COMP2511

Week 4

THURSDAY 9AM - 12PM (H09A)
FRIDAY 10AM - 1PM (F10A)

Attendance

Ask Questions

Also participation marks

This week

- The Functional Paradigm
- Refactoring
- **Introduction to Design Patterns**
- Strategy Pattern
- State Pattern
- Observer Pattern

- **Design Principles**
- **Design by Contract**
- **Streams & Lambdas**

Law of Demeter

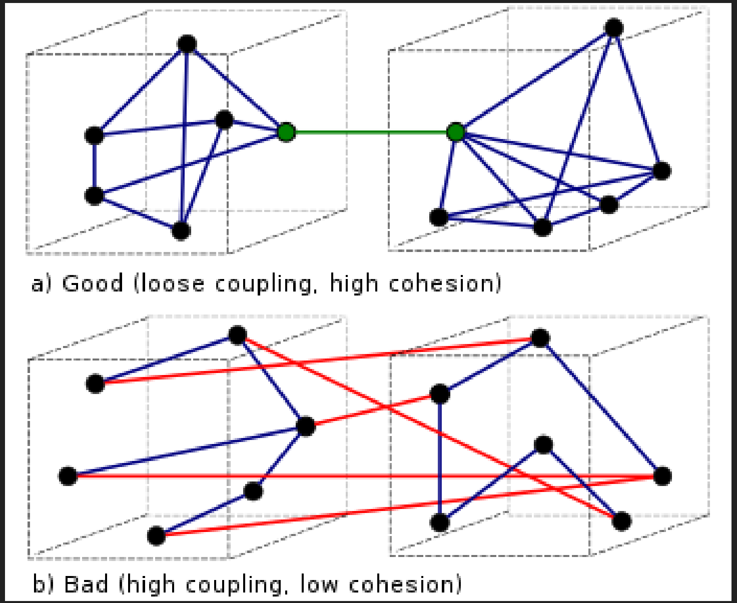
"Principle of least knowledge"

Law of Demeter

What is it?

Law of Demeter (aka principle of least knowledge) is a **design guideline** that says that an **object** should **assume as little as possible knowledge** about the structures or properties of other objects.

It aims to achieve loose coupling in code.


a) Good (loose coupling, high cohesion)
b) Bad (high coupling, low cohesion)

Law of Demeter

What does it actually mean?

A method in an object should only invoke methods of:

- The object itself
- The object passed in as a parameter to the method
- Objects instantiated within the method
- Any component objects
- And not those of objects returned by a method

E.g., don't do this

```
o.get(name).get(thing).remove(node)
```

Code Review

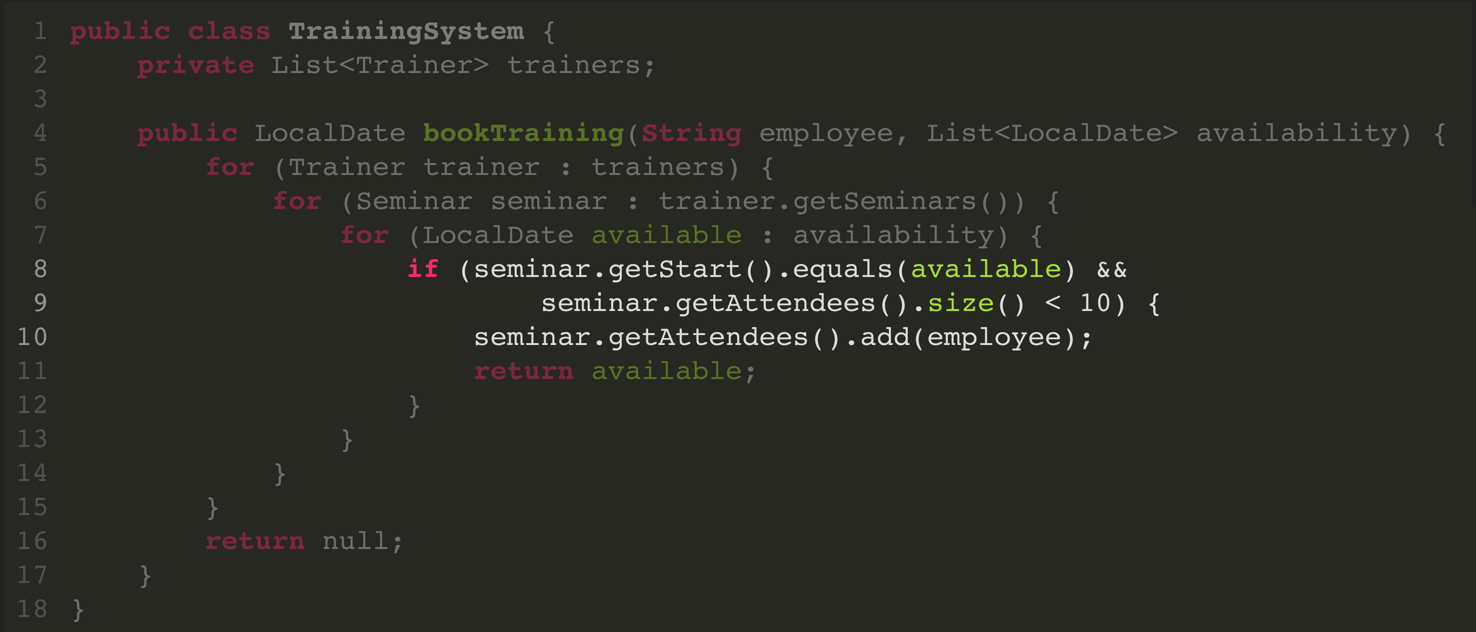
Law of Demeter

Code Review

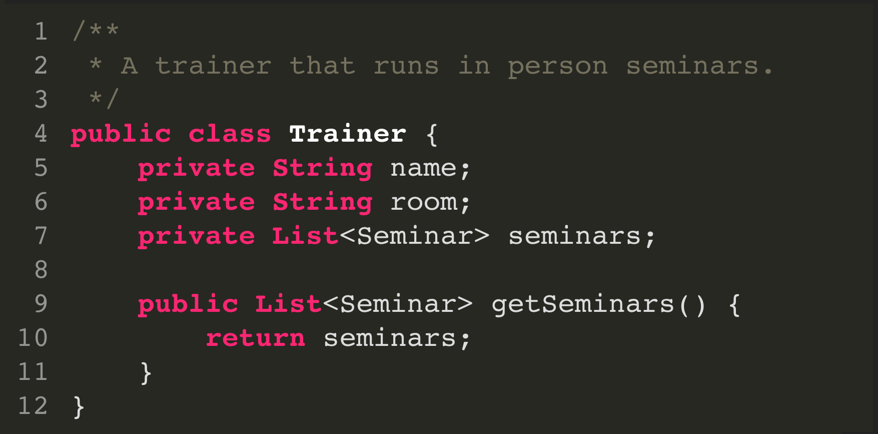
In the `unsw.training` package there is some skeleton code for a training system.

- Every employee must attend a whole day training seminar run by a qualified trainer
- Each trainer is running multiple seminars with no more than 10 attendees per seminar

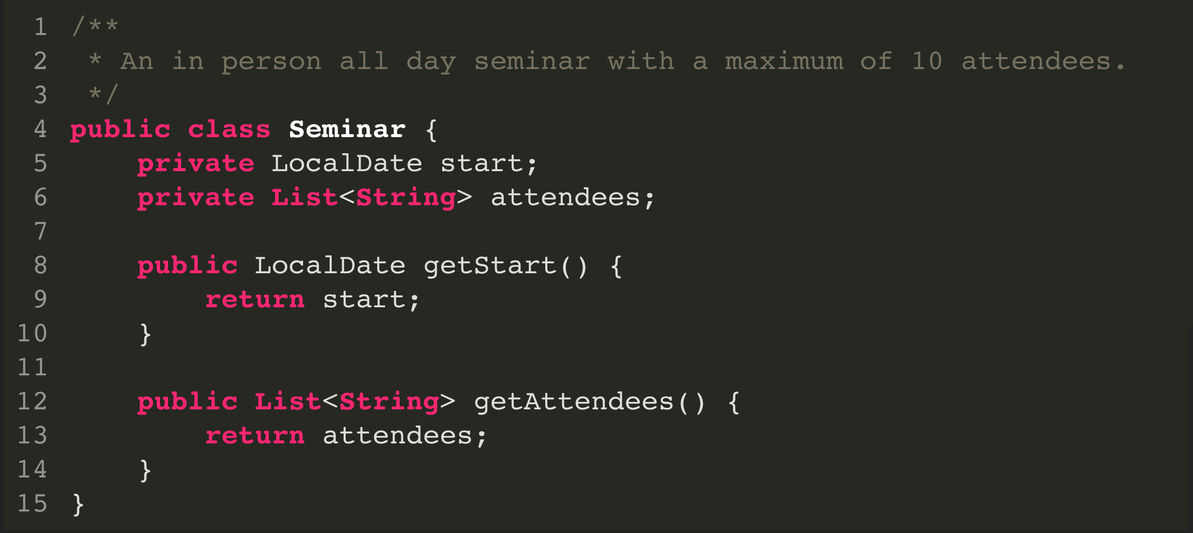
In the `TrainingSystem` class there is a method to book a seminar for an employee given the dates on which they are available. This method violates the principle of least knowledge (Law of Demeter).



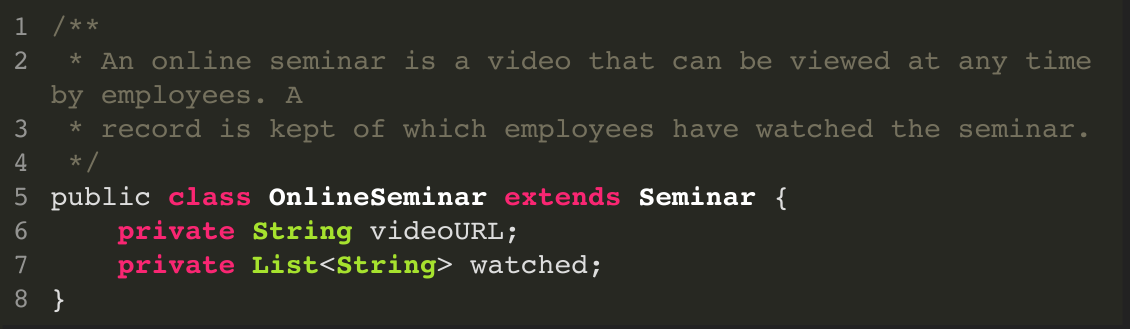
```java
public class TrainingSystem {
    private List<Trainer> trainers;

    public LocalDate bookTraining(String employee, List<LocalDate> availability) {
        for (Trainer trainer : trainers) {
            for (Seminar seminar : trainer.getSeminars()) {
                for (LocalDate available : availability) {
                    if (seminar.getStart().equals(available) &&
                            seminar.getAttendees().size() < 10) {
                        seminar.getAttendees().add(employee);
                        return available;
                    }
                }
            }
        }
        return null;
    }
}
```



```java
/**
 * A trainer that runs in person seminars.
 */
public class Trainer {
    private String name;
    private String room;
    private List<Seminar> seminars;

    public List<Seminar> getSeminars() {
        return seminars;
    }
}
```

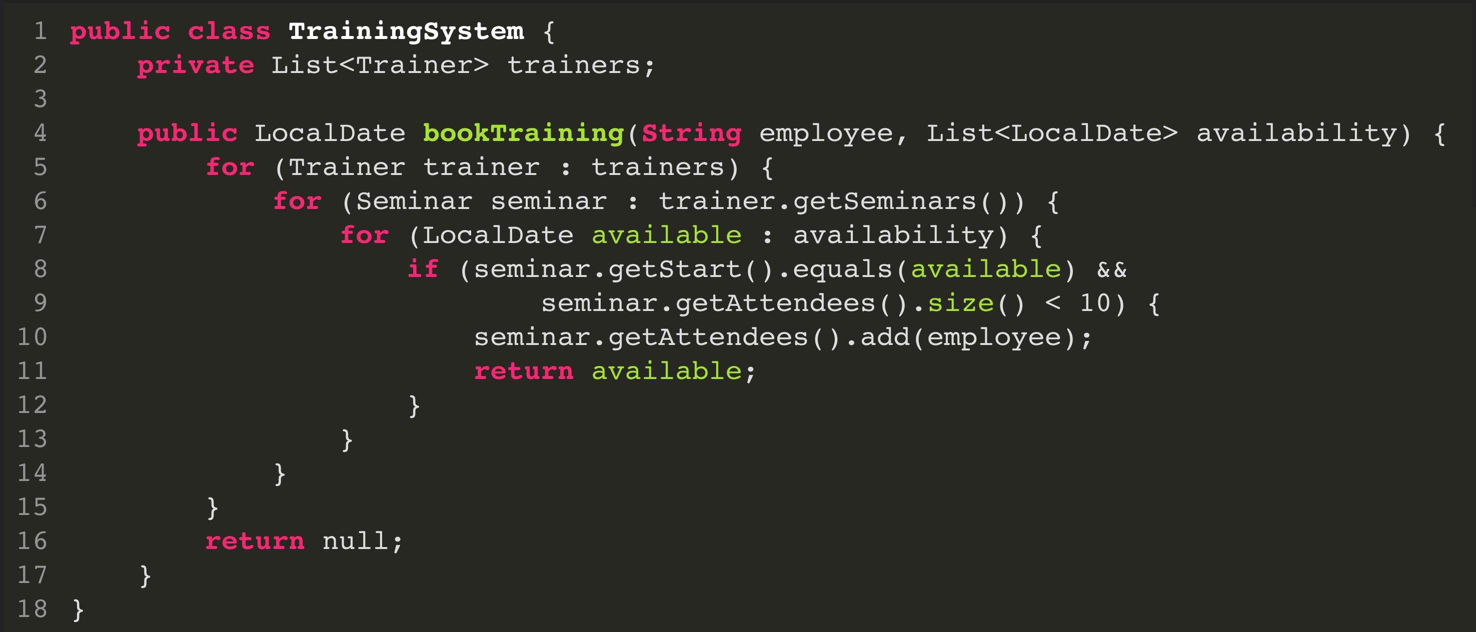


```java
/**
 * An in person all day seminar with a maximum of 10 attendees.
 */
public class Seminar {
    private LocalDate start;
    private List<String> attendees;

    public LocalDate getStart() {
        return start;
    }

    public List<String> getAttendees() {
        return attendees;
    }
}
```

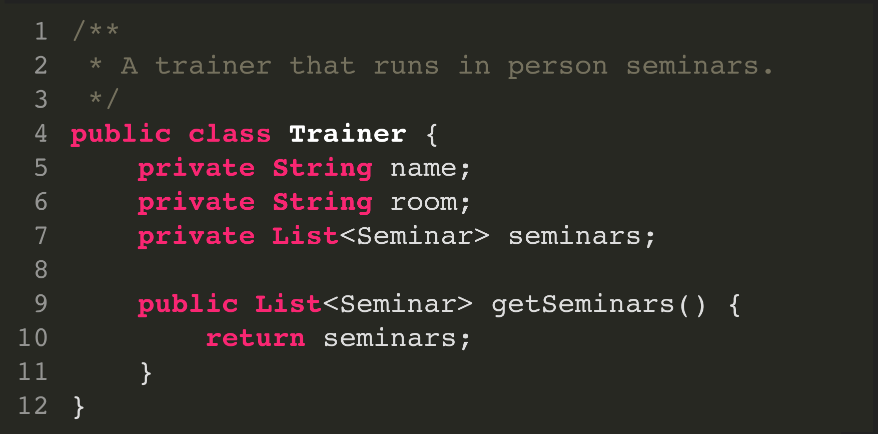


```java
/**
 * An online seminar is a video that can be viewed at any time
by employees. A
 * record is kept of which employees have watched the seminar.
 */
public class OnlineSeminar extends Seminar {
    private String videoURL;
    private List<String> watched;
}
```

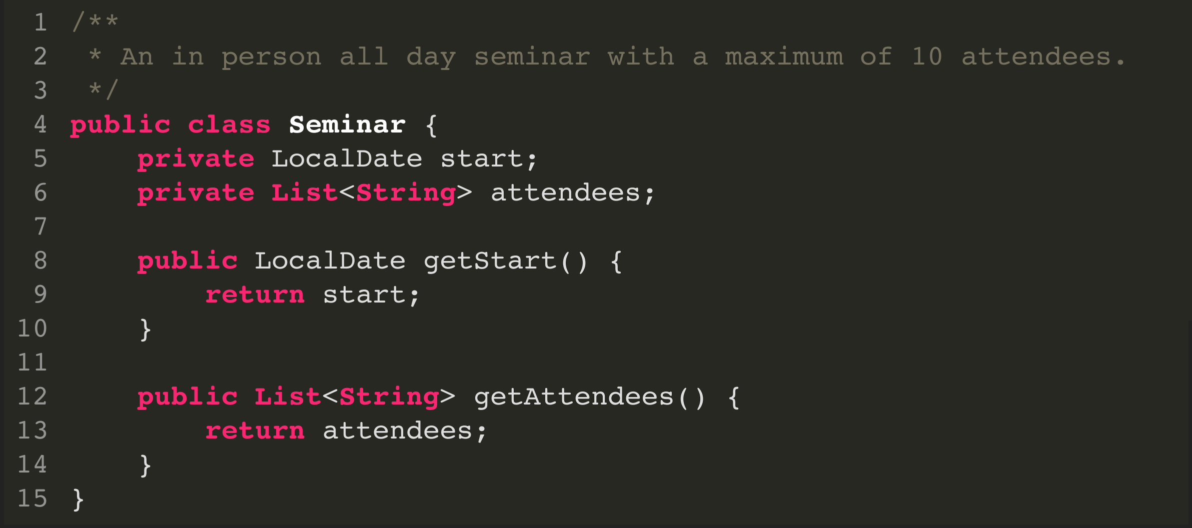
How and why does it violate this principle?



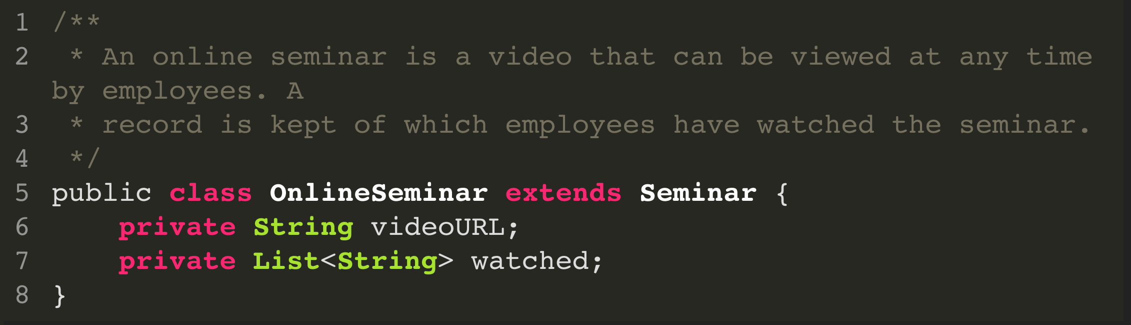
```java
public class TrainingSystem {
    private List<Trainer> trainers;

    public LocalDate bookTraining(String employee, List<LocalDate> availability) {
        for (Trainer trainer : trainers) {
            for (Seminar seminar : trainer.getSeminars()) {
                for (LocalDate available : availability) {
                    if (seminar.getStart().equals(available) &&
                            seminar.getAttendees().size() < 10) {
                        seminar.getAttendees().add(employee);
                        return available;
                    }
                }
            }
        }
        return null;
    }
}
```



```java
/**
 * A trainer that runs in person seminars.
 */
public class Trainer {
    private String name;
    private String room;
    private List<Seminar> seminars;

    public List<Seminar> getSeminars() {
        return seminars;
    }
}
```

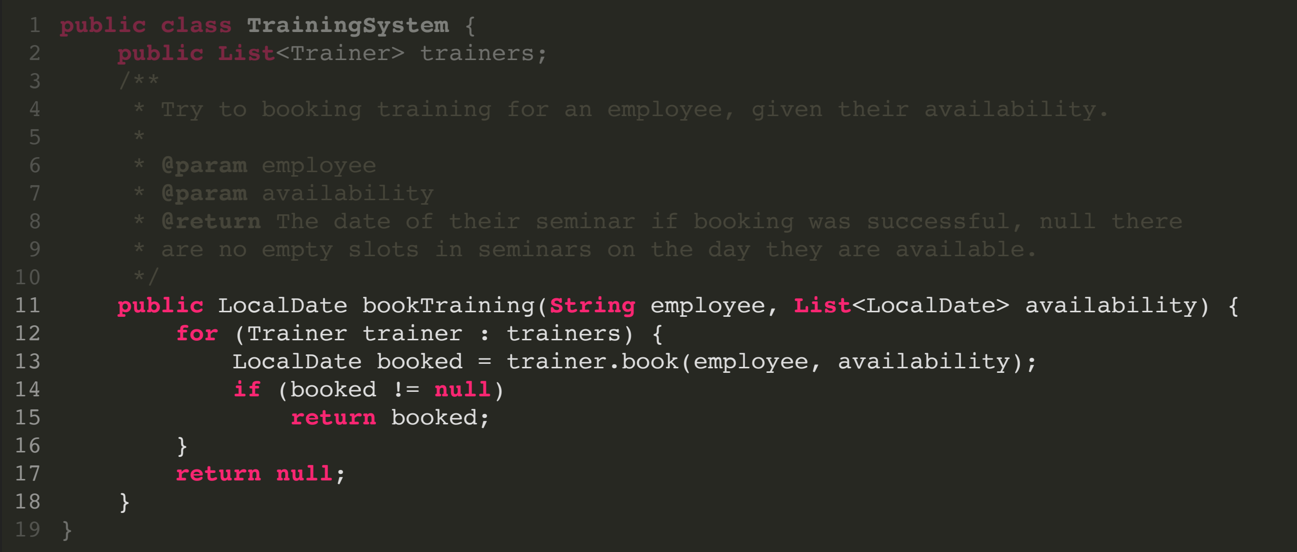


```java
/**
 * An in person all day seminar with a maximum of 10 attendees.
 */
public class Seminar {
    private LocalDate start;
    private List<String> attendees;

    public LocalDate getStart() {
        return start;
    }

    public List<String> getAttendees() {
        return attendees;
    }
}
```

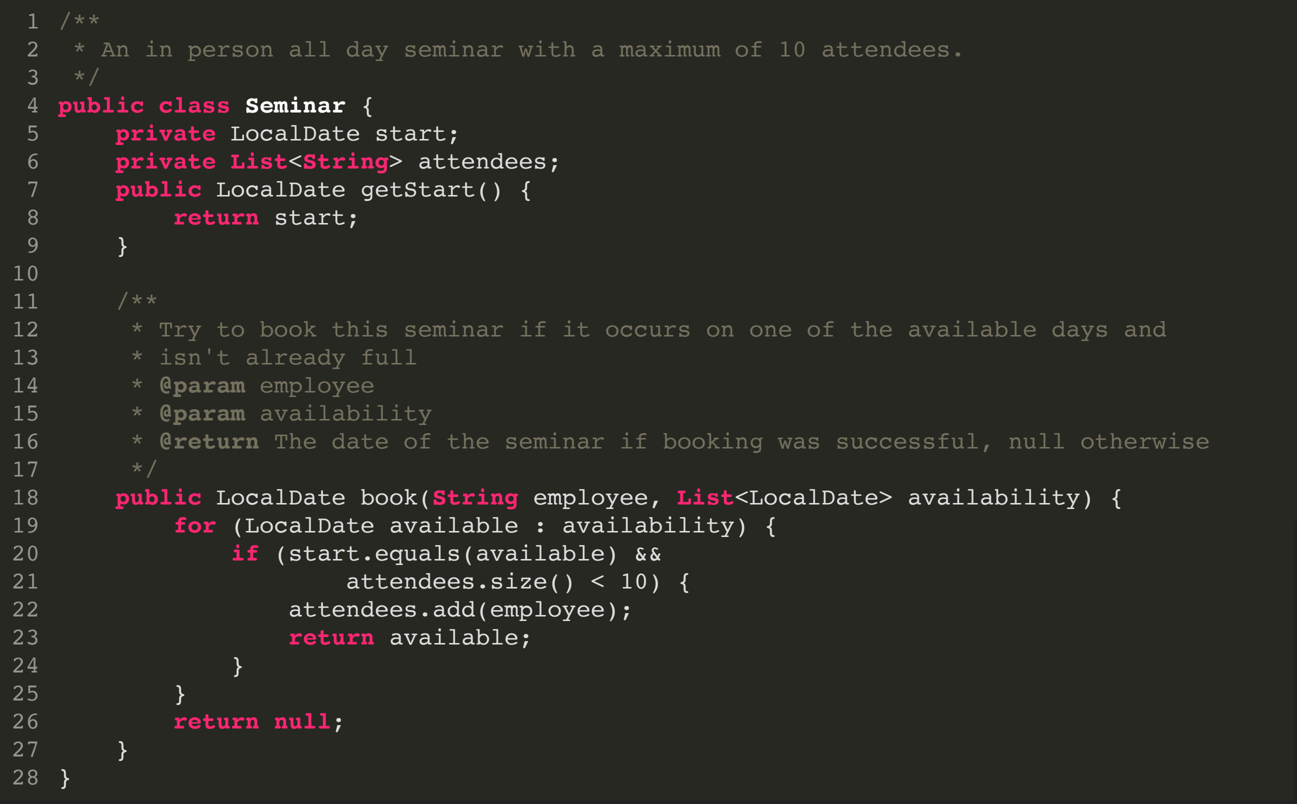


```java
/**
 * An online seminar is a video that can be viewed at any time by employees. A
 * record is kept of which employees have watched the seminar.
 */
public class OnlineSeminar extends Seminar {
    private String videoURL;
    private List<String> watched;
}
```

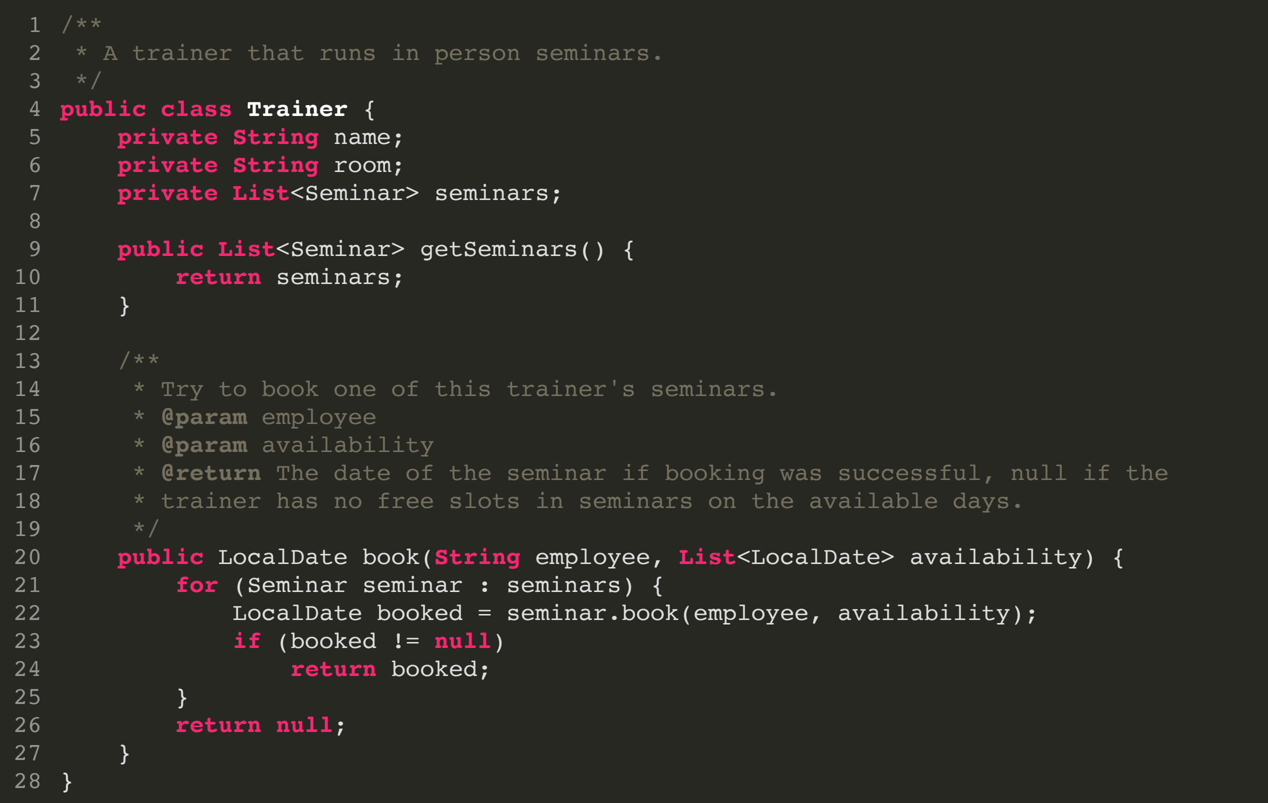
What other properties of this design are not desirable?



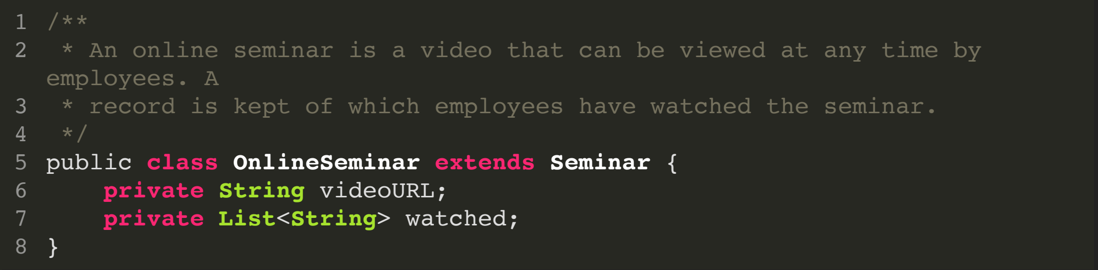
```java
public class TrainingSystem {
    public List<Trainer> trainers;
    /**
     * Try to booking training for an employee, given their availability.
     *
     * @param employee
     * @param availability
     * @return The date of their seminar if booking was successful, null there
     * are no empty slots in seminars on the day they are available.
     */
    public LocalDate bookTraining(String employee, List<LocalDate> availability) {
        for (Trainer trainer : trainers) {
            LocalDate booked = trainer.book(employee, availability);
            if (booked != null)
                return booked;
        }
        return null;
    }
}
```



```java
/**
 * An in person all day seminar with a maximum of 10 attendees.
 */
public class Seminar {
    private LocalDate start;
    private List<String> attendees;
    public LocalDate getStart() {
        return start;
    }

    /**
     * Try to book this seminar if it occurs on one of the available days and
     * isn't already full
     * @param employee
     * @param availability
     * @return The date of the seminar if booking was successful, null otherwise
     */
    public LocalDate book(String employee, List<LocalDate> availability) {
        for (LocalDate available : availability) {
            if (start.equals(available) &&
                    attendees.size() < 10) {
                attendees.add(employee);
                return available;
            }
        }
        return null;
    }
}
```



```java
/**
 * A trainer that runs in person seminars.
 */
public class Trainer {
    private String name;
    private String room;
    private List<Seminar> seminars;

    public List<Seminar> getSeminars() {
        return seminars;
    }

    /**
     * Try to book one of this trainer's seminars.
     * @param employee
     * @param availability
     * @return The date of the seminar if booking was successful, null if the
     * trainer has no free slots in seminars on the available days.
     */
    public LocalDate book(String employee, List<LocalDate> availability) {
        for (Seminar seminar : seminars) {
            LocalDate booked = seminar.book(employee, availability);
            if (booked != null)
                return booked;
        }
        return null;
    }
}
```



```java
/**
 * An online seminar is a video that can be viewed at any time by employees. A
 * record is kept of which employees have watched the seminar.
 */
public class OnlineSeminar extends Seminar {
    private String videoURL;
    private List<String> watched;
}
```

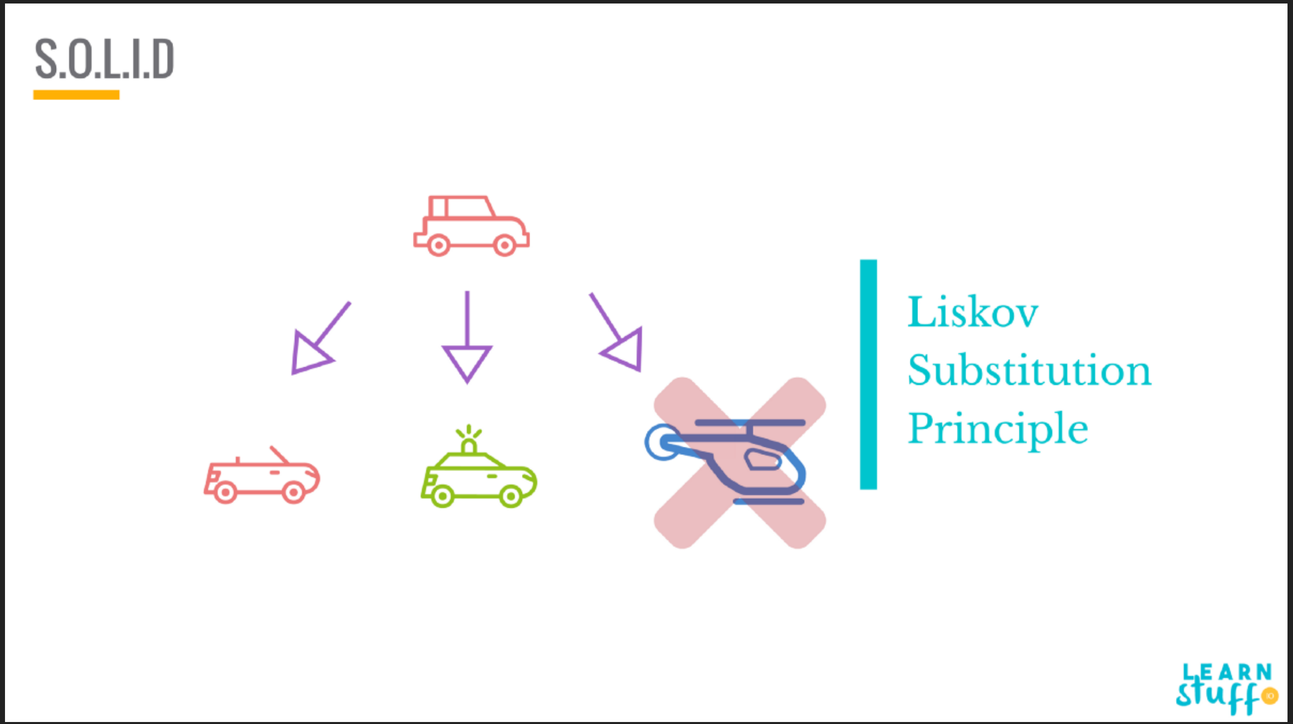
1. `TrainingSystem` no longer has knowledge of `Seminar`
2. Each class has their own responsibility (good cohesion)

Liskov Substitution Principle

Liskov Substitution Principle

What is it?

Liskov Substitution Principle (LSP) states that objects of a **superclass** should be **replaceable** with objects of its **subclasses without breaking the application**.



Liskov Substitution Principle

Solve the problem without inheritance

- Delegation - delegate the functionality to another class
- Composition - reuse behaviour using one or more classes with composition

Design principle: Favour composition over inheritance

If you favour composition over inheritance, your software will be more flexible, easier to maintain, extend.

Liskov Substitution Principle

```java
/**
 * An in person all day seminar with a maximum of 10 attendees.
 */
public class Seminar {
    private LocalDate start;
    private List<String> attendees;

    public LocalDate getStart() {
        return start;
    }

    public List<String> getAttendees() {
        return attendees;
    }
}
```

```java
/**
 * An online seminar is a video that can be viewed at any time by employees. A
 * record is kept of which employees have watched the seminar.
 */
public class OnlineSeminar extends Seminar {
    private String videoURL;
    private List<String> watched;
}
```

Where does `OnlineSeminar` violate LSP?

`OnlineSeminar` doesn't require a list of attendees

Streams

Streams

Streams abstract away the details of data structures and allows you to access all the values in the data structure through a **common interface**

```java
List<String> strings = new ArrayList<String>(Arrays.asList(new String[] {"1", "2", "3", "4", "5"}));
for (String string : strings) {
    System.out.println(string);
}
```

```java
List<String> strings = new ArrayList<String>(Arrays.asList(new String[] {"1", "2", "3", "4", "5"}));
strings.stream().forEach(x -> System.out.println(x));
```

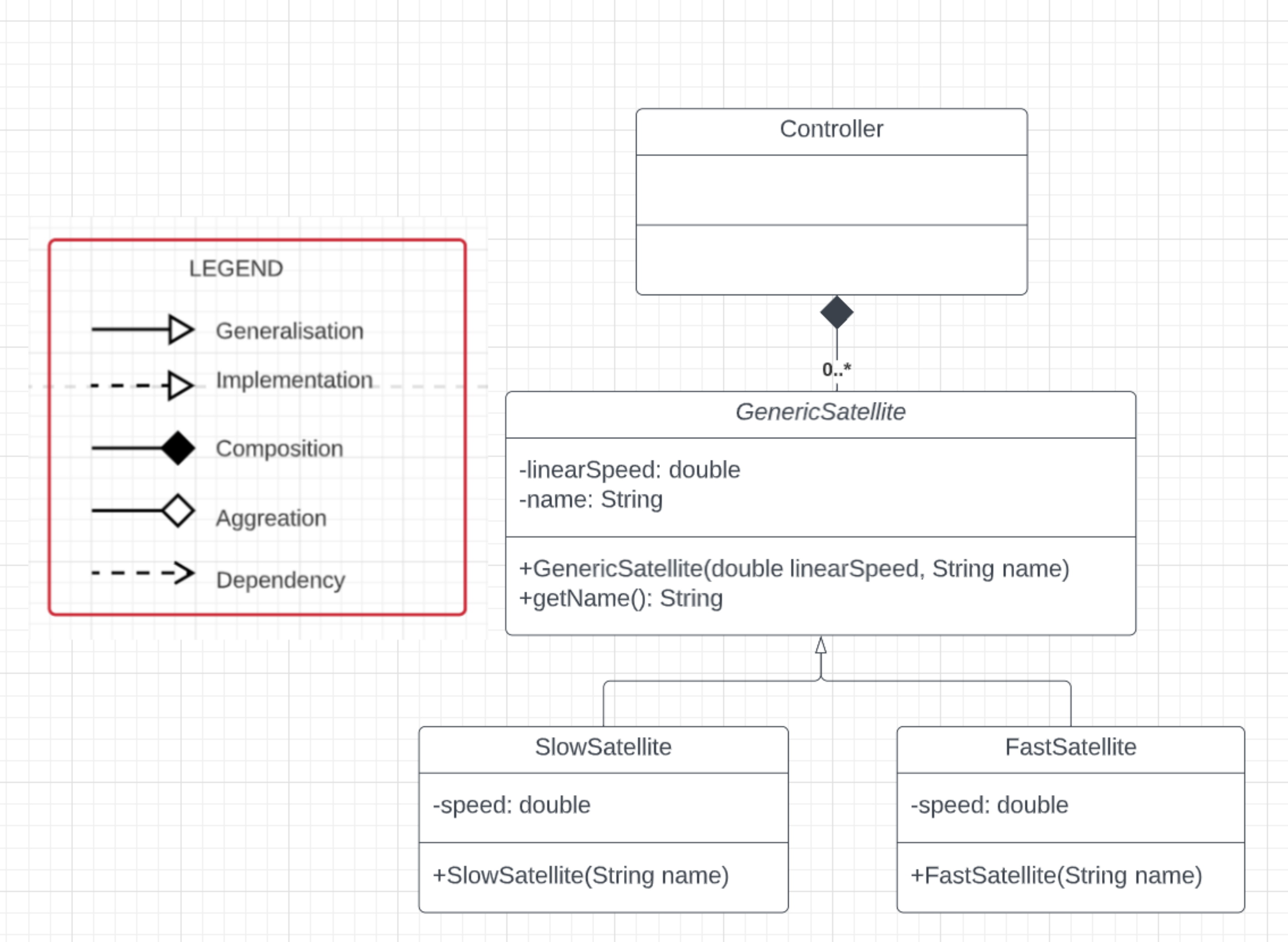
```java
Map<String, Integer> map = new HashMap<>();
map.put("One", 1);
map.put("Two", 2);
map.put("Three", 3);
map.entrySet().stream().forEach(x -> System.out.printf("%s, %s\n", x.getKey(), x.getValue()));
```

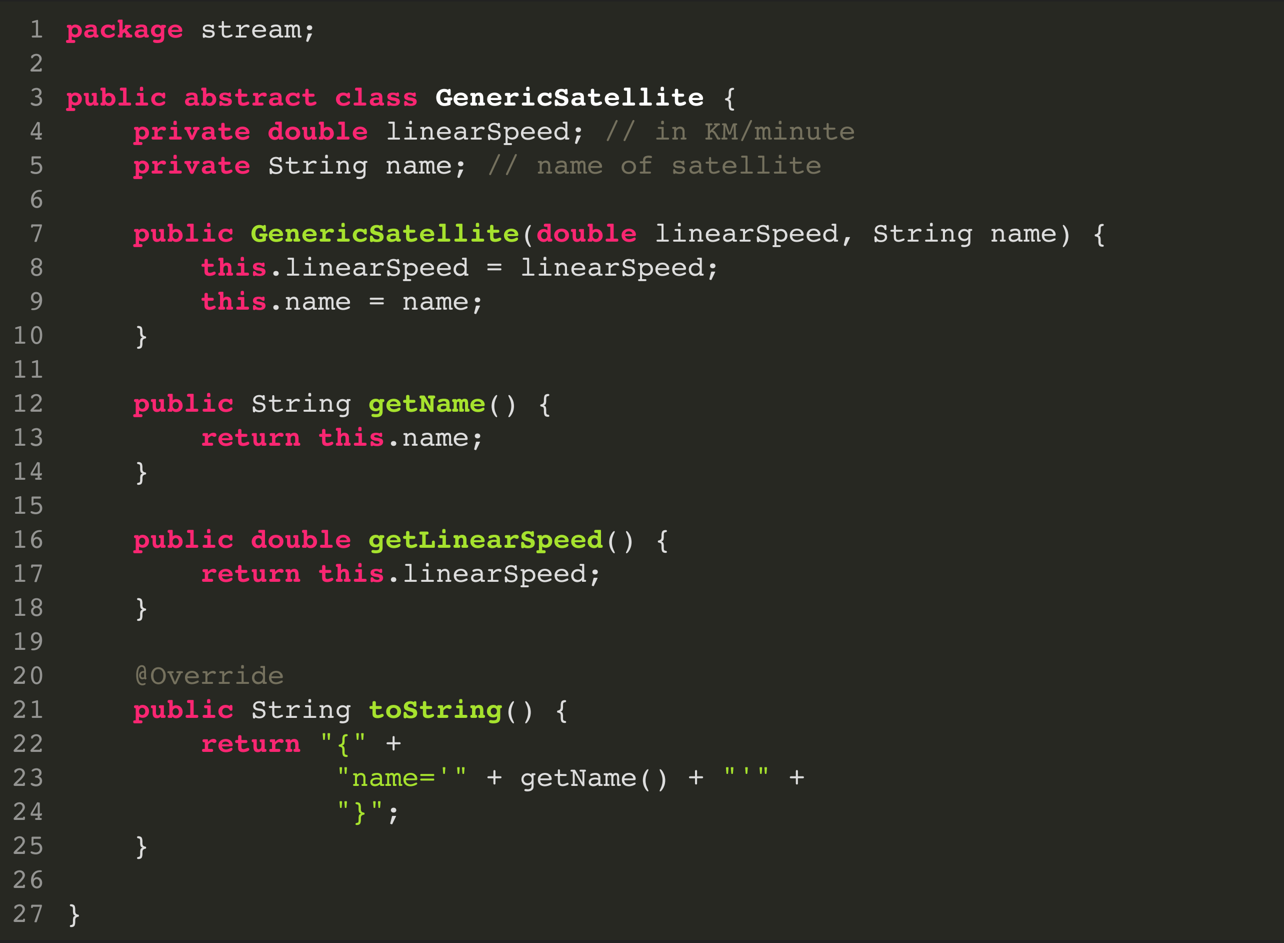
Streams

Common uses of streams are:

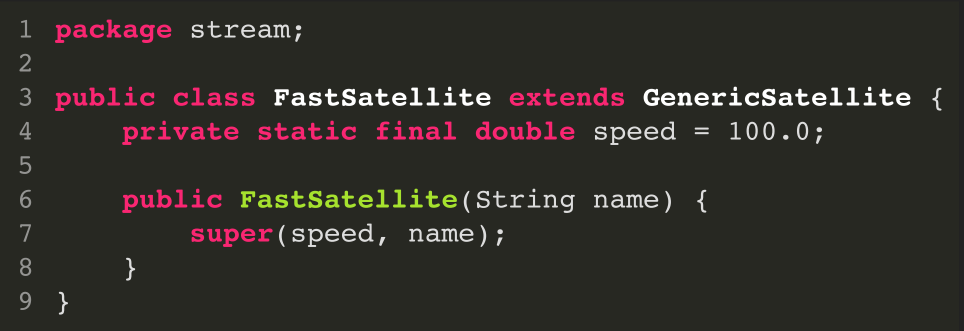
- forEach
- filter
- map
- reduce

Streams Example

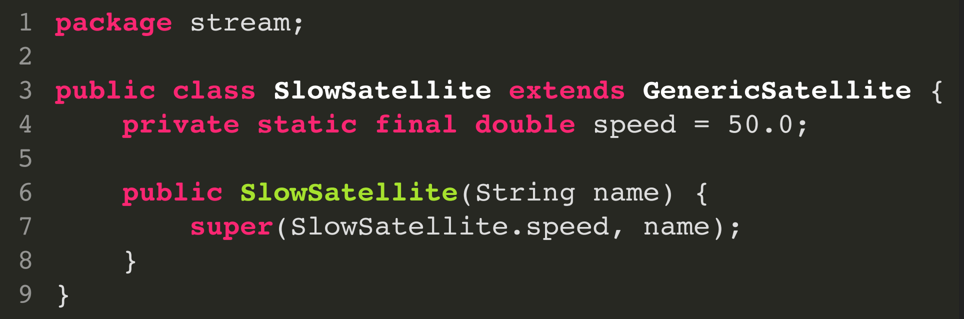




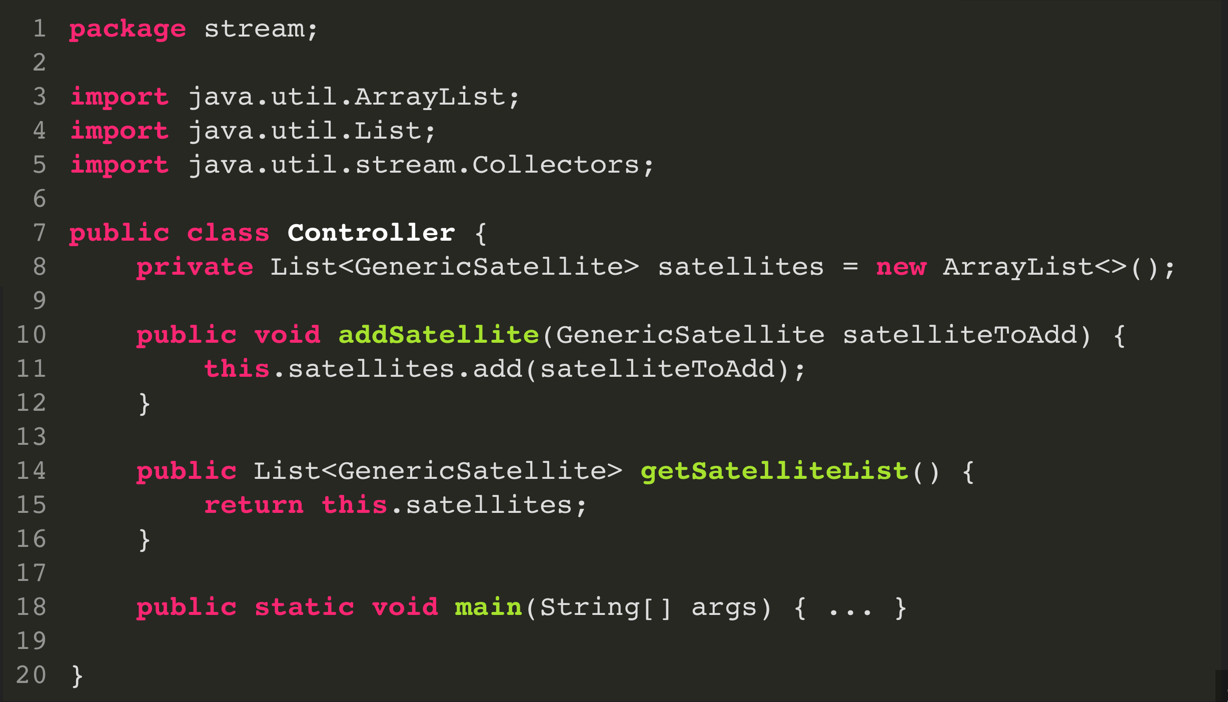
```java
package stream;

public abstract class GenericSatellite {
    private double linearSpeed; // in KM/minute
    private String name; // name of satellite

    public GenericSatellite(double linearSpeed, String name) {
        this.linearSpeed = linearSpeed;
        this.name = name;
    }

    public String getName() {
        return this.name;
    }

    public double getLinearSpeed() {
        return this.linearSpeed;
    }

    @Override
    public String toString() {
        return "{" +
                "name='" + getName() + "'" +
                "}";
    }

}
```



```java
package stream;

public class FastSatellite extends GenericSatellite {
    private static final double speed = 100.0;

    public FastSatellite(String name) {
        super(speed, name);
    }
}
```

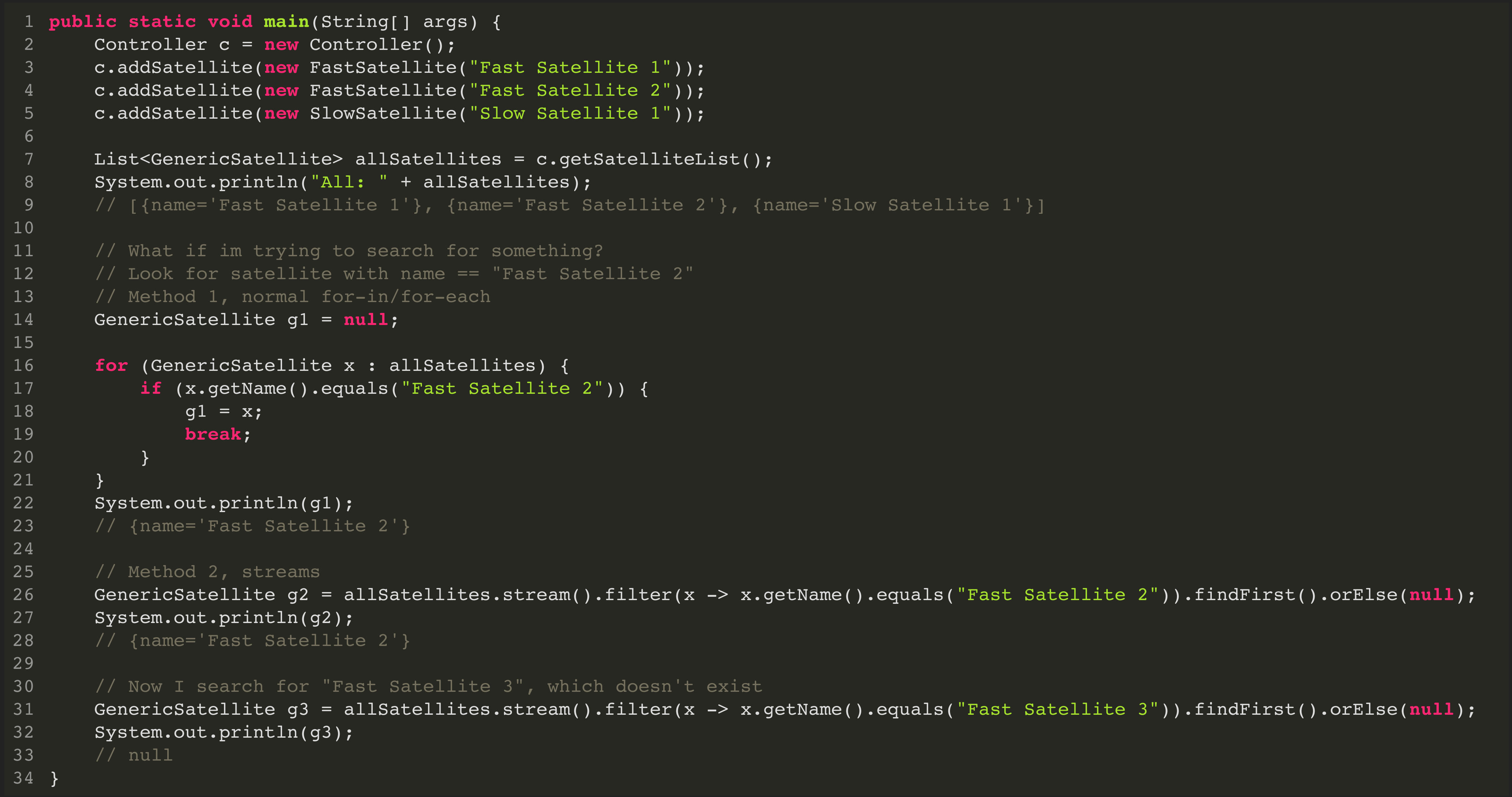


```java
package stream;

public class SlowSatellite extends GenericSatellite {
    private static final double speed = 50.0;

    public SlowSatellite(String name) {
        super(SlowSatellite.speed, name);
    }
}
```



```java
package stream;

import java.util.ArrayList;
import java.util.List;
import java.util.stream.Collectors;

public class Controller {
    private List<GenericSatellite> satellites = new ArrayList<>();

    public void addSatellite(GenericSatellite satelliteToAdd) {
        this.satellites.add(satelliteToAdd);
    }

    public List<GenericSatellite> getSatelliteList() {
        return this.satellites;
    }

    public static void main(String[] args) { ... }

}
```

```java
public static void main(String[] args) {
    Controller c = new Controller();
    c.addSatellite(new FastSatellite("Fast Satellite 1"));
    c.addSatellite(new FastSatellite("Fast Satellite 2"));
    c.addSatellite(new SlowSatellite("Slow Satellite 1"));

    List<GenericSatellite> allSatellites = c.getSatelliteList();
    System.out.println("All: " + allSatellites);
    // [{name='Fast Satellite 1'}, {name='Fast Satellite 2'}, {name='Slow Satellite 1'}]

    // What if I just want FastSatellites only?
    // Method 1, normal for-in/for-each
    List<GenericSatellite> fast1 = new ArrayList<>();
    for (GenericSatellite x : allSatellites) {
        if (x instanceof FastSatellite) {
            fast1.add(x);
        }
    }
    System.out.println("Just fast: " + fast1);
    // [{name='Fast Satellite 1'}, {name='Fast Satellite 2'}]

    // Method 2, streams
    List<GenericSatellite> fast2 = allSatellites.stream().filter(x -> x instanceof FastSatellite).collect(Collectors.toList());
    System.out.println("Just fast: " + fast2);
    // [{name='Fast Satellite 1'}, {name='Fast Satellite 2'}]

    // Same, but I typecast at the same time
    List<FastSatellite> fast3 = allSatellites.stream().filter(x -> x instanceof FastSatellite).map(x -> (FastSatellite) x)
            .collect(Collectors.toList());
    System.out.println("Just fast: " + fast3);
    // [{name='Fast Satellite 1'}, {name='Fast Satellite 2'}]
}
```

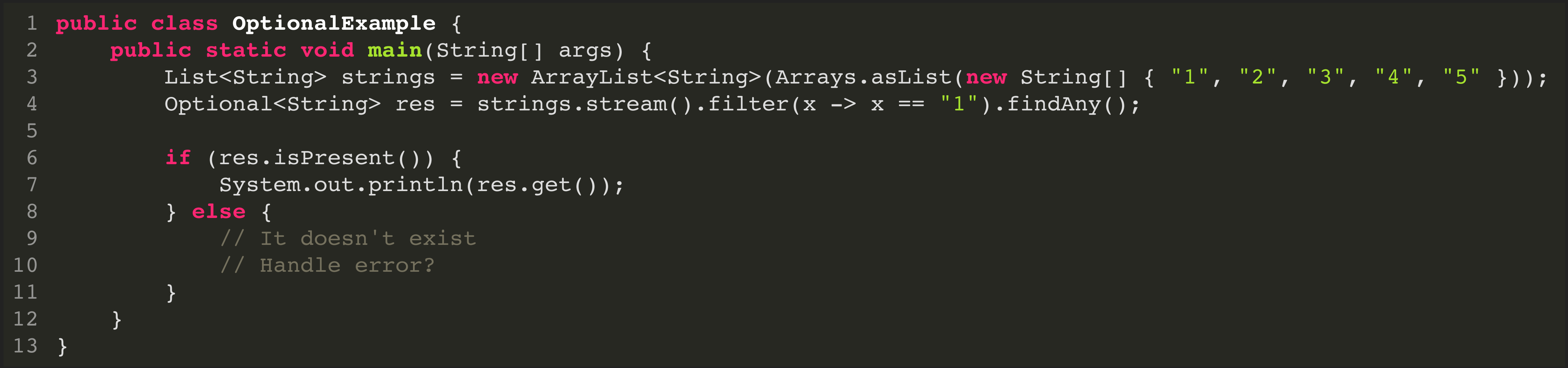


```java
public static void main(String[] args) {
    Controller c = new Controller();
    c.addSatellite(new FastSatellite("Fast Satellite 1"));
    c.addSatellite(new FastSatellite("Fast Satellite 2"));
    c.addSatellite(new SlowSatellite("Slow Satellite 1"));

    List<GenericSatellite> allSatellites = c.getSatelliteList();
    System.out.println("All: " + allSatellites);
    // [{name='Fast Satellite 1'}, {name='Fast Satellite 2'}, {name='Slow Satellite 1'}]

    // What if im trying to search for something?
    // Look for satellite with name == "Fast Satellite 2"
    // Method 1, normal for-in/for-each
    GenericSatellite g1 = null;

    for (GenericSatellite x : allSatellites) {
        if (x.getName().equals("Fast Satellite 2")) {
            g1 = x;
            break;
        }
    }
    System.out.println(g1);
    // {name='Fast Satellite 2'}

    // Method 2, streams
    GenericSatellite g2 = allSatellites.stream().filter(x -> x.getName().equals("Fast Satellite 2")).findFirst().orElse(null);
    System.out.println(g2);
    // {name='Fast Satellite 2'}

    // Now I search for "Fast Satellite 3", which doesn't exist
    GenericSatellite g3 = allSatellites.stream().filter(x -> x.getName().equals("Fast Satellite 3")).findFirst().orElse(null);
    System.out.println(g3);
    // null
}
```

Optional<type>

If a variable can be null, use `Optional<>`.

Try to never set variables to be null, as you can get NullPointerExceptions which aren't fun to deal with

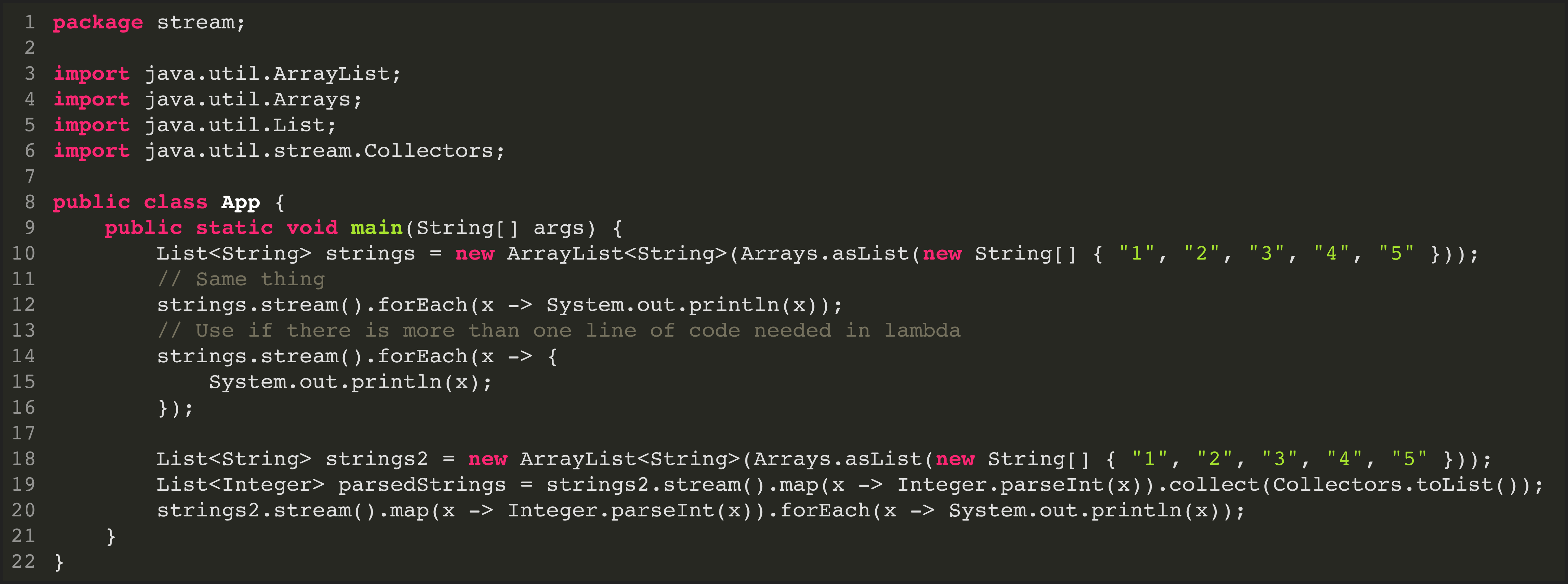


```java
public class OptionalExample {
    public static void main(String[] args) {
        List<String> strings = new ArrayList<String>(Arrays.asList(new String[] { "1", "2", "3", "4", "5" }));
        Optional<String> res = strings.stream().filter(x -> x == "1").findAny();

        if (res.isPresent()) {
            System.out.println(res.get());
        } else {
            // It doesn't exist
            // Handle error?
        }
    }
}
```

.findFirst() actually returns Optional<type>

Code Demo

Streams



```java
package stream;

import java.util.ArrayList;
import java.util.Arrays;
import java.util.List;
import java.util.stream.Collectors;

public class App {
    public static void main(String[] args) {
        List<String> strings = new ArrayList<String>(Arrays.asList(new String[] { "1", "2", "3", "4", "5" }));
        // Same thing
        strings.stream().forEach(x -> System.out.println(x));
        // Use if there is more than one line of code needed in lambda
        strings.stream().forEach(x -> {
            System.out.println(x);
        });

        List<String> strings2 = new ArrayList<String>(Arrays.asList(new String[] { "1", "2", "3", "4", "5" }));
        List<Integer> parsedStrings = strings2.stream().map(x -> Integer.parseInt(x)).collect(Collectors.toList());
        strings2.stream().map(x -> Integer.parseInt(x)).forEach(x -> System.out.println(x));
    }
}
```

Design By Contract

Design By Contract

At the design time, responsibilities are clearly assigned to different software elements, clearly documented and enforced during the development and using unit testing and/or language support.

- Clear demarcation of responsibilities helps prevent redundant checks, resulting in simpler code and easier maintenance
- Crashes if the required conditions are not satisfied. May not be suitable for highly availability applications

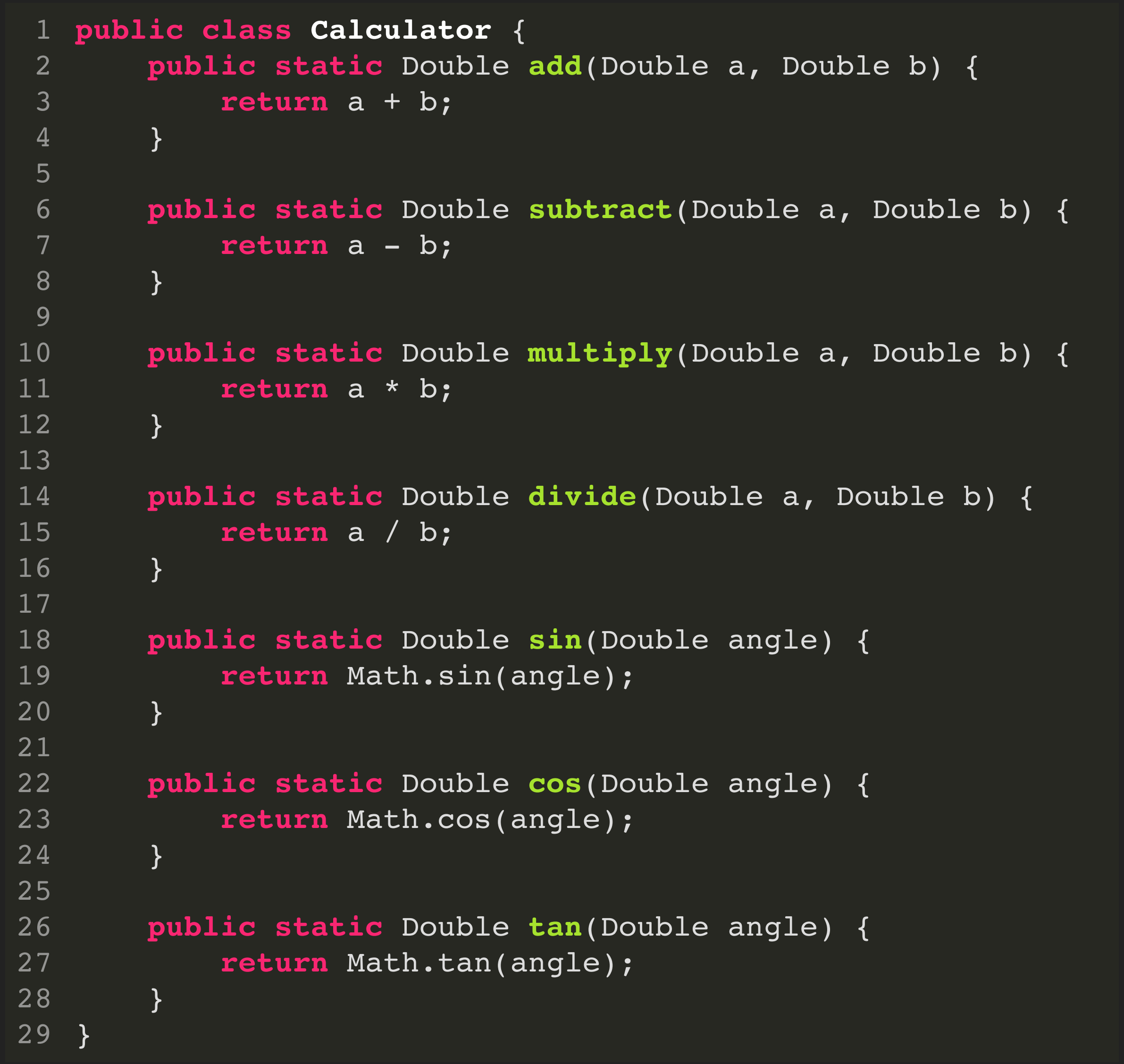
Design By Contract

Every software element should define a specification (or a contract) that govern its transaction with the rest of the software components.

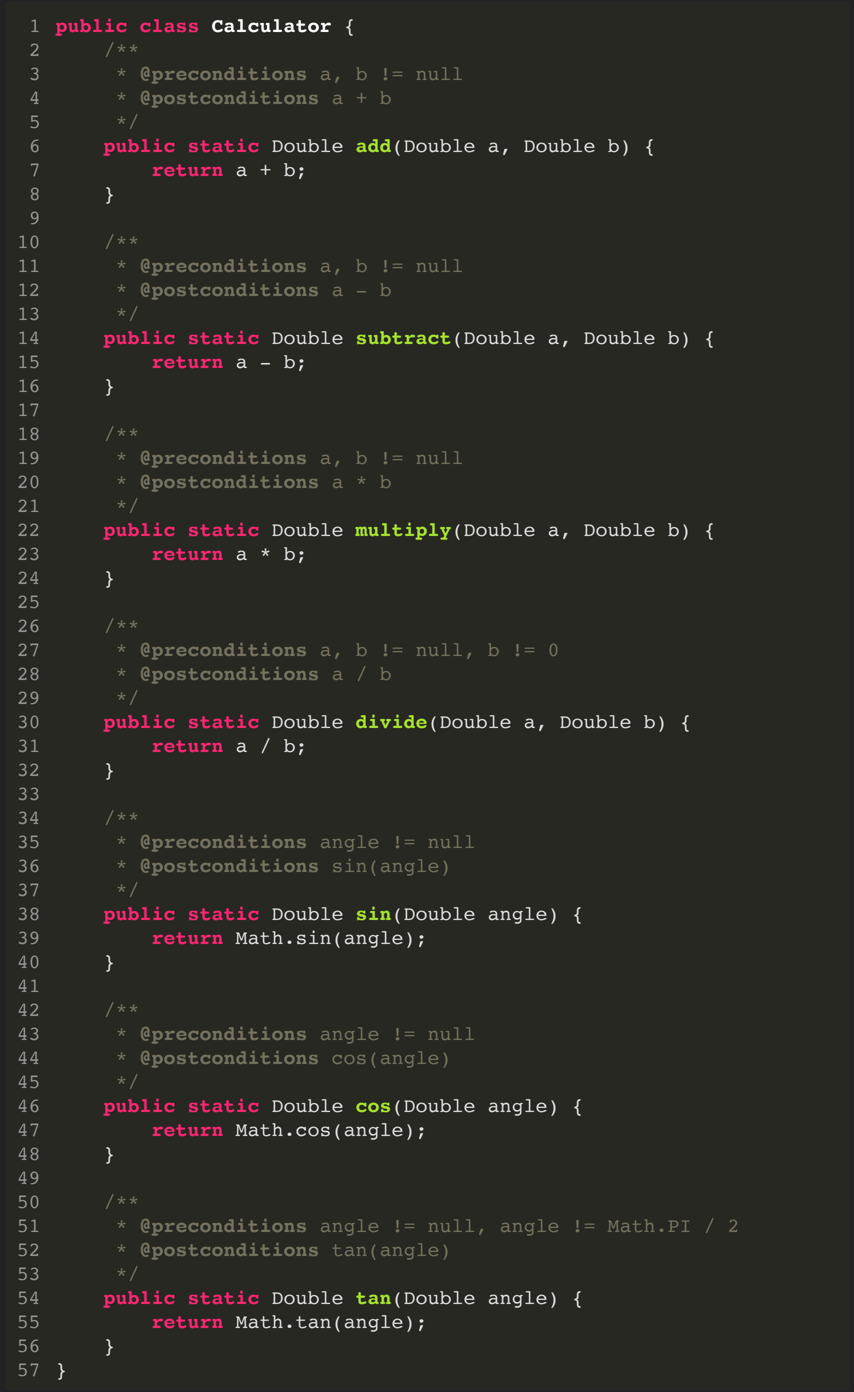
A contract should address the following 3 conditions:

1. Pre-condition - what does the contract expect?
2. Post-condition - what does that contract guarantee?
3. Invariant - What does the contract maintain?

Design By Contract



```java
public class Calculator {
    public static Double add(Double a, Double b) {
        return a + b;
    }

    public static Double subtract(Double a, Double b) {
        return a - b;
    }

    public static Double multiply(Double a, Double b) {
        return a * b;
    }

    public static Double divide(Double a, Double b) {
        return a / b;
    }

    public static Double sin(Double angle) {
        return Math.sin(angle);
    }

    public static Double cos(Double angle) {
        return Math.cos(angle);
    }

    public static Double tan(Double angle) {
        return Math.tan(angle);
    }
}
```



```java
public class Calculator {
    /**
     * @preconditions a, b != null
     * @postconditions a + b
     */
    public static Double add(Double a, Double b) {
        return a + b;
    }

    /**
     * @preconditions a, b != null
     * @postconditions a - b
     */
    public static Double subtract(Double a, Double b) {
        return a - b;
    }

    /**
     * @preconditions a, b != null
     * @postconditions a * b
     */
    public static Double multiply(Double a, Double b) {
        return a * b;
    }

    /**
     * @preconditions a, b != null, b != 0
     * @postconditions a / b
     */
    public static Double divide(Double a, Double b) {
        return a / b;
    }

    /**
     * @preconditions angle != null
     * @postconditions sin(angle)
     */
    public static Double sin(Double angle) {
        return Math.sin(angle);
    }

    /**
     * @preconditions angle != null
     * @postconditions cos(angle)
     */
    public static Double cos(Double angle) {
        return Math.cos(angle);
    }

    /**
     * @preconditions angle != null, angle != Math.PI / 2
     * @postconditions tan(angle)
     */
    public static Double tan(Double angle) {
        return Math.tan(angle);
    }
}
```

Feedback

https://forms.gle/fZDe2zhbo52UNnwh7