Groovy, Java, and Kotlin

Functional Programming

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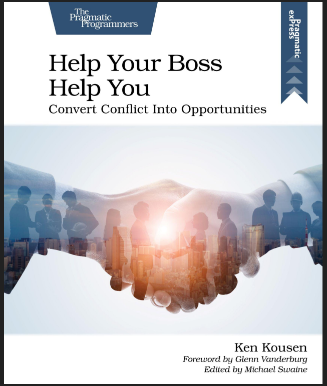
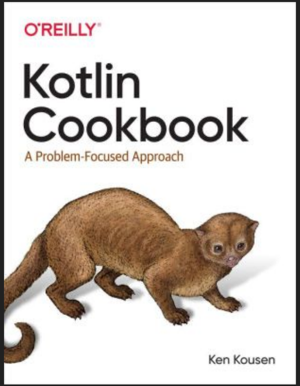
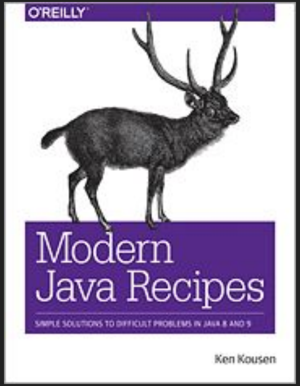
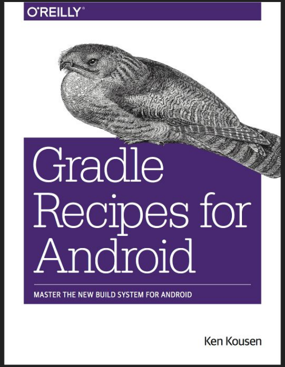
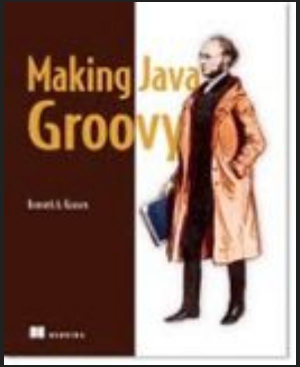

The Pragmatic Programmers
Pragmatic exPress
Help Your Boss Help You
Convert Conflict Into Opportunities
Ken Kousen
Foreword by Glenn Vanderburg
Edited by Michael Swaine






O'REILLY
Gradle Recipes for Android
MASTER THE NEW BUILD SYSTEM FOR ANDROID
Ken Kousen



GitHub repository

All demo code is at:

https://github.com/kousen/java_groovy_kotlin

Uses latest versions of Groovy and Kotlin

Only uses features from Java 11, but works on 1.8 through 19

Java, Groovy, and Kotlin

$$\begin{tikzcd} \text{Java} \arrow[dr] & \text{Groovy} \arrow[d] & \text{Kotlin} \arrow[dl] \\ & \text{All compile to bytecodes on the JVM} & \end{tikzcd}$$

Java, Groovy, and Kotlin

$$\begin{tikzcd}
\text{Java} \arrow[dr] & \text{Groovy} \arrow[d] & \text{Kotlin} \arrow[dl] \\
 & \text{None are functional languages} &
\end{tikzcd}$$

Java, Groovy, and Kotlin

Java Groovy Kotlin

They are OO languages with functional features

Java

Recently had its 25 year anniversary

Managed by Oracle, but with many implementations

- OpenJDK, Azul, Amazon Coretto, SAP, …

Functional features added in version 1.8

Current LTS version is 17 (14 September 2021)

Groovy

- Apache project
    - https://groovy-lang.org
- Syntax very similar to Java
    - Easy for Java devs to learn
- Most Groovy projects are actually combined Java + Groovy projects
- Current version is 4.0.5
- Grails, Spock, Gradle, Ratpack, Geb, Griffon, ...

Kotlin

Managed by JetBrains

- https://kotlinlang.org

Compiles to JVM, or generates JS

- Mobile and native available

Definitive language for Android

- Google develops Android libs "Kotlin first"

Gradle Kotlin DSL also available

Current version is 1.7.20

Lambda Expressions

Java lambda expressions

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  - Can access local variables but not modify them
    - final or "effectively final"

Lambda Expressions

Groovy closures

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Lambda Expressions

- Kotlin lambda expressions
  - Are expressions of the form
    - `(InputType1, InputType2, ...) → OutputType`
  - Have a receiver for resolving members
  - Can access local variables and modify them
    - (Are really closures)

Functional Programming

- Lambda, Method References, and Streams
  - LambdaDemo.java
  - MapFilterReduce.java
  - PrimeChecker.java
  - StreamsDemo.java

Functional Programming

Groovy closures

Many methods added to collections

(collect, findAll, inject) vs (map, filter, reduce)

closures.groovy

map_filter_reduce.groovy

PrimeCheckerGroovy.groovy

Kotlin Functions

Return type shown after signature

```
fun sum(a: Int, b:Int) : Int {
    return a + b
}
```

Single-expression functions:

```
fun sum(a: Int, b: Int) = a + b
```

Return type inferred

primes.kt

Lazy Streams

- Java Streams are lazy
  - Only process as much data as needed
- Groovy and Kotlin collections are not
  - But Groovy can use Java streams and Kotlin has sequences
  - LazyStreams.java
  - LazyStreamsGroovy.groovy
  - LazyStreamsSpec.groovy

Kotlin Sequences

Methods like map, filter, reduce, and fold are added to collections

The "`asSequence()`" method converts collection to sequence

- Like Java streams
- Evaluated element at a time
- No data processed unless there is a terminal expression

Great illustration at https://kotlinlang.org/docs/sequences.html#sequence

- lazySequences.kt, sequenceFunction.kt

map, filter, reduce

Java:

```
int total = myNums.stream()
    .filter(n → n % 3 == 0)
    .map(n → n * 2)
    .reduce(0, (acc, val) → acc + val);

total = myNums.stream()
    .filter(n → n % 3 == 0)
    .mapToInt(n → n * 2)    // map to IntStream
    .sum();
```

map, filter, reduce

Groovy:

```groovy
int total = nums.findAll { it % 3 == 0 }
    .collect { it * 2 }  // unfortunate name (should be map)
    .inject(0) { acc, val -> acc + val }

total = nums.findAll { it % 3 == 0 }
    .collect { it * 2 }
    .sum()  // duck typing
```

map, filter, reduce

Kotlin:

```
int total = nums.filter { it % 3 == 0 }
    .map { it * 2 }
    .fold(0) { acc, val -> acc + val } // reduce if only lambda

total = nums.filter { it % 3 == 0 }
     .map { it * 2 }
     .sum()
```

map, filter, reduce

Kotlin:

```
int total = nums.asSequence()
    .filter { it % 3 == 0 }
    .map { it * 2 }
    .sum()

Sequence works like Java stream:
    each num through entire pipeline before next
    requires terminal operation to process values
```

POGOs vs POJOs

- Plain Old Groovy Objects
  - private attributes, public methods, public class
  - map-based constructor
  - generated getters and setters
  - @Canonical → toString, equals, hashCode, tuple ctor

POJOs vs POGOs

Sorting streams with POJOs/POGOs

- Golfer.java, SortGolfers.java
- GroovyGolfer.groovy, sort_groovy_golfers.groovy
- GroovyGolferCS.groovy

Groovy Records

Groovy supports the Java 16 record keyword

```
record Cyclist(String firstName, String lastName) { }
```

Same behavior as Java records:

- Immutable
- Final (can't be extended)
- Implicit equals, hashCode, and toString methods
- Getters corresponding to property names (firstName(), lastName())

Kotlin Data Classes

Classes defined using the keyword "data"

```
data class Customer(val name: String, val email: String)
```

(That's the entire class)

Data classes have:

- generated getters and setters
- toString, equals, hashCode
- `copy()` method
- componentN() methods for destructuring

Beyond map/filter/reduce

Closure Composition

Memoization, Tail Recursion

Currying

Closure Composition

Java:

default methods in Consumer, Predicate, …

CombineLambdas.java

Groovy:

right-shift operator

composition.groovy

Kotlin:

write your own

composition.kt

Tail Recursion

Groovy:

```
@TailRecursive  // AST transformation
```

Kotlin:

```
tailrec  // keyword
```

Beyond map/filter/reduce

- AST transformations:
  - AnnotatedFunctions.groovy
  - UseAnnotatedFunctions.groovy
  - AnnotatedFunctionsTest.groovy

Libraries

Library to add functional capabilities to Kotlin

Arrow, https://arrow-kt.io/

For Groovy, every Java library can be used right away

Monads, etc

A monad is just a monoid in the category of endofunctors.

What's the problem?

https://www.reddit.com/r/math/comments/ap25mr/a_monad_is_a_monoid_in_the_category_of/

Good luck!

Metaprogramming

- Groovy can add methods to a class at runtime or compile time
  - pirate.groovy

Metaprogramming

Kotlin allows for extension functions added at compile time

- palindrome.kt
- primes.kt

Cat Pictures

Flickr RESTful (sort of) web service

    https://www.flickr.com/services/api/flickr.photos.search.html

Parsing JSON

SwingBuilder

Can use Java parallel streams

    cat_pictures.groovy

Summary

Can use Groovy, Kotlin, and Java together

- Use each for what it does well

Java functional capabilities are limited

Groovy goes beyond them and is quite mature

- builders, parsers, metaprogramming, traits, AST transformations

Kotlin does too, but has its own quirks

All demos at: https://github.com/kousen/java_groovy_kotlin