Java 9 and Beyond: Your Code With Even More Quality

HELBER BELMIRO

$ ~ whoami
Helber Belmiro

I help Java Engineers build libraries and frameworks that are easy to evolve and upgrade so they can stay up-to-date with technology and work on great projects.

Software Engineer at Banrisul

- Develop an internal framework
- Used by several applications that work as a service

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Where do Bugs Come From?

Among others...

- Non-intuitive APIs
- Code that is hard to read
- Verbosity
- Mutable code and objects

Newer versions of Java

JDK 9 and above:

- More intuitive APIs
- More readable
- Less verbose code
- Immutable code and objects

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- More readable
- Less verbose code
- Immutable code and objects

Less bugs!

Versions of Java - History

Java 8 (1.8) – March 2014 – LTS
Java 9 – September 2017
Java 10 – March 2018
Java 11 – September 2018 – LTS
Java 12 – March 2019
Java 13 – September 2019
Java 14 – March 2020
Java 15 – September 2020
Java 16 – March 2021
✨**Java 17 – September 2021 – LTS**✨

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Java 15 – September 2020
Java 16 – March 2021
✨**Java 17 – September 2021 – LTS**✨

What version are you using?

16709 Bugs Fixed

Java Bug System

Project: JDK

Type: Bug

Fix Version: 10, 11, 12, 13, 14, 15, 16, 17, 9

Status: Resolved

Resolution: Fixed

Sorted by: Key descending

1–1000 of **16709** as at: **2021-08-03 17:16**

T	Key	Summary
	JDK-8271489	(doc) Clarify Filter Fa

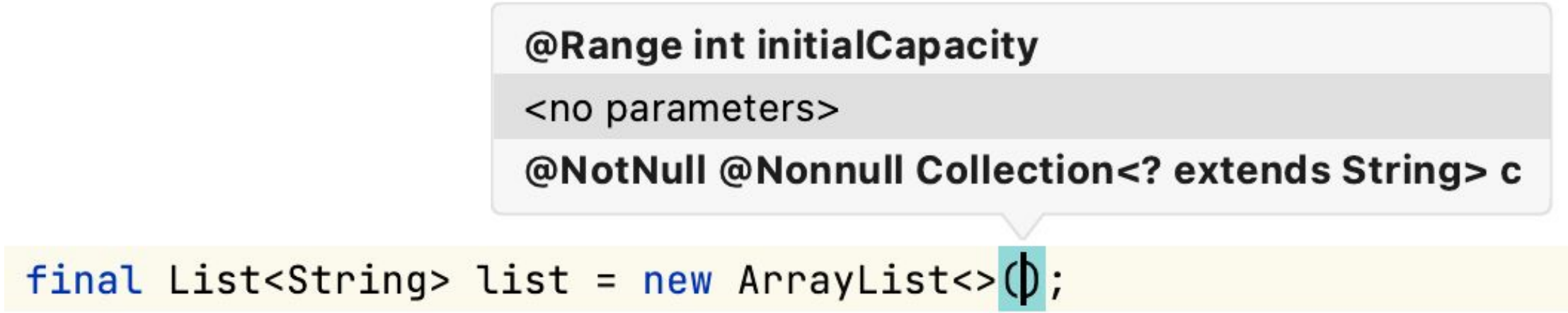
https://bugs.openjdk.java.net/sr/jira.issueviews:searchrequest-printable/temp/SearchRequest.html?jqlQuery=project+%3D+JDK+AND+issuetype+%3D+Bug+AND+status+%3D+Resolved+AND+resolution+%3D+Fixed+AND+fixVersion+in+%28%2210%22%2C+%2211%22%2C+%2212%22%2C+%2213

Java 8 – Creating a List

- How can I create a List with fixed elements?
- Can I pass the elements in constructor?

Java 8 – Creating a List - ArrayList Constructor

3 Overloads



Java 8 – Creating a List

```
final List<String> list = new ArrayList<>();
list.add("This");
list.add("is");
list.add("a");
list.add("list");
```

Java 8 – Creating a List

```
final List<String> list = new ArrayList<>();
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```

Modifiable list!

Java 8 – Making the List Unmodifiable

```
final List<String> list = new ArrayList<>();
list.add("This");
list.add("is");
list.add("a");
list.add("list");
list = Collections.unmodifiableList(list);
```

Java 8 – Making the List Unmodifiable

```
final List<String> list = new ArrayList<>();
list.add("This");
list.add("is");
list.add("a");
list.add("list");
list = Collections.unmodifiableList(list);
```

Cannot assign a value to final variable 'list'

Make 'list' not final ⌥⇧⏎ More actions... ⌘1

```
final List<String> list = new ArrayList<String>()
```

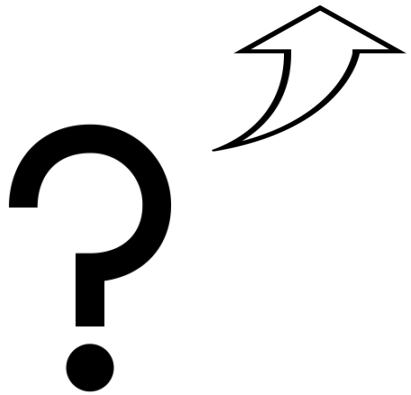
Immutable object, but mutable code

Java 8 – Creating a List - Alternative

```
final List<String> list = Arrays.asList("This", "is", "a", "list");
```

Java 8 – Creating a List - Alternative

```
final List<String> list = Arrays.asList("This", "is", "a", "list");
```



Java 9 – Creating a List

```
final List<String> list = List.of("This", "is", "a", "list");
```

Java 9 – Creating a List/Set/Map

```java
final List<String> list = List.of("This", "is", "a", "list");

final Set<String> set = Set.of("This", "is", "a", "set");

final Map<Integer, String> map = Map.of(
        1, "one",
        2, "two",
        3, "three"
);
```

Java 8 – Finding a Class in the Stack Trace

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```
StackTraceElement stackTraceElement = Thread.currentThread().getStackTrace()[4];
return Class.forName(stackTraceElement.getClassName());
```

Java 8 – Finding a Class in the Stack Trace

```
StackTraceElement stackTraceElement = Thread.currentThread().getStackTrace()[4];
return Class.forName(stackTraceElement.getClassName());
```

Never do that!

- A new method will be added/removed to the stack in the future
- You won't remember to update the index

Java 8 – Finding a Class in the Stack Trace

```
List<String> interestingClassNames = INTERESTING_CLASSES.stream()
                                                        .map(Class::getName)
                                                        .collect(Collectors.toList());

return Arrays.stream(Thread.currentThread().getStackTrace()) Stream<StackTraceElement>
             .map(StackTraceElement::getClassName) Stream<String>
             .filter(interestingClassNames::contains)
             .findFirst() Optional<String>
             .map(className -> {
                 try {
                     return Class.forName(className);
                 } catch (ClassNotFoundException e) {
                     throw new RuntimeException(e);
                 }
             });
```

Java 8 – Finding a Class in the Stack Trace

```
List<String> interestingClassNames = INTERESTING_CLASSES.stream()
                                                        .map(Class::getName)
                                                        .collect(Collectors.toList());

return Arrays.stream(Thread.currentThread().getStackTrace()) Stream<StackTraceElement>
             .map(StackTraceElement::getClassName) Stream<String>
             .filter(interestingClassNames::contains)
             .findFirst() Optional<String>
             .map(className -> {
                 try {
                     return Class.forName(className);
                 } catch (ClassNotFoundException e) {
                     throw new RuntimeException(e);
                 }
             });
```

- Verbose
- Unreadable
- Error-prone
- Bad performance

Java 9 – Finding a Class in the Stack Trace

```
return StackWalker.getInstance(RETAIN_CLASS_REFERENCE).walk(stackFrameStream ->
        stackFrameStream.<Class<?>>map(StackWalker.StackFrame::getDeclaringClass)
                        .filter(INTERESTING_CLASSES::contains)
                        .findFirst());
```

Java 9 – Modules

- APIs are like stars
- To keep evolving an API
- Expose only the API
- Encapsulate the implementations
- OSGi
  - Expose only the specific packages

Java 9 – Modules

Allows us to specify what packages we want to expose

- **Name** – the name of our module
- **Dependencies** – a list of other modules that this module depends on
- **Public Packages** – a list of all packages we want accessible from outside the module
- **Services Offered** – we can provide service implementations that can be consumed by other modules
- **Services Consumed** – allows the current module to be a consumer of a service
- **Reflection Permissions** – explicitly allows other classes to use reflection to access the private members of a package

https://www.baeldung.com/java-9-modularity

Java 10 – Type Inference

Java 8

```
Map<Integer, String> map = new HashMap<>();
ExecutorService executorService = Executors.newSingleThreadExecutor();
try (ByteArrayOutputStream outputStream = new ByteArrayOutputStream("anyString".getBytes().length)) {
    //...
}
```

Java 10 – Type Inference

Java 8

```
Map<Integer, String> map = new HashMap<>();
ExecutorService executorService = Executors.newSingleThreadExecutor();
try (ByteArrayOutputStream outputStream = new ByteArrayOutputStream("anyString".getBytes().length)) {
    //...
}
```

Java 10

```
var map = new HashMap<Integer, String>();
var executorService : ExecutorService = Executors.newSingleThreadExecutor();
try (var outputStream = new ByteArrayOutputStream("anyString".getBytes().length)) {
    //...
}
```

https://openjdk.java.net/projects/amber/LVTIstyle.html

Java 10 – Copying Collections

Java 8

```
List<String> list = Collections.unmodifiableList(new ArrayList<>(originalList));
Set<Object> set = Collections.unmodifiableSet(new HashSet<>(originalSet));
Map<Object, Object> map = Collections.unmodifiableMap(new HashMap<>(originalMap));
```

Java 10 – Copying Collections

Java 8

```
List<String> list = Collections.unmodifiableList(new ArrayList<>(originalList));
Set<Object> set = Collections.unmodifiableSet(new HashSet<>(originalSet));
Map<Object, Object> map = Collections.unmodifiableMap(new HashMap<>(originalMap));
```

Java 10

```
List<String> list = List.copyOf(originalList);
Set<Object> set = Set.copyOf(originalSet);
Map<Object, Object> map = Map.copyOf(originalMap);
```

Java 10 – Collecting an Unmodifiable List/Set/Map from a Stream

Java 8

```
List<String> list = Collections.unmodifiableList(streamForList.collect(Collectors.toList()));

Set<String> set = Collections.unmodifiableSet(streamForSet.collect(Collectors.toSet()));

Map<String, String> map = Collections.unmodifiableMap(pointStream.collect(Collectors.toMap(
        point -> point.getX().toString(),
        point -> point.getY().toString()
)));
```

Java 10 – Collecting an Unmodifiable List/Set/Map from a Stream

Java 8

```
List<String> list = Collections.unmodifiableList(streamForList.collect(Collectors.toList()));

Set<String> set = Collections.unmodifiableSet(streamForSet.collect(Collectors.toSet()));

Map<String, String> map = Collections.unmodifiableMap(pointStream.collect(Collectors.toMap(
        point -> point.getX().toString(),
        point -> point.getY().toString()
)));
```

Java 10

```
List<String> list = streamForList.collect(Collectors.toUnmodifiableList());

Set<String> set = streamForSet.collect(Collectors.toUnmodifiableSet());

Map<String, String> map = pointStream.collect(Collectors.toUnmodifiableMap(
        point -> point.getX().toString(),
        point -> point.getY().toString()
));
```

Java 11 – Repeating Strings

Java 8

```
public String repeat(String s) {
    StringBuilder stringBuilder = new StringBuilder();
    for (int i = 0; i < 4; i++) {
        stringBuilder.append(s);
    }
    return stringBuilder.toString();
}
```

Java 11 – Repeating Strings

Java 8

```
public String repeat(String s) {
    StringBuilder stringBuilder = new StringBuilder();
    for (int i = 0; i < 4; i++) {
        stringBuilder.append(s);
    }
    return stringBuilder.toString();
}
```

Java 11

```
public String repeat(String s) {
    return s.repeat(4);
}
```

Java 12 – Indenting (Multi-line) Strings

Java 8

```
public String indentation(String s, int indentationSize) {
    return Stream.of(s.split(System.lineSeparator()))
                .map(line -> {
                    StringBuilder stringBuilder = new StringBuilder();
                    for (int i = 0; i < indentationSize; i++) {
                        stringBuilder.append(' ');
                    }
                    stringBuilder.append(line);
                    return stringBuilder.toString();
                }).collect(
                   Collectors.joining(
                           System.lineSeparator(),
                           prefix: "",
                           System.lineSeparator()
                   )
            );
}
```

Java 12 – Indenting (Multi-line) Strings

Java 8

```
public String indentation(String s, int indentationSize) {
    return Stream.of(s.split(System.lineSeparator()))
                .map(line -> {
                    StringBuilder stringBuilder = new StringBuilder();
                    for (int i = 0; i < indentationSize; i++) {
                        stringBuilder.append(' ');
                    }
                    stringBuilder.append(line);
                    return stringBuilder.toString();
                }).collect(
                   Collectors.joining(
                           System.lineSeparator(),
                           prefix: "",
                           System.lineSeparator()
                   )
            );
}
```

Java 11

```
public String indentation(String s, int indentationSize) {
    return s.lines()
            .map(line -> " ".repeat(indentationSize) + line)
            .collect(
                    Collectors.joining(
                            System.lineSeparator(),
                            prefix: "",
                            System.lineSeparator()
                    )
            );
}
```

Java 12 – Indenting Strings

Java 8

```
public String indentation(String s, int indentationSize) {
    return Stream.of(s.split(System.lineSeparator()))
                .map(line -> {
                    StringBuilder stringBuilder = new StringBuilder();
                    for (int i = 0; i < indentationSize; i++) {
                        stringBuilder.append(' ');
                    }
                    stringBuilder.append(line);
                    return stringBuilder.toString();
                }).collect(
                    Collectors.joining(
                            System.lineSeparator(),
                            prefix: "",
                            System.lineSeparator()
                    )
            );
}
```

Java 11

```
public String indentation(String s, int indentationSize) {
    return s.lines()
            .map(line -> " ".repeat(indentationSize) + line)
            .collect(
                    Collectors.joining(
                            System.lineSeparator(),
                            prefix: "",
                            System.lineSeparator()
                    )
            );
}
```

Java 12

```
public String indentation(String s, int indentationSize) {
    return s.indent(indentationSize);
}
```

Java 14 – Enhanced Switch

Java 8

```
int value;

switch (dayOfWeek) {
    case MONDAY:
        value = 42;
        break;
    case TUESDAY:
        System.out.println("Today is your lucky day!");
        value = 100;
        break;
    case WEDNESDAY:
    case THURSDAY:
    case FRIDAY:
        value = 12;
        break;
    case SATURDAY:
    case SUNDAY:
        System.out.println("Woohoo! It's weekend!");
        value = 50;
        break;
    default:
        throw new IllegalStateException("Unexpected value: " + dayOfWeek);
}
```

Java 14 – Enhanced Switch

Java 8

```
int value;

switch (dayOfWeek) {
    case MONDAY:
        value = 42;
        break;
    case TUESDAY:
        System.out.println("Today is your lucky day!");
        value = 100;
        break;
    case WEDNESDAY:
    case THURSDAY:
    case FRIDAY:
        value = 12;
        break;
    case SATURDAY:
    case SUNDAY:
        System.out.println("Woohoo! It's weekend!");
        value = 50;
        break;
    default:
        throw new IllegalStateException("Unexpected value: " + dayOfWeek);
}
```

Java 14

```
int value;

value = switch (dayOfWeek) {
    case MONDAY -> 42;
    case TUESDAY -> {
        System.out.println("Today is your lucky day!");
        yield 100;
    }
    case WEDNESDAY, THURSDAY, FRIDAY -> 12;
    case SATURDAY, SUNDAY -> {
        System.out.println("Woohoo! It's weekend!");
        yield 50;
    }
};
```

Java 15 – Text Blocks

Java 15 – Text Blocks

Java 8

```
public String getSql() {
    return new StringBuilder("SELECT")
            .append(System.lineSeparator())
            .append("    id,").append(System.lineSeparator())
            .append("    name,").append(System.lineSeparator())
            .append("    date_of_birth,").append(System.lineSeparator())
            .append("    city").append(System.lineSeparator())
            .append("FROM person").append(System.lineSeparator())
            .append("WHERE").append(System.lineSeparator())
            .append("    country = ? AND").append(System.lineSeparator())
            .append("    active = ?").append(System.lineSeparator())
            .toString();
}
```

Java 15 – Text Blocks

Java 8

```
public String getSql() {
    return new StringBuilder("SELECT")
            .append(System.lineSeparator())
            .append("    id,").append(System.lineSeparator())
            .append("    name,").append(System.lineSeparator())
            .append("    date_of_birth,").append(System.lineSeparator())
            .append("    city").append(System.lineSeparator())
            .append("FROM person").append(System.lineSeparator())
            .append("WHERE").append(System.lineSeparator())
            .append("    country = ? AND").append(System.lineSeparator())
            .append("    active = ?").append(System.lineSeparator())
            .toString();
}
```

Java 15

```
public String getSql() {
    return """
            SELECT
                id,
                name,
                date_of_birth,
                city
            FROM person
            WHERE
                country = ? AND
                active = ?
            """;
}
```

Java 16 – Converting a Stream to an Unmodifiable List

Java 8

```
public void toList(Stream<String> stream) {
    List<String> list = Collections.unmodifiableList(stream.collect(Collectors.toList()));
}
```

Java 16 – Converting a Stream to an Unmodifiable List

Java 8

```
public void toList(Stream<String> stream) {
    List<String> list = Collections.unmodifiableList(stream.collect(Collectors.toList()));
}
```

Java 16

```
public void toList(Stream<String> stream) {
    List<String> list = stream.toList();
}
```

Java 16 – Records

Java 8

```
class Person {
    private final String name;
    private final LocalDate dateOfBirth;
    private final String country;

    Person(String name, LocalDate dateOfBirth, String country) {
        this.name = name;
        this.dateOfBirth = dateOfBirth;
        this.country = country;
    }

    public String getName() {
        return name;
    }

    public LocalDate getDateOfBirth() {
        return dateOfBirth;
    }

    public String getCountry() {
        return country;
    }

    @Override
    public boolean equals(Object o) {
        if (this == o) {
            return true;
        }
        if (o == null || getClass() != o.getClass()) {
            return false;
        }
        Person person = (Person) o;
        return name.equals(person.name)
                && dateOfBirth.equals(person.dateOfBirth)
                && country.equals(person.country);
    }

    @Override
    public int hashCode() {
        return Objects.hash(name, dateOfBirth, country);
    }

    @Override
    public String toString() {
        return "Person[" +
                "name=" + name +
                ", dateOfBirth=" + dateOfBirth +
                ", country=" + country +
                ']';
    }
}
```

Java 16 – Records

Java 8

```
class Person {
    private final String name;
    private final LocalDate dateOfBirth;
    private final String country;

    Person(String name, LocalDate dateOfBirth, String country) {
        this.name = name;
        this.dateOfBirth = dateOfBirth;
        this.country = country;
    }

    public String getName() {
        return name;
    }

    public LocalDate getDateOfBirth() {
        return dateOfBirth;
    }

    public String getCountry() {
        return country;
    }

    @Override
    public boolean equals(Object o) {
        if (this == o) {
            return true;
        }
        if (o == null || getClass() != o.getClass()) {
            return false;
        }
        Person person = (Person) o;
        return name.equals(person.name)
                && dateOfBirth.equals(person.dateOfBirth)
                && country.equals(person.country);
    }

    @Override
    public int hashCode() {
        return Objects.hash(name, dateOfBirth, country);
    }

    @Override
    public String toString() {
        return "Person[" +
                "name=" + name +
                ", dateOfBirth=" + dateOfBirth +
                ", country=" + country +
                ']';
    }
}
```

Project Lombok

```
@AllArgsConstructor
@ToString
@EqualsAndHashCode
static class Person {
    @Getter private final String name;
    @Getter private final LocalDate dateOfBirth;
    @Getter private final String country;
}
```

Java 16 – Records

Java 8

```
class Person {
    private final String name;
    private final LocalDate dateOfBirth;
    private final String country;

    Person(String name, LocalDate dateOfBirth, String country) {
        this.name = name;
        this.dateOfBirth = dateOfBirth;
        this.country = country;
    }

    public String getName() {
        return name;
    }

    public LocalDate getDateOfBirth() {
        return dateOfBirth;
    }

    public String getCountry() {
        return country;
    }

    @Override
    public boolean equals(Object o) {
        if (this == o) {
            return true;
        }
        if (o == null || getClass() != o.getClass()) {
            return false;
        }
        Person person = (Person) o;
        return name.equals(person.name)
                && dateOfBirth.equals(person.dateOfBirth)
                && country.equals(person.country);
    }

    @Override
    public int hashCode() {
        return Objects.hash(name, dateOfBirth, country);
    }

    @Override
    public String toString() {
        return "Person[" +
                "name=" + name +
                ", dateOfBirth=" + dateOfBirth +
                ", country=" + country +
                ']';
    }
}
```

Project Lombok

```
@AllArgsConstructor
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static class Person {
    @Getter private final String name;
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}
```

- External library
- Manipulates the byte code

Java 16 – Records

Java 8

```
class Person {
    private final String name;
    private final LocalDate dateOfBirth;
    private final String country;

    Person(String name, LocalDate dateOfBirth, String country) {
        this.name = name;
        this.dateOfBirth = dateOfBirth;
        this.country = country;
    }

    public String getName() {
        return name;
    }

    public LocalDate getDateOfBirth() {
        return dateOfBirth;
    }

    public String getCountry() {
        return country;
    }

    @Override
    public boolean equals(Object o) {
        if (this == o) {
            return true;
        }
        if (o == null || getClass() != o.getClass()) {
            return false;
        }
        Person person = (Person) o;
        return name.equals(person.name)
                && dateOfBirth.equals(person.dateOfBirth)
                && country.equals(person.country);
    }

    @Override
    public int hashCode() {
        return Objects.hash(name, dateOfBirth, country);
    }

    @Override
    public String toString() {
        return "Person[" +
                "name=" + name +
                ", dateOfBirth=" + dateOfBirth +
                ", country=" + country +
                ']';
    }
}
```

Project Lombok

```
@AllArgsConstructor
@ToString
@EqualsAndHashCode
static class Person {
    @Getter private final String name;
    @Getter private final LocalDate dateOfBirth;
    @Getter private final String country;
}
```

- External library
- Manipulates the byte code

Java 16

```
record Person(String name, LocalDate dateOfBirth, String country) {
}
```

- Pure Java 🙏

Java 16 – Pattern Matching for instanceof

Java 8

```
public void printLength(Object o) {
    if (o instanceof String) {
        System.out.println("The object has length = " + ((String) o).length());
    } else {
        System.out.println("It's not possible to get the object's length");
    }
}
```

Java 16 – Pattern Matching for instanceof

Java 8

```
public void printLength(Object o) {
    if (o instanceof String) {
        System.out.println("The object has length = " + ((String) o).length());
    } else {
        System.out.println("It's not possible to get the object's length");
    }
}
```

Java 16

```
public void printLength(Object o) {
    if (o instanceof String s) {
        System.out.println("The object has length = " + s.length());
    } else {
        System.out.println("It's not possible to get the object's length");
    }
}
```

Java 17 – Sealed classes and interfaces

- Methods that receives interfaces or non-final class can receive any implementation
- Implementations have access to protected members
- Careful to not expose internals with protected members

Java 17 – Sealed classes and interfaces

```
sealed interface Vehicle permits Car, Motorcycle {
    void run();
}

class Truck implements Vehicle {
    @Override
    public void run() {
        System.out.print
    }
}
```

Truck is not allowed in the sealed hierarchy

Add 'Truck' to permits list of a sealed class 'Vehicle' ⌥⇧⏎ More actions... ⌘1

com.thegreatapi.newjdkfeatures.jdk17
interface **SealedClasses.Vehicle**

· jdk17

Java 17 – Sealed classes and interfaces

```
sealed interface Vehicle permits Car, Motorcycle {
    void run();
}

class Car implements Vehicle {
    @Ov
    pub
    }
}
```

sealed, non-sealed or final modifiers expected

Make 'Car' final ⌥⇧⏎ More actions... ⌘1

Java 17 – Sealed classes and interfaces

```java
sealed interface Vehicle permits Car, Motorcycle {
    void run();
}

final class Car implements Vehicle {
    @Override
    public void run() {
        System.out.println("Car noise");
    }
}

non-sealed class Motorcycle implements Vehicle {
    @Override
    public void run() {
        System.out.println("Motorcycle noise");
    }
}
```

Start Using the New Features TODAY!

Clone the repo and try it:

https://github.com/hbelmiro/newjdkfeatures

Download the JDK 17 Early-Access Builds
https://jdk.java.net/17/

https://thegreatapi.com/

http://twitter.com/helber_belmiro

https://www.linkedin.com/in/helber-belmiro-b5286021/