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Object Oriented Design Principles SOLID

(IT069IU)

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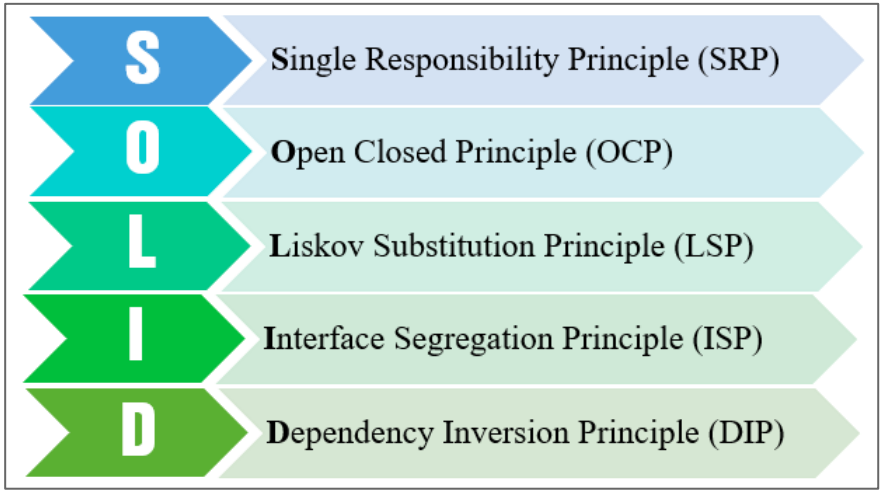
Agenda's today

- Object Oriented Design Principles: SOLID
  - S: Single responsibility
  - O: Open/closed principle
  - L: Liskov substitution principle
  - I: Interface segregation principle
  - D: Dependency inversion principle



So far,

We have learnt about the **four main OOP principles**:

- Encapsulation
- Abstraction
- Inheritance
- Polymorphism

Encapsulation	Abstraction	Inheritance	Polymorphism
When an object only exposes the selected information.	Hides complex details to reduce complexity.	Entities can inherit attributes from other entities.	Entities can have more than one form.

Object Oriented Design (OOD) Principles

Golden rules used by object-oriented developers since the early 2000s!

Intro

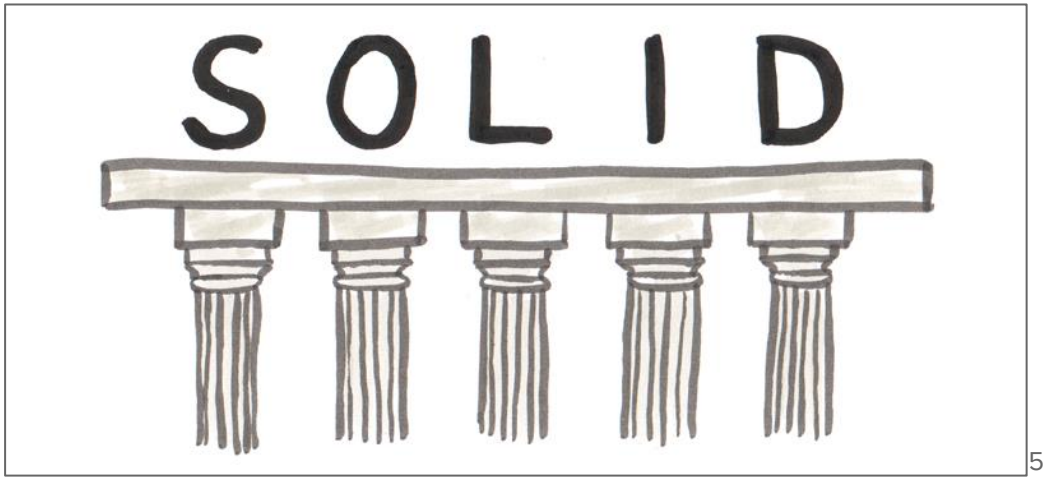
SOLID is an acronym for the first **five object-oriented design (OOD) principles** by Robert Martin (also known as Uncle Bob). They are **a set of rules and best practices to follow while designing a class structure.**

These principles establish the best practices to create more **maintainable**, **understandable**, and **flexible software**. As our applications grow in size, we can reduce their complexity and save ourselves a lot of headaches.

They all serve the same purpose: "To create **understandable**, **readable**, and **testable code** that many developers can collaboratively work on."

SOLID stands for:

- **S** - Single-Responsibility Principle
- **O** - Open-Closed Principle
- **L** - Liskov Substitution Principle
- **I** - Interface Segregation Principle
- **D** - Dependency Inversion Principle



S - Single-Responsibility Principle (SRP)

Single-responsibility Principle (SRP) states:

“A class should have only one reason to change, meaning that a class should have only one job.”

Explanation:

- A class should have full responsibility for **a single functionality** of the program. The class should contain only variables and methods relevant to its functionality -> **fewer bugs and less dependencies**.
- **Smaller, well-organized classes are easier to manage** than monolithic (big) ones.

SRP Examples

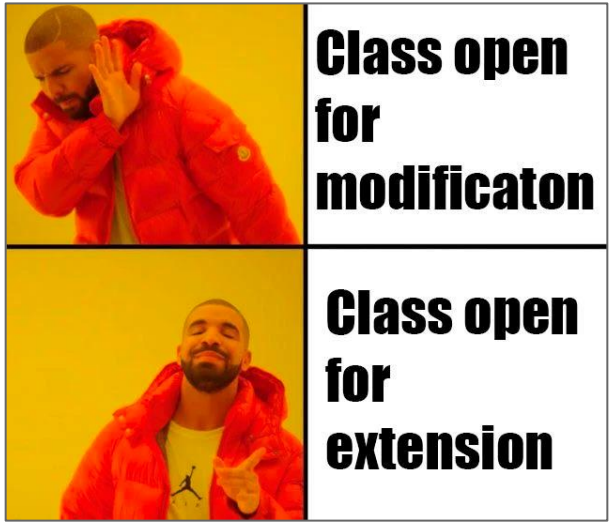
- Imagine that employees of a software company need to do 1 of 3 things:
  - software programmer (developer),
  - software tester (tester),
  - software salesman (salesman).
- Each employee will have a title and based on the title will do the corresponding job.
- **Question:** Then should you design class “Employee” with property “position” and 3 methods developSoftware(), testSoftware() and saleSoftware()?

```
class Employee
{
    string position;

    void developSoftware(){};
    void testSoftware(){};
    void saleSoftware(){};
}
```

SRP Examples Solution

- **The answer is NO.**
- Imagine if there was one more position, human resource manager, we would have to modify the "Employee" class, add a new method?
- What if there were 10 more positions?
- At that time, the created objects will have a lot of redundant methods: Developer does not need to use testSoftware() and saleSoftware() functions right, accidentally using the wrong method will also have unpredictable consequences.
- **Solution with the principle of Single Responsibility:** 1 responsibility per class. We will create an **abstract class "Employee"** whose method is working(), from here you **inherit 3 classes namely Developer, Tester and Salesman.**
  - In each of these classes, you will implement a specific working() method, depending on the task of each person.

O - Open-Closed Principle (OCP)



Open-Closed Principle (OCP) states:

“A class should be open for extension and closed modification.”

Explanation:

- **Modification** means **changing the code of an existing class**, and **extension** means **adding new functionality**.
- We should be able to **add new functionality without touching the existing code for the class**. This is because whenever we modify the existing code, we are taking the risk of creating potential bugs. So we should avoid touching the tested and reliable production code if possible.
- But **how** are we going to **add new functionality without touching the class**, you may ask. **It is usually done with the help of interfaces and abstract classes.**

OCP Example

The shipping logic of an order is placed inside the Order class.

```
public class Order {

    public long calculateShipping(ShippingMethod shippingMethod) {
        if (shippingMethod == GROUND) {
            // Calculate for ground shipping
        } else if (shippingMethod == AIR) {
            // Calculate for air shipping
        } else {
            // Default
        }
    }
}
```

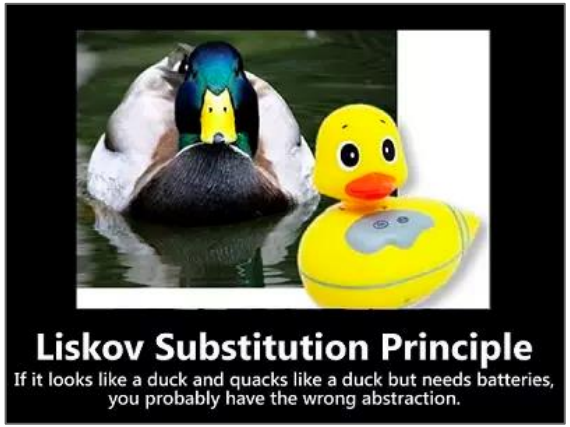
Assuming the system needs to add a new shipping method, we have to add another case in the calculateShipping method. This will make the code very difficult to manage.

OCP Solution

Instead, we should decouple the shipping handling logic into a Shipping interface. Interface Shipping will have many implementations for each form of transportation: GroundShipping, AirShipping, ...

```
public interface Shipping {

    long calculate();
}

public class GroundShipping implements Shipping {

    @Override
    public long calculate() {
        // Calculate for ground shipping
    }
}

public class AirShipping implements Shipping {

    @Override
    public long calculate() {
        // Calculate for air shipping
    }
}

public class Order {

    private Shipping shipping;

    public long calculateShipping() {
        // Find relevant Shipping implementation then call calculate() method
    }
}
```

L: Lisko substitution principle (LSP)



Lisko substitution principle (LSP) states:

“Subclasses should be substitutable for their base classes.”

Explanation:

- This means that, **given that class B is a subclass of class A,** we should **be able to pass an object of class B to any method that expects an object of class A** and **the method should not give any weird output in that case**.
- This is the expected behavior, because when we use inheritance we assume that the child class inherits everything that the superclass has. The child class extends the behavior but never narrows it down.
- Therefore, when a class does not obey this principle, it leads to some nasty bugs that are hard to detect.
- Liskov's principle is easy to understand but hard to detect in code.

LSP Example

We have the Animal interface and two implementations of Bird and Dog as follows:

```
public interface Animal {

    void fly();
}

public class Bird implements Animal {

    @Override
    public void fly() {
        // Flying...
    }
}

public class Dog implements Animal {

    @Override
    public void fly() {
        // Dog can't fly
        throw new UnsupportedOperationException();
    }
}
```

It is clear that the Dog class violates the principle of Liskov substitution.

LSP Solution

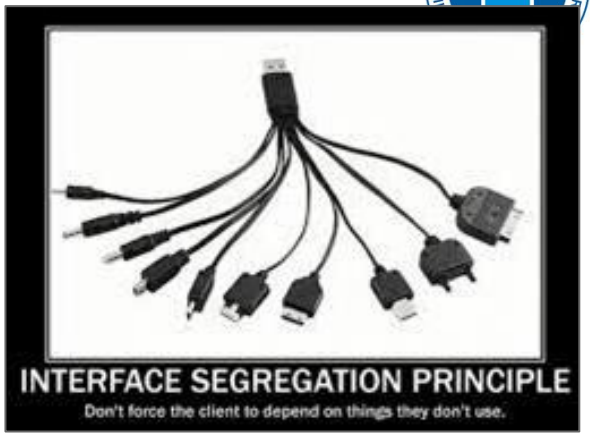
The solution here would be: create a FlyableAnimal interface as follows:

```
public interface Animal {
}

public interface FlyableAnimal {

    void fly();
}

public class Bird implements FlyableAnimal {

    @Override
    public void fly() {
        // Flying...
    }
}

public class Dog implements Animal {
}
```

I: Interface Segregation Principle (ISP)

Interface Segregation Principle (ISP) states:

“Many client-specific interfaces are better than one general-purpose interface. A client should never be forced to implement an interface that it doesn’t use, or clients shouldn’t be forced to depend on methods they do not use.”



Explanation:

- Segregation means keeping things separated, and the Interface Segregation Principle is about **separating the interfaces.**
- **Larger interfaces should be split into smaller ones**. By doing so, we can ensure that implementing classes only need to be concerned about the methods that are of interest to them.
- This principle is easy to understand. Imagine we have a large interface, about 100 methods. The implementation will be very difficult because these interface classes will be forced to implement all the methods of the interface. There can also be redundancy because a class does not need to use all 100 methods. **When separating the interface into many small interfaces, including related methods, the implementation and management will be easier.**

ISP Example 1

We have an Animal interface as follows:

```
interface Animal {

    void eat();

    void run();

    void fly();

}
```

We have two classes Dog and Snake that implement the Animal interface. But it's silly, how can Dog fly(), just like Snake can't run()?

ISP Solution 1

- Instead, we should split into 3 interfaces like this:

```
interface Animal {

    void eat();

}

interface RunnableAnimal extends Animal
{

    void run();

}

interface FlyableAnimal extends Animal
{

    void fly();
}
```

ISP Example 2

We modeled a very simplified parking lot. It is the type of parking lot where you pay an hourly fee.

```
public interface ParkingLot {

            void parkCar();         // Decrease empty spot count by 1
            void unparkCar(); // Increase empty spots by 1
            void getCapacity();     // Returns car capacity
            double calculateFee(Car car); // Returns the price based on number of
hours
            void doPayment(Car car);
}

class Car {
      // Some implementation here…


}
```

ISP 2 Problem

Now consider that we want to implement a parking lot that is **free**.

```
public class FreeParking implements ParkingLot {

        @Override
        public void parkCar() {

        }

        @Override
        public void unparkCar() {

        }

        @Override
        public void getCapacity() {

        }

        @Override
        public double calculateFee(Car car) {
                return 0;
        }

        @Override
        public void doPayment(Car car) {
        throw new Exception("Parking lot is free");
        }


}
```

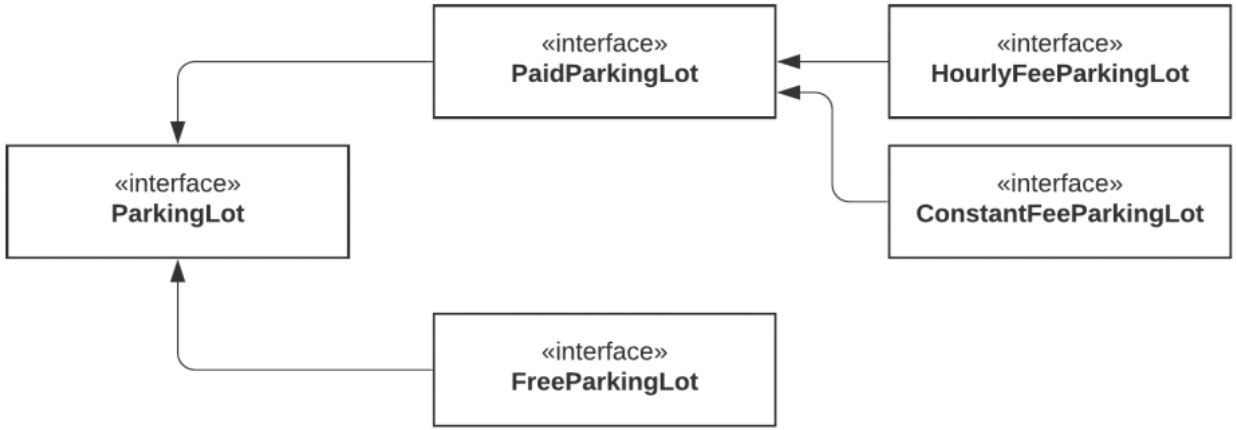
Our parking lot interface was composed of 2 things: **parking related logic** (park car, unpark car, get capacity) and **payment related logic**.

But it is **too specific**. Because of that, our **FreeParking class was forced to implement payment-related methods that are irrelevant. Let's separate or segregate the interfaces**.

ISP 2 Solution

We've now separated the parking lot. With this new model, we can even go further and split the PaidParkingLot to support different types of payment.

Now our model is much more flexible, extendable, and the clients do not need to implement any irrelevant logic because we provide only parking-related functionality in the parking lot interface.



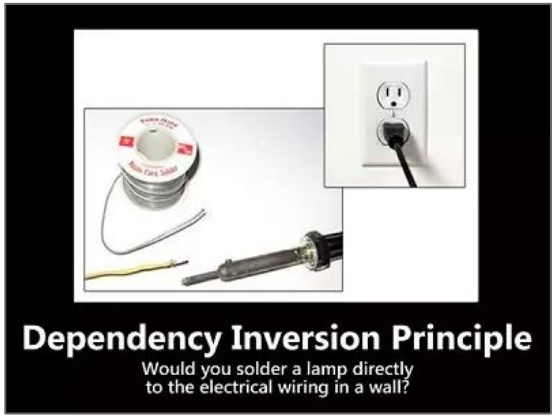
D: Dependency Inversion Principle (DIP)

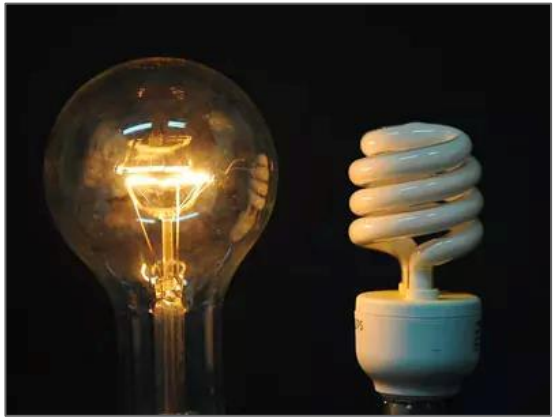
Dependency Inversion Principle (DIP) states:

“Entities must depend on abstractions, not on concretions. It states that the high-level module must not depend on the low-level module, but they should depend on abstractions.”

Explanation:

- **Our classes should depend upon interfaces or abstract classes instead of concrete classes and functions.**
- This principle is related to Open-Closed Principles (OCP).





DIP Example

To demonstrate this, let's bring to life a Windows computer with code:

```
public class WindowsComputer {}
```

But what good is a computer without a monitor and keyboard? Let's add one of each to our constructor so that every computer comes with a Monitor and a StandardKeyboard:

```
public class WindowsComputer {

    private final StandardKeyboard keyboard;
    private final Monitor monitor;

    public WindowsComputer() {
        monitor = new Monitor();
        keyboard = new StandardKeyboard();
    }

}
```

This code will work, and we'll be able to use the StandardKeyboard and Monitor freely within our WindowsComputer class.

Problem solved? Not quite. By declaring the StandardKeyboard and Monitor with the new keyword, we've tightly coupled these three classes together.

Not only does this make our WindowsComputer hard to test, but we've also lost the ability to switch out our StandardKeyboard class with a different new one. And we're stuck with our Monitor class too.

DIP Solution

Let's decouple our machine from the StandardKeyboard by adding a more general Keyboard interface and using this in our class:

```
public interface Keyboard { }
```

```
public class WindowsComputer{

    private final Keyboard keyboard;
    private final Monitor monitor;

    public WindowsComputer(Keyboard keyboard, Monitor monitor) {
        this.keyboard = keyboard;
        this.monitor = monitor;
    }
}
```

Here, we're using the dependency injection pattern to facilitate adding the Keyboard dependency into the WindowsComputer class. Let's also modify our StandardKeyboard class to implement the Keyboard interface so that it's suitable for injecting into the WindowsComputer class:

```
public class StandardKeyboard implements Keyboard { }
```

Now our classes are decoupled and communicate through the Keyboard abstraction. If we want, we can easily switch out the type of keyboard in our machine with a different implementation of the interface.

Thank you for your listening!

“Motivation is what gets you started.
Habit is what keeps you going!”

Jim Ryun