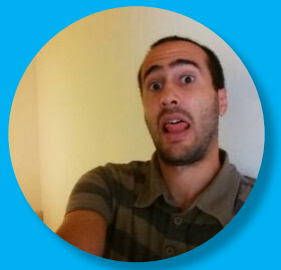
Deep Dive Kotlin : du Hello World au ByteCode

#DevoxxFR #Kotlin @emmanuelVinas @ilaborie

DEVOXX France



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Roadmap

I. ByteCode Java ?
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VI. Les fonctions
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ByteCode Java ?

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
```

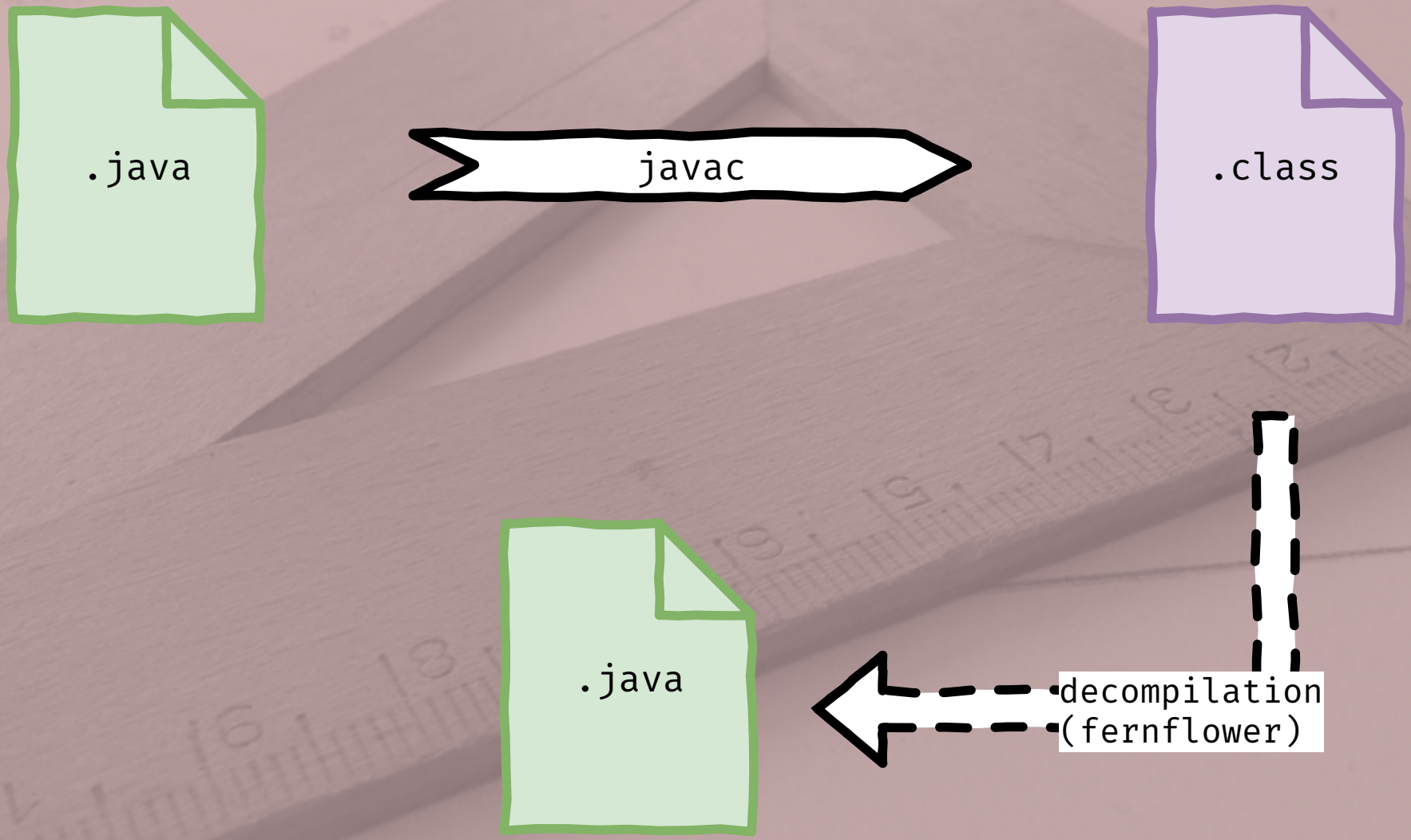
```
00000000  ca fe ba be 00 00 00 34  00 1d 0a 00 06 00 0f 09  |.......4........|
00000010  00 10 00 11 08 00 12 0a  00 13 00 14 07 00 15 07  |................|
00000020  00 16 01 00 06 3c 69 6e  69 74 3e 01 00 03 28 29  |.....<init>...()|
00000030  56 01 00 04 43 6f 64 65  01 00 0f 4c 69 6e 65 4e  |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/lan
       4: return

  public static void main(java.lang.String[]);
    Code:
       0: getstatic     #2                  // Field java/lang
       3: ldc           #3                  // String Hello De
       5: invokevirtual #4                  // Method java/io/
       8: return
}
```

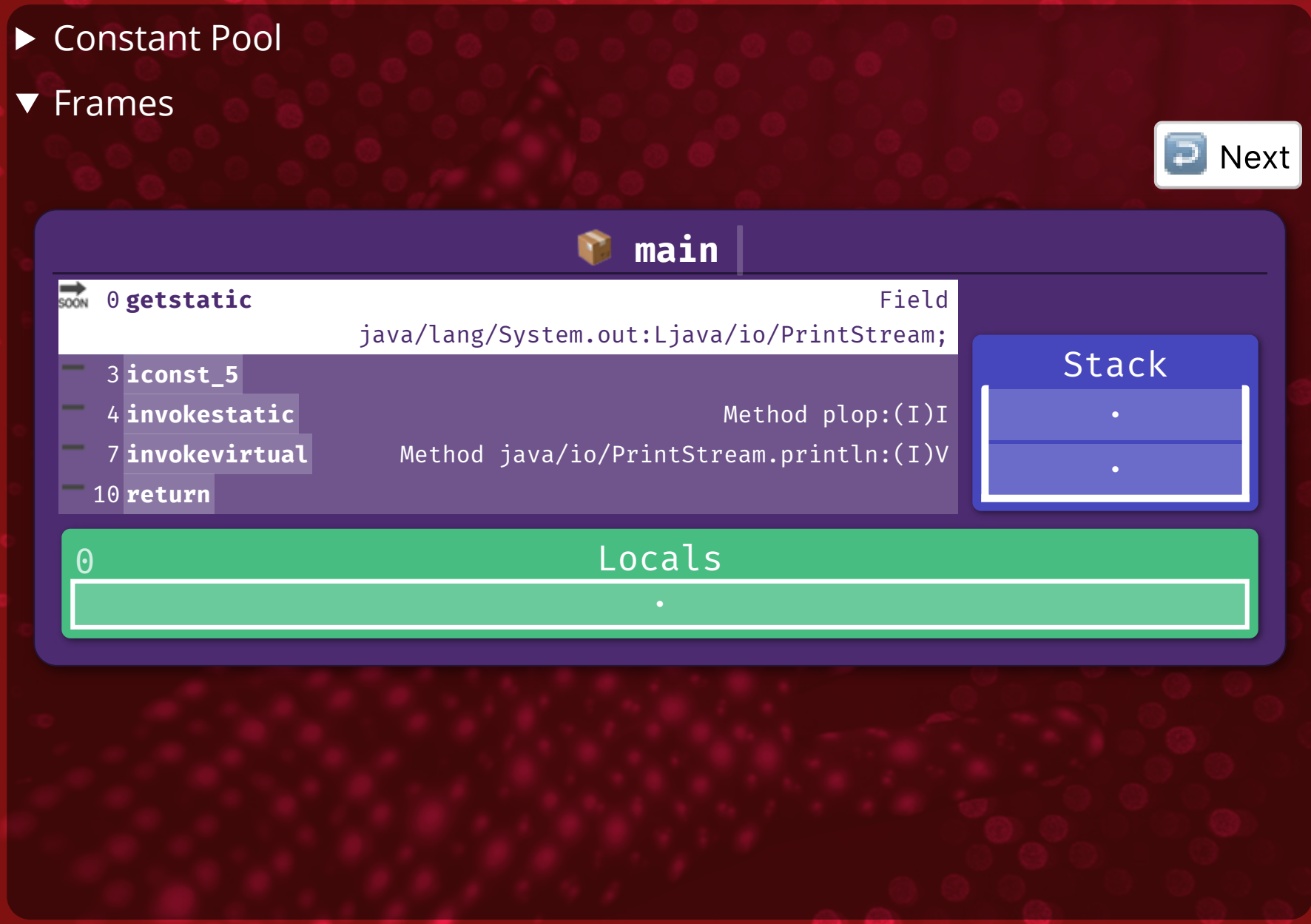
Transpile



À propos du ByteCode

- environ 200 opérations possibles (maxi. 256 opscodes)
- préfix pour le type d'opérations (`i` pour entier, `d` pour double, ...)
- manipulation de la pile, des variables locales (`iconst_0`, `istore`, `iload`, ...)
- controle du flux des instructions (`if_icmpgt`, `goto`, ...)
- manipulation d'objets (`invokevirtual`, `invokedynamic`, ...)
- arithmétiques et conversion de type (`iadd`, `iinc`, `i2d`, ...)
- autres (`athrow`, ...)

Jouons un peu



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

- ➳ Byte Buddy
- ➳ asm

> Soyez curieux: regardez comment ça marche avec `javap -c`

Introduction Kotlin

Historique

- **2011**

  Dévoilé par JetBrains
- **2016:**

  v1.0

  Supporté par Spring Framework
- **2017:**

  v1.1: coroutines, ...

  Officiellement supportée par Google

  v1.2: multiplatform
- **2018:**

  Kotlin Native (external) 0.6

Cibles

JVM et Android

JavaScript

Native avec
LLVM

HelloWorld.kt


```kotlin
package _00_helloworld

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

```
$ kotlinc HelloWorld.kt
```

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/
       6: ldc           #17                 // String Hello D
       8: astore_1
       9: getstatic     #23                 // Field java/lan
      12: aload_1
      13: invokevirtual #29                 // Method java/io/
      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\u
   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/MonkeyPatchIo/kotlin-perf

Benchmark	Mode	Cnt	Score	Error	Units
MyBenchmark.testJava	thrpt	200	66490.271	± 879.996	ops/s
MyBenchmark.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


```
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\u000
   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.getLas
      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/
       6: new           #17                 // class java/lang
       9: dup
      10: invokespecial #21                 // Method java/la
      13: ldc           #23                 // String Hello
      15: invokevirtual #27                 // Method java/la
      18: aload_0
      19: invokevirtual #30                 // Method java/la
      22: bipush        33
      24: invokevirtual #33                 // Method java/la
      27: invokevirtual #37                 // Method java/la
      30: astore_1
      31: getstatic     #43                 // Field java/lang
      34: aload_1
```

numeric.kt


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

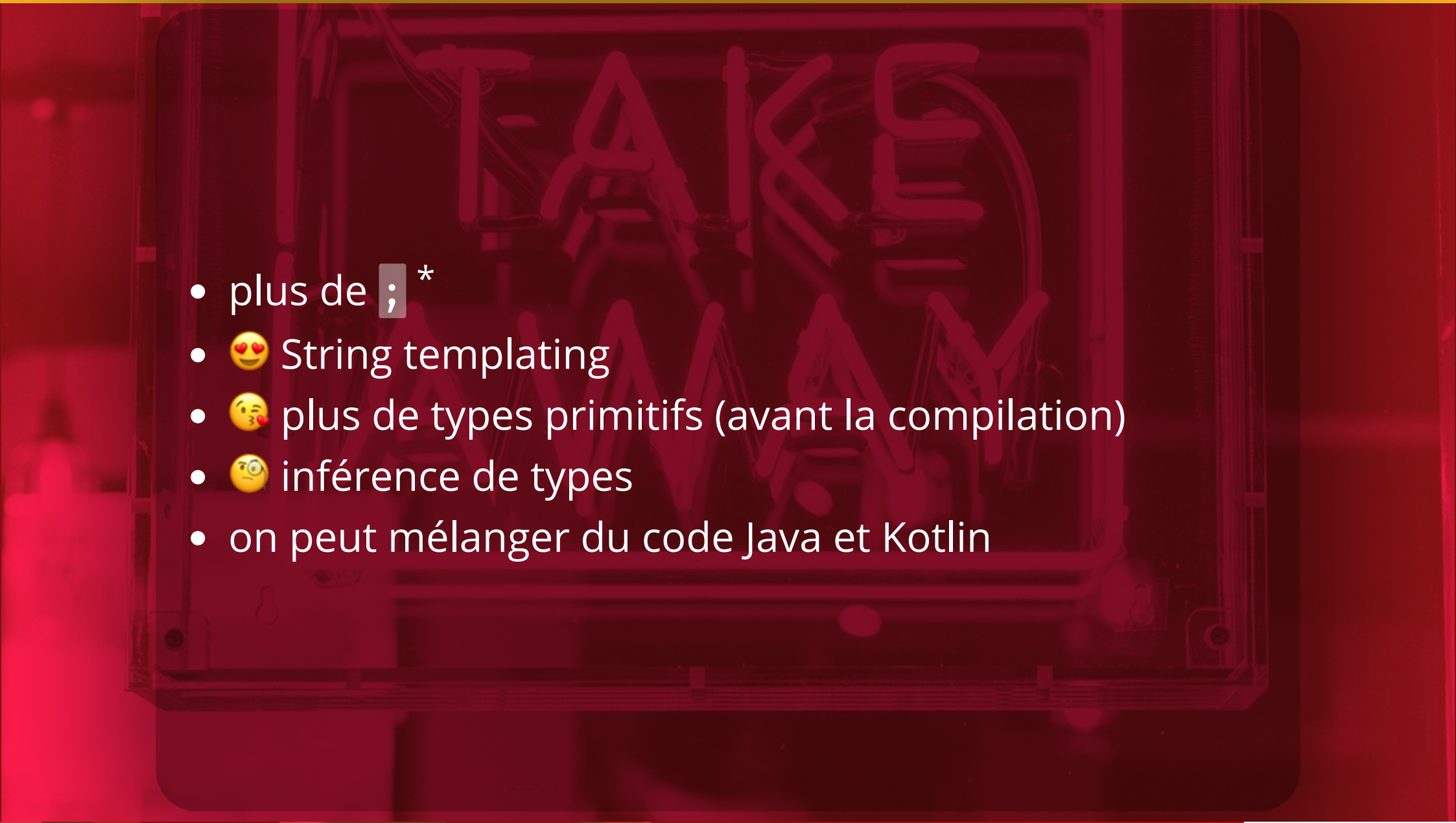
numeric.java

```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\u0000(
    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
      11: astore_3
      12: return
}
```

C'est simple



- plus de ; *
- 😍 String templating
- 😘 plus de types primitifs (avant la compilation)
- 🧐 inférence de types
- on peut mélanger du code Java et Kotlin

null-safety

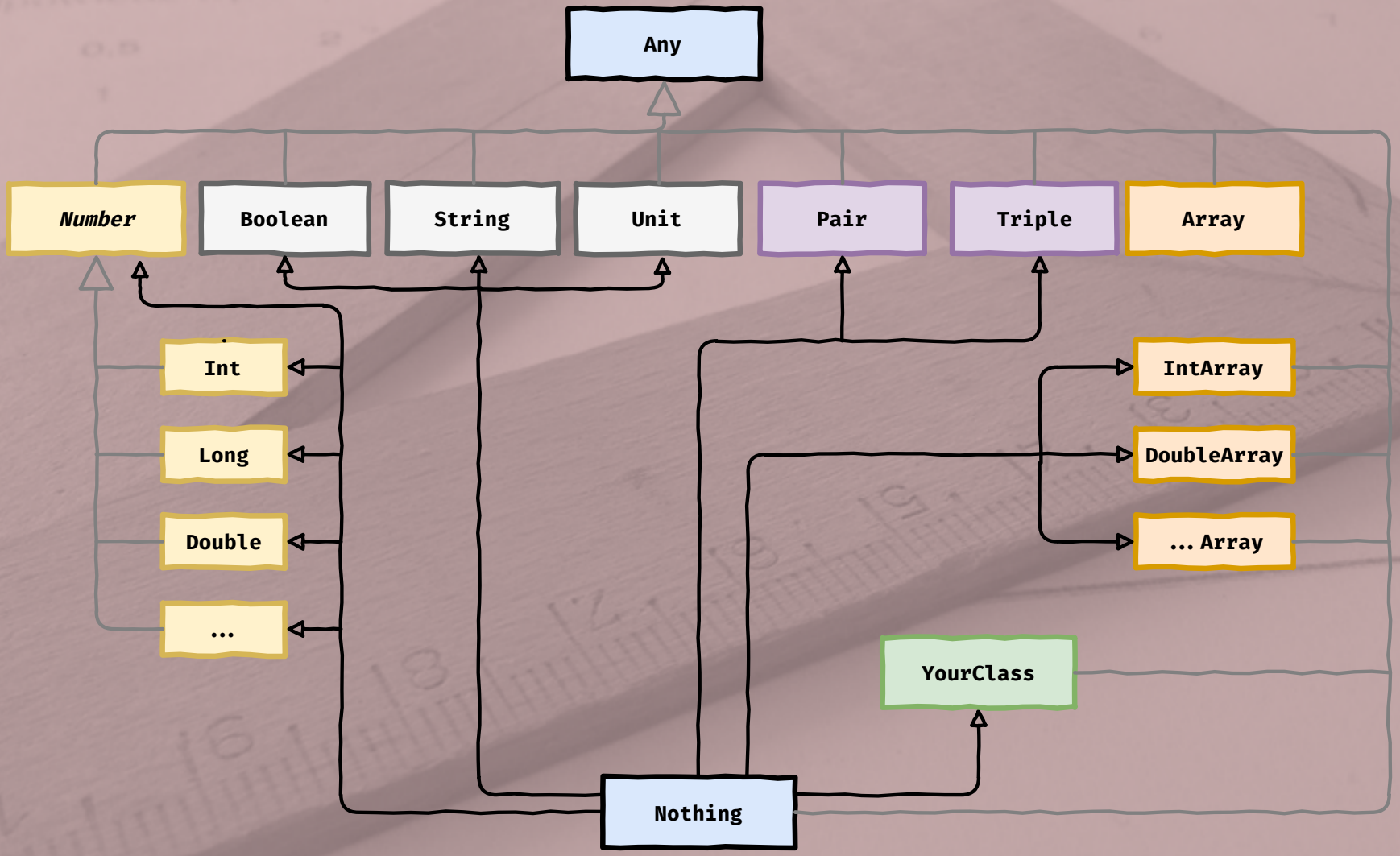
billion-dollar mistake

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

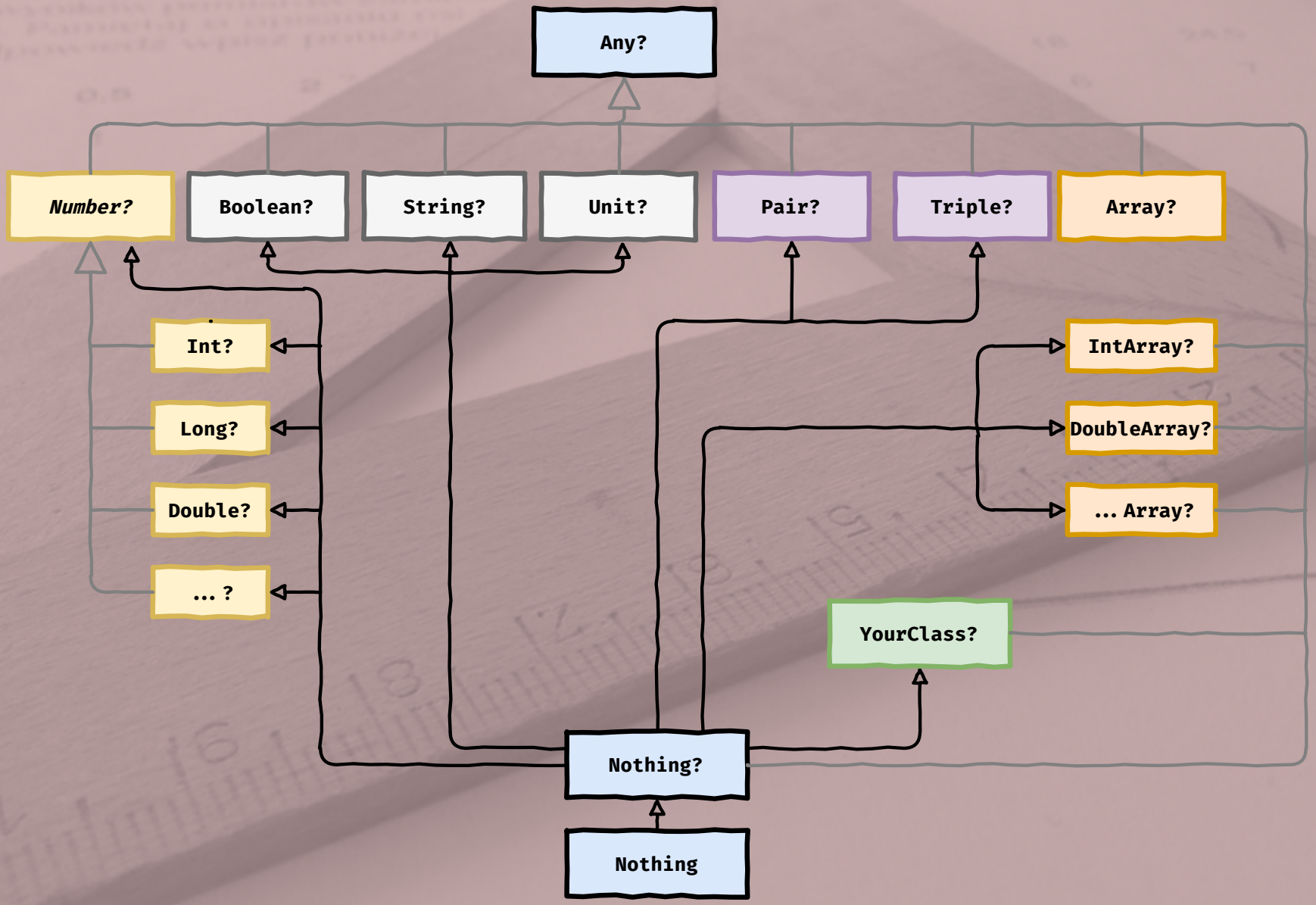
➳ Null References: The Billion Dollar Mistake

Les types

Types basiques



Types basiques nullable



todo.kt


```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 = "He
```

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\u
   d2 = {"buildString", "", "prefix", "who", "enhanced", "",
)
public final class NamedKt {
   @NotNull
   public static final String buildString(@NotNull String pre
      Intrinsics.checkParameterIsNotNull(prefix, "prefix");
      Intrinsics.checkParameterIsNotNull(who, "who");
      String msg = "" + prefix + ' ' + who;
      if (enhanced) {
```

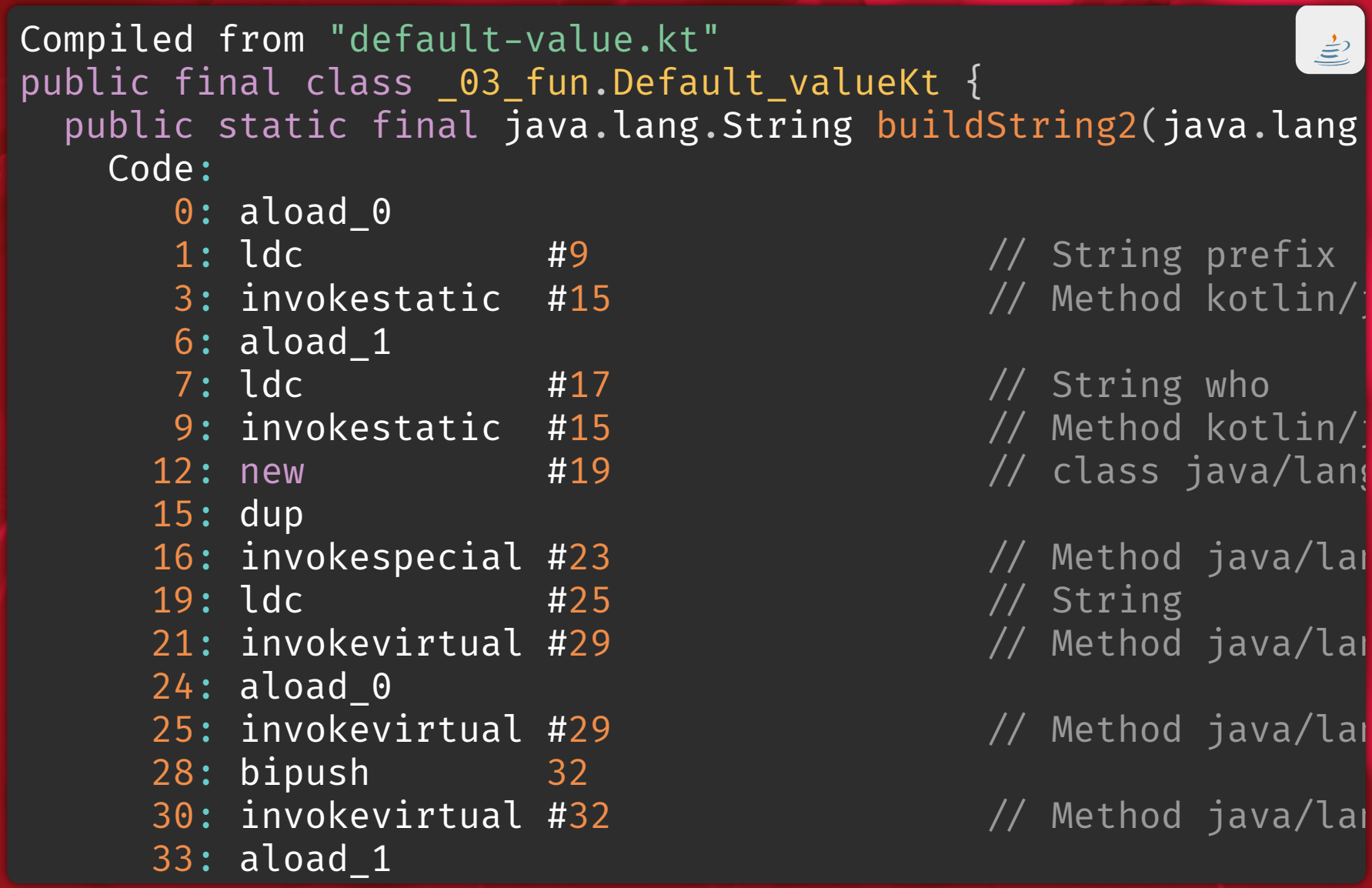
default-value.kt


```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\u
   d2 = {"buildString2", "", "prefix", "who", "enhanced", "",
)
public final class Default_valueKt {
   @NotNull
   public static final String buildString2(@NotNull String pre
      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
    Code:
       0: aload_0
       1: ldc           #9                  // String prefix
       3: invokestatic  #15                 // Method kotlin/
       6: aload_1
       7: ldc           #17                 // String who
       9: invokestatic  #15                 // Method kotlin/
      12: new           #19                 // class java/lang
      15: dup
      16: invokespecial #23                 // Method java/la
      19: ldc           #25                 // String
      21: invokevirtual #29                 // Method java/la
      24: aload_0
      25: invokevirtual #29                 // Method java/la
      28: bipush        32
      30: invokevirtual #32                 // Method java/la
      33: aload_1
```

✨ 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 ambigüités

📝 Notes

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

Les lambdas

Les lambdas

Les classes

Héritage en Kotlin

```kotlin
open class Animal { // need open
    open fun talk(): String =
        "???"
}

data class Cat(val name: String) : Animal() {
    override fun talk(): String = // need override
        "Meow"
}

data class Dog(val name: String) : Animal() {
    override fun talk(): String =  // need override
        "Woof"
}

fun main(args: Array<String>) {
    val pets: List<Animal> = listOf(Cat("Felix"), Dog("Rex"))

    // 😱
    pets.forEach { pet →
```

Génerics

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

Borne supérieur

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

Les détails:
https://kotlinlang.org/docs/reference/generics.html

Projection *


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

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

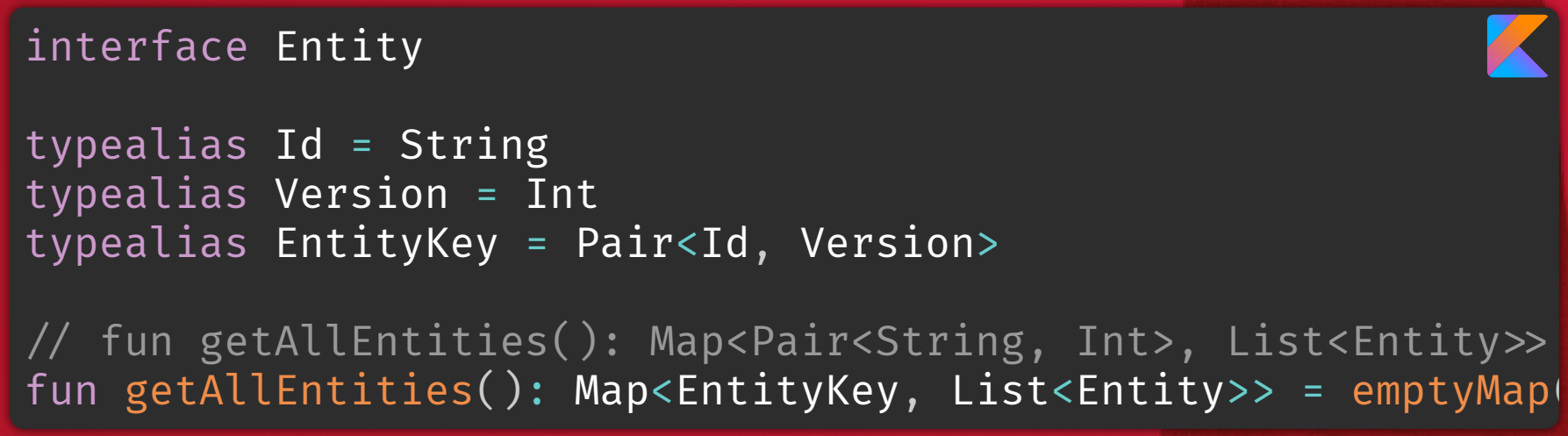
```
Function<Int, *> // correspond à Function<Int, out Any?>
```

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

Sealed


```kotlin
sealed class JsonValue

data class JsonObject(val attributes: Map<String, 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

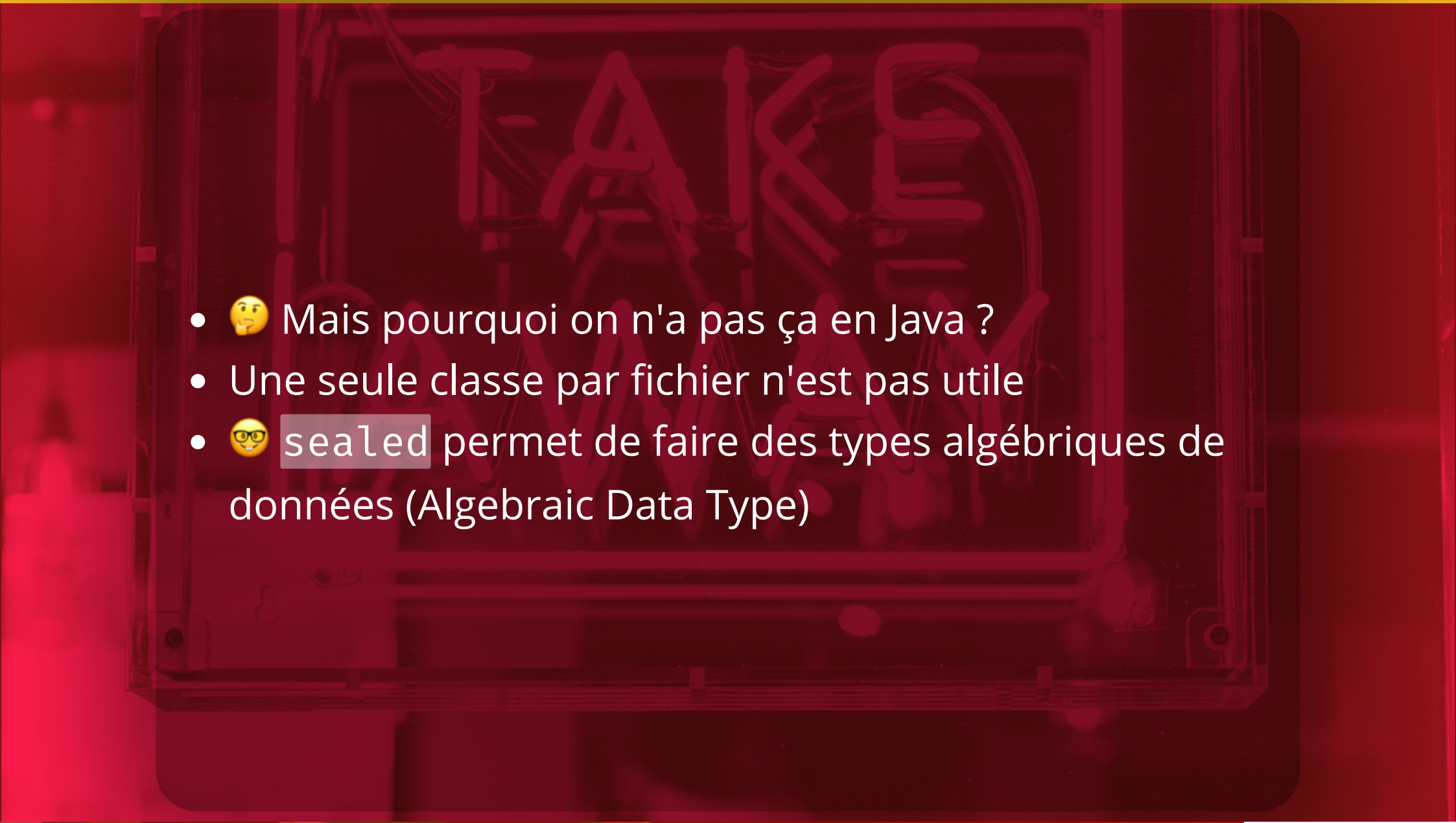


```kotlin
interface Entity

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

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

ByteCode d'alias


```
Compiled from "typealias.kt"
public final class _06_class_2.TypealiasKt {
  public static final java.util.Map<kotlin.Pair<java.lang.Str
    Code:
       0: invokestatic  #12                 // Method kotlin/
       3: areturn
}
```

Classe, le bilan



- 🤔 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)

Extensions de fonctions

Extension

Pause

ByteCode Android

Android ByteCode

ProGuard

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)
    }
}
```

```java
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\u
   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().iterat
```

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/
       6: getstatic     #21                 // Field astronomy
       9: invokevirtual #25                 // Method astronor
      12: invokeinterface #31,  1           // InterfaceMethod
      17: astore_2
      18: aload_2
      19: invokeinterface #37,  1           // InterfaceMethod
      24: ifeq          47
      27: aload_2
      28: invokeinterface #41,  1           // InterfaceMethod
      33: checkcast     #43                 // class astronomy
      36: astore_1
      37: getstatic     #49                 // Field java/lang
      40: aload_1
```

while-do.kt


```
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


```kotlin
// 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


```
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
```

rec-factorial.kt


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

ByteCode factoriel avec recursivité


```
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 recFacto
      16: imul
      17: ireturn
}
```

tailrec-factorial.kt


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

    tailrec fun aux(n: Int, acc: Int): Int =
        if (n < 1) 1 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_factorialK
  public static final int tailRecFactorial(int);
    Code:
       0: getstatic     #12                 // Field _09_struc
       3: astore_1
       4: aload_1
       5: iload_0
       6: iconst_1
       7: invokevirtual #16                 // Method _09_stru
      10: ireturn
}
```

ByteCode factoriel avec recursivité terminal 2/2


```
Compiled from "tailrec-factorial.kt"
final class _09_structures.recusion.Tailrec_factorialKt$tailRe
  public static final _09_structures.recusion.Tailrec_factoria

  public java.lang.Object invoke(java.lang.Object, java.lang.(
    Code:
       0: aload_0
       1: aload_1
       2: checkcast     #11                 // class java/lang
       5: invokevirtual #15                 // Method java/la
       8: aload_2
       9: checkcast     #11                 // class java/lang
      12: invokevirtual #15                 // Method java/la
      15: invokevirtual #18                 // Method invoke:(
      18: invokestatic  #24                 // Method java/la
      21: areturn

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

Performances sur 10!

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

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

Benchmark	Mode	Cnt	Score	Error	Units
MyBenchmark.factorialJava	thrpt	200	274141213.561	± 28963758.069	ops/s
MyBenchmark.factorialKotlinFor	thrpt	200	267717955.205	± 8457315.205	ops/s
MyBenchmark.factorialKotlinRec	thrpt	200	56270660.700	± 2453418.383	ops/s
MyBenchmark.factorialKotlinTailRec	thrpt	200	341898899.761	± 11456349.191	ops/s

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 recursives, faites les `tailrec`

Les collections

```
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

```kotlin
fun main(args: Array<String>) {

    val earthMoon = listOf(Moon("moon"))
    val add = earthMoon + Moon("moon 2")

    println("earthMoon: $earthMoon") // earthMoon: [Moon(name=
    println("add: $add")             // add: [Moon(name=moon)
    println("reference equality: ${earthMoon === add}") //refe

    println("\n")
    val earthMoon2 = mutableListOf(Moon("moon"))
    val add2 = earthMoon2.add(Moon("moon 2"))

    println("earthMoon2: $earthMoon2") // earthMoon2: [Moon(na
    println("add2: $add2")             // add2: true
}
```

break-immutable.kt

```kotlin
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)
```

Bilan collection

- Super on a de l'immutabilité, des `map`, `flatMap`, `fold`, `aggregate`...
- Mais ça reste des collections Java

Les delegates

Delegate

Un peu plus sur les fonctions

inline.kt

```kotlin
import java.time.Instant

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

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

    private inline fun log(lvl: Level, message: () → String)
        if (level ≥ lvl) {
            println("[${level.name}] $name - ${message()}")
        }
    }
}

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

Logger.java

```java
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\u(
   d2 = {"L_13_advanced_function/Logger;", "", "name", "", "(I
)
public final class Logger {
   private final Logger.Level level;
   private final String name;

   public final void info(@NotNull Function0 message) {
      Intrinsics.checkParameterIsNotNull(message, "message");
```

reified.kt

```
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"
    println(p2)
```

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`

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

Conclusion

- Faible surchage
- Support officiel par Google
- Using Project Kotlin for Android
- Kotlin Guide
- Kotlin extensions for Android

Serveur

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

Web et Natif

Web

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

Natif

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

Kotlin vs Java

- JVM : 💎
- Déjà mature
- Code plus expressif, plus sûr, plus simple
- Interopérable avec Java
- Outillage (editeur, gradle, maven)
- Ecosystème et communauté

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

Liens

- Référence
- Blog
- Forum
- Slack
- Koans
- Kotlin by example

Bibliothèques

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

Questions ?

Pensez au votes et aux retours