The Present and the Future of Java

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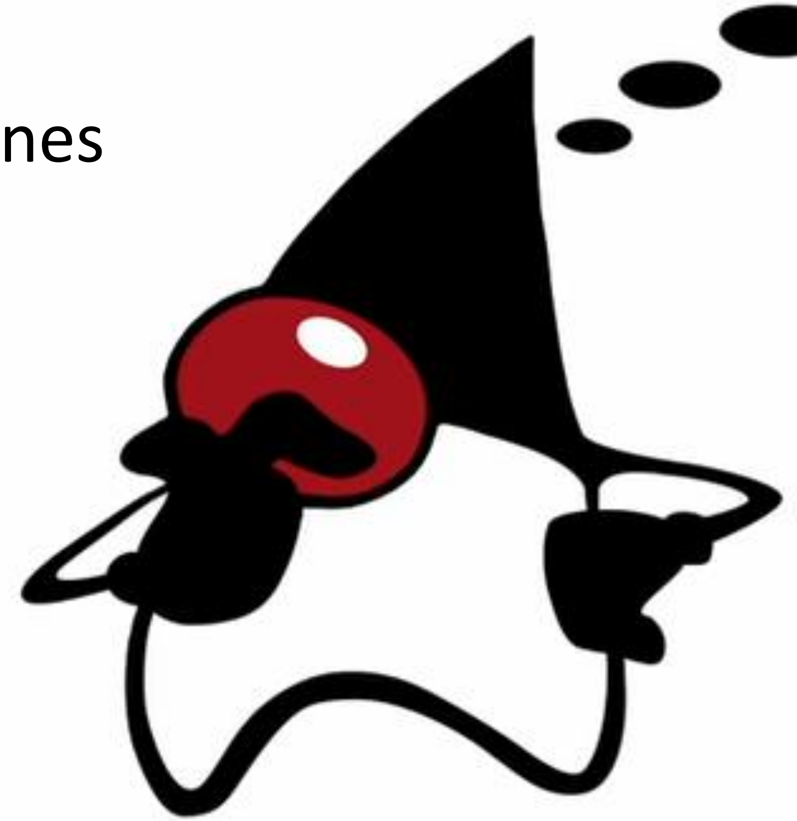
HUJAK

Assessing the New Development Landscape

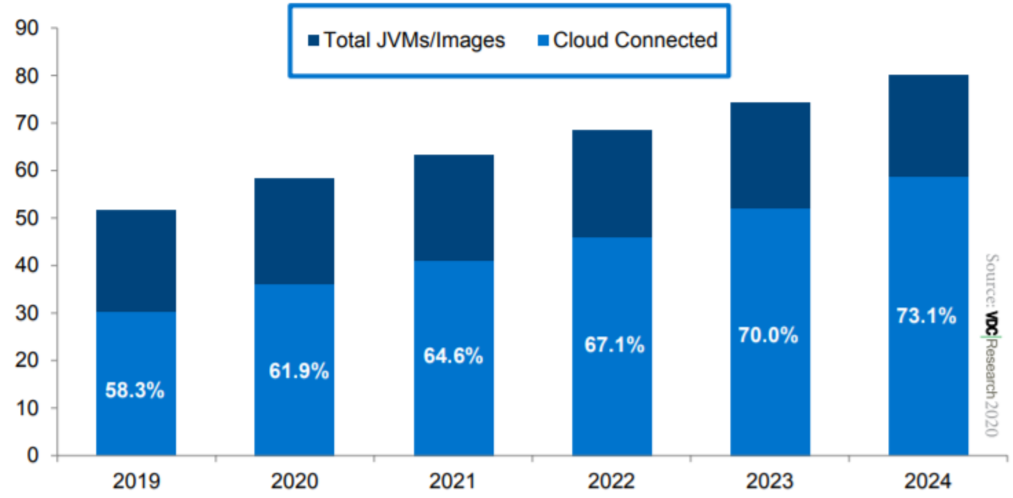
- New programming **languages**, programming **polyglotism & interoperability**
- New software development **paradigms**
- New **frameworks** or new (different) versions of old ones
- Changing hardware and software **architectures**
- Modern application **solutions**
- Variety of **deployment models**
- **Cloud**-everywhere
- **Micro**services
- Anything/everything-**as-a-service**



Java **Facts**

- **#1 Development Platform**
  - **Continued growth** for **27+ years**
- **#1 Programming Language**
- **A Few Dozen Billion Devices** run **Java**
- **56 Billion Active JVMs**
  - **64%** are **Cloud**-based JVMs
  - Expected to grow at over **9% per year** over the next 5 years

#1 Analytics	#3 Artificial intelligence	#2 Augmented reality/virtual reality	#1 Big data	#2 Blockchain/ distributed hyperledger	#1 Chatbots	#1 Continuous integration dev tools
#1 Data management	#1 DevOps	#2 Internet of Things	#1 Microservices	#1 Mobile	#2 Security	#1 Social



Source: Addressing Next-Generation Development with Java, Chris Rommel, VDC https://www.oracle.com/a/ocom/docs/2020-oracle-wp-next-generation-development-vdc.pdf

Why do we (still) use Java and JVM?

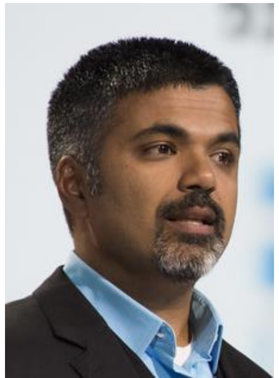
- **Openness** and **Platform Independence**
- Community **Acceptance** and **Familiarity**
- Variety of **Tools, Libraries** and **Frameworks**
- **Reliability** and **Trust**
- **Continuous Innovation** and **Predictability**
- **Contribution** of the Entire **Community**

…

*Java’s ability to boost **performance**, **stability**, and **security** continues to make it the **world’s most popular programming language**.*

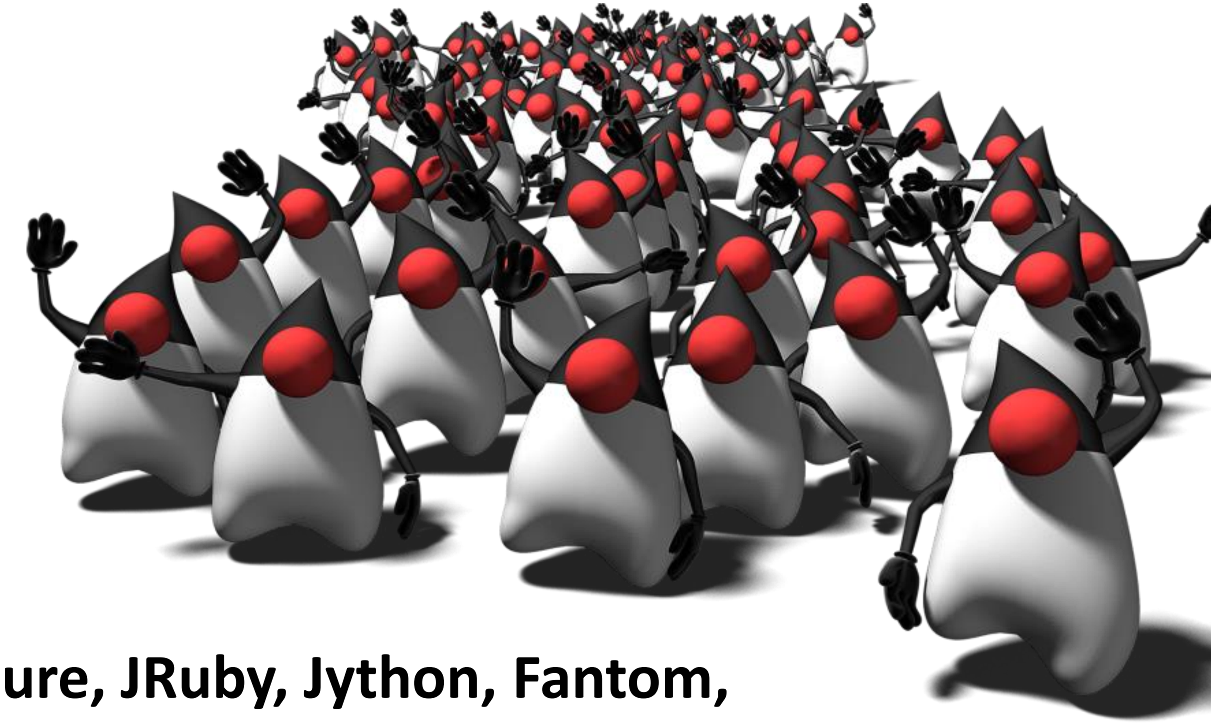
*According to an IDC report over **10 million developers**, representing **75% of full-time developers** worldwide, **use Java**, more than any other language.*

Sharat Chander, September 2021



More Java Facts

- **10 Million Java Developers**
  - With many **Java Certificates**
- **98% Fortune 100** companies hiring **Java Developers**
- **69%** of **Software Developers** run (some kind of…) Java

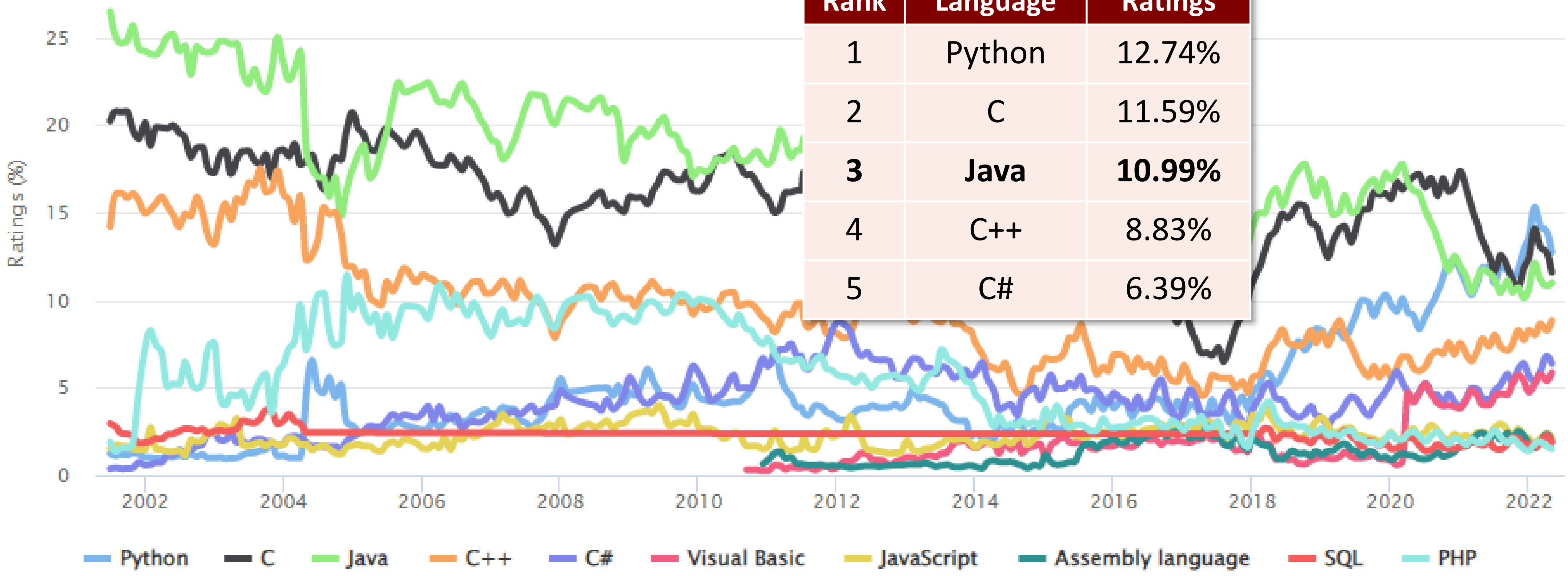


- **50+ JVM languages**
  - JVM languages : **Groovy, Kotlin, Scala, Clojure, JRuby, Jython, Fantom, Ceylon, Xtend, X10, LuaJ, Golo, Frege, Mirah, Eta**, **JavaScript…**
- And **all other languages** with **GraalVM (+ Truffle + Sulong)**

Is Java still popular?

- **TIOBE index** for May 2022

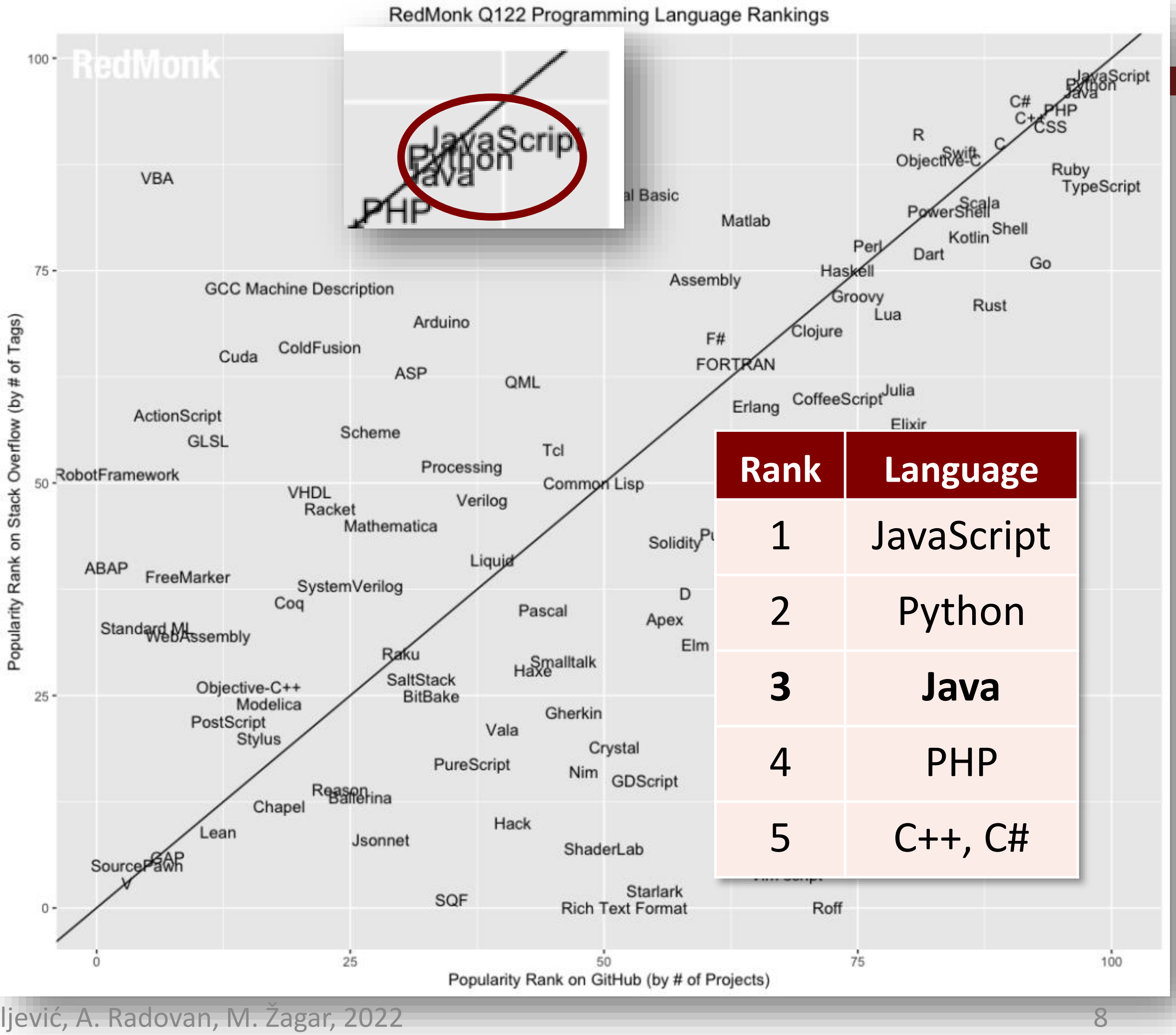
Rank	Language	Ratings
1	Python	12.74%
2	C	11.59%
3	**Java**	**10.99%**
4	C++	8.83%
5	C#	6.39%



Source: TIOBE Index for May 2022, www.tiobe.com/tiobe-index/

Is Java still popular? #2

- **RedMonk Programming Language Rankings**: January 2022
  - Extraction of language rankings from **GitHub** and **Stack Overflow**
  - Combining them to reflect both code (GitHub) and discussion (Stack Overflow) traction



Rank	Language
1	JavaScript
2	Python
3	**Java**
4	PHP
5	C++, C#

Source: The RedMonk Programming Language Rankings: January 2022, https://redmonk.com/sogrady/2022/03/28/language-rank

Available JDKs?

- Oracle JDK or one of many OpenJDKs

- Oracle OpenJDK
- AdoptOpenJDK's OpenJDK
- Azul Zulu OpenJDK
- Amazon's Corretto OpenJDK
- Linux distribution's OpenJDKs
- RedHat's OpenJDK
- IBM Java SDK

- Azul Zing
- Alibaba Dragonwell
- Bellsoft Liberica OpenJDK
- Eclipse Adoptium OpenJDK
- SAP SapMachine
- Microsoft OpenJDK ☺
- …

+ Oracle GraalVM CE or EE

Available JDKs and Versions

- **Oracle JDK** www.oracle.com/java/technologies/downloads/
  - Java SE **18**.0.1.1, Java SE **17**.0.3.1 (LTS), Java SE **11**.0.15.1 (LTS) or Java SE **8**u333 (LTS)
  - License: NFTC (17 and after) or OTN (before 17) – to be discussed later
- **Oracle OpenJDK** jdk.java.net
  - Java SE **18**.0.1.1, Java SE **17** (LTS), or any other between **16** and **7**
  - License: GPLv2+CE
- **~~AdoptOpenJDK~~ Adoptium Eclipse Temurin** adoptium.net
  - Java SE **18**.0.1+10, Java SE **17**.0.3+7 (LTS), Java SE **16**.0.2+7, Java SE **11**.0.15+10 (LTS) or Java SE **8**u332 (LTS)
  - License: Apache Version 2.0 and GPLv2+CE
- **Azul's Zulu OpenJDK** www.azul.com/downloads/?package=jdk
  - Java SE **18**.0.1+10, Java SE **17**.0.3+7 (LTS), and all others back to Open JDK **6**

Is Java **Moving Forward**?

Predictability

- Evolving Java incrementally and predictably via JCP – **stable evolution**
- Progress not alienating extremely large user base – **careful backward compatibility**

Trust

- Open and transparent development model, preserving values – **no surprises**
- Java community suggests and adopts new features – **community involvement**

Innovation

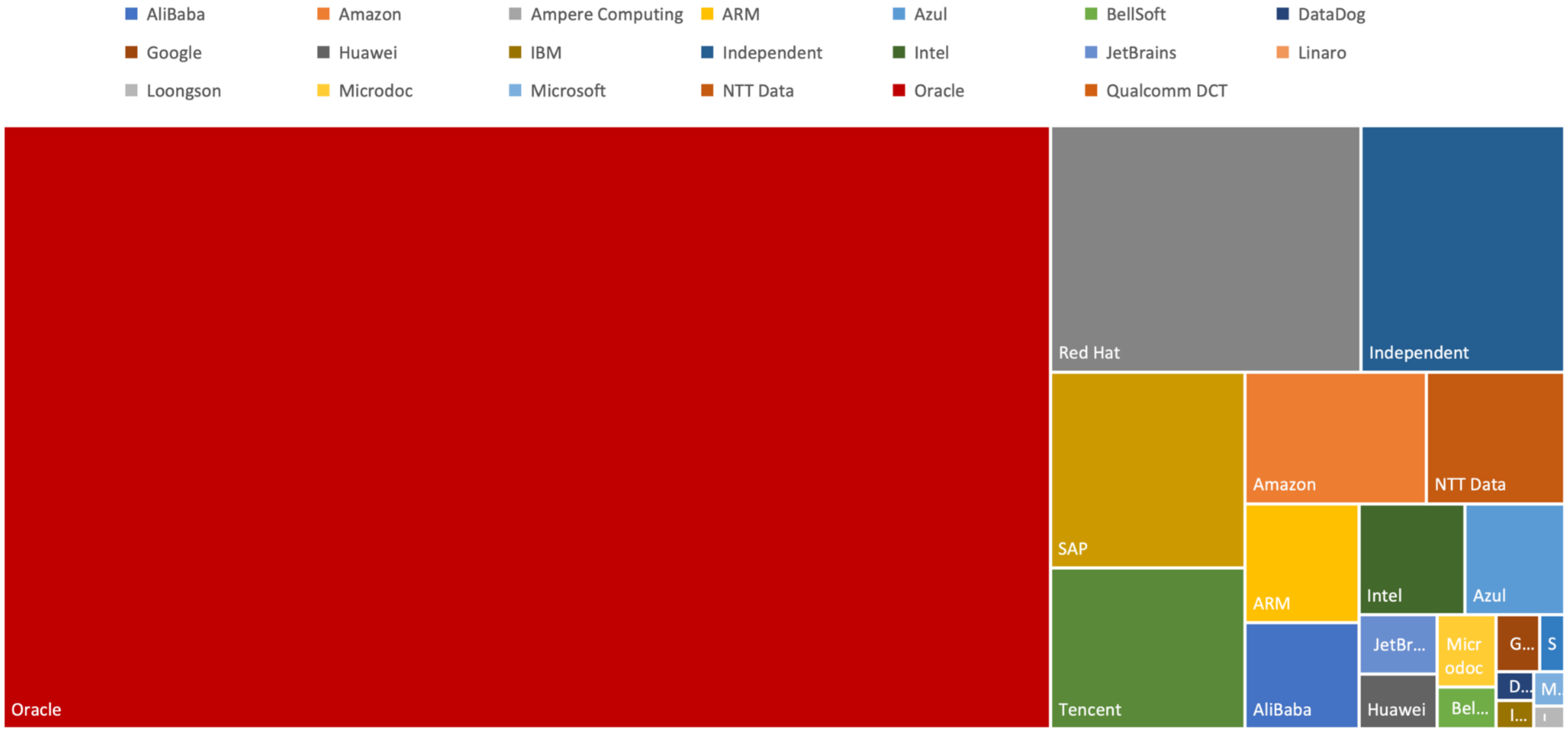
- Respecting contemporary software development – **innovative improvements**
- Gradually introducing language and platform enhancements – **cautious innovation**

Innovation with Incubators and Preview

- **Incubator Features**
  - New API and tools that, after stabilization, are most likely to be included in JDKs
- **Preview Features**
  - Features believed to be implemented but subject to changes before becoming final
- **Experimental Features**
  - Test-bed to gather feedback on nontrivial enhancements
- **Early Access Releases**
  - Allowing developers to prepare for the next version of JDK in advance
- **JDK development projects**
  - Amber, Valhalla, Panama, Loom, Leyden, ZGC and many others

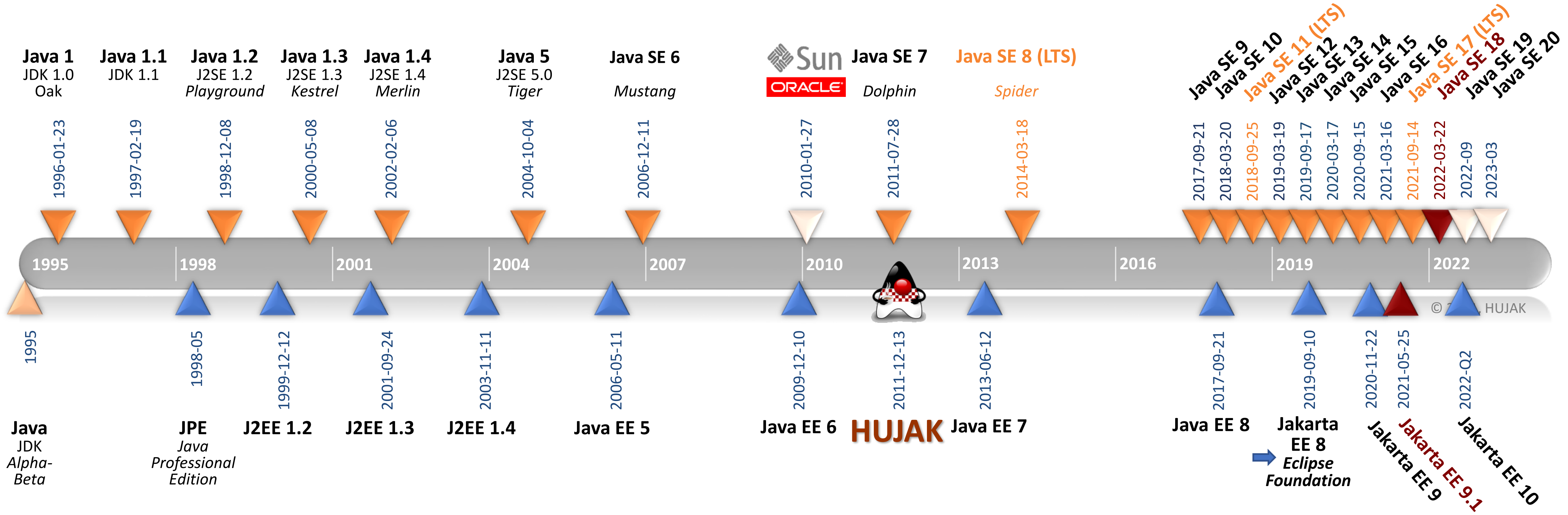
Creating Java Together

- Issues fixed in JDK 11-17 per **organization**
  - Led by **Oracle**, but significant contributions by many others: **Red Hat, SAP, Tencent, Amazon, NTT Data, ARM, Intel, Azul, Alibaba, JetBrains, Microdoc, Huawei** …



Java **Timeline**

- 27+ years of history…



Java 1
JDK 1.0
Oak
1996-01-23

Java 1.1
JDK 1.1
1997-02-19

Java 1.2
J2SE 1.2
Playground
1998-12-08

Java 1.3
J2SE 1.3
Kestrel
2000-05-08

Java 1.4
J2SE 1.4
Merlin
2002-02-06

Java 5
J2SE 5.0
Tiger
2004-10-04

Java SE 6
Mustang
2006-12-11

Sun
ORACLE
2010-01-27

Java SE 7
Dolphin
2011-07-28

Java SE 8 (LTS)
Spider
2014-03-18

Java SE 9 — 2017-09-21
Java SE 10 — 2018-03-20
Java SE 11 (LTS) — 2018-09-25
Java SE 12 — 2019-03-19
Java SE 13 — 2019-09-17
Java SE 14 — 2020-03-17
Java SE 15 — 2020-09-15
Java SE 16 — 2021-03-16
Java SE 17 (LTS) — 2021-09-14
Java SE 18 — 2022-03-22
Java SE 19 — 2022-09
Java SE 20 — 2023-03

1995
Java
JDK
Alpha-Beta

1998-05
JPE
Java Professional Edition

1999-12-12
J2EE 1.2

2001-09-24
J2EE 1.3

2003-11-11
J2EE 1.4

2006-05-11
Java EE 5

2009-12-10
Java EE 6

2011-12-13
HUJAK

2013-06-12
Java EE 7

2017-09-21
Java EE 8

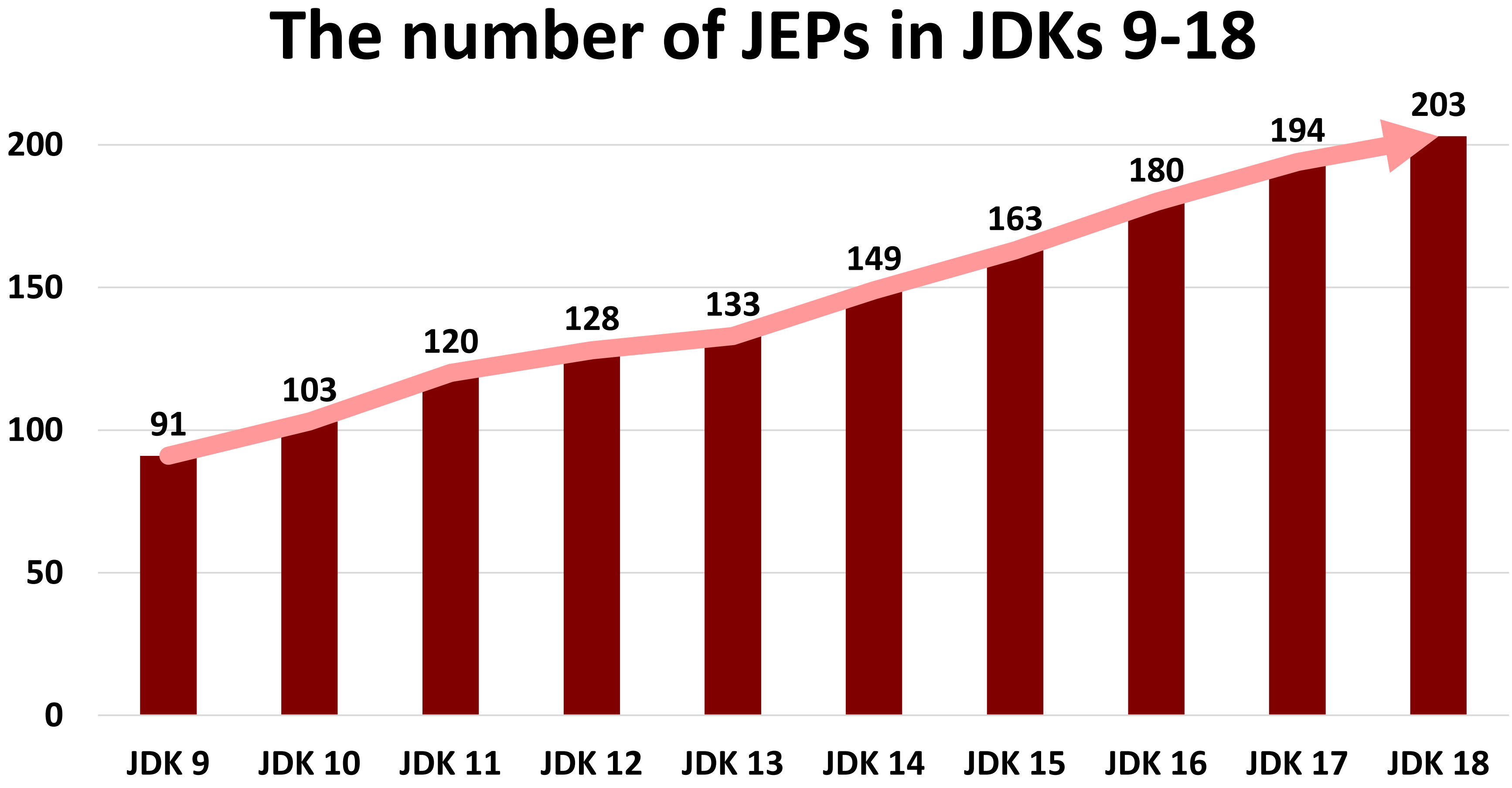
2019-09-10
Jakarta EE 8
➡ ***Eclipse Foundation***

2020-11-22
Jakarta EE 9

2021-05-25
Jakarta EE 9.1

2022-Q2
Jakarta EE 10

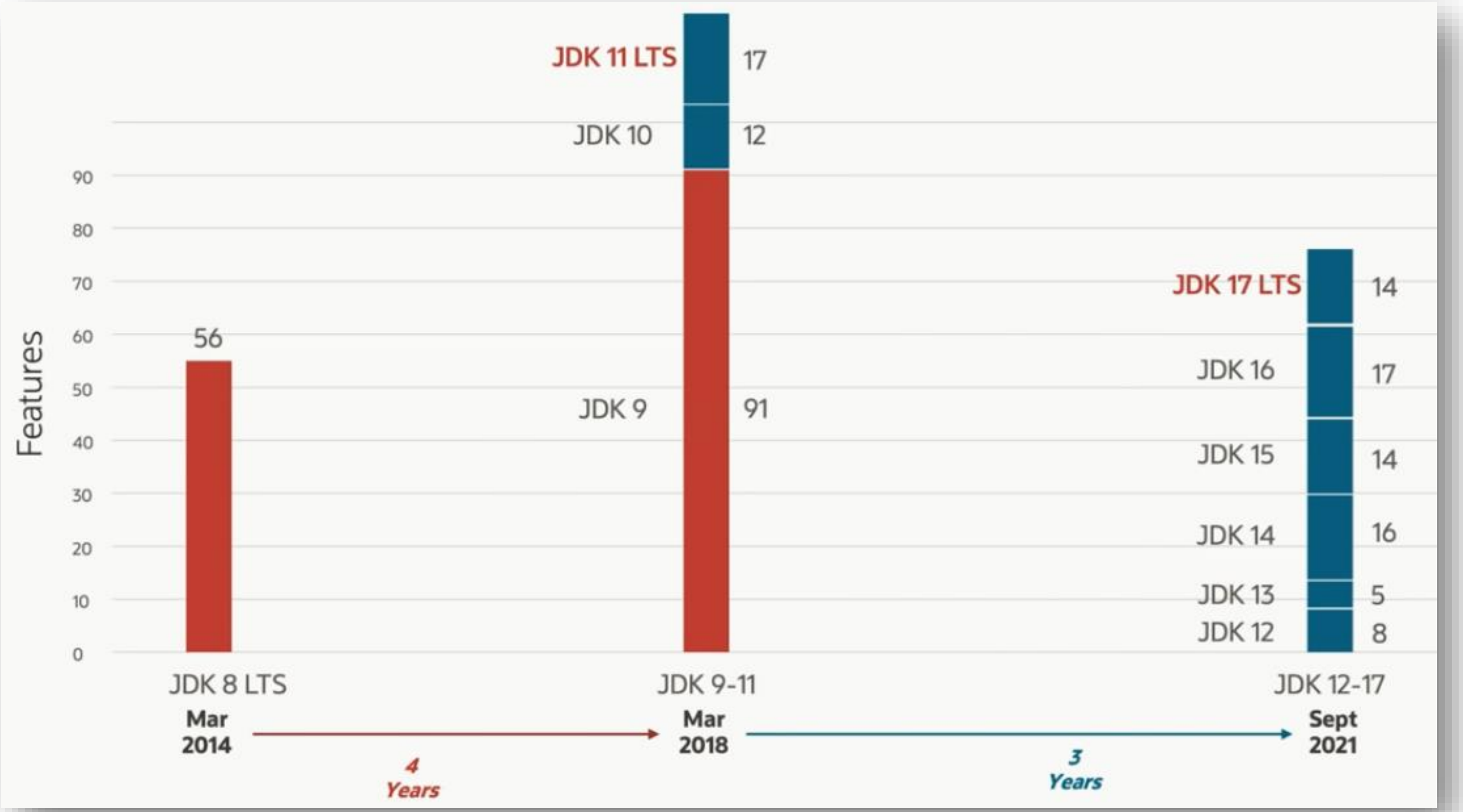
Constant Evolution through JEPs



- The number of JEPs is on the **constant rise**
- Continuous flow of **new features**
- But what about Long Term Support (LTS)?

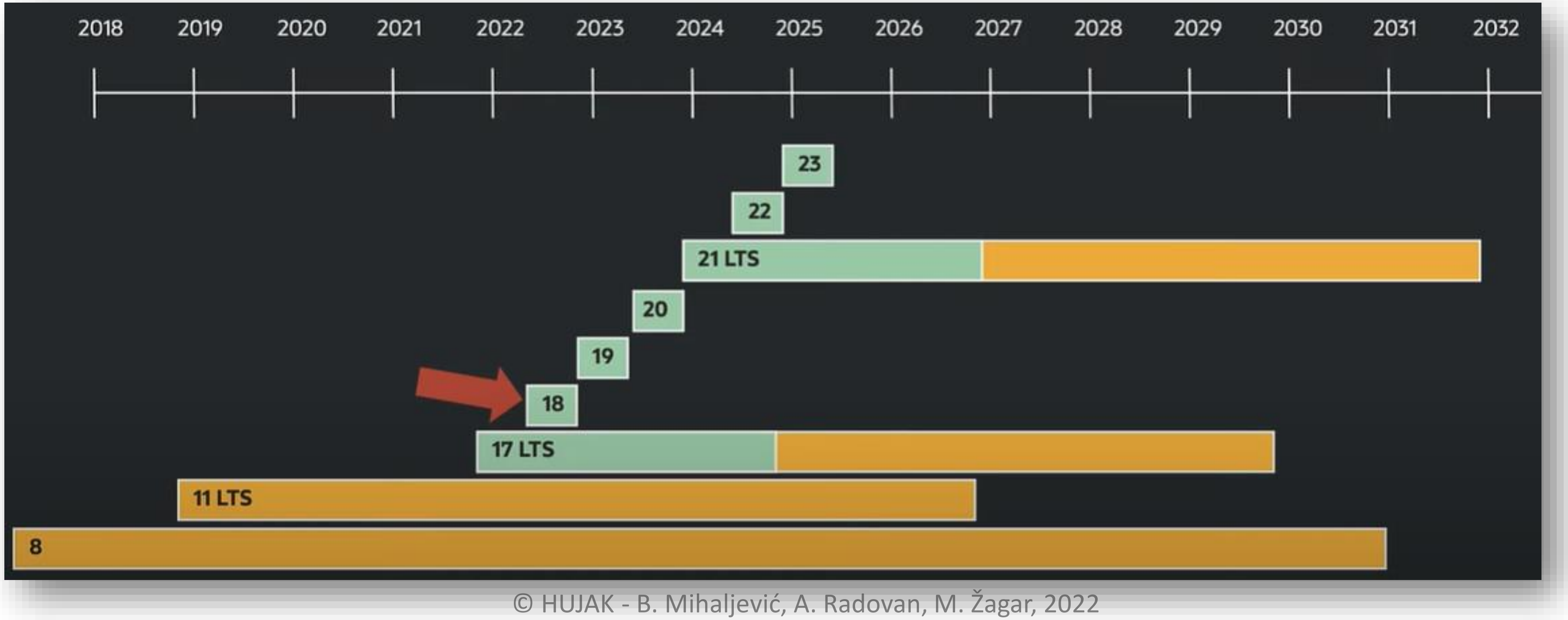
LTS Releases Include Many JEPs

- **Accumulating improvements** over 6-months feature releases every 3 years
- **LTS (Long Term Support) Releases** presented a significant number of JEPs
  - JDK **8** – **56** JEPs
  - JDK 9-**11** – **120** JEPs
  - JDK 12-**17** – **74** JEPs



LTS Release – Every 2 Years NEW!

- Demand for LTS (Long Term Support) has grown
  - Surveys show 6-month releases not being used often in production
- Proposing the **new LTS release** schedule –> **every 2 years** (instead of 3)



Is Java Really "Free"?

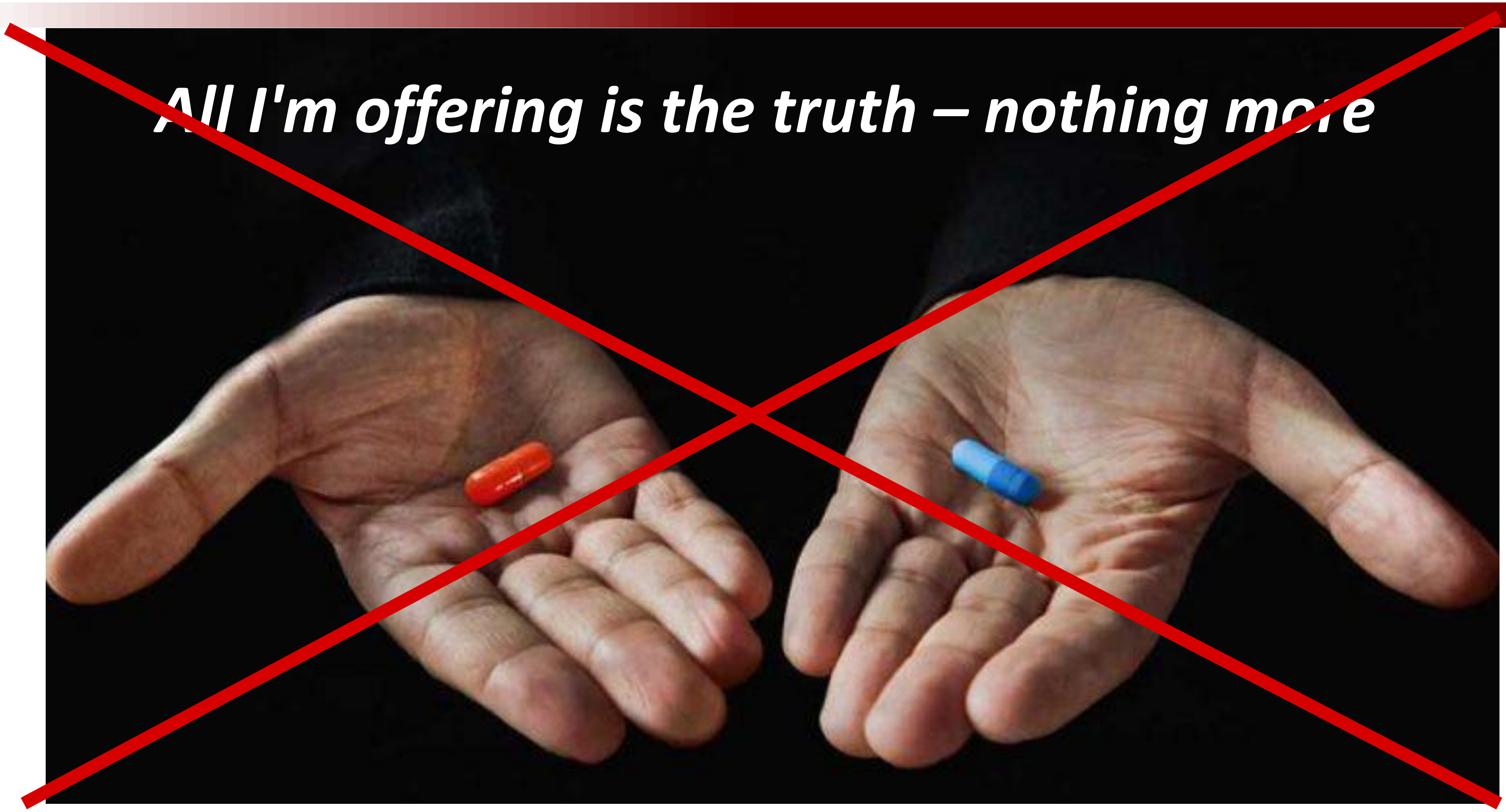
- Use of **OpenJDK** for **free** with **GPLv2+CE license**
- **Updates** (code patches) – typically **free of charge**
- **Support** (fixing bugs and answering questions) – it was **never free of charge**

What about **Oracle JDK?**

- **Oracle JDK 8** can be used **indefinitely for free**
  - Of course, without any further security patches and bug fixes
- **Oracle JDK 11-16** in **production** used with **commercial Java SE subscription**
  - Under **Oracle Technology Network** (**OTN**) license
  - Completely free JDK 11-16 are only OpenJDK binaries

What about **Oracle JDK 17+?**

OpenJDK or Commercial JDK?

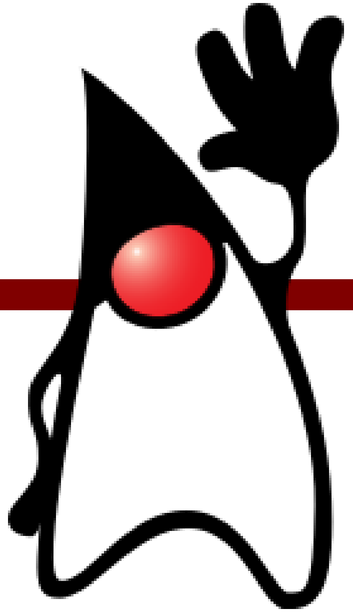


~~*All I'm offering is the truth – nothing more*~~

Java is (Finally Completely) Free!

- **Oracle JDK 17 and later** with **Oracle No-Fee Terms and Conditions (NFTC)** licensing
  - Oracle JDK permits **free use** for all users, even commercial and production use
  - www.oracle.com/downloads/licenses/no-fee-license.html
- Oracle JDK free releases and updates will be provided for at least **one full year** after the **next** LTS release
  - Prior versions are not affected by this change
- Oracle **OpenJDK** releases will continue to be provided under GPL
  - On the same releases and schedule as it has since Java 9

Current State of Java?



Some questions for all of us:

- Still using **Java 8** (2014)?
- Switched to the **old LTS** version **Java 11** (2018)?
- Upgraded to 6-month release of **Java 12-16** or **18**?
- Upgrading to the **latest LTS** version **Java 17** (2021)?
- What about ~~Java~~ **Jakarta EE** (9.1)?

JDK 8 – ancient history

- **JDK 8** in **March 2014**
- We hope that we will **not** talk about JDK 8 anymore ☺
- Ooops, are you **still using it**?

JDK 9 – very, very old news?

- **JDK 9** in **September 2017**
  - **Many new features** and **APIs** (after 3.5 years)
- **90 JEPs included**
- The most important – **Java Platform Module System (JPMS)**
  - All core Java libraries are now modules (JEP 220) – 97 modules
- **"New" 6-months OpenJDK release model**
  - New features included (only) when ready
  - Feature release versions every 6 months (in March & September)
  - Update releases quarterly (in January, April, July, and October)
- **Long-term support (LTS) feature release** every 3 (now 2) **years**
  - Updates available for at least 3 years

JDK 10 – was new, but already old?

- **JDK 10** in **March 2018**
  - **109 new features** and **APIs** (after 6 months)
- **12 JEPs** included (only?)

- 286: **Local-Variable Type Inference** ← ***vars***
- 296: Consolidate the JDK Forest into a Single Repository
- 304: Garbage-Collector Interface
- 307: **Parallel Full GC for G1**
- 310: Application Class-Data Sharing
- 312: Thread-Local Handshakes
- 313: Remove the Native-Header Generation Tool (javah)
- 314: Additional Unicode Language-Tag Extensions
- 316: Heap Allocation on Alternative Memory Devices
- 317: Experimental Java-Based JIT Compiler
- 319: Root Certificates
- 322: Time-Based Release Versioning

JDK 11 – the "older" LTS version

- **JDK 11** in **September 2018**
  - **90 new features** and **APIs**!
- **LTS version** (first in a long time, after JDK 8 in 2014)
- **17 JEPs** included:

- 181: Nest-Based Access Control
- 309: Dynamic Class-File Constants
- 315: Improve Aarch64 Intrinsics
- 318: Epsilon: A No-Op Garbage Collector
- 320: Remove the Java EE and CORBA Modules
- 321: **HTTP Client** (Standard)
- 323: **Local-Variable Syntax for Lambda Parameters**
- 324: Key Agreement with Curve25519 and Curve448
- 327: Unicode 10
- 328: **Flight Recorder**
- 329: ChaCha20 and Poly1305 Cryptographic Algorithms
- 330: Launch Single-File Source-Code Programs
- 331: Low-Overhead Heap Profiling
- 332: Transport Layer Security (TLS) 1.3
- 333: **ZGC**: A Scalable Low-Latency Garbage Collector (Experimental)
- 335: **Deprecate the ~~Nashorn~~ JavaScript Engine**
- 336: Deprecate the Pack200 Tools and API

New Garbage Collectors

Many GCs to choose from:

- **Serial GC**
- **Parallel GC** (and **Parallel Old GC**)
- **CMS GC** (deprecated in Java 9)
- **G1** (Garbage-First) **GC** (default since Java 9)
  - **Parallel Full GC** for G1 (updated in Java 10)
  - Improved in Java 12+
- **ZGC** (experimental in Java 11, improved in 12-17)
- **Shenandoah GC** (experimental in Java 12, improved)
- **Azul's C4 GC**
- **Epsilon GC** (no-op GC, experimental in Java 11)
- Others …

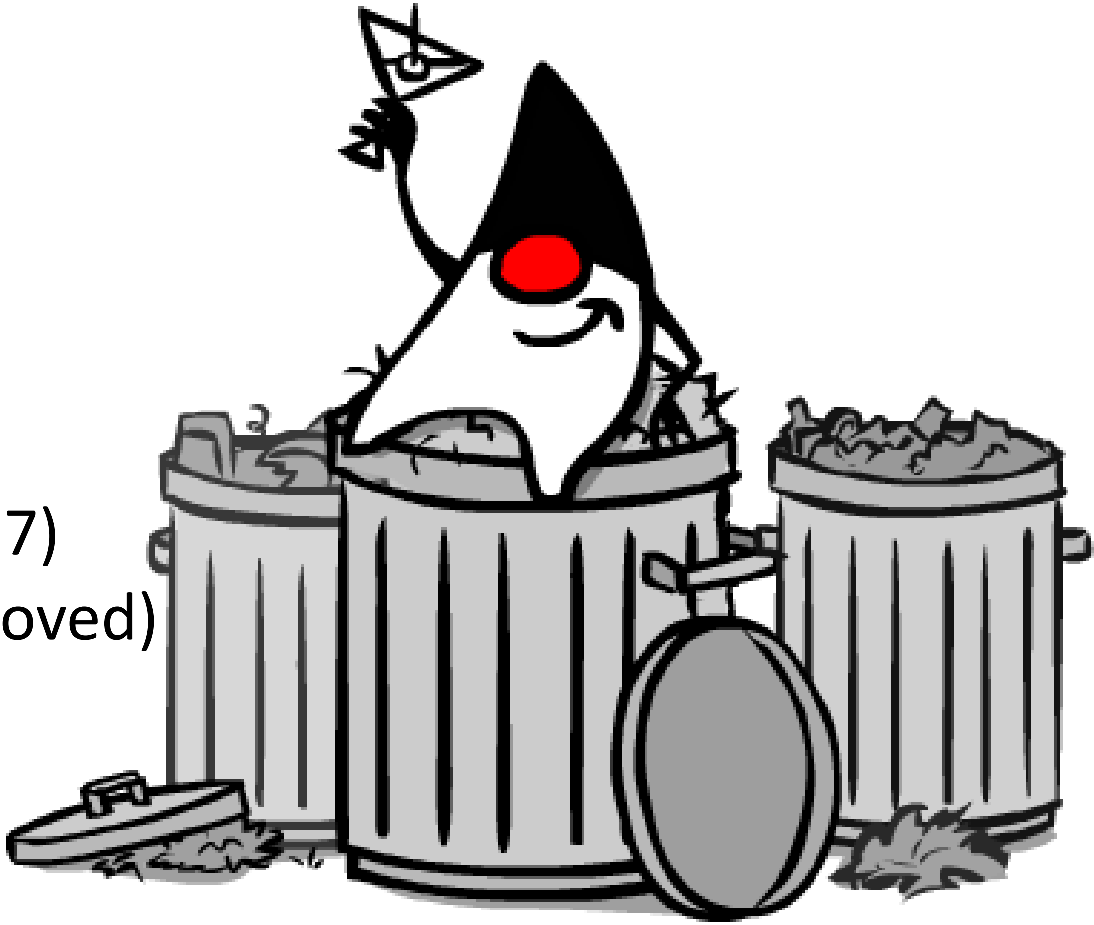


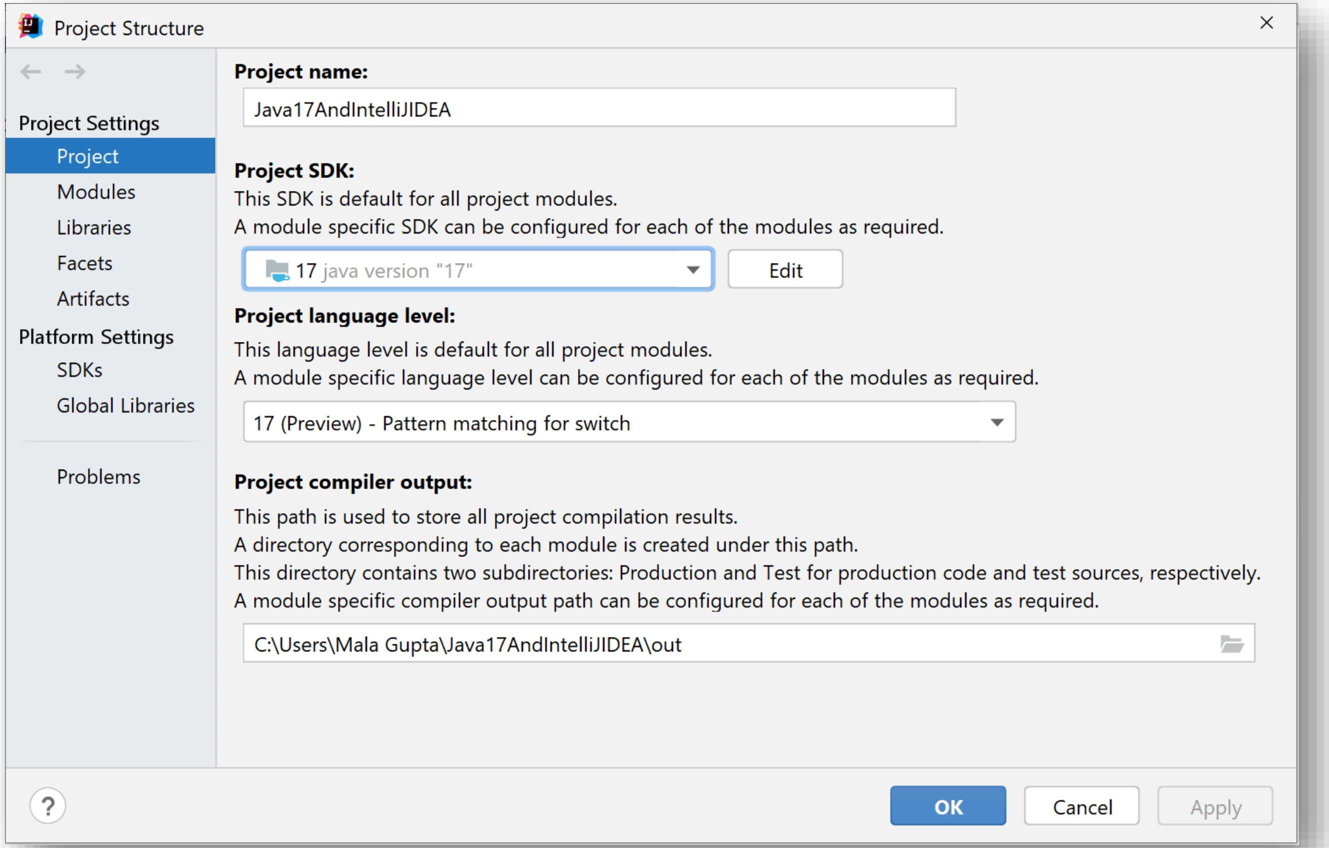
Image Source: 5 Coding Hacks to Reduce GC Overhead, Tall Weiss, OverOps, 2013

JDK 12 – with the first "Previews"

- **JDK 12 in March 2019**
  - **39 new features** and **APIs** – relatively small number
- **8 JEPs** included:
  - 189: **Shenandoah**: A Low-Pause-Time Garbage Collector (Experimental)
  - 230: Microbenchmark Suite
  - 325: **Switch Expressions (Preview)**
  - 334: JVM Constants API
  - 340: One AArch64 Port, Not Two
  - 341: Default CDS Archives
  - 344: **Abortable Mixed Collections for G1**
  - 346: **Promptly Return Unused Committed Memory from G1**

What are Preview Features?

- **Preview language** (or VM) **features** are **fully implemented** and **fully specified**, yet **impermanent**
  - Made available in a release to get real world use feedback from developers
- To try out a preview feature it has to be **enabled** at compile time and at runtime
- Use `--enable-preview`



Project name:

Java17AndIntelliJIDEA

Project SDK:

This SDK is default for all project modules.

A module specific SDK can be configured for each of the modules as required.

17 java version "17"

Project language level:

This language level is default for all project modules.

A module specific language level can be configured for each of the modules as required.

17 (Preview) - Pattern matching for switch

Project compiler output:

This path is used to store all project compilation results.

A directory corresponding to each module is created under this path.

This directory contains two subdirectories: Production and Test for production code and test sources, respectively.

A module specific compiler output path can be configured for each of the modules as required.

C:\Users\Mala Gupta\Java17AndIntelliJIDEA\out

Switch Expressions (Preview)

```
int numLetters;
switch (day) {
    case MONDAY:
    case FRIDAY:
    case SUNDAY:
        numLetters = 6;
        break;
    case TUESDAY:
        numLetters = 7;
        break;
    case THURSDAY:
    case SATURDAY:
        numLetters = 8;
        break;
    case WEDNESDAY:
        numLetters = 9;
        break;
    default:
        throw new IllegalStateException("Hmm: " + day);
};
```

```
enum Weekdays { MONDAY, TUESDAY, WEDNESDAY, THURSDAY,
FRIDAY, SATURDAY, SUNDAY }
```

```
int numLetters = switch (day) {
    case MONDAY, FRIDAY, SUNDAY -> 6;
    case TUESDAY                -> 7;
    case THURSDAY, SATURDAY     -> 8;
    case WEDNESDAY              -> 9;
    // no default!!!
};
```

Used as an expression

No fall through

No default needed

JDK 13 – "only 5" JEPs

- **JDK 13 in September 2019**
  - **81 new features** and **APIs** – relatively small n
- **5 JEPs** included (only):
  - 350: Dynamic CDS Archives
  - 351: **ZGC**: Uncommitted Unused Memory
  - 353: Reimplement the Legacy Socket API
  - 354: **Switch Expressions (Second Preview)**
  - 355: **Text Blocks (Preview)**

Switch Expressions (2nd Preview)

- When working switch expression, if a full block is needed, a new **yield statement** is introduced
- It **yields a value** that becomes the value of the enclosing switch expression

```
int j = switch (day) {
    case MONDAY  -> 0;
    case TUESDAY -> 1;
    default      -> {
        int k = day.toString().length();
        int result = f(k);
        yield result;
    }
};
```

JDK 14 – a lot of new features

- **JDK 14 on March 17, 2020**
  - **Many new features** and **APIs** at openjdk.java.net/projects/jdk/14/
- **16 JEPs** targeted:

- 305: **Pattern Matching for instanceof (Preview)**
- 343: Packaging Tool (Incubator)
- 345: **NUMA-Aware Memory Allocation for G1**
- 349: **JFR Event Streaming**
- 352: Non-Volatile Mapped Byte Buffers
- 358: **Helpful NullPointerExceptions**
- 359: Records (Preview)
- 361: **Switch Expressions (Standard)**
- 362: Deprecate the Solaris and SPARC Ports
- 363: **Remove the ~~Concurrent Mark Sweep (CMS)~~ Garbage Collector**
- 364: **ZGC on macOS**
- 365: **ZGC on Windows**
- 366: **Deprecate the ~~ParallelScavenge + SerialOld~~ GC Combination**
- 367: Remove the Pack200 Tools and API
- 368: **Text Blocks (Second Preview)**
- 370: **Foreign-Memory Access API** (Incubator)

Text Blocks

- **SQL** example using a "two-dimensional" block of text

```
String query = """
               SELECT "EMP_ID", "LAST_NAME" FROM "EMPLOYEE_TB"
               WHERE "CITY" = 'INDIANAPOLIS'
               ORDER BY "EMP_ID", "LAST_NAME";
               """;
```

- **Polyglot language** example using a "two-dimensional" block of text

```
ScriptEngine engine = new ScriptEngineManager().getEngineByName("js");
Object obj = engine.eval("""
                         function hello() {
                             print('"Hello, world"');
                         }
                         hello();
                         """);
```

JDK 15 –

- **JDK 15 on September 15, 2020**
  - **New features** and **APIs** at https://openjdk.java.net/projects/jdk/15/
- **14 JEPs** targeted:
  - 339: Edwards-Curve Digital Signature Algorithm (EdDSA)
  - 360: **Sealed Classes (Preview)**
  - 371: **Hidden Classes**
  - 372: Remove the ~~Nashorn~~ JavaScript Engine
  - 373: Reimplement the Legacy DatagramSocket API
  - 374: Disable and Deprecate Biased Locking
  - 375: **Pattern Matching for instanceof (Second Preview)**
  - 377: **ZGC: A Scalable Low-Latency Garbage Collector**
  - 378: **Text Blocks**
  - 379: **Shenandoah: A Low-Pause-Time Garbage Collector**
  - 381: Remove the Solaris and SPARC Ports
  - 383: **Foreign-Memory Access API (Second Incubator)**
  - 384: **Records (Second Preview)**
  - 385: Deprecate RMI Activation for Removal

Sealed and Hidden Classes

- **Sealing** allows classes and interfaces to define their permitted subtypes
  - Enabling more fine-grained inheritance control in Java.
- *Example*: Sealed class may omit permit if subclasses are defined in same file

```
abstract sealed class Shape { ...
    final class Circle extends Shape { ... }
    final class Rectangle extends Shape { ... }
    final class Square extends Shape { ... }
}
```

- Anonymous classes and local classes cannot be permitted subtypes of a sealed class
- **Hidden** classes cannot be used directly by the bytecode or other classes
  - A standard way to generate dynamic classes

JDK 16 –

- **JDK 16 on March 16, 2021**
  - **New features** and **APIs** at https://openjdk.java.net/projects/jdk/16/
- **17 JEPs** targeted:
  - 338: **Vector API (Incubator)**
  - 347: Enable C++14 Language Features
  - 357: Migrate **from Mercurial to Git**
  - 369: Migrate to **GitHub**
  - 376: **ZGC: Concurrent Thread-Stack Processing**
  - 380: Unix-Domain Socket Channels
  - 386: Alpine Linux Port
  - 387: Elastic Metaspace
  - 388: Windows/AArch64 Port
  - 389: **Foreign Linker API (Incubator)**
  - 390: Warnings for Value-Based Classes
  - 392: Packaging Tool
  - 393: **Foreign-Memory Access API (Third Incubator)**
  - 394: **Pattern Matching for instanceof**
  - 395: **Records**
  - 396: Strongly Encapsulate JDK Internals by Default
  - 397: **Sealed Classes (Second Preview)**

Records

- *Example*: A point

```
class Point {

   final double x;
   final double y;

   public Point (double x, double y) {
      this.x = x;
      this.y = y;
   }

   public double x() { return x; }

   public double y() { return y; }
```

```
@Override
public double equals (Object o) {
   if (…)
      …
   return …
}

@Override
Public double hashCode () {
   return …
}

@Override
Public double toString() {
   return …
}
```

Records

- *Example*: A point

```
record Point { }
```

Sometimes data is just … data.

Mark Reinhold

```
    final double x;
    final double y;

    public Point (double x, double y) {
        this.x = x;
        this.y = y;
    }

    public double x() { return x; }

    public double y() { return y; }
```

```
@Override
public double equals (Object o) {
    if (…)
        …
    return …
}

@Override
Public double hashCode () {
    return …
}

@Override
Public double toString() {
    return …
}
```

Pattern Matching for instanceof

- First preview as JEP 305 in JDK 14, Standard as JEP 375 in JDK 16
- *Example*:

```
if (obj instanceof String s && s.length() > 5) {..
s.contains(..) ..}
```

- Another example:

```
@Override public boolean equals(Object o) {
    return (o instanceof CaseInsensitiveString cis) &&
        cis.s.equalsIgnoreCase(s);
}
```

JDK 17 – the "new" LTS

- **JDK 17 (LTS) on September 14, 2021**
  - **New features** and **APIs** at https://openjdk.java.net/projects/jdk/17/
- **14 JEPs** targeted:

- 306: Restore Always-Strict Floating-Point Semantics
- 356: **Enhanced Pseudo-Random Number Generators**
- 382: New macOS Rendering Pipeline
- 391: macOS/AArch64 Port
- 398: **Deprecate the Applet API for Removal**
- 403: Strongly Encapsulate JDK Internals
- 406: **Pattern Matching for switch** (Preview)
- 407: Remove RMI Activation
- 409: **Sealed Classes**
- 410: **Remove the Experimental AOT and JIT Compiler**
- 411: Deprecate the Security Manager for Removal
- 412: **Foreign Function & Memory API** (Incubator)
- 414: **Vector API** (Second Incubator)
- 415: Context-Specific Deserialization Filters

Pattern Matching for switch

- *Example*:

```
static String formatterPatternSwitch(Object o) {
    return switch (o) {
        case null      -> "null";
        case Integer i -> String.format("int %d", i);
        case Long l    -> String.format("long %d", l);
        case Double d  -> String.format("double %f", d);
        case String s  -> String.format("String %s", s);
        default        -> o.toString();
    };
}
```

Foreign Function & Memory API

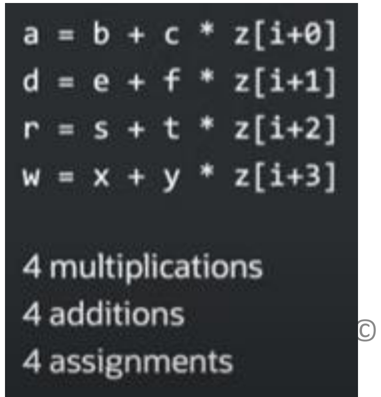
- JEP 412: **Foreign Function & Memory API** (Incubator) openjdk.java.net/jeps/412
- Introducing API to of statically-typed, pure-Java access to **native code**
- Simplifying error-prone process of **binding** to a native library
- Use any native library
- Java Native Interface (JNI) was a bit hard an brittle
- Foreign Linker API supports foreign function support
- Foreign Memory Access API allows access to memory outside of heap

JDK 18 – Foreseeable Future

- **JDK 18 in March 2022**
  - **New features** and **APIs** at https://openjdk.java.net/projects/jdk/18/
- **9 JEPs** targeted:
  - 400: **UTF-8** by Default
  - 408: **Simple Web Server**
  - 413: Code Snippets in Java API Documentation
  - 416: Reimplement Core Reflection with Method Handles
  - 417: **Vector API** (Third Incubator)
  - 418: Internet-Address Resolution SPI
  - 419: Foreign Function & Memory API (Second Incubator)
  - 420: Pattern Matching for switch (Second Preview)
  - 421: Deprecate Finalization for Removal

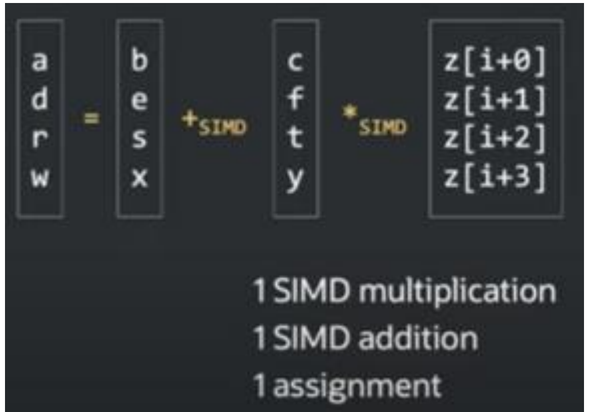
Vector API

- JEP 414: **Vector API** (Second Incubator) https://openjdk.java.net/jeps/414
- API to express vector computations that reliably compile at runtime to optimal vector hardware instructions
  - Achieve superior performance to equivalent scalar computations
- Taking advantage of the Single Instruction Multiple Data (SIMD) instructions on most modern CPUs
- Allows developers to write complex vector algorithms in Java



```
a = b + c * z[i+0]
d = e + f * z[i+1]
r = s + t * z[i+2]
w = x + y * z[i+3]
```

4 multiplications
4 additions
4 assignments



1 SIMD multiplication
1 SIMD addition
1 assignment

JDK 19 – Foreseeable Future

- **JDK 19 in September 2022**
  - **New features** and **APIs** at https://openjdk.java.net/projects/jdk/19/
- **JEPs** targeted (so far):
  - 422: Linux/RISC-V Port
  - 424: **Foreign Function & Memory API** (Preview)
  - 425: **Virtual Threads** (Preview)
  - 426: **Vector API** (Fourth Incubator)
  - 427: **Pattern Matching for switch** (Third Preview)
- **JEPs** proposed to target (so far):
  - 405: **Record Patterns** (Preview)

Virtual Threads and Record Patterns

- **Virtual Threads** (Preview) – **lightweight threads** that dramatically reduce the effort of writing, maintaining, and observing high-throughput concurrent applications
- **Record Patterns** (Preview) – enhance Java with *record patterns* to deconstruct record values
  - Record patterns and type patterns can be nested to enable a powerful, declarative, and composable form of data navigation and processing
  - Lifts the declaration of local variables for extracted components into the pattern
  - Initializes those variables by invoking the accessor methods when a value is matched against the pattern
  - In effect, a record pattern disaggregates an instance of a record into its components

Tooling Support for JDK 17/18

- Timely support for new features by tools and libraries helps drive developer productivity
- The efforts of leading IDE vendors whose most timely updates offer developers support for current Java versions
- Developers can already take advantage of Java 17/18 support today within:
  - **JetBrains IntellliJ IDEA 2022.1**
  - **Eclipse IDE 2022-03 (4.23)** via a marketplace solution
  - **NetBeans 12.8** with support for JDK 17
  - **Visual Studio Code**
  - …

AI and Code

- **AI-generated Source Code**
  - Predicts your next block of code delivering accurate code completions
  - Accelerates development by providing code guidance with patterns learned from millions of projects
  - Automates repetitive work and reduces the need for expensive and distracting code search
  - Improves code quality and consistency across your project
- **Github Copilot** (copilot.github.com)
  - Technical Preview – based on a natural language processing model called “Codex”
  - Works best with Java, Python, JavaScript, Ruby, and Go but supports 50+ other languages
  - Extensions for many modern IDEs
- **Tabnine** (former Codota) (www.tabnine.com)
  - 25 supported languages including Java, Python, Go, Dart, Julia, HCL, Ruby, Rust, C++
  - 21 supported IDEs/editors
- **Kite** (www.kite.com)
  - Supports Python and 15 other languages
  - 16 supported IDEs/editors

The Most Important Java Features (11-18)

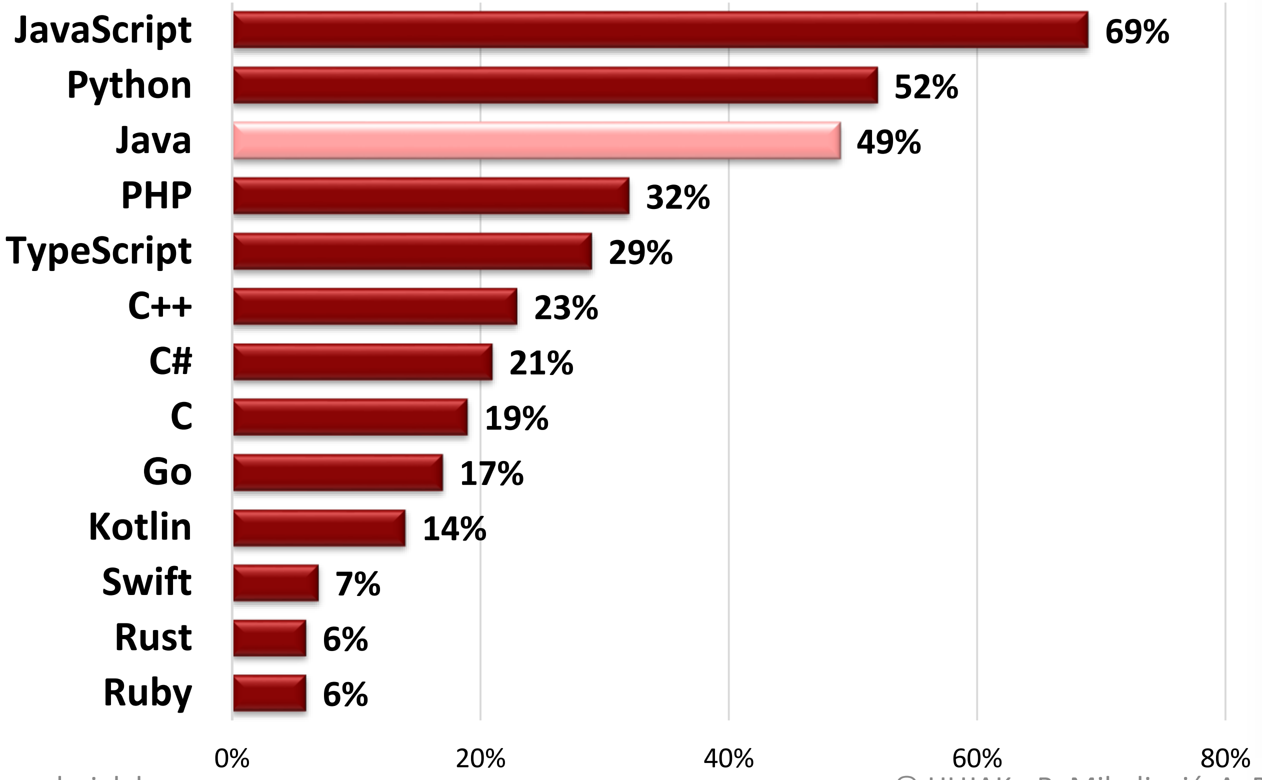
- **Languages Features** – Records, Switch Expressions, Text Blocks, vars, Pattern Matching for instanceof, Sealed Classes, Pattern Matching for switch…
- **Memory Management** – G1 GC enhancements (Full Parallel), ZGC, Shenandoah GC, Elastic Metaspace…
- **Library Enhancements** – Pseudo-Random Generator, Deserealization Filters, Vector API, Foreign Fuction & Memory API…
- **Future Proofing** – Module System (JPMS), Strong Encapsulation for JDK Internals…
- **Easier Debugging** – Flight Recorder, JFT Event Streaming, NullPointerExceptions…
- **Modernizing Infrastructure** – ~~Mercurial~~→Git, GitHub, AArch64 port…
- **Deprecations & Removals** – ~~CMS GC, Nashorn, Biased Locking, RMI Activation, Applet API, Security Manager~~…

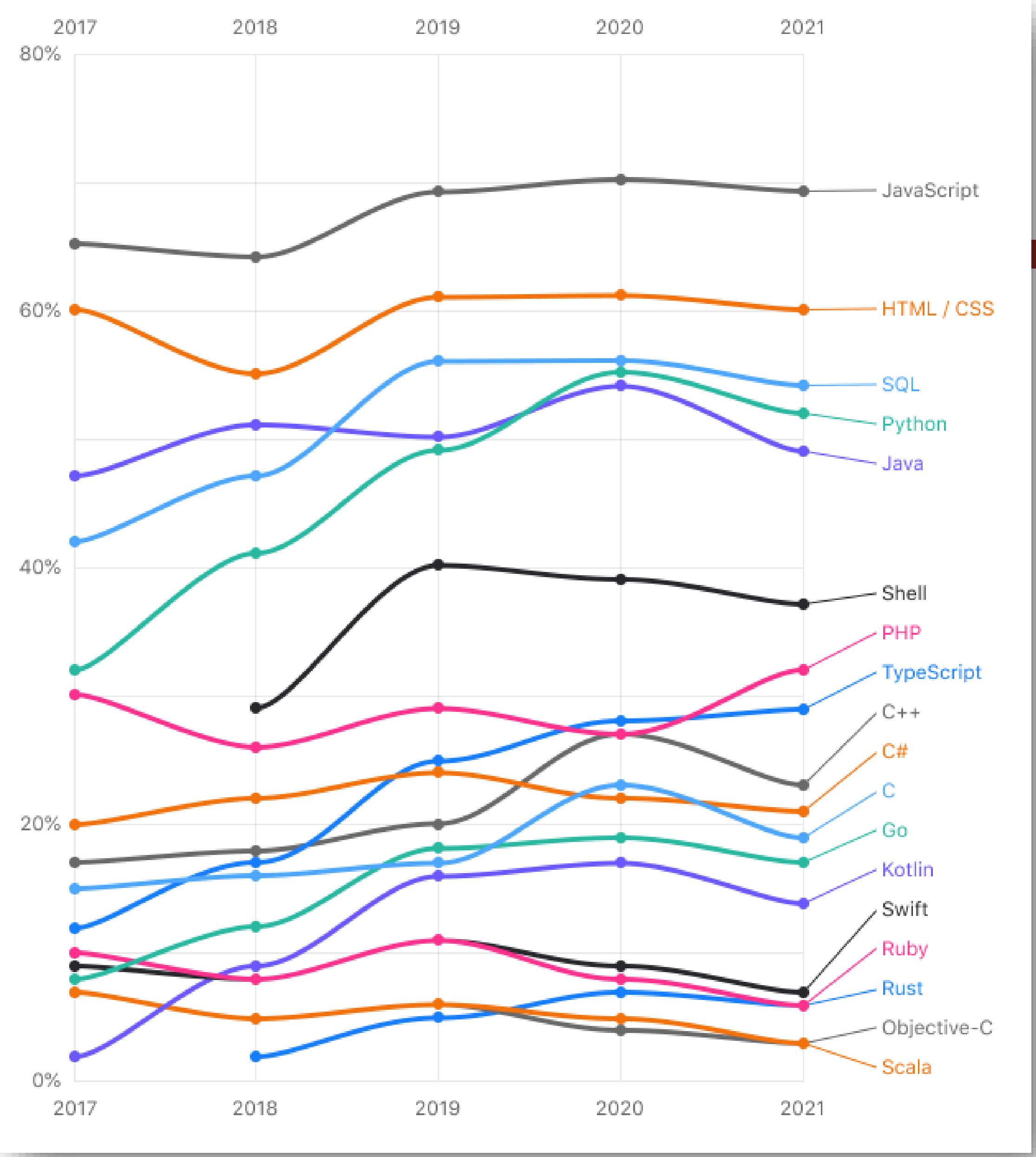
Some surveys

- **The State of Developer Ecosystem 2021** by **JetBrains**
  - 31743 developers from 183 countries in 2021
- **2021 Developer Survey** by **Stack Overflow**
  - 83000+ developers in 2021
- **2022 Java Developer Productivity Report** by **JRebel**
  - 876 developers in 2022
- **JVM Ecosystem Report 2021** by **Snyk**
  - 2000 Java developers in 2021
- **2021 Jakarta EE Developer Survey** by **Eclipse Foundation**
  - 940 developers in 2021
- **Java InfoQ Trends Report – December 2021**
- **2022 State of the Java Ecosystem** by **New Relic**

Top Languages

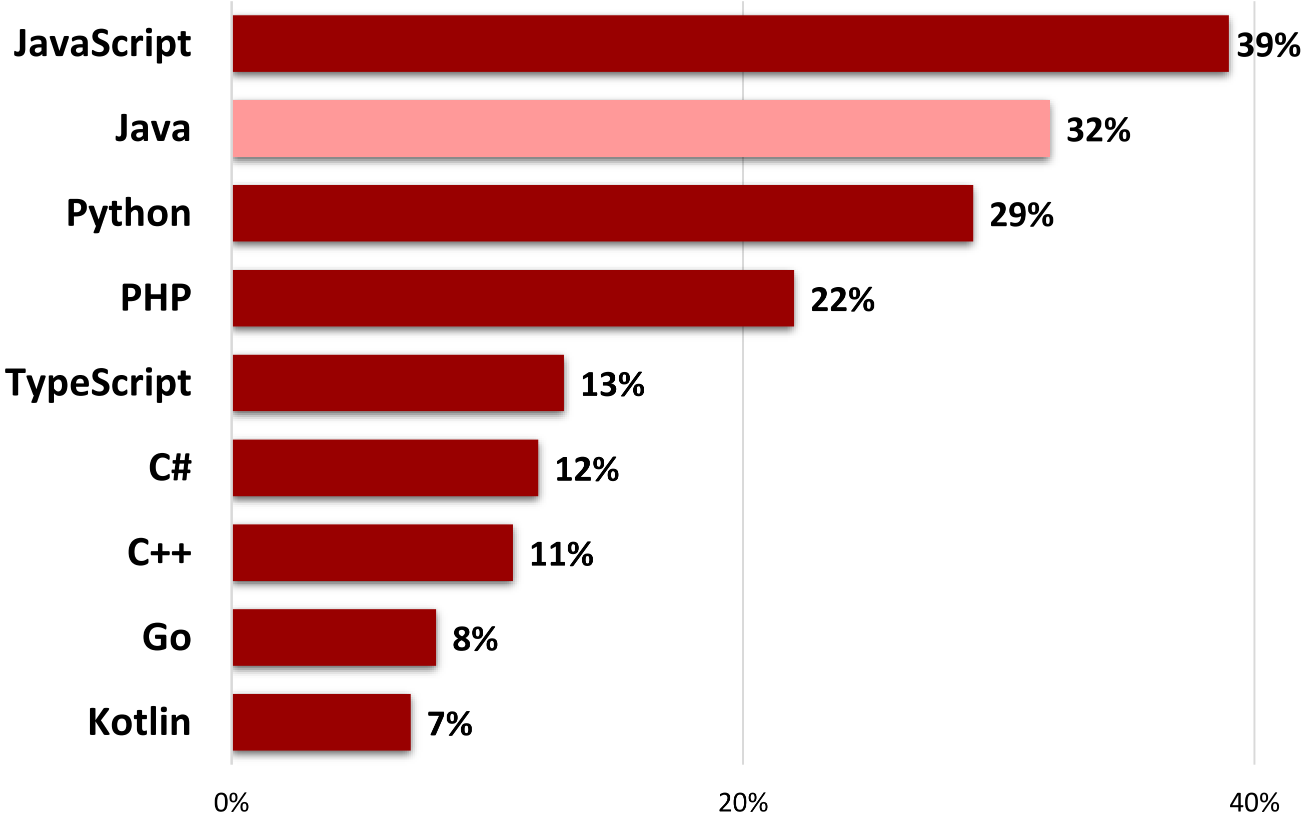
- What programming languages have you used (JetBrains)?



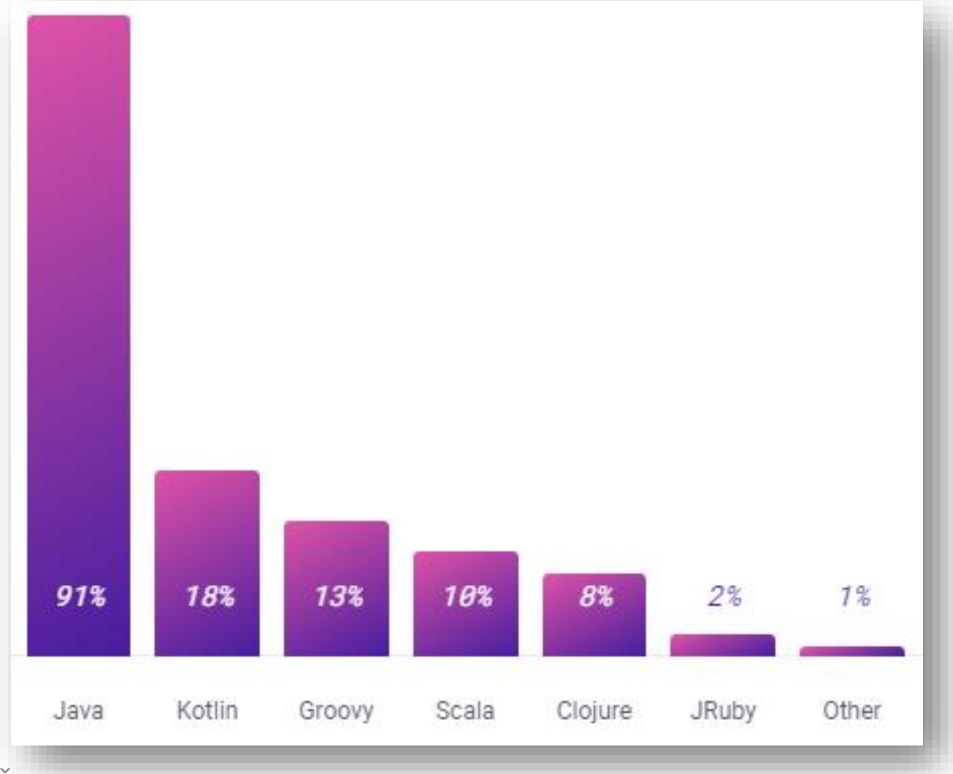


Main Language

- What is your **primary programming language** (JetBrains)?

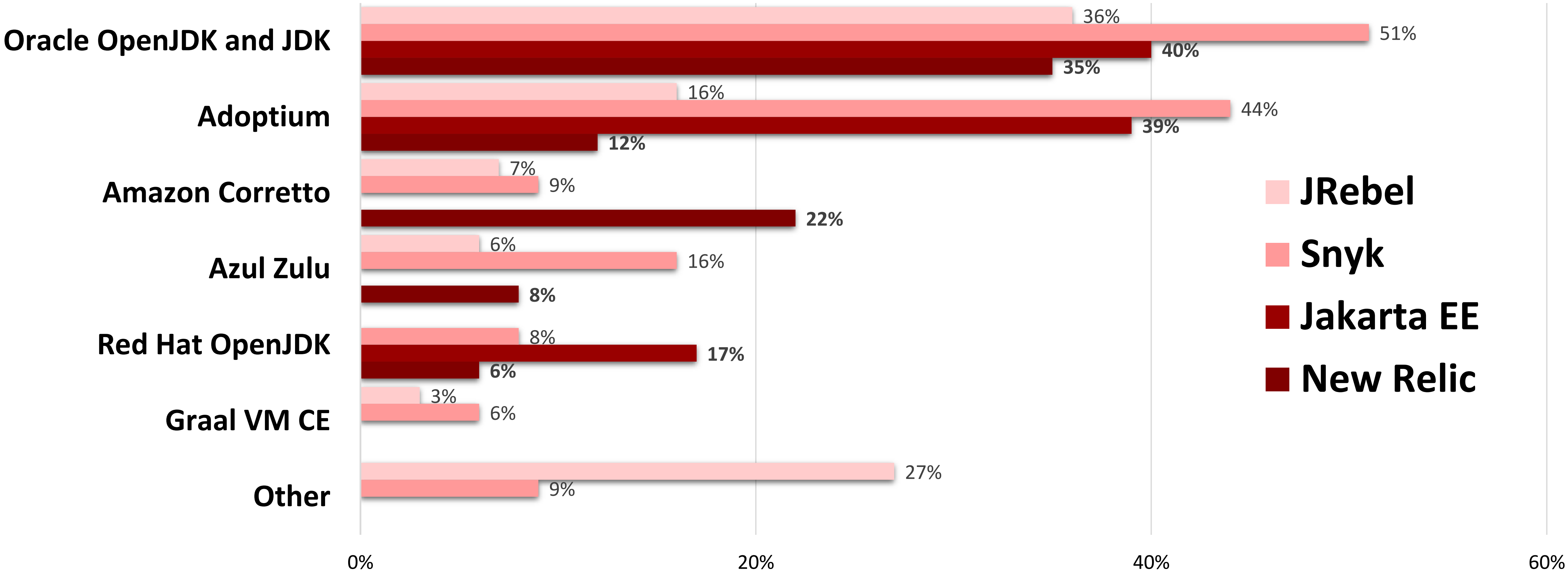


- **JVM languages**? (Snyk)



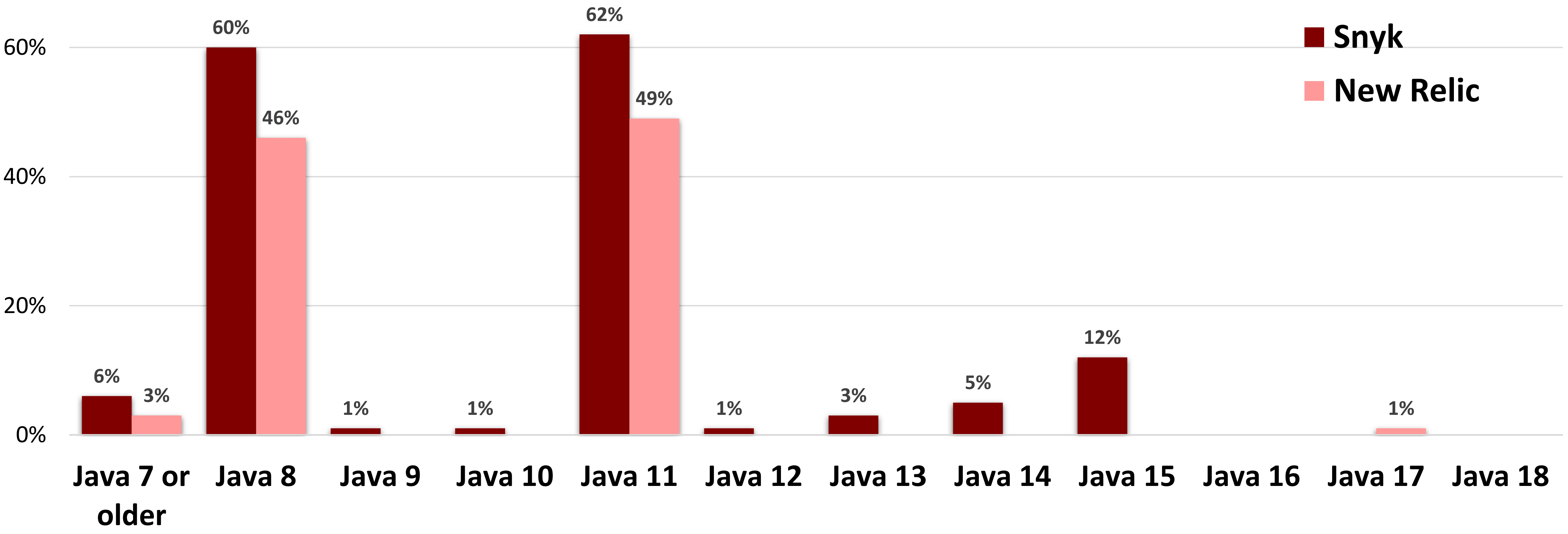
JDK Distributions

- Which **JRE/JDK distribution** do you use?



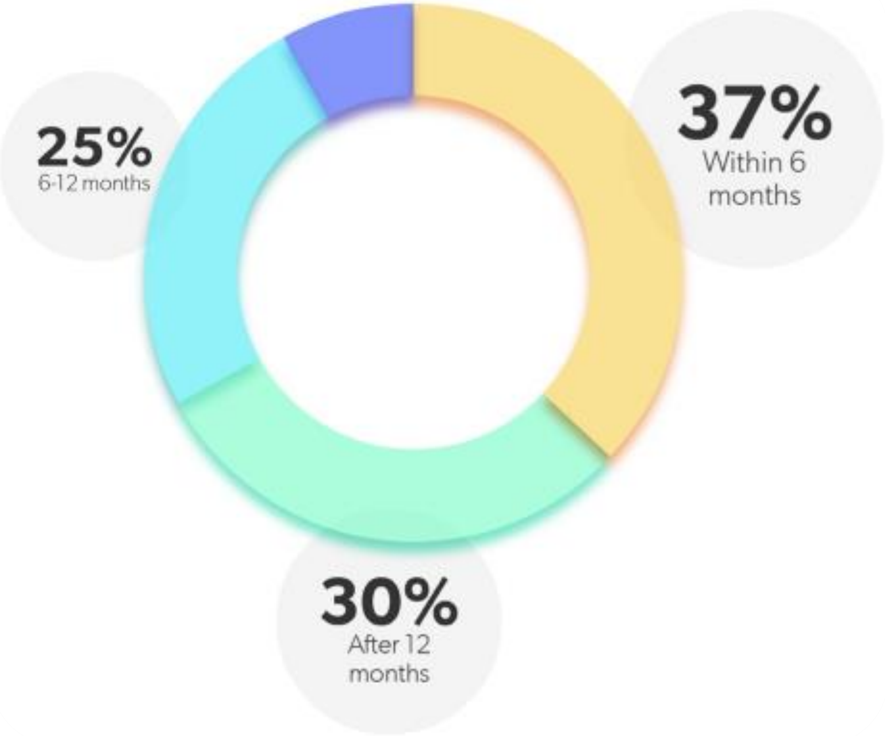
Versions of Java

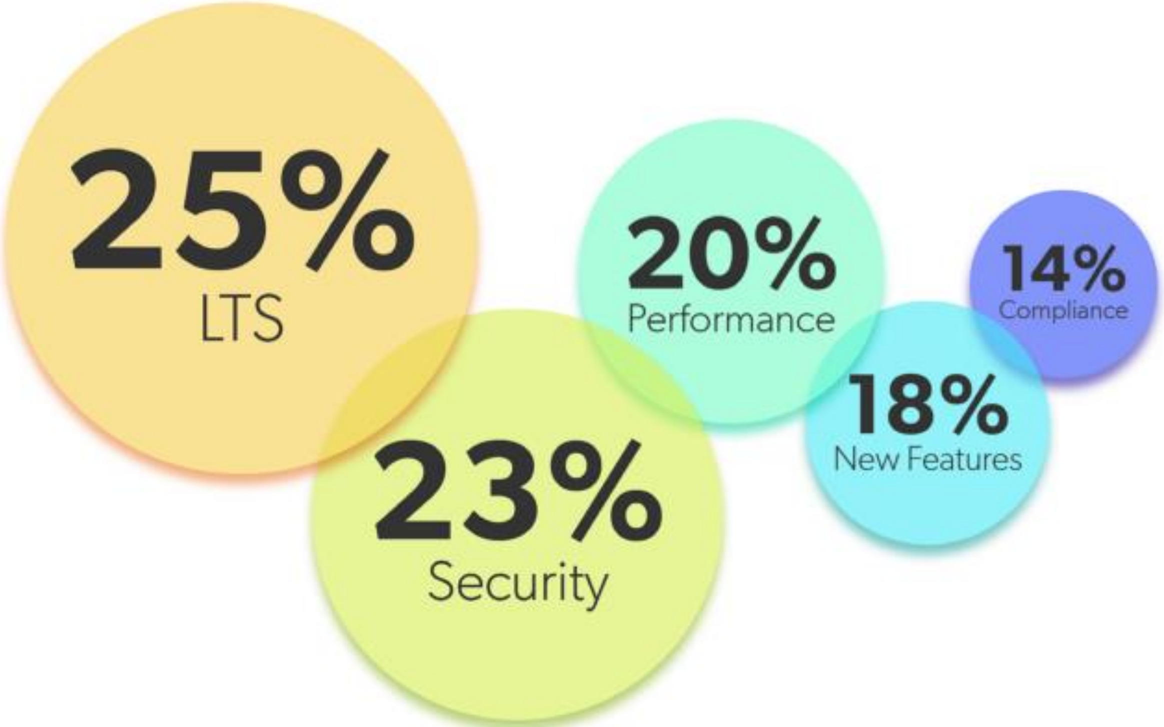
- **Java platform versions** used in projects (in production)



Upgrade to JDK 17

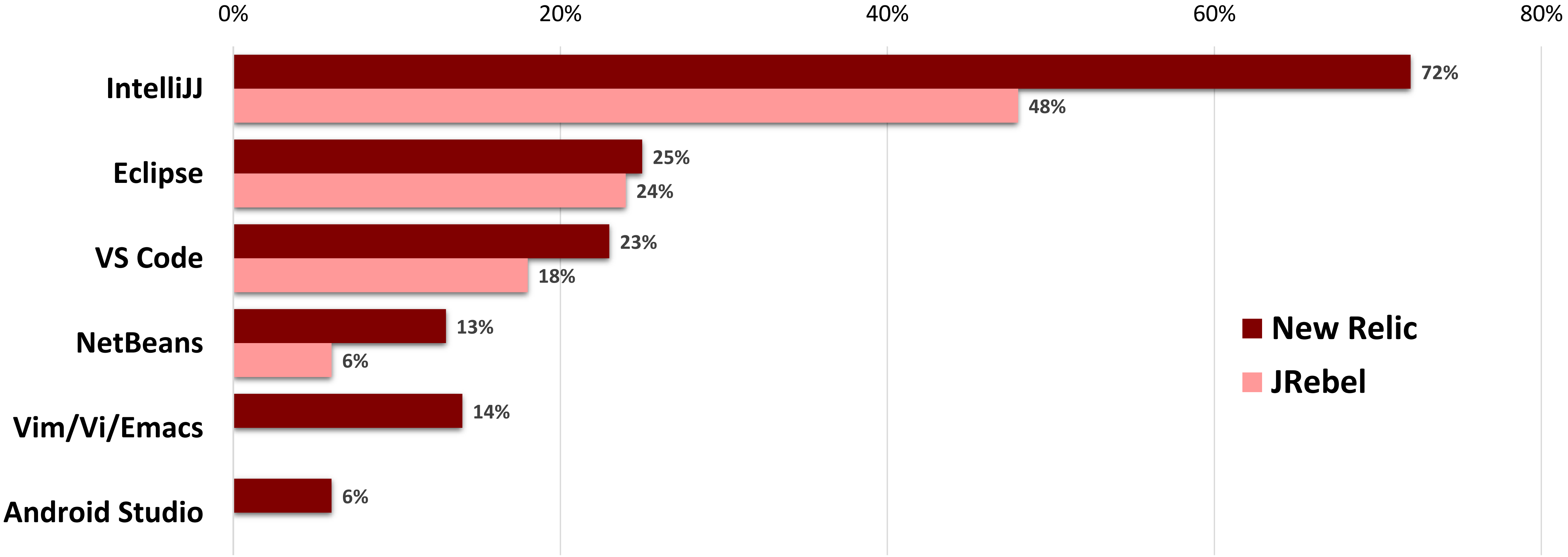
- Which **factors** influence your decision to upgrade JDK Versions? (JRebel)
- When will you upgrade to **JDK 17**? (JRebel)





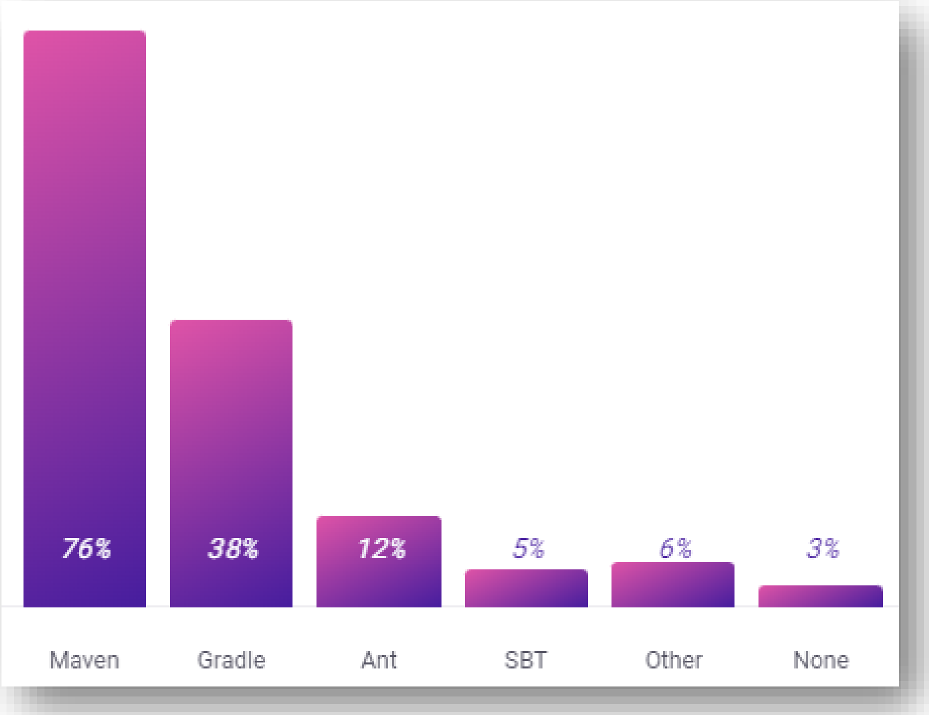
Most popular IDEs

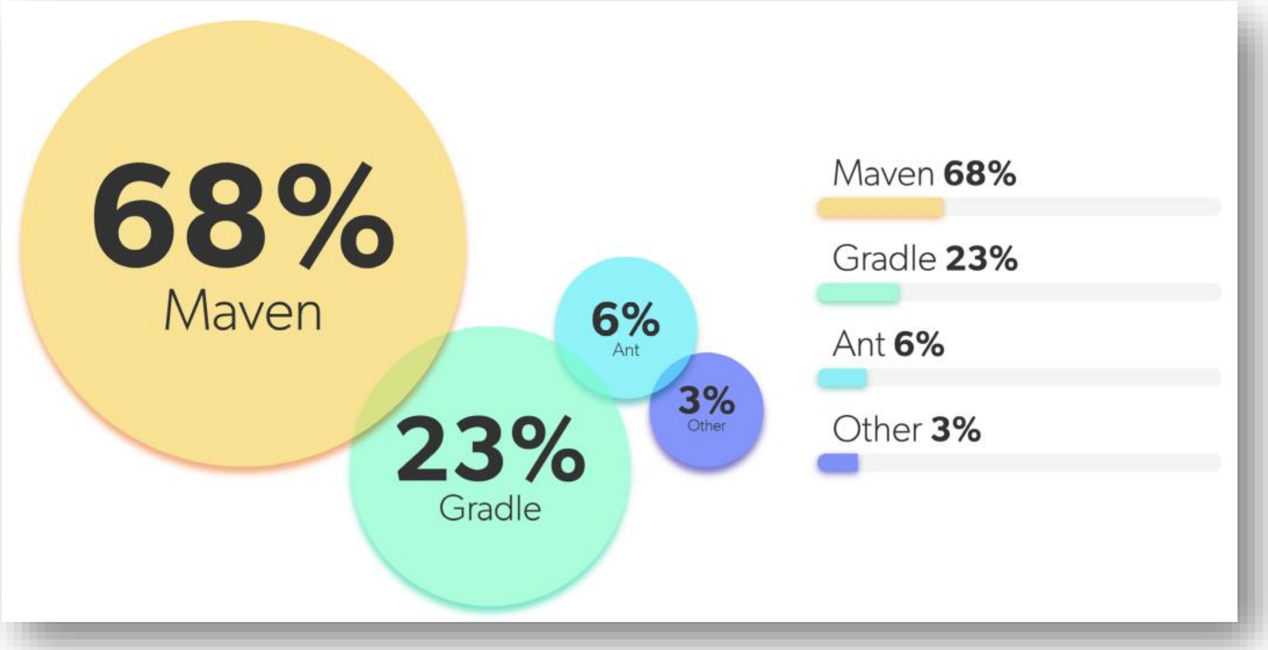
- The most **popular IDEs** used?



Build Tools

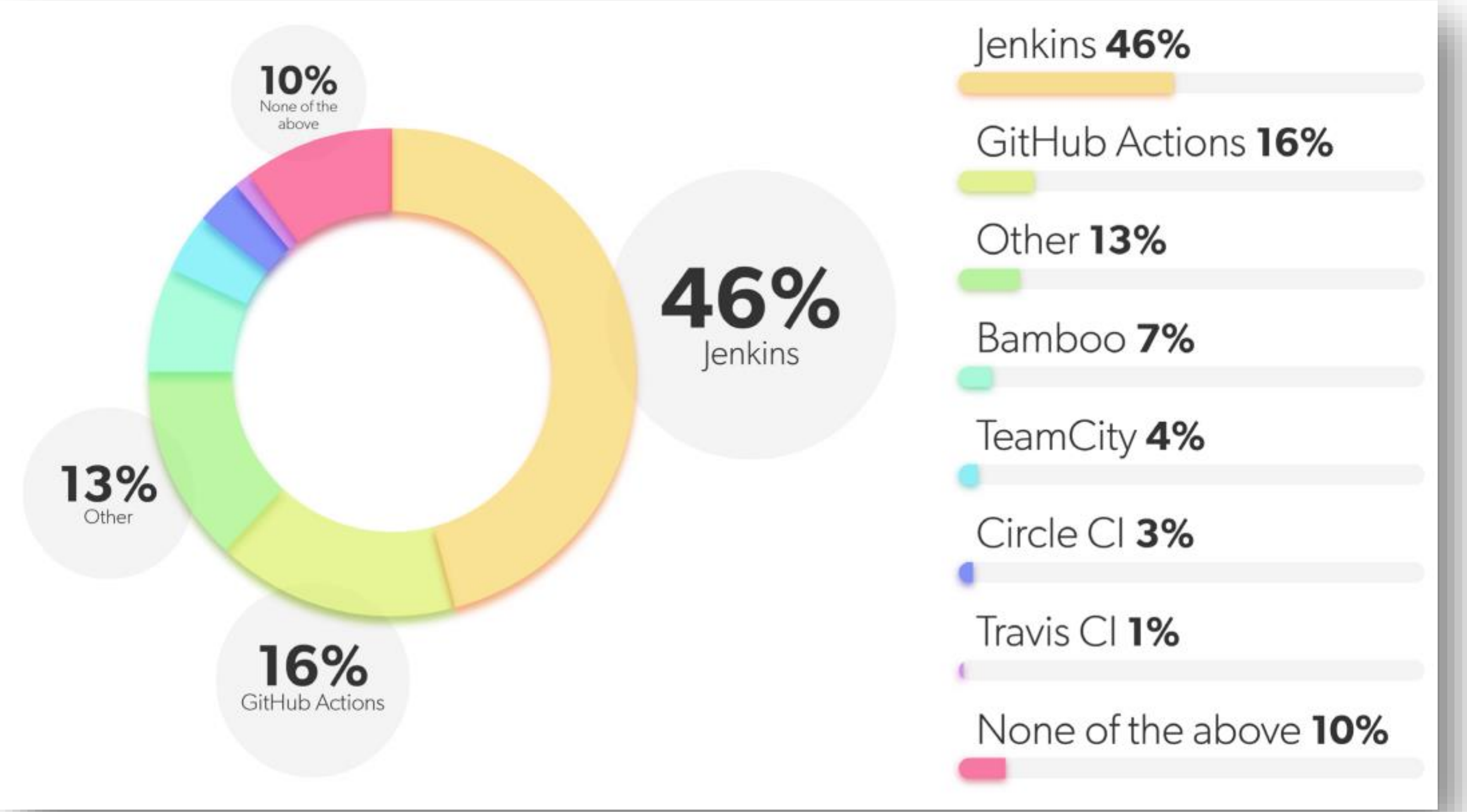
- **Tools for building** applications? (Snyk)
  - What **build tool** do you use in your main application? (JRebel)





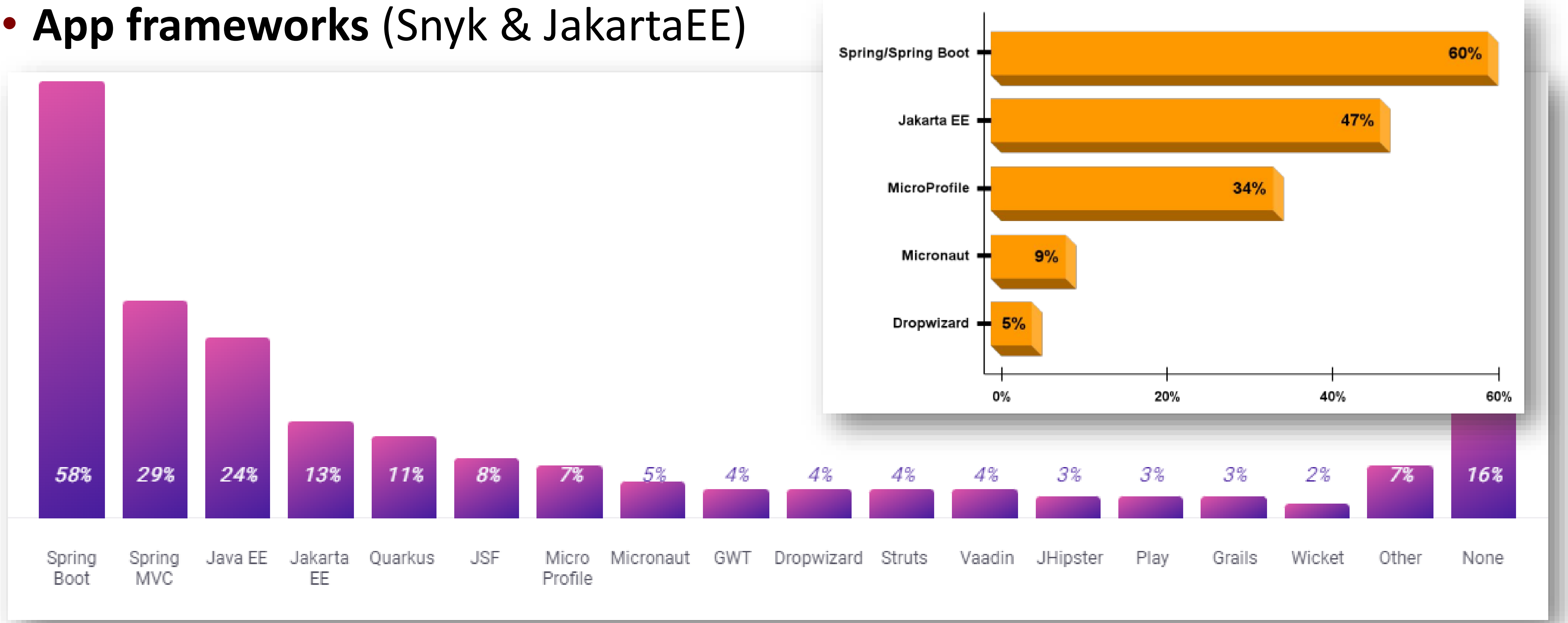
CI/CD

- Which **CI/CD technologies** are you using? (JRebel)



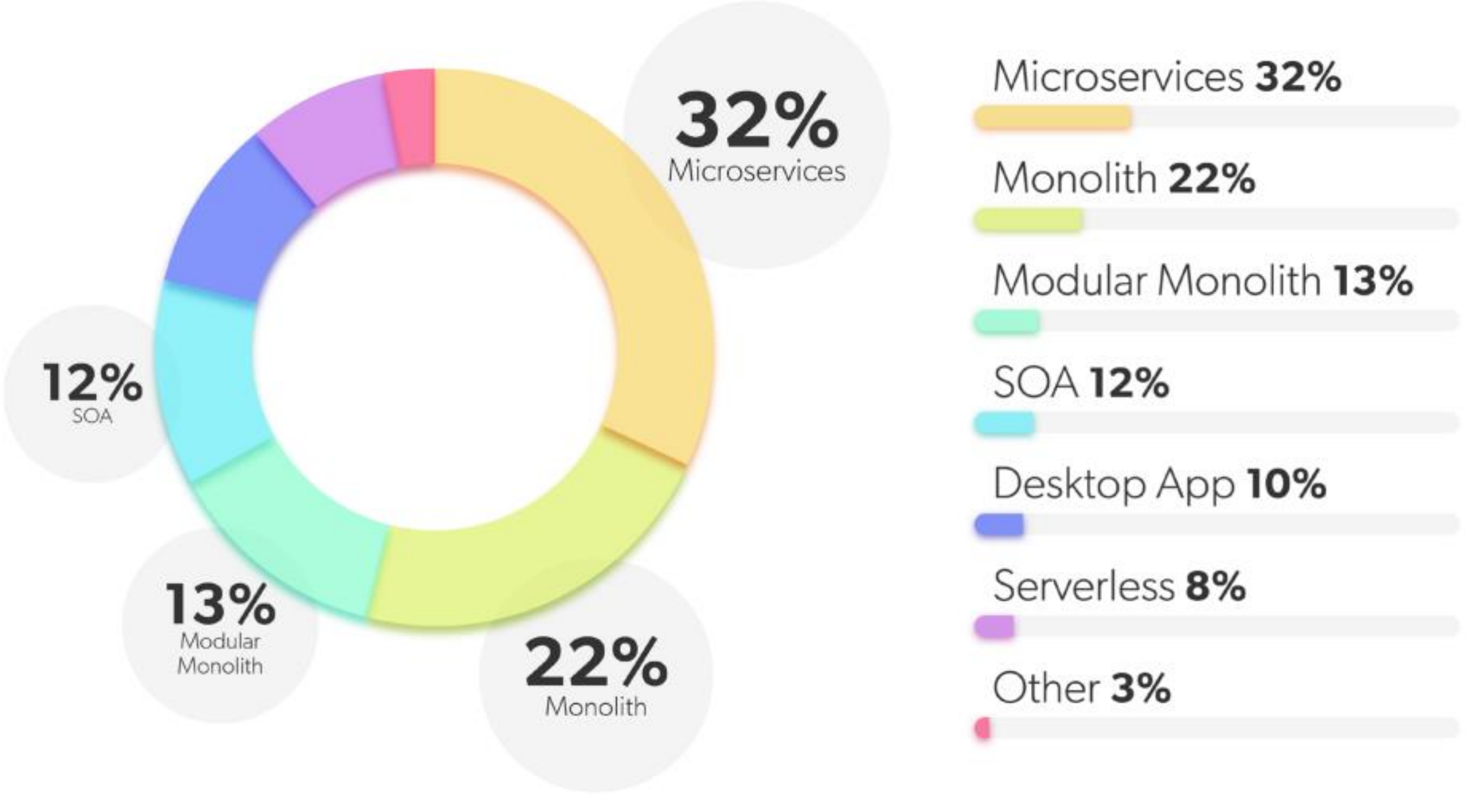
Application frameworks

- **App frameworks** (Snyk & JakartaEE)



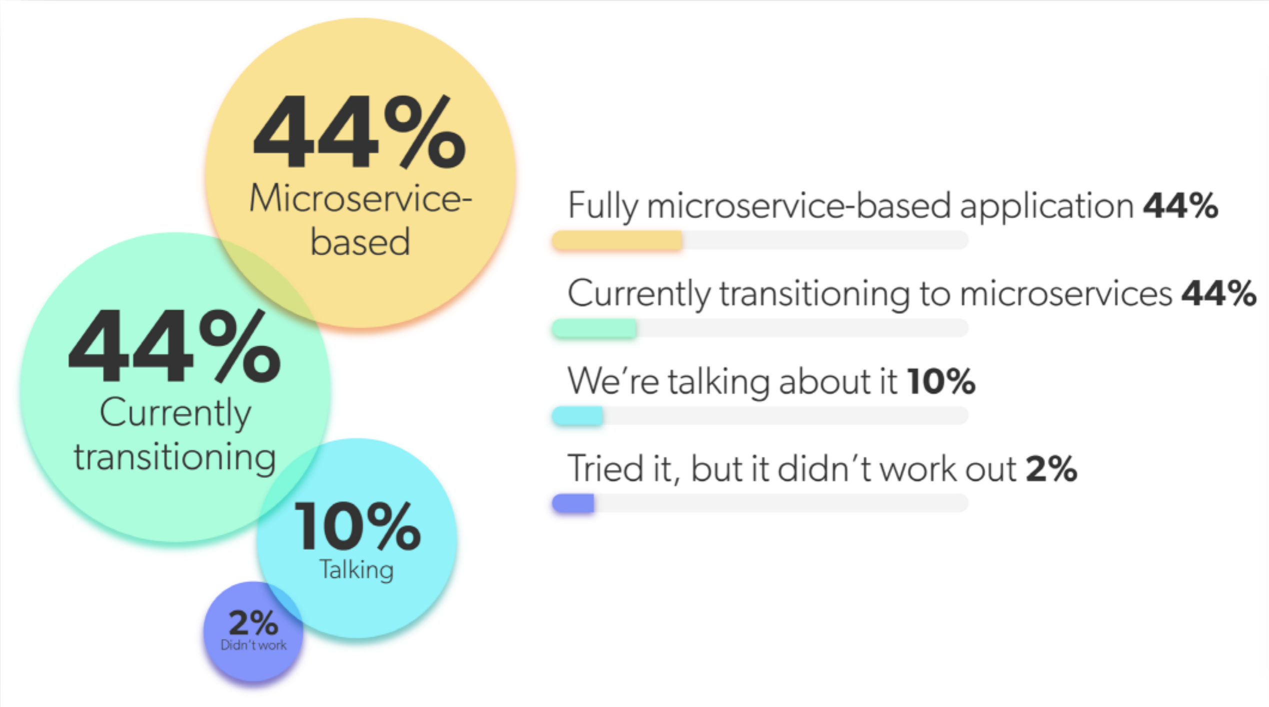
Architecture Trends

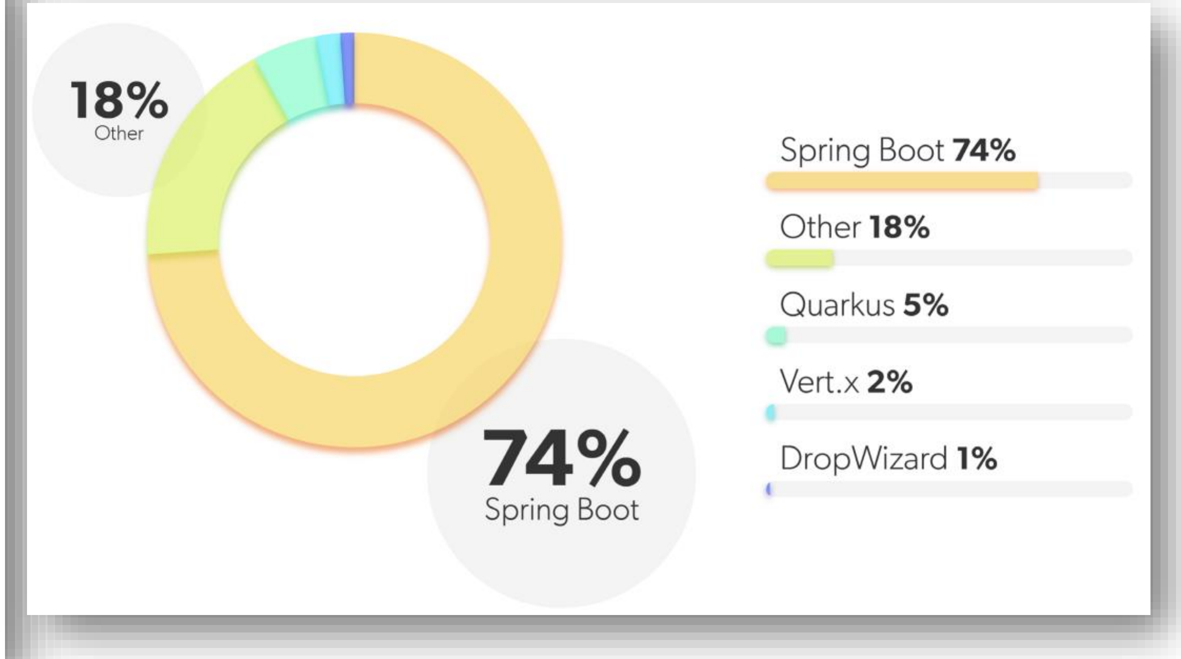
- What is the most used **architecture**?



Microservices

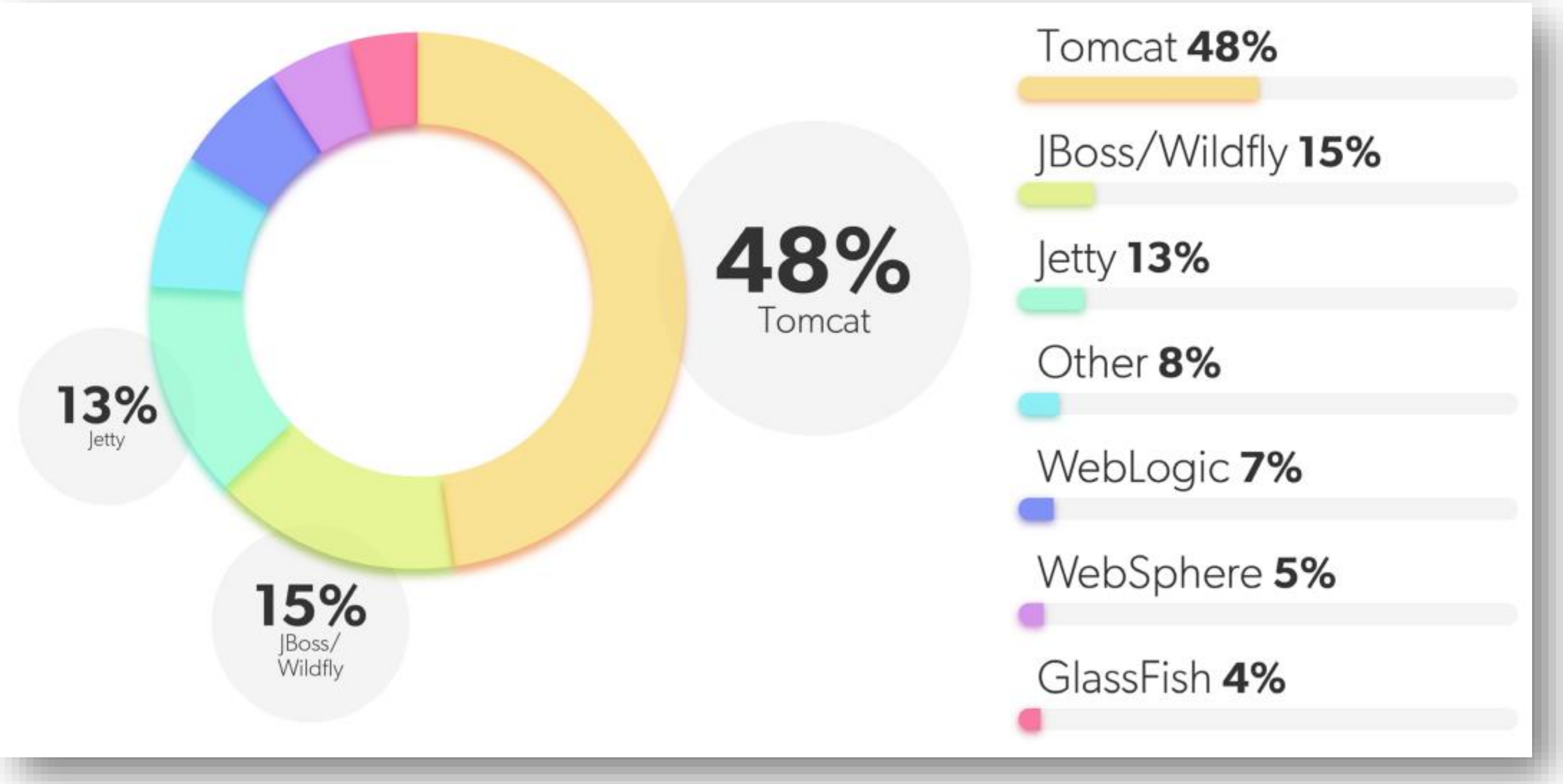
- What is your status for **Microservice** adoption? (JRebel)
- What **Microservice Application Framework** on your main project? (JRebel)





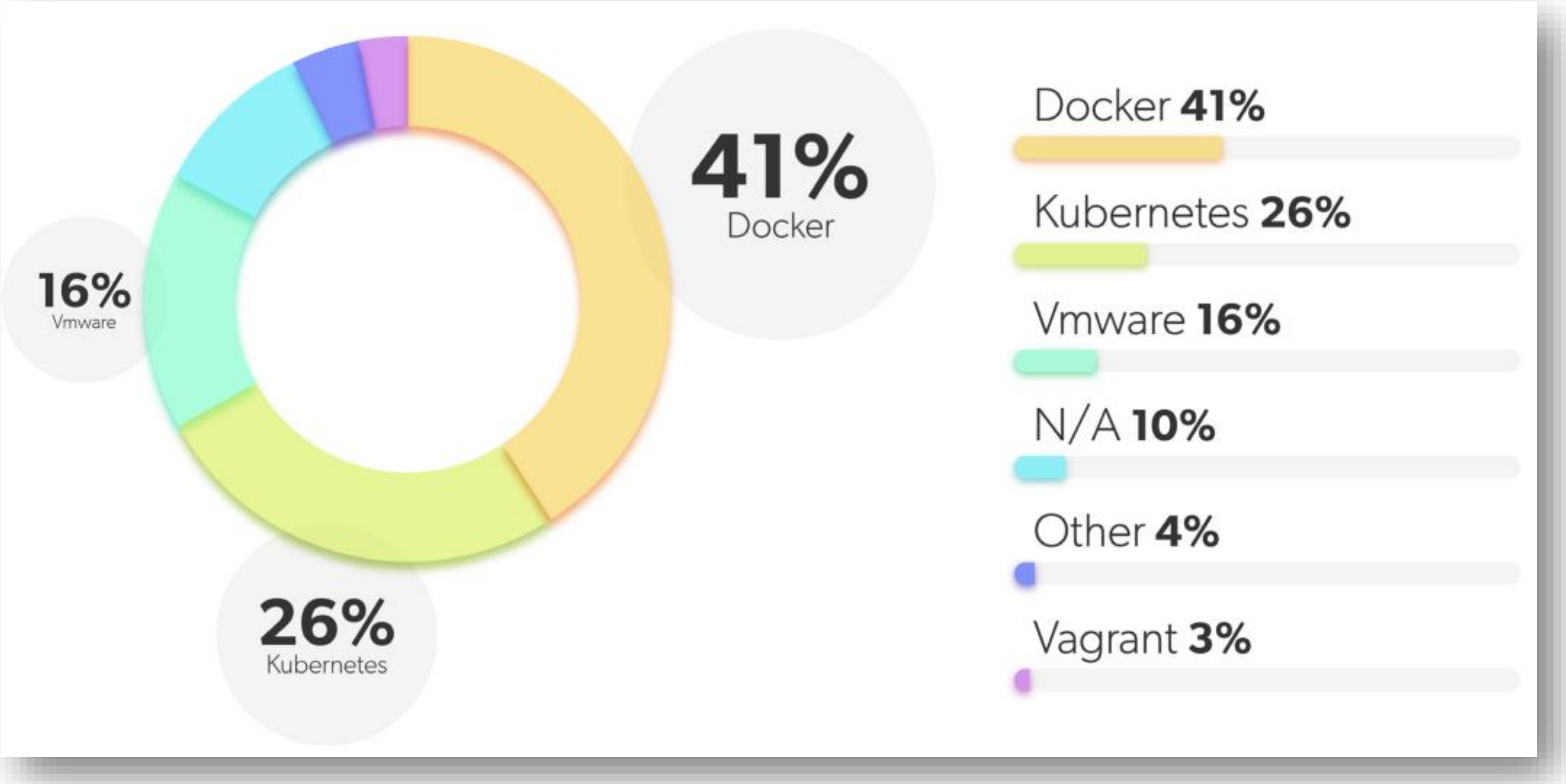
App Servers

- What **Application Server** do you use on your main application? (JRebel)



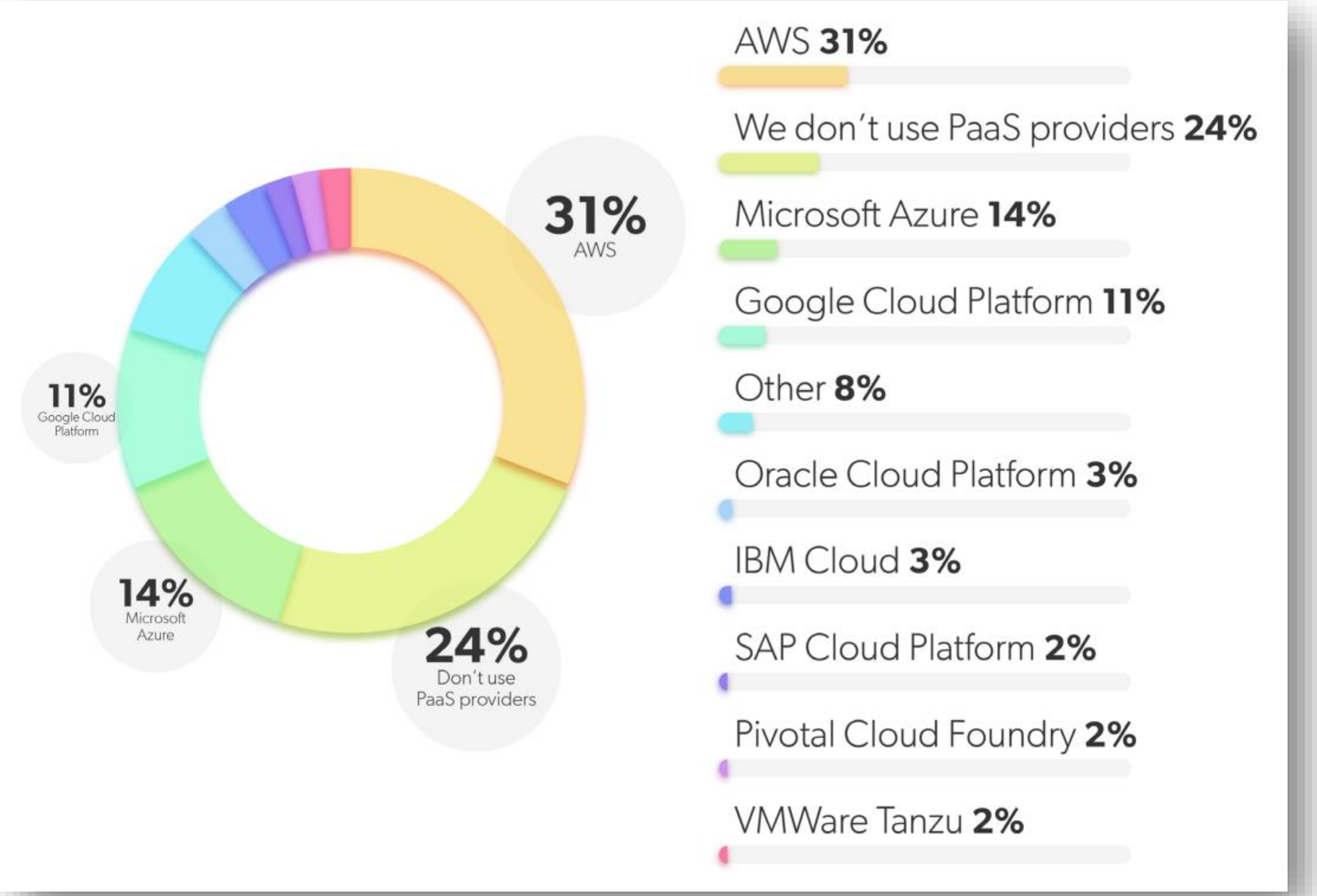
Virtual Machine

- Which **Virtual Machine Platform** do you use? (JRebel)



PaaS Providers

- If you use a platform, who is your **PaaS provider**?



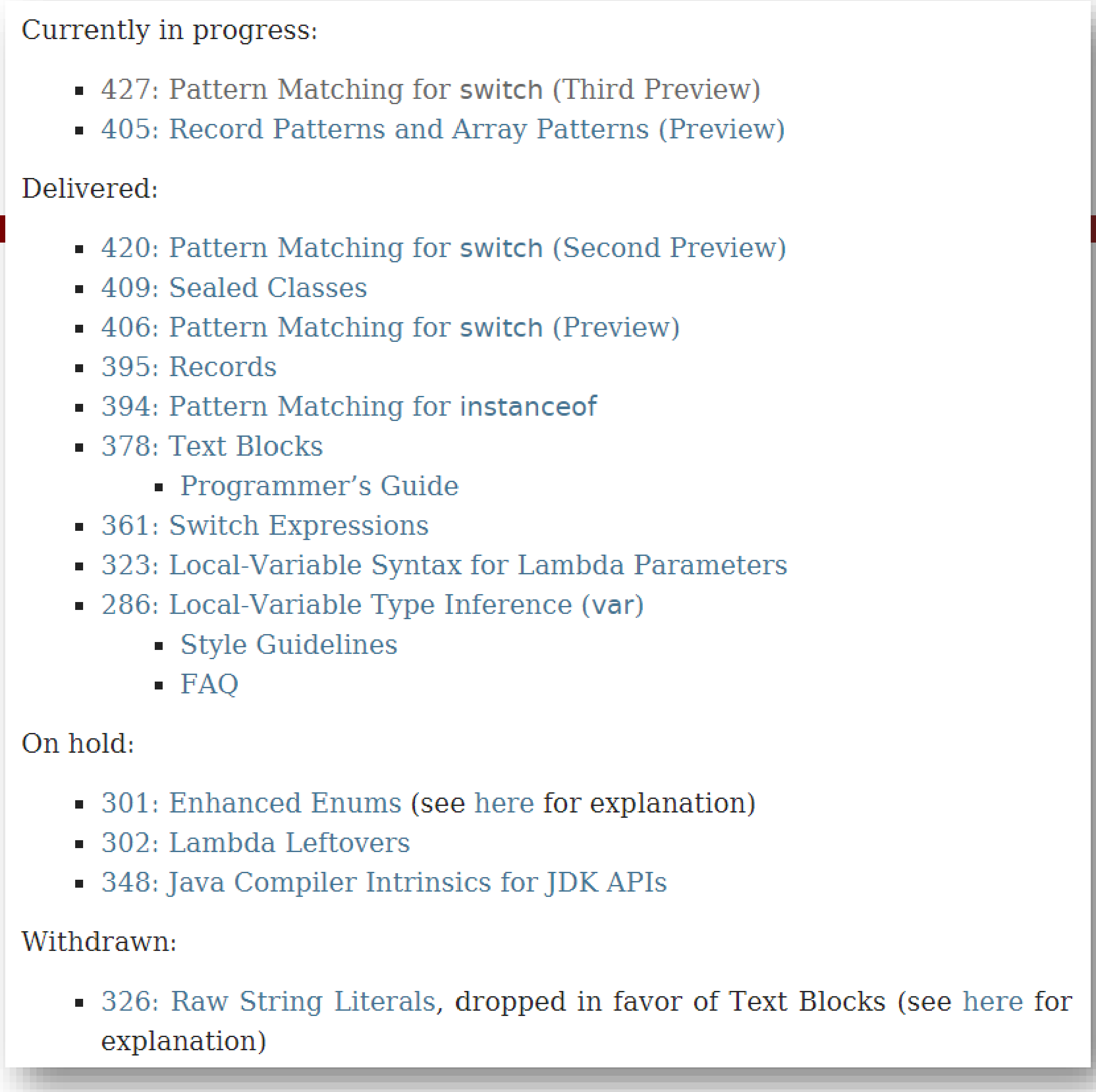
Projects – Long-term Java Future

OpenDJK Projects – https://openjdk.java.net/projects/

- Project **Amber** – incubator for smaller, productivity-oriented **language features** and **simplifying syntax**
- Project **Valhalla** – incubator project for **advanced JVM and language feature** candidates
- Project **Loom** – to **increase performance** and **reduce complexity** in writing concurrent applications
- Project **Panama** – to interconnect JVM and **native** code
- Project **Metropolis** – JVM re-written in Java, i.e. "***Java on Java***"
- Project **Wakefield** – implement JDK support for Linux **Wayland** display server
- Project **Leyden** – improve **start-up time** to achieve peak performance

Project Amber

- **Right-sizing language** ceremony
  - Explore and incubate smaller, productivity-oriented Java language features
  - openjdk.java.net/projects/amber/
- Defined process:
  - First, must be accepted as candidate JEPs under the OpenJDK
  - Most features go through at least one round of *Preview* before becoming an official part of Java SE



Currently in progress:

- 427: Pattern Matching for switch (Third Preview)
- 405: Record Patterns and Array Patterns (Preview)

Delivered:

- 420: Pattern Matching for switch (Second Preview)
- 409: Sealed Classes
- 406: Pattern Matching for switch (Preview)
- 395: Records
- 394: Pattern Matching for instanceof
- 378: Text Blocks
  - Programmer's Guide
- 361: Switch Expressions
- 323: Local-Variable Syntax for Lambda Parameters
- 286: Local-Variable Type Inference (var)
  - Style Guidelines
  - FAQ

On hold:

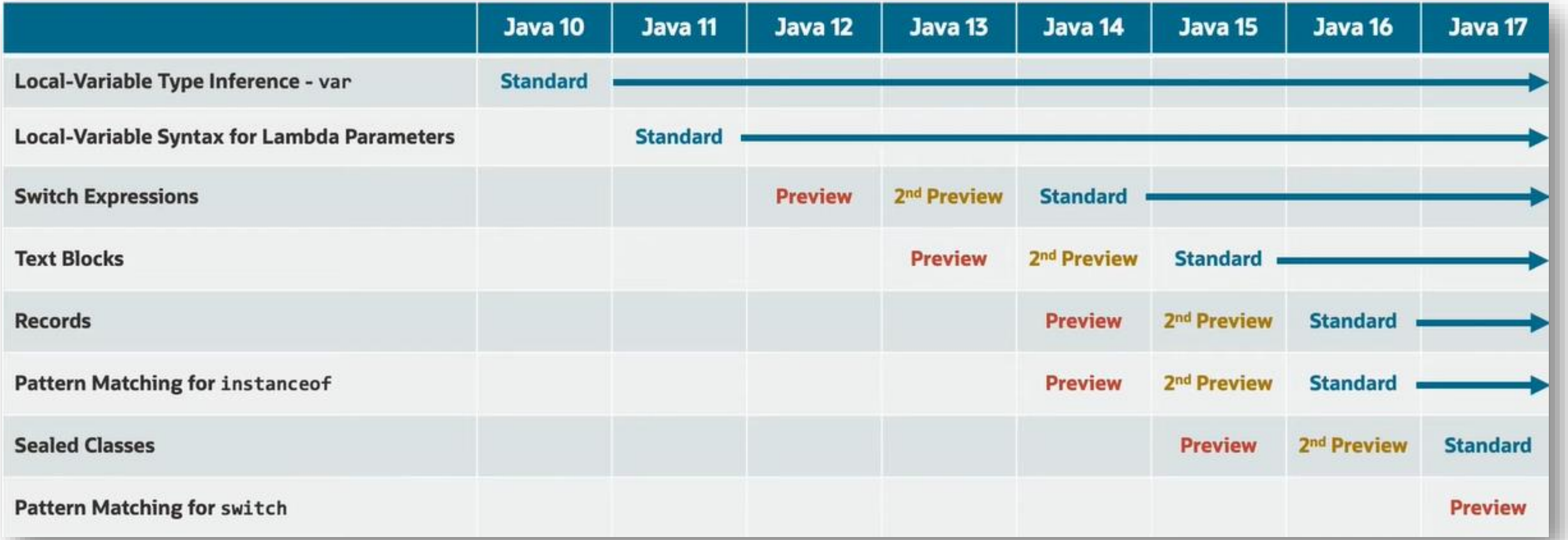
- 301: Enhanced Enums (see here for explanation)
- 302: Lambda Leftovers
- 348: Java Compiler Intrinsics for JDK APIs

Withdrawn:

- 326: Raw String Literals, dropped in favor of Text Blocks (see here for explanation)

Project Amber – Timeline Example

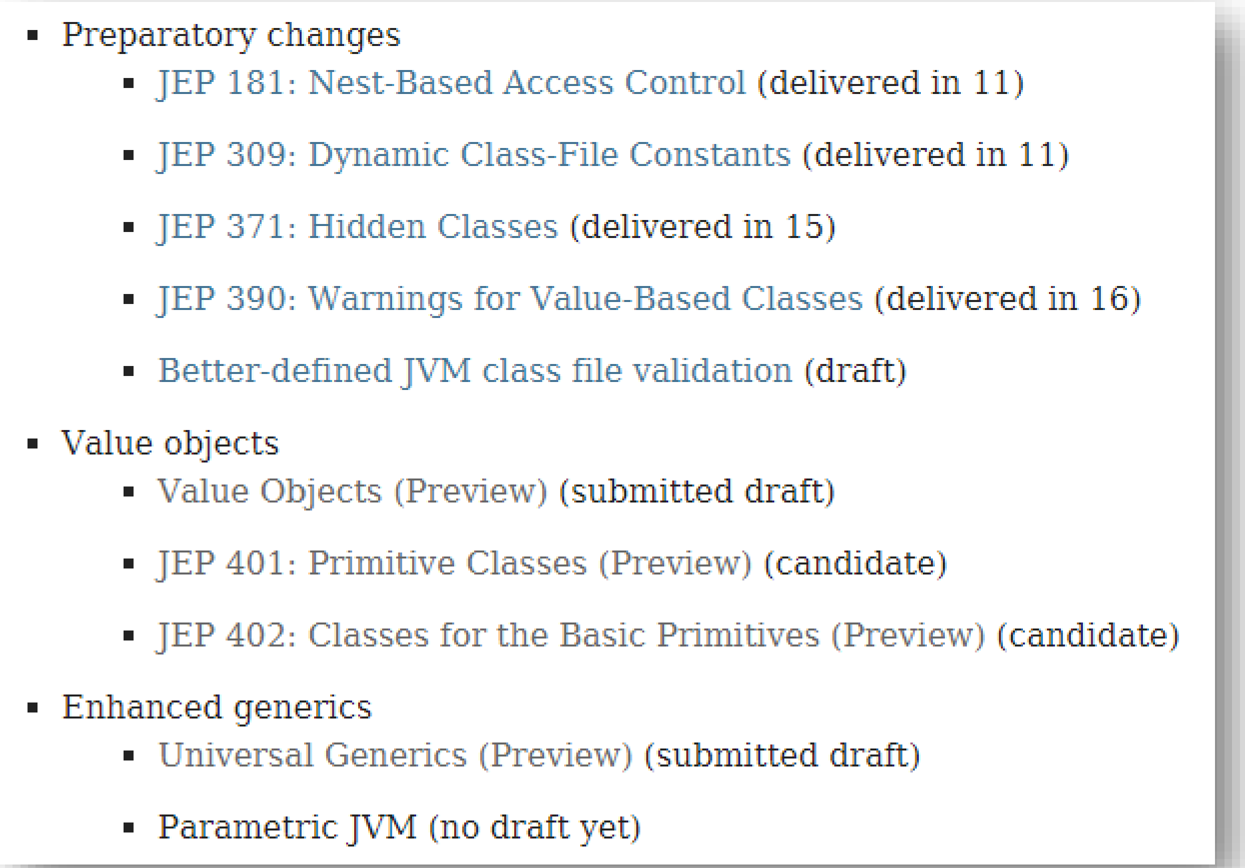
- Improving the programming language continuously



	Java 10	Java 11	Java 12	Java 13	Java 14	Java 15	Java 16	Java 17
Local-Variable Type Inference - `var`	Standard	→	→	→	→	→	→	→
Local-Variable Syntax for Lambda Parameters		Standard	→	→	→	→	→	→
Switch Expressions			Preview	2nd Preview	Standard	→	→	→
Text Blocks				Preview	2nd Preview	Standard	→	→
Records					Preview	2nd Preview	Standard	→
Pattern Matching for `instanceof`					Preview	2nd Preview	Standard	→
Sealed Classes						Preview	2nd Preview	Standard
Pattern Matching for `switch`								Preview

Project Valhalla

- Incubator project for more **advanced Java VM and language feature** candidates
  - openjdk.java.net/projects/valhalla/
- Problems to solve:
  - **Primitives** for performance and **objects** for OO, encapsulation, polymorphism, inheritance…
  - But still, there is no **ArrayList<int>** ☹
  - If we use Integer than (un)boxing, creation of object, heap, indirection reference…



- Preparatory changes
  - JEP 181: Nest-Based Access Control (delivered in 11)
  - JEP 309: Dynamic Class-File Constants (delivered in 11)
  - JEP 371: Hidden Classes (delivered in 15)
  - JEP 390: Warnings for Value-Based Classes (delivered in 16)
  - Better-defined JVM class file validation (draft)
- Value objects
  - Value Objects (Preview) (submitted draft)
  - JEP 401: Primitive Classes (Preview) (candidate)
  - JEP 402: Classes for the Basic Primitives (Preview) (candidate)
- Enhanced generics
  - Universal Generics (Preview) (submitted draft)
  - Parametric JVM (no draft yet)

Project **Valhalla**

- **Value Objects** (Preview) in Draft – "*codes like a class, works like a primitive*"
  - Supports methods, fields, implements interface, encapsulation, generic, but not support mutation or sub-classes
- **Primitive Classes** (JEP 401, Preview) in Candidate
  - Special kinds of value classes that define new developer-declared primitive types
- **Classes for the Basic Primitives** (JEP 402, Preview) in Candidate
  - Repurpose the primitive wrapper classes to act as declarations for the basic primitives (int, double, etc.)
- **Universal Generics** (Preview) in Draft
  - Unify the treatment of reference and primitive types in generic code by allowing Java type variables to range over both kinds of types

Project Panama

- Interconnecting JVM and **native code**
  - Featuring **native function calling** and **native data access** from the JVM
- **Foreign function interface (FFI)** as a simple, safe and performant replacement for JNI, includes:
  - Native function calling from JVM (C, C++)
  - Native data access from JVM or inside JVM heap
  - Native library management APIs and native-oriented JIT optimizations
- Access to low-level hardware functionality from Java (vector instructions, special memory types)?
- Big Data, Machine Learning…

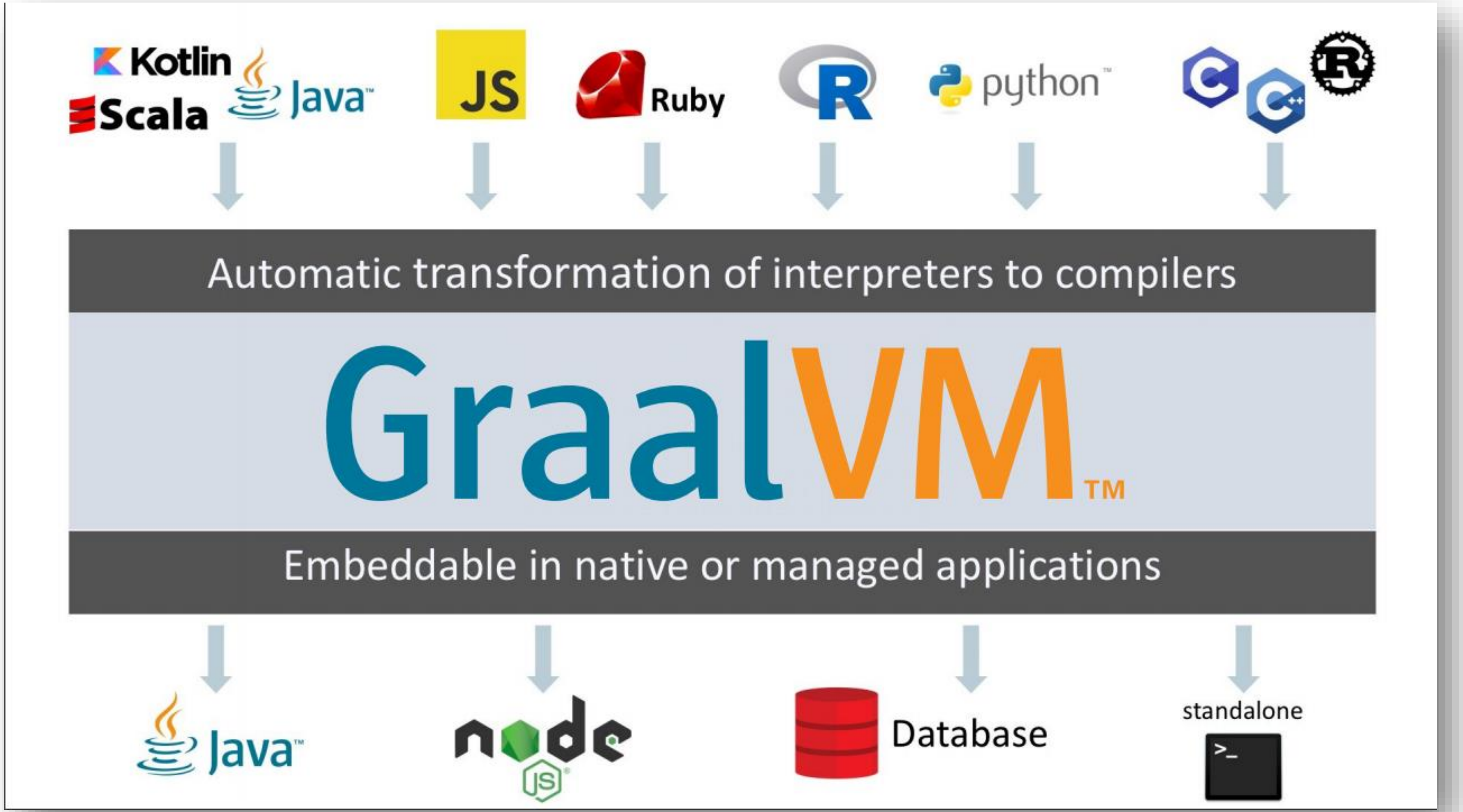
Project Loom

- **Threads** cannot match the scale of the domain’s unit of concurrency
  - Millions of transactions, users or sessions – number of OS threads is much less
- Most concurrent applications need some synchronization between threads
  - An expensive context switch between OS threads
- Project **Loom** – reducing complexity in writing concurrent applications via alternative, **user-mode thread implementations**
- Proposal for lightweight JVM-level threads called **Virtual Threads** as alternative implementation of threads
- Ordinary Java threads preserved, performance improved, and footprint reduced
  - Less memory and almost zero overhead when task switching

Programming Polyglotism & other

- **Polyglot programming** and **cross-language interoperability**
- OpenJDK's Project **Metropolis**
- **GraalVM** – high-performance embeddable polyglot virtual machine
  - **combine different programming languages** that incur almost no overhead
  - In the JVM, into standalone native image, or embedded into large application
- **Graal Compiler** – new optimized compiler for JVM languages
- **Truffle** framework – any other language
- **Sulong** (LLVM) – high-performance Low-Level Virtual Machine bitcode interpreter
- + **Native images** with **Substrate VM**
- **+ Quarkus: Kubernetes** Native Java stack tailored for **GraalVM**

GraalVM – architecture



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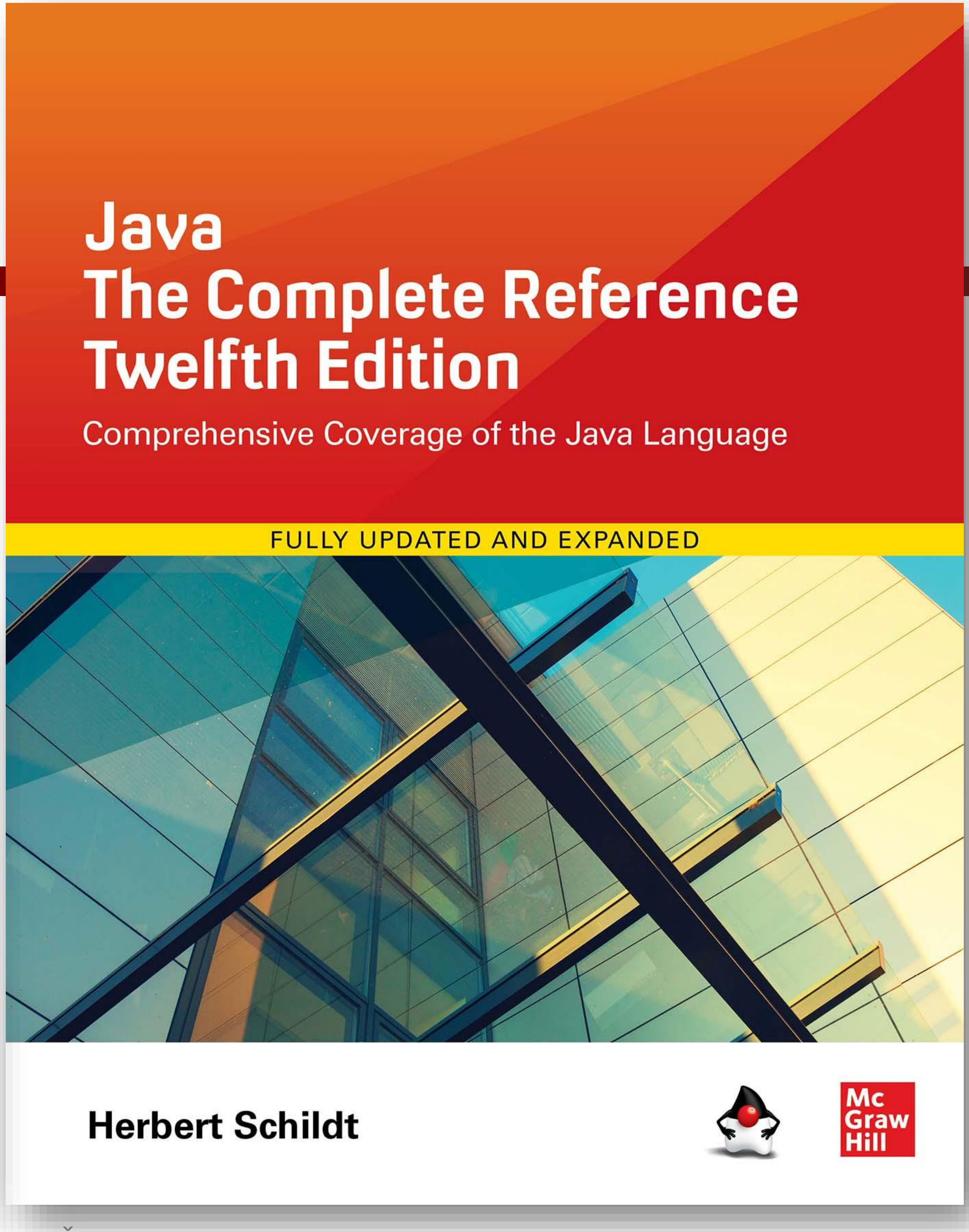
New Books

- **Java: The Complete Reference, 12th ed.,** Herbert Schildt, MGH, November 2021
  - ISBN: 9781260463415
  - 1280 pages
  - 45-60 €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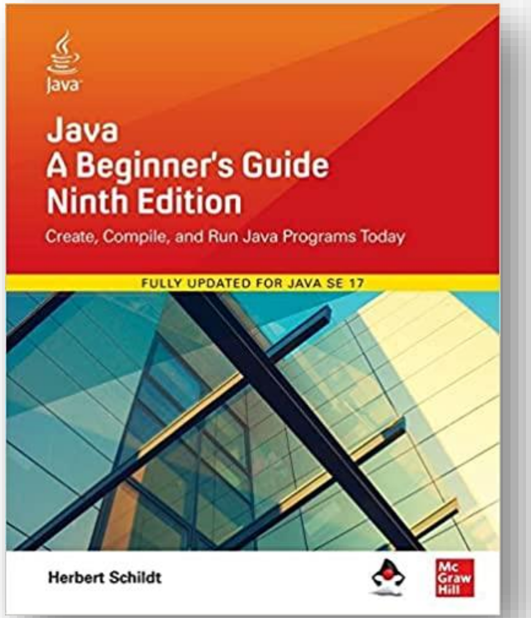
- **Java: A Beginner's Guide, 9th ed.**, Herbert Schildt, MGH, January 2022
  - ISBN: 9781260463552
  - 728 pages
  - 30-35 €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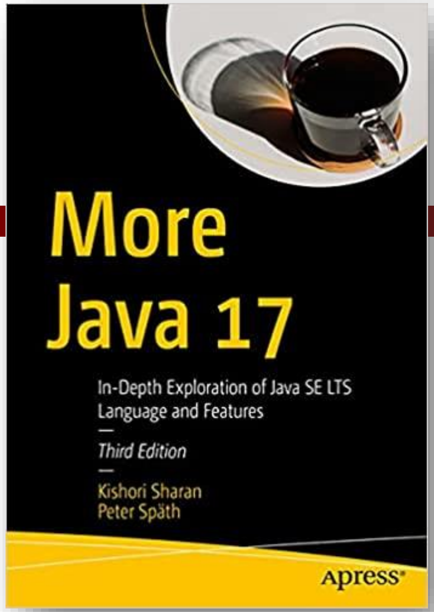
More New Books

- **Beginning Java 17 Fundamentals, 3rd ed.** by Kishori Sharan, Adam L. Davis, Apress, Nov 2021
  - 9781484273067, 800 pages, approx. 45 €
- **More Java 17, 3rd ed.** by Kishori Sharan, Peter Späth, Apress, Dec 2021
  - 9781484271346, approx. 64 €
- **Java 17 Quick Syntax Reference** by Mikael Olsson, Apress, Oct 2021
  - 9781484273708, 218 pages, approx. 26 €
- **Java 17 for Absolute Beginners** by Iuliana Cosmina, Apress, Dec 2021
  - 9781484270790, 600 pages, approx. 42 €



More Java 17

In-Depth Exploration of Java SE LTS Language and Features

Third Edition

Kishori Sharan
Peter Späth

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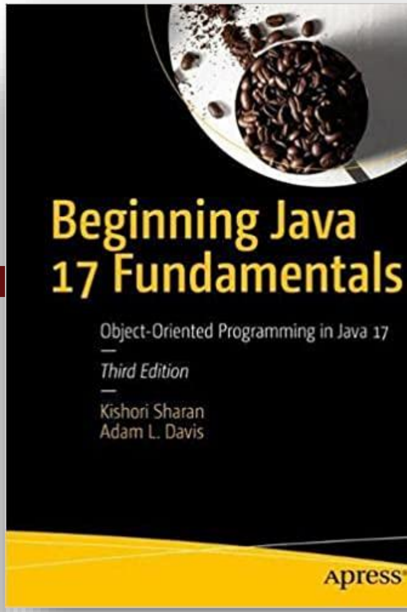

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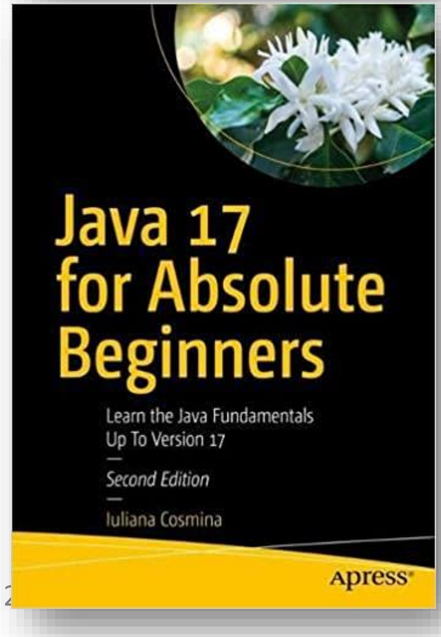

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Learn the Java Fundamentals Up To Version 17

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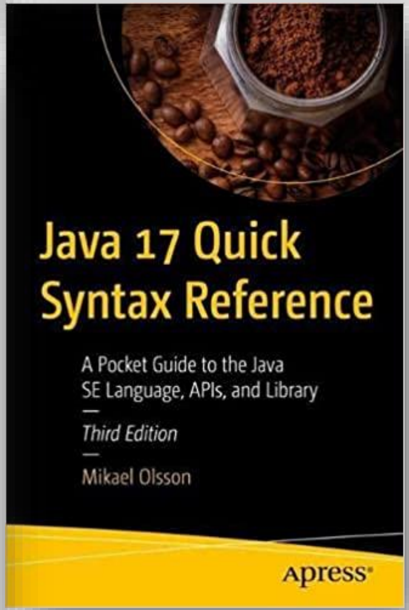

Java 17 Quick Syntax Reference

A Pocket Guide to the Java SE Language, APIs, and Library

Third Edition

Mikael Olsson

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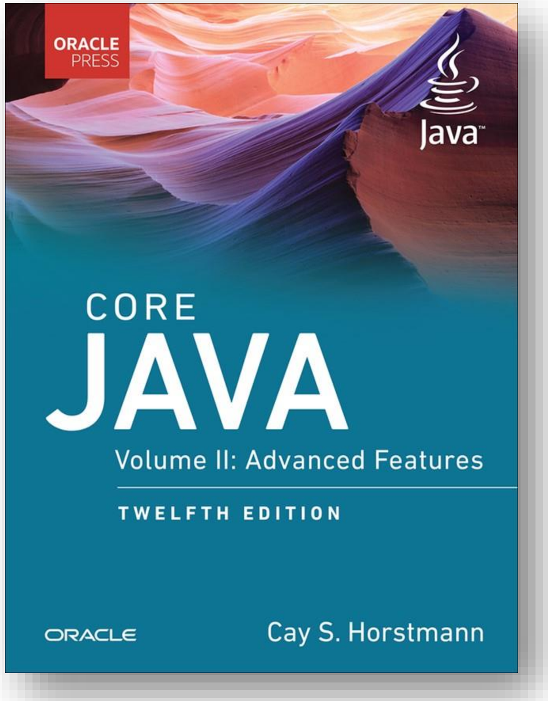
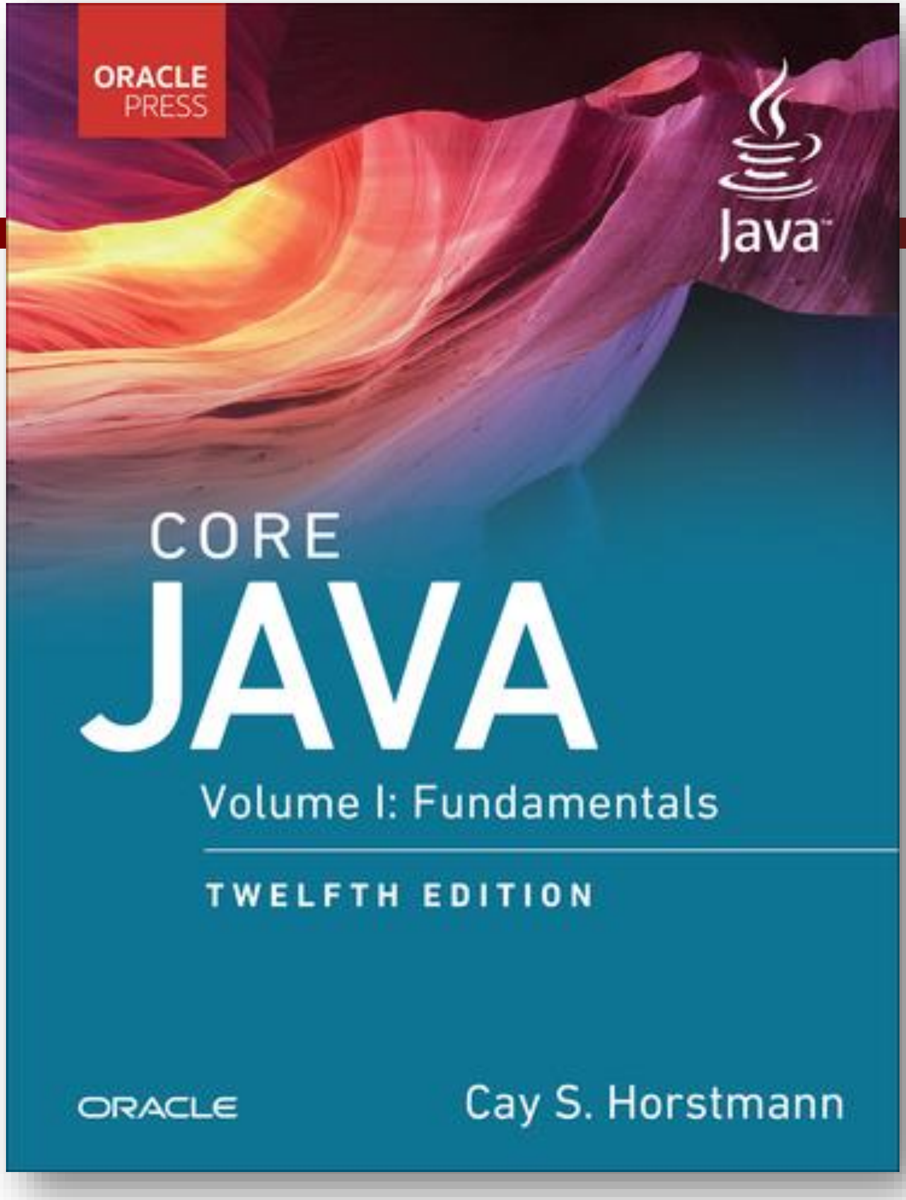
More New **Books**

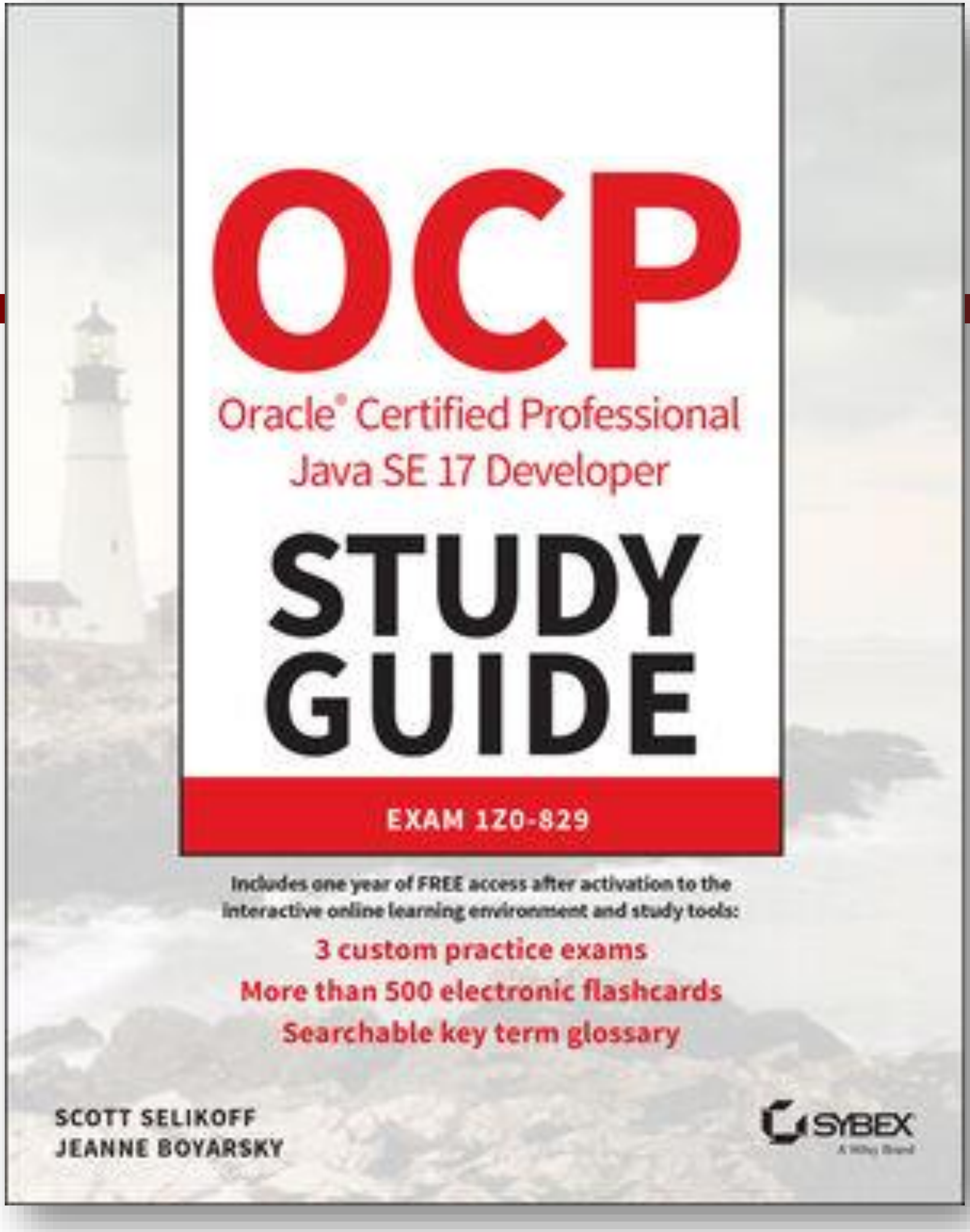
- **Core Java, Volume I: Fundamentals, 12th ed.,** Cay S. Horstmann, December 2021, Oracle Press
  - ISBN: 9780137673629
  - 861 pages
  - Approx. 60 €
- **Core Java, Volume II: Advanced Features, 12th ed.,** Cay S. Horstmann, April 2022, Oracle Press
  - ISBN: 9780137870899
  - 1185 pages
  - Approx. 50 €





OCP Books

- **OCP Oracle Certified Professional Java SE 17 Developer Study Guide: Exam 1Z0-829,** by Scott Selikoff and Jeanne Boyarsky, May 2022, Wiley
  - ISBN: 9781119864585
  - 1056 pages
  - Approx. 60 €



OCP

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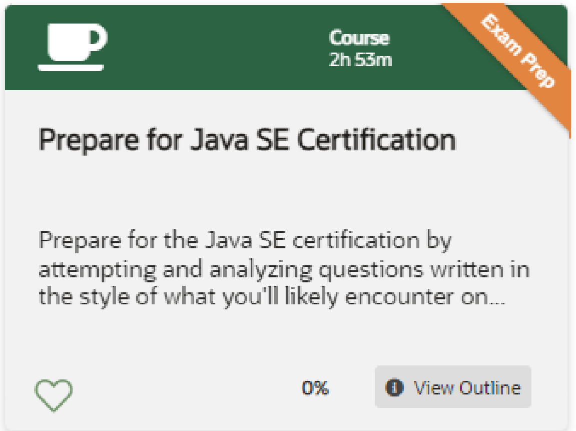

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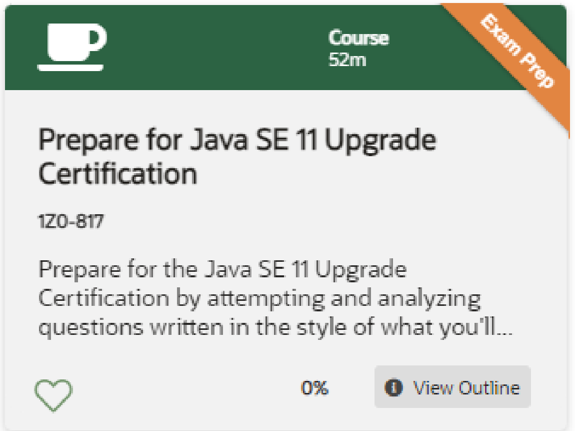

Prepare for Java SE 11 Upgrade Certification

1Z0-817

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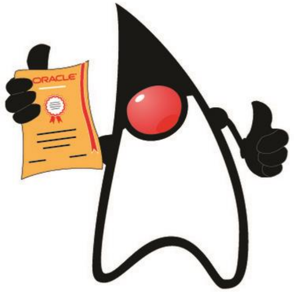
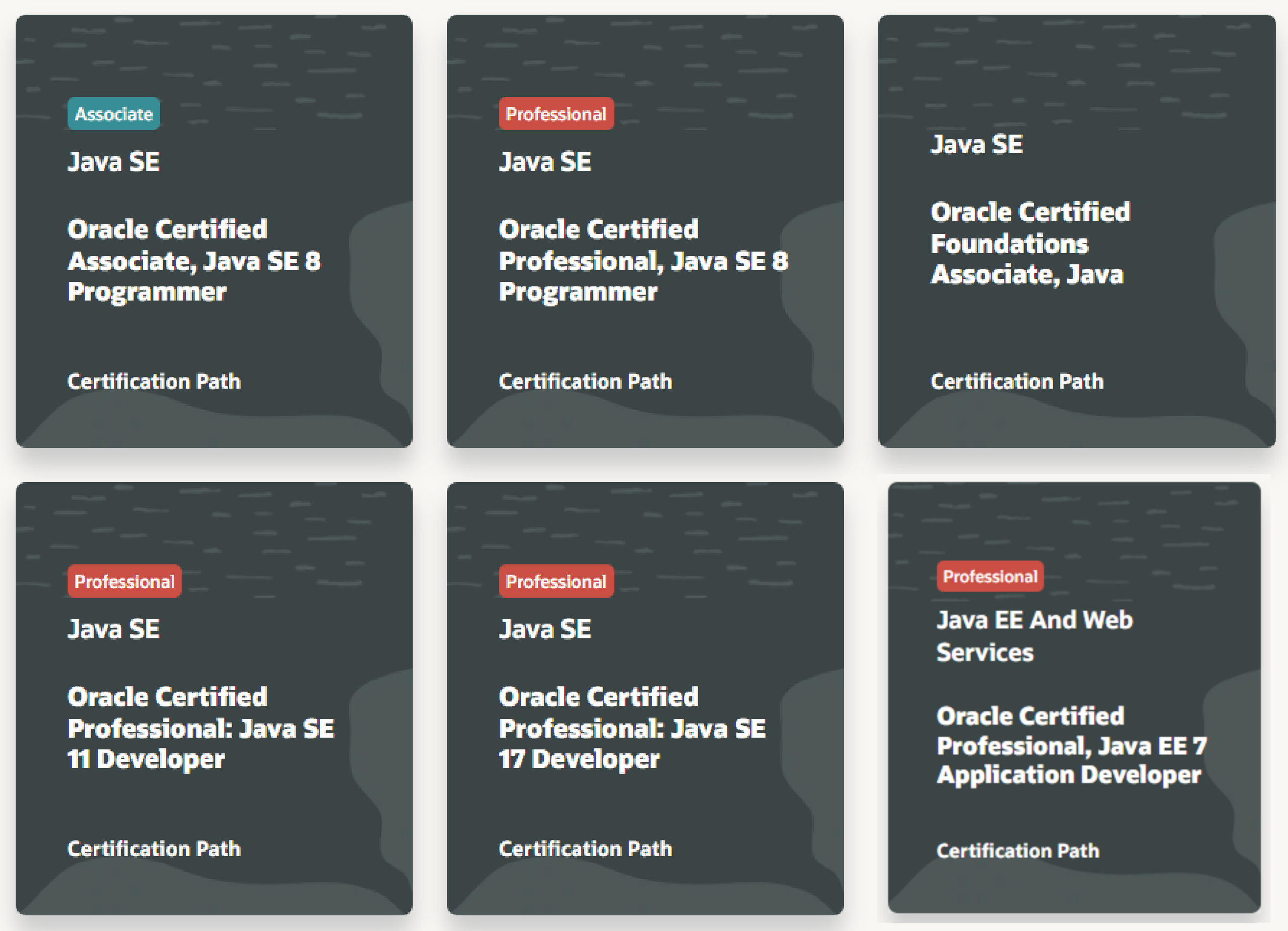
Java **Certification**



- **Oracle Java Certification Paths**

- **Oracle Certified Professional (OCP): Java SE 17 Developer**
- Oracle Certified Professional (OCP): Java SE 11 Developer
- Oracle Certified Professional (OCP): Java SE 8 Developer
- Oracle Certified Associate (OCA), Java SE 8 Programmer
- Oracle Certified Foundations Associate, Java



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Oracle Certified Associate, Java SE 8 Programmer
Certification Path

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Certification Path

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Java SE
Oracle Certified Professional: Java SE 17 Developer
Certification Path

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Java EE And Web Services
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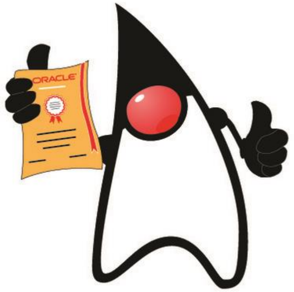
Java Certifications



- **Oracle Certified Professional (OCP): Java SE 17 Developer**
  - Exam: Java SE 17 Developer 1Z0-829
  - Price: 1634 kn | Duration: 90 Minutes | Passing Score: 68%
- **Oracle Certified Professional (OCP): Java SE 11 Developer**
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  - Price: 1634 kn | Duration: 90 Minutes | Passing Score: 68%
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  - Price: 634 kn | Duration: 150 Minutes | Passing Score: 65%
  - Part of Oracle Academy offerings for students

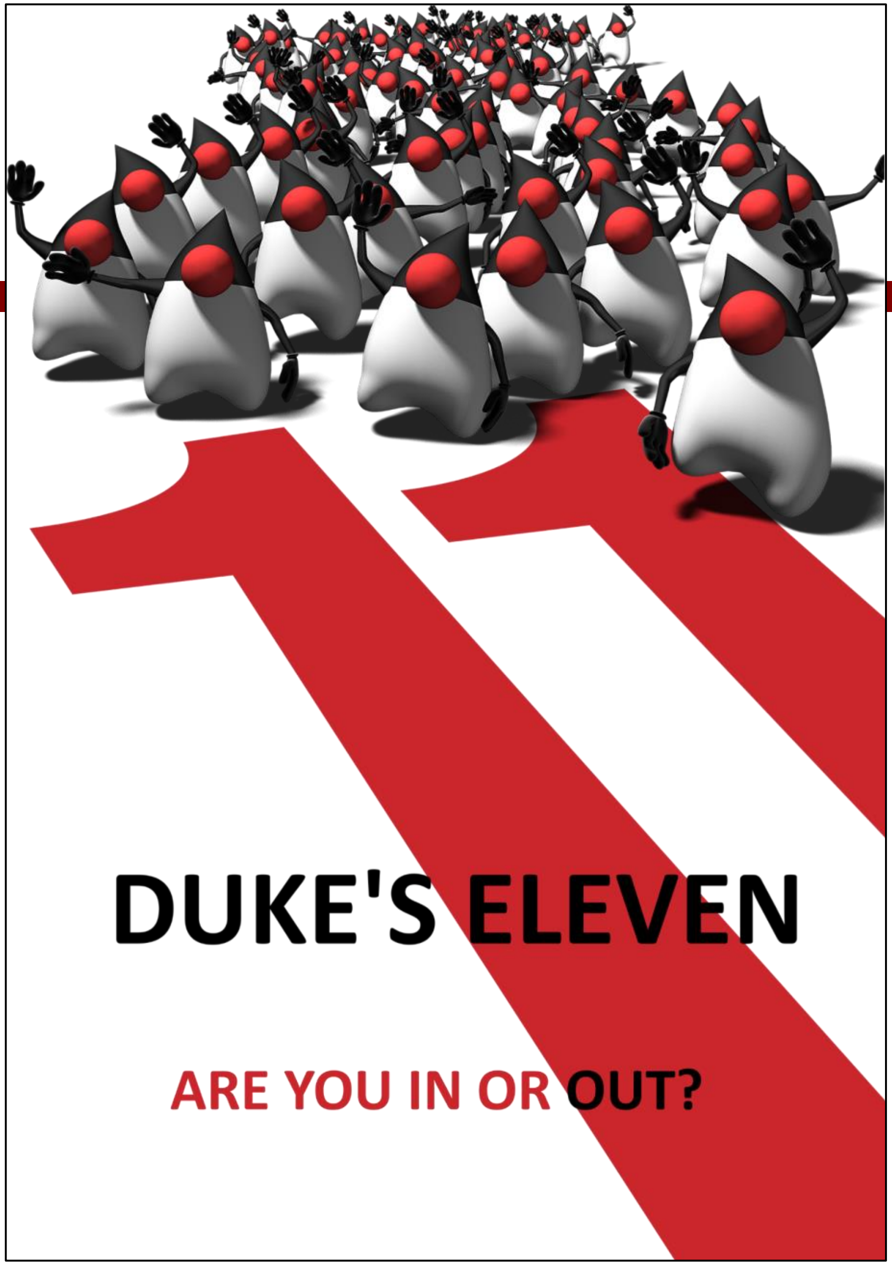
Is Java really "Moving Forward Faster"?

- Community opinion ☺
- More frequent Java releases every 6 months
- Java LTS releases every 2 years
- Faster access to new features
- Many new improvement ideas
- A lot of maintenance and housekeeping
- Java is (finally) free

Looking forward to new things!

What is our **advice**?

- Obviously – **use Java 17 LTS** ☺
  or the latest **Java 18**
  or at least use **Java 11 LTS**
- **Any JDK** or any other – **it's up to you** ☺
- Try to **abandon older versions** (Java 8 or older)
- **Check** what is **@Deprecated**
- **Migrate** every **6 months** or **2 years** (with LTS)
- **Get involved** more with **HUJAK** and
  visit more to **conferences**!



Instead of conclusion…

Call for Speakers
will open soon for
JavaCro'22 Fall
in **October** in **Rovinj**

Thank you & greetings from HUJAK!

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