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IT3180 – Introduction to Software Engineering

15 – Reuse and Design Patterns

ONE LOVE. ONE FUTURE.

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Software Reuse

It is good to design a program to reuse existing components. This can lead to better software at lower cost.

Potential benefits of reuse

- Reduced development time and cost
- Improved reliability of mature components
- Shared maintenance cost

Potential disadvantages of reuse

- Difficulty in finding appropriate components
- Components may be a poor fit for application
- Quality control and security may be unknown



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Evaluating Software

- It is impossible to remove all bugs from software, even a well-established software
- Maintenance
 - **Is the software supported by an organization that will continue maintenance over the long term?**



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Design For Change: Replacement of Components (1)

The software design should anticipate possible changes in the system over its life-cycle

New vendor or new technology

- Components are replaced because its supplier goes out of business
- Components from other source provide better functionality, support, pricing, etc.
- This can apply to either **open source** or **vendor-supplied** components



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Design For Change: Replacement of Components (2)

The software design should anticipate possible changes in the system over its life-cycle

New Implementation

- The original implementation may be **problematic**
 - Poor performance
 - Inadequate backup and recovery
 - Unable to support growth and new features added to the system



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Design For Change: Replacement of Components (3)

The software design should anticipate possible changes in the system over its life-cycle

Additions to the requirements

- When the system goes into production, it is usual to reveal both **weakness** and **opportunities** for **extra functionality** and **enhancement** to the user interface design
- For example, in data-driven application, it is almost certain that there will be requests for extra reports and ways of analyzing the data

Request for enhancements are often the sign of a successful system.
Clients recognize latent possibilities



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Design For Change: Replacement of Components (4)

The software design should anticipate possible changes in the system over its life-cycle

Changes in the application domain

- Most application domains change continually
 - Because of business opportunities
 - External changes (such as new laws)
 - New group of users
 - New technology
- It is rarely feasible to implement a completely new system when the application domain changes
 - ➔ Existing system must be modified
 - ➔ This may involve **extensive restructuring**, but it is important to **reuse existing code as much as possible**



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Design Patterns

- **Design Patterns** are template designs that can be used in a variety of systems
- They are particularly appropriate in situations where classes are likely to be reused in a **system that evolves over time**

Sources:

- E. Gamma, R. Helm, R. Johnson, and J. Vlissides, *Design Patterns: Elements of Reusable Object-Oriented Software*. Addison-Wesley, 1994
- Wikipedia has good discussion of many design patterns, using UML and other notation, with code samples.



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Inheritance and Abstract Class

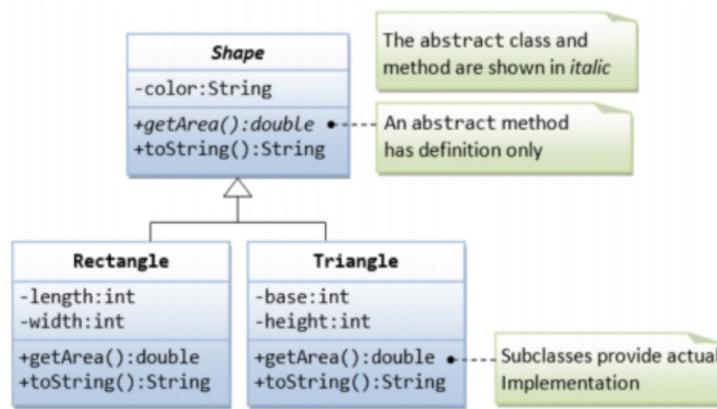
- Design patterns make extensive use of **inheritance** and **abstract classes**
- Classes can be defined in terms of other classes through **inheritance**
 - Generalization classes – super classes
 - Specialization classes – subclasses
- Abstract classes
 - Super classes which contain abstract methods and are defined such that concrete subclasses extend them by implementing the abstract methods
 - May have no abstract methods, in this case, the intention is to prevent the creation of instances
 - Interface classes are abstract classes but for multi-inheritances and for specifying a standard protocols for all classes that realize them



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Inheritance and Abstract Class (2) - Example

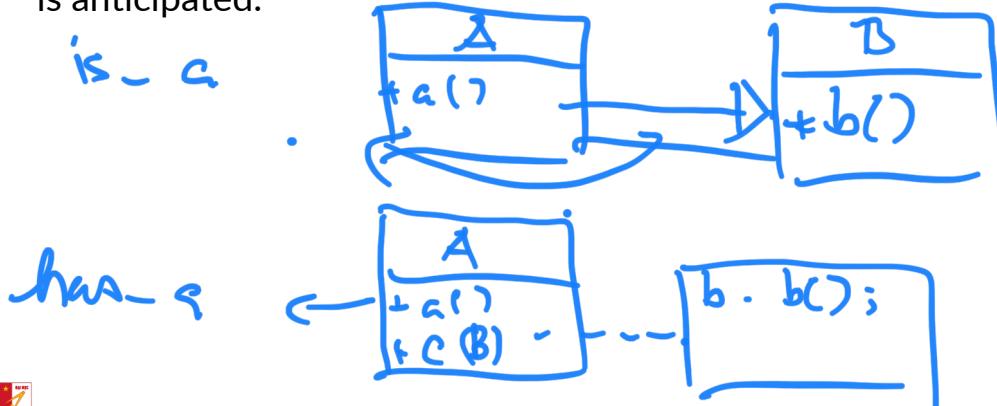


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Delegation

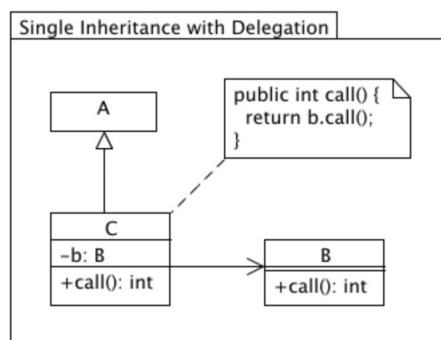
- A class is said to **delegate** to another class if it implements an operation by **resending a message** to another class.
- Delegation is an alternative to **inheritance** that can be used when reuse is anticipated.



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Delegation (2)



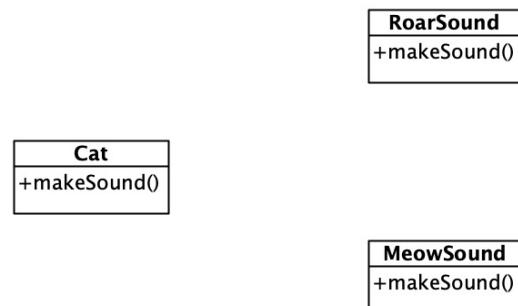
Delegation is like inheritance done manually through object composition

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Delegation (3) - Example

- Case study: a cat's sound behavior - "meow" and "roar"



- How to compose the behavior of Cat at runtime?
Inheritance or **Delegation**?

dynamic polymorph...

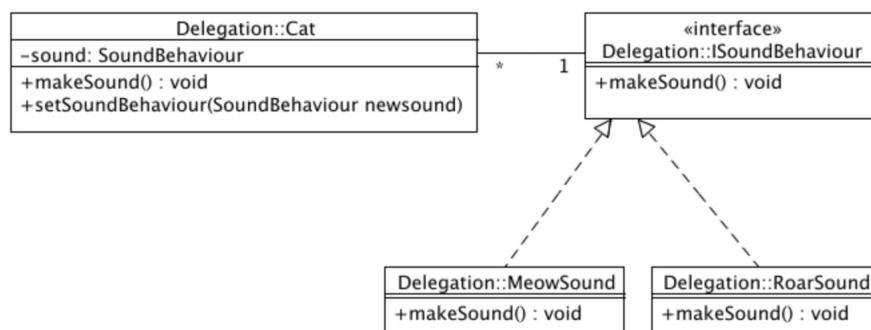


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Delegation (4) - Example

- Delegation makes it easy to compose behaviors at runtime



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Delegation (5) – Example Source Code

```
public interface ISoundBehaviour {
    public void makeSound();
}

public class MeowSound implements ISoundBehaviour {
    public void makeSound() {
        System.out.println("Meow");
    }
}

public class RoarSound implements ISoundBehaviour {
    public void makeSound() {
        System.out.println("Roar!");
    }
}
```



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Delegation (6) – Example Source Code

```
public class Cat {
    private ISoundBehaviour sound = new MeowSound();

    public void makeSound() {
        this.sound.makeSound();
    }

    public void setSoundBehaviour(ISoundBehaviour newsound) {
        this.sound = newsound;
    }
}
```

```
public class Main {
    public static void main(String args[]) {
        Cat c = new Cat();
        // Delegation
        c.makeSound();           // Output: Meow
        // now to change the sound it makes
        ISoundBehaviour newsound = new RoarSound();
        c.setSoundBehaviour(newsound);
        // Delegation
        c.makeSound();           // Output: Roar!
    }
}
```



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Notation

- ClassName* class name in italic indicates an abstract class
- > dependency
- delegation
- > inheritance



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Strategy Pattern

Encapsulating Algorithms

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Problematic

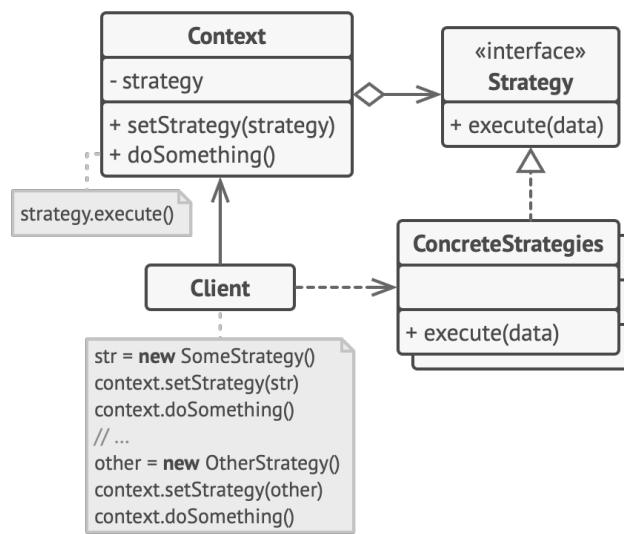
- To solve a specific problem, there may be a **family of algorithms**
- Each algorithm is separated in a class called **strategy**
- The client will decide which strategy will be selected



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Strategy Pattern - Structure



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Strategy Pattern - Components

- The **Context** maintains a reference to one of the concrete strategies through the strategy interface
- The **Strategy** interface is common to all concrete strategies. It declares the methods which are used by the Context
- **Concrete Strategies** implement different variations of an algorithm the Context uses
- The **Client** creates a specific strategy object and passes it to the Context



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Case Study in many software projects

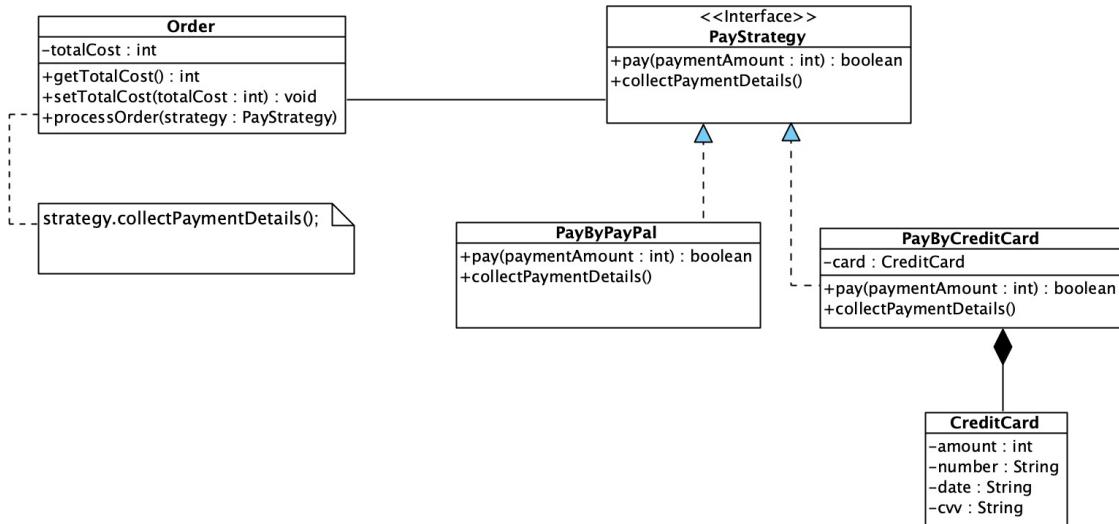
- Payment method in an e-commerce application
- There are various payment methods in an e-commerce application. After selecting a product to purchase, a customer picks a payment method: either Paypal or Credit Card.
- MoMo and ZaloPay are considered in the future



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Case Study in many software projects



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Observer Pattern Subscriber-Publisher



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Problematic

- To define a **subscription mechanism** to **notify** multiple objects about any **events** that happen to the object they are observing
- **Event-Subscriber**
- **Listener**

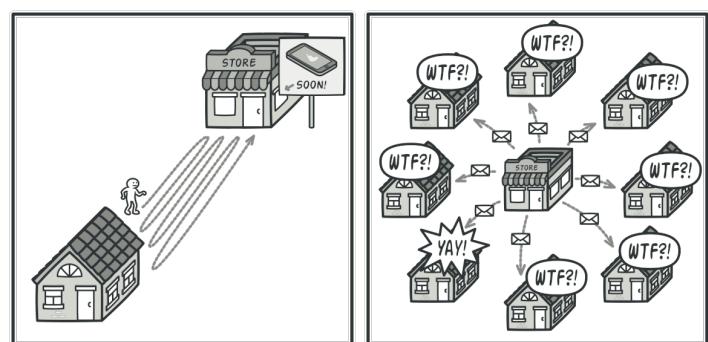


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Case Study in many software projects

- The customer want to be **notified** about a new coming **product**
- **Notify** a set of customers about new **events**, new **vouchers**
- An admin want to associate a discount/coupon with multiple product. Any changes in discount/coupon must be **notified** to its associated products

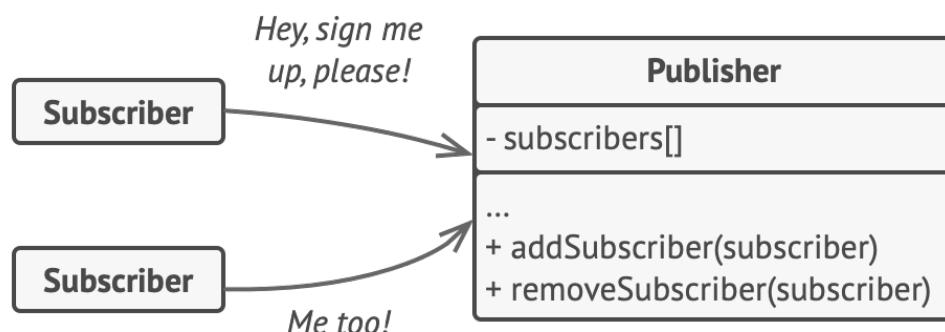


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Observer Pattern Structure

- Add a subscription mechanism to the publisher so individual object can subscribe to or unsubscribe from a stream of events coming
- subscribers: a list of subscribers of the publisher

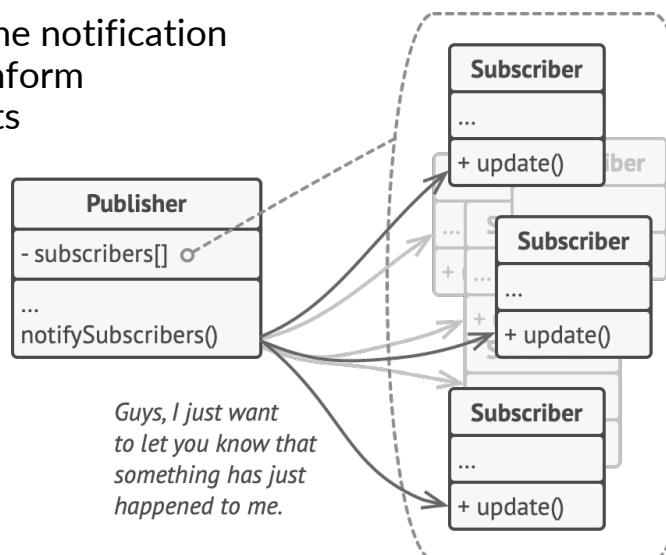


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Observer Pattern Structure (2)

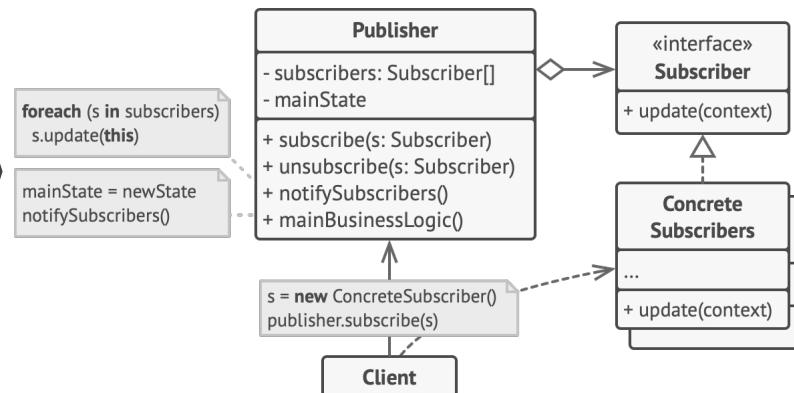
- `notifySubscribers()`: the notification mechanism of publisher to inform subscribers about new events



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Observer Pattern Structure (3)



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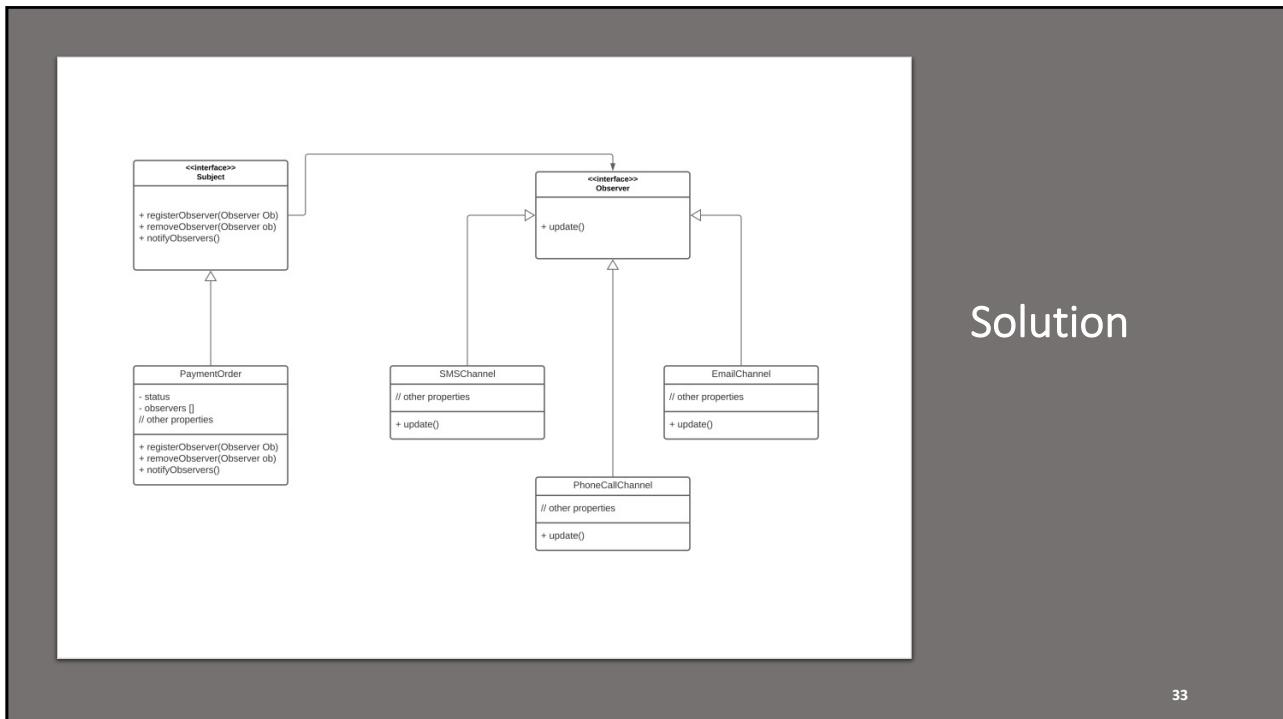
Case study: ecommerce

- Whenever an user make a new purchase, he or she will receive a notification about the order.
- Notification mechanisms: email, SMS, PhoneCall
- What plays the role of **Publisher**?
- What are **Observers**?



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Solution

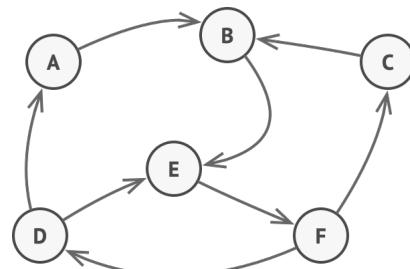


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Problematic

- **State is a behavior pattern**
- Allow an object to alter its behavior when its internal state changes
- Closely related to the concept of **Finite State Machine**



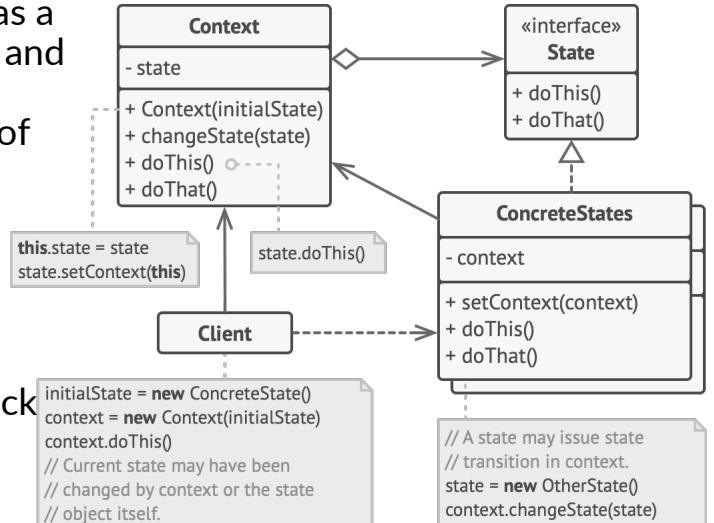
Case study in many projects

- When a new order is created, the users should view the state of the order
- When the state of an order is changed, some actions will be fired!



State Structure

- Context: the object which has a reference to one of its **state** and a mechanism to process whenever there is a change of its state (**changeState**)
- abstract State: state specific methods
- concrete States: **specific implementation for state methods**, has a reference back to the context

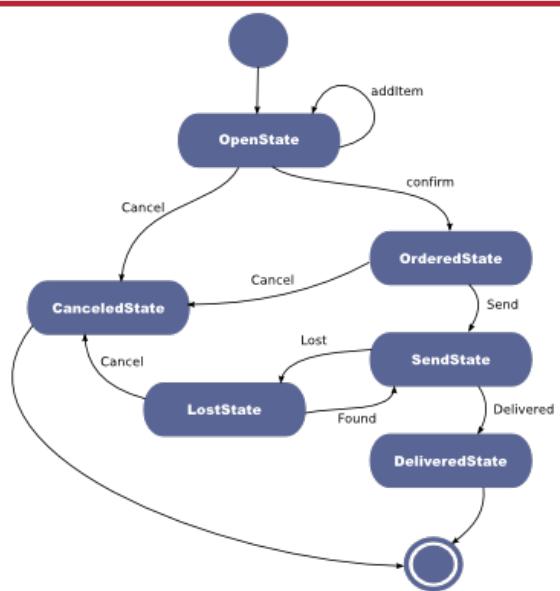


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Case study

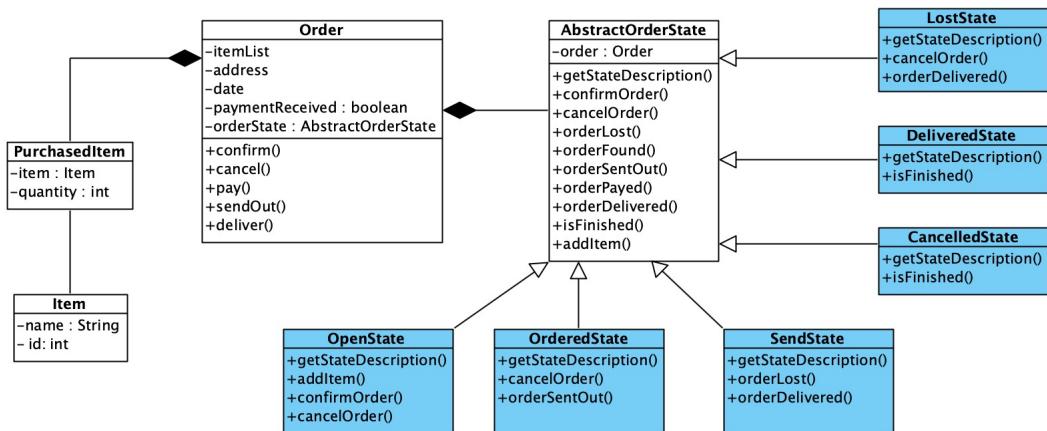
- Order states follow a finite-state machine diagram
- Which is the Context object?
- What are states objects?



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Solution



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15 – Reuse and Design Pattern

(end of lecture)

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