NPRG014 – 2023 plan

2th Oct - Groovy (syntax, scripting, functional programming) (VP)

9th Oct - Groovy (dynamic meta-programming, DSLs) (VP)

16th Oct - Groovy (static meta-programming) (VP)

23rd Oct – Modern concurrency (VP)

30th Oct - Backup

6th Nov – Scala (TB)

13th Nov - Scala (TB)

20th Nov - Scala (TB)

2th Nov - Scala (TB)

4th Dec - Prototype-based languages - IO (TB)

11th Dec - Prototype-based languages - JavaScript, TypeScript (TB)

18th Dec - Backup

Criteria

A homework assignment will be given at each lecture

A solution to each homework must be submited through the Teams project **by the start of the following lecture**

Submit **at least 8** out of 10 correctly implemented homeworks

Repository

https://github.com/d3scomp/NPRG014

Clone and then checkout before each lecture

https://github.com/d3scomp/NPRG014.git

Communication using Teams

Language dynamism, scripting and functional programming

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Today's agenda

Scripting

Functional programming

- Groovy syntax and interoperability
- Language dynamism

Groovy

A JVM programming language

- Dynamic
- Dynamically-typed
- Scripting
- Object-oriented
- Building on Java syntax

Why Groovy

Flat learning curve

Concise, readable and expressive syntax, easy to learn for Java developers

Smooth Java integration

Seamlessly and transparently integrates and interoperates with Java and any third-party libraries

Vibrant and rich ecosystem

Web development, reactive applications, concurrency / asynchronous / parallelism library, test frameworks, build tools, code analysis, GUI building

Powerful features

Closures, builders, runtime & compile-time meta-programming, functional programming, type inference, and static compilation

Domain-Specific Languages

Flexible & malleable syntax, advanced integration & customization mechanisms, to integrate readable business rules in your applications

Scripting and testing glue

Great for writing concise and maintainable tests, and for all your build and automation tasks

They all use Apache Groovy!

Part 1

Groovy syntax and interoperability

Interoperability

Groovy and *Java* can **implement**, **extend**, **refer** and **call** each other at will.

Groovy sources compile into *.class* files

IDEs provide cross-reference support

Java

```
public class Person {
    private final String name;
    public Person(String name) {
        this.name = name;
    }
    public String getName() {
        return name;
    }
}
```

Groovy

```
public class Person {
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Groovy

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    }
}
```

Groovy is Java

```
class Person {
    final String name
}
```

Variables, constants, params

String s

def s – a re-assignable variable

final s – a constant value

Intuitiveness

Equality a == b

Identity a.is(b)

() sometimes optional: println 'Joe'

String interpolation

```
final s = 'Hi Joe'

final s = "Hi Dave"

final s = "Hi $name"

final s = "Hi ${user.name}"

final s = """Hi Dave,

How are you?

"""
```

Numbers and primitive types

15 - integer

15G - BigInteger

1.5 - BigDecimal

1.5d - Double

All values are objects: 5.upto(10)

Clever boxing and unboxing

Properties

```
class City {
    String name
    int size
    boolean capital = false
}

City c1 = new City(name: 'Praha', size: 1200000, capital: true)
City c2 = new City(name: 'Písek', size: 25000)

print c1.name
c2.size = 25001
```

Power assert

```
assert 5 == customer.score
```

```
Exception thrown
17.2.2012 12:30:12 org.codehaus.groovy.runtime.StackTraceUtils sanitize

WARNING: Sanitizing stacktrace:

Assertion failed:

assert 5 == customer.score
         |  |        |
         |  |        4
         |  [score:4]
         false
```

Closures

```
Closure multiply = {int a, int b -> return a * b}
```

Closures

```
Closure multiply = {int a, int b -> a * b}
```

Closures

```
Closure multiply = {a, b -> a * b}
```

Closures – implicit parameter

```
def triple1 = {int number -> number * 3}

def triple2 = {number -> number * 3}

def triple3 = {it * 3}
```

Groovy is functional

```
def multiply = {a, b -> a * b}
def double = multiply.curry(2)
def triple = multiply.curry(3)

assert 4 == multiply(2, 2)
assert 8 == double(4)
assert 6 == triple(2)
```

Currying vs. Partial application

```
def multiply = {a, b → a * b}

def partial = multiply.curry(3)

def curried1 = {x → {y → multiply(x, y)}}

def curried2 = {x → multiply.curry(x)}
```

Memoize

def func = {a → longComputation(a)}

def fastFunc = func.memoize()

Closure scope

owner

delegate

this

closure.resolveStrategy =

DELEGATE_FIRST / OWNER_FIRST

DELEGATE_ONLY / OWNER_ONLY

Collections

```
final emptyList = []
final list = [1, 2, 3, 4, 5]
final emptyMap = [:]
final capitals = [cz : 'Prague', uk : 'London']

final list = [1, 2, 3, 4, 5] as LinkedList
final emptyMap = [:] as ConcurrentHashMap
```

Collections API

```
(1..10).each {println it}
2.step(10, 2) {println it}

(10..20).findAll{it%2==0}
        .collect {3*it}
        .inject(0){acc, v -> acc + v}
```

map, filter, and reduce explained with emoji 😂

```
map([🐮, 🍠, 🐔, 🌽], cook)
=> [🍔, 🍟, 🍗, 🍿]

filter([🍔, 🍟, 🍗, 🍿], isVegetarian)
=> [🍟, 🍿]

reduce([🍔, 🍟, 🍗, 🍿], eat)
=> 💩
```

(Not exhaustive) list

each (aka for loop)

collect (aka map)

inject (aka reduce)

findAll (aka filter)

sum, size, findFirst, grep, groupBy

any, every, min, max, ...

Some more operators

```
['Java', 'Groovy']*.toUpperCase()

customer?.shippingAddress?.street

return user.locale ?: defaultLocale
```

GDK = JDK + FUN

- java.util.Collection
  - each(), find(), join(), min(), max() …
- java.lang.Object
  - any(), every(), print(), invokeMethod(), …
- java.lang.Number
  - plus(), minus(), power(), upto(), times(), …

Tip: Ask *DefaultGroovyMethods* for help

Syntax enhancements

- Dynamic (duck) typing – optional!
- GDK
- Syntax enhancements
  - Properties, Named parameters
  - Closures
  - Collections and maps
  - Operator overloading
  - …

List comprehension (Python)

```
odd = [x for x in range(0, 100) if x % 2 !=0]

squares = [x*x for x in odd]
```

Generators (Python)

```
def fibonacci():
    a = 0
    b = 1
    yield b
    while True:
        a, b = b, a + b
        yield b


allFibs = fibonacci()
```

Part 2

Scripting

Agenda

- Scripting
- Script engine customization
- Grabbing libraries

Scripting

Evaluate custom Groovy code

At run-time!!!

```
new GroovyShell().evaluate('println Hi!')
```

http://groovyconsole.appspot.com/

Script customization

CompilerConfiguration

CompilationCustomizer

- ImportCustomizer
- ASTCustomizer
- SecureASTCustomizer

Functors

Dealing with wrapped data

map: ([A], f: A -> B) → [B]

map: (Maybe<A>, f: A -> B) → Maybe<B>

Functors are *mappable* (they have a **map** operation)

Monoids

Aggregating data and operations

Monoids

Aggregating data and operations

- A set of elements
- An operation that combines two elements
- An 'id' element neutral with respect to the operation
- Closure of the set with respect to the operation

1. $a + id = id + a = a$
2. $(a + b) + c = a + (b + c)$
3. $a \in M \,\&\, b \in M \Rightarrow a+b \in M$

Monoids

Reducible – any set of elements from a monoid can be reduced into a single value

reduce: ([A], f: (A, A) → A) → A

Monoids

class Customer {name, address, orders}

vs.

class CustData {orders, totalAmount}

Monoids

class Customer {name, address, orders}

not a monoid

vs.

class CustData {orders, totalAmount}

a monoid

Monoids

class Customer {name, address, orders}

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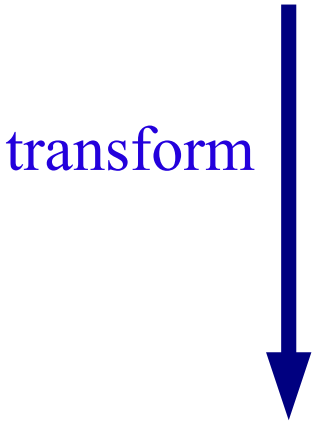

vs.

class CustData {orders, totalAmount}

a monoid

Reduce vs. Fold

m.reduce {v1, v2 → v1 + v2}

m.foldLeft(0) {acc, v → acc + v}

Composing functions

f: A → B

g: B → C

f >> g: A → C

Composing functions

f: A → B

g: B → C

f >> g: A → C

```
def f = {String s → s.size()}

def g = {Integer i → i%2==0 ? true : false}

def h = f >> g
```

Composing functions

f: A → B

g: B → C

f >> g: A → C

Not a monoid

Endofunctors

f: A → A

with composition (**>>**) and an **id()** function form a monoid

[f1, f2, f3, f4, f5, …].reduce(id, >>)

Other monoids of functions

Elements: f: String → Boolean

Other monoids of functions

Elements: f: String → Boolean

id() – returns *true/false*

Operation: logical AND/OR

Summary

Groovy syntax

Scripting

Functional programming

- closures
- functors (map)
- monoids (reduce)

References

http://groovy-lang.org

http://grails.org

http://groovyconsole.appspot.com/

http://www.manning.com/koenig2/