Best of Modern Java 21 – 23
My Favorites

https://github.com/Michaeli71/Best-Of-Modern-Java-21-23-My-Favorites

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Speaker Intro

- **Michael Inden**, Year of Birth 1971
- Diploma Computer Science, C.v.O. Uni Oldenburg
- ~8 ¼ Years **SSE** at Heidelberger Druckmaschinen AG in Kiel
- ~6 ¾ Years **TPL, SA** at IVU Traffic Technologies AG in Aachen
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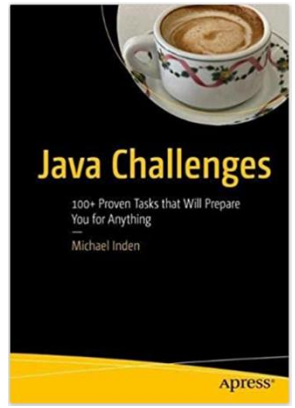


https://github.com/Michaeli71/Best-Of-Modern-Java-21-23-My-Favorites

All Time Favorites + My Top 10 from Java 21 LTS to Java 23

All Time Favorites:

- ATF1: Switch Expressions / Text Blocks / Records (Java 17)
- ATF2: Helpful `NullPointerExceptions` / Pattern Matching for instanceof (Java 17)

My top 10 from Java 21 LTS to Java 23:

1. Record Patterns (Java 21)
2. Pattern Matching for switch (Java 21)
3. Virtual Threads (Java 21)
4. *Structured Concurrency (Preview) (Java 21 & 23)*
5. Unnamed Variables & Patterns (Java 21 & 22)
6. Markdown Comments (Java 23)
7. *Flexible Constructor Bodies (Second Preview) (Java 23)*
8. Launch Multi-File Source-Code Programs (Java 22)
9. *Stream Gatherers (Second Preview) (Java 23)*
10. *Implicitly Declared Classes and Instance Main Methods (Third Preview) (Java 23)*

Build-Tools, IDEs and Sandbox

IDE & Tool Support for Java 21 LTS

- Eclipse: Version 2023-12 (not all Previews supported)
- IntelliJ: Version 2023.3.x
- Maven: 3.9.6, Compiler Plugin: 3.11.0
- Gradle: 8.5
- Activation of preview features / Incubator necessary
  - In dialogs
  - In build scripts

Maven™

Gradle

IDE & Tool Support for Java 23

- **Eclipse: Version 2024-09 (with Plugin)**
- **IntelliJ: Version 2024.2.2**
- **Maven: 3.9.9, Compiler Plugin: 3.13.0**
- **Gradle: 8.10**
- **Activation of preview features / Incubator necessary**
  - In dialogs
  - In build scripts

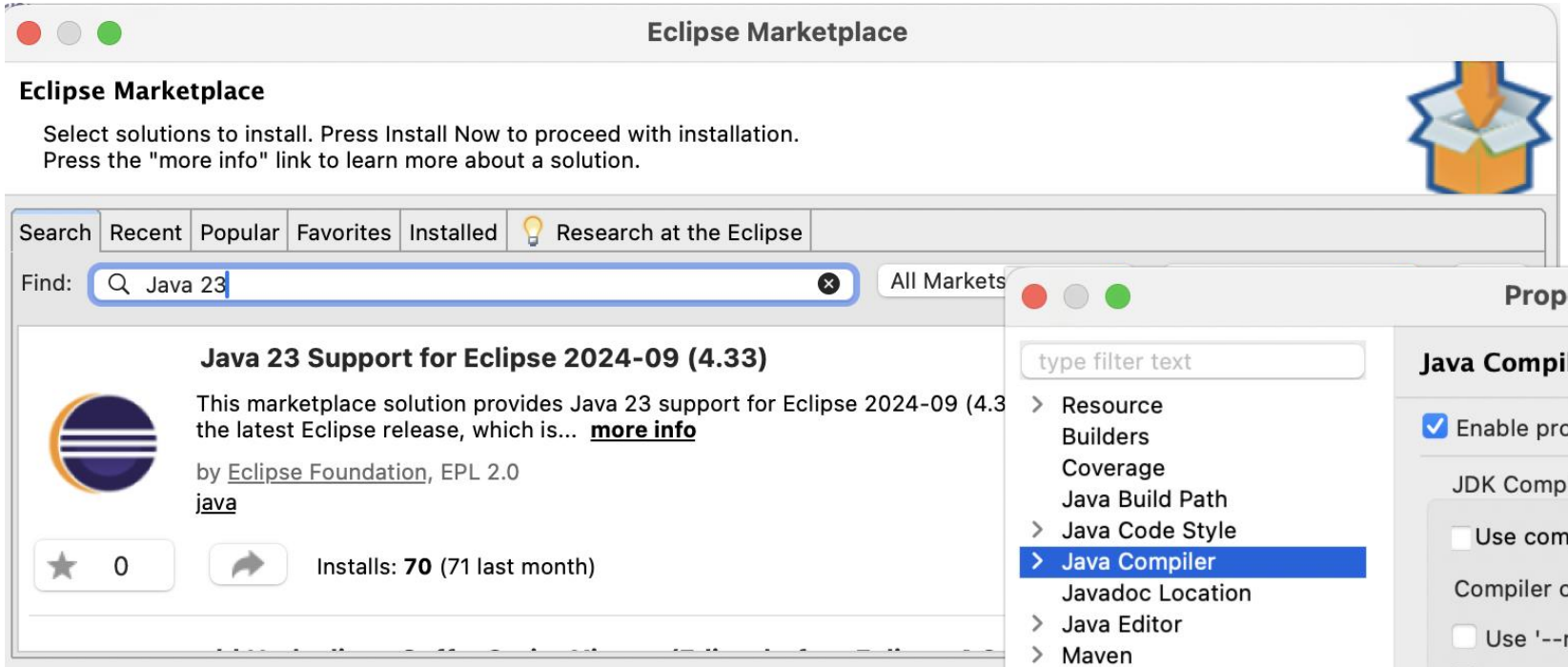
Maven™

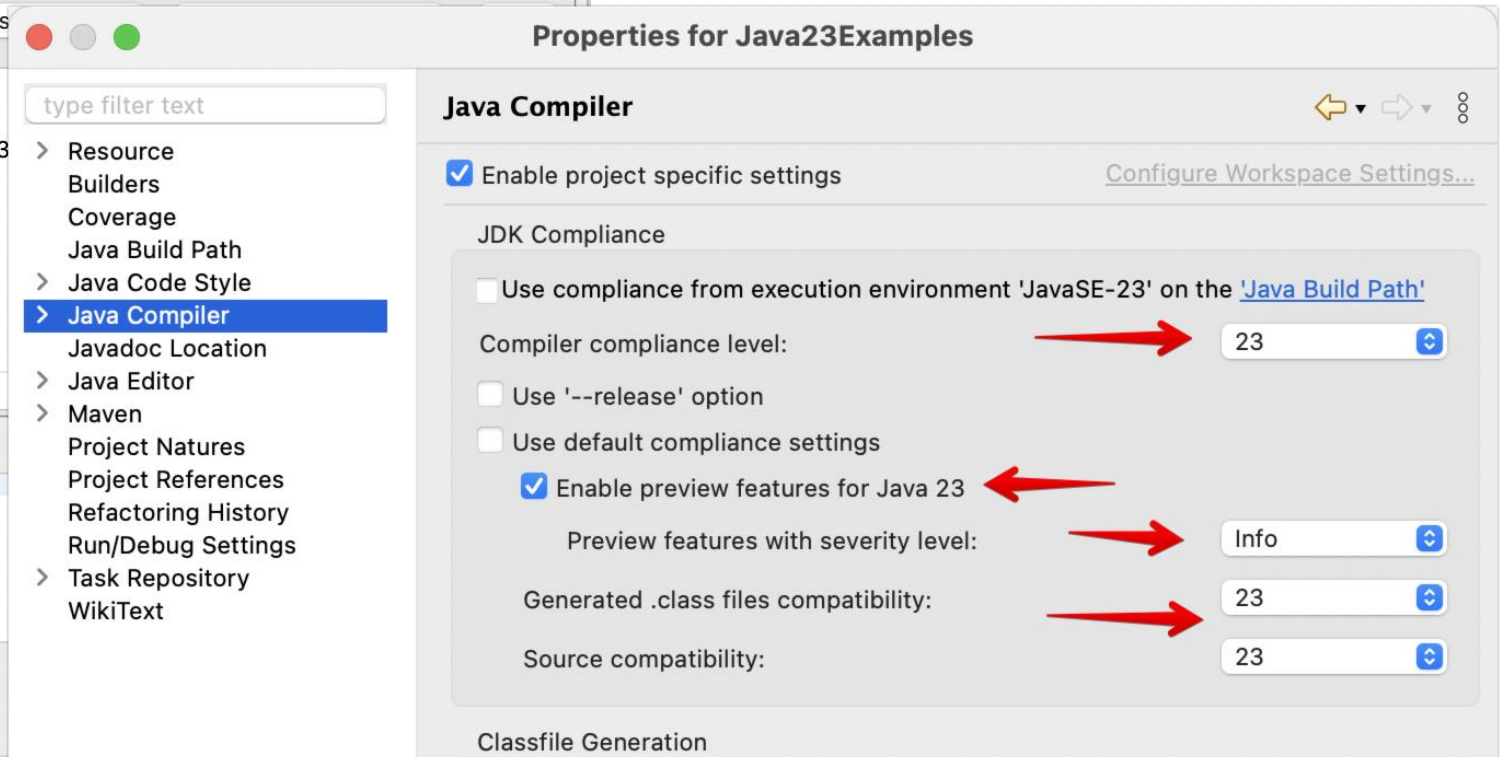
Gradle

IDE & Tool Support Java 23

- **Eclipse 2024-09 with Plugin**

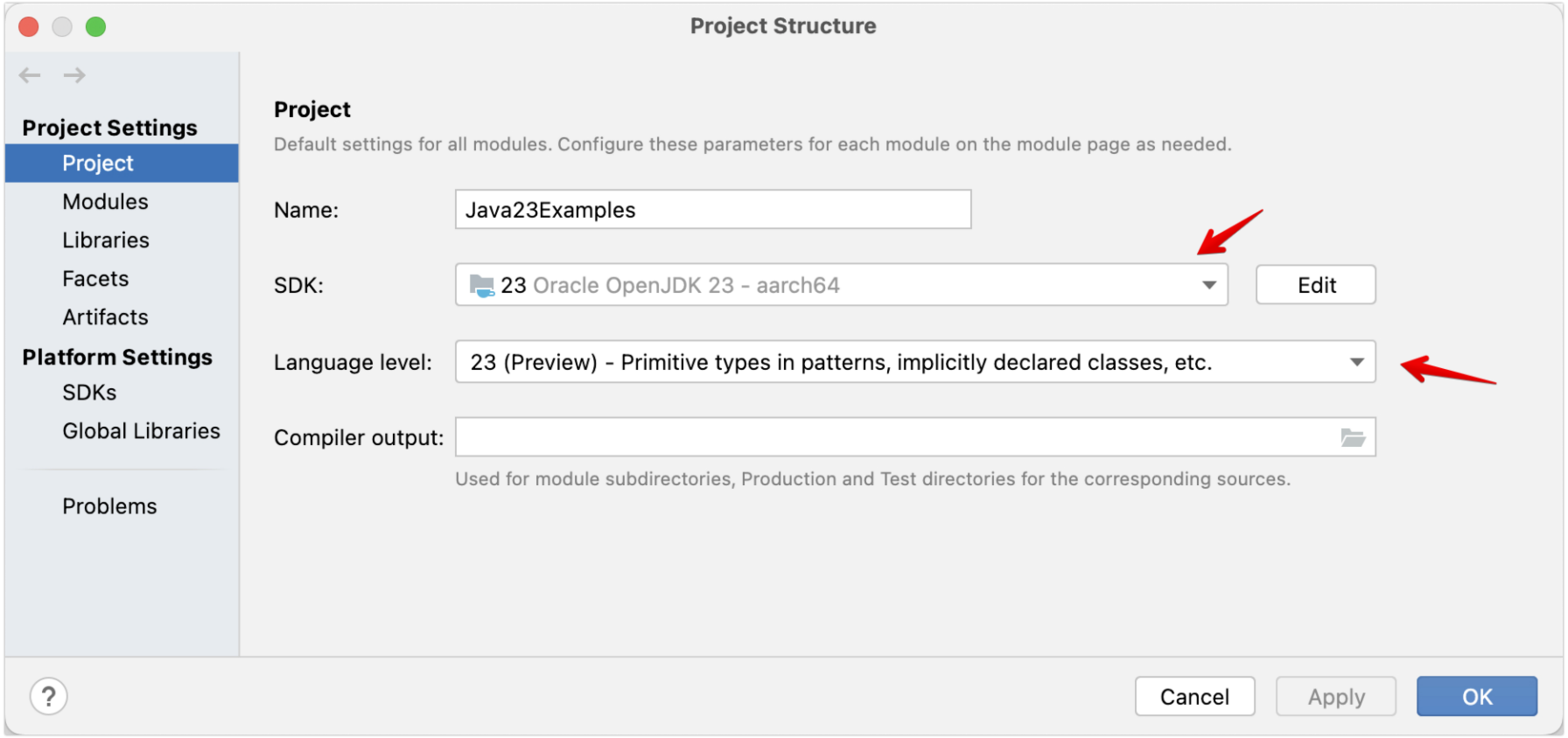
Activation of preview features necessary





IDE & Tool Support

- Activation of preview features / Incubator necessary



IDE & Tool Support Java 23

- **Activation of preview features / Incubator necessary**

Gradle 8.10

```
java {
   toolchain {
      languageVersion = JavaLanguageVersion.of(23)
   }
}

tasks.withType(JavaCompile).configureEach {
   options.compilerArgs += ["--enable-preview"]
}


tasks.withType(JavaCompile).configureEach {
   options.compilerArgs += ["--enable-preview",
                            "--add-modules", "jdk.incubator.vector"]
}
```

IDE & Tool Support

- **Activation of preview features / Incubator necessary**

Maven 3.9.9

```
<plugins>
  <plugin>
    <groupId>org.apache.maven.plugins</groupId>
    <artifactId>maven-compiler-plugin</artifactId>
    <version>3.13</version>
    <configuration>
      <source>23</source>
      <target>23</target>
      <!– Important for Preview Features -->
      <compilerArgs>--enable-preview</compilerArgs>
    </configuration>
  </plugin>
</plugins>
```

```
<plugin>
  <artifactId>maven-compiler-plugin</artifactId>
  <version>3.13.0</version>
  <configuration>
    <release>23</release>
    <compilerArgs>
      <arg>--enable-preview</arg>
      <arg>--add-modules</arg>
      <arg>jdk.incubator.vector</arg>
    </compilerArgs>
  </configuration>
</plugin>
```

https://javaalmanac.io/

The Java Version Almanac

Feedback on this page?

Systematic collection of information about the history and the future of Java.

Details	Status	Documentation	Download	Compare API to										
Java 24	DEV	API | Notes	JDK | JRE	23	22	21	20	19	18	17	16	15	14	...
Java 23	REL	API | Lang | VM | Notes	JDK | JRE	22	21	20	19	18	17	16	15	14	13	...
Java 22	EOL	API | Lang | VM | Notes	JDK | JRE	21	20	19	18	17	16	15	14	13	12	...
Java 21	LTS	API | Lang | VM | Notes	JDK | JRE	20	19	18	17	16	15	14	13	12	11	...
Java 20	EOL	API | Lang | VM | Notes	JDK | JRE	19	18	17	16	15	14	13	12	11	10	...
Java 19	EOL	API | Lang | VM | Notes	JDK | JRE	18	17	16	15	14	13	12	11	10	9	...
Java 18	EOL	API | Lang | VM | Notes	JDK | JRE	17	16	15	14	13	12	11	10	9	8	...
Java 17	LTS	API | Lang | VM | Notes	JDK | JRE	16	15	14	13	12	11	10	9	8	7	...
Java 16	EOL	API | Lang | VM | Notes	JDK | JRE	15	14	13	12	11	10	9	8	7	6	...
Java 15	EOL	API | Lang | VM | Notes	JDK | JRE	14	13	12	11	10	9	8	7	6	5	...
Java 14	EOL	API | Lang | VM | Notes	JDK | JRE	13	12	11	10	9	8	7	6	5	1.4	...
Java 13	EOL	API | Lang | VM | Notes	JDK | JRE	12	11	10	9	8	7	6	5	1.4	1.3	...
Java 12	EOL	API | Lang | VM | Notes	JDK | JRE	11	10	9	8	7	6	5	1.4	1.3	1.2	...
Java 11	LTS	API | Lang | VM | Notes	JDK | JRE	10	9	8	7	6	5	1.4	1.3	1.2	1.1	...
Java 10	EOL	API | Lang | VM | Notes	JDK | JRE	9	8	7	6	5	1.4	1.3	1.2	1.1	1.0	
Java 9	EOL	API | Lang | VM | Notes	JDK | JRE	8	7	6	5	1.4	1.3	1.2	1.1	1.0		
Java 8	LTS	API | Lang | VM | Notes	JDK | JRE	7	6	5	1.4	1.3	1.2	1.1	1.0			
Java 7	EOL	API | Lang | VM | Notes	JDK | JRE	6	5	1.4	1.3	1.2	1.1	1.0				
Java 6	EOL	API | Lang | VM | Notes	JDK | JRE	5	1.4	1.3	1.2	1.1	1.0					
Java 5	EOL	API | Lang | VM | Notes		1.4	1.3	1.2	1.1	1.0						
Java 1.4	EOL	API		1.3	1.2	1.1	1.0							
Java 1.3	EOL	API		1.2	1.1	1.0								
Java 1.2	EOL	API | Lang		1.1	1.0									
Java 1.1	EOL	API		1.0										
Java 1.0	EOL	API | Lang | VM												
Pre 1.0	EOL													

Data Source

Sandbox – https://javaalmanac.io/

Sandbox

Instantly compile and run Java 23 snippets without a local Java installation.

Java23.java ▶ Run 23+37-2369

```
1  import java.lang.reflect.ClassFileFormatVersion;
2
3  public class Java23 {
4
5      public static void main(String[] args) {
6          var v = ClassFileFormatVersion.latest();
7          System.out.printf("Hello Java bytecode version %s!", v.major());
8      }
9
10 }
```

No Support for Preview Features!

Java23.java ▶ Run 23+37-2369

```
Hello Java bytecode version 67!
```

All Time Favorites

ATF 1:
Switch Expressions / Text Blocks / Records

https://www.freepik.com/premium-vector/realistic-gold-silver-bronze-medal-with-red-ribbon_10027399.htm

Switch Expressions

- **Mapping of weekdays to their length … elegantly with modern Java:**

Return-Value

```
DayOfWeek day = DayOfWeek.FRIDAY;
int numOfLetters = switch (day)
{
  case MONDAY, FRIDAY, SUNDAY -> 6;
  case TUESDAY                -> 7;
  case THURSDAY, SATURDAY     -> 8;
  case WEDNESDAY              -> 9;
};
```

- **More elegance using case:**
  - Besides the obvious arrow instead of the colon also several values allowed
  - No break necessary, no case-through either
  - switch can now return a value, avoids artificial auxiliary variables

Switch Expressions

- **Mapping months to their names... elegantly with modern Java:**

```
static String monthToName(final Month month)
{
   return switch (month)
   {
      case JANUARY -> "January";
      default -> "N/A";  // here is NO Fall Through
      case FEBRUARY -> "February";
      case MARCH -> "March";
      case JULY -> "JULY";
   };
}
```

Switch Expressions: yield with return value

```
public static void main(final String[] args)
{
    DayOfWeek day = DayOfWeek.SUNDAY;

    int numOfLetters = switch (day)
    {
        case MONDAY, FRIDAY, SUNDAY -> {
            if (day == DayOfWeek.SUNDAY)
                System.out.println("SUNDAY is FUN DAY");
            yield 6;
        }
        case TUESDAY            -> 7;
        case THURSDAY, SATURDAY -> 8;
        case WEDNESDAY          -> 9;
    };
    System.out.println(numOfLetters);
}
```

```
SUNDAY is FUN DAY
6
```

Text Blocks

Text Blocks

```
String jsonObj = """
                 {
                    "name": "Mike",
                    "birthday": "1971-02-07",
                    "comment": "Text blocks are nice!"
                 }
                 """;
```

Text Blocks

```
public String exportAsHtml()
{
    String result = """
            <html>
              <head>
                <style>
                  td {
                     font-size: 18pt;
                  }
                </style>
              </head>
             <body>
             """;

    result += createTable();
    result += createWordList();

    result += """
                </body>
              </html>
              """;

    return result;
}
```

D	F	I	L	Z	N	C	O	M	P	U	T	E	R	K	B	H	L	M	G
V	N	T	Ö	N	B	V	R	M	M	L	M	S	J	Z	O	Ä	U	Q	R
G	L	C	W	C	A	L	A	R	G	L	Q	I	D	T	R	Z	R	N	Y
C	J	L	E	M	E	C	V	A	W	E	U	A	T	H	B	S	L	D	Z
F	L	E	R	I	J	J	U	R	I	A	H	T	E	L	E	F	A	N	T
B	A	M	Z	R	P	K	V	V	Q	H	P	J	Y	U	X	M	M	O	F
Y	T	E	L	Q	B	U	B	Y	C	C	X	Q	C	J	C	C	E	J	F
J	Y	N	Z	R	N	X	S	P	I	I	U	G	I	R	A	F	F	E	V
C	Q	S	O	N	D	N	N	V	M	M	K	C	E	K	W	Z	J	Y	Y
W	O	Q	O	V	A	H	A	N	D	Y	O	Z	D	G	H	A	Z	V	A

- LÖWE
- COMPUTER
- BÄR
- GIRAFFE
- HANDY
- CLEMENS
- ELEFANT
- MICHAEL
- TIM

Records

Enhancement Record

```
record MyPoint(int x, int y) { }
```

What you get

```
Michaels-iMac:java14 michaeli$ javap MyPoint
Compiled from "MyPoint.java"
final class java14.MyPoint extends java.lang.Record {
  public java14.MyPoint(int, int);
  public int x();
  public int y();
  public java.lang.String toString();
  public int hashCode();
  public boolean equals(java.lang.Object);
}
```

```
public final class MyPoint
{
    private final int x;
    private final int y;

    public MyPoint(int x, int y)
    {
        this.x = x;
        this.y = y;
    }

    @Override
    public boolean equals(Object o)
    {
        if (this == o)
            return true;
        if (o == null || getClass() != o.getClass())
            return false;

        MyPoint point = (MyPoint) o;
        return x == point.x && y == point.y;
    }

    @Override
    public int hashCode()
    {
        return Objects.hash(x, y);
    }

    @Override public String toString()
    {
        return "MyPoint[x=" + x + ", y=" + y + "]";
    }

    // Zugriffsmethoden auf x und y
}
```

Records for Complex Return Types or Parameters

```
record IntStringReturnValue(int code, String info) { }
record IntListReturnValue(int code, List<String> values) { }

record ReturnTuple(String first, String last, int amount) { }
record CompoundKey(String name, int age) { }


IntStringReturnValue calculateTheAnswer()
{
   // Some complex stuff here
   return new IntStringReturnValue(42, "the answer");
}

IntListReturnValue calculate(CompoundKey inputKey)
{
   // Some complex stuff here
   return new IntListReturnValue(201,
                        List.of("This", "is", "a", "complex", "result"));
}
```

Records for modelling Pairs and Tupels

```
record IntIntPair(int first, int second) {};

record StringIntPair(String name, int age) {};

record Pair<T1, T2>(T1 first, T2 second) {};

record Top3Favorites(String top1, String top2, String top3) {};

record CalcResultTuple(int min, int max, double avg, int count) {};
```

- **Extremely little writing effort**
- **Very practical for Pair, Tuples etc.**
- **Records work great with primitive types**
- **Implementations of accessor methods as well as equals() and hashCode() automatically and adhering to contracts**

ATF 2:
Helpful `NullPointerExceptions` / Pattern Matching for `instanceof`

https://www.freepik.com/premium-vector/realistic-gold-silver-bronze-medal-with-red-ribbon_10027399.htm

Helpful NullPointerExceptions

```
public static void main(final String[] args)
{
   SomeType a = null;
   a.value = "ERROR";
}
```

```
Exception in thread "main" java.lang.NullPointerException
at java14.NPE_Example.main(NPE_Example.java:8)
```

https://www.freepik.com/free-vector/realistic-bomb-illustration_3886825.htm

Helpful NullPointerExceptions

```
public static void main(final String[] args)
{
   SomeType a = null;
   a.value = "ERROR";
}
```

```
Exception in thread "main" java.lang.NullPointerException
at java14.NPE_Example.main(NPE_Example.java:8)
```

-XX:+ShowCodeDetailsInExceptionMessages

```
Exception in thread "main" java.lang.NullPointerException: Cannot assign field "value" because "a" is null
at java14.NPE_Example.main(NPE_Example.java:8)
```

Helpful NullPointerExceptions

```
public static void main(final String[] args)
{
    int width = getWindowManager().getWindow(5).size().width();
    System.out.println("Width: "  + width);
}
```

```
Exception in thread "main" java.lang.NullPointerException: Cannot invoke
"jvm.NPE_Third_Example$Window.size()" because the return value of
"jvm.NPE_Third_Example$WindowManager.getWindow(int)" is null
at jvm.NPE_Third_Example.main(NPE_Third_Example.java:7)
```

Pattern Matching `instanceof`

Pattern Matching `instanceof`

- **OLD STYLE**

```
final Object obj = new Person("Michael", "Inden");
if (obj instanceof Person)
{
   final Person person = (Person) obj;
   // ... Access to person...
}
```

- **NEW STYLE**

```
if (obj instanceof Person person)
{
   // here is is possible to access variable person directly
}
```

Pattern Matching `instanceof`

```
if (obj2 instanceof String str2 && str2.length() > 5)
{
   System.out.println("Length: " + str2.length());
}
```

My Top 10

https://depositphotos.com/photo/top-10-red-grunge-textured-vintage-isolated-stamp-48094793.html

Position 1: Record Patterns

https://www.freepik.com/premium-vector/realistic-gold-silver-bronze-medal-with-red-ribbon_10027399.htm

JEP 440: Record Patterns

- **The basis for this JEP and its predecessors JEP 405 and JEP 432 is the pattern matching for instanceof from Java 16:**

```
record Point(int x, int y) {}

static void printCoordinateInfo(Object obj)
{
   if (obj instanceof Point point)
   {
      int x = point.x();
      int y = point.y();

      System.out.println("x: %d, y: %d, sum: %d".formatted(x, y, x + y));
   }
}
```

- **Although this is often already practical, you still have to access the individual components in some cases in a cumbersome way.**
- **The goal is to be able to decompose records into their components and access them.**

JEP 440: Pattern Matching for `switch`

- **The goal is to be able to decompose records into their components and access them.**

```
static void printCoordinateInfo(Object obj)
{
   if (obj instanceof Point point)
   {
      int x = point.x();
      int y = point.y();
      System.out.println("x: %d y: %d, sum: %d".formatted(x, y, x + y));
   }
}
```

- **=>**

```
static void printCoordinateInfoNew(Object obj)
{
   if (obj instanceof Point(int x, int y))
   {
      System.out.println("x: %d y: %d, sum: %d".formatted(x, y, x + y));
   }
}
```

JEP 440: Pattern Matching for `switch`

- **Record patterns can be nested to provide a declarative, powerful, and combinable form of data navigation and processing.**

```
record Point(int x, int y) {}

enum Color { RED, GREEN, BLUE }
record ColoredPoint(Point point, Color color) {}
record Rectangle(ColoredPoint upperLeft, ColoredPoint lowerRight) {}


static void printColorOfUpperLeftPoint(Rectangle rect)
{
   if (rect instanceof Rectangle(ColoredPoint(Point point, Color color),
                                 ColoredPoint lowerRight))
   {
      System.out.println(color);
   }
}
```

Where can Record Patterns show their strength?

JEP 440: Record Patterns

- **Let's assume the following records as a data model:**

```
record Person(String firstname, String lastname, LocalDate birthday) {
}

record Phone(String areaCode, String number) {
}

record City(String name, String country, String languageCode) {
}

record FlightReservation(Person person,
                         Phone phoneNumber,
                         City origin,
                         City destination) {
}
```

JEP 440: Record Patterns

- **Legacy code contains deeply nested queries like this:**

```
boolean checkAgeAndDestinationLanguageCorrectOld(Object obj)
{
   if (obj instanceof FlightReservation reservation)
   {
      if (reservation.person() != null)
      {
         Person person = reservation.person();
         LocalDate birthday = person.birthday();

         if (reservation.destination() != null) {
            City destination = reservation.destination();
            String languageCode = destination.languageCode();

            if (birthday != null && languageCode != null) {
               long years = ChronoUnit.YEARS.between(birthday, LocalDate.now());
               return years >= 18 && List.of("EN", "DE", "FR").contains(languageCode);
            }
         }
      }
   }
   return false;
}
```

JEP 440: Record Patterns

- **Using nested record patterns, we write the above nesting of ifs elegantly and much more understandably as follows:**

```
boolean checkAgeAndDestinationLanguageCorrectNew(Object obj)
{
   if (obj instanceof FlightReservation(
         Person(String firstname, String lastname, LocalDate birthday),
         Phone phoneNumber, City origin,
         City(String name, String country, String languageCode)))
   {
      if (birthday != null && languageCode != null)
      {
         long years = ChronoUnit.YEARS.between(birthday, LocalDate.now());
         return years >= 18 &&
               List.of("EN", "DE", "FR").contains(languageCode);
      }
   }
   return false;
}
```

JEP 440: Record Patterns

```
boolean checkAgeAndDestinationLanguageCorrectNew(Object obj)
{
   if (obj instanceof FlightReservation(
         Person(String firstname, String lastname, LocalDate birthday),
         Phone phoneNumber, City from,
         City(String name, String country, String languageCode)))
   {
      if (birthday != null && languageCode != null)
      {
         long years = ChronoUnit.YEARS.between(birthday, LocalDate.now());
         return years >= 18 &&
               List.of("EN", "DE", "FR").contains(languageCode);
      }
   }
   return false;
}
```

- **Checking with `instanceof` automatically fails if one of the record components is `null`, i.e. here `Person` or `City` (`destination`).**
- **Only the attributes are not protected in this way and may need to be checked for null.**
- **However, if you get into the good habit of avoiding `null` as a value of parameters in calls, you can even do without it.**

Position 2: Pattern Matching and `switch`

https://www.freepik.com/premium-vector/realistic-gold-silver-bronze-medal-with-red-ribbon_10027399.htm

JEP 427: Pattern Matching for `switch`: Dominance check

- **Problem area: Multiple patterns can match on one input.**

```
public static void main(String[] args) {
    multiMatch("Python");
    multiMatch(null);
}

static void multiMatch(Object obj) {
    switch (obj) {
        case null -> System.out.println("null");
        case String s && s.length() > 5 -> System.out.println(s.toUpperCase());
        case String s                   -> System.out.println(s.toLowerCase());
        case Integer i                  -> System.out.println(i * i);
        default -> {}
    }
}
```

- **The one that fits "most generally" is called the dominant pattern.**
- **In the example, the shorter pattern `String s` dominates the longer one specified before it.**

JEP 427: Pattern Matching for `switch` with Record Patterns

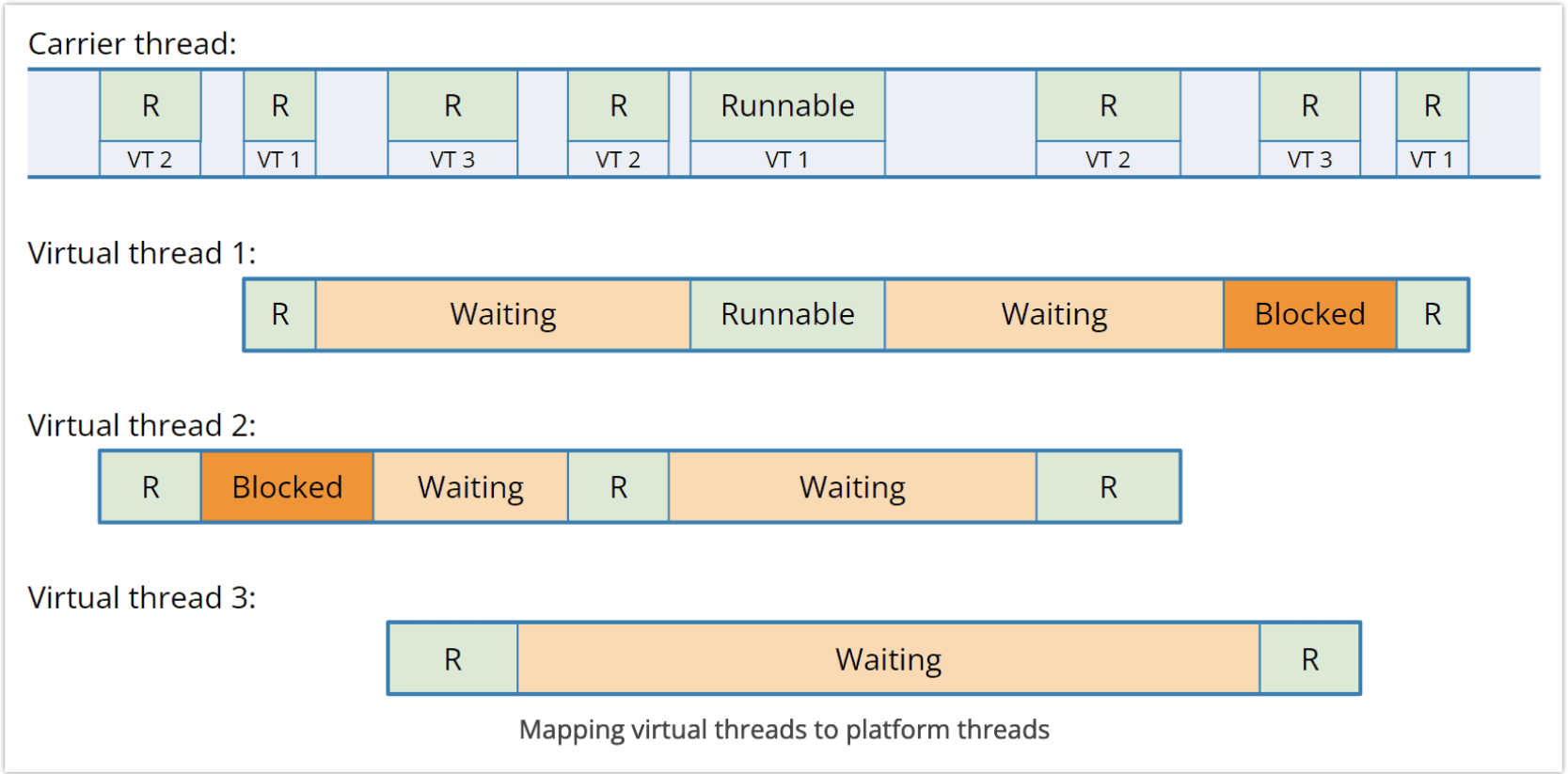
```
record Pos3D(int x, int y, int z) { }

enum RgbColor {RED, GREEN, BLUE}


static void recordPatternsAndMatching(Object obj) {
    switch (obj) {
        case RgbColor color when color == RgbColor.RED ->
            System.out.println("RED WARNING");

        case Pos3D pos when pos.z() == 0 ->
            System.out.println("Record: " + pos);

        case Pos3D(int x, int y, int z) when y > 0 ->
            System.out.println("Record decomposed: " + x + ", " + y + ", " + z);

        default -> System.out.println("Something else");
    }
}
```

Position 3: Virtual Threads

https://www.freepik.com/premium-vector/realistic-gold-silver-bronze-medal-with-red-ribbon_10027399.htm

JEP 444: Virtual Threads

- This JEP introduces the concept of lightweight virtual threads.
- Virtual threads "feel" like normal threads, but are not mapped 1:1 to operating system threads.



Mapping virtual threads to platform threads

https://www.happycoders.eu/java/virtual-threads/

JEP 444: Virtual Threads

- **Virtual threads permit to work with a separate thread per request in the area of server programming. This is helpful because many client requests usually perform blocking I/O such as retrieving resources.**

- **What is the problem with blocking I/O? => miserable server utilization**

Concurrency Issues

Why is it bad to block?

```
Json request         = buildContractRequest(id);
String contractJson  = contractServer.getContract(request);
Contract contract    = Json.unmarshal(contractJson);
```

https://www.youtube.com/watch?v=d_XmNicqC2I

JEP 444: Virtual Threads

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

   try (var executor = Executors.newVirtualThreadPerTaskExecutor())
   {
      for (int  i = 0; i < 10_000_000; i++)
      {
         final int pos = i;
         executor.submit(() -> {
            Thread.sleep(Duration.ofSeconds(5));
            return pos;
         });
      }
   }
   // executor.close() is called implicitly,
   // and waits until all tasks are completed
   System.out.println("End");
}
```

Position 4: Structured Concurrency (Preview)

https://www.freepik.com/premium-vector/realistic-gold-silver-bronze-medal-with-red-ribbon_10027399.htm

JEP 453: Structured Concurrency

- This JEP brings Structured Concurrency as a simplification of multithreading.
- Here, different tasks that are executed in multiple threads are considered as a single unit. This improves reliability, reduces the risk for errors and simplifies their handling.
- Let's consider determining a user and their orders based on a user ID:

```
static Response handleSynchronously(Long userId) throws InterruptedException
{
    var user = findUser(userId);
    var orders = fetchOrders(userId);

    return new Response(user, orders
}
```

- Both actions could run in parallel.

JEP 453: Structured Concurrency

```
static Response handleOldStyle(Long userId) throws ExecutionException,
                                                   InterruptedException
{
    var executorService = Executors.newCachedThreadPool();

    var userFuture = executorService.submit(() -> findUser(userId));
    var ordersFuture = executorService.submit(() -> fetchOrders(userId));

    var user = userFuture.get();      // Join findUser
    var orders = ordersFuture.get();  // Join fetchOrders

    return new Response(user, orders):
}
```

- **Because the subtasks are executed in parallel, they can succeed or fail independently. Then the handling can become quite complicated.**
- **Often, for example, one does not want the second `get()` to be called if an exception has already occurred during the processing of the `findUser()` method.**

JEP 453: Structured Concurrency

- **Implementation of Structurd Concurrency with class `StructuredTaskScope`:**

```
static Response handle(Long userId) throws ExecutionException,
                                           InterruptedException
{
    try (var scope = new StructuredTaskScope.ShutdownOnFailure()) {
        var userSubtask  = scope.fork(() -> findUser(userId));
        var ordersSubtask = scope.fork(() -> fetchOrder(userId));

        scope.join();          // Join both forks
        scope.throwIfFailed(); // ... and propagate errors

        // Here, both forks have succeeded, so compose their results
        return new Response(userSubtask.get(), ordersSubtask.get());
    }
}
```

- **With structured concurrency, one splits off competing subtasks with `fork()`.**
- **The results are collected with a blocking call to `join()`, which waits until all subtasks are processed or an error occurred.**

JEP 453: Structured Concurrency

The `StructuredTaskScope` class has two specializations:

- `ShutdownOnFailure` – catches the first exception and terminates the `StructuredTaskScope`. This class is intended when results of all subtasks are needed ("invoke all"); if one subtask fails, the results of the other uncompleted subtasks are no longer needed.

- `ShutdownOnSuccess` – determines the first incoming result and then terminates the `StructuredTaskScope`. This helps when the result of any subtask is sufficient already ("invoke any") and it is not necessary to wait for the results of other uncompleted tasks.

JEP 453: Structured Concurrency

- **Implementation of Structurd Concurrency with class `StructuredTaskScope`:**

```
public static void main(final String[] args) throws ExecutionException,
                                                     InterruptedException
{
   try (var scope =
       new StructuredTaskScope.ShutdownOnSuccess<NetworkConnection>())
   {
      var result1 = scope.fork(() -> tryToGetWifi());
      var result2 = scope.fork(() -> tryToGet5g());
      var result3 = scope.fork(() -> tryToGet4g());
      var result4 = scope.fork(() -> tryToGet3g());
      scope.join();

      System.out.println("found connection: " + scope.result());
   }
}
```

Position 5: Unnamed Variables and Patterns (Preview)

https://www.freepik.com/premium-vector/realistic-gold-silver-bronze-medal-with-red-ribbon_10027399.htm

JEP 443: Unnamed Patterns and Variables (Preview)

- **What do you observe using record patterns?**

```
Point p3_4 = new Point(3, 4);
var green_p3_4 = new ColoredPoint(p3_4, Color.GREEN);

if (green_p3_4 instanceof ColoredPoint(Point point, Color color))
{
   System.out.println("x = " + point.x());
}

if (green_p3_4 instanceof ColoredPoint(Point(int x, int y),
                                       Color color))
{
   System.out.println("x = " + x);
}
```

- **Only a few parts are really of interest**

JEP 443: Unnamed Patterns and Variables (Preview)

- **And what about similar situations in «normal» Java code:**

```
BiFunction<String, String, String> doubleFirst =
                        (String str1, String str2) -> str1.repeat(2);


try
{
   Files.writeString(Path.of("UnnamedVars.txt"), "Underscore");
}
catch (IOException ex)
{
   // just some logging
}
```

- **Some variables are unused in the code that follows**

JEP 443: Unnamed Patterns and Variables (Preview)

- **The following three variations exist:**

1. **unnamed variable** – allows to use _ for naming or marking unused variables
2. **unnamed pattern variable** – allows the identifier that would normally follow the type (or var) in a record pattern to be omitted
3. **unnamed pattern** – allows to omit the type and name of a record pattern component completely (and replace with single _)

JEP 443: Unnamed Patterns and Variables (Preview)

- **Unnamed variable**

```
BiFunction<String, String, String> doubleFirst =
                        (String str1, String _) -> str1.repeat(2);

interface IntTriFunction
{
   int apply(int x, int y, int z);
}

IntTriFunction addFirstTwo = (int x, int y, int _) -> x + y;

IntTriFunction doubleSecond = (int _, int y, int _) -> y * 2;
```

- **Interestingly, multiple unnamed variables can also be used in the same scope, which (besides simple lambdas) is of interest especially for record patterns and in switch.**

JEP 443: Unnamed Patterns and Variables (Preview)

- **Unnamed pattern variable**

```
if (green_p3_4 instanceof ColoredPoint(Point point, Color color))
{
   System.out.println("x = " + point.x());
}
```

- **=>**

```
if (green_p3_4 instanceof ColoredPoint(Point point, Color _))
{
   System.out.println("x = " + point.x());
}
```

- **Same applies for `case` `ColoredPoint(Point point, Color _)`**

JEP 443: Unnamed Patterns and Variables (Preview)

- **Unnamed pattern**

```
if (green_p3_4 instanceof ColoredPoint(Point(int x, int y), Color color))
{
   System.out.println("x = " + x);
}
```

- **=>**

```
if (cp instanceof ColoredPoint(Point(int x, _), _))
{
   System.out.println("x = " + x);
}
```

instanceof _
instanceof _(int x, int y)

- **Same applies for case.**

Unnamed Variables & Patterns

```
static boolean checkFirstNameAndCountryCodeAgainImproved_UNNAMED_2(Object obj)
{
   if (obj instanceof Journey(
         Person(var firstname, _, _),
         TravelInfo(_, var maxTravellingTime), _,
         City(var zipCode, _))) {

      if (firstname != null && maxTravellingTime != null && zipCode != null) {

         return firstname.length() > 2 && maxTravellingTime.toHours() < 7 &&
               zipCode >= 8000 && zipCode < 8100;
      }
   }
   return false;
}
```

Position 6:
Markdown Comments

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JEP 467: Markdown Documentation Comments

- **It is also displayed in IntelliJ directly on the commented program element (class / method)**

```
/// Returns the greater of two `int` values. That is, the
/// result is the argument closer to the value of
/// [Integer#MAX_VALUE]. If the arguments have the same
/// value, the result is that same value.
///
/// @param   a   an argument.
/// @param   b   another argument.
/// @return  the larger of `a` and `b`.
public static int max(int a, int b) {
   return (a >= b) ? a : b;
}
```

syntax.MarkDownComment

```
@Contract(pure = true)
public static int max(
    int a,
    int b
)
```

Returns the greater of two `int` values. That is, the result is the argument closer to the value of Integer#MAX_VALUE. If the arguments have the same value, the result is that same value.

Params: `a` – an argument.
`b` – another argument.

Returns: the larger of `a` and `b`.

Java23Examples

JEP 467: Markdown Documentation Comments -- Formatierung

- **Text passages should be emphasized from time to time**
  - *italics* (*...* or _..._) or **bold** (**...**)
  - Change font by backtick ('...') to `typewriter` font. Bold and/or italics are also possible.
  - Integrate multi-line source code snippets with ("'...'") into a comment.

```
/// **FETT**  \
/// *kursiv*  \
/// _kursiv_  \
/// _**FETT und KURSIV**_ \
/// `code-font` \
/// _**`code-font FETT und KURSIV`**_ \
///
/// Mehrzeiliger Sourcecode:
/// ```
/// public static int max(int a, int b) {
///    return (a >= b) ? a : b;
/// }
/// ```
```

syntax

```
public class MarkDownComment
```

FETT
kursiv
kursiv
FETT und KURSIV
`code-font`
`code-font FETT und KURSIV` \

Mehrzeiliger Sourcecode:

```
public static int max(int a, int b) {
   return (a >= b) ? a : b;
}
```

Java23Examples

JEP 467: Markdown Documentation Comments – References

- **References to any program elements (modules, classes, methods, etc.) by [<ref>]**
- **Types defined in `java.lang` can be written without the package, other types must be specified fully qualified.**

```
/// [java.base/] - verweist auf ein Modul \
/// [java.util] - verweist auf ein Package
///
/// Hinweis: _**`java.lang`**_ kann man im Verweis weglassen: \
/// [java.lang.String] - verweist auf eine Klasse \
/// [String] - verweist auf eine Klasse \
/// [Integer] - verweist auf eine Klasse
///
/// [String#chars()] - verweist auf eine Methode \
/// [Integer#valueOf(String, int)] - verweist auf eine Methode
///
/// [String#CASE_INSENSITIVE_ORDER] - verweist auf ein Attribut \
/// [SPECIAL_ORDER][String#CASE_INSENSITIVE_ORDER] - Verweis mit Beschriftung
```

JEP 467: Markdown Documentation Comments – Lists & Tables

```
/// - Punkt A
/// * Punkt B
/// - Punkt C
///
/// 1. Eintrag 1
/// 1. Eintrag 2 -- **wird automatisch nummeriert, also 2.**
/// 1. Eintrag 3
/// 2. Eintrag 4 -- **wird automatisch auf 4. geändert**
```

- Punkt A
- Punkt B
- Punkt C

1. Eintrag 1
2. Eintrag 2 -- **wird automatisch nummeriert, als**
3. Eintrag 3
4. Eintrag 4 -- **wird automatisch auf 4. geändert**

```
/// | Latein | Griechisch |
/// |--------|------------|
/// | a      | &alpha; (alpha) |
/// | b      | &beta; (beta)  |
/// | c      | &gamma; (gamma) // &Gamma; |
/// | ...    |  ... |
/// | z      | &omega; (omega) |
```

Latein	Griechisch
a	α (alpha)
b	β (beta)
c	γ (gamma) // Γ
...	...
z	ω (omega)

Position 7: Flexible Constructor Bodies / Statements before super(...) (Second Preview)

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JEP 482: Flexible Constructor Bodies

```
public class PositiveBigIntegerOld1 extends BaseInteger
{
   public PositiveBigIntegerOld1(long value)
   {
      super(value);          // Potentially unnecessary work

      if (value <= 0)
         throw new IllegalArgumentException("non-positive value");
   }
}
```

- **If we look at the source code, it doesn't look very elegant. Furthermore, the check only takes place after the base class has been constructed ...**
- **Potentially unnecessary calls and object constructions have already taken place**
- **Espacially older legacy code is often ingloriously characterized by the fact that (too) many actions already take place in the constructor.**

JEP 482: Flexible Constructor Bodies

- **Conventional workaround: static helper method**

```
public class PositiveBigIntegerOld2 extends BaseInteger
{
   public PositiveBigIntegerOld2(final long value)
   {
      super(verifyPositive(value));
   }

   private static long verifyPositive(final long value)
   {
      if (value <= 0)
         throw new IllegalArgumentException("non-positive value");

      return value;
   }
}
```

JEP 482: Flexible Constructor Bodies – News in Java 22/23

- **The argument check is much easier to read and understand if the validation logic takes place directly in the constructor before `super()` is called.**

- **JEP 482 allows the arguments of a constructor to be validated before the constructor of the super class is called:**

```
public class PositiveBigIntegerNew extends BaseInteger
{
   public PositiveBigIntegerNew(final long value) {
      if (value <= 0)
         throw new IllegalArgumentException("non-positive value");

      super(value);
   }
}
```

JEP 482: Flexible Constructor Bodies

- **Sometimes it makes sense to execute actions before calling `this()` to avoid multiple actions, like calls to `split()`, in the following:**

```
record MyPointOld(int x, int y)
{
   public MyPointOld(final String values)
   {
      this(Integer.parseInt(values.split(",")[0].strip()),
          Integer.parseInt(values.split(",")[1].strip()));
   }
}

record MyPoint3dOld(int x, int y, int zy)
{
   public MyPoint3dOld(final String values)
   {
      this(Integer.parseInt(values.split(",")[0].strip()),
          Integer.parseInt(values.split(",")[1].strip()),
          Integer.parseInt(values.split(",")[2].strip()));
   }
}
```

JEP 482: Flexible Constructor Bodies – News in Java 22 (JEP 447)

- With the new syntax, we can extract the actions from the call to `this()` and, in particular, call the `split()` only once.
- An additional helper method `parseInt()` may be introduced if you want to make the stripping more elegant and the constructor easier to read:

```
record MyPoint3d(int x, int y, int z)
{
   public MyPoint3d(final String values)
   {
      var separatedValues = values.split(",");
      int x = parseInt(separatedValues[0]);
      int y = parseInt(separatedValues[1]);
      int z = parseInt(separatedValues[2]);

      this(x, y, z);
   }

   private static int parseInt(final String strValue)
   {
      return Integer.parseInt(strValue.strip());
   }
}
```

JEP 482: Flexible Constructor Bodies – News in Java 23

```
public class SubClass extends BaseClass
{
   private final String subClassInfo;

   public SubClass(int baseValue, String subClassInfo)
   {
      super(baseValue);
      this.subClassInfo = subClassInfo;
   }

   protected void logValues()
   {
      super.logValues();
      System.out.println("subClassInfo: " + subClassInfo);
   }

   public static void main(final String[] args)
   {
      new SubClass(42, "SURPRISE");
   }
}
```

baseValue: 42
subClassInfo: null

During the processing of the base class constructor, the attribute `subClassInfo` is still unassigned, as the call to `super()` takes place BEFORE the assignment to the variable. This results in the above but unexpected output.

JEP 482: Flexible Constructor Bodies – News in Java 23

```
public class NewSubClass extends BaseClass {

    private final String subClassInfo;

    public NewSubClass(int baseValue, String subClassInfo)
    {
        this.subClassInfo = subClassInfo;
        super(baseValue);
    }

    protected void logValues()
    {
        super.logValues();
        System.out.println("subClassInfo: " + subClassInfo);
    }

    public static void main(final String[] args)
    {
        new NewSubClass(42, "AS_EXPECTED");
    }
}
```

```
baseValue: 42
subClassInfo: AS_EXPECTED
```

During the processing of the base class constructor, the attribute `subClassInfo` is now already unassigned, as the call to `super()` takes place AFTER the assignment to the variable. This results in the above and expected output.

Position 8: Launch Multi-File Source-Code Programs

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JEP 458: Launch Multi-File Source-Code Programs

```
package jep458_Launch_MultiFile_SourceCode_Programs;

public class MainApp
{
   public static void main(final String[] args) {
      var result = Helper.performCalculation();
      System.out.println(result);
   }
}
```

```
package jep458_Launch_MultiFile_SourceCode_Programs;

class Helper
{
   public static String performCalculation() {
      return "Heavy, long running calculation!";
   }
}
```

```
$ java MainApp.java
Heavy, long running calculation!
```

JEP 458: Launch Multi-File Source-Code Programs

```java
package jep458_Launch_MultiFile_SourceCode_Programs;

public class MainAppV2
{
   public static void main(final String[] args) {
      var result = StringHelper.mark(Helper.performCalculation());
      System.out.println(result);
   }
}
```

```java
package jep458_Launch_MultiFile_SourceCode_Programs;

class StringHelper
{
   public static String mark(String input) {
      return ">>" + input + "<<";
   }
}
```

```
$ java MainAppV2.java
>>Heavy, long running calculation!<<
```

Position 9: Stream Gatherers (Preview)

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JEP 473: Stream Gatherers

- **Let's assume we want to filter out all duplicates from a stream and specify a criterion for this:**

```
var result = Stream.of("Tim", "Tom", "Jim", "Mike").
             distinctBy(String::length).     // Hypothetical
             toList();
```

- **You can solve this conventionally with a trick as follows:**

```
var result = Stream.of("Tim", "Tom", "Jim", "Mike").
             map(DistinctByLength::new).
             distinct().
             map(DistinctByLength::str).
             toList();
```

JEP 473: Stream Gatherers

- **Another example is grouping a stream's data into sections of a fixed size. For example, four numbers are to be combined/grouped into one unit, and only the first three groups are to be included in the result.**

```
var result = Stream.iterate(0, i -> i + 1).
                windowFixed(4).       // Hypothetical
                limit(3).
                toList();

// result ==> [[0, 1, 2, 3], [4, 5, 6, 7], [8, 9, 10, 11]]
```

- **Over the years, various intermediate operations such as `distinctBy()` or `windowFixed()` have been proposed as additions to the Stream API.**

- **These are often useful in specific contexts, but they would make the Stream API rather bloated and (further) complicate access to the (already extensive) API.**

JEP 473: Stream Gatherers – `windowFixed()`

- **To divide a stream into smaller components of fixed size without overlapping, `windowFixed()` is used.**

```
private static void windowFixed() {
    var result = Stream.iterate(0, i -> i + 1).
                        gather(Gatherers.windowFixed(4)).
                        limit(3).
                        toList();
    System.out.println("windowFixed(4): " + result);

    var result2 = Stream.of(0, 1, 2, 3, 4, 5, 6).
                         gather(Gatherers.windowFixed(3)).
                         toList();
    System.out.println("windowFixed(3): " + result2);
}
```

- **In some cases, the dataset does not contain enough elements. This means that the last sub-range simply contains fewer elements.**

```
windowFixed(4): [[0, 1, 2, 3], [4, 5, 6, 7], [8, 9, 10, 11]]
windowFixed(3): [[0, 1, 2], [3, 4, 5], [6]]
```

JEP 473: Stream Gatherers – `windowSliding()`

- **To divide a stream into smaller components of fixed size with overlapping, `windowSliding()` is used:**

```
private static void windowSliding() {
    var result = Stream.iterate(0, i -> i + 1).
                        gather(Gatherers.windowSliding(4)).
                        limit(3).
                        toList();
    System.out.println("windowSliding(4): " + result);

    var result2 = Stream.of(0, 1, 2, 3, 4, 5, 6).
                         gather(Gatherers.windowSliding(3)).
                         toList();
    System.out.println("windowSliding(3): " + result2);
}
```

- **In some cases, the dataset does not contain enough elements. This means that the last sub-range simply contains fewer elements (not shown here):**

```
windowSliding(4): [[0, 1, 2, 3], [1, 2, 3, 4], [2, 3, 4, 5]]
windowSliding(3): [[0, 1, 2], [1, 2, 3], [2, 3, 4], [3, 4, 5], [4, 5, 6]]
```

JEP 473: Stream Gatherers – `fold()`

- **The `fold()` method is used to combine the values of a stream. Similar to `reduce()`, a start value and a calculation rule are specified:**

```
private static void foldMult()
{
   var crossMult = Stream.of(10, 20, 30, 40, 50).
                   gather(Gatherers.fold(() -> 1L,
                         (result, number) -> result * number)).
                   findFirst();
   System.out.println("mult with fold(): " + crossMult);
}
```

- **To access the value, the call to `findFirst()` is used again, which returns an `Optional<T>`:**

```
mult with fold(): Optional[12000000]
```

JEP 473: Stream Gatherers – `fold()`

- **What happens if we also want to execute actions for the value combination and these actions are not defined for the types of the values, in this case `int`?**
- **As an example, a numerical value is converted into a string and this is repeated according to the numerical value with `repeat()`:**

```
private static void foldRepeat()
{
   var repeatedNumbers = Stream.of(1, 2, 3, 4, 5, 6, 7).
                         gather(Gatherers.fold(() -> "",
                               (result, number) -> result + ("" +
                               number).repeat(number))).
                         toList();
   System.out.println("repeat with fold(): " + repeatedNumbers);
}
```

- **The output is as follows:**

```
repeat with fold(): [1223334444555556666667777777]
```

JEP 473: Stream Gatherers – `scan()`

- **If the elements of a stream are to be merged into new combinations so that one element is added at a time, then this is the task of `scan()`.**
- **The method works in a similar way to `fold()`, which combines the values to produce a result. With `scan()`, however, a new result is produced for each combination of values:**

```
private static void scanRepeat()
{
   var repeatedNumbers = Stream.of(1, 2, 3, 4, 5, 6, 7).
                         gather(Gatherers.scan(() -> "",
                               (result, number) -> result + ("" +
                               number).repeat(number))).
                         toList();
   System.out.println("repeat with scan(): " + repeatedNumbers);
}
```

- **The output is as follows:**

```
repeat with scan(): [1, 122, 122333, 1223334444, 122333444455555, 1223334445555566666,
122333444455555666667777777]
```

Position 10: Implicitly Declared Classes and Instance Main Methods (Preview)

https://www.freepik.com/premium-vector/realistic-gold-silver-bronze-medal-with-red-ribbon_10027399.htm

Implicitly Declared Classes and Instance Main Methods

- Maybe it's been a while since you learned Java, too.
- If you want to teach Java to novice programmers, you realize **how difficult it is to get started**.
- From the beginner's perspective Java has a **really steep learning curve**.
- It already starts with the simplest Hello-World.

```
package preview;

public class OldStyleHelloWorld {
    public static void main(String[] args) {
        System.out.println("Hello, World!");
    }
}
```

- Python – reduced to the essentials:

```
print("Hello, World!")
```

You as trainer mention the following facts for beginners:

1) Forget about `package`, `public` , `class`, `static`, `void`, etc. they are not important right now …
2) Just look at the one line with the `System.out.println()`
3) Oh yes, `System.out` is an instance of a class, but even that is not important now.

Quite a lot of confusing and distracting words and concepts apart from the actual task.

Implicitly Declared Classes and Instance Main Methods

- **PAST**

```
public class InstanceMainMethodOld {
    public static void main(final String[] args) {
        System.out.println("Hello, World!");
    }
}
```

- **PRESENT**

```
class InstanceMainMethod {
    void main() {
        System.out.println("Hello, World!");
    }
}
```

- **PRESENT OPTIMIZED**

```
void main() {
    System.out.println("Hello World!");
}
```

Implicitly Declared Classes and Instance Main Methods

Further possibilities

```
String greeting = "Hello again!!";

String enhancer(String input, int times)
{
  return " ---> " + input.repeat(times) + " <---";
}

void main()
{
   System.out.println("Hello World!");
   System.out.println(greeting);
   System.out.println(enhancer("Michael", 2));
}
```

```
$ java --enable-preview --source 21\ src/main/java/preview/UnnamedClassesMoreFeatures.java
Hello, World!
Hello again!
 ---> MichaelMichael <---
```

JEP 477: Implicitly Declared Classes and Instance Main Methods

- **JEP 477 from Java 23 contains the innovations from Java 22. In addition, two significant innovations have been added in Java 23:**
  - **Interaction with the console:** Implicitly declared classes automatically import threee static methods `print()`, `println()` and `readln()` defined in the `java.io.IO` class that simplify textual interaction with the console.
  - **Automatic module import from `java.base`:** Implicitly declared classes automatically import all public classes and interfaces of the packages exported by the `java.base` module.
- **Based on both, the `main()` method in Java 23 can be written more clearly and briefly as follows:**

```
void main()
{
   println("Shortest and Python-like 'Hello World!'");
}
```

Conclusion

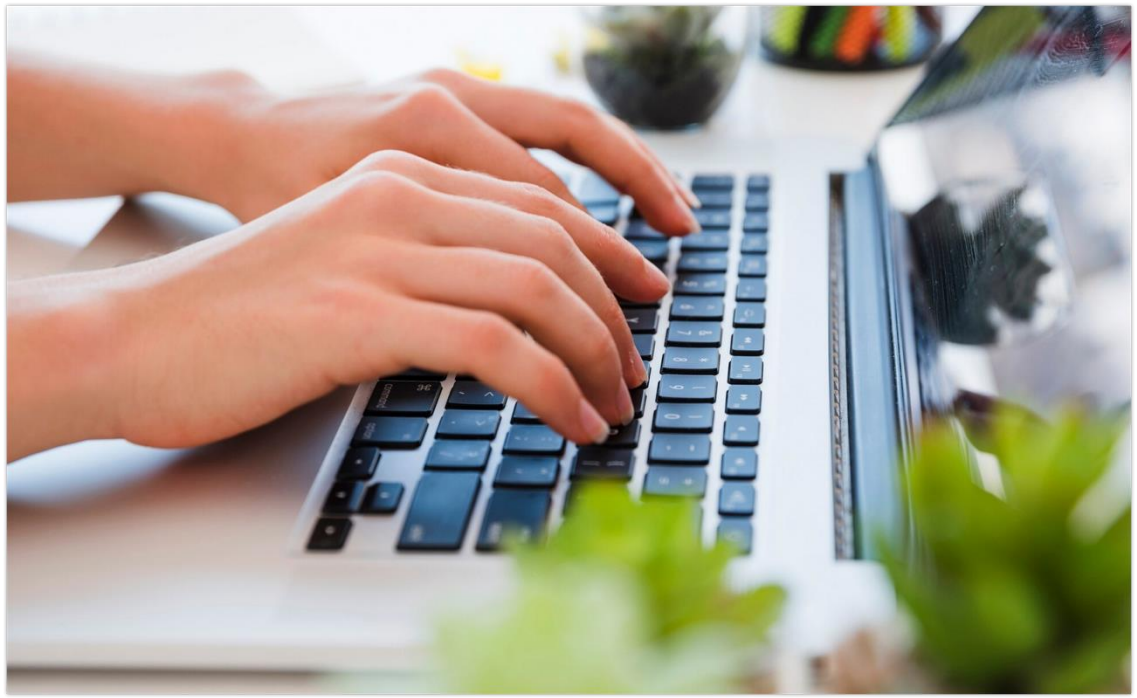
Positive things

- Reliable 6-month release cadence and LTS versions will be released every 2 years
- Java becomes easier and more attractive
- Many nice improvements in syntax and APIs like switch, records, text blocks, …
- Pattern Matching and record patterns
- Virtual Threads & Structured Concurrency

On the negative side

- Next releases were on time, but sometimes bringing just a few new features (execpt Java 14), even only preview features.
- Java 21 LTS contains lots of unfinished things …
  in my opinion LTS should contain only few preview and incubators, ideally none
- We have to wait 2 more years to have the nice unnamed classes and vars accessible for stable use
- Why is the syntax of pattern matching inconsistent for `instanceof` and `switch`?

Try it out :-)



https://github.com/Michaeli71/Best-Of-Modern-Java-21-23-My-Favorites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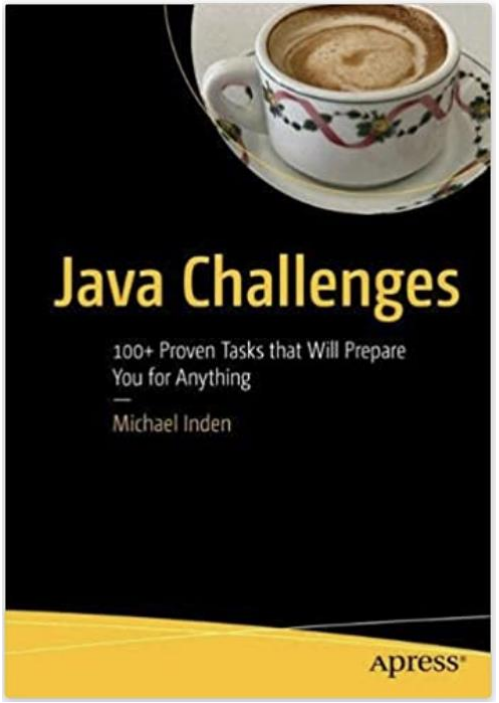
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Questions?

Thank You