CSCB07 - Software Design

SOLID Design

Summer 2022

What is SOLID?

Single Responsibility Principle

Open/Closed Principle

Liskov Substitution Principle

Interface Segregation Principle

Dependency Inversion Principle

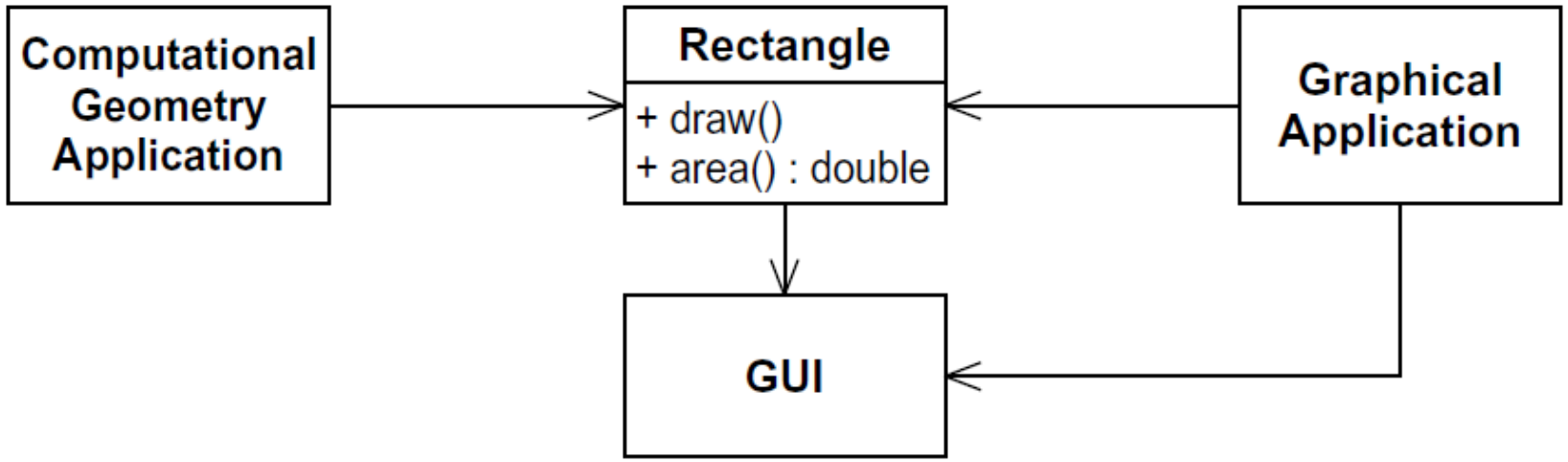
Single Responsibility Principle (SRP)

A class should have only one reason to change

- If you can think of more than one motive for changing a class, then that class has more than one responsibility
- If a class has more than one responsibility, then the responsibilities become coupled

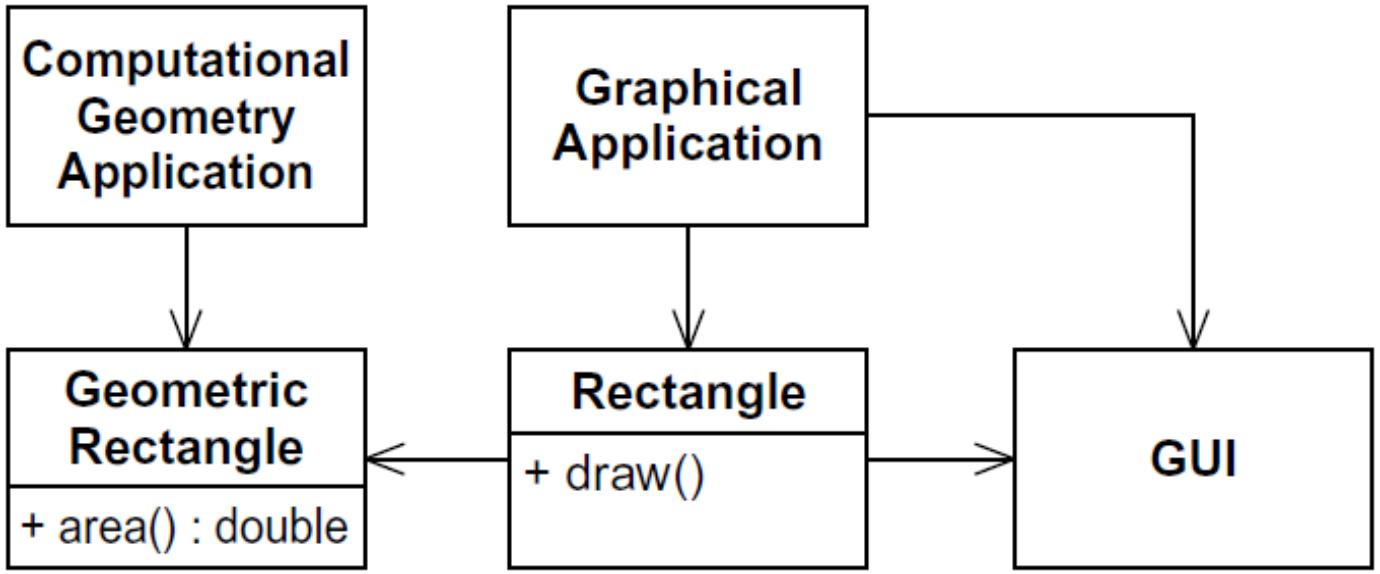
Single Responsibility Principle (SRP)

Violating the SRP (example)



Single Responsibility Principle (SRP)

Conforming to the SRP (example)



The Open/Closed Principle (OCP)

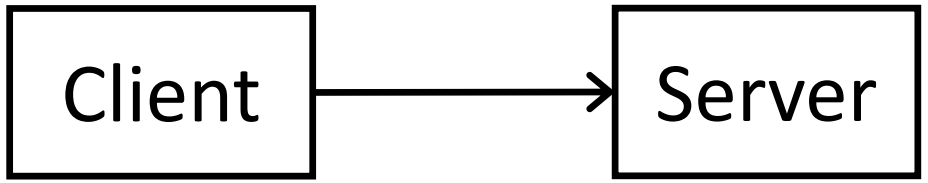
Software entities (classes, modules, functions, etc.) should be open for extension, but closed for modification.

- When a single change to a program results in a cascade of changes to dependent modules, the design smells of rigidity.
  - If the Open/Closed principle is applied well, then further changes of that kind are achieved by adding new code, not by changing old code that already works.
- In Java, it is possible to create abstractions that are fixed and yet represent an unbounded group of possible behaviors
  - The abstractions are abstract base classes, and the unbounded group of possible behaviors is represented by all the possible derivative classes.

The Open/Closed Principle (OCP)

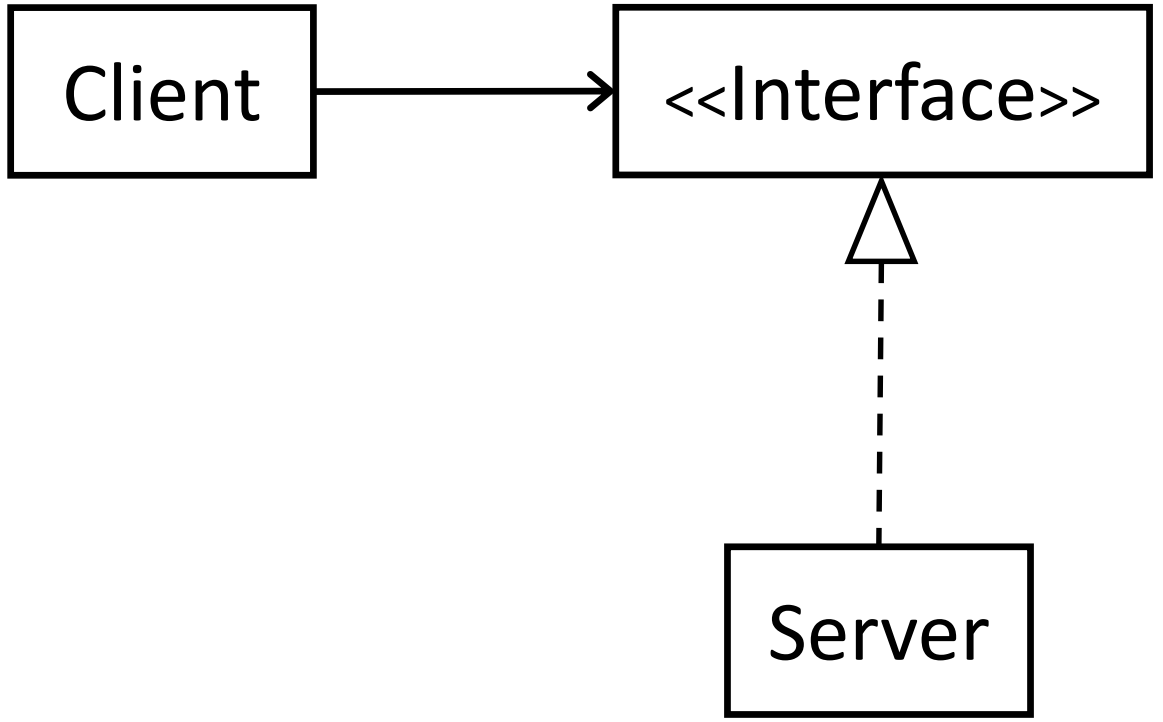
Violating the OCP (example)

- Both classes are concrete
- The **Client** uses the **Server** class



The Open/Closed Principle (OCP)

Conforming to the OCP (example)



The Liskov Substitution Principle (LSP)

Subtypes must be substitutable for their base types.

- Formally: *Let Φ(x) be a property provable about objects x of type T. Then Φ(y) should be true for objects y of type S where S is a subtype of T.*
- Counter-example: *"If it looks like a duck, quacks like a duck, but needs batteries – you probably have the wrong abstraction"*

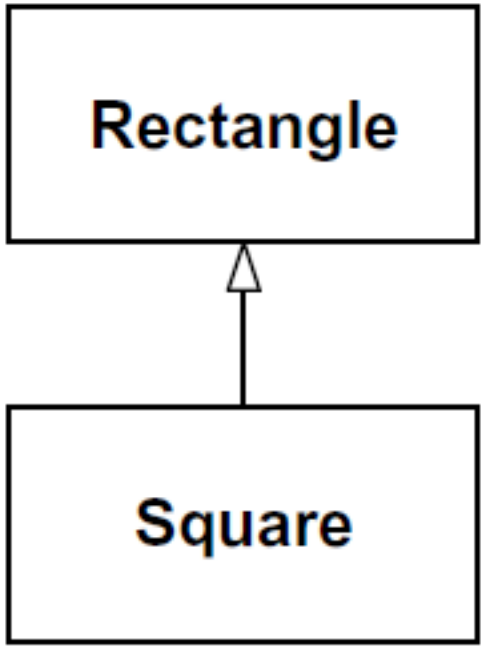
The Liskov Substitution Principle (LSP)

Violating the LSP (example)

Issues

- Inheriting **height** and **width**
- Overriding **setHeight** and **setWidth**
- Conflicting assumptions. For example:

```
void testRectangleArea(Rectangle r){
        r.setWidth(5);
        r.setHeight(4);
        assertEquals(r.computeArea(), 20);
}
```



The Liskov Substitution Principle (LSP)

- Implication: A model, viewed in isolation, cannot be meaningfully validated.
  - The validity of a model can only be expressed in terms of its clients.
  - One must view the design in terms of the reasonable assumptions made by the users of that design.

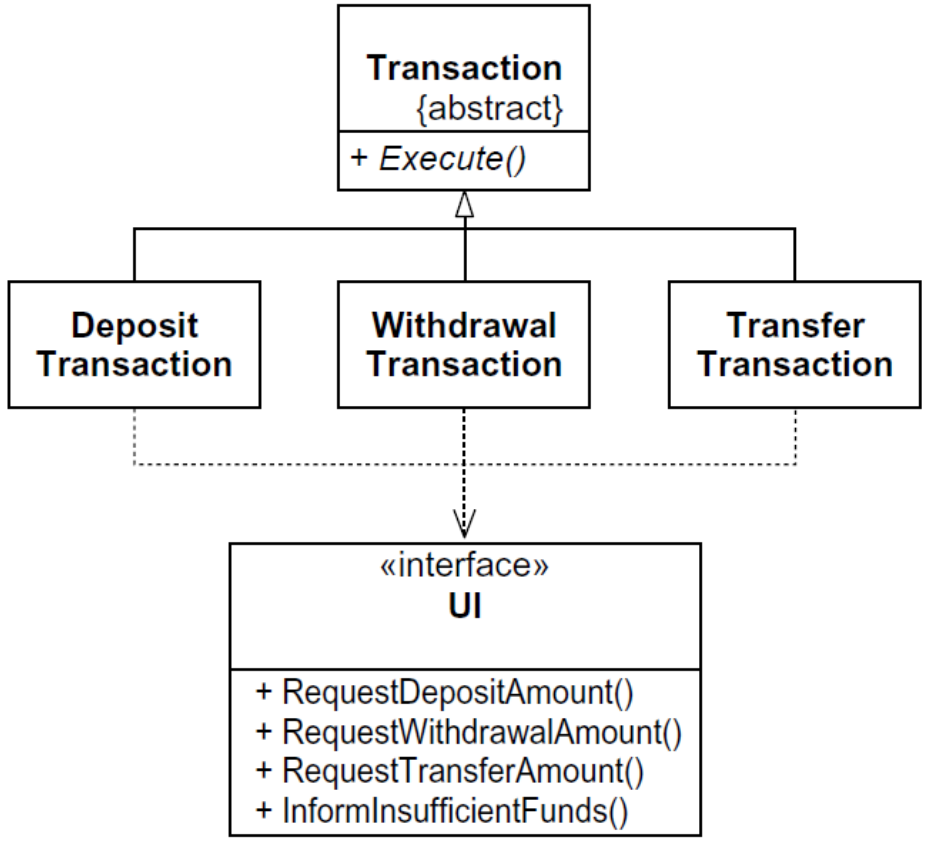
The Interface Segregation Principle (ISP)

Clients should not be forced to depend on methods that they do not use.

- This principle deals with classes whose interfaces are not cohesive. That is, the interfaces of the class can be broken up into groups of methods where each group serves a different set of clients.
- When clients are forced to depend on methods that they don’t use, then those clients are subject to changes to those methods.

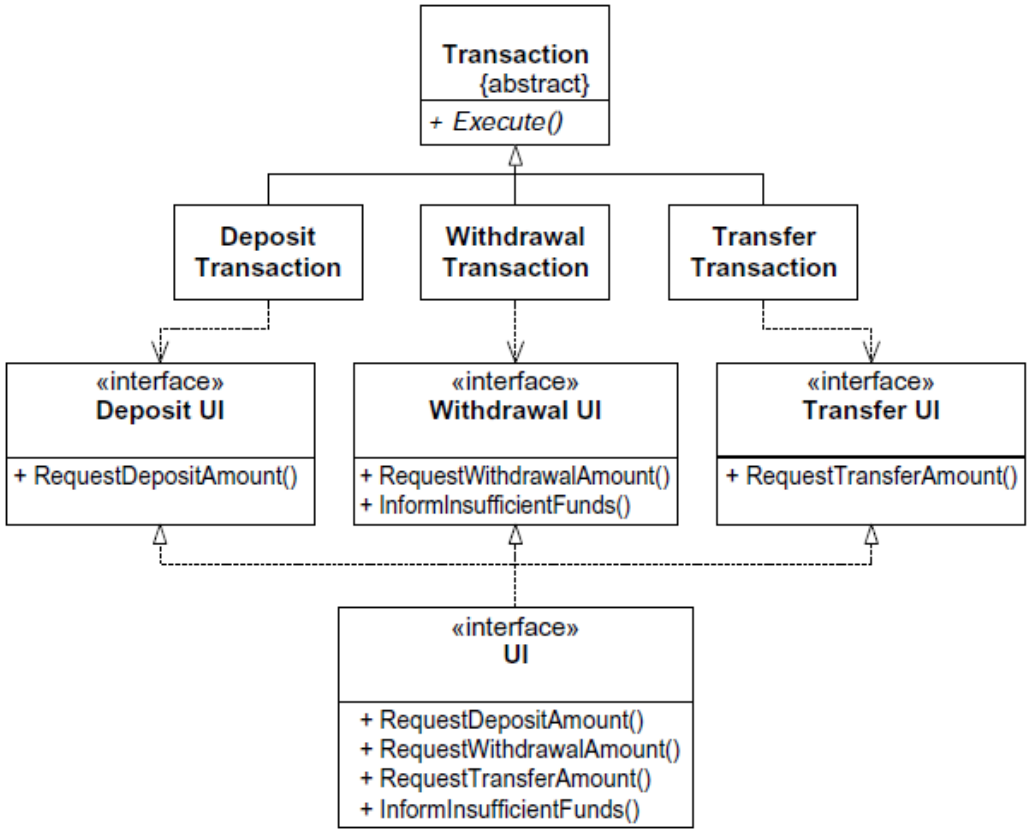
The Interface Segregation Principle (ISP)

Violating the ISP (example)



The Interface Segregation Principle (ISP)

Conforming to the ISP (example)



The Dependency-Inversion Principle (DIP)

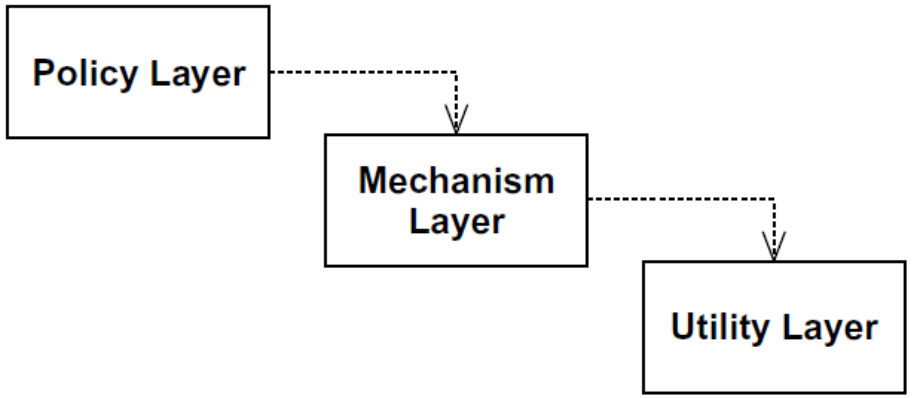
A. High-level modules should not depend on low-level modules. Both should depend on abstractions.

B. Abstractions should not depend on details. Details should depend on abstractions.

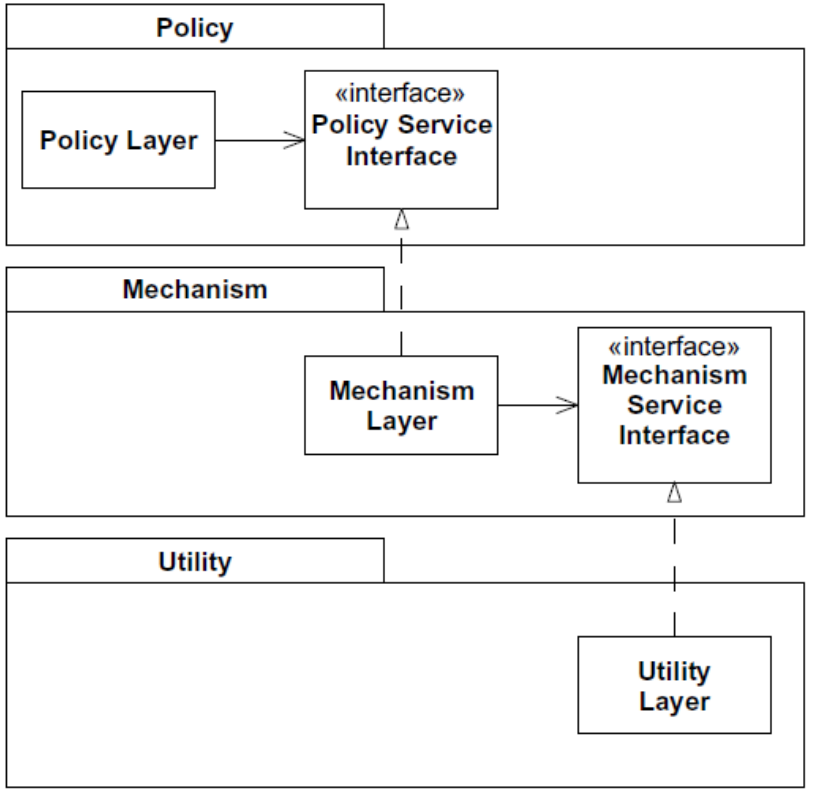
- The modules that contain the high-level business rules should take precedence over, and be independent of, the modules that contain the implementation details.
- When high-level modules depend on low-level modules, it becomes very difficult to reuse those high-level modules in different contexts.

The Dependency-Inversion Principle (DIP)

Naïve Layering

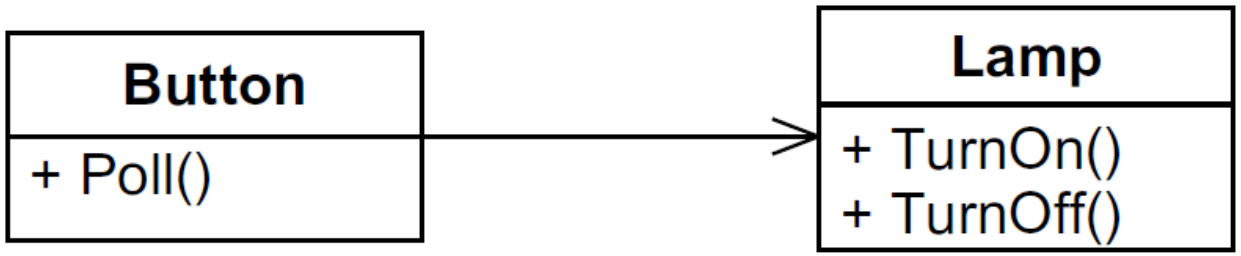


Inverted Layers



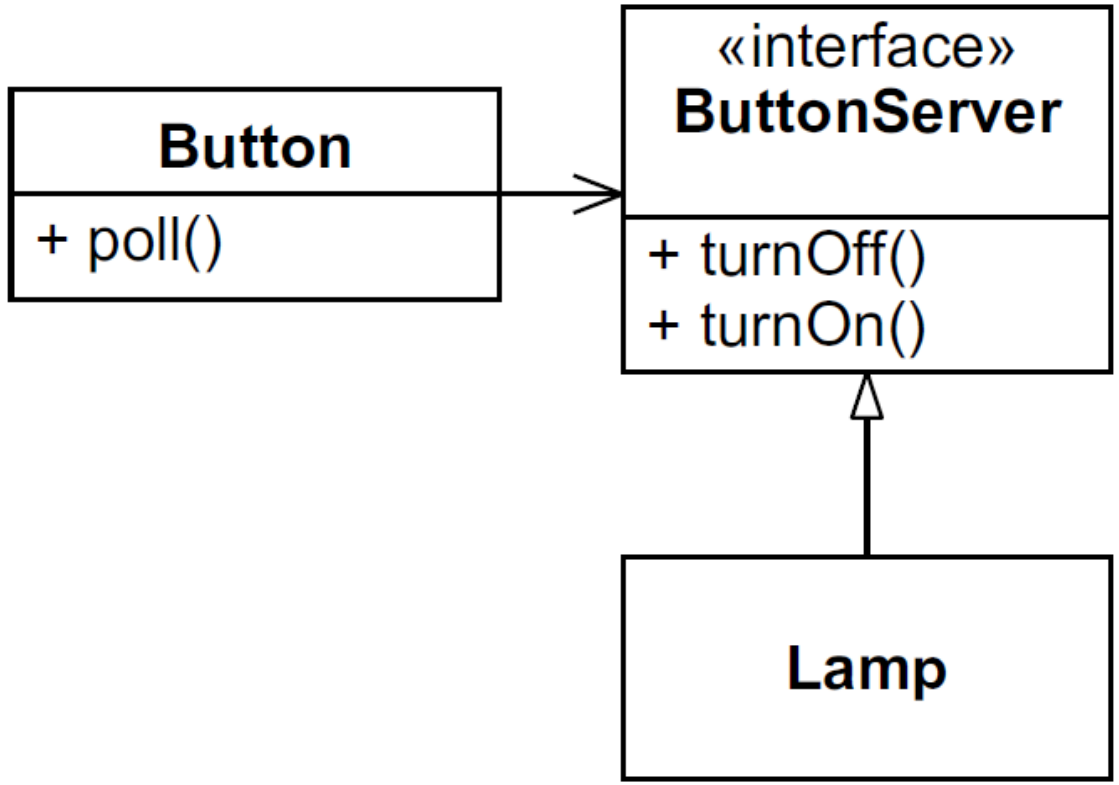
The Dependency-Inversion Principle (DIP)

Violating the DIP (example)



The Dependency-Inversion Principle (DIP)

Conforming to the DIP (example)



Design Smells

- Symptoms of poor design
- Often caused by the violation of one or more of the design principles
  - For example, the smell of *Rigidity* is often a result of insufficient attention to OCP.
- These symptoms include:
  1. Rigidity—The design is hard to change.
  2. Fragility—The design is easy to break.
  3. Immobility—The design is hard to reuse.
  4. Viscosity—It is hard to do the right thing.
  5. Needless Complexity—Overdesign.
  6. Needless Repetition—Mouse abuse.
  7. Opacity—Disorganized expression.