

Deep Dive Kotlin : du Hello World au ByteCode



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- I. ByteCode Java ?
- II. Introduction Kotlin
- III. Les bases
- IV. null-safety
- V. Les types
- VI. Les fonctions
- VII. Les lambdas
- VIII. Les classes
- IX. Pause
- X. ByteCode Android
- XI. Autres structures
- XII. Extensions de fonctions
- XIII. Les collections
- XIV. Les delegates
- XV. Un peu plus sur les fonctions
- XVI. Conclusion

ByteCode Java ?

HelloWorld.java

3

```
package _00_helloworld;

public class HelloWorld {

    public static void main(String[] args) {
        System.out.println("Hello Devoxx");
    }
}
```



```
$ javac HelloWorld.java
```

Java ByteCode binary

4

```
$ hexdump -C HelloWorld.class
```

00000000	ca fe ba be 00 00 00 34	00 1d 0a 00 06 00 0f 094.....
00000010	00 10 00 11 08 00 12 0a	00 13 00 14 07 00 15 07
00000020	00 16 01 00 06 3c 69 6e	69 74 3e 01 00 03 28 29 ()
00000030	56 01 00 04 43 6f 64 65	01 00 0f 4c 69 6e 65 4e	V ... Code ... LineN
00000040	75 6d 62 65 72 54 61 62	6c 65 01 00 04 6d 61 69	umberTable ... mai
00000050	6e 01 00 16 28 5b 4c 6a	61 76 61 2f 6c 61 6e 67	n ... ([Ljava/lang
00000060	2f 53 74 72 69 6e 67 3b	29 56 01 00 0a 53 6f 75	/String;)V ... Sou
00000070	72 63 65 46 69 6c 65 01	00 0f 48 65 6c 6c 6f 57	rceFile ... HelloW
00000080	6f 72 6c 64 2e 6a 61 76	61 0c 00 07 00 08 07 00	orld.java.....
00000090	17 0c 00 18 00 19 01 00	0c 48 65 6c 6c 6f 20 44Hello D
000000a0	65 76 6f 78 78 07 00 1a	0c 00 1b 00 1c 01 00 19	evoxx.....
000000b0	5f 30 30 5f 68 65 6c 6c	6f 77 6f 72 6c 64 2f 48	_00_helloworld/H
000000c0	65 6c 6c 6f 57 6f 72 6c	64 01 00 10 6a 61 76 61	elloWorld ... java
000000d0	2f 6c 61 6e 67 2f 4f 62	6a 65 63 74 01 00 10 6a	/lang/Object ... j
000000e0	61 76 61 2f 6c 61 6e 67	2f 53 79 73 74 65 6d 01	ava/lang/System.
000000f0	00 03 6f 75 74 01 00 15	4c 6a 61 76 61 2f 69 6f	.. out ... Ljava/ic
00000100	2f 50 72 69 6e 74 53 74	72 65 61 6d 3b 01 00 13	/PrintStream; ...
00000110	6a 61 76 61 2f 69 6f 2f	50 72 69 6e 74 53 74 72	java/io/PrintStr
00000120	65 61 6d 01 00 07 70 72	69 6e 74 6c 6e 01 00 15	eam... println ...
00000130	28 4c 6a 61 76 61 2f 6c	61 6e 67 2f 53 74 72 69	((Ljava/lang/Stri
00000140	6e 67 3b 29 56 00 21 00	05 00 06 00 00 00 00 00	ng;)V.!.....
00000150	02 00 01 00 07 00 08 00	01 00 09 00 00 00 1d 00
00000160	01 00 01 00 00 00 05 2a	b7 00 01 b1 00 00 00 01*
00000170	00 0a 00 00 00 06 00 01	00 00 00 03 00 09 00 0b

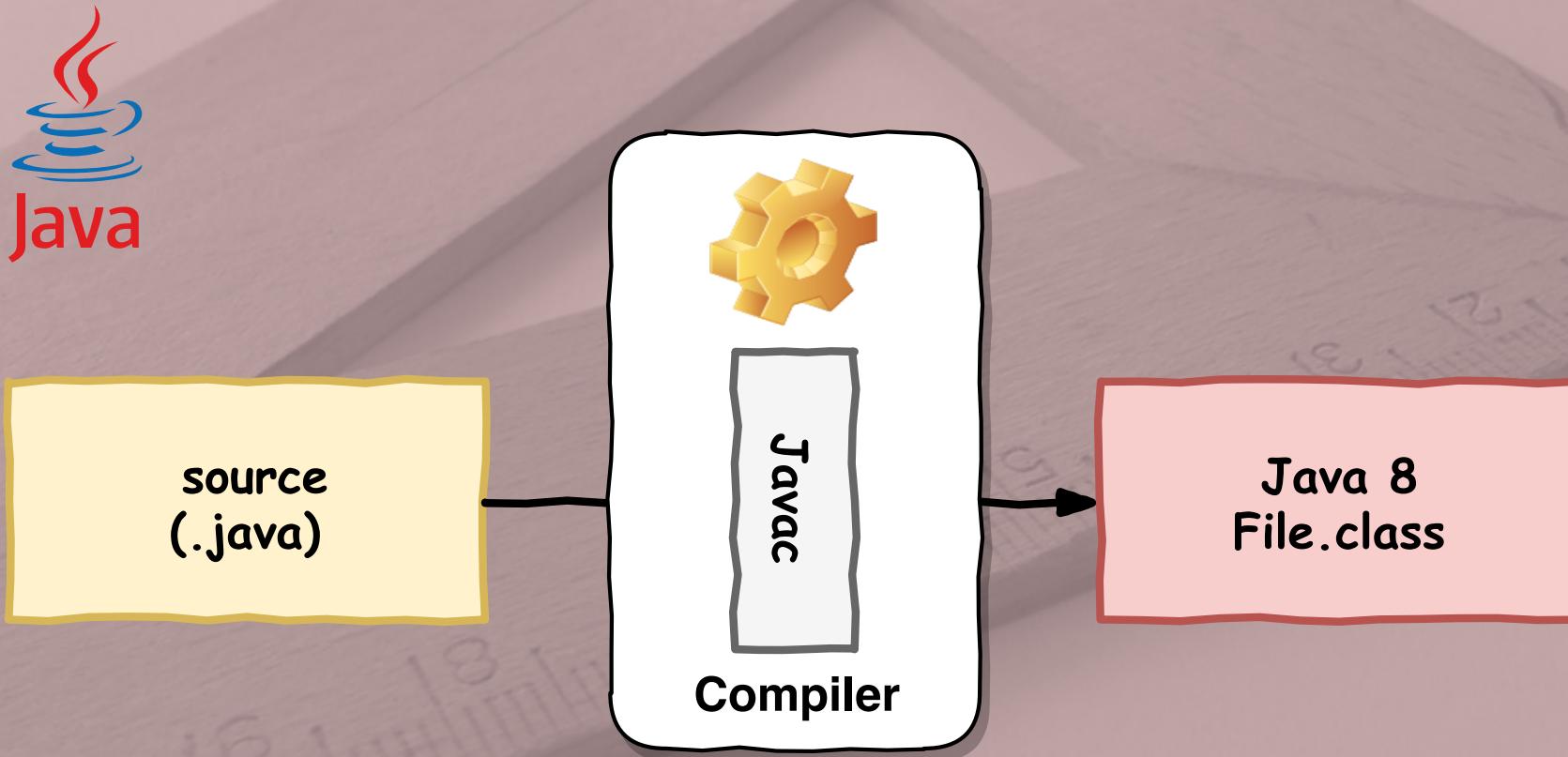
Explorons le ByteCode

5

```
$ javap -c HelloWorld.class
```

```
Compiled from "HelloWorld.java"
public class _00_helloworld.HelloWorld {
    public _00_helloworld.HelloWorld();
        Code:
            0: aload_0
            1: invokespecial #1                  // Method java/lang/Object."<init>":()V
            4: return

    public static void main(java.lang.String[]);
        Code:
            0: getstatic      #2                  // Field java/lang/System.out:Ljava/io/PrintStr
            3: ldc           #3                  // String Hello Devoxx
            5: invokevirtual #4                  // Method java/io/PrintStream.println:(Ljava/la
            8: return
}
```

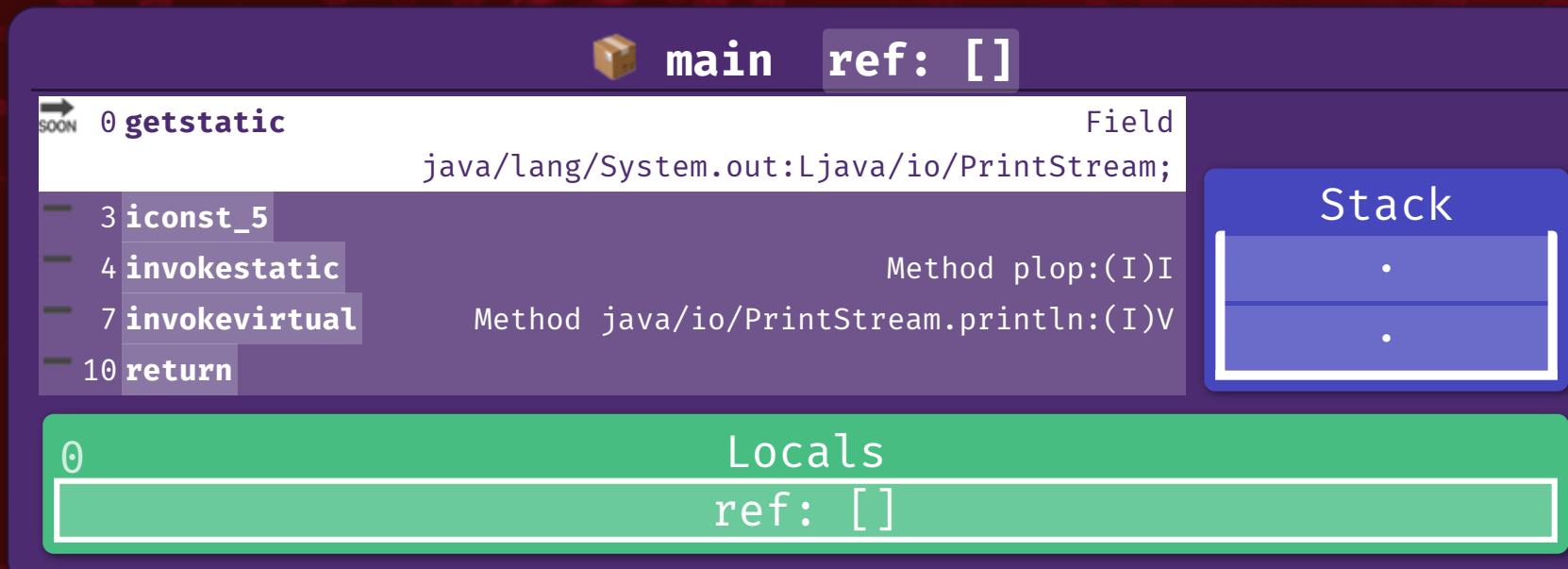


À propos du ByteCode

- Environ 200 opérations possibles (maxi. 256 opcodes)
- Préfix pour le type d'opérations (`i` pour entier, `d` pour double, ...)
- Manipulation de la pile, des variables locales (`iconst_0`, `istore`, `iload`, ...)
- Contrôle du flux des instructions (`if_icmpgt`, `goto`, ...)
- Arithmétiques et conversion de type (`iadd`, `iinc`, `i2d`, ...)
- Manipulation d'objets (`invokevirtual`, `invokedynamic`, ...)
- Autres (`athrow`, ...)

- ▶ Constant Pool
- ▼ Frames

 Next



- ➡ Mastering Java Bytecode at the Core of the JVM
- ➡ Introduction to Java Bytecode
- ➡ The Java® Virtual Machine Specification
- ➡ The Java Virtual Machine Instruction Set
- ➡ Suivez le lapin blanc : Exploration au coeur de la JVM
- ➡ Byte Buddy
- ➡ asm



Soyez curieux, regardez comment ça marche
avec `javap -c` !

Introduction Kotlin

Historique

#11





JVM et Android



JavaScript



Native avec
LLVM

HelloWorld.kt

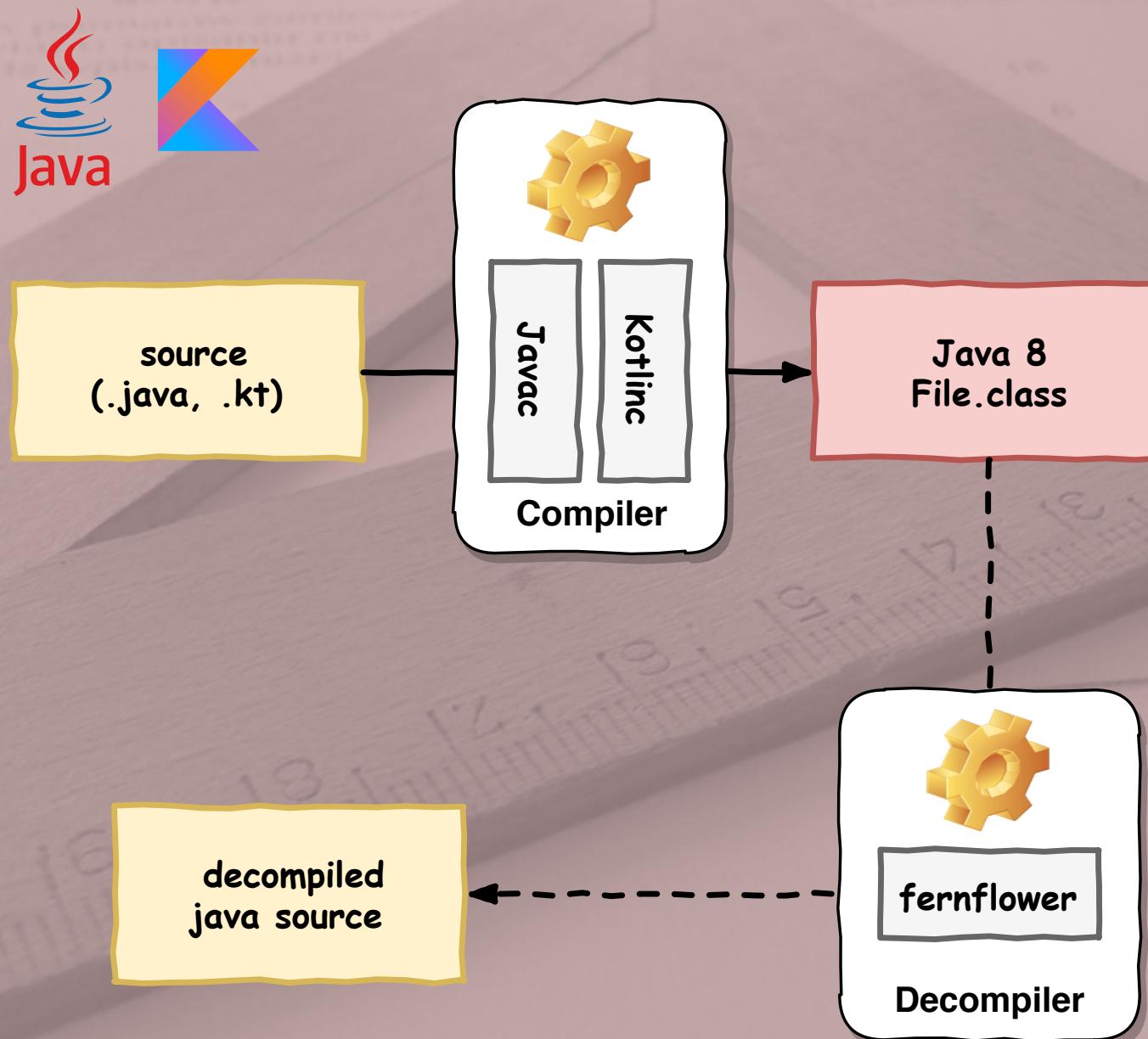
#13

```
package _00_helloworld

fun main(args: Array<String>) {
    println("Hello Devoxx")
}
```



```
$ kotlinc HelloWorld.kt
```



00000000	ca fe ba be 00 00 00 00 32 00 33 01 00 1b 5f 30 30 2.3 ... _00
00000010	5f 68 65 6c 6c 6f 77 6f 72 6c 64 2f 48 65 6c 6c _helloworld/Hell
00000020	6f 57 6f 72 6c 64 4b 74 07 00 01 01 00 10 6a 61 oWorldKt.....ja
00000030	76 61 2f 6c 61 6e 67 2f 4f 62 6a 65 63 74 07 00 va/lang/Object ..
00000040	03 01 00 04 6d 61 69 6e 01 00 16 28 5b 4c 6a 61 main ... ([Lja
00000050	76 61 2f 6c 61 6e 67 2f 53 74 72 69 6e 67 3b 29 va/lang/String;)
00000060	56 01 00 23 4c 6f 72 67 2f 6a 65 74 62 72 61 69 V.. #Lorg/jetbrai
00000070	6e 73 2f 61 6e 6e 6f 74 61 74 69 6f 6e 73 2f 4e ns/annotations/M
00000080	6f 74 4e 75 6c 6c 3b 01 00 04 61 72 67 73 08 00 otNull; ... args ..
00000090	08 01 00 1e 6b 6f 74 6c 69 6e 2f 6a 76 6d 2f 69 kotlin/jvm/i
000000a0	6e 74 65 72 6e 61 6c 2f 49 6e 74 72 69 6e 73 69 nternal/Intrinsic
000000b0	63 73 07 00 0a 01 00 17 63 68 65 63 6b 50 61 72 cs.....checkPar
000000c0	61 6d 65 74 65 72 49 73 4e 6f 74 4e 75 6c 6c 01 ameterIsNotNull.
000000d0	00 27 28 4c 6a 61 76 61 2f 6c 61 6e 67 2f 4f 62 .'(Ljava/lang/Ob
000000e0	6a 65 63 74 3b 4c 6a 61 76 61 2f 6c 61 6e 67 2f ject;Ljava/lang/
000000f0	53 74 72 69 6e 67 3b 29 56 0c 00 0c 00 0d 0a 00 String;)V.....
00000100	0b 00 0e 01 00 0c 48 65 6c 6c 6f 20 44 65 76 6f Hello Devc
00000110	78 78 08 00 10 01 00 10 6a 61 76 61 2f 6c 61 6e xx.....java/lar
00000120	67 2f 53 79 73 74 65 6d 07 00 12 01 00 03 6f 75 g/System.....ou
00000130	74 01 00 15 4c 6a 61 76 61 2f 69 6f 2f 50 72 69 t ... Ljava/io/Pri
00000140	6e 74 53 74 72 65 61 6d 3b 0c 00 14 00 15 09 00 ntStream;.....
00000150	13 00 16 01 00 13 6a 61 76 61 2f 69 6f 2f 50 72 java/io/Pr
00000160	69 6e 74 53 74 72 65 61 6d 07 00 18 01 00 07 70 intStream.....p
00000170	72 69 6e 74 6c 6e 01 00 15 28 4c 6a 61 76 61 2f rintln ... (Ljava/
00000180	6c 61 6e 67 2f 4f 62 6a 65 63 74 3b 29 56 0c 00 lang/Object;)V ..
00000190	1a 00 1b 0a 00 19 00 1c 01 00 13 5b 4c 6a 61 76 [Ljav
000001a0	61 2f 6c 61 6e 67 2f 53 74 72 69 6e 67 3b 01 00 a/lang/String; ..
000001b0	11 4c 6b 6f 74 6c 69 6e 2f 4d 65 74 61 64 61 74 .Lkotlin/Metadat

```
Compiled from "HelloWorld.kt"
public final class _00_helloworld.HelloWorldKt {
    public static final void main(java.lang.String[]);
        Code:
            0: aload_0
            1: ldc           #9                  // String args
            3: invokestatic  #15                 // Method kotlin/jvm/internal/Intrinsics.checkNotNullParameter(Ljava/lang/String;Ljava/lang/String;)V
            6: ldc           #17                 // String Hello Devoxx
            8: astore_1
            9: getstatic     #23                 // Field java/lang/System.out:Ljava/io/PrintStream;
            12: aload_1
            13: invokevirtual #29                 // Method java/io/PrintStream.println:(Ljava/lang/String;)V
            16: return
}
```

HelloWorld-java

#17



```
package _00_helloworld;

import kotlin.Metadata;
import kotlin.jvm.internal.Intrinsics;
import org.jetbrains.annotations.NotNull;

@Metadata(
    mv = {1, 1, 9},
    bv = {1, 0, 2},
    k = 2,
    d1 = {"\u0000\u0012\n\u0000\n\u0002\u0010\u0002\n\u0000\n\u0002\u0010\u0011\n\u0002\u0011"},
    d2 = {"main", "", "args", "", "", "([Ljava/lang/String;)V"}
)
public final class HelloWorldKt {
    public static final void main(@NotNull String[] args) {
        Intrinsics.checkNotNull(args, "args");
        String var1 = "Hello Devoxx";
        System.out.println(var1);
    }
}
```

- 🚂♂ Kotlin ajoute des contrôles
- du coup on a besoin de JARs en plus

jar	taille
kotlin-stdlib-1.2.31.jar	919K
kotlin-stdlib-jdk7-1.2.31.jar	3.1K
kotlin-stdlib-jdk8-1.2.31.jar	13K
kotlin-reflect-1.2.31.jar	2.5M
guava-18.0.jar	2.2M
lombok-1.16.18.jar	1.4M
spring-core-5.0.5.RELEASE.jar	1.2M
jackson-databind-2.9.5.jar	1.3M

- 🚗 Performances ?

 Ne croyez pas les benchmarks, faites les vous-même !

-  <https://github.com/JetBrains/kotlin-benchmarks>
-  <https://github.com/MonkeyPatchIo/kotlin-perf>

Benchmark	Mode	Cnt	Score	Error	Units
testJava	thrpt	200	66490.271	± 879.996	ops/s
testKotlin	thrpt	200	72393.914	± 935.962	ops/s

Les bases

```
var x: Int = 10
val y: Int = 3
x += 4
// y += 4 ← Compilation Error

println(x * y) // 42
```



string-template.kt

#22

```
fun greeting(who: Someone) {  
    println("Hello $who!")  
    println("Hello ${who.firstName} ${who.lastName}!")  
}
```



string-template.java



ByteCode de string-template

#24

```
Compiled from "string-templates.kt"
public final class _01_basic.String_templatesKt {
    public static final void greeting(_01_basic.Someone);
        Code:
            0: aload_0
            1: ldc           #9           // String who
            3: invokestatic #15          // Method kotlin/jvm/internal/Intrinsics.checkNotNullParameter(Ljava/lang/Object;Ljava/lang/String;)V
            6: new           #17          // class java/lang/StringBuilder
            9: dup
            10: invokespecial #21         // Method java/lang/StringBuilder."<init>":()V
            13: ldc           #23          // String Hello
            15: invokevirtual #27         // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder
            18: aload_0
            19: invokevirtual #30         // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder
            22: bipush        33
            24: invokevirtual #33         // Method java/lang/StringBuilder.append:(C)Ljava/lang/StringBuilder
            27: invokevirtual #37         // Method java/lang/StringBuilder.toString:()Ljava/lang/String
            30: astore_1
            31: getstatic     #43          // Field java/lang/System.out:Ljava/io/PrintStream
            34: aload_1
            35: invokevirtual #49         // Method java/io/PrintStream.println:(Ljava/lang/String)V
```

```
val anInt = 42 // type inference: Int  
val aLong = 42L // type inference: Long  
var aDouble: Double? = null
```



numeric.java

#26



ByteCode de numeric

#27

```
Compiled from "numeric.kt"
public final class _01_basic.NumericKt {
    public static final void tryNumeric();
        Code:
            0: bipush      42
            2: istore_0
            3: ldc2_w      #7                      // long 42l
            6: lstore_1
            7: aconst_null
            8: checkcast   #10                     // class java/lang/Double
           11: astore_3
           12: return
}
```

- Plus de ; *
- 😍 String templating
- 😊 Plus de types primitifs (avant la compilation)
- 🤔 Inférence de type
- On peut mélanger du code Java et Kotlin

null-safety

“ I call it my billion-dollar mistake. It was the invention of the `null` reference in 1965. At that time, I was designing the first comprehensive type system for references in an object oriented language (ALGOL W). My goal was to ensure that all use of references should be absolutely safe, with checking performed automatically by the compiler. But I couldn't resist the temptation to put in a `null` reference, simply because it was so easy to implement. This has led to innumerable errors, vulnerabilities, and system crashes, which have probably caused a billion dollars of pain and damage in the last forty years.

--Tony Hoare (C.A.R. Hoare)

► Null References: The Billion Dollar Mistake

```
fun main(args: Array<String>) {  
  
    val somethingNotNull: String = "aString"  
    // somethingNotNull: String = null ⇒ compilation error  
  
    var length = somethingNotNull.length  
  
    var something: String? = null  
    length = something?.length ?: 0  
  
    length = something().length ?: 0  
  
    // length = something()!! .length // throw kotlin.NullPointerException  
  
    // SmartCast  
    something = "aString"  
    length = something.length  
}  
  
fun something(): String? = null
```



```
package _02_null_safety;

import kotlin.Metadata;
import kotlin.jvm.internal.Intrinsics;
import org.jetbrains.annotations.NotNull;
import org.jetbrains.annotations.Nullable;

@Metadata(
    mv = {1, 1, 9},
    bv = {1, 0, 2},
    k = 2,
    d1 = {"\u0000\u0014\n\u0000\n\u0002\u0010\u0002\n\u0000\n\u0002\u0010\u0011\n\u0002",
    d2 = {"main", "", "args", "", "", "([Ljava/lang/String;)V", "something"}
)
public final class NullSafetyKt {
    public static final void main(@NotNull String[] args) {
        Intrinsics.checkNotNull(args, "args");
        String somethingNotNull = "aString";
        int length = somethingNotNull.length();
        String something = (String)null;
        int length = false;
    }
}
```

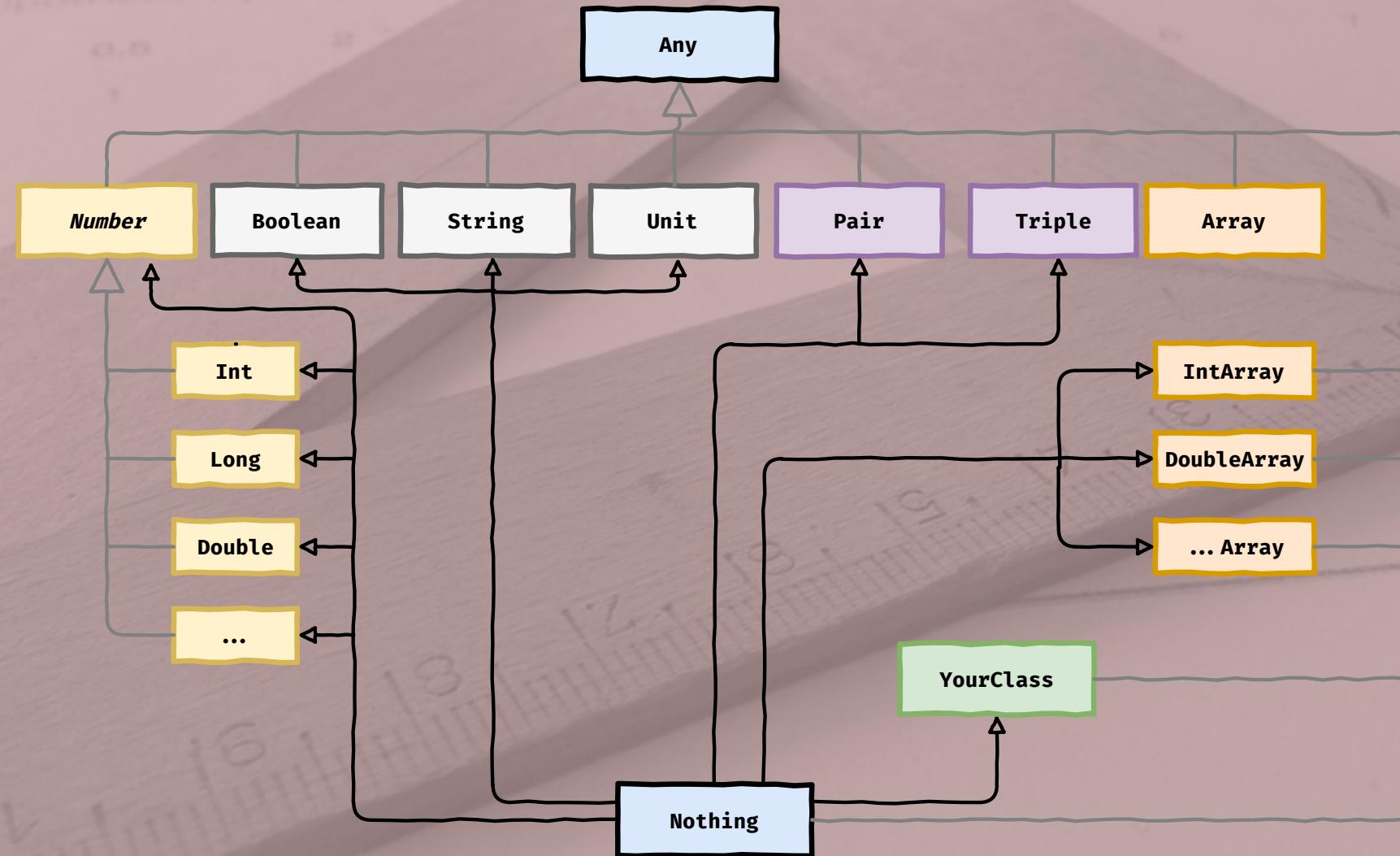


- 🎸 Elvis operator: ?:
- 🙌 plus de NullPointerException
- ⚠️ quand on appelle du Java

Les types

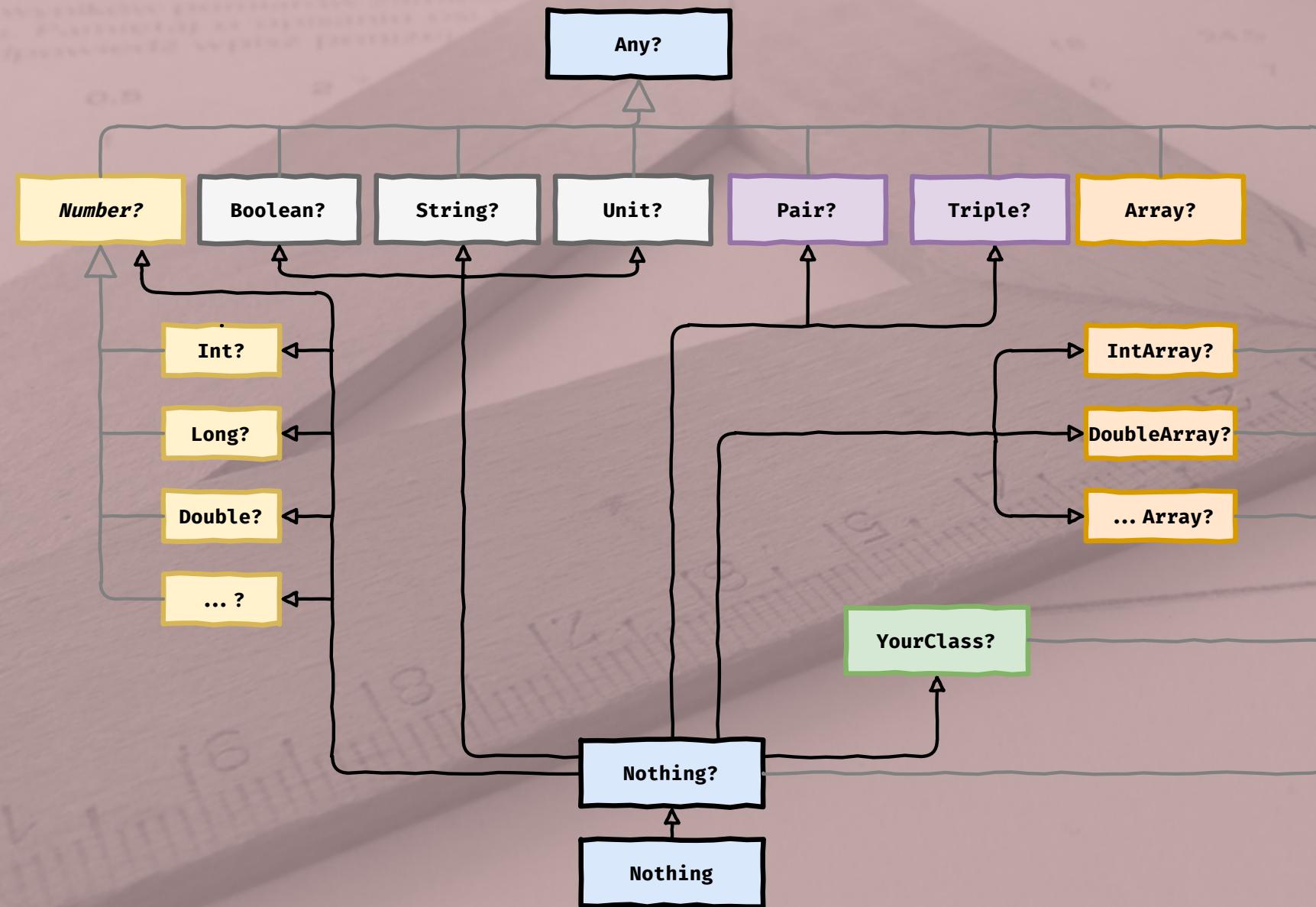
Types basiques

#35



Types basiques nullable

#36



```
fun `is P = NP`() : Boolean =  
    TODO()  
  
fun main(args: Array<String>) {  
    println("P = NP is ${`is P = NP`()}")  
}
```



- 🤝 le TODO() est l'ami du TDD

Les fonctions

named-params.kt

#40

```
fun buildString(prefix: String,  
               who: String,  
               enhanced: Boolean): String {  
    var msg = "$prefix $who"  
    if (enhanced) {  
        msg += '!'  
    }  
    return msg  
}  
  
fun greetings(): String =  
    buildString(enhanced = true, who = "Devoxx", prefix = "Hello")
```



named-params.java

41



default-value.kt

#42

```
fun buildString2(prefix: String = "Hello",
                 who: String,
                 enhanced: Boolean = true): String {
    var msg = "$prefix $who"
    if (enhanced) {
        msg += '!'
    }
    return msg
}

fun greetings2(): String =
    buildString2(who = "Devoxx")
```



default-value.java

43



ByteCode de default-value

#44

```
Compiled from "default-value.kt"
public final class _03_fun.Default_valueKt {
    public static final java.lang.String buildString2(java.lang.String, java.lang.String, boo
    Code:
        0: aload_0
        1: ldc           #9                  // String prefix
        3: invokestatic  #15                 // Method kotlin/jvm/internal/Intrinsics.checkNotNullParameter(Ljava/lang/String;Ljava/lang/String;)Ljava/lang/String;
        6: aload_1
        7: ldc           #17                 // String who
        9: invokestatic  #15                 // Method kotlin/jvm/internal/Intrinsics.checkNotNullParameter(Ljava/lang/String;Ljava/lang/String;)Ljava/lang/String;
       12: new           #19                 // class java/lang/StringBuilder
       15: dup
       16: invokespecial #23                // Method java/lang/StringBuilder."<init>":()V
       19: ldc           #25                 // String
       21: invokevirtual #29                // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;
       24: aload_0
       25: invokevirtual #29                // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;
       28: bipush        32
       30: invokevirtual #32                // Method java/lang/StringBuilder.append:(C)Ljava/lang/StringBuilder;
       33: aload_1
       34: invokevirtual #29                // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;
```

✨ Conseils

- Toujours typer le retour de vos fonctions (sauf si c'est évident et une surcharge comme le `toString`)
- Kotlin est plus expressif que Java => évitez de faire des fonctions trop longues
- Sautez une ligne après le `=`
- Utilisez le passage des arguments par nom quand ça lève des ambiguïtés



Notes

- Le passage des arguments par nom, ne marche pas sur les appels de code Java

Les lambdas

```
// Declare apply function with function as parameter
fun apply(x: Int, y: Int, operation: (Int, Int) → Int): Int =
    operation(x, y)

// Declare function
fun sumf(x: Int, y: Int) : Int =
    x + y

// call apply with function reference
val sum5 = apply(2,3, ::sumf)

// store function reference
val sumLam = ::sumf

// call apply with the function reference
val sum6 = apply(1,5, sumLam)
```





```
package _04_lamda;

import kotlin.Metadata;
import kotlin.jvm.functions.Function2;
import kotlin.jvm.internal.Intrinsics;
import kotlin.reflect.KFunction;
import org.jetbrains.annotations.NotNull;

@Metadata(
    mv = {1, 1, 9},
    bv = {1, 0, 2},
    k = 2,
    d1 = {"\u0000\u0001c\n\u0000\n\u0002\u0010\b\n\u0002\b\u0005\n\u0002\u0018\u0002\n\u0002",
    d2 = {"sum5", "", "getSum5", "()I", "sum6", "getSum6", "sumLam", "Lkotlin/reflect/KFunct
)
public final class FunctionKt {
    private static final int sum5;
    @NotNull
    private static final KFunction sumLam;
    private static final int sum6;
```

```
// Declare lambda
val suml: (Int, Int) → Int = { x: Int, y: Int → x + y }

// call apply with suml lambda
val sum3 = apply(1, 2, suml)

// call apply with lamda
val sum4 = apply(1, 3) { x, y → x + y }
```



```
package _04_lamda;

import kotlin.Metadata;
import kotlin.jvm.functions.Function2;
import org.jetbrains.annotations.NotNull;

@Metadata(
    mv = {1, 1, 9},
    bv = {1, 0, 2},
    k = 2,
    d1 = {"\u0000\u0012\n\u0000\n\u0002\u0010\b\n\u0002\b\u0005\n\u0002\u0018\u0002\n\u0002\",
    d2 = {"sum3", "", "getSum3", "()I", "sum4", "getSum4", "suml", "Lkotlin/Function2;", "ge
)
public final class LambdaKt {

    @NotNull
    private static final Function2 suml;
    private static final int sum3;
    private static final int sum4;

    @NotNull
    public static final Function2 getSuml() {
```



```
val other = sumf(1,2)
    .let { it + 1 }

val nullable = maybeAnInt()
    ?.let { it + 1 }
```





```
package _04_lambda;

import kotlin.Metadata;
import kotlin.NotImplementedError;
import kotlin.jvm.internal.DefaultConstructorMarker;
import org.jetbrains.annotations.Nullable;

@Metadata(
    mv = {1, 1, 9},
    bv = {1, 0, 2},
    k = 2,
    d1 = {"\u0000\n\n\u0000\n\u0002\u0010\b\n\u0002\b\u0007\u001a\r\u0010\b\u001a\u0004\u0011",
    d2 = {"nullable", "", "getNullable", "()Ljava/lang/Integer;", "Ljava/lang/Integer;", "ot"
)
public final class LetKt {
    private static final int other;
    @Nullable
    private static final Integer nullable;

    @Nullable
    public static final Integer maybeAnInt() {
```

- ! pas de `return`
- pensez à mettre vos lambda comme dernier argument
- voir aussi les `apply`, `also`, `run`, `use`, `with`
 -  the tldr; on Kotlin's let, apply, also, with and run functions

Les classes



```
interface AstronomicalBody {  
    val name: String  
}  
  
data class Planet(override val name: String,  
                  val moons: List<Moon> = emptyList()) : AstronomicalBody {  
    init {  
        require(name.isNotEmpty())  
    }  
  
    operator fun plus(moon: Moon): Planet {  
        return this.copy(moons = kotlin.collections.listOf(moon))  
    }  
}  
  
data class Moon(override val name: String) : AstronomicalBody  
  
object SolarSystem {  
    val earth = Planet(name = "Earth")  
    val moon = Moon(name = "Moon")
```

astronomy.java

56



```
open class SmallBody {  
    open fun sizeRange(): IntRange = 0..10  
}  
  
data class Comet(val name: String) : SmallBody()  
  
data class Asteroid(val name: String) : SmallBody() {  
    override fun sizeRange(): IntRange = 0..4  
}  
  
fun main(args: Array<String>) {  
    val bodies = listOf(Comet("Halley"), Asteroid("Adeona"))  
  
    bodies.forEach { body →  
        println("$body: ${body.sizeRange()}")  
    }  
}
```



- ⚠ Les contrôles de types génériques ne sont fait qu'au moment de la compilation
- Covariant: `out`, en java ? `extends T`
- Contravariant: `in`, en java ? `super T`

Borne supérieure

```
fun <T : Comparable<T>> sort(list: List<T>): List<T>
```

Les détails: 

<https://kotlinlang.org/docs/reference/generics.html>

```
interface Function<in T, out U>
```

```
Function<*, String> // correspond à Function<in Nothing, String>
```

```
Function<Int, *> // correspond à Function<Int, out Any?>
```

```
Function<*, *> // correspond à Function<in Nothing, out Any?>
```

```
sealed class JsonValue

data class JsonObject(val attributes: Map<String, JsonValue>) : JsonValue()
data class JSONArray(val values: List<JsonValue>) : JsonValue()
data class JsonString(val value: String) : JsonValue()
data class JsonNumber(val value: Number) : JsonValue()
data class JsonBoolean(val value: Boolean) : JsonValue()
object JsonNull : JsonValue()
```



Alias en Kotlin

#61

```
interface Entity

typealias Id = String
typealias Version = Int
typealias EntityKey = Pair<Id, Version>

// fun getAllEntities(): Map<Pair<String, Int>, List<Entity>> = emptyMap()
fun getAllEntities(): Map<EntityKey, List<Entity>> = emptyMap()
```



ByteCode d'alias

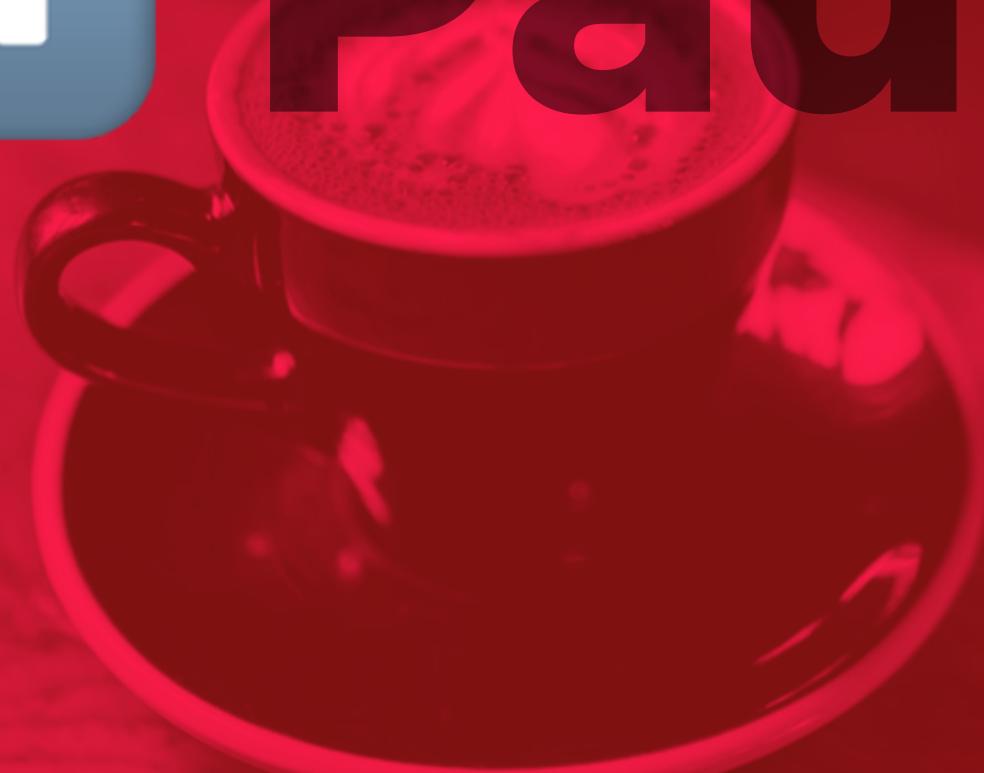
#62

```
Compiled from "typealias.kt"
public final class _06_class_2.TypealiasKt {
    public static final java.util.Map<kotlin.Pair<java.lang.String, java.lang.Integer>, java.
        Code:
            0: invokestatic #12                      // Method kotlin/collections/MapsKt.emptyMap:()
            3: areturn
}
```

- 😂 **data class**
- 🤔 Mais pourquoi on n'a pas ça en Java ?
- Une seule classe par fichier n'est pas utile
- 😎 **sealed** permet de faire des types algébriques de données (Algebraic Data Type)



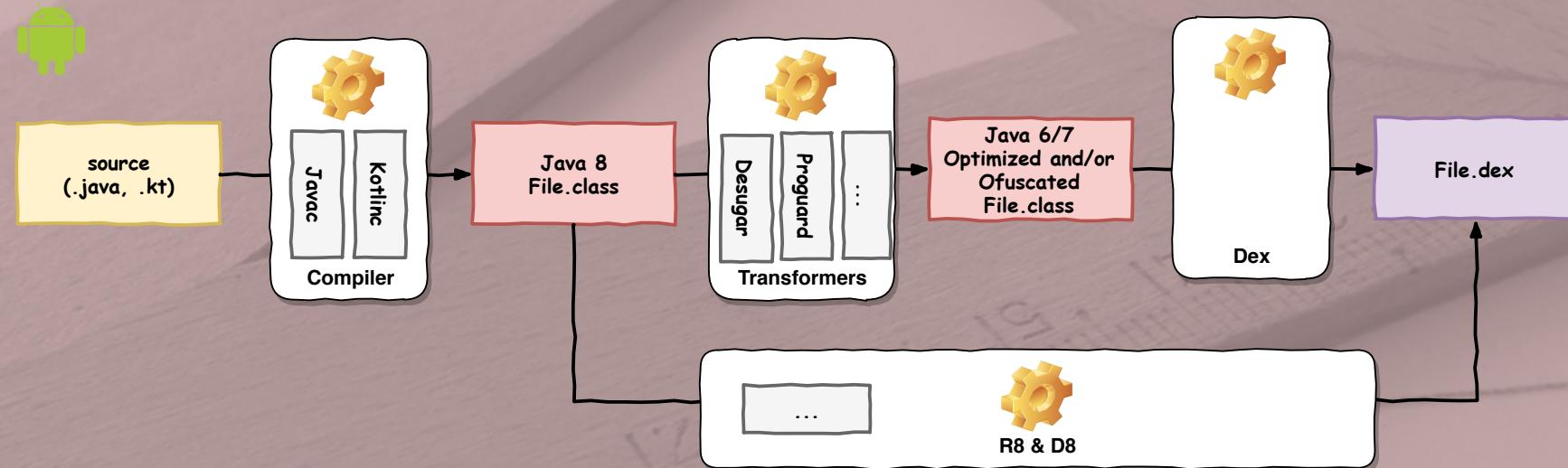
Pause



ByteCode Android

Compilation pour Android

#66



Dalvik EXecutable format

#67

Dalvik Executable format

```
$ java -jar ./scripts/lib/d8.jar --release \
    --output ./target/android/dex \
    ./target/android/hello.jar
```

00000000	64 65 78 0a 30 33 35 00 06 50 f0 61 50 10 7c c0	dex.035..P.aP. .
00000010	b2 f9 77 2d 54 df 60 f3 ac dd b0 10 eb 55 53 e1	..w-T.`.....US.
00000020	28 f6 10 00 70 00 00 00 78 56 34 12 00 00 00 00	(...p...xV4.....
00000030	00 00 00 00 4c f5 10 00 12 17 00 00 70 00 00 00L.....p...
00000040	31 03 00 00 b8 5c 00 00 2a 08 00 00 7c 69 00 00	1....\..*... i..
00000050	30 03 00 00 74 cb 00 00 20 1a 00 00 f4 e4 00 00	0...t...
00000060	75 02 00 00 f4 b5 01 00 94 f1 0e 00 94 04 02 00	u.....
00000070	4a f1 07 00 4c f1 07 00 75 f1 07 00 a4 f1 07 00	J...L...u.....
00000080	c2 f1 07 00 e0 f1 07 00 00 f2 07 00 23 f2 07 00#...
00000090	71 f2 07 00 b9 f2 07 00 07 f3 07 00 37 f3 07 00	q.....7...
000000a0	69 f3 07 00 90 f3 07 00 bc f3 07 00 e3 f3 07 00	i.....
000000b0	27 f4 07 00 71 f4 07 00 8f f4 07 00 ad f4 07 00	'...q.....
000000c0	cb f4 07 00 ed f4 07 00 0f f5 07 00 2c f5 07 00,...
000000d0	49 f5 07 00 79 f5 07 00 b1 f5 07 00 e9 f5 07 00	I...y.....
000000e0	1a f6 07 00 51 f6 07 00 7b f6 07 00 a6 f6 07 00Q...{....
000000f0	d1 f6 07 00 0a f7 07 00 47 f7 07 00 84 f7 07 00G....
00000100	c1 f7 07 00 02 f8 07 00 43 f8 07 00 84 f8 07 00C....
00000110	f1 f8 07 00 12 f9 07 00 41 f9 07 00 6e f9 07 00A...n...
00000120	b0 f9 07 00 dd f9 07 00 0a fa 07 00 39 fa 07 009...
00000130	68 fa 07 00 ab fa 07 00 e0 fa 07 00 25 fb 07 00	h.....%...

```
$ ~/.android-sdk/build-tools/23.0.1/dexdump -d \
./target/android/dex/classes.dex \
> ./target/android/dex/classes.dex.dump
```

```
Processing './target/android/dex/classes.dex'...
Opened './target/android/dex/classes.dex', DEX version '035'
Class #0      -
  Class descriptor : 'L_00_helloworld/HelloWorldKt;'
  Access flags    : 0x0011 (PUBLIC FINAL)
  Superclass      : 'Ljava/lang/Object;'
  Interfaces      -
  Static fields   -
  Instance fields -
  Direct methods  -
    #0            : (in L_00_helloworld/HelloWorldKt; )
      name        : 'main'
      type        : '([Ljava/lang/String;)V'
      access      : 0x0019 (PUBLIC STATIC FINAL)
      code        -
      registers   : 2
```



```
$ sh ./scripts/lib/dextools/d2j-dex2smali.sh \
    ./target/android/dex/classes.dex -f \
    -o ./target/android/smali
```

```
.class public final L_00_helloworld/HelloWorldKt;
.super Ljava/lang/Object;
.source "HelloWorld.kt"

.annotation system Ldalvik/annotation/SourceDebugExtension;
    value = "SMAP\nHelloWorld.kt\nKotlin\n*S Kotlin\n*n*F\n+n+ 1 HelloWorld.kt\nn_00_helloworld/He
.end annotation
.annotation runtime Lkotlin/Metadata;
    bv = {
        1,
        0,
        2
    }
    d1 = {
        "\u0000\u0012\n\u0000\u0000\n\u0002\u0010\u0002\n\u0000\u0000\n\u0002\u0010\u0011\n\u0002\u0010\u0000
    }
```



Autres structures

```
fun handleAstronomicalBody(body: AstronomicalBody) {  
    val message =  
        if (body is Planet && body.name == "Earth") {  
            "Welcome Earth"  
        } else {  
            "Welcome martian"  
        }  
    println(message)  
}
```



```
fun main(args: Array<String>) {  
    for (body in SolarSystem.bodies) { // 🌎  
        print(body)  
    }  
}
```





```
package _09_structures;

import astronomy.AstronomicalBody;
import astronomy.SolarSystem;
import java.util.Iterator;
import kotlin.Metadata;
import kotlin.jvm.internal.Intrinsics;
import org.jetbrains.annotations.NotNull;

@Metadata(
    mv = {1, 1, 9},
    bv = {1, 0, 2},
    k = 2,
    d1 = {"\u0000\u0012\n\u0000\n\u0002\u0010\u0002\n\u0000\n\u0002\u0010\u0011\n\u0002\u0011"},
    d2 = {"main", "", "args", "", "", "([Ljava/lang/String;)V"}
)
public final class ForKt {
    public static final void main(@NotNull String[] args) {
        Intrinsics.checkNotNull(args, "args");
        Iterator var2 = SolarSystem.INSTANCE.getBodies().iterator();
    }
}
```

```
Compiled from "for.kt"
public final class _09_structures.ForKt {
    public static final void main(java.lang.String[]);
        Code:
            0: aload_0
            1: ldc           #9                  // String args
            3: invokestatic  #15                 // Method kotlin/jvm/internal/Intrinsics.checkNotNullStringParameter
            6: getstatic     #21                 // Field astronomy/SolarSystem.INSTANCE:LastronomicalBody
            9: invokevirtual #25                 // Method astronomy/SolarSystem.getBodies:()Ljava.util.List;
           12: invokeinterface #31,  1          // InterfaceMethod java/util/Collection.iterator()
           17: astore_2
           18: aload_2
           19: invokeinterface #37,  1          // InterfaceMethod java/util/Iterator.hasNext:()
           24: ifeq          47
           27: aload_2
           28: invokeinterface #41,  1          // InterfaceMethod java/util/Iterator.next:()Ljava.util.Object;
           33: checkcast     #43                 // class astronomy/AstronomicalBody
           36: astore_1
           37: getstatic     #49                 // Field java/lang/System.out:Ljava/io/PrintStream;
           40: aload_1
           41: invokevirtual #55                 // Method java/io/PrintStream.print:(Ljava/lang/Object)
```

```
while (x > 0) {  
    x--  
}  
  
do {  
    val y = retrieveData()  
} while (y != null) // y is visible here!
```



```
for (body in SolarSystem.bodies) { // 🌎  
  
    val message = when (body) {  
        is Planet → "Planet ${body.name}"  
        is Star   → "Star ${body.name}"  
        else       → null  
    }  
  
    if (message ≠ null) {  
        println(message)  
    }  
}
```



for-factorial.kt

#77

```
// Note: assert(n ≥ 0)
fun forFactorial(n: Int): Int { // 🤔
    var acc = 1
    for (i in 1..n) {
        acc *= i
    }
    return acc
}
```



ByteCode factoriel avec for

#78

```
Compiled from "for-factorial.kt"
public final class _09_structures.recusion.For_factorialKt {
    public static final int forFactorial(int);
        Code:
            0:  iconst_1
            1:  istore_1
            2:  iconst_1
            3:  istore_2
            4:  iload_0
            5:  istore_3
            6:  iload_2
            7:  iload_3
            8:  if_icmpgt    26
            11: iload_1
            12: iload_2
            13: imul
            14: istore_1
            15: iload_2
            16: iload_3
            17: if_icmpeq    26
            20: iinc          2, 1
```

```
// Note: assert(n ≥ 0)
fun recFactorial(n: Int): Int =
    if (n < 1) 1 else n * recFactorial(n - 1)
```



ByteCode factoriel avec recursivité

#80

```
Compiled from "rec-factorial.kt"
public final class _09_structures.recusion.Rec_factorialKt {
    public static final int recFactorial(int);
        Code:
            0: iload_0
            1: iconst_1
            2: if_icmpge    9
            5: iconst_1
            6: goto      17
            9: iload_0
            10: iload_0
            11: iconst_1
            12: isub
            13: invokestatic #8           // Method recFactorial:(I)I
            16: imul
            17: ireturn
}
```

tailrec-factorial.kt

#81

```
// Note: assert(n ≥ 0)
fun tailRecFactorial(n: Int): Int {

    tailrec fun aux(n: Int, acc: Int): Int =
        if (n < 1) acc else aux(n - 1, acc * n)

    return aux(n, 1)
}
```



ByteCode factoriel avec recursivité terminal #82

1/2

```
Compiled from "tailrec-factorial.kt"
public final class _09_structures.recusion.Tailrec_factorialKt {
    public static final int tailRecFactorial(int);
        Code:
            0: getstatic      #12           // Field _09_structures/recusion/Tailrec_factor
            3: astore_1
            4: aload_1
            5: iload_0
            6: iconst_1
            7: invokevirtual #16           // Method _09_structures/recusion/Tailrec_facto
            10: ireturn
}
```

ByteCode factoriel avec recursivité terminal #83

2/2

```
Compiled from "tailrec-factorial.kt"
final class _09_structures.recusion.Tailrec_factorialKt$tailRecFactorial$1 extends kotlin.j
    public static final _09_structures.recusion.Tailrec_factorialKt$tailRecFactorial$1 INSTAN

    public java.lang.Object invoke(java.lang.Object, java.lang.Object);
        Code:
            0: aload_0
            1: aload_1
            2: checkcast    #11                  // class java/lang/Number
            5: invokevirtual #15                // Method java/lang/Number.intValue:()I
            8: aload_2
            9: checkcast    #11                  // class java/lang/Number
           12: invokevirtual #15                // Method java/lang/Number.intValue:()I
           15: invokevirtual #18                // Method invoke:(II)I
           18: invokestatic #24                // Method java/lang/Integer.valueOf:(I)Ljava/la
           21: areturn

    public final int invoke(int, int);
        Code:
            0: iload_1
            1: iconst_1
```

/// Ne croyez pas les benchmarks, faites les vous-même !

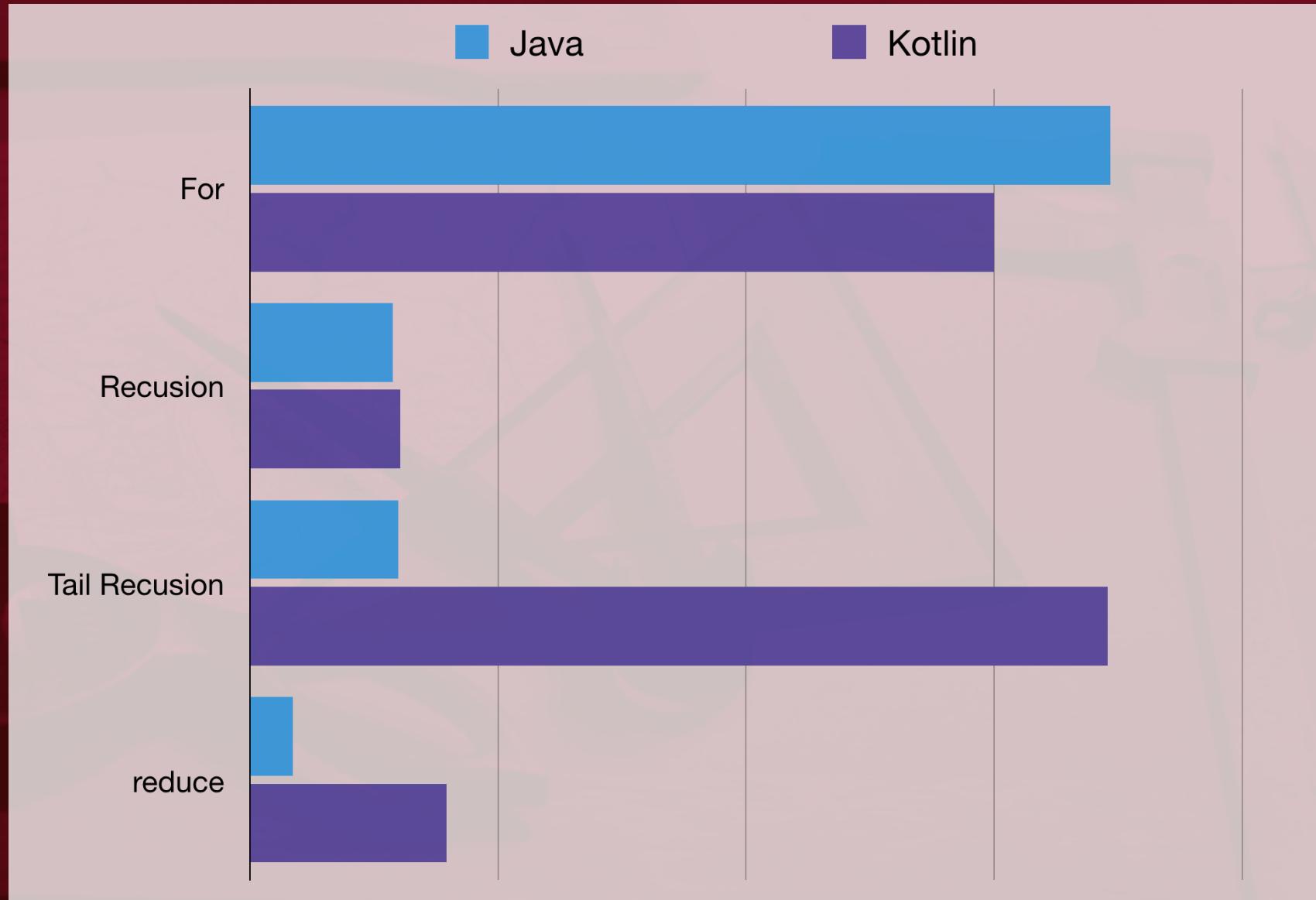


<https://github.com/MonkeyPatchlo/kotlin-perf>

Benchmark	Mode	Cnt	Score	Error	Units
factorialJavaFor	thrpt	200	433372258.508	± 1218796.228	ops/s
factorialKotlinFor	thrpt	200	374900724.013	± 1836466.839	ops/s
factorialJavaRec	thrpt	200	71945600.003	± 1621282.609	ops/s
factorialKotlinRec	thrpt	200	75889169.327	± 803516.130	ops/s
factorialJavaTailRec	thrpt	200	74708348.540	± 385285.112	ops/s
factorialKotlinTailRec	thrpt	200	432005903.950	± 2558012.821	ops/s
factorialJavaReduce	thrpt	200	21560855.907	± 586144.742	ops/s
factorialKotlinReduce	thrpt	200	99169022.775	± 2711794.007	ops/s

Performances sur 10! 2/2

#85



- Il y a aussi des `break` et `continue`, label pour les boucles
- `when` peut être utiliser avec
 - des constantes,
 - plusieurs valeurs séparées par `,`
 - une expression
 - avec `is` et un type (avec un 'smart cast')

✨ Tips

- privilégier les `when` si vous avez plus de 2 cas
- si vous faites des fonctions récursives, faites les `tailrec`

Extensions de fonctions

```
val AstronomicalBody.size: Int
    get() = name.length

fun AstronomicalBody.display() = "Body $name $size"

fun main(args: Array<String>) {
    SolarSystem.bodies
        .forEach { println(it.display()) }
}
```



extension.java



```
package _08_extension;

import astronomy.AstronomicalBody;
import astronomy.SolarSystem;
import java.util.Iterator;
import kotlin.Metadata;
import kotlin.jvm.internal.Intrinsics;
import org.jetbrains.annotations.NotNull;

@Metadata(
    mv = {1, 1, 9},
    bv = {1, 0, 2},
    k = 2,
    d1 = {"\u0000 \n\u0000\n\u0002\u0010\b\n\u0002\u0018\u0002\n\u0002\b\u0003\n\u0002",
    d2 = {"size", "", "Lastronomy/AstronomicalBody;", "getSize", "(Lastronomy/Astronomi
})

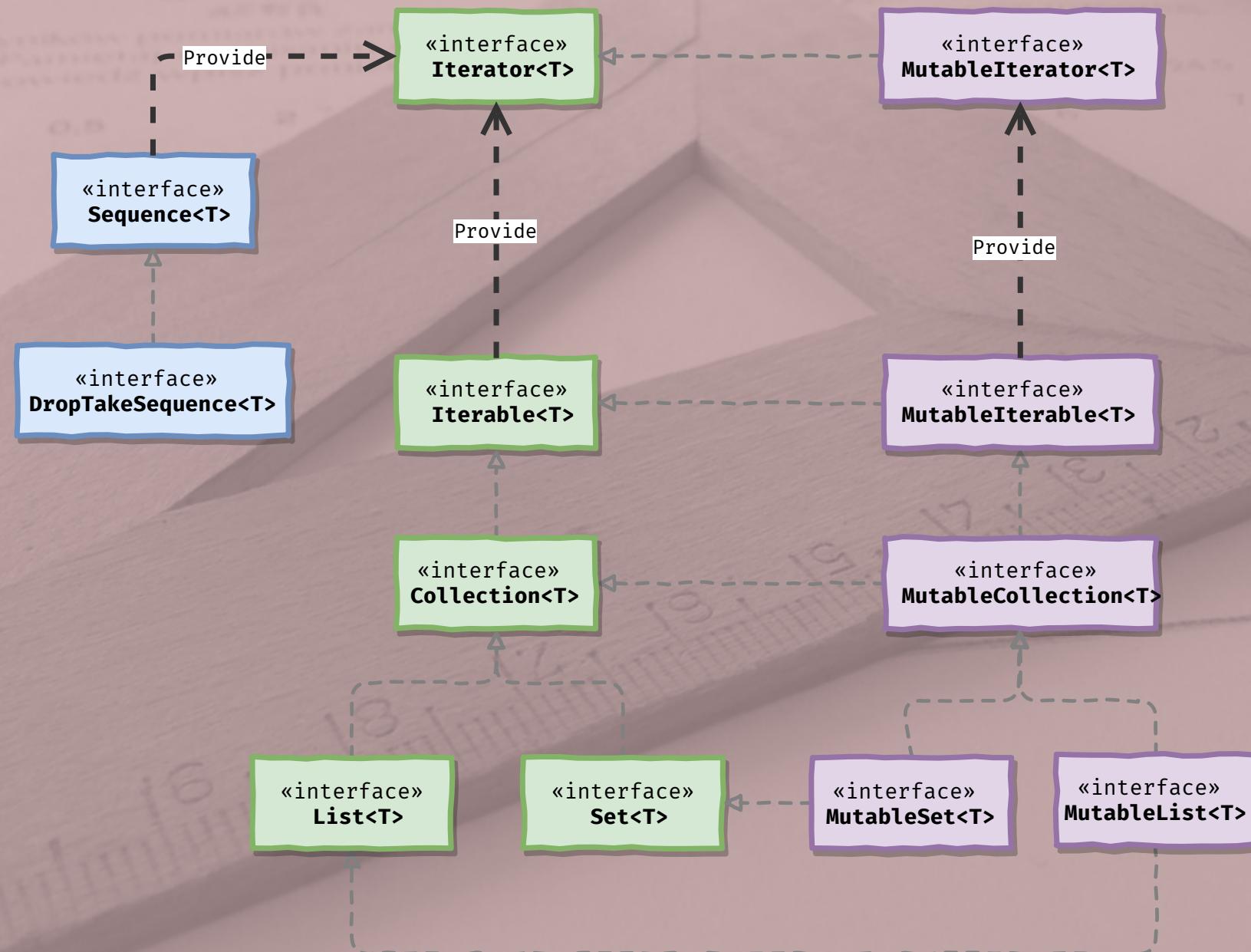
public final class ExtensionKt {
    public static final int getSize(@NotNull AstronomicalBody $receiver) {
        Intrinsics.checkNotNullParameter($receiver, "$receiver");
        return $receiver.getName().length();
    }
}
```

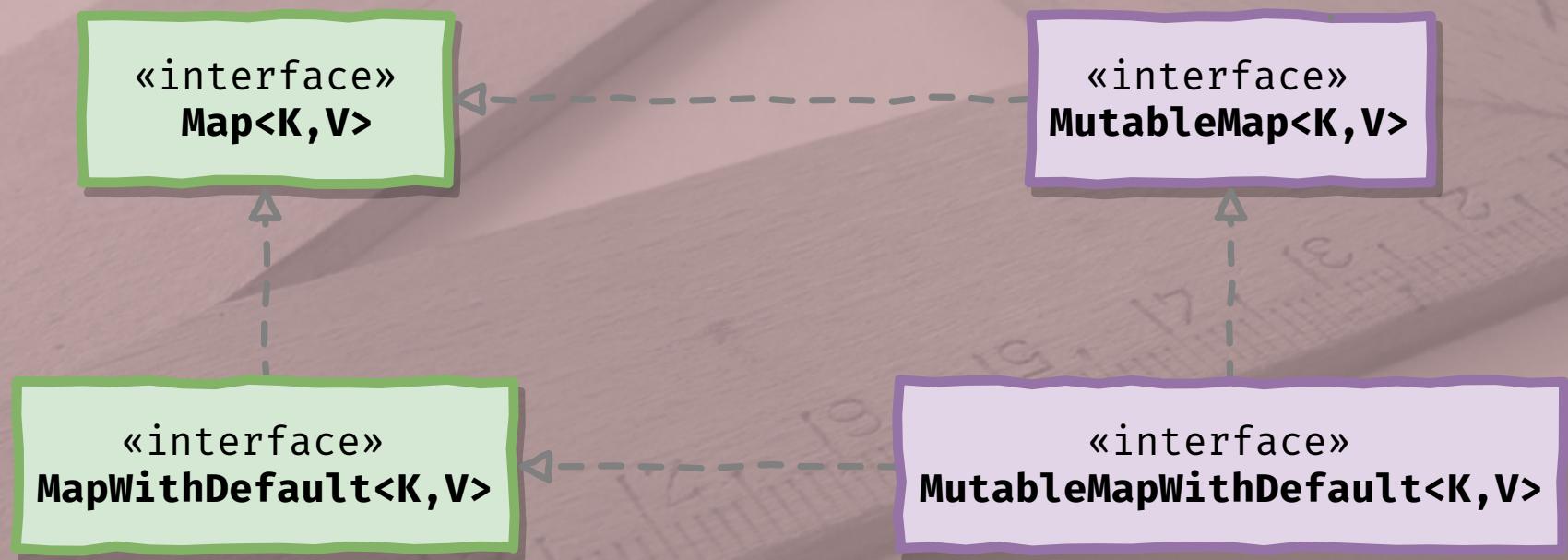
- Permet d'enrichir les APIs Java
 -  Spring
 -  RxKotlin
 -  SparkJava
 - ...
- Permet la SoC (Separation of Concerns)

Les collections

Collections

#92





```
val s = SolarSystem.bodies
    .filterIsInstance<Planet>()
    .flatMap { planet → planet.moons } // 🐱
    .filterNot { it.name.startsWith("S/") }
    .sortedBy { it.name }

//      .fold("") { acc, moon →
//          (if (acc == "") "" else "$acc,\n") + moon.name
//      }
    .joinToString(",\n") { it.name }

println(s)
```



immutable-mutable.kt

#95

```
fun main(args: Array<String>) {  
  
    val earthMoon = listOf(Moon("moon"))  
    val add = earthMoon + Moon("moon 2")  
  
    println("earthMoon: $earthMoon") // earthMoon: [Moon(name=moon)]  
    println("add: $add")           // add: [Moon(name=moon), Moon(name=moon 2)]  
    println("reference equality: ${earthMoon === add}") //reference equality: false  
  
    println("\n")  
    val earthMoon2 = mutableListOf(Moon("moon"))  
    val add2 = earthMoon2.add(Moon("moon 2"))  
  
    println("earthMoon2: $earthMoon2") // earthMoon2: [Moon(name=moon), Moon(name=moon 2)]  
    println("add2: $add2")           // add2: true  
}
```



break-immutable.kt

#96

```
fun main(args: Array<String>) {  
    val moons = (1..9).map { Moon("Moon #$it") }.toList()  
  
    println(moons.javaClass) // class java.util.ArrayList  
  
    moons.javaClass.methods  
        .find { it.name == "add" && it.parameterCount == 1 }  
        ?.invoke(moons, Moon("XXX"))  
  
    println(moons.joinToString("\n"))  
    // Moon(name=Moon #1)  
    // Moon(name=Moon #2)  
    // Moon(name=Moon #3)  
    // Moon(name=Moon #4)  
    // Moon(name=Moon #5)  
    // Moon(name=Moon #6)  
    // Moon(name=Moon #7)  
    // Moon(name=Moon #8)  
    // Moon(name=Moon #9)  
    // Moon(name=XXX)  
}
```



```
val s = SolarSystem.bodies.asSequence()  
    .filterIsInstance<Planet>()  
    .flatMap { planet → planet.moons.asSequence() } // 😺  
    .filterNot { it.name.startsWith("S/") }  
    .sortedBy { it.name }  
    .joinToString(",\n") { it.name }  
  
println(s)
```



 Ne croyez pas les benchmarks, faites les vous-même !

Benchmark	Mode	Cnt	Score	Error	Units
collectionApiClassic	thrpt	200	44535.029	± 3550.944	ops/s
collectionApiSequence	thrpt	200	23652.238	± 1967.535	ops/s

```
val s = SolarSystem.bodies.asSequence()  
    .filterIsInstance<Planet>()  
    .flatMap { planet → planet.moons.asSequence() } // 😺  
    .filterNot { it.name.startsWith("S/") }  
    .map { it.name }  
    .first()  
  
println(s)
```



 Ne croyez pas les benchmarks, faites les vous-même !

Benchmark	Mode	Cnt	Score	Error	Units
collectionApiClassicFirst	thrpt	200	241752.062	± 5022.663	ops/s
collectionApiSequenceFirst	thrpt	200	3615451.391	± 454502.198	ops/s

timed-sequence.kt

#101

```
fun <T> timed(block: () → T) {  
    val startTime = System.currentTimeMillis()  
    val result = block()  
    val endTime = System.currentTimeMillis()  
    val duration = endTime - startTime  
    val readable = String.format("%d min %02d seconds", duration / 60000, (duration % 60000)  
        .println("$result in $readable")  
}  
  
fun main(args: Array<String>) {  
    fun Long.toMB(): String =  
        "${this / 1048576}MB"  
  
    fun Runtime.usedMemory(): String =  
        (totalMemory() - freeMemory()).toMB()  
  
    fun Runtime.getMemoryInfo(): String =  
        "used: ${usedMemory()}, total: ${totalMemory().toMB()}"  
  
    timed {  
        (0 .. 1_000_000)
```



```
for (i in 1..3) print(i) // prints 123  
  
for (i in 3 downTo 1) print(i) // prints 321  
  
for (i in 1..5 step 2) print(i) // prints 135
```





```
package _11_collections_2;

import kotlin.Metadata;
import kotlin.jvm.internal.Intrinsics;
import kotlin.ranges.IntProgression;
import kotlin.ranges.IntRange;
import org.jetbrains.annotations.NotNull;

@Metadata(
    mv = {1, 1, 9},
    bv = {1, 0, 2},
    k = 2,
    d1 = {"\u0000\u0012\n\u0000\n\u0002\u0010\u0002\n\u0000\n\u0002\u0010\u0011\n\u0002\u0011"},
    d2 = {"main", "", "args", "", "", "([Ljava/lang/String;)V"}
)
public final class RangesKt {
    public static final void main(@NotNull String[] args) {
        Intrinsics.checkNotNull(args, "args");
        int i = 1;

        byte var2;
```

```
fun main(args: Array<String>) {  
    val aPair = "Earth" to "Moon" // ~ Pair("Earth", "Moon")  
    val (planet, moon) = aPair  
  
    val aTriple = Triple("Voyager 1", 1977, listOf("Jupiter", "Saturn"))  
    val (probeName, launchYear, flyOver) = aTriple  
}
```



```
package _11_collections_2;

import java.util.List;
import kotlin.Metadata;
import kotlin.Pair;
import kotlin.Triple;
import kotlin.collections.CollectionsKt;
import kotlin.jvm.internal.Intrinsics;
import org.jetbrains.annotations.NotNull;

@Metadata(
    mv = {1, 1, 9},
    bv = {1, 0, 2},
    k = 2,
    d1 = {"\u0000\u0012\n\u0000\n\u0002\u0010\u0002\n\u0000\n\u0002\u0010\u0011\n\u0002",
    d2 = {"main", "", "args", "", "", "([Ljava/lang/String;)V"}
)
public final class TuplesKt {

    public static final void main(@NotNull String[] args) {
        Intrinsics.checkNotNull(args, "args");
        Pair aPair = kotlin.TuplesKt.to("Earth", "Moon");
    }
}
```



- ❤️ Super on a de l'immutabilité, des map, flatMap, fold, aggregate,...
- 😐 Mais ça reste des collections Java
- ⚖️ Avant d'utiliser les Sequence, faites des mesures

Les delegates

```
import kotlin.properties.ReadOnlyProperty
import kotlin.reflect.KProperty

fun main(args: Array<String>) {
    val value: String by MyDelegateClass()
    println(value)
}

class MyDelegateClass : ReadOnlyProperty<Nothing?, String> {
    override operator fun getValue(thisRef: Nothing?,
                                  property: KProperty<*>) = "Hello Devoxx"
}
```



```
object DeepThought {  
    fun answer(): Int {  
        print("Computing ... ")  
        return 42  
    }  
}  
  
fun main(args: Array<String>) {  
  
    val ultimateQuestionOfLife: Int by lazy {  
        DeepThought.answer()  
    }  
    println("The Ultimate Question of Life, " +  
        "the Universe and Everything ?")  
    print("Answer: ")  
    println(ultimateQuestionOfLife)  
}
```



```
import kotlin.properties.Delegates

fun main(args: Array<String>) {

    var observable: String by Delegates.observable("Initial value") {
        _, old, new →
        println("$old → $new")
    }

    observable = "new value"
}
```



```
lateinit var str: String

fun main(args: Array<String>) {
    // println(str) kotlin.UninitializedPropertyAccessException
    str = "Hello Devoxx"
    println(str)
}
```



- Lazy : utile pour les propriétés qui ne sont pas systématiquement utilisées.
⚠ À manipuler avec précaution dans les activités Android (avec le cycle de vie, cela peut référencer une ancienne instance)
- Delegate : Observable, Not null, ...
- lateinit : évite les null check pour les propriétés qui ne peuvent être initialisées immédiatement (ex référence de vues sur **Activity**, **Fragment**).
 - Ne peut pas être utilisé avec les types primitifs

Un peu plus sur les fonctions

```
import java.time.Instant

class Logger(private val name: String) {
    private enum class Level { TRACE, DEBUG, INFO, WARN, ERROR, FATAL }
    private val level = Level.INFO

    fun info(message: () -> String) {
        log(Level.INFO, message)
    }

    private inline fun loglvl: Level, message: () -> String) { // inline
        if (level >= lvl) {
            println("[${level.name}] $name - ${message()}")
        }
    }
}

fun main(args: Array<String>) {
    val logger = Logger("Main")

    logger.info { "Time: ${Instant.now()}" }
```



Logger.java

#115



```
package _13_advanced_function;
```

```
import kotlin.Metadata;
import kotlin.jvm.functions.Function0;
import kotlin.jvm.internal.Intrinsics;
import org.jetbrains.annotations.NotNull;
```

```
@Metadata(
```

```
    mv = {1, 1, 9},
```

```
    bv = {1, 0, 2},
```

```
    k = 1,
```

```
    d1 = {"\u0000&\n\u0002\u0018\u0002\n\u0002\u0010\u0000\n\u0000\n\u0002\u0010\u000e\n\u0000"},
```

```
    d2 = {"L_13_advanced_function/Logger;", "", "name", "", "(Ljava/lang/String;)V", "level"}
```

```
)
```

```
public final class Logger {
```

```
    private final Logger.Level level;
```

```
    private final String name;
```

```
    public final void info(@NotNull Function0 message) {
```

```
        Intrinsics.checkNotNull(message, "message");
```

```
        Logger.Level lvl$iv = Logger.Level.INFO;
```



```
class Pojo {  
    var name: String? = null  
    override fun toString() = "Pojo $name"  
}  
  
object JavaBeanBuilder {  
  
    fun <T> createBean(clazz: Class<T>): T =  
        clazz.newInstance()  
  
    inline fun <reified T> createBean(): T =  
        createBean(T::class.java)  
}  
  
fun main(args: Array<String>) {  
    val p1 = Pojo()  
    p1.name = "Plop1"  
    println(p1)  
  
    val p2 = JavaBeanBuilder.createBean<Pojo>()  
    p2.name = "Plop2"
```

reified.java

#11?

```
package _13_advanced_function;

import kotlin.Metadata;
import kotlin.jvm.internal.Intrinsics;
import org.jetbrains.annotations.NotNull;

@Metadata(
    mv = {1, 1, 9},
    bv = {1, 0, 2},
    k = 2,
    d1 = {"\u0000\u0012\n\u0000\n\u0002\u0010\u0002\n\u0000\n\u0002\u0010\u0011\n\u0002",
    d2 = {"main", "", "args", "", "", "([Ljava/lang/String;)V"}
)
public final class ReifiedKt {
    public static final void main(@NotNull String[] args) {
        Intrinsics.checkNotNull(args, "args");
        Pojo p1 = new Pojo();
        p1.setName("Plop1");
        System.out.println(p1);
        JavaBeanBuilder this_$iv = JavaBeanBuilder.INSTANCE;
        Pojo p2 = (Pojo)this_$iv.createBean(Pojo.class);
```



Cas d'utilisation du `reified`

- Pour créer des extensions Kotlin des fonctions Java qui utilisent des `Class<T>`

Cas d'utilisation des `inline`, `noinline`, `crossinline`

- Quand on utilise `reified`
- Quand on sait se qu'on fait, 
<https://kotlinlang.org/docs/reference/inline-functions.html>

Conclusion

- Faible surcharge
- Support officiel par Google
-  Using Project Kotlin for Android
-  Kotlin Guide
-  android-ktx
-  Kotlin Android Extensions

- Supporté officiellement depuis  Spring 5,  Spring Boot 2
-  SparkJava,  javalin
-  Vert.x
-  KTor
- ...

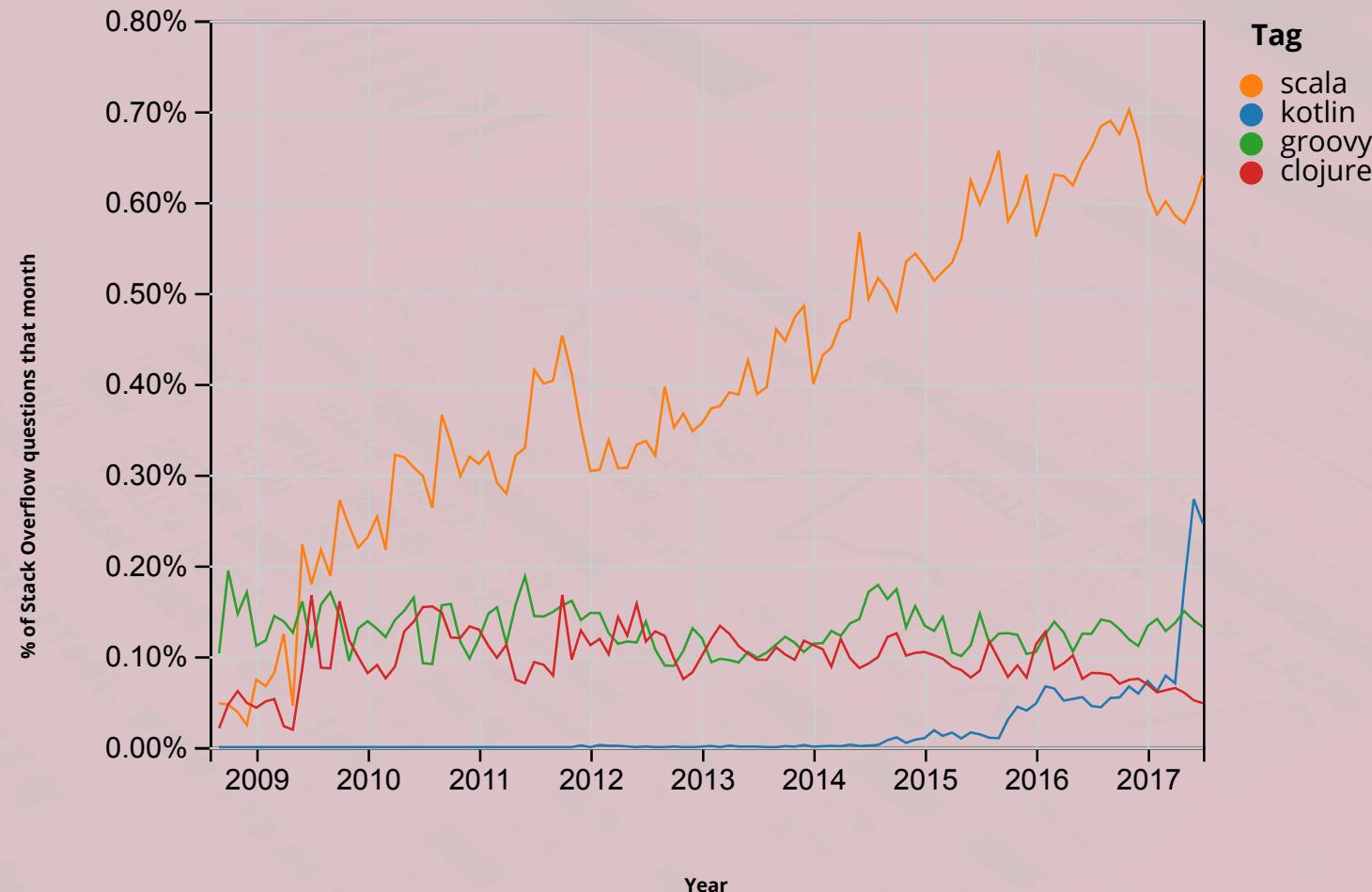
Web

- Partager du code commun
-  Use Kotlin with npm, webpack and react

Natif

- Faire des applications sans JVM
- Partager du code avec iOS
- WebAssembly

- 💎 JVM
- 😎 Le byte code c'est cool
- 🌟 Généralement, ça ne suffit pas pour prédire les performances
- ⚖ Mesurez !



Stackoverflow insights

- C'est déjà mature
- 🤝 Code plus expressif, plus sûr, plus simple
- 🤝 Interopérable avec Java
- 🤝 Outilage (éditeur, gradle, maven)
- 🤝 Ecosystème et communauté
- 🚀 Évolution rapide
- 🐚 Code multiplatform
- DSL

|| Kotlin réussit une belle alchimie entre pragmatisme, puissance, sûreté, accessibilité.

-  Référence
-  Blog
-  Forum
-  Slack
-  Koans
-  KEEP - Kotlin Evolution and Enhancement Process

- Slides en HTML: ➡ <http://bit.ly/KotlinDevoxxFR>
- Slides en PDF: ➡ <http://bit.ly/KotlinDevoxxFRpdf>
- 🐱 kotlin-perf
- 🐱 Kotlin by example
- 🐱 catnip

-  kotlinx.serialization
-  kotlinx.coroutines
-  KotlinTest
-  Javalin
-  RxKotlin
-  Arrow
- ...
-  Kotlin is Awesome

Questions ?

Pensez au votes et aux retours