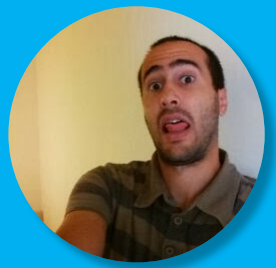
Deep Dive Kotlin : du Hello World au ByteCode



Emmanuel Vinas

Expert Android & Java

@emmanuelvinas

emmanuel@monkeypatch.io

Igor Laborie

Expert Java & Web

@ilaborie

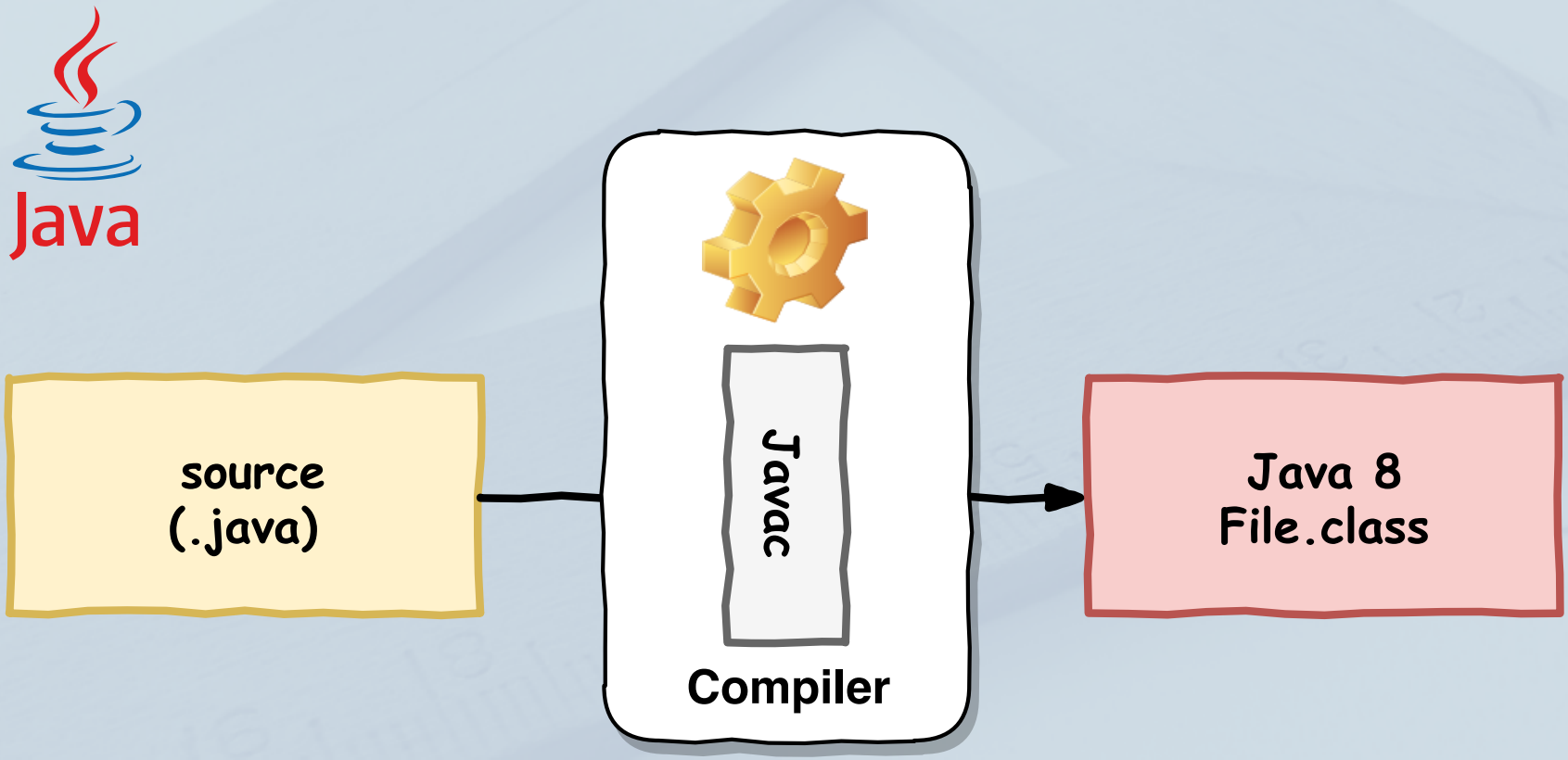
igor@monkeypatch.io

Roadmap

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. ByteCode Android
X. Autres structures
XI. Extensions de fonctions
XII. Les collections
XIII. Bonus
XIV. Conclusion

ByteCode Java ?

javac



HelloWorld.java

```java
package _00_helloworld;

public class HelloWorld {

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

```
$ javac HelloWorld.java
```


Java ByteCode binary


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

```
00000000  ca fe ba be 00 00 00 34  00 1d 0a 00 06 00 0f 09  |.......4........|
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  |.....<init>...()|
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 44  |.........Hello 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/io|
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  |.......*........|
```


Explorons le ByteCode

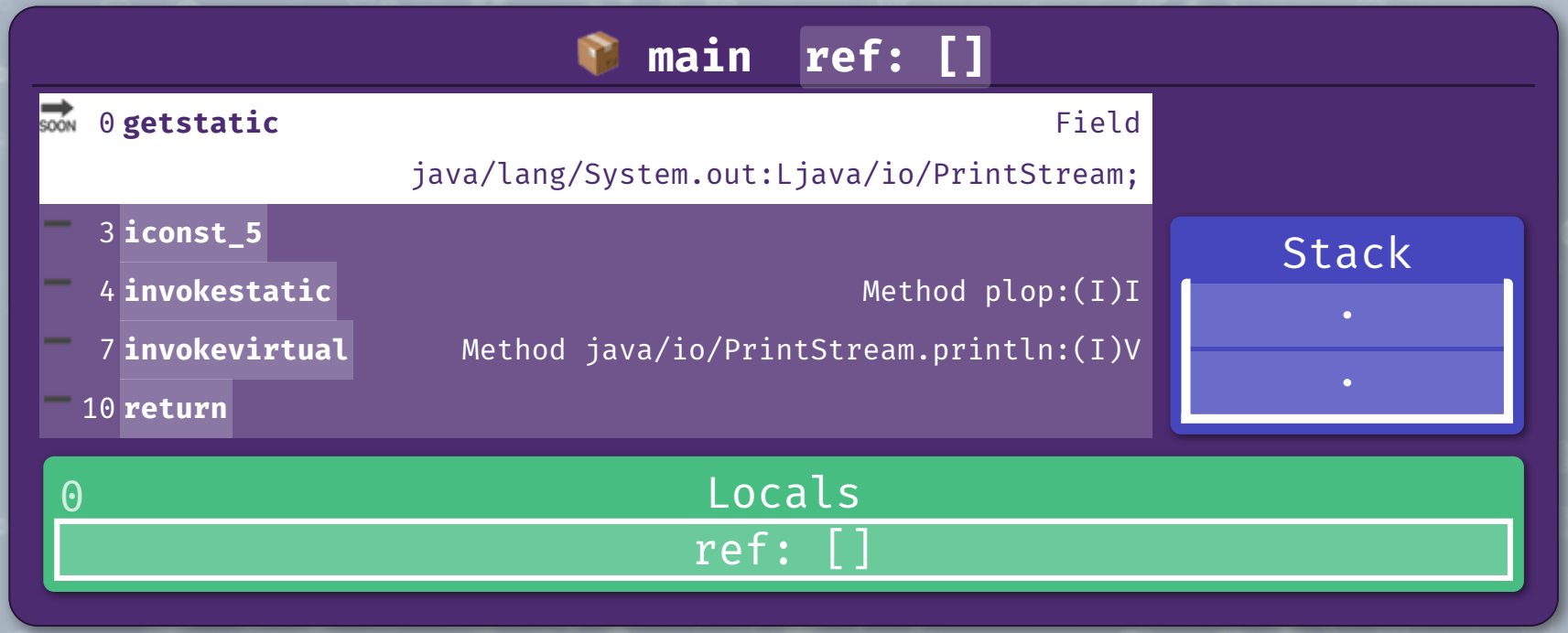

```
$ javap -c HelloWorld.class
```

```
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
}
```


Jouons un peu

▶ Constant Pool

▼ Frames



Liens

- ➳ 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


Dévoilé par JetBrains
v1.1 : coroutines, JS, ...
Support annoncé par Google
v1.2 : multiplatform
2011 - 2015
2016
2017
2018
...
v1.0
Support annoncé par Spring
Kotlin Native 0.7
v1.3 ?

Cibles

JVM et Android

JavaScript

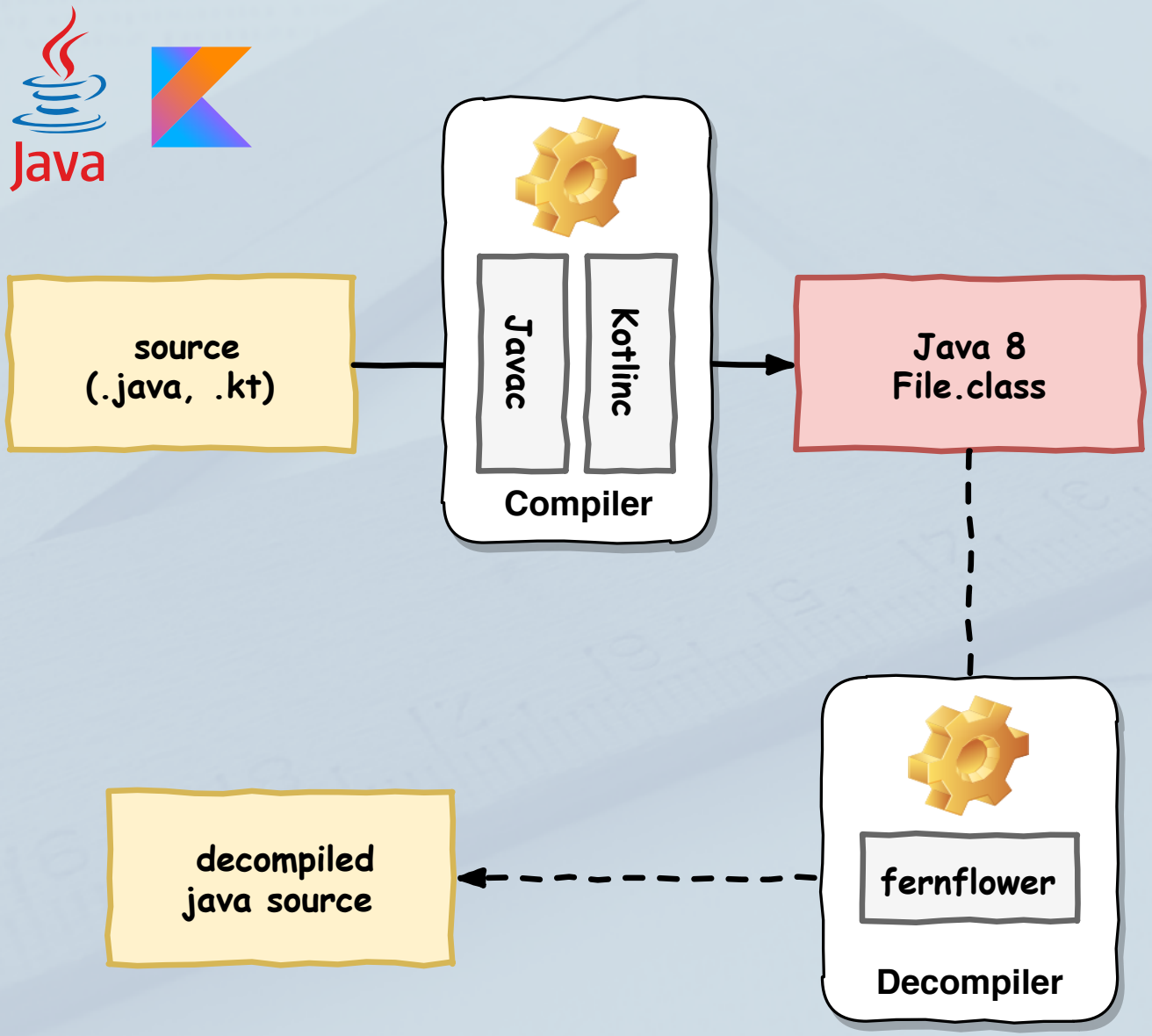
Native avec LLVM

HelloWorld.kt


```
package _00_helloworld

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

```
$ kotlinc HelloWorld.kt
```


kotlinc


Java
source
(.java, .kt)
Javac
Kotlinc
Compiler
Java 8
File.class
fernflower
Decompiler
decompiled
java source

hexdump


```
00000000  ca fe ba be 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/N|
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/Intrinsi|
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 Devo|
00000110  78 78 08 00 10 01 00 10  6a 61 76 61 2f 6c 61 6e  |xx......java/lan|
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;..|
```


Java ByteCode


```
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.checkP
       6: ldc           #17                 // String Hello Devoxx
       8: astore_1
       9: getstatic     #23                 // Field java/lang/System.out:Ljava/io/PrintStr
      12: aload_1
      13: invokevirtual #29                 // Method java/io/PrintStream.println:(Ljava/la
      16: return
}
```


HelloWorld-java

```java
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\u001
   d2 = {"main", "", "args", "", "", "([Ljava/lang/String;)V"}
)
public final class HelloWorldKt {
   public static final void main(@NotNull String[] args) {
      Intrinsics.checkParameterIsNotNull(args, "args");
      String var1 = "Hello Devoxx";
      System.out.println(var1);
   }
}
```


Bilan HelloWorld.kt

- 👮‍♂️ 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 ?

Performance HelloWorld.kt

> 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

val-var.kt

```kotlin
var x: Int = 10
val y: Int = 3
x += 4
// y += 4 ⟸ 💣 Compilation Error

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


string-template.kt


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

string-template.java

```java
package _01_basic;

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\f\n\u0000\n\u0002\u0010\u0002\n\u0000\n\u0002\u0018\u0002\u001a\u000e\u001
   d2 = {"greeting", "", "who", "L_01_basic/Someone;"}
)
public final class String_templatesKt {
   public static final void greeting(@NotNull Someone who) {
      Intrinsics.checkParameterIsNotNull(who, "who");
      String var1 = "Hello " + who + '!';
      System.out.println(var1);
      var1 = "Hello " + who.getFirstName() + ' ' + who.getLastName() + '!';
      System.out.println(var1);
```


ByteCode de string-template


```
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.checkP
       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
      18: aload_0
      19: invokevirtual #30                 // Method java/lang/StringBuilder.append:(Ljava
      22: bipush        33
      24: invokevirtual #33                 // Method java/lang/StringBuilder.append:(C)Lja
      27: invokevirtual #37                 // Method java/lang/StringBuilder.toString:()Lj
      30: astore_1
      31: getstatic     #43                 // Field java/lang/System.out:Ljava/io/PrintStr
      34: aload_1
```


numeric.kt


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

numeric.java

```
package _01_basic;

import kotlin.Metadata;

@Metadata(
   mv = {1, 1, 9},
   bv = {1, 0, 2},
   k = 2,
   d1 = {"\u0000\u0006\n\u0000\n\u0002\u0010\u0002\u001a\u0006\u0010\u0000\u001a\u00020\u00
   d2 = {"tryNumeric", ""}
)
public final class NumericKt {
   public static final void tryNumeric() {
      int anInt = true;
      long aLong = 42L;
      Double aDouble = (Double)null;
   }
}
```


ByteCode de numeric


```
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
}
```


C'est simple

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

null-safety

billion-dollar mistake

> I call it my *billion-dollar mistake*. It was the invention of the `null` reference in 1965. At that time, [...]. 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

null-safety.kt

```kotlin
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.KotlinNullPointerException

    // SmartCast
    something = "aString"
    length = something.length
}

fun something(): String? = null
```


null-safety.java

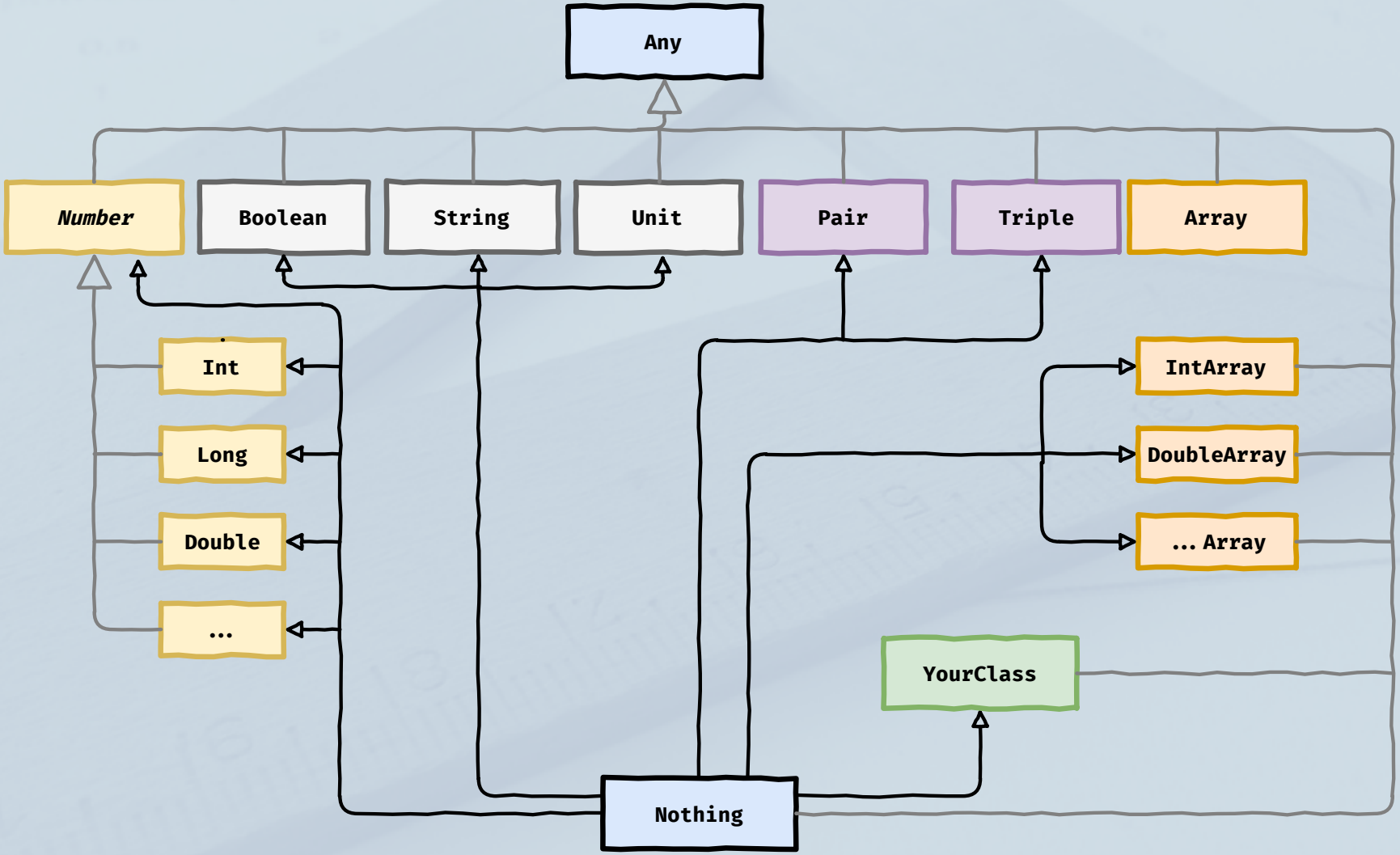
```java
package _02_null_safety;

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.checkParameterIsNotNull(args, "args");
      String somethingNotNull = "aString";
      int length = somethingNotNull.length();
      String something = (String)null;
```


Bilan null-safety

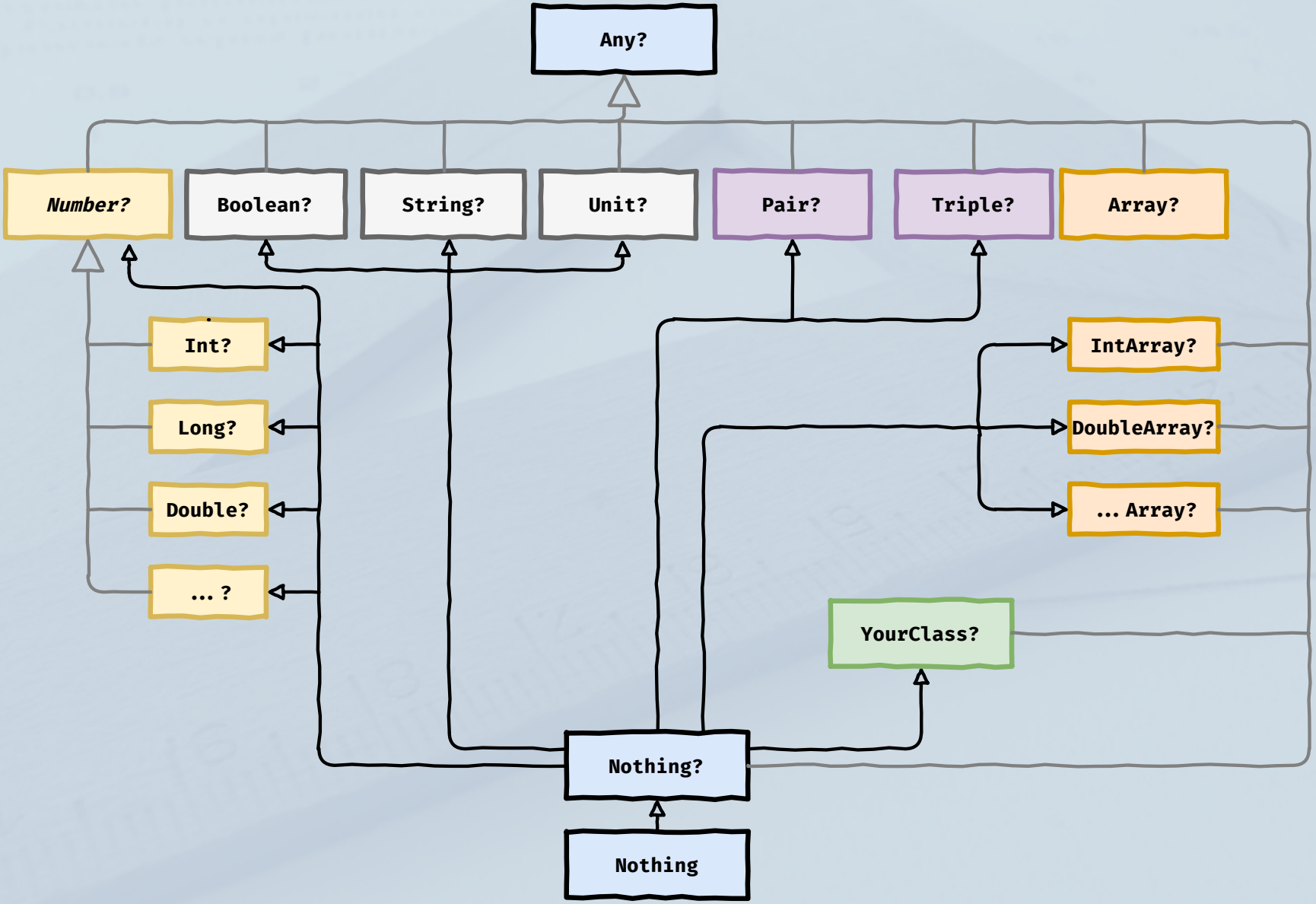
- 🎸 Elvis operator: `?:`
- 🙌 plus de `NullPointerException`
- ⚠️ quand on appel du Java

Les types

Types basiques



Types basiques nullable



```kotlin
fun `is P = NP`(): Boolean =
    TODO()

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

Hierarchie des types

- 🤝 le `TODO( )` est l'ami du TDD

Les fonctions

named-params.kt


```kotlin
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

```java
package _03_fun;

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\u0010\n\u0000\n\u0002\u0010\u000e\n\u0002\b\u0003\n\u0002\u0010\u000b\n\u0
   d2 = {"buildString", "", "prefix", "who", "enhanced", "", "greetings"}
)
public final class NamedKt {
   @NotNull
   public static final String buildString(@NotNull String prefix, @NotNull String who, bool
      Intrinsics.checkParameterIsNotNull(prefix, "prefix");
      Intrinsics.checkParameterIsNotNull(who, "who");
      String msg = "" + prefix + ' ' + who;
      if (enhanced) {
```


default-value.kt


```kotlin
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

```java
package _03_fun;

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\u0010\n\u0000\n\u0002\u0010\u000e\n\u0002\b\u0003\n\u0002\u0010\u000b\n\u0
   d2 = {"buildString2", "", "prefix", "who", "enhanced", "", "greetings2"}
)
public final class Default_valueKt {
   @NotNull
   public static final String buildString2(@NotNull String prefix, @NotNull String who, boo
      Intrinsics.checkParameterIsNotNull(prefix, "prefix");
      Intrinsics.checkParameterIsNotNull(who, "who");
      String msg = "" + prefix + ' ' + who;
      if (enhanced) {
```


ByteCode de default-value


```
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.checkP
       6: aload_1
       7: ldc           #17                 // String who
       9: invokestatic  #15                 // Method kotlin/jvm/internal/Intrinsics.checkP
      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
      24: aload_0
      25: invokevirtual #29                 // Method java/lang/StringBuilder.append:(Ljava
      28: bipush        32
      30: invokevirtual #32                 // Method java/lang/StringBuilder.append:(C)Lja
      33: aload_1
```


C'est fun !

✨ 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

```kotlin
// 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)
```


function.java

```
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\u001c\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;
```


lambda.kt

```kotlin
// 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 }
```


lambda.java

```
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
```


let.kt


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

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

let.java

```
package _04_lamda;

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\u001
   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
```


Les lambdas

- ⚠️ 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

```kotlin
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 = moons + moon)
    }
}

data class Moon(override val name: String) : AstronomicalBody

object SolarSystem {
    val earth = Planet(name = "Earth")
    val moon = Moon(name = "Moon")
```


astronomy.java

```java
package _05_class_1;

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

@Metadata(
   mv = {1, 1, 9},
   bv = {1, 0, 2},
   k = 1,
   d1 = {"\u00000\n\u0002\u0018\u0002\n\u0002\u0018\u0002\n\u0000\n\u0002\u0010\u000e\n\u00
   d2 = {"L_05_class_1/Planet;", "L_05_class_1/AstronomicalBody;", "name", "", "moons", "",
)
public final class Planet implements AstronomicalBody {
   @NotNull
   private final String name;
   @NotNull
```


Héritage en Kotlin

```kotlin
class SmallBody {
    fun sizeRange(): IntRange = 0..10
}

// Inherit SmallBody
data class Comet(val name: String)

// Inherit SmallBody
data class Asteroid(val name: String) {
    fun sizeRange(): IntRange = 0..4
}

fun main(args: Array<String>) {
    val bodies = listOf(Comet("Halley"), Asteroid("Adeona"))

//    bodies.forEach { body ->
//        println("$body: ${body.sizeRange()}")
//    }
}
```


Génériques

- ⚠️ 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

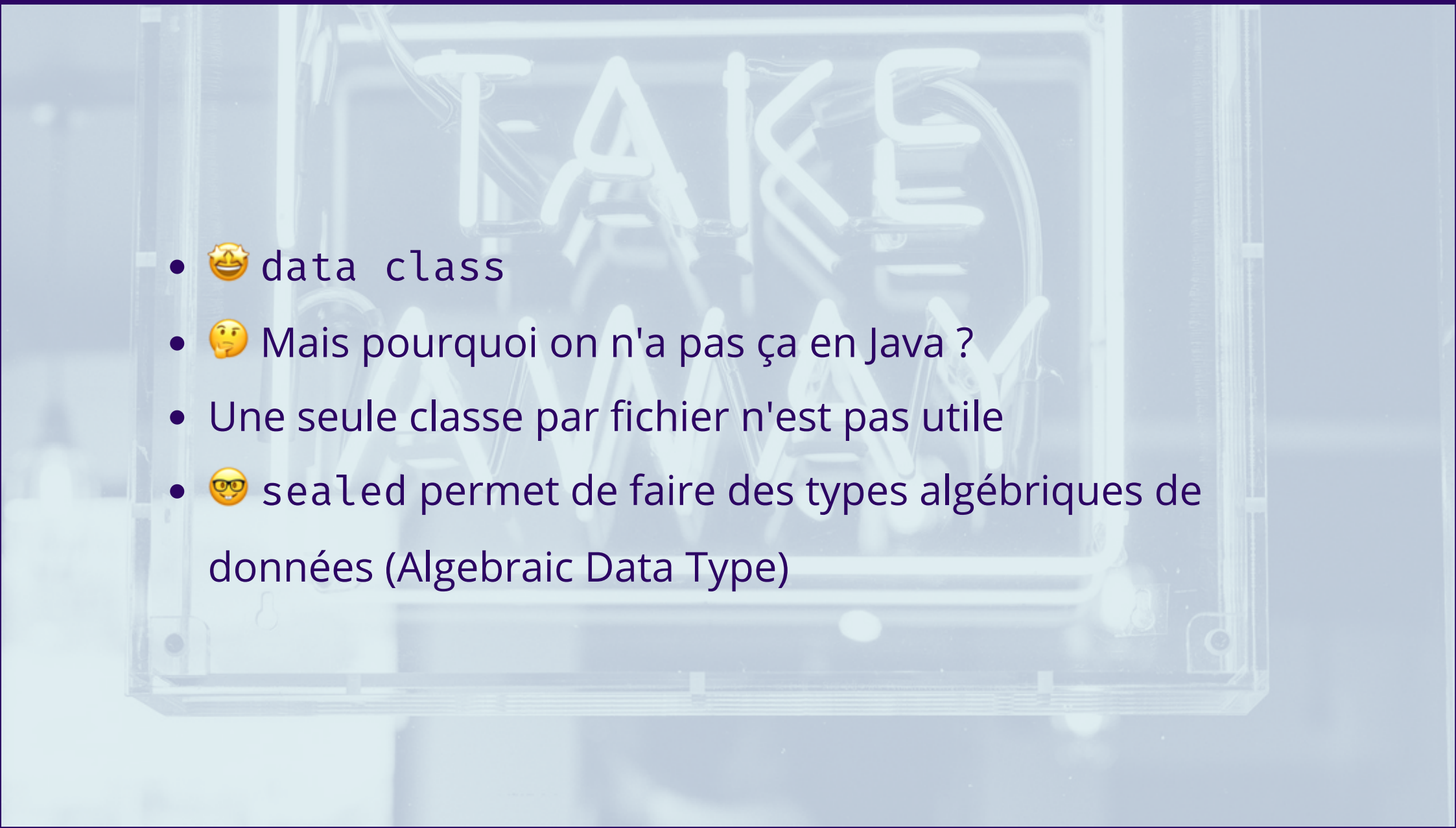
Sealed

```kotlin
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

```kotlin
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()
```

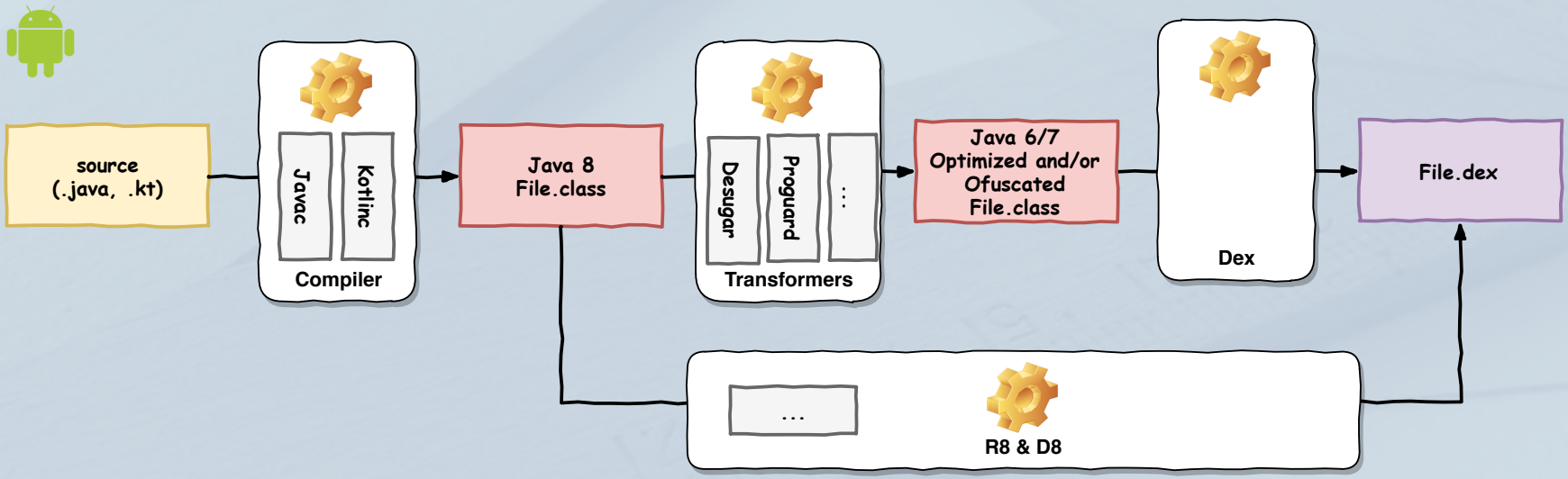

Classe, le bilan



- 🤩 `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)

ByteCode Android

Compilation pour Android



Dalvik EXecutable format

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 00  |....L.......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 00  |....Q...{.......
000000f0  d1 f6 07 00 0a f7 07 00  47 f7 07 00 84 f7 07 00  |........G.......
00000100  c1 f7 07 00 02 f8 07 00  43 f8 07 00 84 f8 07 00  |........C.......
00000110  f1 f8 07 00 12 f9 07 00  41 f9 07 00 6e f9 07 00  |........A...n...
```


dexdump


```
$ ~/.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      : 0×0011 (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        : 0×0019 (PUBLIC STATIC FINAL)
      code          -
```


```
$ 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*F\n+ 1 HelloWorld.kt\n_00_helloworld/He
.end annotation
.annotation runtime Lkotlin/Metadata;
  bv = {
    1,
    0,
    2
  }
  d1 = {
    "\u0000\u0012\n\u0000\n\u0002\u0010\u0002\n\u0000\n\u0002\u0010\u0011\n\u0002\u0010\u00
```


Autres structures

if-then-else.kt


```kotlin
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\u001
   d2 = {"main", "", "args", "", "", "([Ljava/lang/String;)V"}
)
public final class ForKt {
   public static final void main(@NotNull String[] args) {
      Intrinsics.checkParameterIsNotNull(args, "args");
      Iterator var2 = SolarSystem.INSTANCE.getBodies().iterator();
```


ByteCode du for


```
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.checkP
       6: getstatic     #21                 // Field astronomy/SolarSystem.INSTANCE:Lastron
       9: invokevirtual #25                 // Method astronomy/SolarSystem.getBodies:()Lja
      12: invokeinterface #31,  1           // InterfaceMethod java/util/Collection.iterato
      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:()Lj
      33: checkcast     #43                 // class astronomy/AstronomicalBody
      36: astore_1
      37: getstatic     #49                 // Field java/lang/System.out:Ljava/io/PrintStr
      40: aload_1
```


while-do.kt


```
while (x > 0) {
    x--
}

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

when.kt


```
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


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

rec-factorial.kt


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

tailrec-factorial.kt


```kotlin
// 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 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 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
```

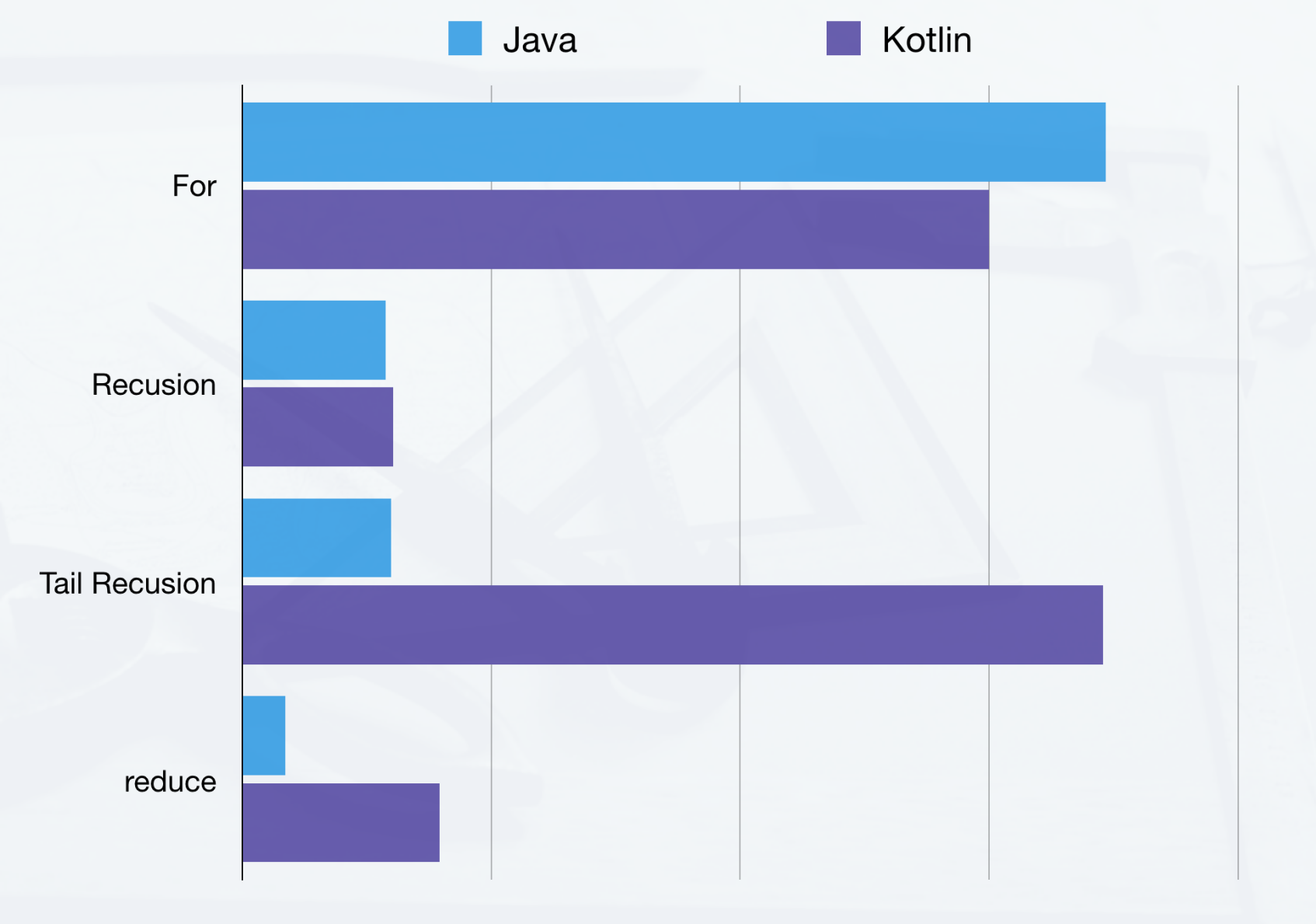

Performances sur 10! 1/2

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

https://github.com/MonkeyPatchIo/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



Bilan structures

- 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

extension.kt


```kotlin
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

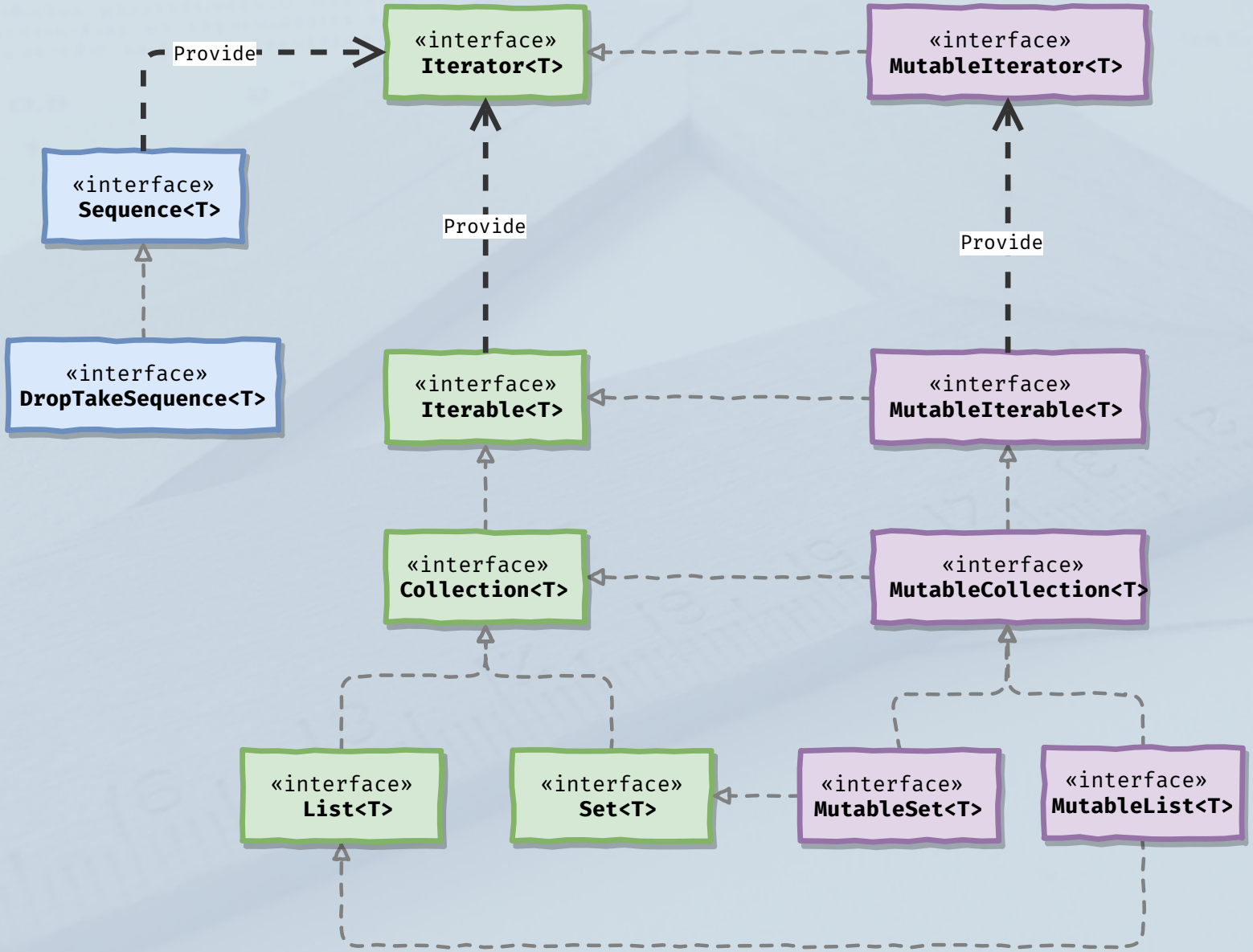
```java
package _08_extension;

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 $receiver) {
      Intrinsics.checkParameterIsNotNull($receiver, "$receiver");
      return $receiver.getName().length();
```


Extension

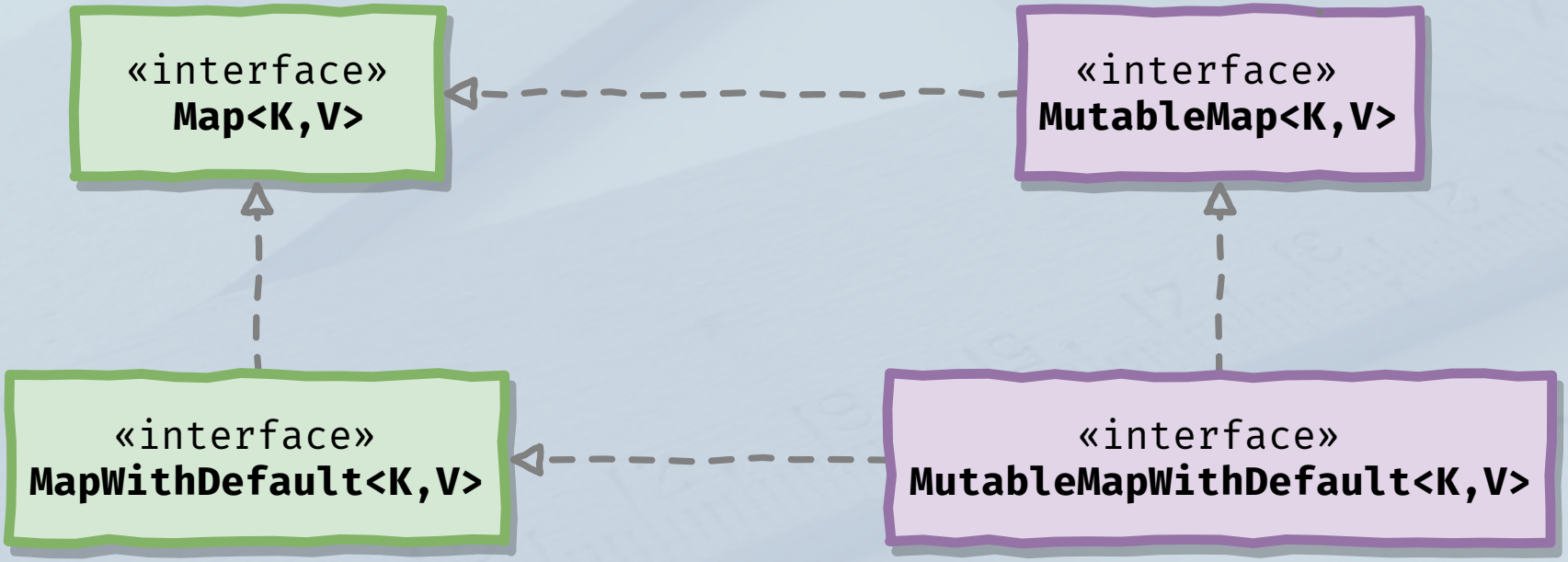
- Permet d'enrichir les APIs Java
  -  Spring
  -  RxKotlin
  -  SparkJava
  - ...
- Permet la *SoC* (Separation of Concerns)

Les collections

Collections



Les Maps


«interface»
Map<K,V>
«interface»
MutableMap<K,V>
«interface»
MapWithDefault<K,V>
«interface»
MutableMapWithDefault<K,V>

```kotlin
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)
```


sequence.kt


```kotlin
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)
```

Performance des sequences

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

https://github.com/MonkeyPatchIo/kotlin-perf

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

timed-sequence.kt

```kotlin
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 {
```


ranges.kt


```kotlin
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
```

tuples.kt


```kotlin
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 (probeNane, launchYear, flyOver) = aTriple
}
```


Bilan collection

- 💪 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

Bonus

delegate.kt

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

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

    // Lazy
    val ultimateQuestionOfLife: Int by lazy {
        DeepThought.answer()
    }
    println("The Ultimate Question of Life, " +
                    "the Universe and Everything ?")
    println("Answer: $ultimateQuestionOfLife" )

    // Observable
    var observable: String by Delegates.observable("Initial value") {
            _, old, new →
```


Delegate

- 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

```kotlin
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>()
```


Plus sur les fonctions

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`

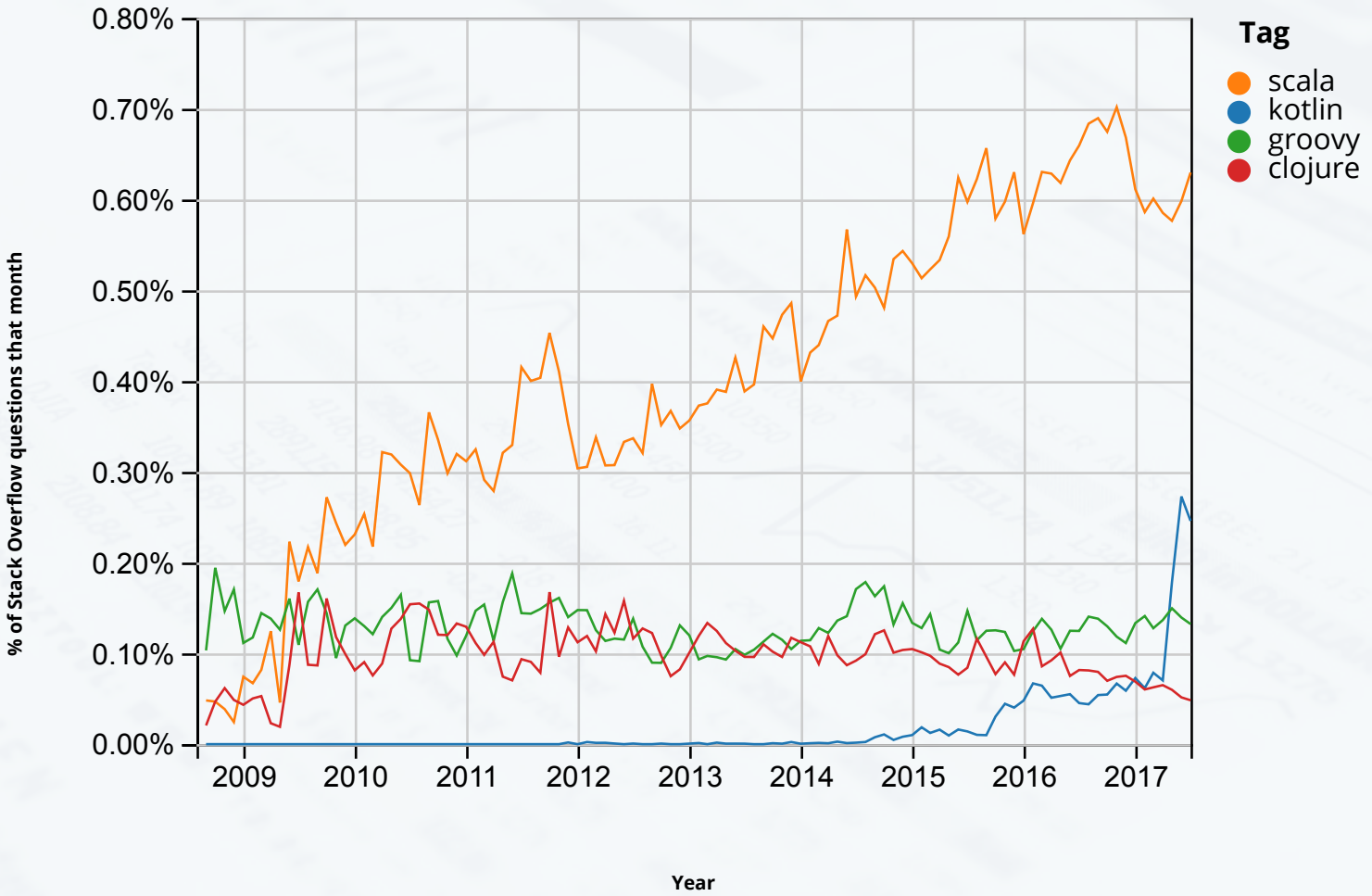
- Quand on utilise `reified`
- Quand on sait se qu'on fait, https://kotlinlang.org/docs/reference/inline-functions.html

Conclusion

Bilan

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

Tendance



Stackoverflow insights

Kotlin vs Java

- C'est déjà mature
- ✊ Code plus expressif, plus sûr, plus simple
- 🤝 Interopérable avec Java
- 👍 Outillage (editeur, gradle, maven)
- 👍 Ecosystème et communauté
- 🚀 Évolution rapide
- 🐣 Code multiplatform
- DSL

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

Liens

- Référence
- Blog
- Forum
- Slack
- Koans
- KEEP
- Multi Platform
- Kotlin Guide
- android-ktx
- Kotlin Android Extensions
- Spring 5, Spring Boot 2
- SparkJava, javalin, Vert.x
- KTor

Liens présentation

- Slides en PDF: https://ilaborie.github.io/slides/deepDiveKotlin/jug.pdf
- kotlin-perf
- Kotlin by example
- catnip

Bibliothèques

- kotlinx.serialization
- kotlinx.coroutines
- KotlinTest
- Javalin
- RxKotlin
- ∧rrow
- ...
- Kotlin is Awesome

Questions ou 🍕 & 🍻 ?