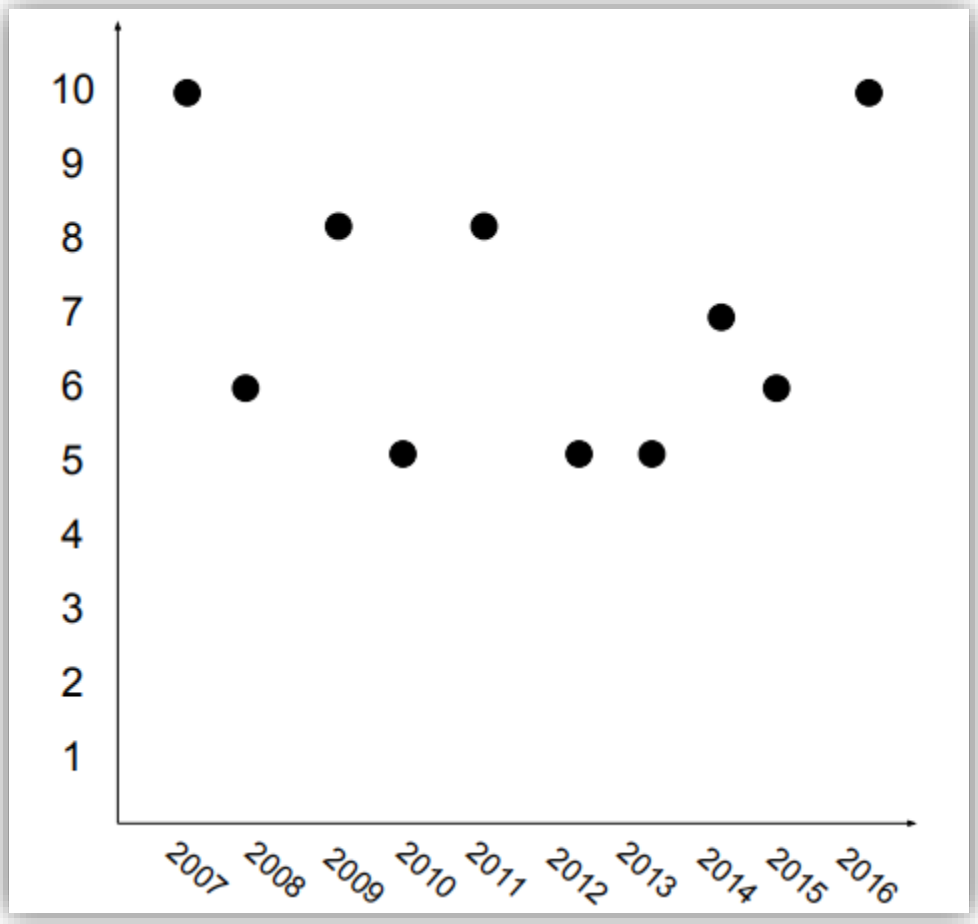
3) execute function

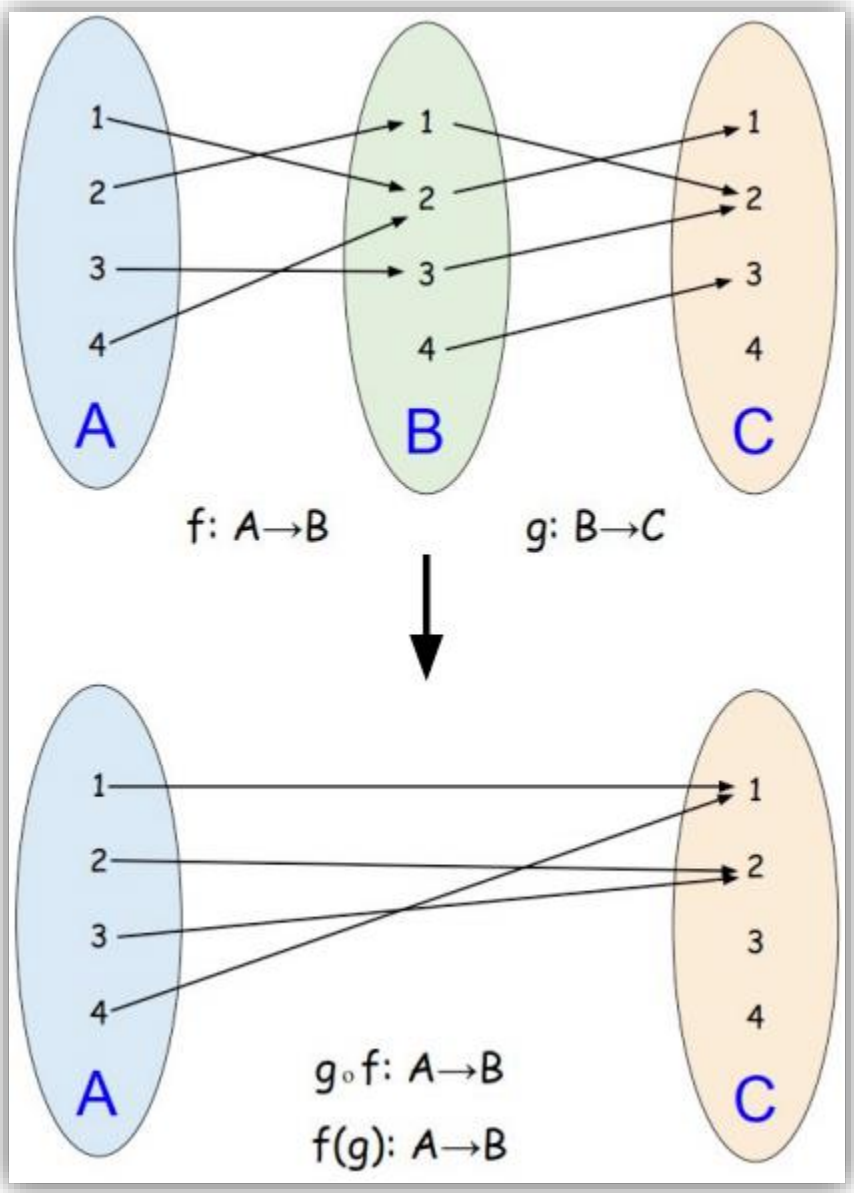

MILK
MILK
MILK

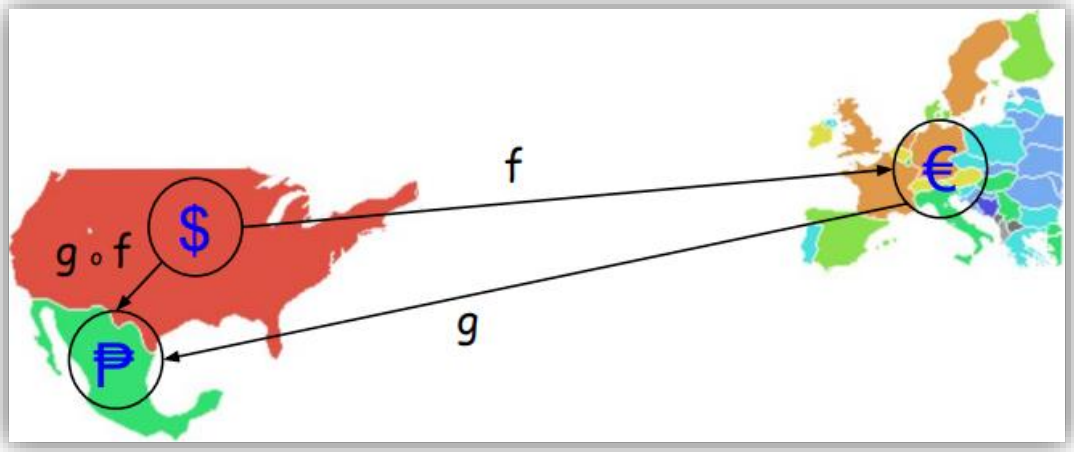

Functor
Pointed
Comonad
Applicative
Monoid
Category
Alternative
Foldable
Monad
Arrow
ArrowZero
ArrowPlus
Traversable
MonadFix
MonadPlus
ArrowApply
ArrowChoice
ArrowLoop

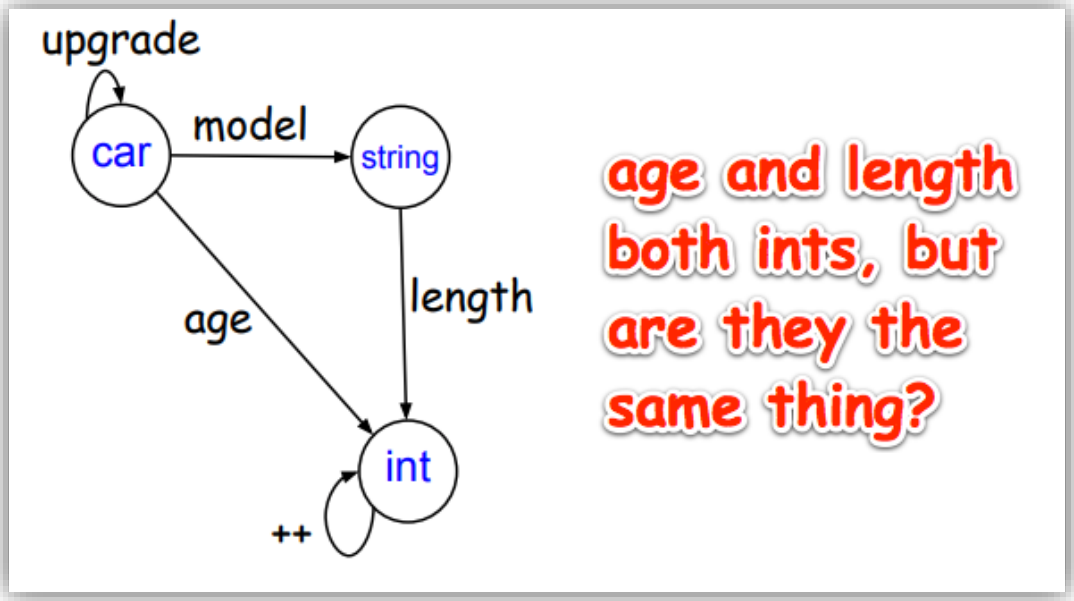
Composition Table		Ordered Pairs	Correspondence
Year *(Domain A)* x	Goals Scored *(Range B)* f(x)		
2007	10	(2007,10)	
2008	6	(2008, 6)	
2009	8	(2008, 8)	
2010	5	(2010, 5)	
2011	8	(2011, 8)	
2012	5	(2012, 5)	
2013	5	(2013, 5)	
2014	7	(2014, 7)	
2015	6	(2015, 6)	
2016	10	(2016, 10)	



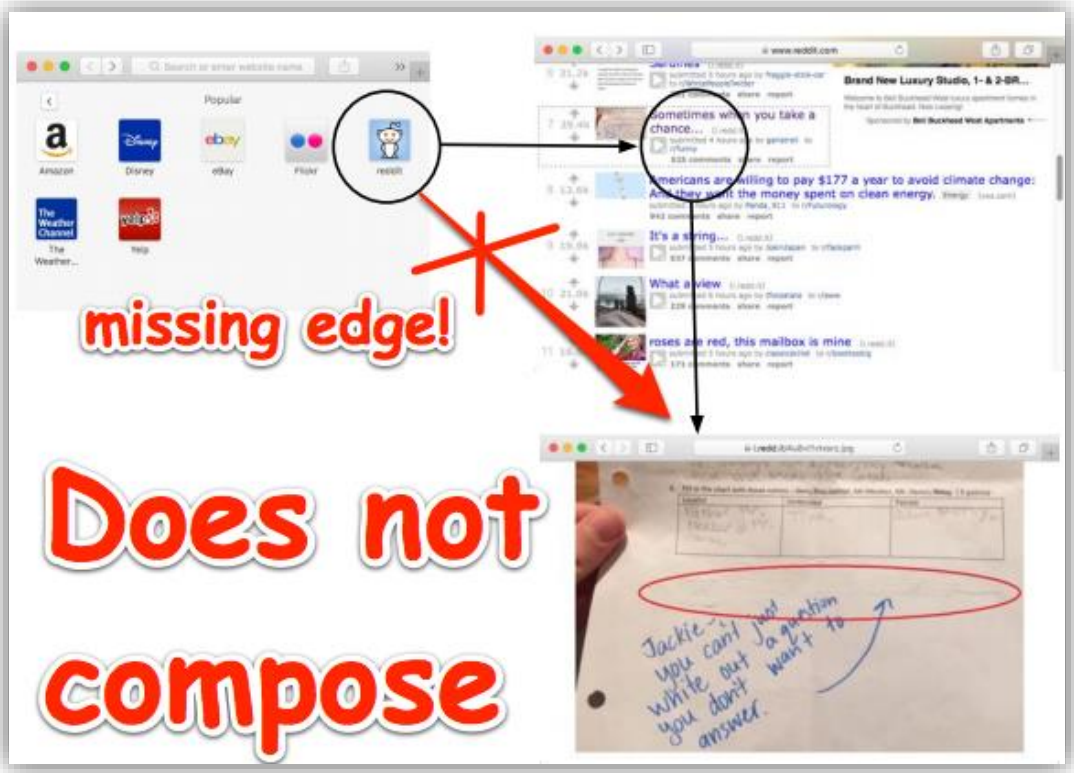

10
9
8
7
6
5
4
3
2
1
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

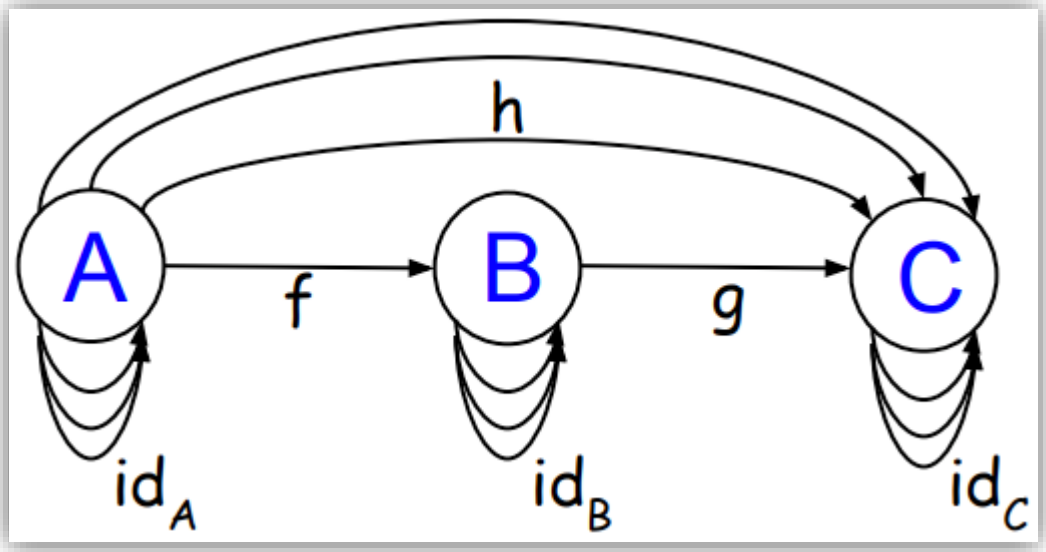

1
2
3
4
A
1
2
3
4
B
1
2
3
4
C
f: A→B
g: B→C
1
2
3
4
A
1
2
3
4
C
g∘f: A→B
f(g): A→B

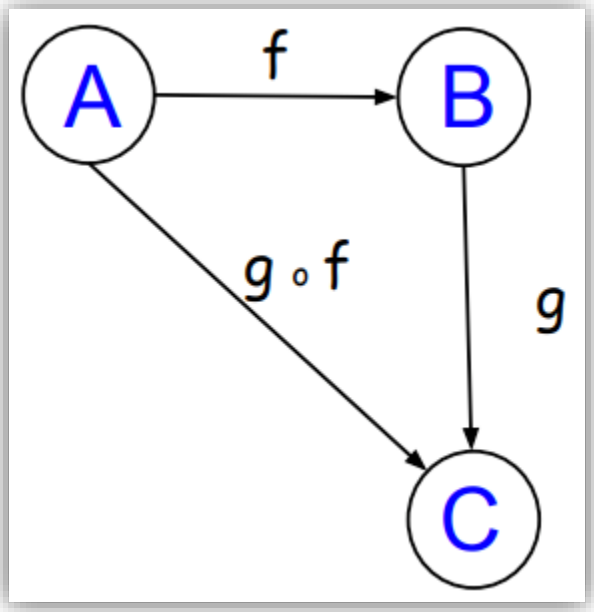


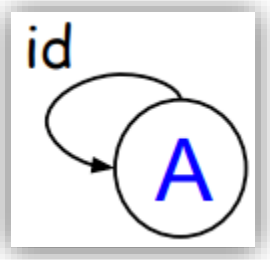


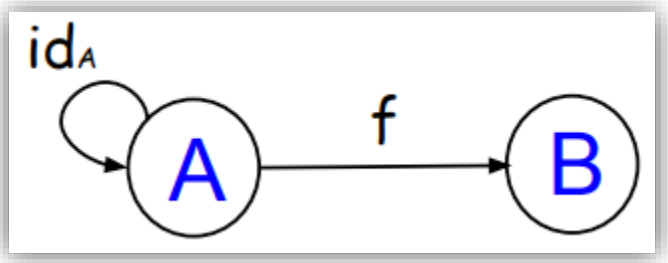
age and length both ints, but are they the same thing?

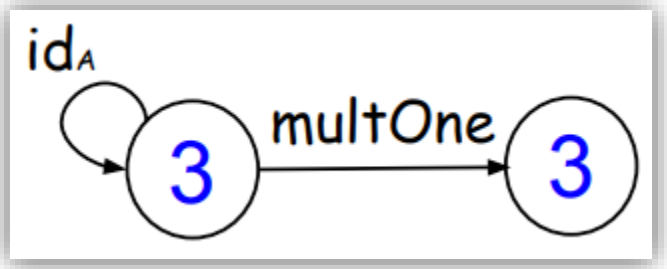

Popular
Amazon
Disney
eBay
Flickr
reddit
The Weather...
Yelp
missing edge!
Does not compose
Brand New Luxury Studio, 1- & 2-BR...
Sometimes when you take a chance...
Americans are willing to pay $177 a year to avoid climate change: And they want the money spent on clean energy.
It's a spring...
What a view
roses are red, this mailbox is mine
Jackie - you can't just write out a question you don't want to answer.

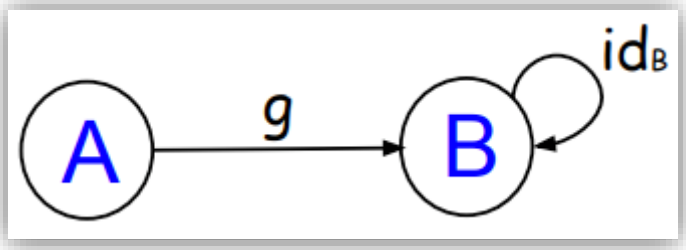

h
A
f
B
g
C
id_A
id_B
id_C

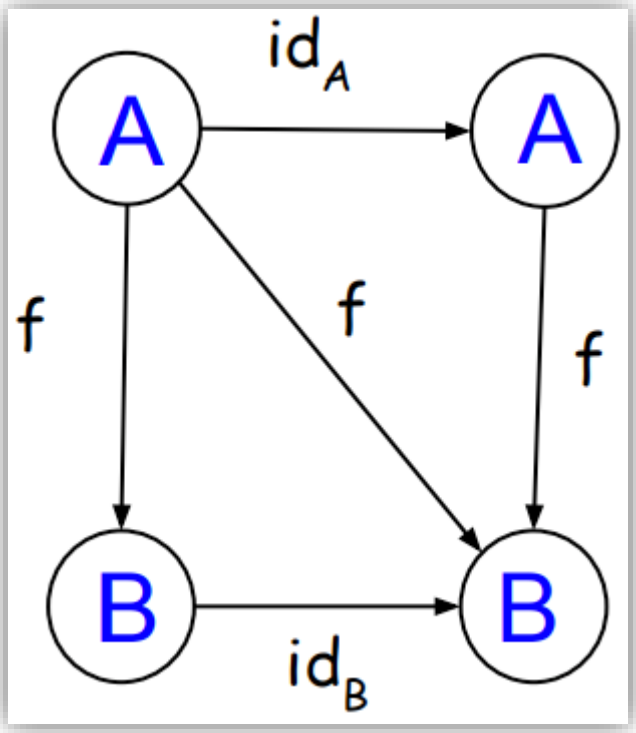

A
f
B
g ∘ f
g
C

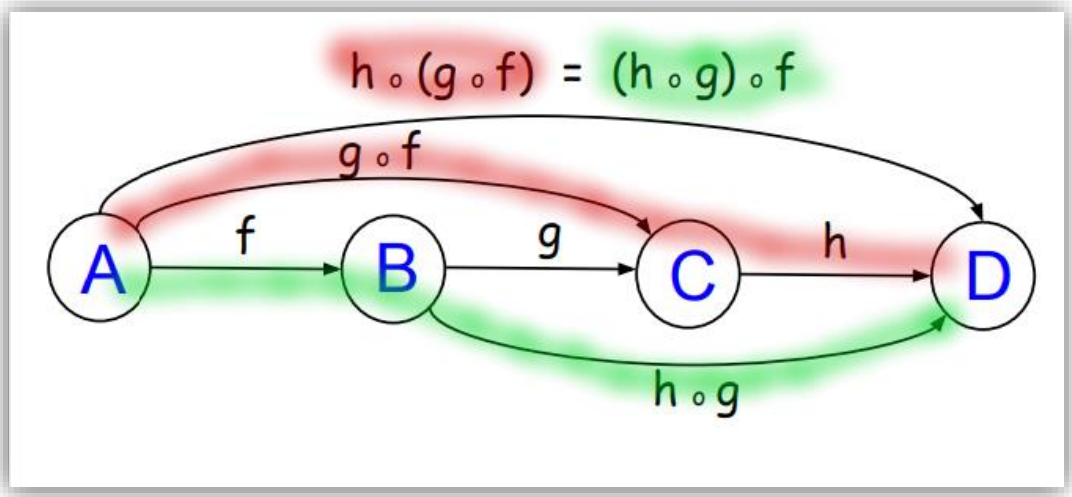

id
A

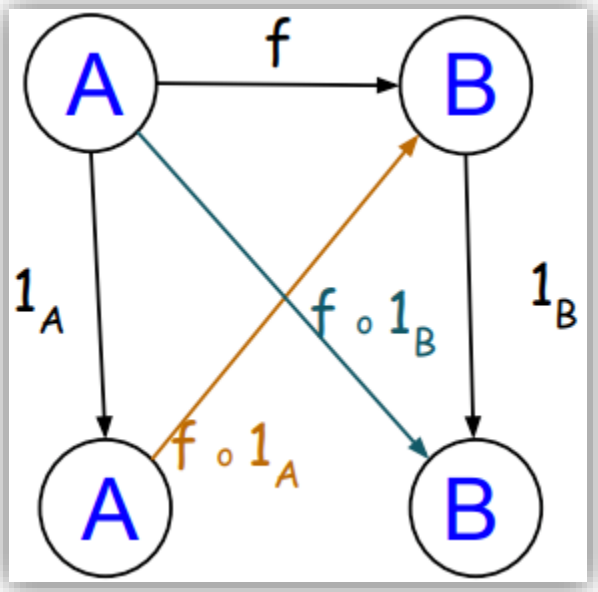

id_A
A
f
B

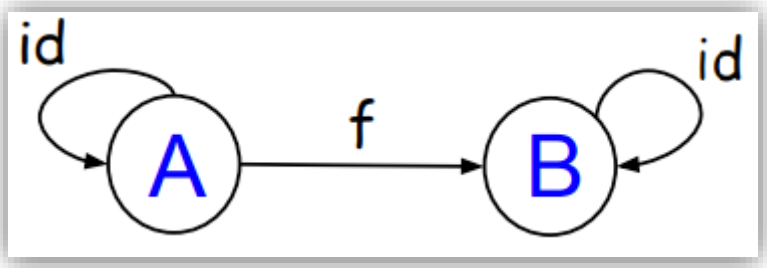

id_A
3
multOne
3

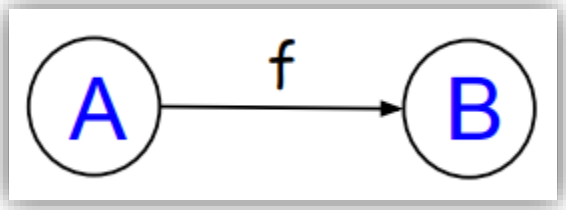

A
g
B
id_B

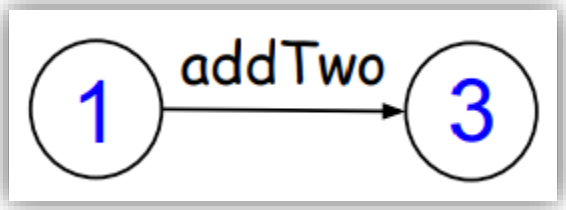

id_A
A
A
f
f
f
B
B
id_B

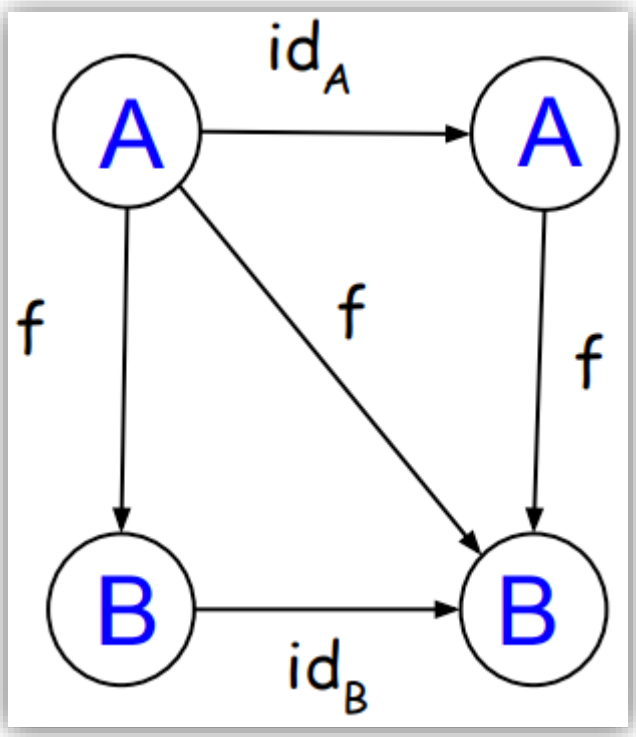

h ∘ (g ∘ f) = (h ∘ g) ∘ f
g ∘ f
A
f
B
g
C
h
D
h ∘ g

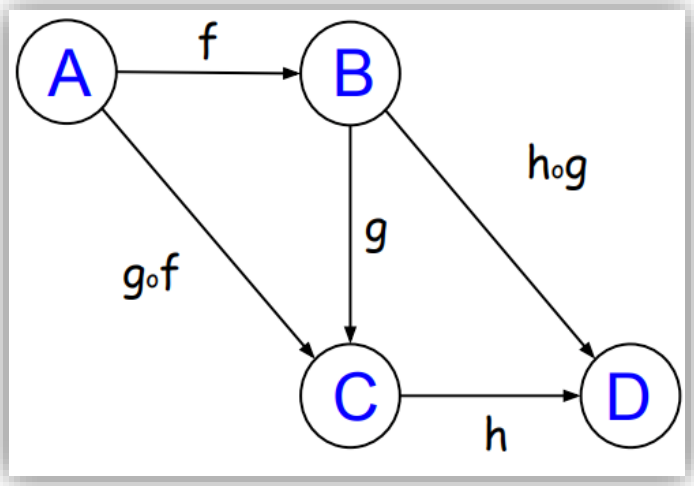

A
f
B
1A
f ∘ 1B
1B
f ∘ 1A
A
B

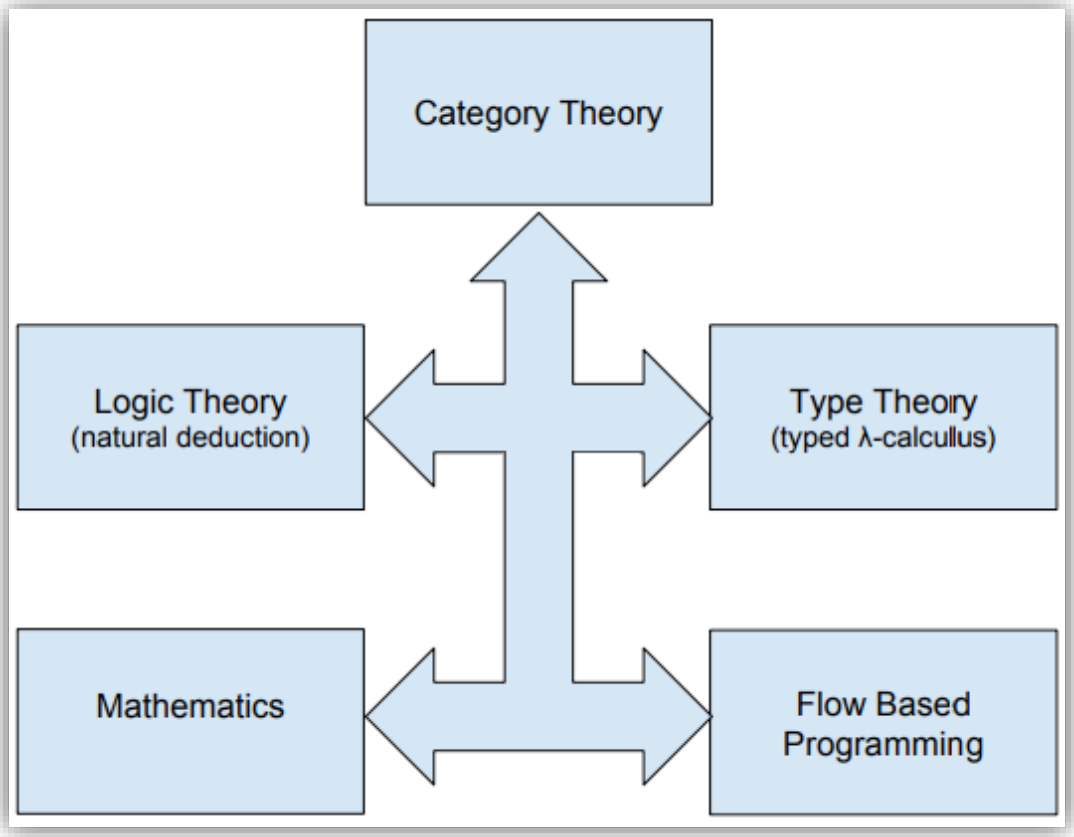

id
id
A
f
B

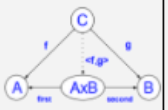
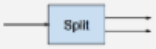
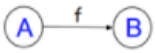
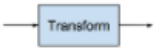
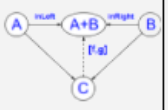
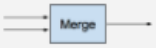
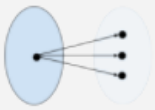
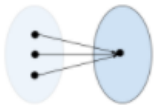

A
f
B

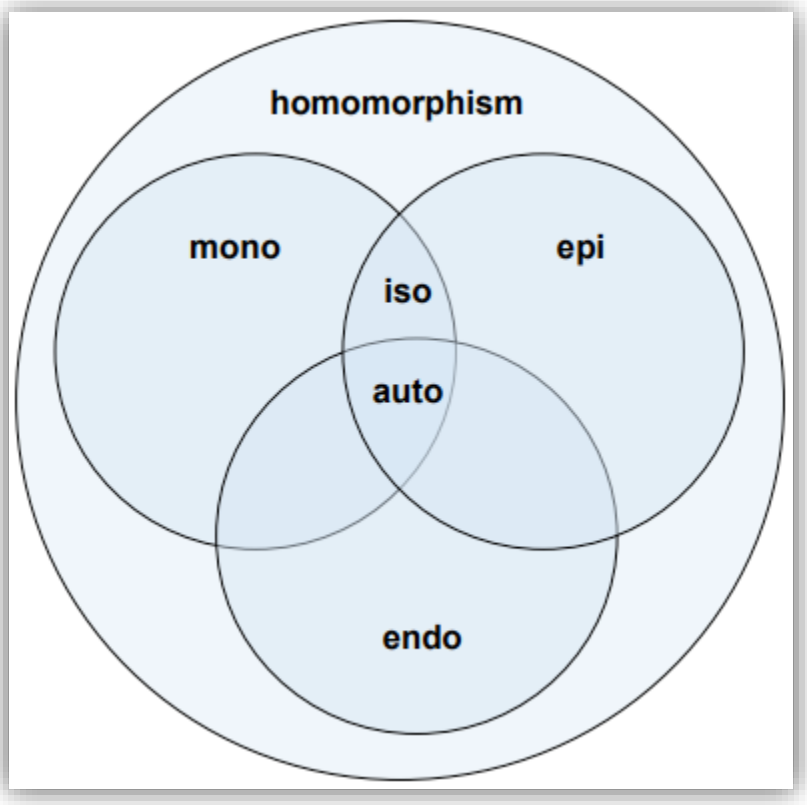

1
addTwo
3

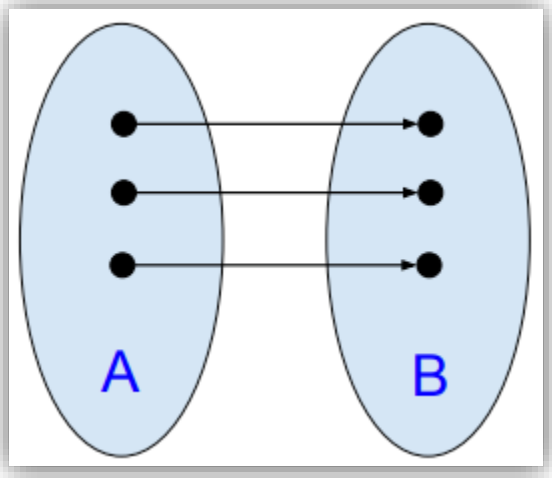

id_A
A
A
f
f
f
B
B
id_B

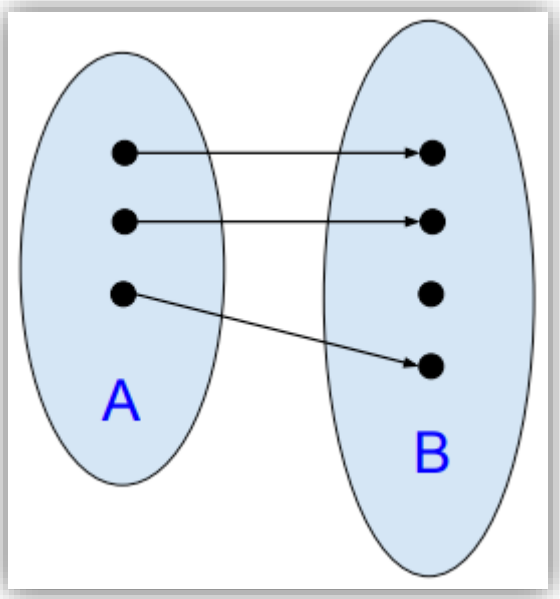

A
f
B
h∘g
g
g∘f
C
D
h

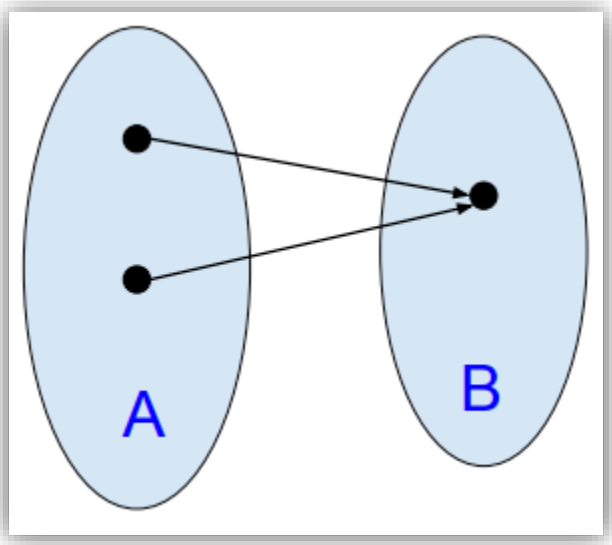

Category Theory
Logic Theory
(natural deduction)
Type Theory
(typed λ-calculus)
Mathematics
Flow Based
Programming

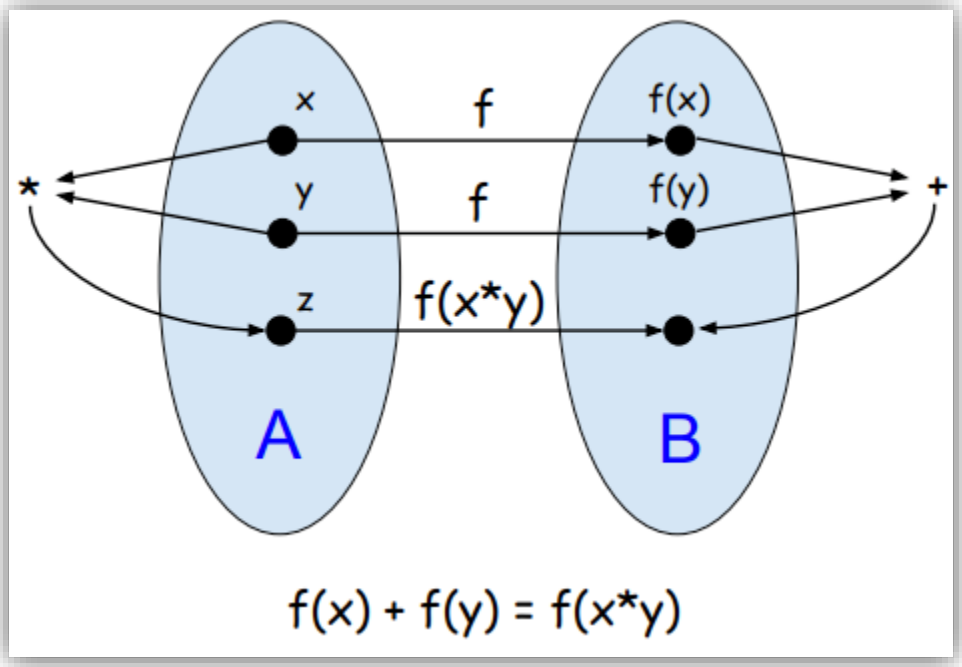
Category Theory		Logical Theory		Type Theory		Flow Based	
				I/O Monad		Read	
Product		Or	∨	Filter	A x B	Split	
Morphism		Imply if...then	⇒	Map	A → B	Transform	
Sum		And	∧	Reduce	A + B	Merge	
				I/O Monad		Write	
initial object		false		Empty Space	Void	Beginning	
terminal object		true		Unit Type one element	()	End	

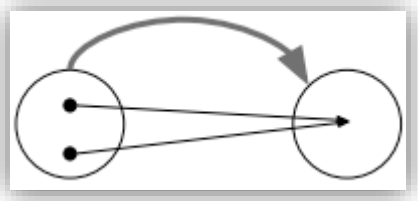

homomorphism
mono
epi
iso
auto
endo

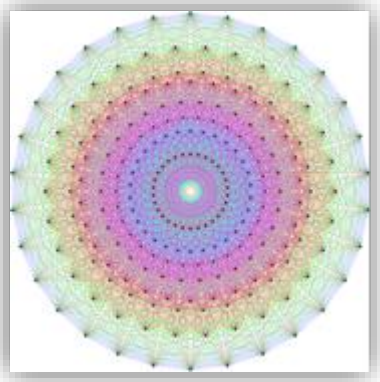

A
B

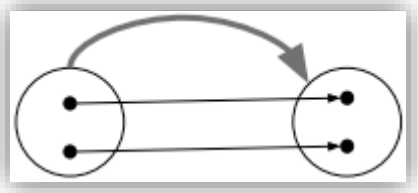

A
B

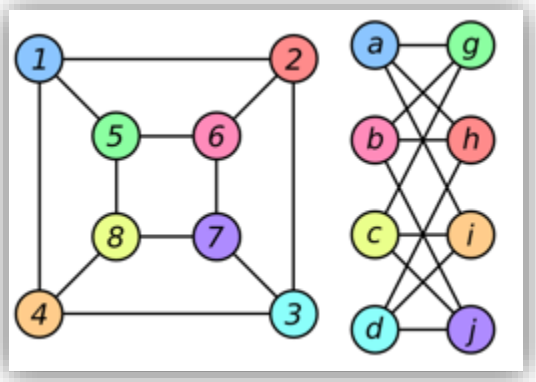

A
B


x
y
z
f
f
f(x*y)
f(x)
f(y)
*
+
A
B
f(x) + f(y) = f(x*y)








1
2
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6
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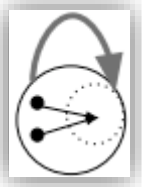
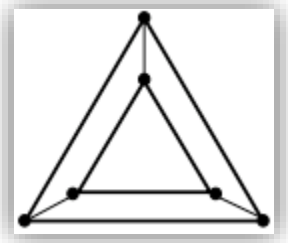
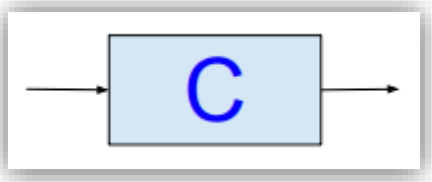
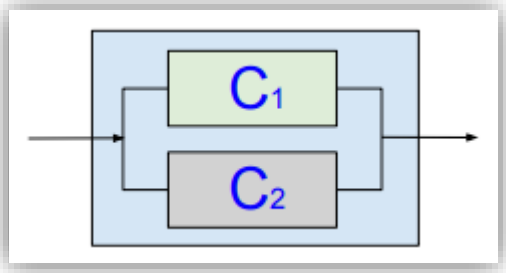
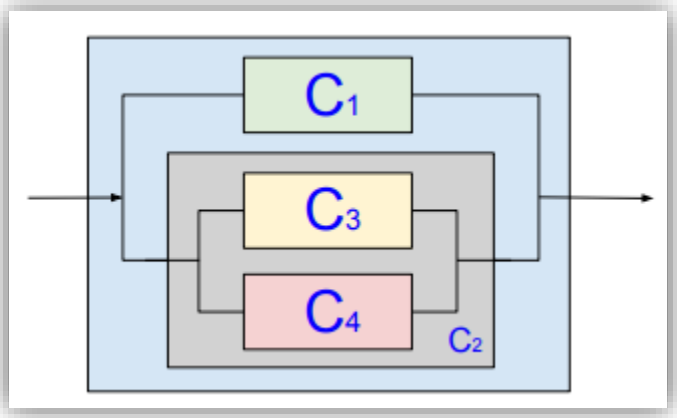
7
4
3
a
g
b
h
c
i
d
j

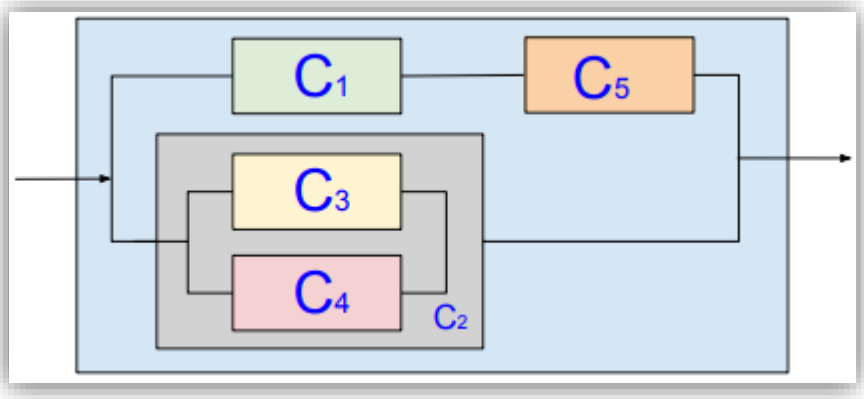


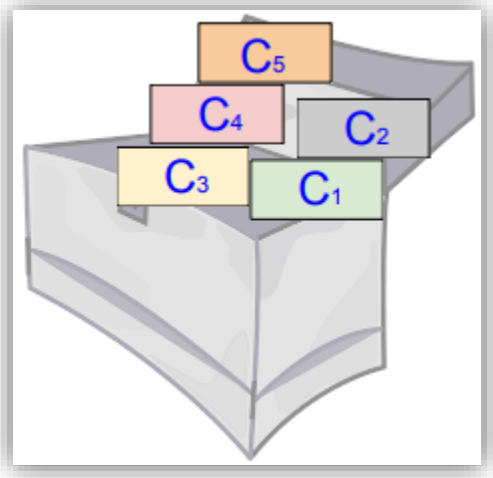


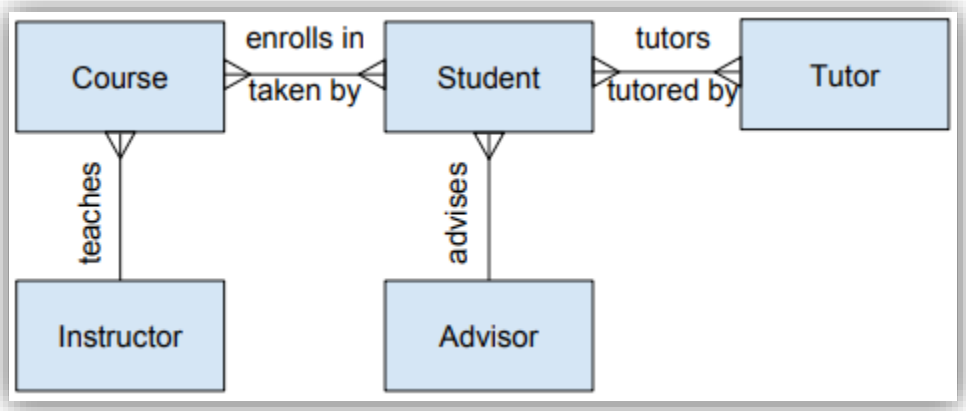

C

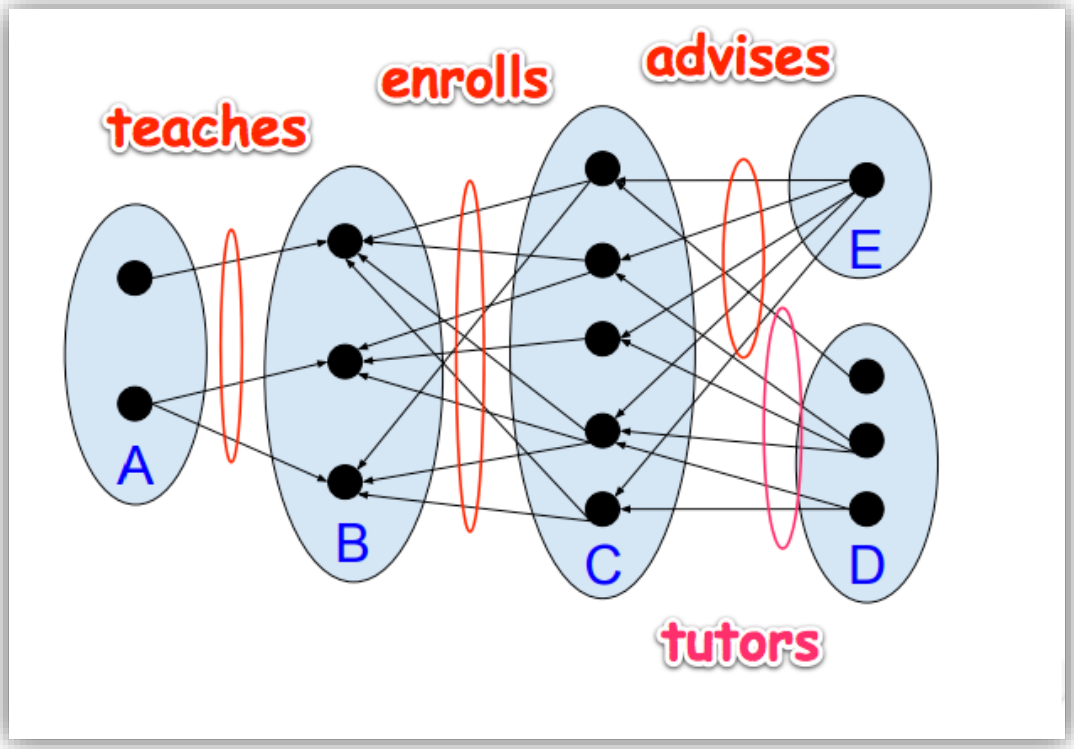

C1
C2

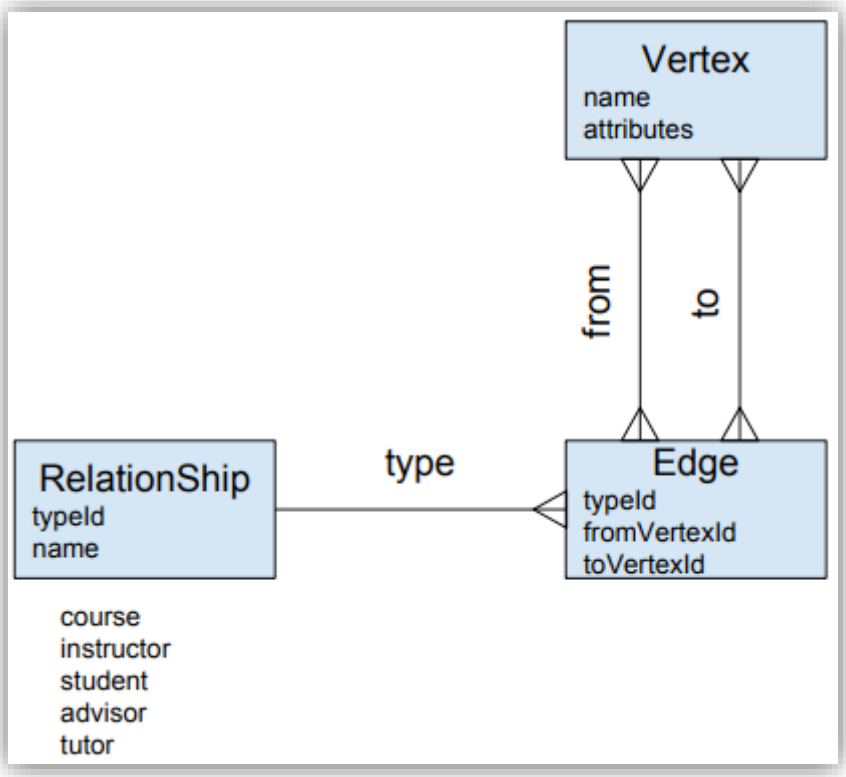

C1
C3
C4
C2

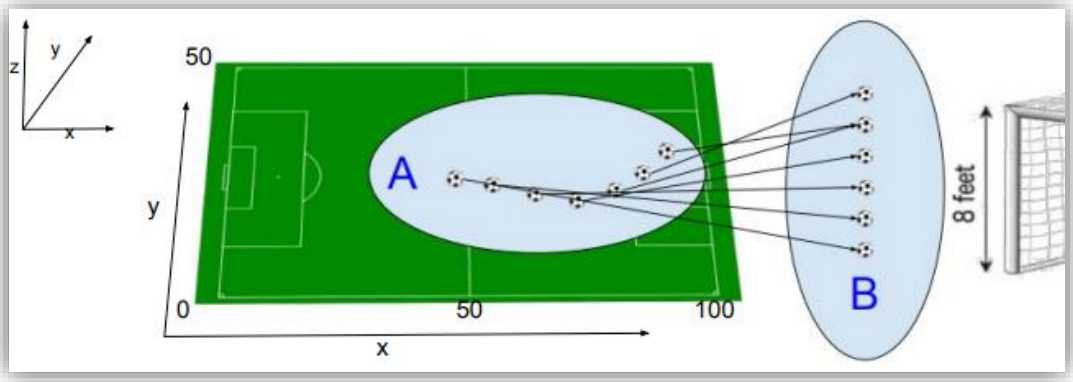

C1
C5
C3
C4
C2

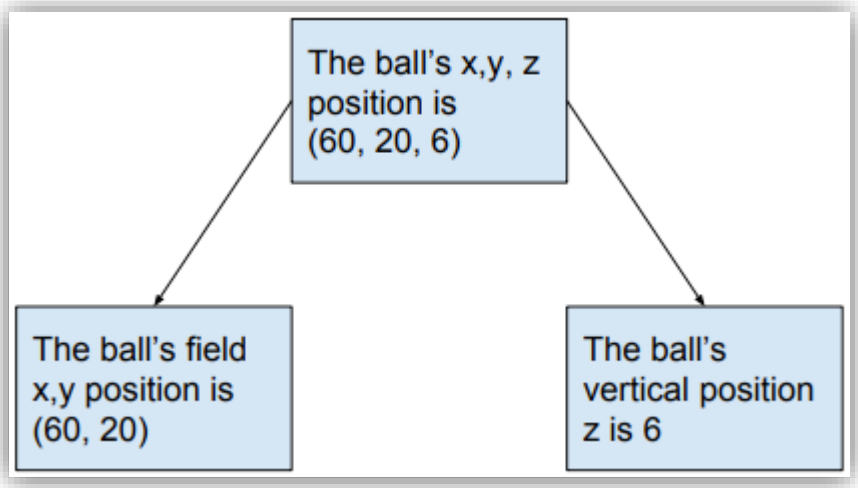

C5
C4
C2
C3
C1

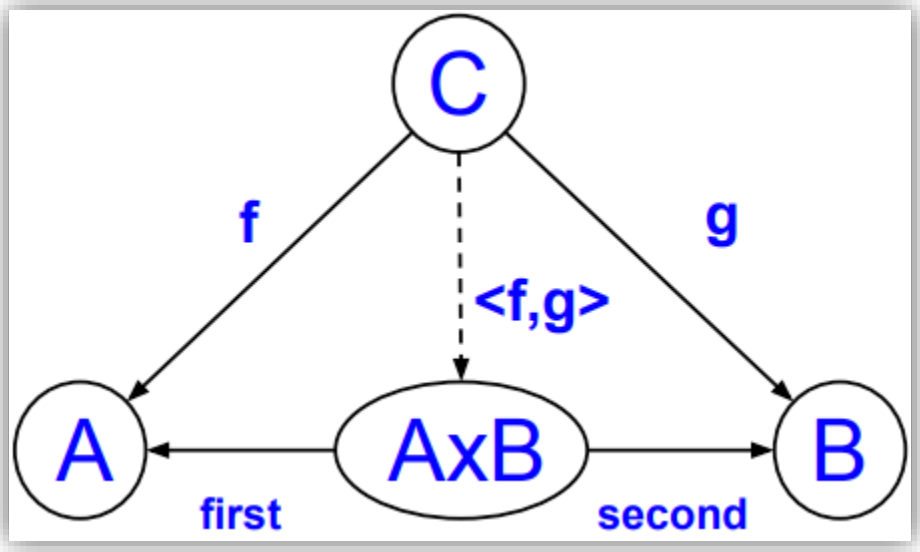

Course
enrolls in
taken by
Student
tutors
tutored by
Tutor
teaches
advises
Instructor
Advisor

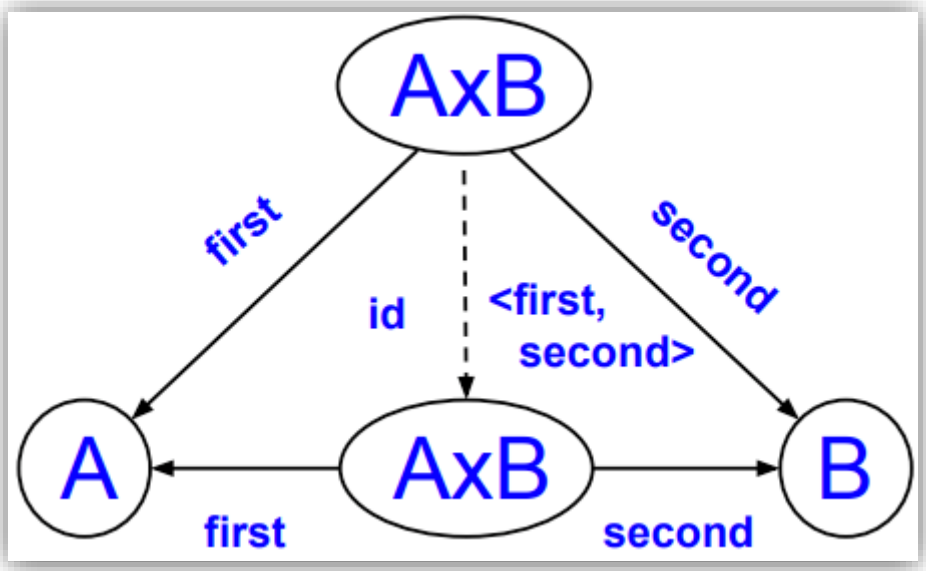

teaches
enrolls
advises
A
B
C
D
E
tutors

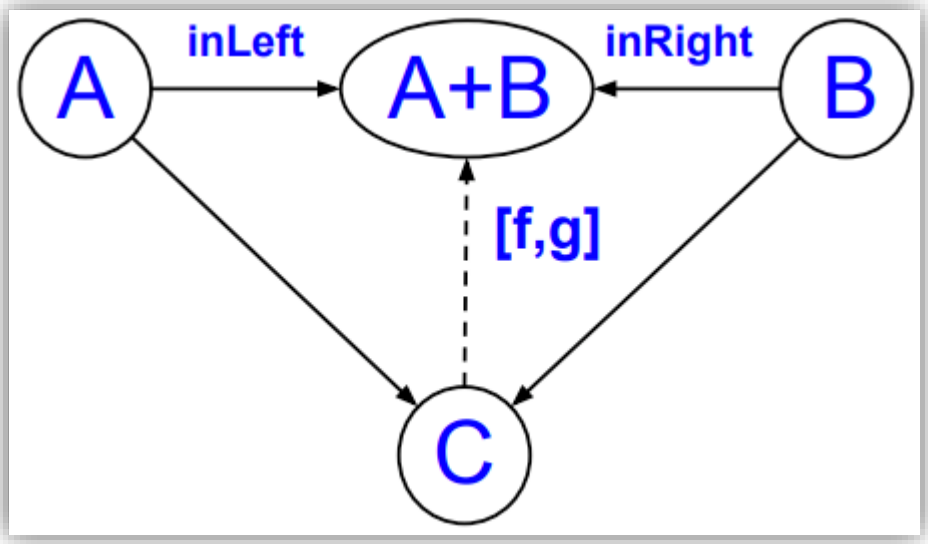

Vertex
name
attributes
from
to
RelationShip
typeId
name
type
Edge
typeId
fromVertexId
toVertexId
course
instructor
student
advisor
tutor


z
y
x
50
y
A
B
8 feet
0
50
100
x

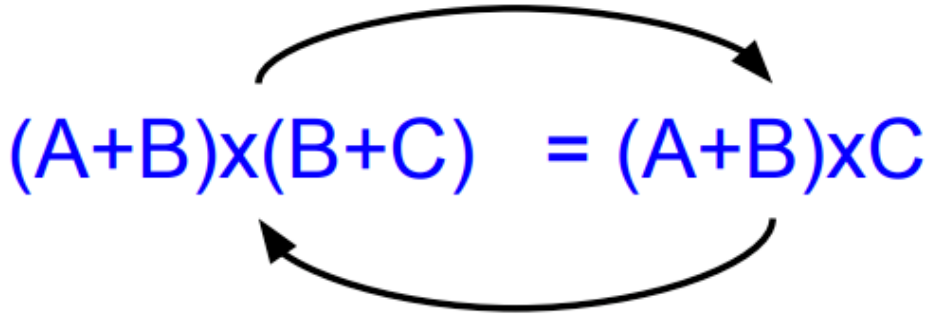

The ball's x,y, z position is (60, 20, 6)
The ball's field x,y position is (60, 20)
The ball's vertical position z is 6


C
f
g
<f,g>
A
AxB
B
first
second


AxB
first
id
<first,
second>
second
A
AxB
B
first
second


A
inLeft
A+B
inRight
B
[f,g]
C

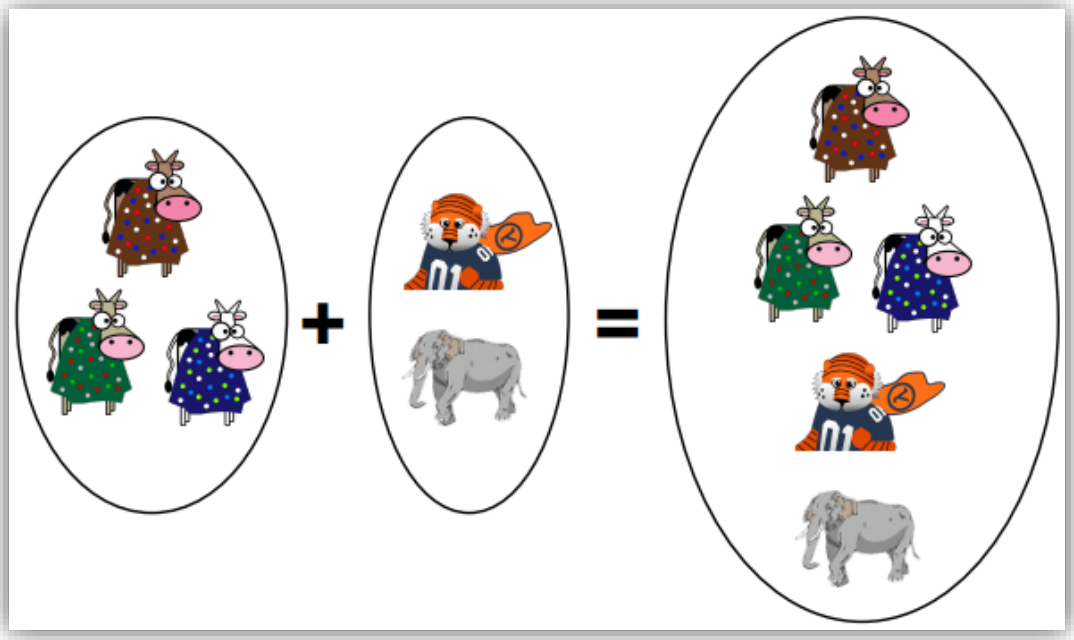
<[first;inLeft, first;inRigh], [second, second]>

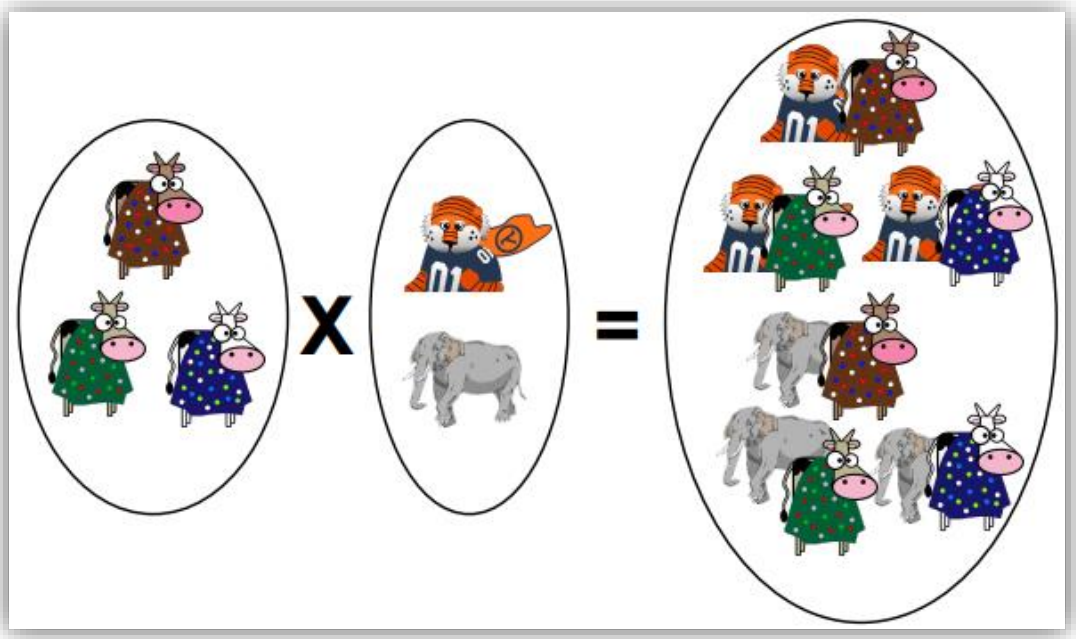


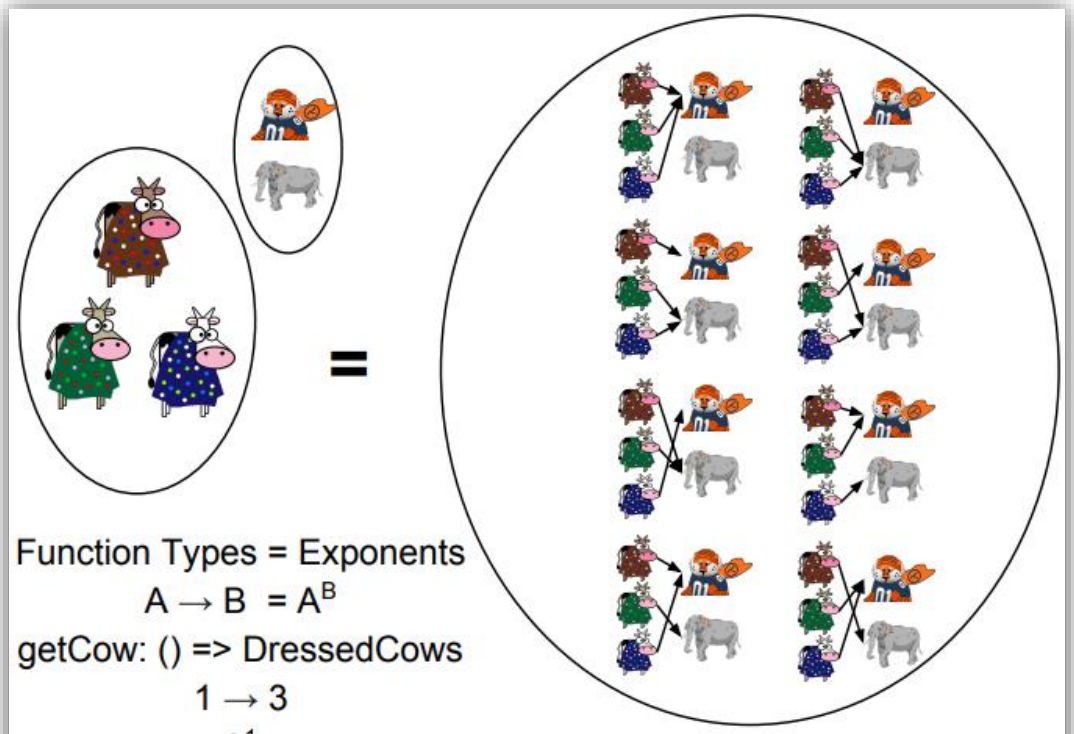
<[first;[curry(inLeft), curry(inRight)], second>; apply

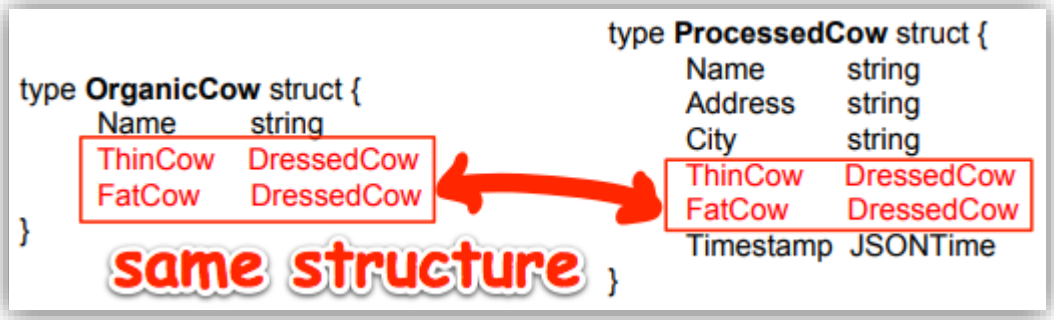
$$\frac{\Gamma, x: A \vdash N: B}{\Gamma \vdash (\lambda x: A.N): [A \Rightarrow B]} \qquad \frac{\Gamma \times A \xrightarrow{f} B}{\Gamma \xrightarrow{curry(f)} [A \Rightarrow B]}$$

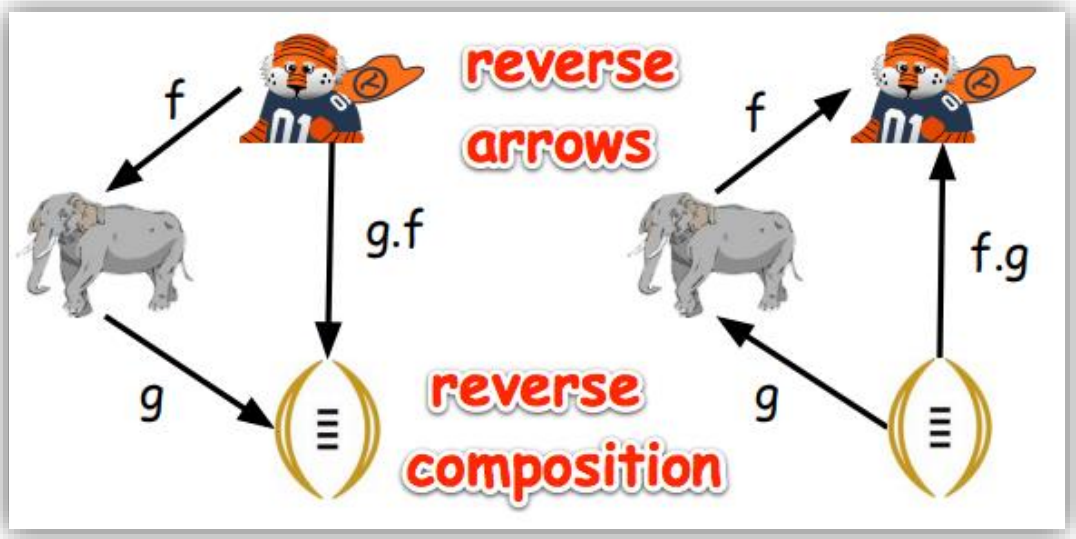
$$\frac{\Gamma \vdash L: [A \Rightarrow B] \quad \Gamma \vdash M: A}{\Gamma \vdash LM: B} \qquad \frac{\Gamma \xrightarrow{f} [A \Rightarrow B] \quad \Gamma \xrightarrow{g} A}{\Gamma \xrightarrow{\langle f,g \rangle} [A \Rightarrow B] \times A \xrightarrow{apply} B}$$

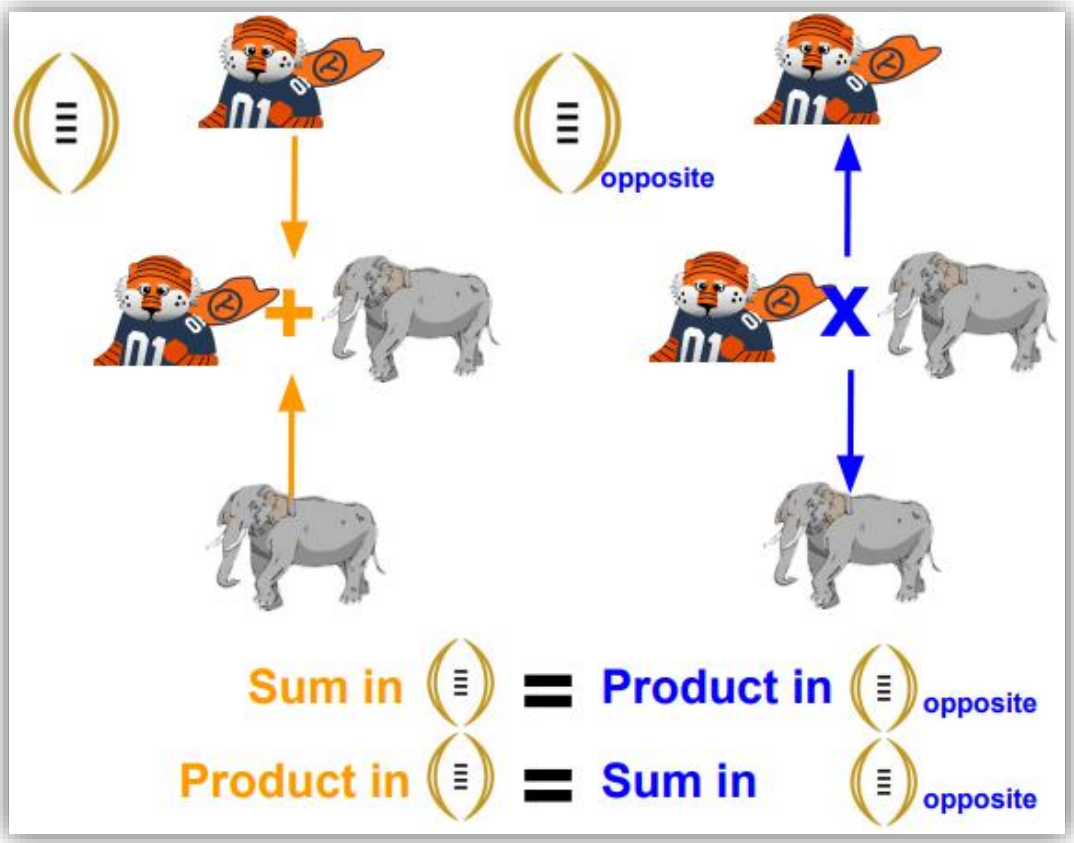


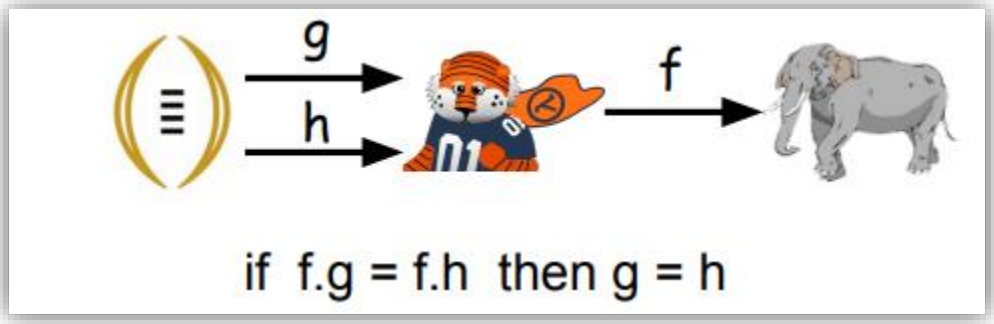


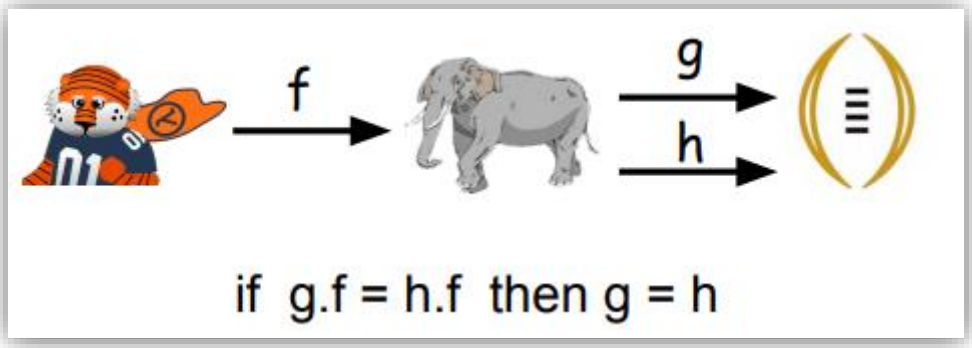

=
Function Types = Exponents
A → B = A^B
getCow: () => DressedCows
1 → 3
3^1

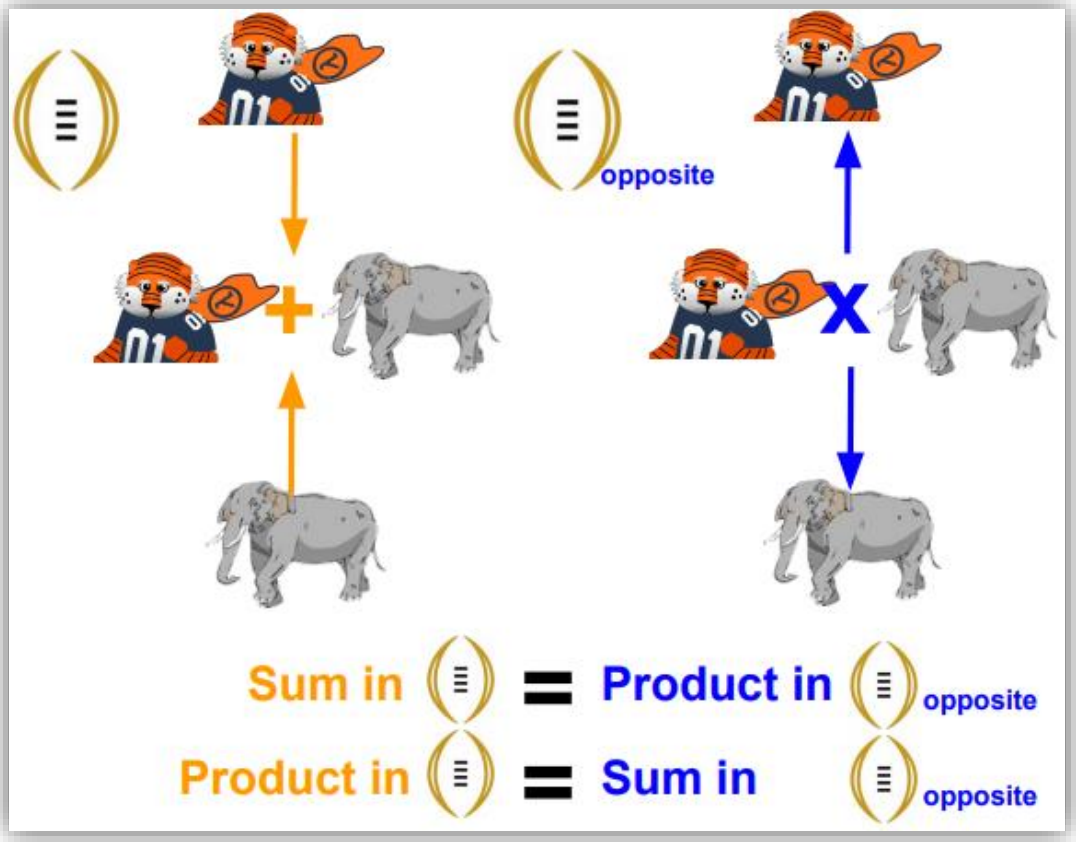

type OrganicCow struct {
Name string
ThinCow DressedCow
FatCow DressedCow
}
same structure
type ProcessedCow struct {
Name string
Address string
City string
ThinCow DressedCow
FatCow DressedCow
Timestamp JSONTime
}

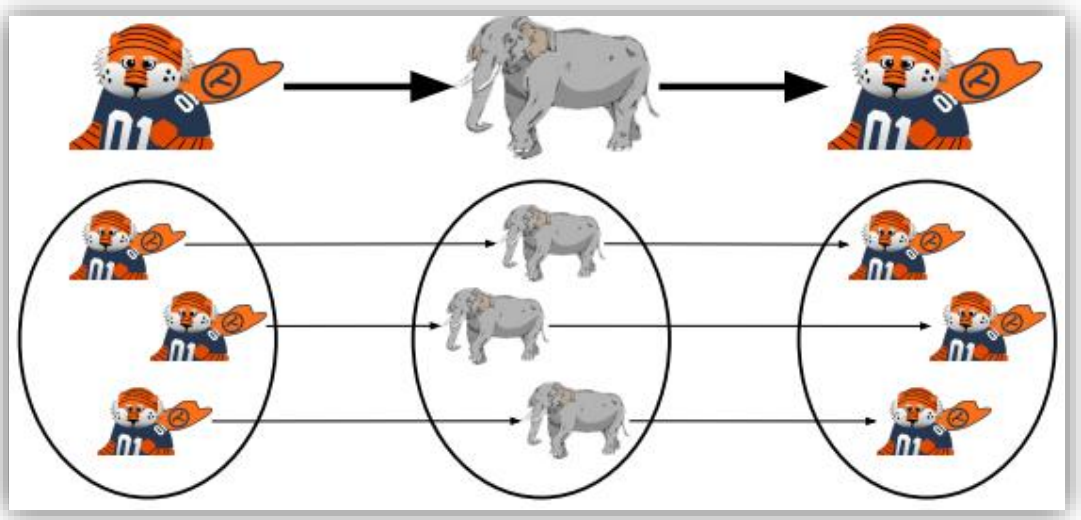

reverse
arrows
f
g.f
g
reverse
composition
f
f.g
g

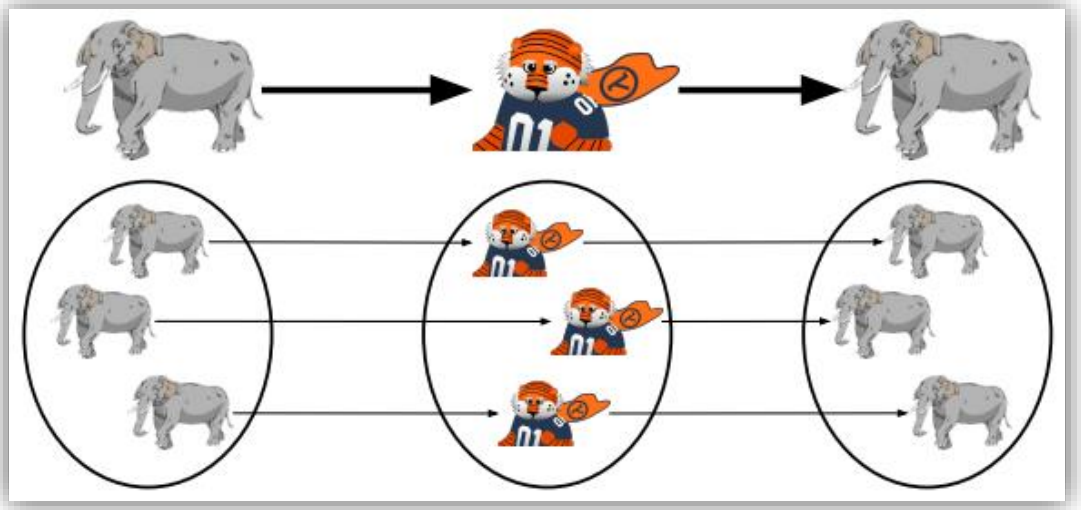

opposite
Sum in = Product in opposite
Product in = Sum in opposite

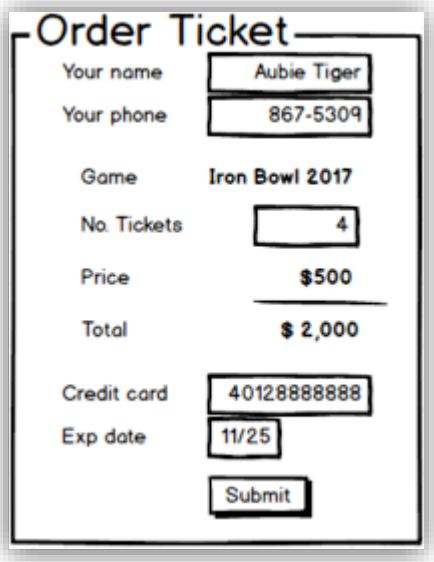

g
h
f
if f.g = f.h then g = h

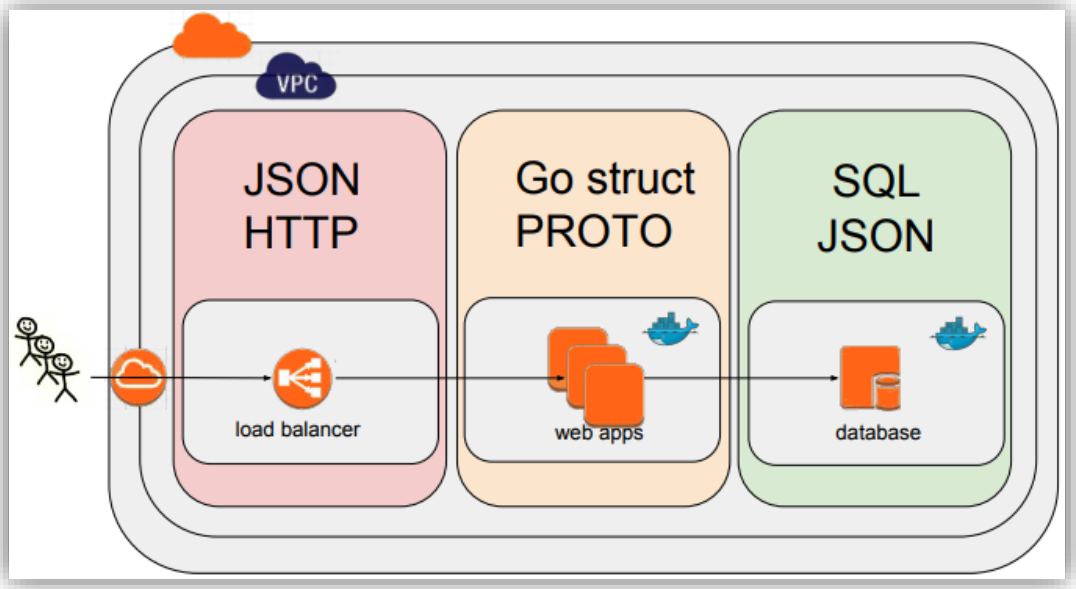

f
g
h
if g.f = h.f then g = h

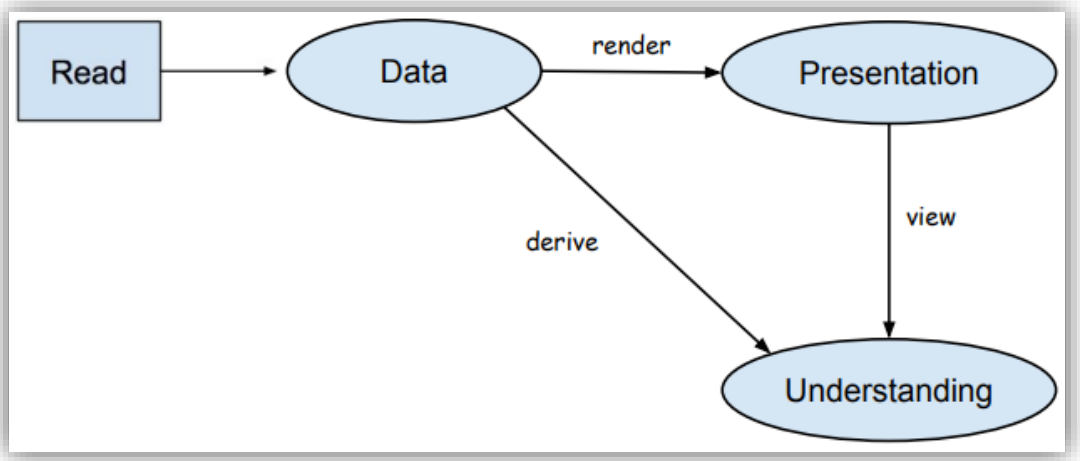

opposite
Sum in = Product in opposite
Product in = Sum in opposite

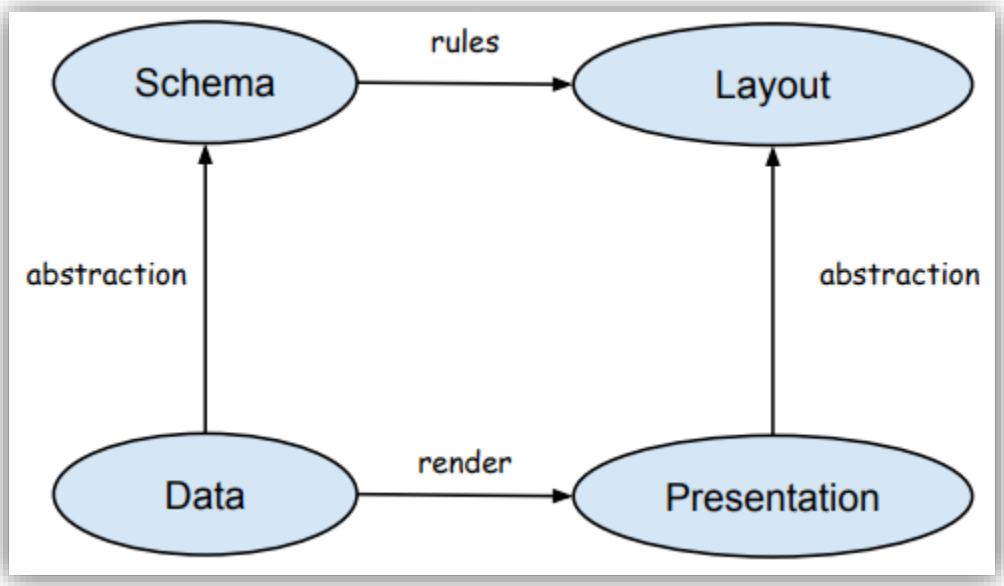


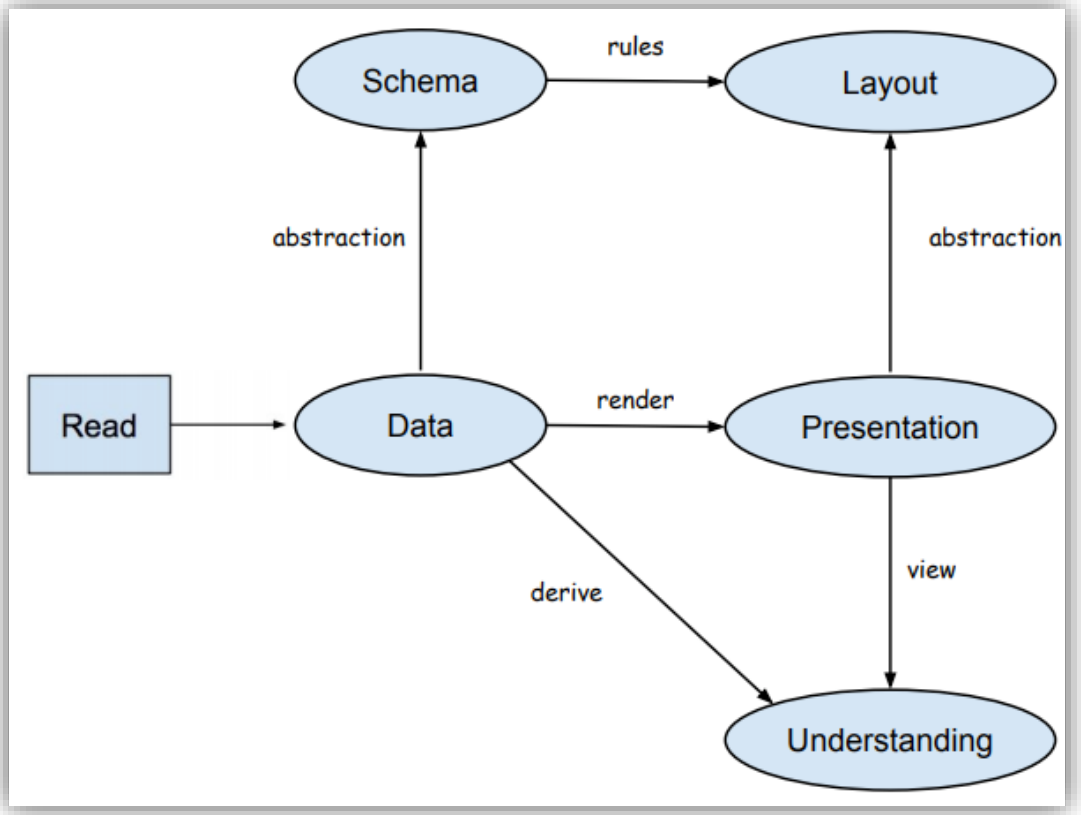


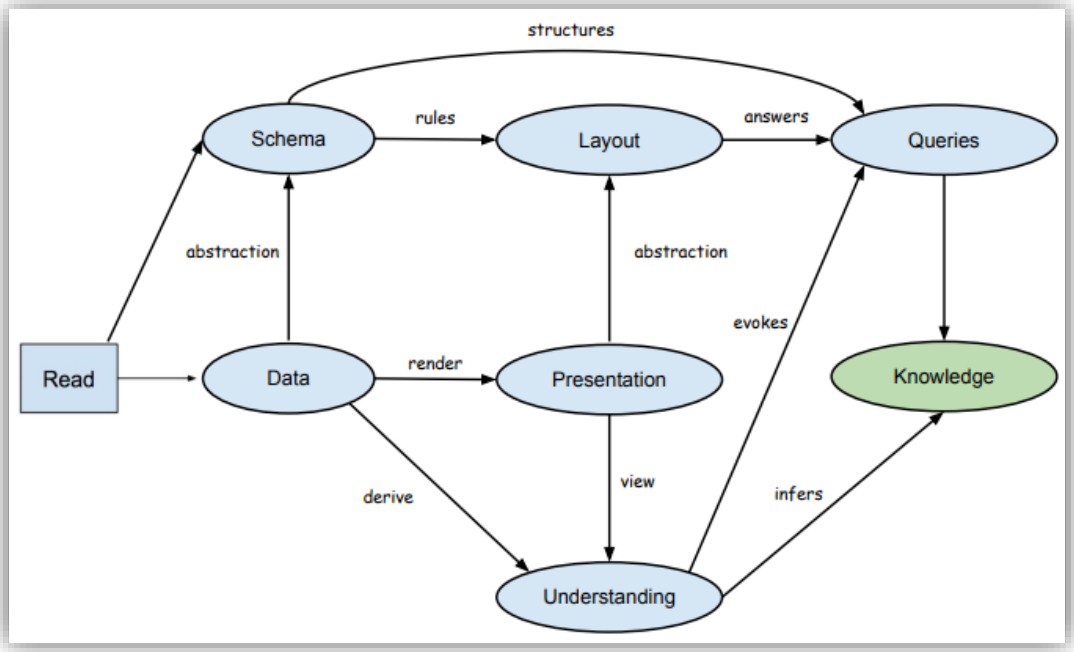

Order Ticket
Your name
Aubie Tiger
Your phone
867-5309
Game
Iron Bowl 2017
No. Tickets
4
Price
$500
Total
$ 2,000
Credit card
40128888888
Exp date
11/25
Submit

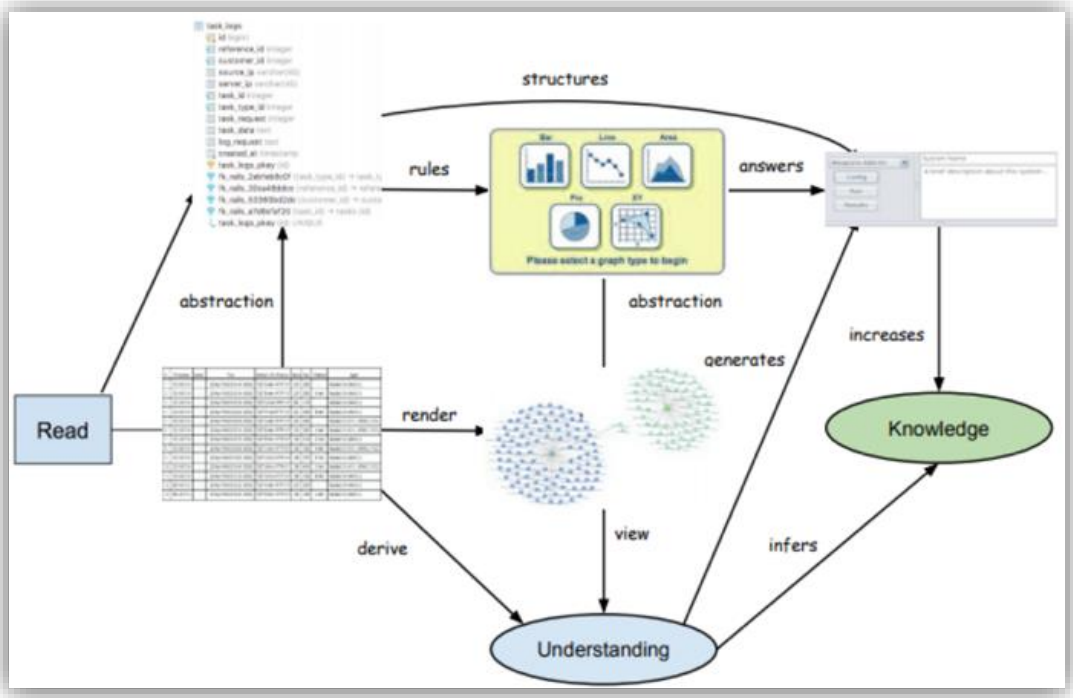

VPC
JSON
HTTP
Go struct
PROTO
SQL
JSON
load balancer
web apps
database


Read
Data
render
Presentation
derive
view
Understanding

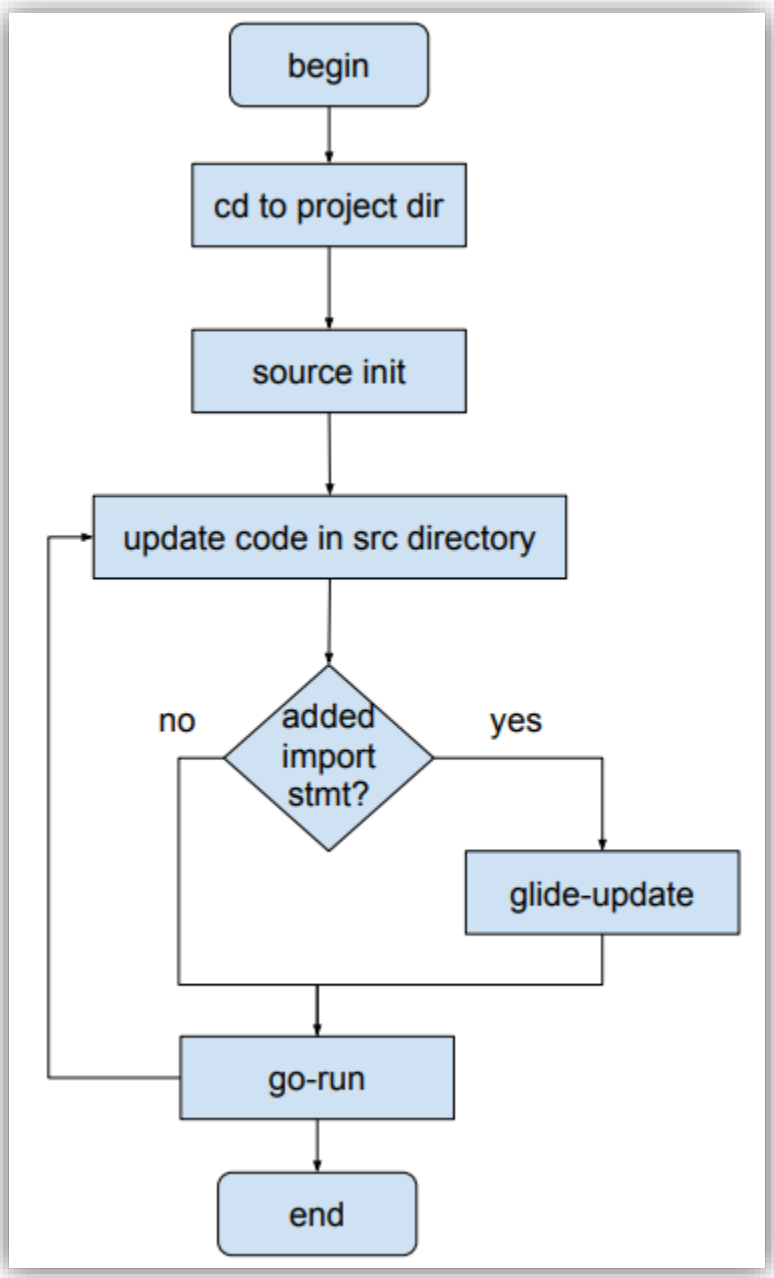

Schema
rules
Layout
abstraction
abstraction
Data
render
Presentation


Schema
rules
Layout
abstraction
abstraction
Read
Data
render
Presentation
derive
view
Understanding

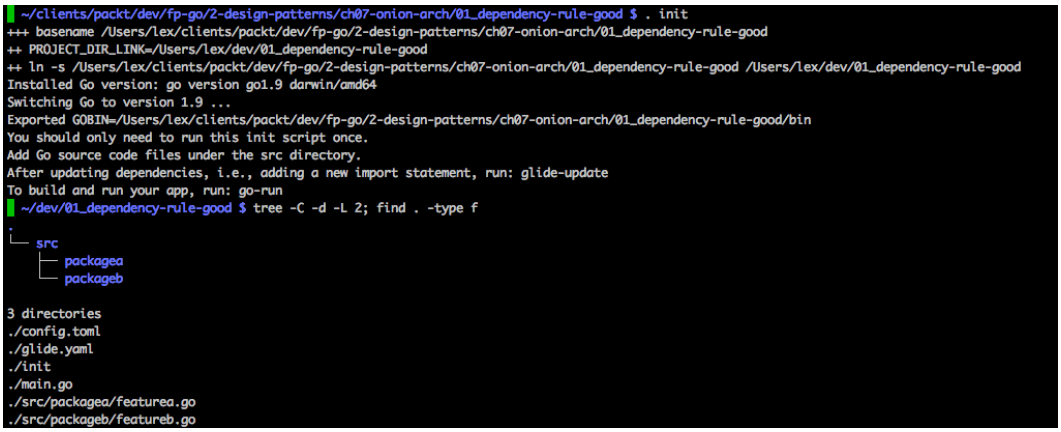

structures
Schema
rules
Layout
answers
Queries
abstraction
abstraction
evokes
Read
Data
render
Presentation
Knowledge
derive
view
infers
Understanding


structures
rules
answers
abstraction
abstraction
increases
generates
Read
render
Knowledge
derive
view
infers
Understanding

Appendix: Miscellaneous Information and How-Tos




~ $ cd ~/clients/packt/dev/fp-go/2-design-patterns/ch07-onion-arch/01_dependency-rule-good
~/clients/packt/dev/fp-go/2-design-patterns/ch07-onion-arch/01_dependency-rule-good $ goenv info
STATUS: ERROR: $GOROOT != Go version
TIP: Don't forget to source goenv when running goenv commands that change your Go version (For more info run $ goenv info)
GOROOT: /usr/local/Cellar/go/1.7.4_2/libexec
GOPATH: /Users/lex/dev/someold-go-project
GOBIN :
GOOS : darwin
GOARCH: amd64
Current Go version: 1.8.3
Latest Brew Go version file:
switchtogo version file: /Users/lex/.goenv/version
switchtogo version: 1.8.3
goenv version: 1.1.2
Installed Go versions:
/usr/local/Cellar/go/1.4.3 (4,549 files, 142.8MB)
/usr/local/Cellar/go/1.7.3 (6,438 files, 250.6MB)
/usr/local/Cellar/go/1.7.4_2 (6,438 files, 250.7MB)
/usr/local/Cellar/go/1.7.6 (6,440 files, 262.4MB)
/usr/local/Cellar/go/1.8 (7,017 files, 281.6MB)
/usr/local/Cellar/go/1.8.3 (7,035 files, 282MB) *
/usr/local/Cellar/go/1.9 (7,639 files, 293.7MB)
old/invalid settings


~/clients/packt/dev/fp-go/2-design-patterns/ch07-onion-arch/01_dependency-rule-good $. init
+++ basename /Users/lex/clients/packt/dev/fp-go/2-design-patterns/ch07-onion-arch/01_dependency-rule-good
++ PROJECT_DIR_LINK=/Users/lex/dev/01_dependency-rule-good
++ ln -s /Users/lex/clients/packt/dev/fp-go/2-design-patterns/ch07-onion-arch/01_dependency-rule-good /Users/lex/dev/01_dependency-rule-good
Installed Go version: go version go1.9 darwin/amd64
Switching Go to version 1.9 ...
Exported GOBIN=/Users/lex/clients/packt/dev/fp-go/2-design-patterns/ch07-onion-arch/01_dependency-rule-good/bin
You should only need to run this init script once.
Add Go source code files under the src directory.
After updating dependencies, i.e., adding a new import statement, run: glide-update
To build and run your app, run: go-run
~/dev/01_dependency-rule-good $ tree -C -d -L 2; find . -type f
.
└── src
├── packagea
└── packageb
3 directories
./config.toml
./glide.yaml
./init
./main.go
./src/packagea/featurea.go
./src/packageb/featureb.go

```
~/dev/01_dependency-rule-good $ glide-update
~/clients/packt/dev/fp-go/2-design-patterns/ch07-onion-arch/01_dependency-rule-good ~/dev/01_dependency-rule-good
[INFO]  Generating a YAML configuration file and guessing the dependencies
[INFO]  Attempting to import from other package managers (use --skip-import to skip)
[INFO]  Scanning code to look for dependencies
[INFO]  Writing configuration file (glide.yaml)
[INFO]  You can now edit the glide.yaml file. Consider:
[INFO]  --> Using versions and ranges. See https://glide.sh/docs/versions/
[INFO]  --> Adding additional metadata. See https://glide.sh/docs/glide.yaml/
[INFO]  --> Running the config-wizard command to improve the versions in your configuration
[INFO]  Downloading dependencies. Please wait...
[INFO]  No references set.
[INFO]  Resolving imports
[INFO]  Downloading dependencies. Please wait...
[INFO]  Setting references for remaining imports
[INFO]  No references set.
[INFO]  Exporting resolved dependencies...
[INFO]  Replacing existing vendor dependencies
[INFO]  Project relies on 0 dependencies.
vendor packages have been moved to /Users/lex/clients/packt/dev/fp-go/2-design-patterns/ch07-onion-arch/01_dependency-rule-good/vendors and your
GOPATH: /Users/lex/clients/packt/dev/fp-go/2-design-patterns/ch07-onion-arch/01_dependency-rule-good:/Users/lex/clients/packt/dev/fp-go/2-design-
patterns/ch07-onion-arch/01_dependency-rule-good/vendors
~/dev/01_dependency-rule-good
~/dev/01_dependency-rule-good $ go-run
A
B
```

```
~/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof $ . init
+++ basename /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof
++ PROJECT_DIR_LINK=/Users/lex/dev/01_hof
++ ln -s /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof /Users/lex/dev/01_hof
Installed Go version: go version go1.9 darwin/amd64
Switching Go to version 1.9 ...
You should only need to run this init script once.
Add Go source code files under the src directory.
After updating dependencies, i.e., adding a new import statement, run: glide-update
To build and run your app, run: go-run
```

```
~/dev/01_hof $ glide-update
~/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof ~/dev/01_hof
[INFO]  Generating a YAML configuration file and guessing the dependencies
[INFO]  Attempting to import from other package managers (use --skip-import to skip)
[INFO]  Scanning code to look for dependencies
[INFO]  --> Found reference to github.com/julienschmidt/httprouter
[INFO]  Writing configuration file (glide.yaml)
[INFO]  You can now edit the glide.yaml file. Consider:
[INFO]  --> Using versions and ranges. See https://glide.sh/docs/versions/
[INFO]  --> Adding additional metadata. See https://glide.sh/docs/glide.yaml/
[INFO]  --> Running the config-wizard command to improve the versions in your configuration
[INFO]  Downloading dependencies. Please wait...
[INFO]  --> Fetching updates for github.com/julienschmidt/httprouter.
[INFO]  Resolving imports
[INFO]  Downloading dependencies. Please wait...
[INFO]  Setting references for remaining imports
[INFO]  Exporting resolved dependencies...
[INFO]  --> Exporting github.com/julienschmidt/httprouter
[INFO]  Replacing existing vendor dependencies
[INFO]  Project relies on 1 dependencies.
vendor packages have been moved to /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof/vendors an
d your GOPATH: /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof:/Users/lex/clients/packt/dev/f
p-go/1-functional-fundamentals/ch03-hof/01_hof/vendors
~/dev/01_hof
```

```
~/dev/02_dependency-with-import $ go-run
A
2017/10/03 18:06:06 B
```

```
~/dev/02_dependency-with-import $ tree -C -d -L 2; find . -type f
.
├── bin
├── pkg
│   └── darwin_amd64
├── src
│   ├── packagea
│   └── packageb
└── vendors
    └── src

8 directories
./bin/02_dependency-with-import
./config.toml
./glide.lock
./glide.yaml
./init
./main.go
./pkg/darwin_amd64/packagea.a
./pkg/darwin_amd64/packageb.a
./src/packagea/featurea.go
./src/packageb/featureb.go
```

```
~/dev/03_with-third-party-import $ find . -type f -name "*.go" -exec grep -A3 "import" {} \; -exec echo {} \; -exec echo --- \;
import (
        a "packagea"
)

./main.go
---
import (
        b "packageb"
        "fmt"
        u "go-goodies/go_utils"
./src/packagea/featurea.go
---
import (
        "log"
)

./src/packageb/featureb.go
---
```

```
~/dev/02_dependency-with-import $ glide-update
~/clients/packt/dev/fp-go/4-appendix/02_dependency-with-import ~/dev/02_dependency-with-import
[INFO]  Generating a YAML configuration file and guessing the dependencies
[INFO]  Attempting to import from other package managers (use --skip-import to skip)
[INFO]  Scanning code to look for dependencies
[INFO]  Writing configuration file (glide.yaml)
[INFO]  You can now edit the glide.yaml file. Consider:
[INFO]  --> Using versions and ranges. See https://glide.sh/docs/versions/
[INFO]  --> Adding additional metadata. See https://glide.sh/docs/glide.yaml/
[INFO]  --> Running the config-wizard command to improve the versions in your configuration
[INFO]  Downloading dependencies. Please wait...
[INFO]  No references set.
[INFO]  Resolving imports
[INFO]  Downloading dependencies. Please wait...
[INFO]  Setting references for remaining imports
[INFO]  No references set.
[INFO]  Exporting resolved dependencies...
[INFO]  Replacing existing vendor dependencies
[INFO]  Project relies on 0 dependencies.
vendor packages have been moved to /Users/lex/clients/packt/dev/fp-go/4-appendix/02_dependency-with-import/vendors and your GOPATH: /Users/lex/cl
ients/packt/dev/fp-go/4-appendix/02_dependency-with-import:/Users/lex/clients/packt/dev/fp-go/4-appendix/02_dependency-with-import/vendors
~/dev/02_dependency-with-import
```

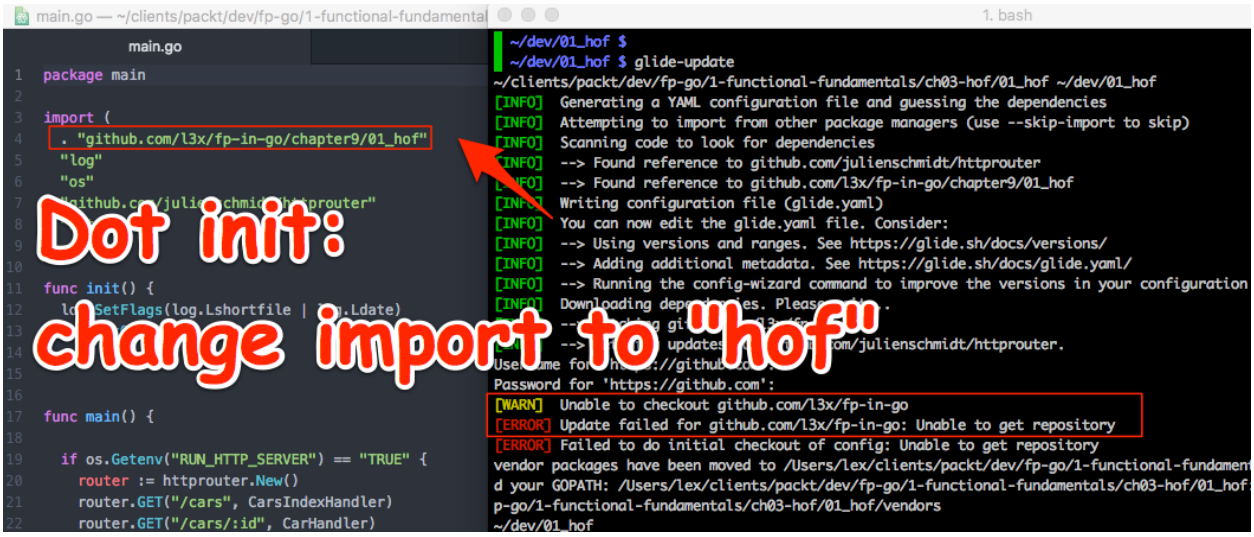
```
~/dev/03_with-third-party-import $ tree -C -d -L 2; find . -type f
.
├── src
│   ├── packagea
│   └── packageb
└── vendors
    └── src

5 directories
./config.toml
./glide.lock
./glide.yaml
./init
./main.go
./src/packagea/featurea.go
./src/packageb/featureb.go
./vendors/src/github.com/go-goodies/go_utils/contains.go
./vendors/src/github.com/go-goodies/go_utils/file.go
./vendors/src/github.com/go-goodies/go_utils/golang-gopher-utils.png
./vendors/src/github.com/go-goodies/go_utils/LICENSE
./vendors/src/github.com/go-goodies/go_utils/num_conversions.go
./vendors/src/github.com/go-goodies/go_utils/README.md
./vendors/src/github.com/go-goodies/go_utils/singleton.go
./vendors/src/github.com/go-goodies/go_utils/types.go
./vendors/src/github.com/go-goodies/go_utils/utils.go
./vendors/src/github.com/go-goodies/go_utils/utils_test.go
./vendors/src/github.com/margnus1/go-deepcopy/.gitignore
./vendors/src/github.com/margnus1/go-deepcopy/deepcopy.go
./vendors/src/github.com/margnus1/go-deepcopy/deepcopy_test.go
./vendors/src/github.com/margnus1/go-deepcopy/LICENSE
./vendors/src/github.com/margnus1/go-deepcopy/Makefile
./vendors/src/github.com/margnus1/go-deepcopy/README.md
./vendors/src/github.com/nu7hatch/gouuid/.gitignore
./vendors/src/github.com/nu7hatch/gouuid/COPYING
./vendors/src/github.com/nu7hatch/gouuid/example_test.go
./vendors/src/github.com/nu7hatch/gouuid/README.md
./vendors/src/github.com/nu7hatch/gouuid/uuid.go
./vendors/src/github.com/nu7hatch/gouuid/uuid_test.go
```

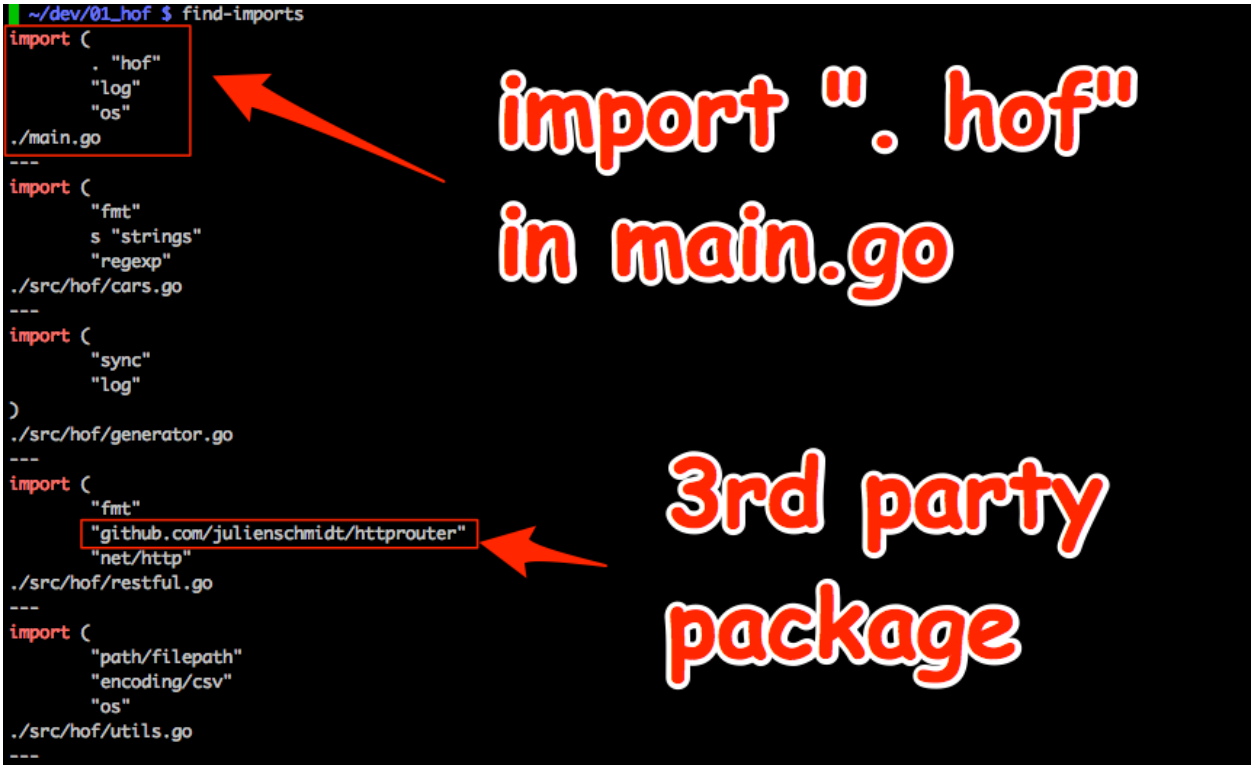
```
~/dev/03_with-third-party-import $ go-run
  A
B
~/dev/03_with-third-party-import $
```

u.PadLeft("A", 3)

```
~/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof $ . init
+++ basename /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof
++ PROJECT_DIR_LINK=/Users/lex/dev/01_hof
++ ln -s /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof /Users/lex/dev/01_hof
Installed Go version: go version go1.9 darwin/amd64
Switching Go to version 1.9 ...
You should only need to run this init script once.
Add Go source code files under the src directory.
After updating dependencies, i.e., adding a new import statement, run: glide-update
To build and run your app, run: go-run
```


main.go — ~/clients/packt/dev/fp-go/1-functional-fundamental
main.go
1. bash
Dot init:
change import to "hof"
~/dev/01_hof $
~/dev/01_hof $ glide-update
~/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof ~/dev/01_hof
[INFO] Generating a YAML configuration file and guessing the dependencies
[INFO] Attempting to import from other package managers (use --skip-import to skip)
[INFO] Scanning code to look for dependencies
[INFO] --> Found reference to github.com/julienschmidt/httprouter
[INFO] --> Found reference to github.com/l3x/fp-in-go/chapter9/01_hof
[INFO] Writing configuration file (glide.yaml)
[INFO] You can now edit the glide.yaml file. Consider:
[INFO] --> Using versions and ranges. See https://glide.sh/docs/versions/
[INFO] --> Adding additional metadata. See https://glide.sh/docs/glide.yaml/
[INFO] --> Running the config-wizard command to improve the versions in your configuration
Password for 'https://github.com':
[WARN] Unable to checkout github.com/l3x/fp-in-go
[ERROR] Update failed for github.com/l3x/fp-in-go: Unable to get repository
[ERROR] Failed to do initial checkout of config: Unable to get repository
vendor packages have been moved to /Users/lex/clients/packt/dev/fp-go/1-functional-fundament
d your GOPATH: /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof
p-go/1-functional-fundamentals/ch03-hof/01_hof/vendors
~/dev/01_hof


~/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/02_fib $ brew info go|grep Cellar|grep -v export
/usr/local/Cellar/go/1.4.3 (4,549 files, 142.8MB)
/usr/local/Cellar/go/1.7.3 (6,438 files, 250.6MB)
/usr/local/Cellar/go/1.7.4_2 (6,438 files, 250.7MB)
/usr/local/Cellar/go/1.7.6 (6,440 files, 262.4MB)
/usr/local/Cellar/go/1.8 (7,017 files, 281.6MB)
/usr/local/Cellar/go/1.8.3 (7,035 files, 282MB)
/usr/local/Cellar/go/1.9 (7,639 files, 293.7MB) *
most current
reset env vars
~/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/02_fib $ export GOROOT=/usr/local/Cellar/go/1.9/libexec
~/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/02_fib $ export GOPATH=$(pwd)
~/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/02_fib $ export GOBIN=$GOPATH/bin

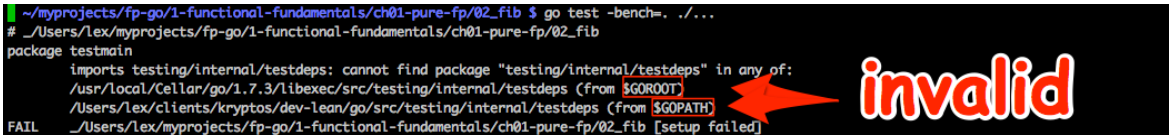



```
~/dev/01_hof $ glide-update
~/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof ~/dev/01_hof
[INFO]  Generating a YAML configuration file and guessing the dependencies
[INFO]  Attempting to import from other package managers (use --skip-import to skip)
[INFO]  Scanning code to look for dependencies
[INFO]  --> Found reference to github.com/julienschmidt/httprouter
[INFO]  Writing configuration file (glide.yaml)
[INFO]  You can now edit the glide.yaml file. Consider:
[INFO]  --> Using versions and ranges. See https://glide.sh/docs/versions/
[INFO]  --> Adding additional metadata. See https://glide.sh/docs/glide.yaml/
[INFO]  --> Running the config-wizard command to improve the versions in your configuration
[INFO]  Downloading dependencies. Please wait...
[INFO]  --> Fetching updates for github.com/julienschmidt/httprouter.
[INFO]  Resolving imports
[INFO]  Downloading dependencies. Please wait...
[INFO]  Setting references for remaining imports
[INFO]  Exporting resolved dependencies...
[INFO]  --> Exporting github.com/julienschmidt/httprouter
[INFO]  Replacing existing vendor dependencies
[INFO]  Project relies on 1 dependencies.
vendor packages have been moved to /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof/vendors an
d your GOPATH: /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof:/Users/lex/clients/packt/dev/f
p-go/1-functional-fundamentals/ch03-hof/01_hof/vendors
~/dev/01_hof
```

```
~/dev/01_hof $ go-run
-bash: 01_hof: command not found
```

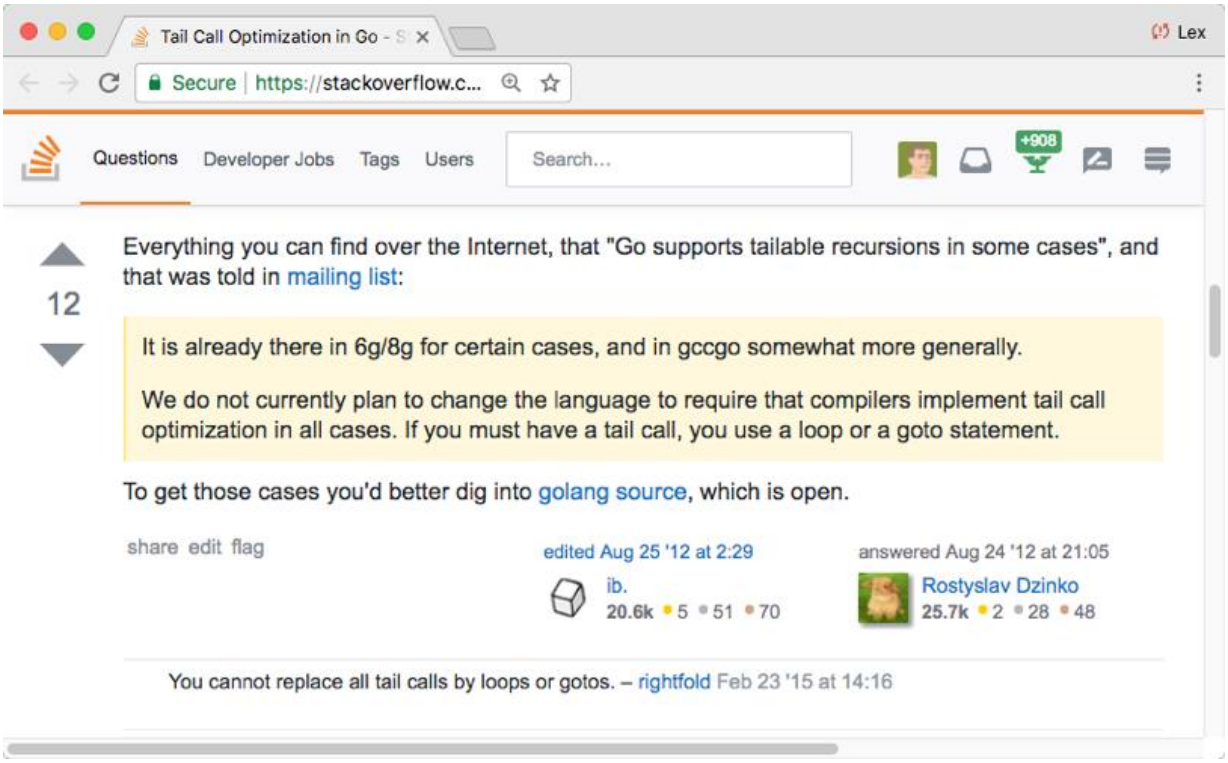
```
~/dev/01_hof $ cd -
/Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof
~/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof $ . init
+++ basename /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof
++ PROJECT_DIR_LINK=/Users/lex/dev/01_hof
++ ln -s /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof /Users/lex/dev/01_hof
Installed Go version: go version go1.9 darwin/amd64
Switching Go to version 1.9 ...
You should only need to run this init script once.
Add Go source code files under the src directory.
After updating dependencies, i.e., adding a new import statement, run: glide-update
To build and run your app, run: go-run
~/dev/01_hof $ go-run
main.go:7:2: cannot find package "github.com/julienschmidt/httprouter" in any of:
        /usr/local/Cellar/go/1.9/libexec/src/github.com/julienschmidt/httprouter (from $GOROOT)
        /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof/src/github.com/julienschmidt/httprout
er (from $GOPATH)
```

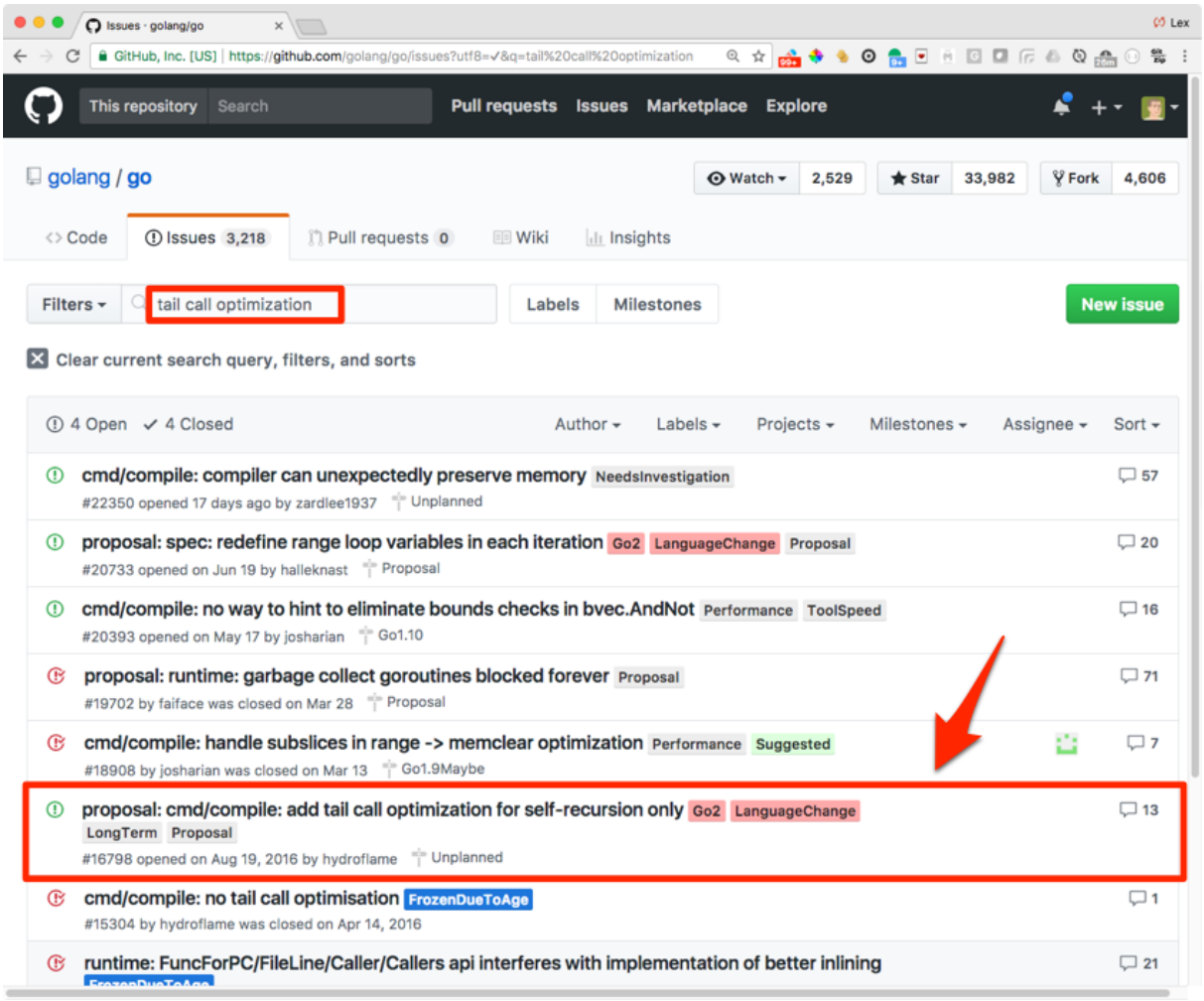
```
~/dev/01_hof $ glide-update
~/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof ~/dev/01_hof
[INFO]  Generating a YAML configuration file and guessing the dependencies
[INFO]  Attempting to import from other package managers (use --skip-import to skip)
[INFO]  Scanning code to look for dependencies
[INFO]  --> Found reference to github.com/julienschmidt/httprouter
[INFO]  Writing configuration file (glide.yaml)
[INFO]  You can now edit the glide.yaml file. Consider:
[INFO]  --> Using versions and ranges. See https://glide.sh/docs/versions/
[INFO]  --> Adding additional metadata. See https://glide.sh/docs/glide.yaml/
[INFO]  --> Running the config-wizard command to improve the versions in your configuration
[INFO]  Downloading dependencies. Please wait...
[INFO]  --> Fetching updates for github.com/julienschmidt/httprouter.
[INFO]  Resolving imports
[INFO]  Downloading dependencies. Please wait...
[INFO]  Setting references for remaining imports
[INFO]  Exporting resolved dependencies...
[INFO]  --> Exporting github.com/julienschmidt/httprouter
[INFO]  Replacing existing vendor dependencies
[INFO]  Project relies on 1 dependencies.
vendor packages have been moved to /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof/vendors an
d your GOPATH: /Users/lex/clients/packt/dev/fp-go/1-functional-fundamentals/ch03-hof/01_hof:/Users/lex/clients/packt/dev/f
p-go/1-functional-fundamentals/ch03-hof/01_hof/vendors
~/dev/01_hof
~/dev/01_hof $ go-run
2017/10/04 generator.go:78:
Generated Cars (1 to 4)
----------------------
2017/10/04 generator.go:83: car: Honda Accord ES2
2017/10/04 generator.go:83: car: Lexus IS250
2017/10/04 generator.go:83: car: Honda CR-V
2017/10/04 utils.go:15:
GenerateCars(1, 3)
----------------------
2017/10/04 utils.go:17: car: Honda Accord ES2
2017/10/04 utils.go:17: car: Honda CR-V
2017/10/04 utils.go:17: car: Lexus IS250
2017/10/04 generator.go:78:
Generated Cars (1 to 15)
----------------------
2017/10/04 generator.go:83: car: Ford F-150
2017/10/04 generator.go:83: car: Lexus IS250
2017/10/04 generator.go:83: car: Lexus SC 430
2017/10/04 generator.go:83: car: Honda Accord ES2
2017/10/04 generator.go:83: car: Toyota Highlander
2017/10/04 generator.go:83: car: Honda CR-V
2017/10/04 generator.go:83: car: Chrysler Pacifica
2017/10/04 generator.go:83: car: Toyota 86
2017/10/04 generator.go:83: car: Dodge Charger
2017/10/04 generator.go:83: car: Dodge 330
2017/10/04 generator.go:83: car: GM Oldsmobile Cutlass Supreme
2017/10/04 generator.go:83: car: GM Hummer H3
2017/10/04 generator.go:83: car: Toyota RAV4
2017/10/04 generator.go:83: car: GM Hummer H2
2017/10/04 utils.go:15:
GenerateCars(1, 14), Domestic, Numeric, JSON
----------------------
2017/10/04 utils.go:17: car: {"car": {"make": "Ford", "model": " F-150 XL"}}
2017/10/04 utils.go:17: car: {"car": {"make": "GM", "model": " Hummer H3 X"}}
2017/10/04 utils.go:17: car: {"car": {"make": "GM", "model": " Hummer H2 X"}}
```

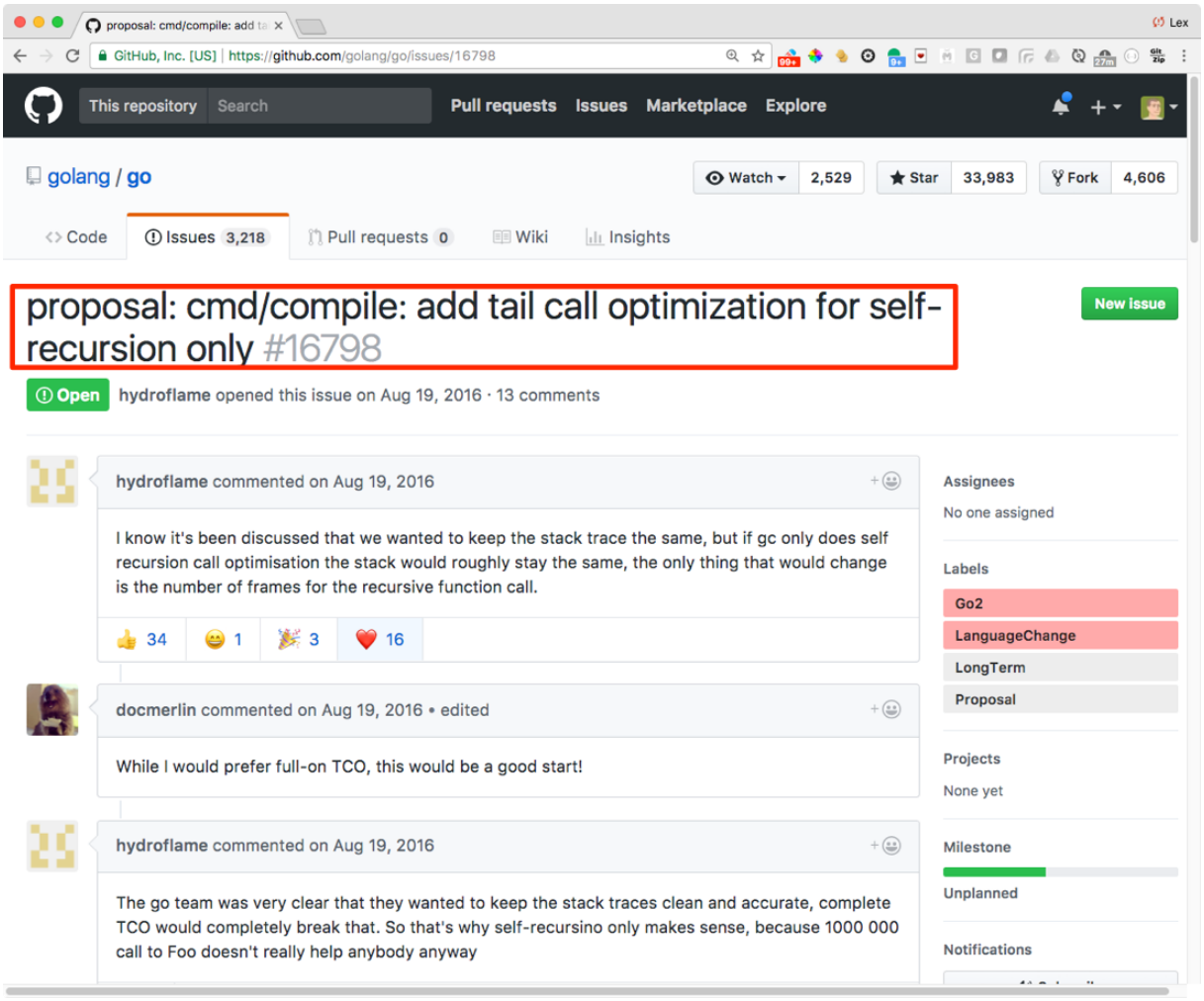

~/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/02_fib $ go test -bench=. ./...
_/Users/lex/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/02_fib
package testmain
imports testing/internal/testdeps: cannot find package "testing/internal/testdeps" in any of:
/usr/local/Cellar/go/1.7.3/libexec/src/testing/internal/testdeps (from $GOROOT)
/Users/lex/clients/kryptos/dev-lean/go/src/testing/internal/testdeps (from $GOPATH)
FAIL _/Users/lex/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/02_fib [setup failed]
invalid


~/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/02_fib $ brew info go|grep Cellar|grep -v export
/usr/local/Cellar/go/1.4.3 (4,549 files, 142.8MB)
/usr/local/Cellar/go/1.7.3 (6,438 files, 250.6MB)
/usr/local/Cellar/go/1.7.4_2 (6,438 files, 250.7MB)
/usr/local/Cellar/go/1.7.6 (6,440 files, 262.4MB)
/usr/local/Cellar/go/1.8 (7,017 files, 281.6MB)
/usr/local/Cellar/go/1.8.3 (7,035 files, 282MB)
/usr/local/Cellar/go/1.9 (7,639 files, 293.7MB) *
~/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/02_fib $ export GOROOT=/usr/local/Cellar/go/1.9/libexec
~/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/02_fib $ export GOPATH=$(pwd)
~/myprojects/fp-go/1-functional-fundamentals/ch01-pure-fp/02_fib $ export GOBIN=$GOPATH/bin
most current
reset env vars


~/dev/01_hof $ find src -type f
src/hof/cars.csv
src/hof/cars.go
src/hof/generator.go
src/hof/more_cars.csv
src/hof/restful.go
src/hof/types.go
src/hof/utils.go
created hof dir
and moved files


Tail Call Optimization in Go - S
Lex
Secure | https://stackoverflow.c...
Questions
Developer Jobs
Tags
Users
Search...
+908
12
Everything you can find over the Internet, that "Go supports tailable recursions in some cases", and that was told in mailing list:
It is already there in 6g/8g for certain cases, and in gccgo somewhat more generally.
We do not currently plan to change the language to require that compilers implement tail call optimization in all cases. If you must have a tail call, you use a loop or a goto statement.
To get those cases you'd better dig into golang source, which is open.
share edit flag
edited Aug 25 '12 at 2:29
ib.
20.6k 5 51 70
answered Aug 24 '12 at 21:05
Rostyslav Dzinko
25.7k 2 28 48
You cannot replace all tail calls by loops or gotos. – rightfold Feb 23 '15 at 14:16


Issues · golang/go
GitHub, Inc. [US] | https://github.com/golang/go/issues?utf8=✓&q=tail%20call%20optimization
This repository
Search
Pull requests
Issues
Marketplace
Explore
golang / go
Watch 2,529
Star 33,982
Fork 4,606
Code
Issues 3,218
Pull requests 0
Wiki
Insights
Filters
tail call optimization
Labels
Milestones
New issue
Clear current search query, filters, and sorts
4 Open
4 Closed
Author
Labels
Projects
Milestones
Assignee
Sort
cmd/compile: compiler can unexpectedly preserve memory NeedsInvestigation
#22350 opened 17 days ago by zardlee1937 Unplanned
57
proposal: spec: redefine range loop variables in each iteration Go2 LanguageChange Proposal
#20733 opened on Jun 19 by halleknast Proposal
20
cmd/compile: no way to hint to eliminate bounds checks in bvec.AndNot Performance ToolSpeed
#20393 opened on May 17 by josharian Go1.10
16
proposal: runtime: garbage collect goroutines blocked forever Proposal
#19702 by faiface was closed on Mar 28 Proposal
71
cmd/compile: handle subslices in range -> memclear optimization Performance Suggested
#18908 by josharian was closed on Mar 13 Go1.9Maybe
7
proposal: cmd/compile: add tail call optimization for self-recursion only Go2 LanguageChange LongTerm Proposal
#16798 opened on Aug 19, 2016 by hydroflame Unplanned
13
cmd/compile: no tail call optimisation FrozenDueToAge
#15304 by hydroflame was closed on Apr 14, 2016
1
runtime: FuncForPC/FileLine/Caller/Callers api interferes with implementation of better inlining
21


proposal: cmd/compile: add tail call optimization for self-recursion only #16798
New issue
Open
hydroflame opened this issue on Aug 19, 2016 · 13 comments
hydroflame commented on Aug 19, 2016
I know it's been discussed that we wanted to keep the stack trace the same, but if gc only does self recursion call optimisation the stack would roughly stay the same, the only thing that would change is the number of frames for the recursive function call.
34
1
3
16
docmerlin commented on Aug 19, 2016 • edited
While I would prefer full-on TCO, this would be a good start!
hydroflame commented on Aug 19, 2016
The go team was very clear that they wanted to keep the stack traces clean and accurate, complete TCO would completely break that. So that's why self-recursino only makes sense, because 1000 000 call to Foo doesn't really help anybody anyway
Assignees
No one assigned
Labels
Go2
LanguageChange
LongTerm
Proposal
Projects
None yet
Milestone
Unplanned
Notifications

sovietspaceship commented on Aug 19, 2016

Many functional programming languages have excellent support for (general) TCO and it is not an impediment at all for debugging. Code compiled in debug mode can still be instrumented to keep count of self-calls and informations about lost stackframes. In functional languages like Haskell, purity from side-effects helps debugging since only the initial values are needed to know the state of every subsequent call; in Go it's not guaranteed so you lose intermediate stackframes and there's no way to recover them, but since most uses for recursive calls are in algorithms, which I hope are implemented in a mathematically sound manner, the issue is greatly reduced. Everything is moving in this direction, and Go should not be left behind.

Also, as dr2chase noted, I often find myself rewriting beautifully recursive code from their mathematical description to ugly hackish iterative style and it is not easy at all to prove they are completely equivalent until your application in production decides to run an infinite loop because the terminating condition is not met with certain inputs.

Do it.

👍 8

SophisticaSean commented on Jun 21

Would like to add that this would be an amazing feature to have in go. There's just no getting around proper recursion with some algorithms, and if you try, the iterative implementation is terrible to read and understand and, usually, takes way longer to write.

I would love go way more if we did this. I think its a low-impact feature that will help a lot of devs.

👍 4

l3x commented just now

What if Go supported compiler directives (compiler hints) in the form of annotations in the comment line directly above a function like the following?

```
// @tco yCombinator implements the lambda expression that
// enables composition of unpure components in our workflow
func yCombinator(f FuncFunc) Func {
   g := func(r RecursiveFunc) Func {
       return f(func(x int) int {
           return r(r)(x)
       })
   }
   return g(g)
}
```

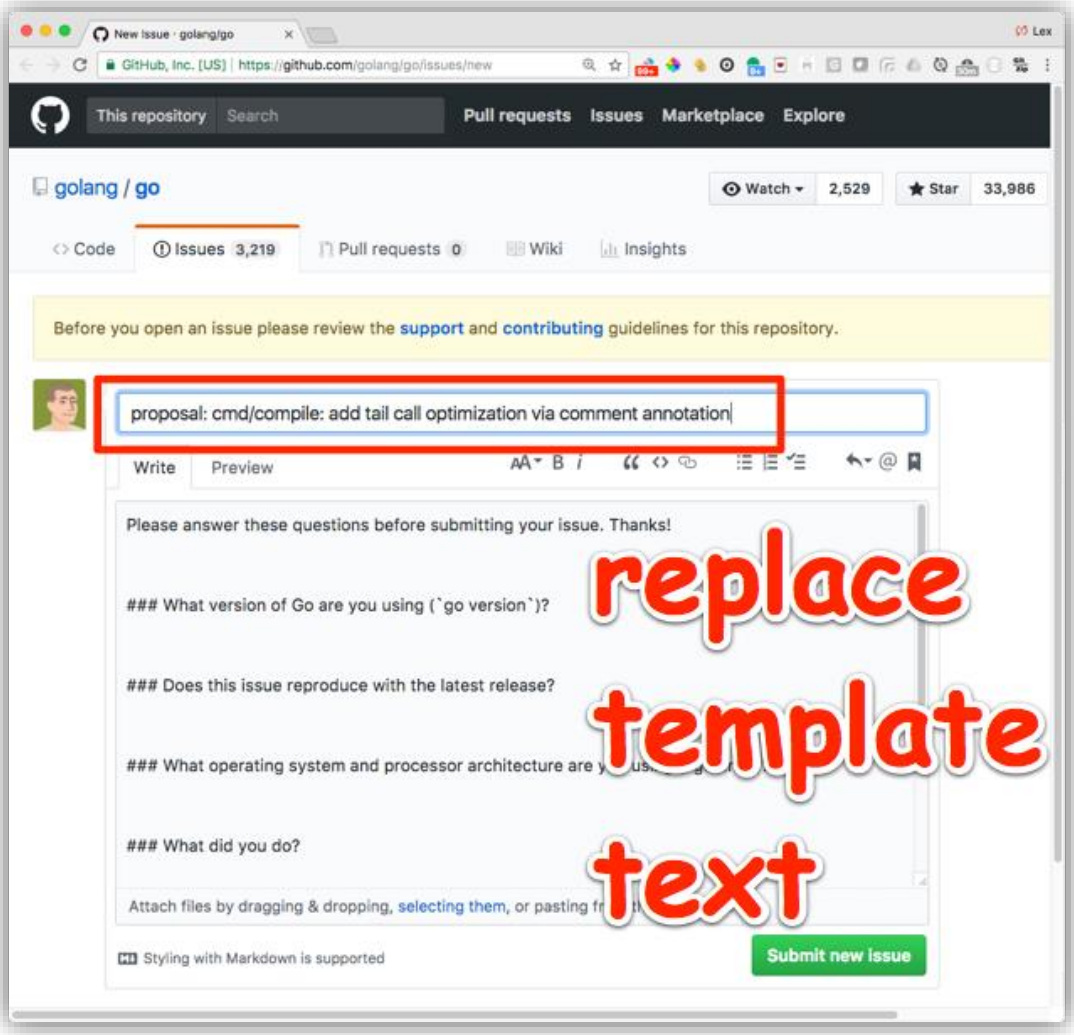
I agree with **@SophisticaSean** in that this would likely be a low impact feature that would help a lot of developers, especially the ones that would like to introduce functional programming (FP) techniques in their apps.

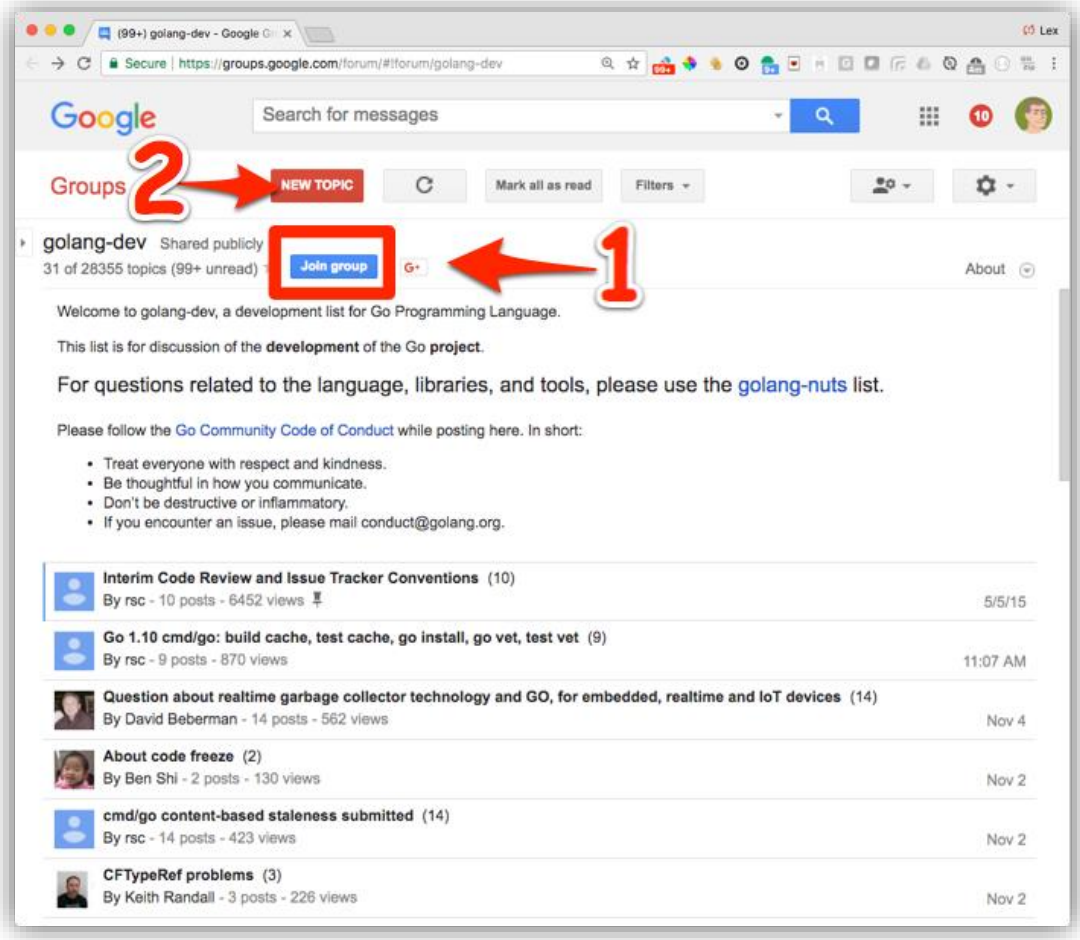
Supporting the **@tco** annotation compiler hint would allow Go to support TCO in a backwards compatible manner, right? Optimization for programmers that know what they want, with no ill side effects. What's not to love?

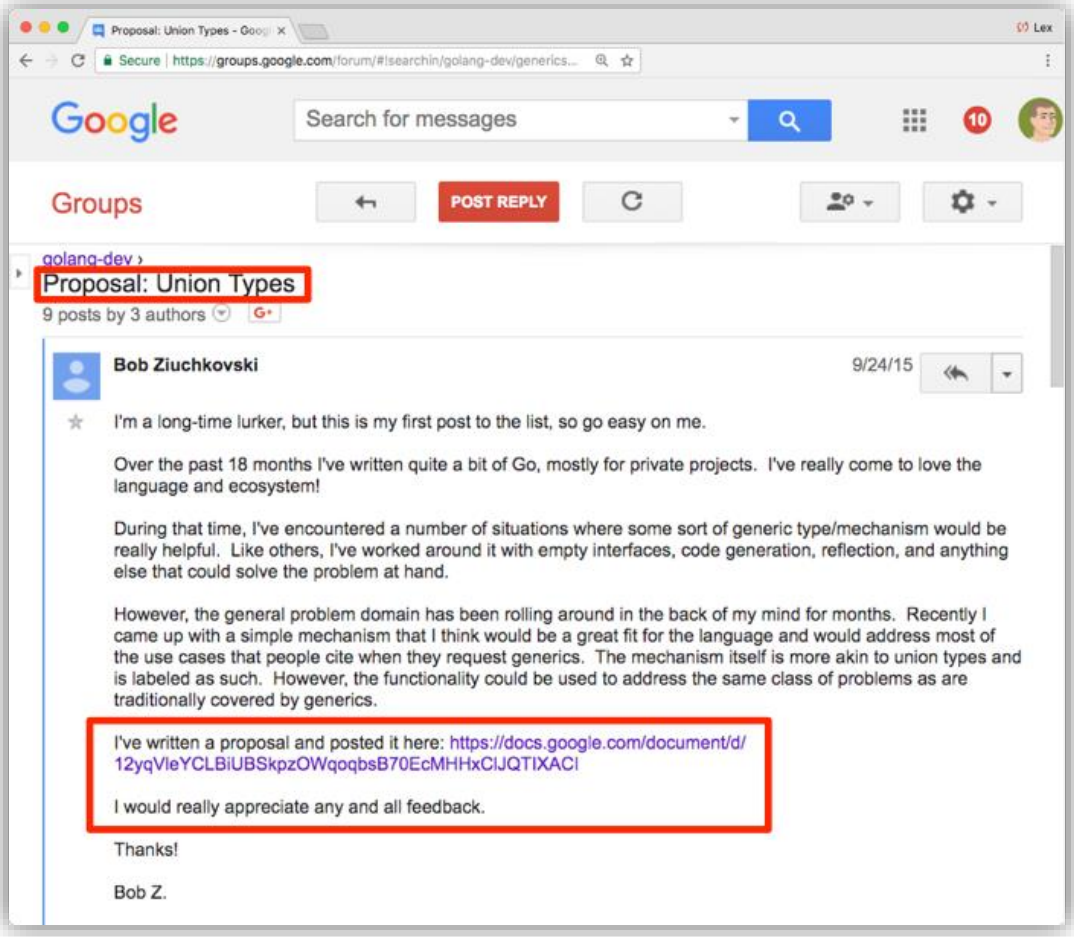
If Go offered TCO support, that would increase the performance of FP apps by approx. three fold and make FP in Go generally viable.

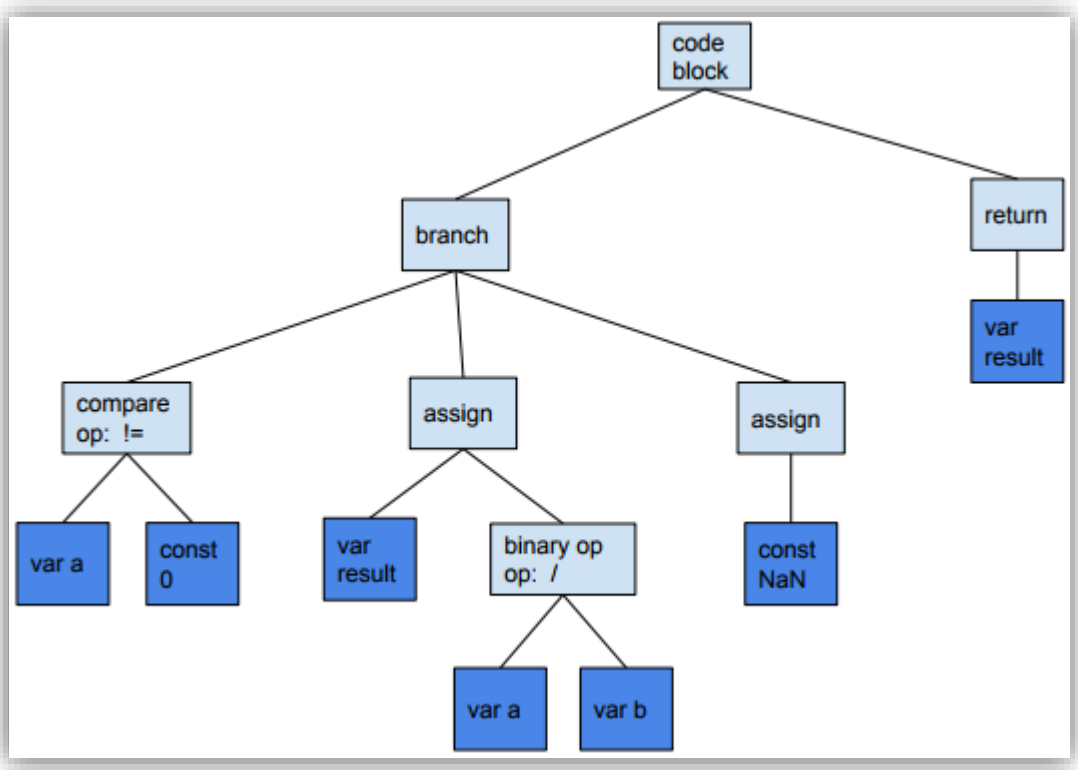
p.s. For a detailed discussion of TCO, Recursion, Y-Combinator, Generics, Monads and more please get a copy of my book (to be released in a few weeks).

Thanks! Lex


New issue · golang/go
GitHub, Inc. [US] | https://github.com/golang/go/issues/new
This repository
Search
Pull requests
Issues
Marketplace
Explore
golang / go
Watch
2,529
Star
33,986
Code
Issues 3,219
Pull requests 0
Wiki
Insights
Before you open an issue please review the support and contributing guidelines for this repository.
proposal: cmd/compile: add tail call optimization via comment annotation
Write
Preview
Please answer these questions before submitting your issue. Thanks!
What version of Go are you using (`go version`)?
Does this issue reproduce with the latest release?
What operating system and processor architecture are
What did you do?
Attach files by dragging & dropping, selecting them, or pasting
Styling with Markdown is supported
Submit new issue
replace
template
text


(99+) golang-dev - Google
Secure | https://groups.google.com/forum/#!forum/golang-dev
Google
Search for messages
Groups
2
NEW TOPIC
Mark all as read
Filters
golang-dev Shared publicly
31 of 28355 topics (99+ unread)
Join group
1
About
Welcome to golang-dev, a development list for Go Programming Language.
This list is for discussion of the development of the Go project.
For questions related to the language, libraries, and tools, please use the golang-nuts list.
Please follow the Go Community Code of Conduct while posting here. In short:
Treat everyone with respect and kindness.
Be thoughtful in how you communicate.
Don't be destructive or inflammatory.
If you encounter an issue, please mail conduct@golang.org.
Interim Code Review and Issue Tracker Conventions (10)
By rsc - 10 posts - 6452 views
5/5/15
Go 1.10 cmd/go: build cache, test cache, go install, go vet, test vet (9)
By rsc - 9 posts - 870 views
11:07 AM
Question about realtime garbage collector technology and GO, for embedded, realtime and IoT devices (14)
By David Beberman - 14 posts - 562 views
Nov 4
About code freeze (2)
By Ben Shi - 2 posts - 130 views
Nov 2
cmd/go content-based staleness submitted (14)
By rsc - 14 posts - 423 views
Nov 2
CFTypeRef problems (3)
By Keith Randall - 3 posts - 226 views
Nov 2


Proposal: Union Types - Goog
Lex
Secure | https://groups.google.com/forum/#!searchin/golang-dev/generics...
Google
Search for messages
10
Groups
POST REPLY
golang-dev ›
Proposal: Union Types
9 posts by 3 authors
Bob Ziuchkovski
9/24/15
I'm a long-time lurker, but this is my first post to the list, so go easy on me.
Over the past 18 months I've written quite a bit of Go, mostly for private projects. I've really come to love the language and ecosystem!
During that time, I've encountered a number of situations where some sort of generic type/mechanism would be really helpful. Like others, I've worked around it with empty interfaces, code generation, reflection, and anything else that could solve the problem at hand.
However, the general problem domain has been rolling around in the back of my mind for months. Recently I came up with a simple mechanism that I think would be a great fit for the language and would address most of the use cases that people cite when they request generics. The mechanism itself is more akin to union types and is labeled as such. However, the functionality could be used to address the same class of problems as are traditionally covered by generics.
I've written a proposal and posted it here: https://docs.google.com/document/d/12yqVIeYCLBiUBSkpzOWqoqbsB70EcMHHxClJQTIXACI
I would really appreciate any and all feedback.
Thanks!
Bob Z.


code block
branch
return
var result
compare op: !=
assign
assign
var a
const 0
var result
binary op op: /
const NaN
var a
var b