Object Oriented Design

Thursday, October 4

Announcements

S.O.L.I.D. Design Principles

Single Responsibility Principle (SRP)

Open-Closed Principle (OCP)

Liskov Substitution Principle (LSP)

Interface Segregation Principle (ISP)

Dependency Inversion Principle (DIP)

Single Responsibility Principle

A class should have only one responsibility.

Responsibility = Reason for change

A class should have only one reason to change.

Single Responsibility Principle

```
public class Person {
 public void save(){…}
 public double calculateHours(){…}
 public double calculateSalary(){…}
 public double calculateTax(){…}
}
```

The person class has at least 3 reasons to change:

If the database schema changes

If the salary calculation rules change

If the tax code changes

The solution

Extract separate responsibilities into their own classes.

Only when the changes occur.

```
public class Person {
 public void save();
 public double calculateHours(){…}
 public double calculateSalary(){…}
 public double
 calculateTax(TaxCalculator c){…}
}

public class TaxCalculator {
 public double calculateTax(…){ … }
}
```

Open Closed Principle

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

Open Closed Principle

Closed for modification: the source code doesn't need to be modified when requirements change

Open for extension: You can easily add new features, change the behavior to meet new requirements

```
public class Shape {
 private String shape;
 public void draw() {
  if (shape.equals("circle")) {
   … // draw a circle
  } else if (shape.equals("square")) {
   …  // draw a square
  }
 }
}
```

What if I want to add a triangle?

```
public abstract class Shape(){
 public abstract void draw();
}
```

```
public class Circle extends Shape { … }

public class Square extends Shape { … }

public class Triangle extends Shape {…}
```

Known uses

Chrome extensions

Any tool that allows plugins (VS Code, Atom, IDEA, Eclipse)

Operating systems drivers

Strategic closure

Can a system be 100% closed?

No.

Closure must be **strategic.**

Places in the code that **change often** are generally good candidates.

```
public class NotificationSender {
 public send(User user, String text) {
  val message = new EmailMessage(user);
   message(text);
 }
}
```

What if I want to send a text message?

```
public class NotificationSender {
 public send(String text, EmailMessage
  message) {
  message.send(text);
 }
}

notificationSender.send(new
 EmailMessage(bob), "Hello");
```

Will this work?

```
public class NotificationSender {
 public send(String text, Message
  message) {
  message.send(text);
 }
}
```

```
public abstract class Message {
 public Message(User user) { … }
 public abstract void send(String text);
}
```

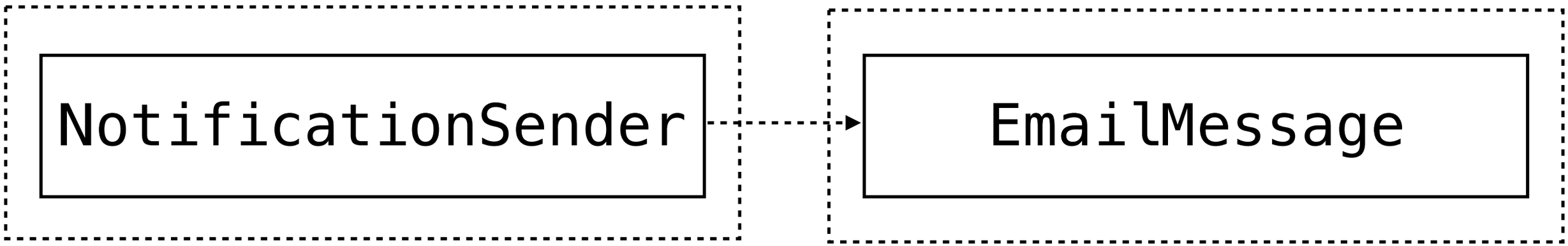
```
public class EmailMessage extends
 Message {
 public send(String text) { … }
}

public class TextMessage extends
 Message {
 public send(String text) { … }
}

notificationSender.send(new
 EmailMessage(bob), "Hello");
notificationSender.send(new
 TextMessage(bob), "Hello");
```

Dependency Inversion Principle

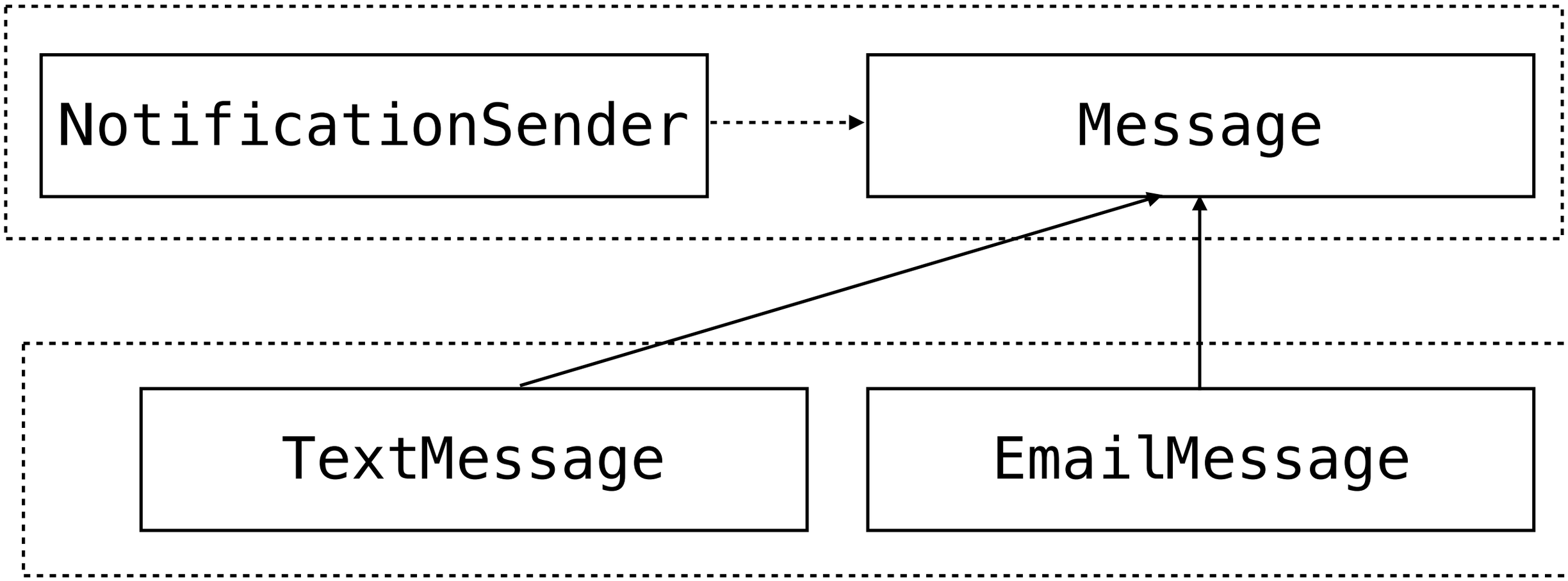
High level modules (classes) should not depend on low level modules (classes). Both should depend on **abstractions.**

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

Dependency Inversion Principle



Dependency Inversion Principle



Liskov Substitution Principle

Named after Barbara Liskov, who defined it

She was the Turing Award in 2008 for her work in the design of programming languages.

Liskov Substitution Principle

Liskov Substitution Principle

Functions that use references to base classes must be able to use objects of derived classes (subclasses) without knowing it.

You should always be able to substitute a derived class for its base class.

```
public abstract class Bird{
 public abstract void fly();
}

public class Pigeon extends Bird {
 public void fly() {
  // fly like a pigeon
 }
}

public class Duck extends Bird {
 public void fly() {
  // fly like a duck
 }
}
```

```
public class Penguin extends Bird {
 public void fly() {
  // fly like a penguin
 }
}
```

Penguins don't fly? What are our options:

1. leave the method empty

2. throw an exception

3. A penguin isn't a bird

The contract

A bird must fly.

When we call `Bird.fly();` we expect something to happen; e.g. the bird's location changed, and it's at a higher altitude

If nothing happens, I've **broken** the contract.

The contract

Each class (abstract or not), or interface, defines a contract.

Bertrand Meyer's **design by contract** expresses this in a formal way, with pre-, post-conditions and invariants.

Every sub-class must respect the contract

The contract

Why is breaking the contract bad?

Everywhere I use a bird, I must check, to see if's a Penguin, and act accordingly.

```
if (bird instanceof Penguin) {
 //do penguin stuff
}
```

This breaks OCP, among others.

The solution

```
public abstract class FlightlessBird {
  public abstract void waddle();
}

public abstract class Bird extends FlightlessBird {
  public abstract void fly();
}

public class Pigeon extends Bird {
  public void fly() { … }
}

public class Penguin extends FlightlessBird {
  public void waddle() { … }
}
```

Interface Segregation Principle

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

This applies to abstract classes and interfaces

```
public interface CoffeeMachine {
 public void addGroundCoffee(
  GroundCoffee c);
 public Drink brewFilterCoffee();
}
```

```
public class MrCoffee
 implements CoffeeMachine {
 public void addGroundCoffee(
  GroundCoffee c){ … }
 public Drink brewFilterCoffee(){ … }
}
```

```
public interface CoffeeMachine {
 public void addGroundCoffee(
  GroundCoffee c);
 public Drink brewFilterCoffee();
 public Drink brewEspresso();
}
```

```
public class FancyEspressoMachine
 implements CoffeeMachine {
 public void addGroundCoffee(
  GroundCoffee c) { … }
 public Drink brewFilterCoffee() { … }
 public Drink brewEspresso() { … }
}
```

The problem

The `CoffeeMachine` interface is too broad

Implementing classes for forced to no-op at least some of the methods.

This breaks the contract, and makes things ambiguous.

The solution

```
public interface CoffeeMachine {
  public void addGroundCoffee(
    GroundCoffee c);
  public Drink brewFilterCoffee();
  public Drink brewEspresso();
}

public interface FilterCoffeeMachine
  extends CoffeeMachine {
  public Drink brewFilterCoffee();
}

public interface EspressoCoffeeMachine
  extends CoffeeMachine {
  public Drink brewEspresso();
}
```

The solution

```
public class MrCoffee
 implements FilterCoffeeMachine {
 public void addGroundCoffee(
  GroundCoffee c){ … }
 public Drink brewFilterCoffee(){ … }
}

public class FancyEspressoMachine
 implements EspressoMachine {
 public Drink brewEspresso(){ … }
}
```

The result

Small, composable interfaces

Each interface does one thing

Complex objects will implement multiple interfaces

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