Object-oriented Design Principles

CSC207 Summer 2017

OO Design Principles

First five basic principles of object-oriented design.

SOLID

SOLID

S Single responsibility principle

O Open/closed principle

L Liskov substitution principle

I Interface segregation principle

D Dependency inversion principle

S: Single Responsibility Principle

- every class should have a single responsibility
- responsibility should be entirely encapsulated by the class
- all class services should be should be aligned with that responsibility

Why?

- makes the class more robust
- makes the class more reusable

Note the terminology clash here: in CRC cards "responsibility" is what we call "service" here.

O: Open/Closed Principle (simplified)

- Software entities (classes, modules, functions, etc.) should be **open for extension**, but **closed for modification**.
- Add new features not by modifying the original class, but rather by extending it and adding new behaviours.
- The derived class may or may not have the same interface as the original class.

O: Open/Closed Principle (simplified)

Example:

`area` calculates the area of all `Rectangle`s in the input.

What if we need to add more shapes?

Rectangle
- width: double - height: double
+ getWidth(): double + getHeight(): double + setWidth(w: double): void + setHeight(h: double): void

AreaCalculator
+ area(shapes: Rectangle []): double

O: Open/Closed Principle (simplified)

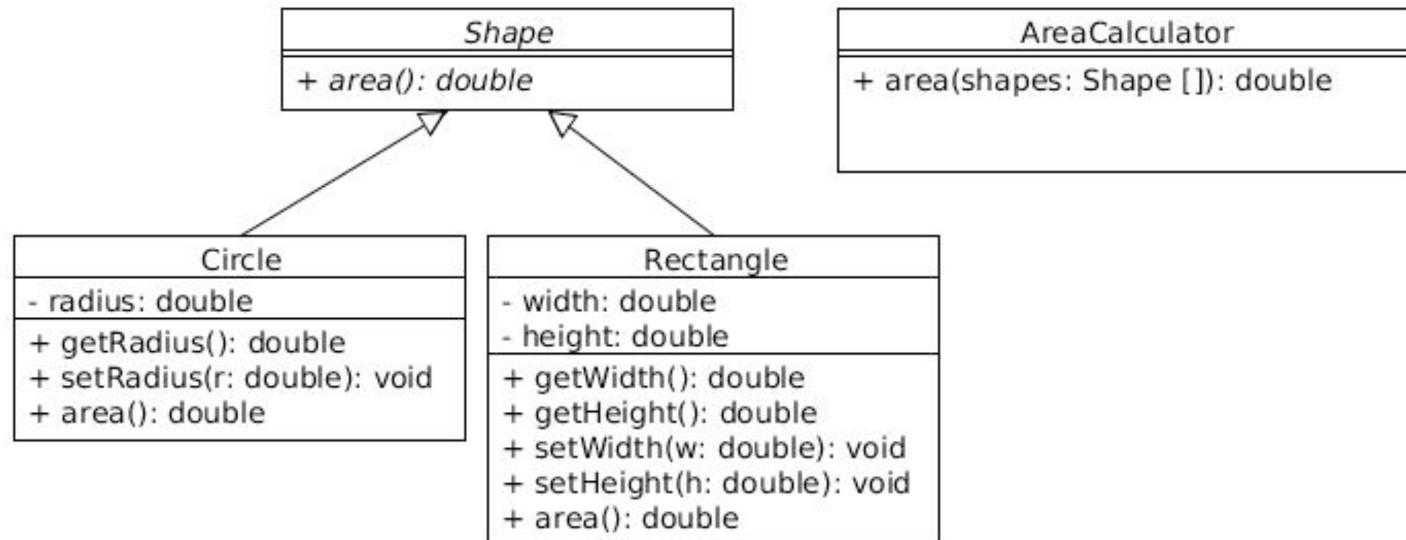
Rectangle
- width: double
- height: double
+ getWidth(): double
+ getHeight(): double
+ setWidth(w: double): void
+ setHeight(h: double): void

AreaCalculator
+ area(shapes: Object []): double

Circle
- radius: double
+ getRadius(): double
+ setRadius(r: double): void

What if we need to add even more shapes?

O: Open/Closed Principle (simplified)



With this design, we can add any number of shapes (open for extension) and we don't need to re-write the `AreaCalculator` class (closed for modification).

L: Liskov Substitution Principle (simplified)

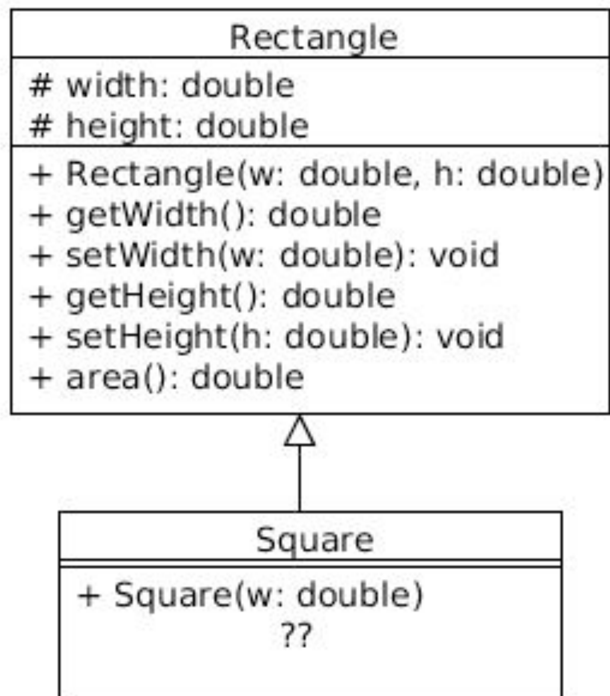
- If *S* is a subtype of *T*, then objects of type *S* may be substituted for objects of type *T*, without altering any of the desired properties of the program.
- "`S` is a subtype of `T`"?

  In Java, `S` is a child class of `T`, or `S` implements interface `T`.

- For example, if `C` is a child class of `P`, then we should be able to substitute `C` for `P` in our code without breaking it.

L: Liskov Substitution Principle (simplified)

A classic example of breaking this principle:



L: Liskov Substitution Principle (simplified)

- In OO programming and design, unlike in math, it is not the case that a `Square` is a `Rectangle`!
- This is because a `Rectangle` has more behaviours than a `Square`, not less.
- The LSP is related to the Open/Close principle: the sub classes should only extend (add behaviours), not modify or remove them.

I: Interface Segregation Principle

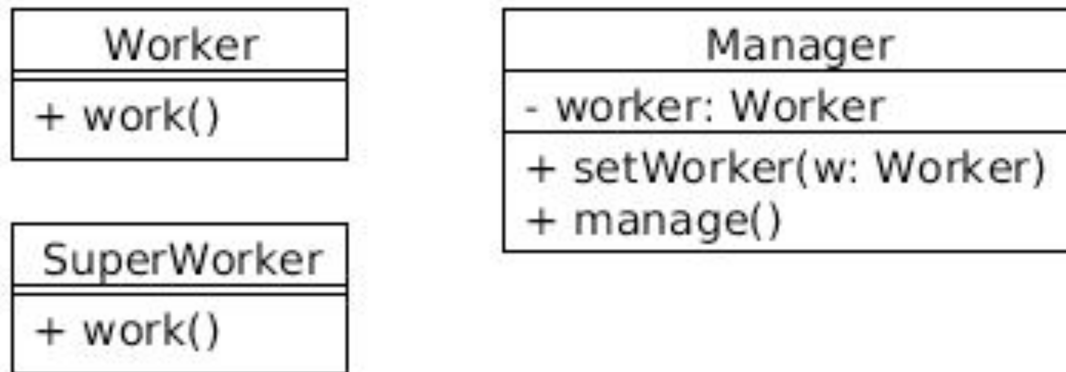
- No client should be forced to depend on methods it doesn't use.
- Better to have lots of small, specific interfaces than fewer larger ones.
- Easier to extend and modify the design.

D: Dependency inversion principle

- When building a complex system, we may be tempted to define the “low-level” classes first and then build the “higher-level” classes that use the low-level classes directly.
- But this approach is not flexible! What if we need to replace a low-level class? The logic in the high-level class will need to be replaced.
- To avoid such problems, we can introduce an abstraction layer between low-level classes and high-level classes.

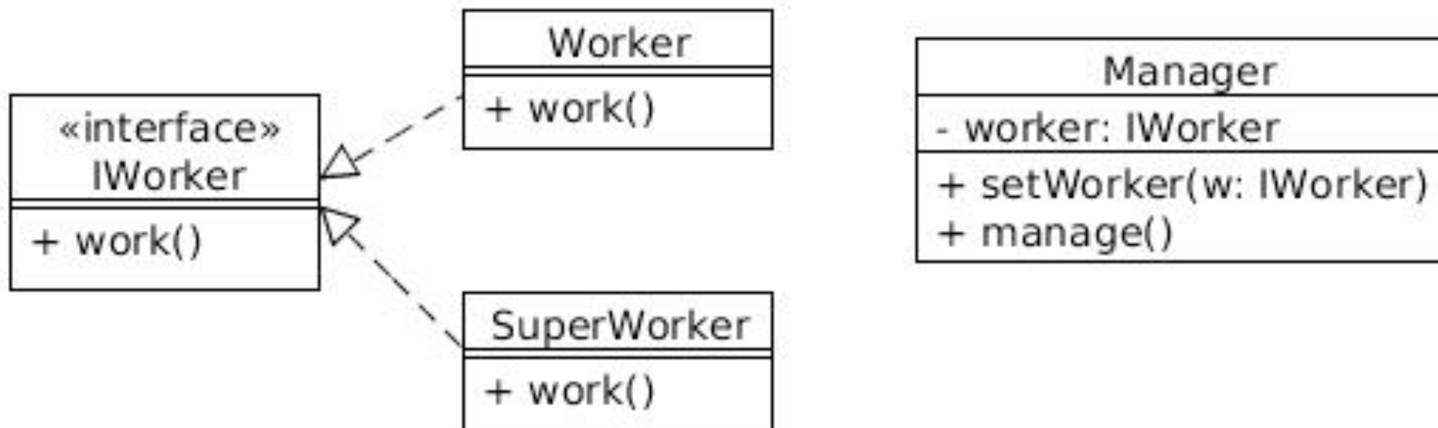
D: Dependency inversion principle

To make `Manager` work with `SuperWorker`, we would need to rewrite the code in `Manager`.



D: Dependency inversion principle

Now `Manager` does not know anything about `Worker`, nor about `SuperWorker`. It can work with any `IWorker`, the code in `Manager` does not need rewriting.



SOLID

Many Design Patterns follow the SOLID principles of object-oriented Design.

Can you identify any of these principles in any of the design patterns we saw?

D: Dependency inversion principle

- Two aspects:
  - High-level modules should not depend on low-level modules. Both should depend on abstractions.
  - Abstractions should not depend upon details. Details should depend upon abstractions.
- When building a complex system, we may be tempted to define the “low-level” classes first and then build the “higher-level” classes that use the low-level classes directly.
- But this approach is not flexible! What if we need to replace a low-level class? The logic in the high-level class will need to be replaced.
- To avoid such problems, we can introduce an abstraction layer between low-level classes and high-level classes.