DePaul University

Design Principles:

S.O.L.I.D.

(2)

Object-oriented Software Development
SE 350– Spring 2021

Vahid Alizadeh

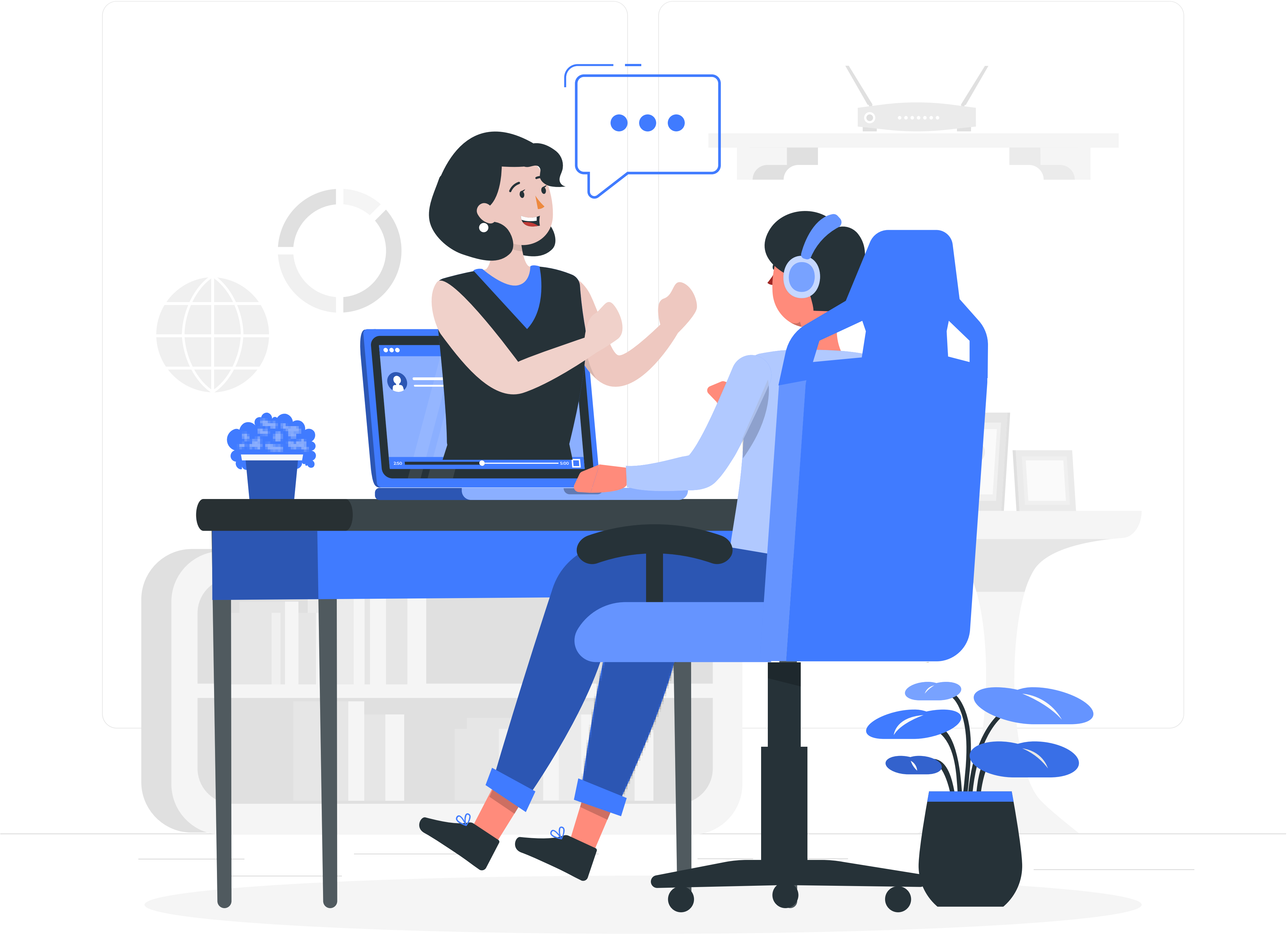
Week 6.2
May 6, 2021

Announcements

UML Class Diagram Q&A Session

Wednesday May 12, 2021

3:00 PM – 4:30 PM



Design Principles

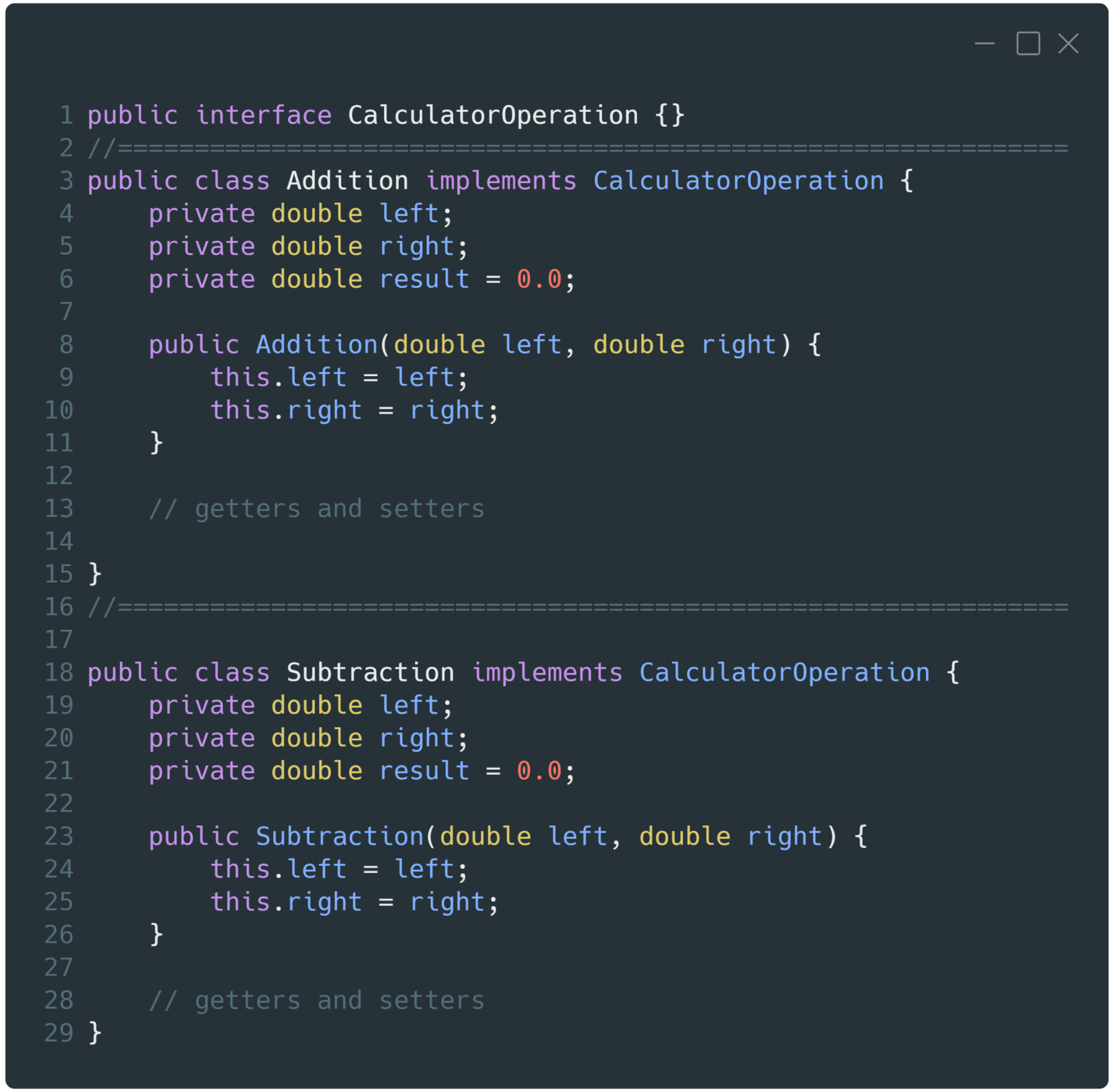
SOLID

Open-Closed Principle

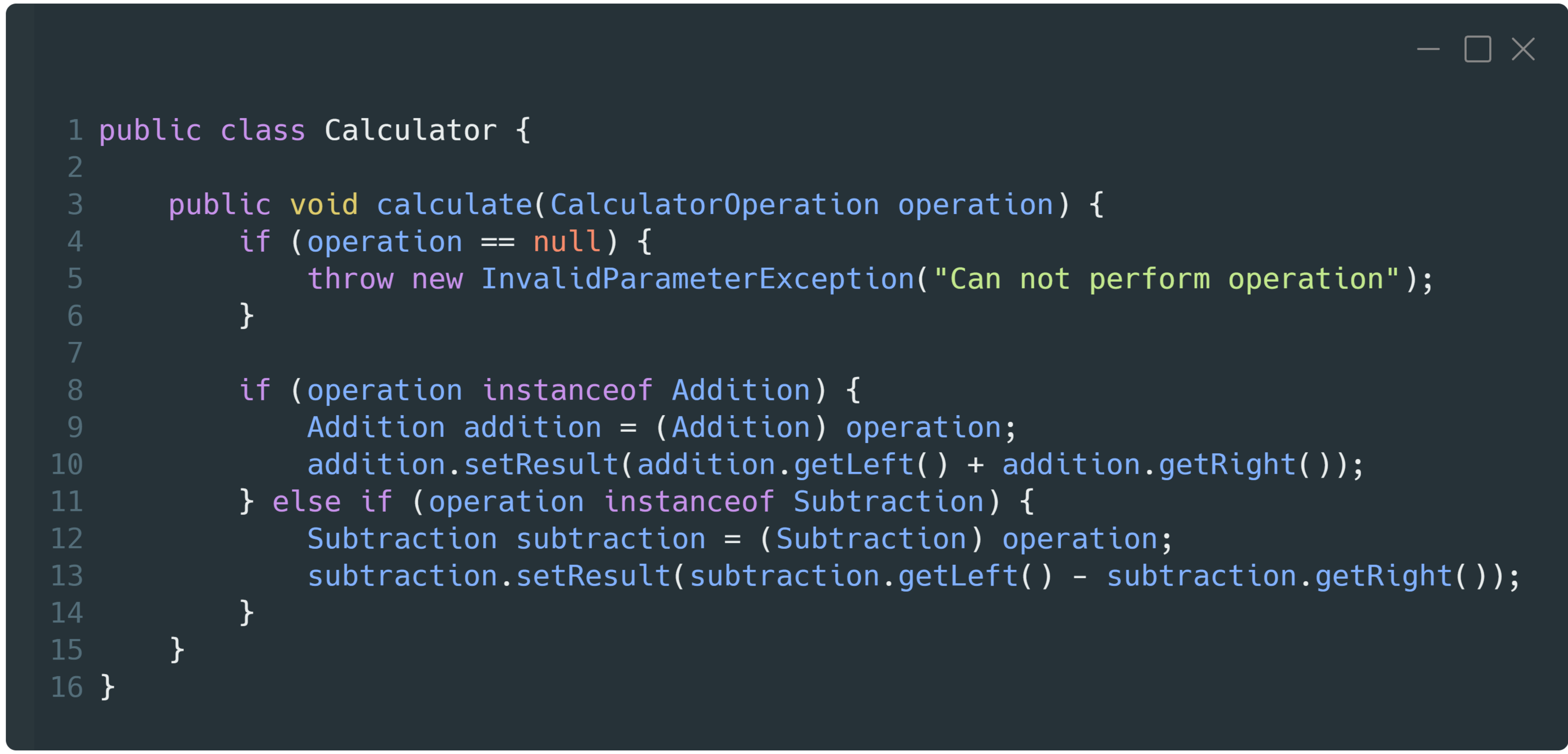
- **Component**
  - Can be anything from a single class to an entire program
- **Modification:**
  - Changing the code
- **Extension:**
  - Adding new functionality
- **OCP is usually done with the help of interfaces and abstract classes.**
- **How to make sure your code follows the Open/Closed Design Principle?**
  - Implementation inheritance
  - Interface inheritance

> **“Software components should be open for extension, but closed for modification”**

OCP Example: Calculator App Problem

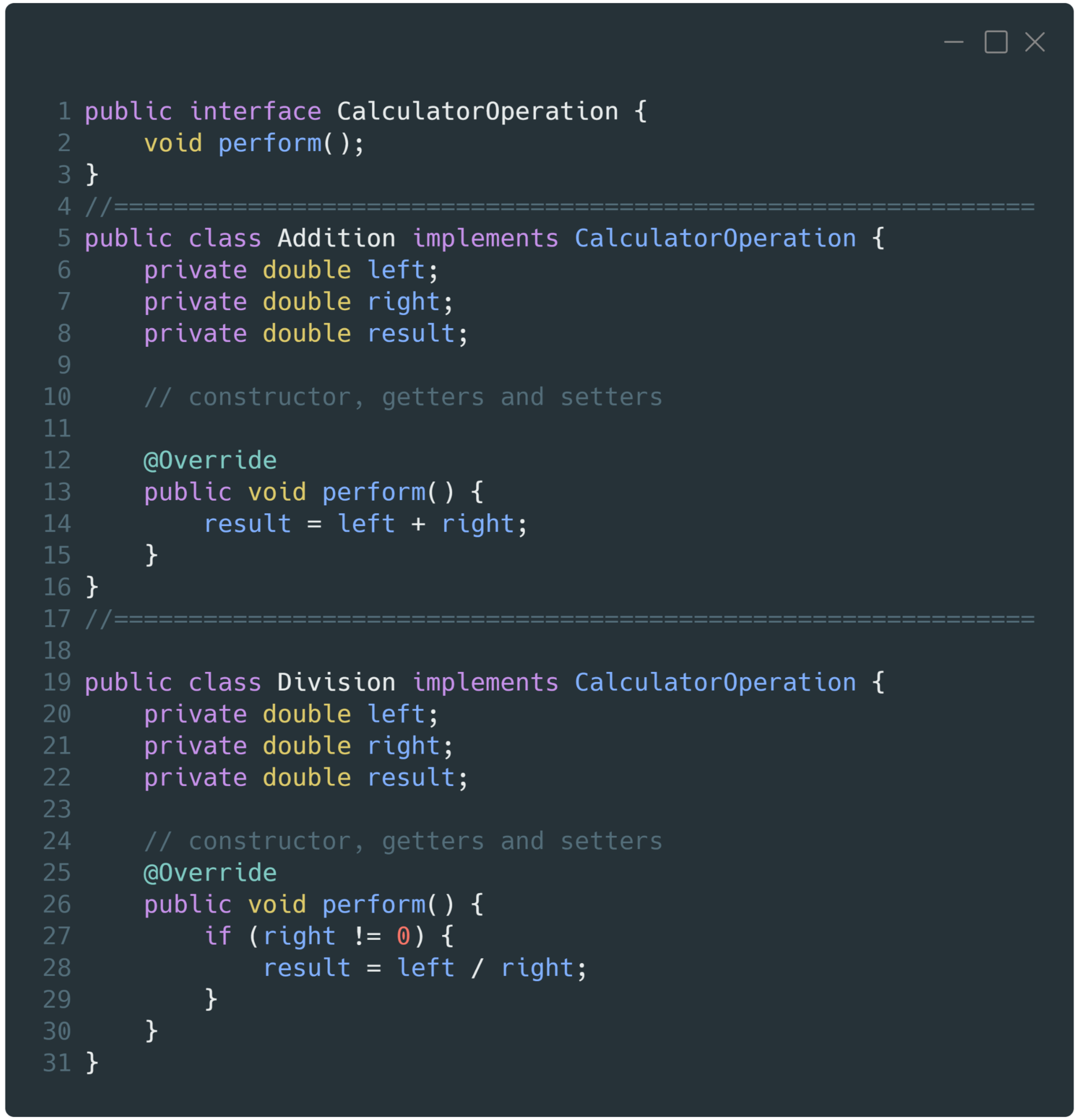


```java
public interface CalculatorOperation {}
//==============================================================
public class Addition implements CalculatorOperation {
    private double left;
    private double right;
    private double result = 0.0;

    public Addition(double left, double right) {
        this.left = left;
        this.right = right;
    }

    // getters and setters

}
//==============================================================

public class Subtraction implements CalculatorOperation {
    private double left;
    private double right;
    private double result = 0.0;

    public Subtraction(double left, double right) {
        this.left = left;
        this.right = right;
    }

    // getters and setters
}
```

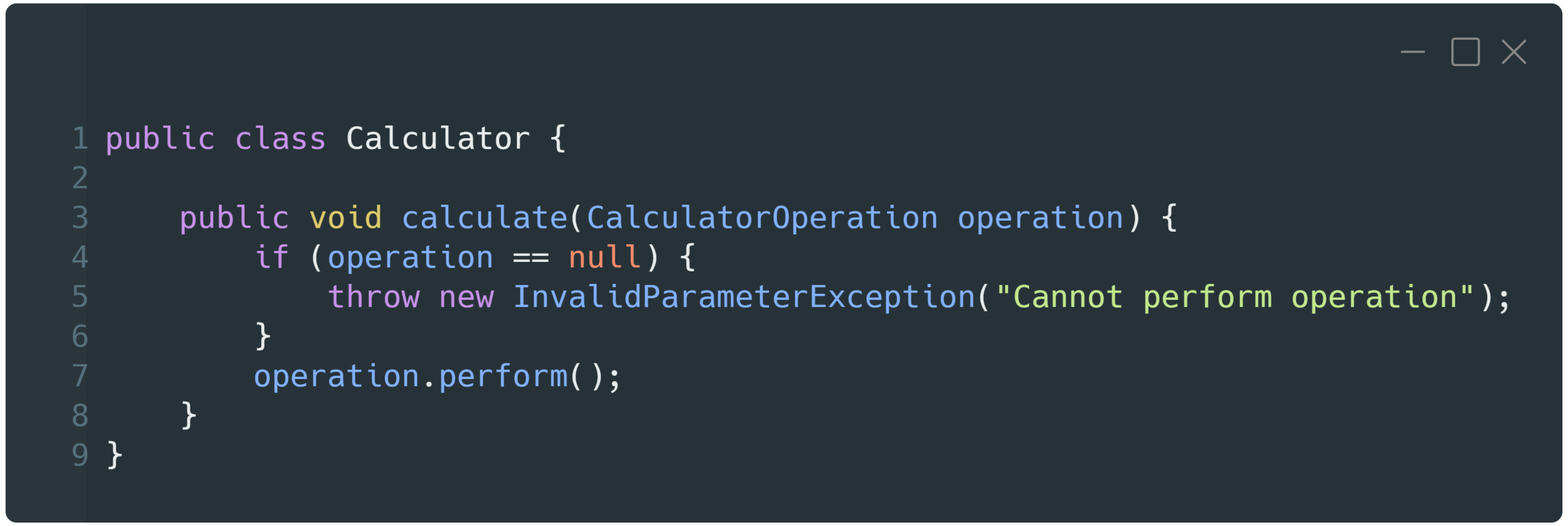


```java
public class Calculator {

    public void calculate(CalculatorOperation operation) {
        if (operation == null) {
            throw new InvalidParameterException("Can not perform operation");
        }

        if (operation instanceof Addition) {
            Addition addition = (Addition) operation;
            addition.setResult(addition.getLeft() + addition.getRight());
        } else if (operation instanceof Subtraction) {
            Subtraction subtraction = (Subtraction) operation;
            subtraction.setResult(subtraction.getLeft() - subtraction.getRight());
        }
    }
}
```

OCP Example: Calculator App Solution

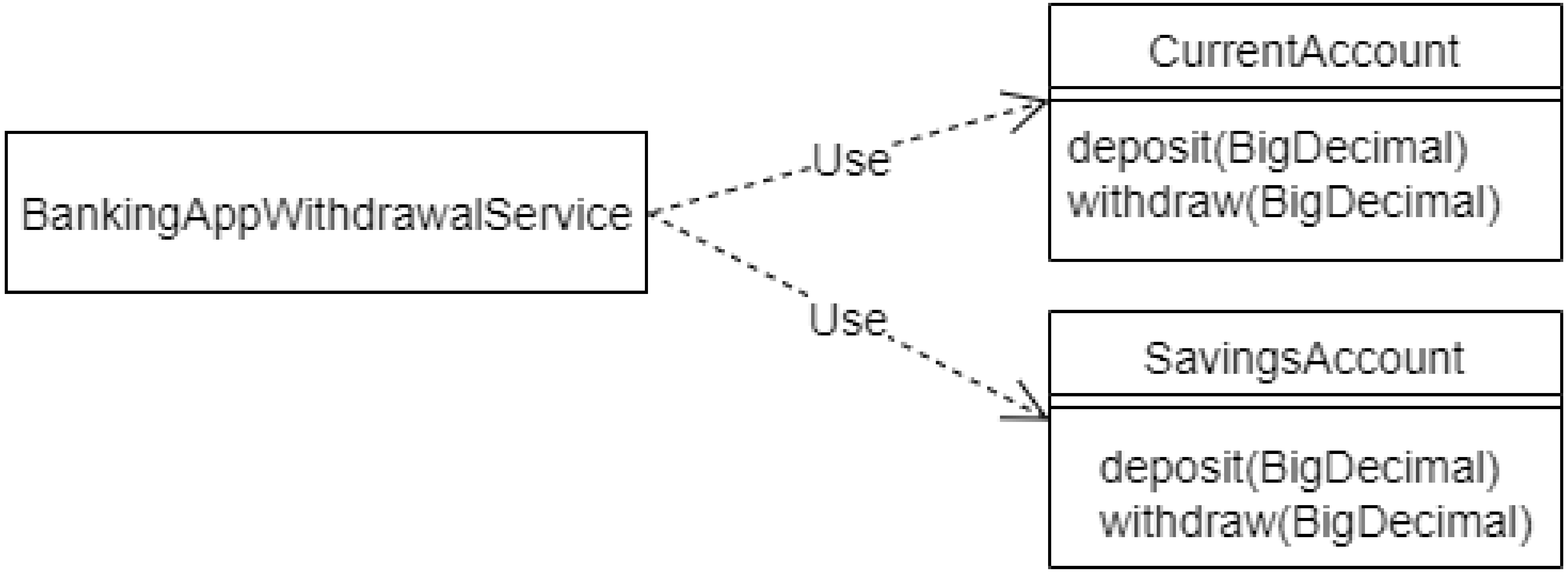


```java
public interface CalculatorOperation {
    void perform();
}
//=================================================================
public class Addition implements CalculatorOperation {
    private double left;
    private double right;
    private double result;

    // constructor, getters and setters

    @Override
    public void perform() {
        result = left + right;
    }
}
//=================================================================

public class Division implements CalculatorOperation {
    private double left;
    private double right;
    private double result;

    // constructor, getters and setters
    @Override
    public void perform() {
        if (right != 0) {
            result = left / right;
        }
    }
}
```

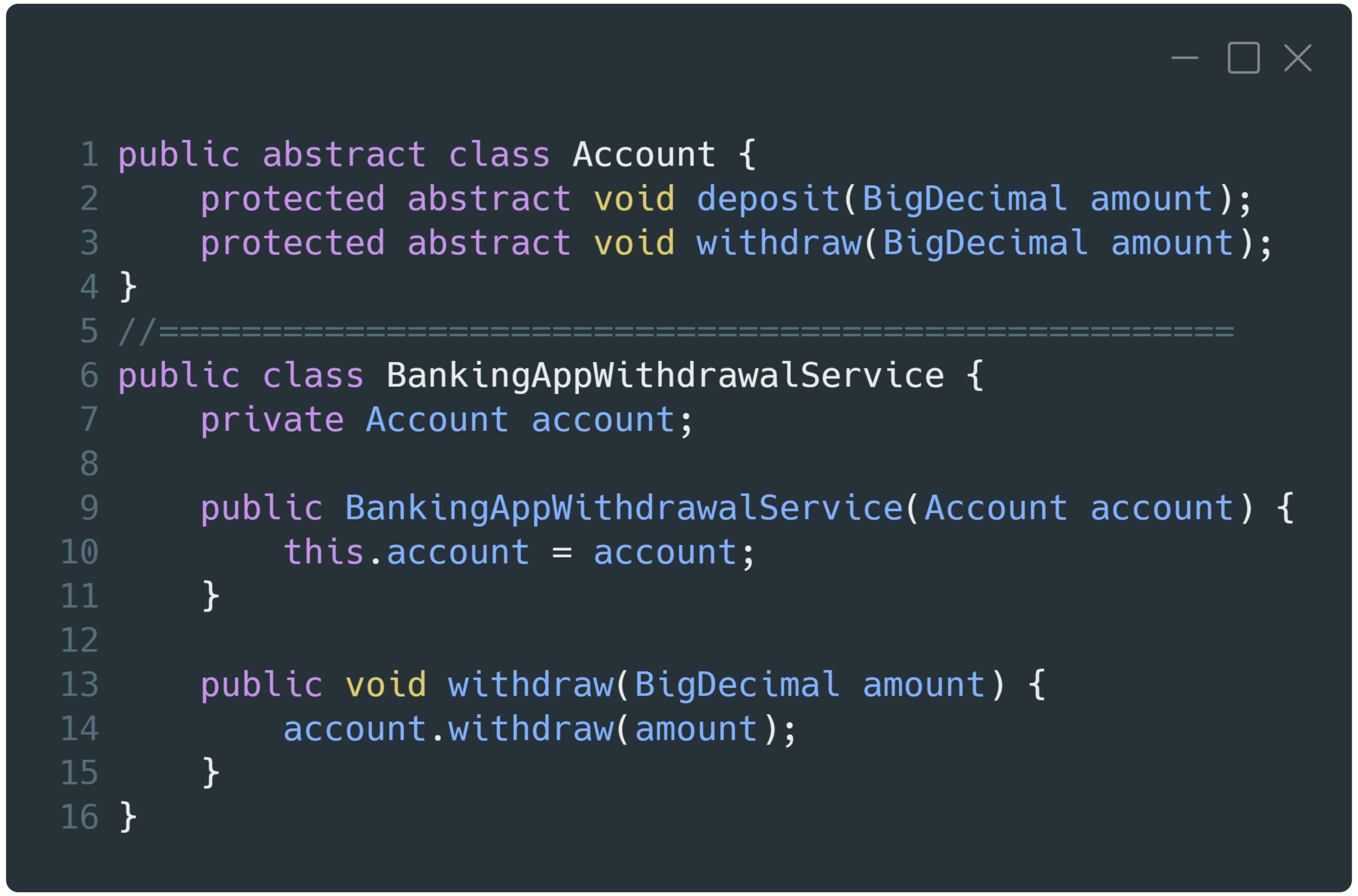


```java
public class Calculator {

    public void calculate(CalculatorOperation operation) {
        if (operation == null) {
            throw new InvalidParameterException("Cannot perform operation");
        }
        operation.perform();
    }
}
```

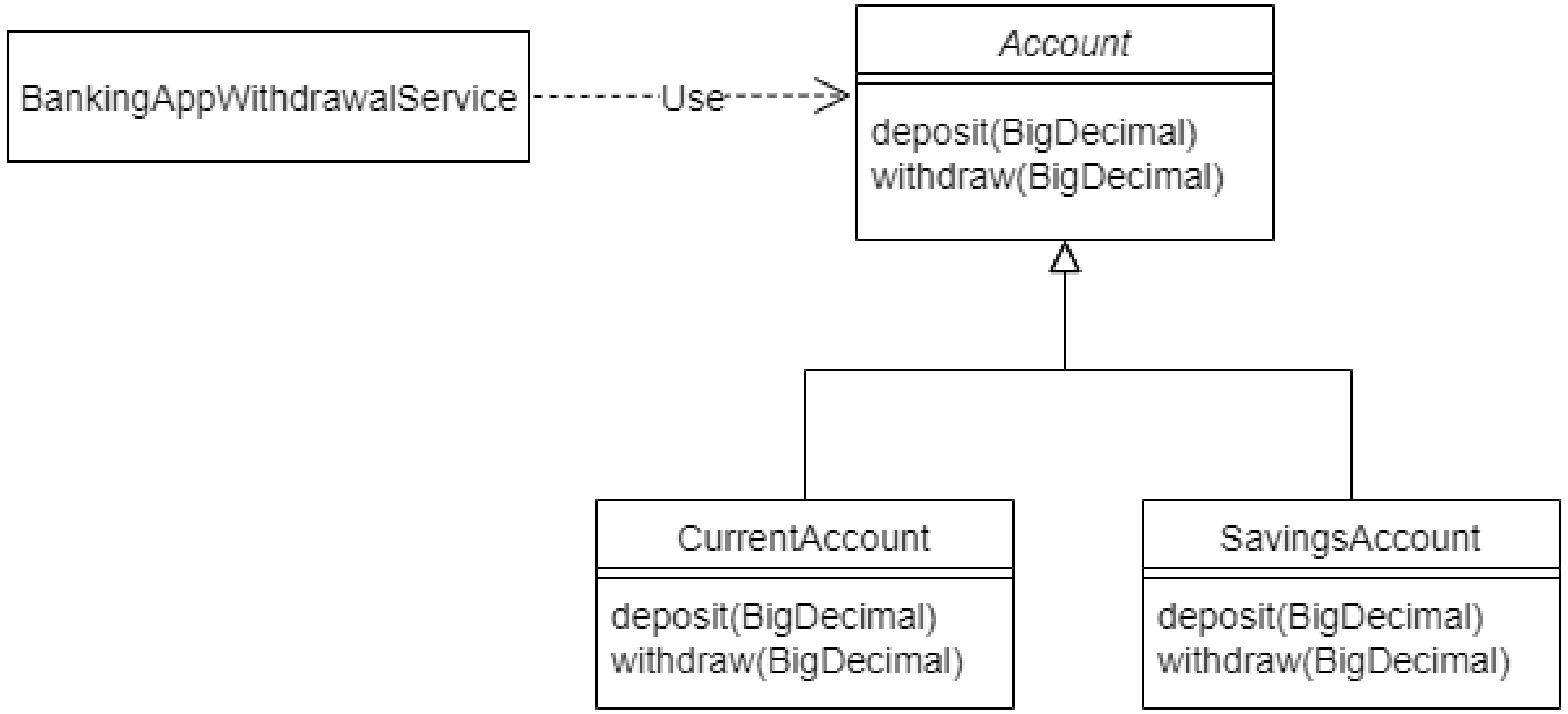
OCP Example: Banking System Problem



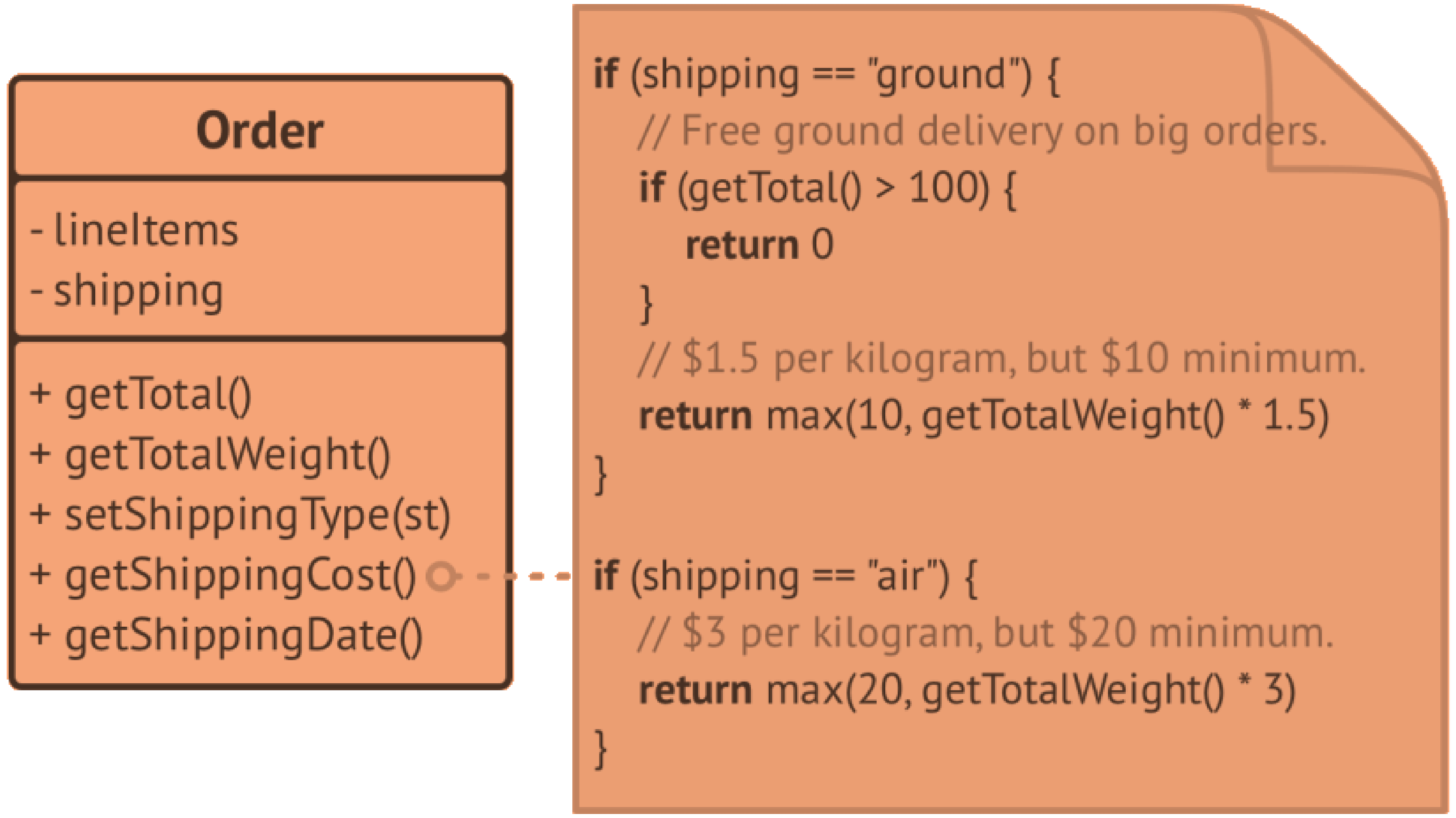
OCP Example: Banking System Solution



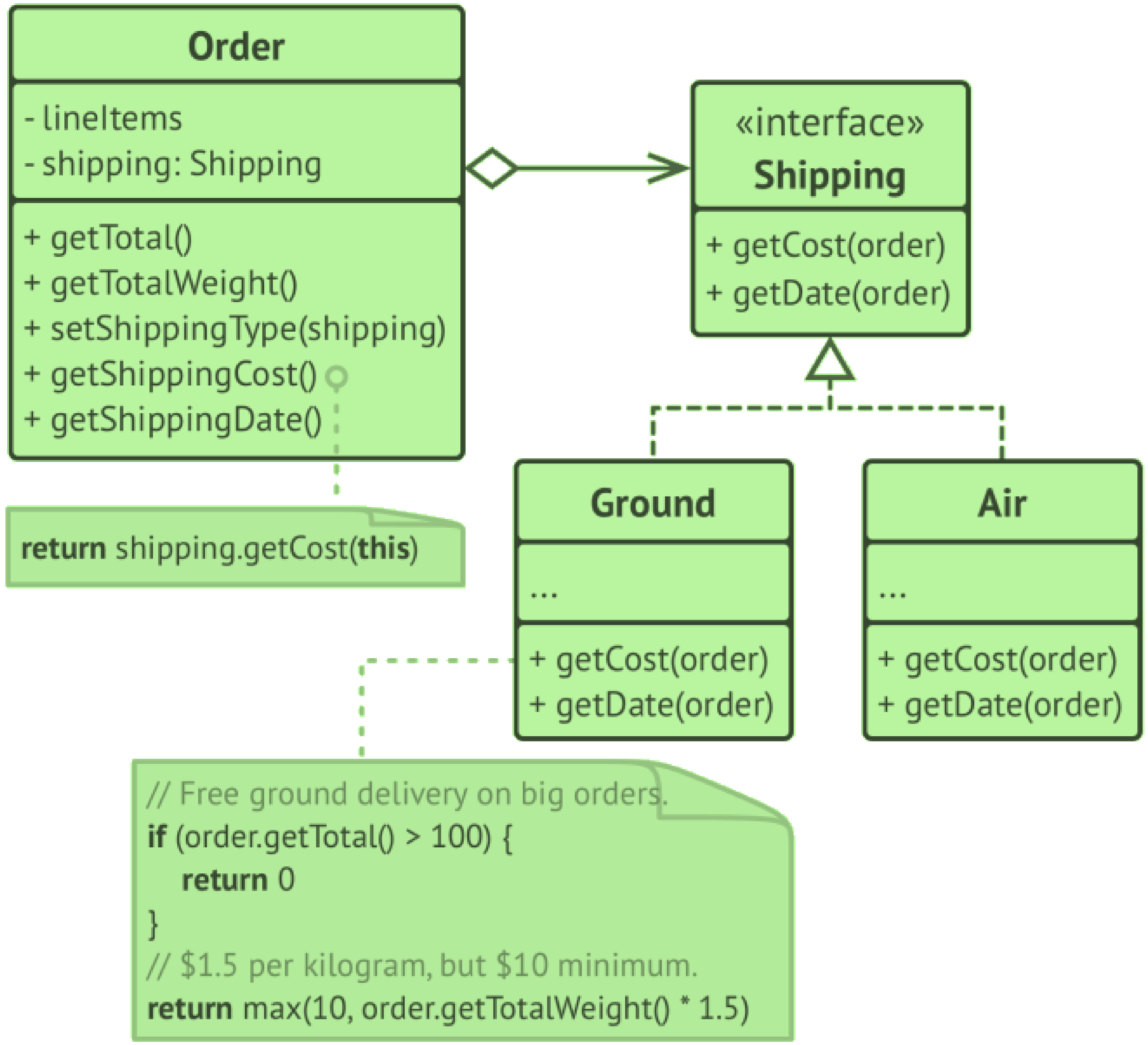
```java
public abstract class Account {
    protected abstract void deposit(BigDecimal amount);
    protected abstract void withdraw(BigDecimal amount);
}
//====================================================
public class BankingAppWithdrawalService {
    private Account account;

    public BankingAppWithdrawalService(Account account) {
        this.account = account;
    }

    public void withdraw(BigDecimal amount) {
        account.withdraw(amount);
    }
}
```



OCP Example: eCommerce Application



```
if (shipping == "ground") {
    // Free ground delivery on big orders.
    if (getTotal() > 100) {
        return 0
    }
    // $1.5 per kilogram, but $10 minimum.
    return max(10, getTotalWeight() * 1.5)
}

if (shipping == "air") {
    // $3 per kilogram, but $20 minimum.
    return max(20, getTotalWeight() * 3)
}
```



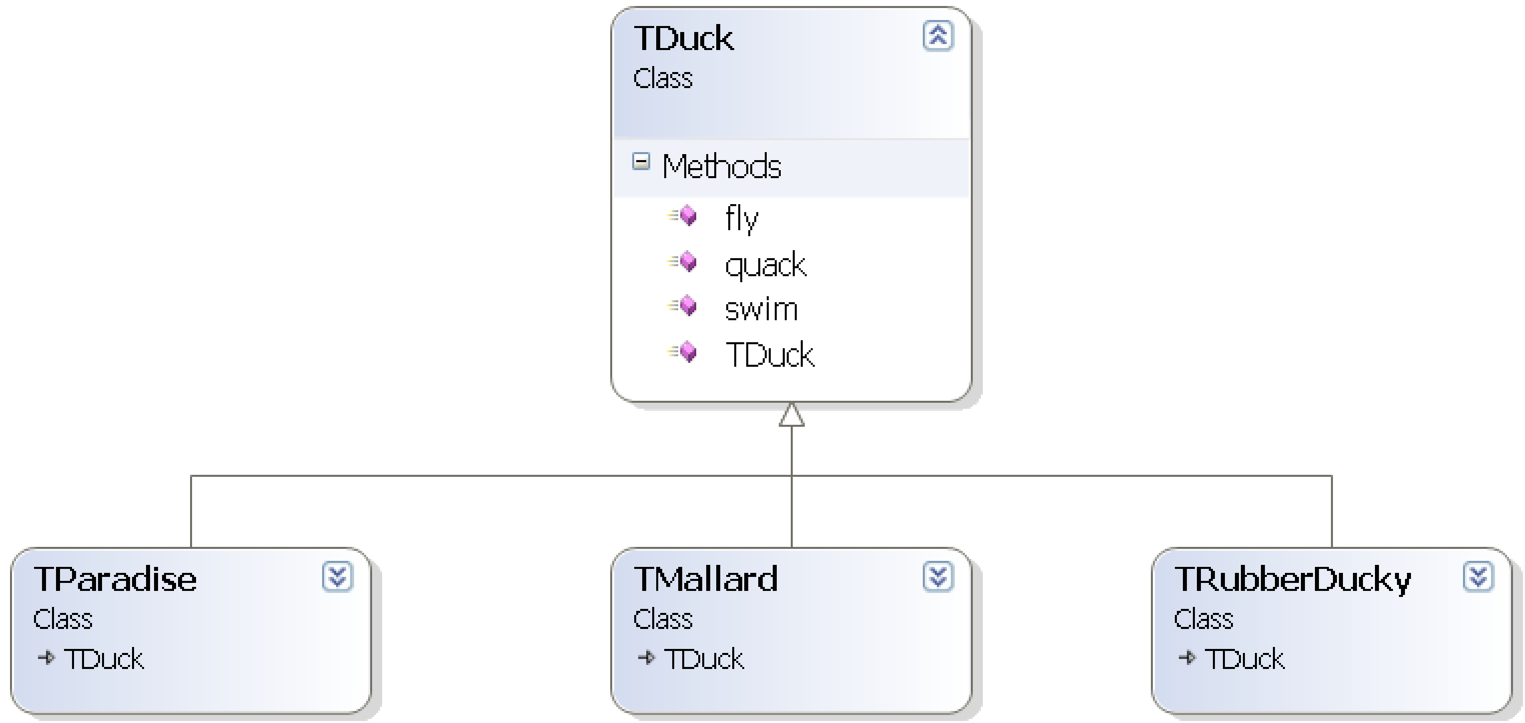
```
return shipping.getCost(this)
```

```
// Free ground delivery on big orders.
if (order.getTotal() > 100) {
    return 0
}
// $1.5 per kilogram, but $10 minimum.
return max(10, order.getTotalWeight() * 1.5)
```

Liskov Substitution Principle

- **Barbara Liskov - 1988**
  - If for each object o1 of type S there is an object o2 of type T such that for all programs P defined in terms of T, the behavior of P is unchanged when o1 is substituted for o2 then S is a subtype of T.
- **Design by contract – Bertrand Meyer**
  - helps us conform to the "is-a" relationship
- **Implementations of the same interface should never give a different result.**
- **To be substitutable, the subtype must behave like its supertype.**
- **Example Scenario: Using file system for testing purposes before developing database structure.**
- **How to make sure your code follows LSP?**
  - mindful programming

> **“Derived types must be completely substitutable for their base types”**

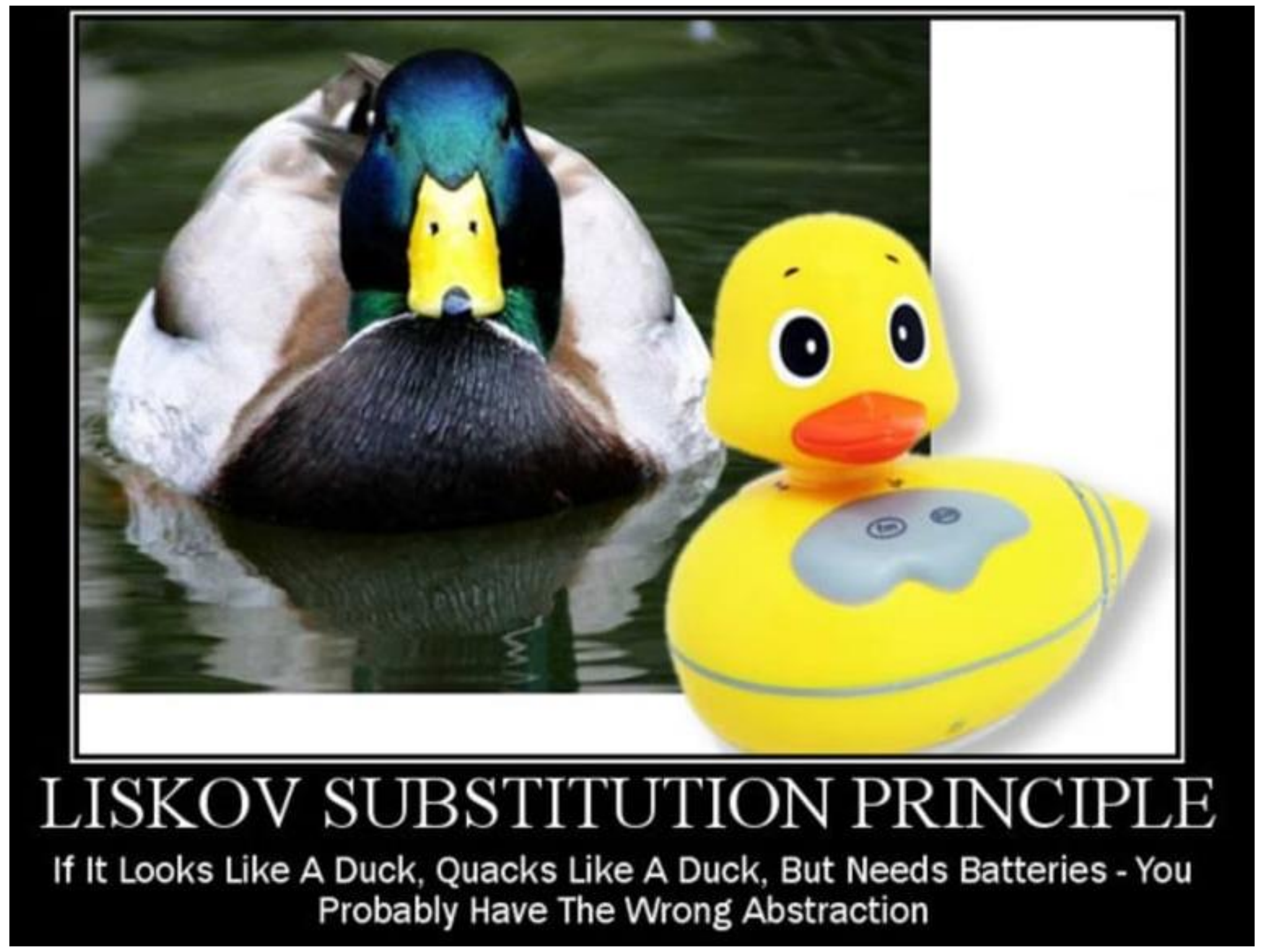


TDuck
Class
Methods
fly
quack
swim
TDuck

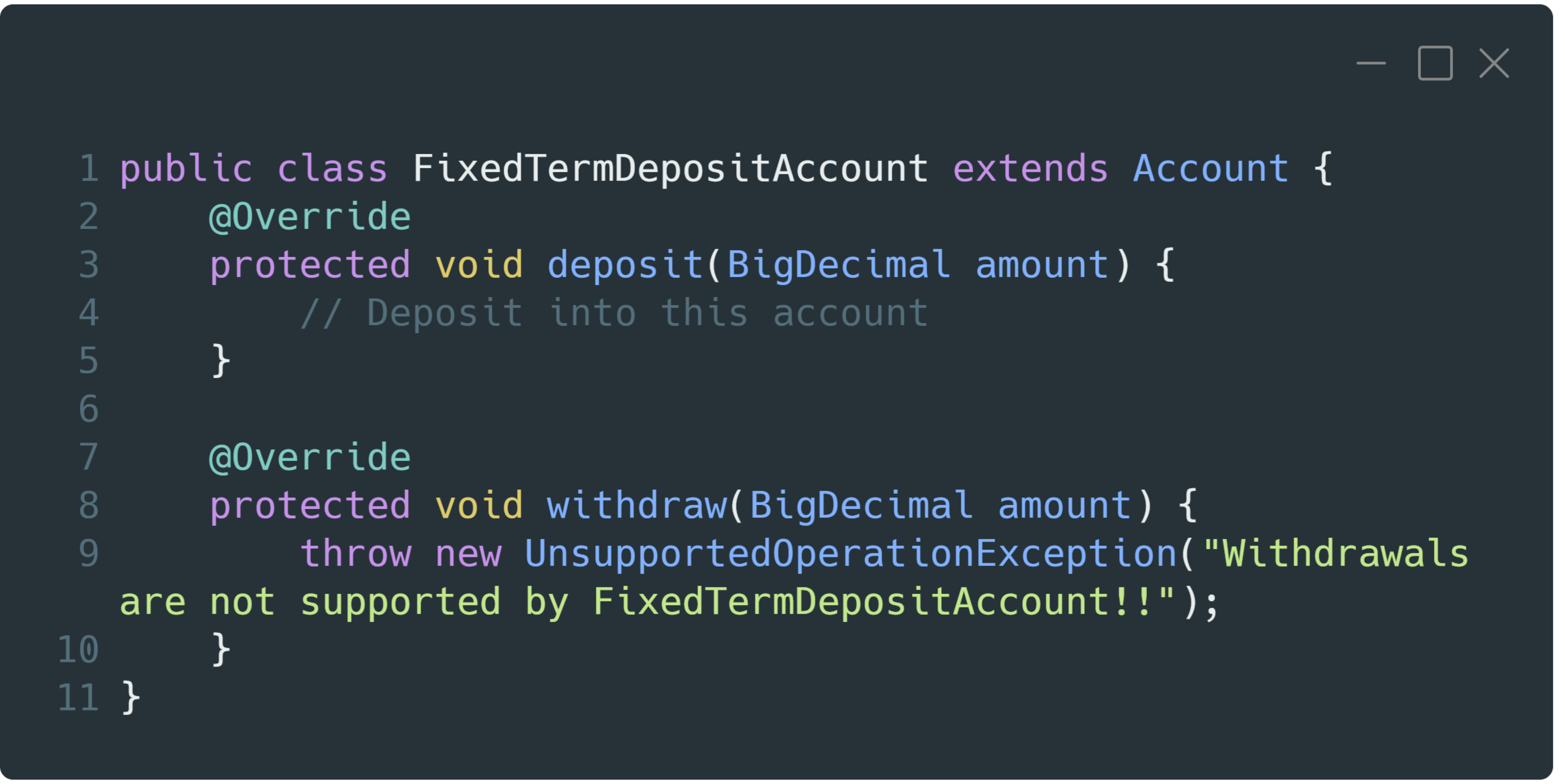
TParadise
Class
→ TDuck

TMallard
Class
→ TDuck

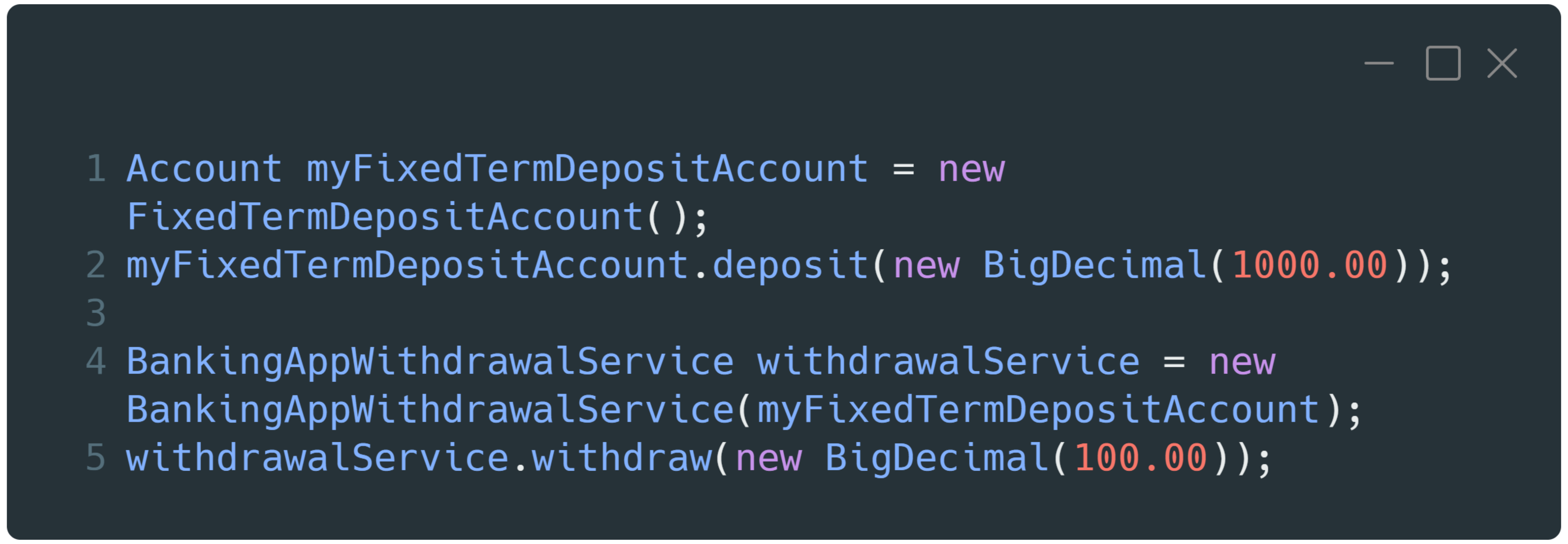
TRubberDucky
Class
→ TDuck


LISKOV SUBSTITUTION PRINCIPLE
If It Looks Like A Duck, Quacks Like A Duck, But Needs Batteries - You Probably Have The Wrong Abstraction

LSP Example: Banking System Problem

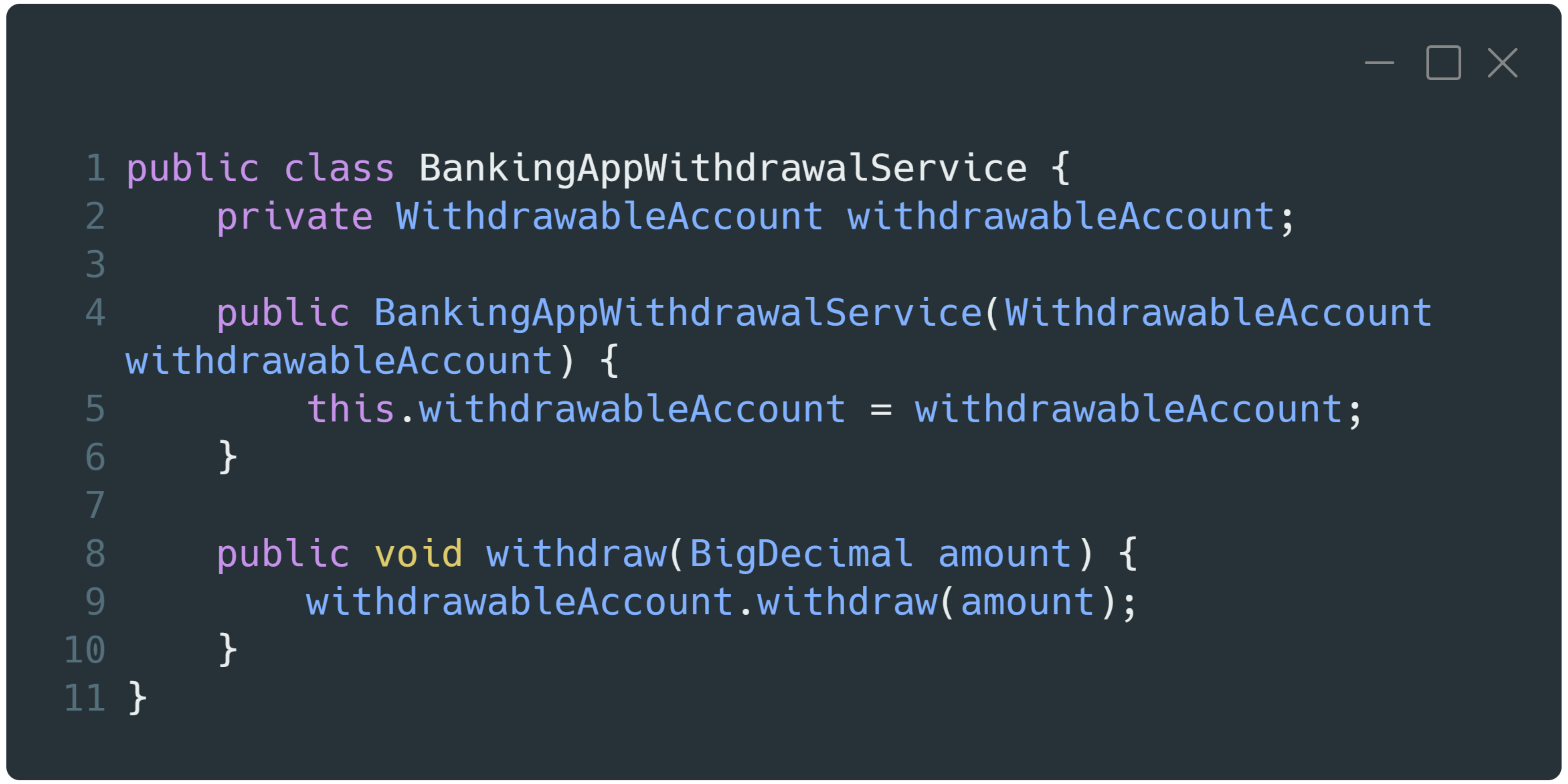


```java
public class FixedTermDepositAccount extends Account {
    @Override
    protected void deposit(BigDecimal amount) {
        // Deposit into this account
    }

    @Override
    protected void withdraw(BigDecimal amount) {
        throw new UnsupportedOperationException("Withdrawals are not supported by FixedTermDepositAccount!!");
    }
}
```

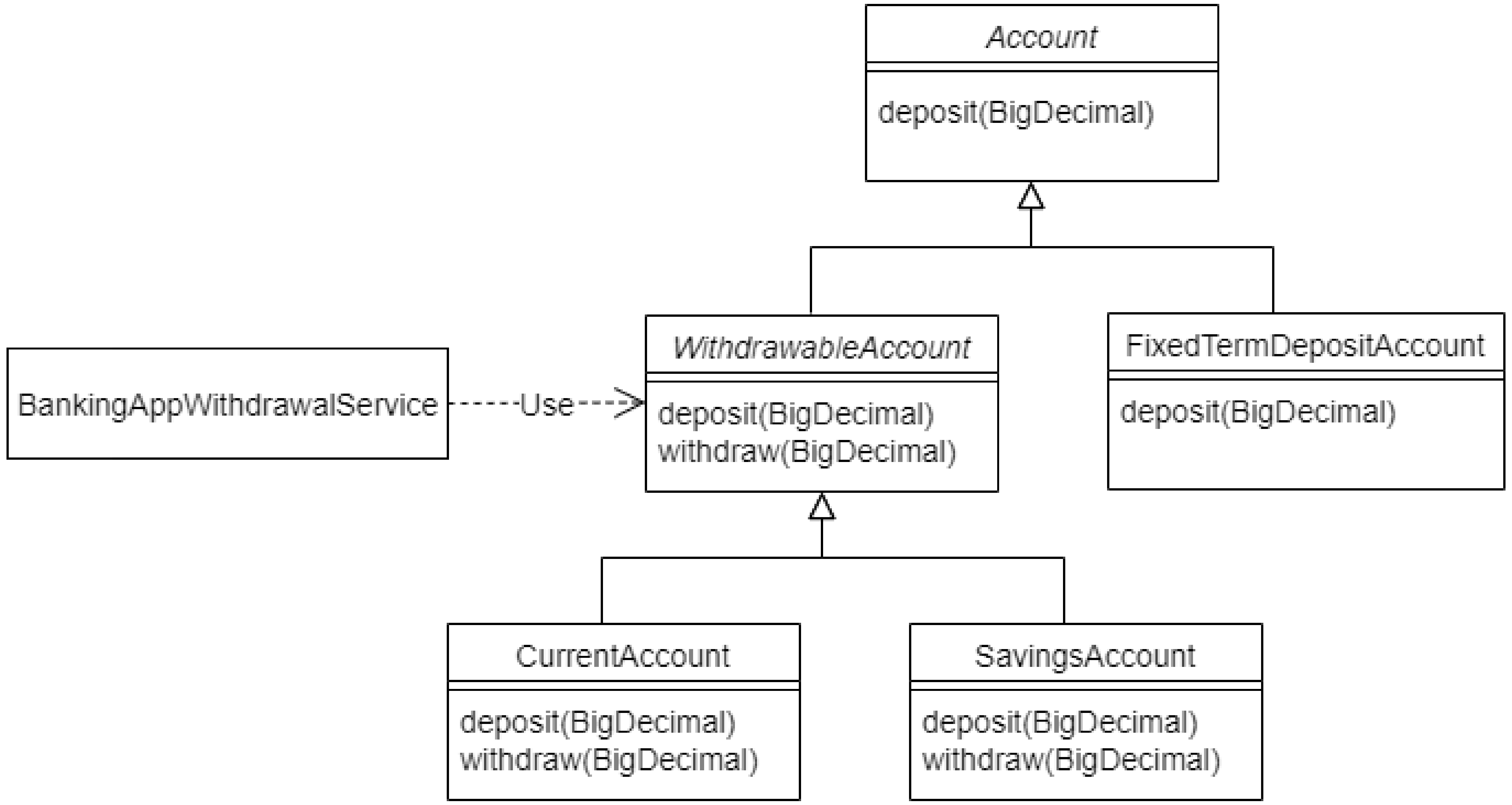


```java
Account myFixedTermDepositAccount = new FixedTermDepositAccount();
myFixedTermDepositAccount.deposit(new BigDecimal(1000.00));

BankingAppWithdrawalService withdrawalService = new BankingAppWithdrawalService(myFixedTermDepositAccount);
withdrawalService.withdraw(new BigDecimal(100.00));
```

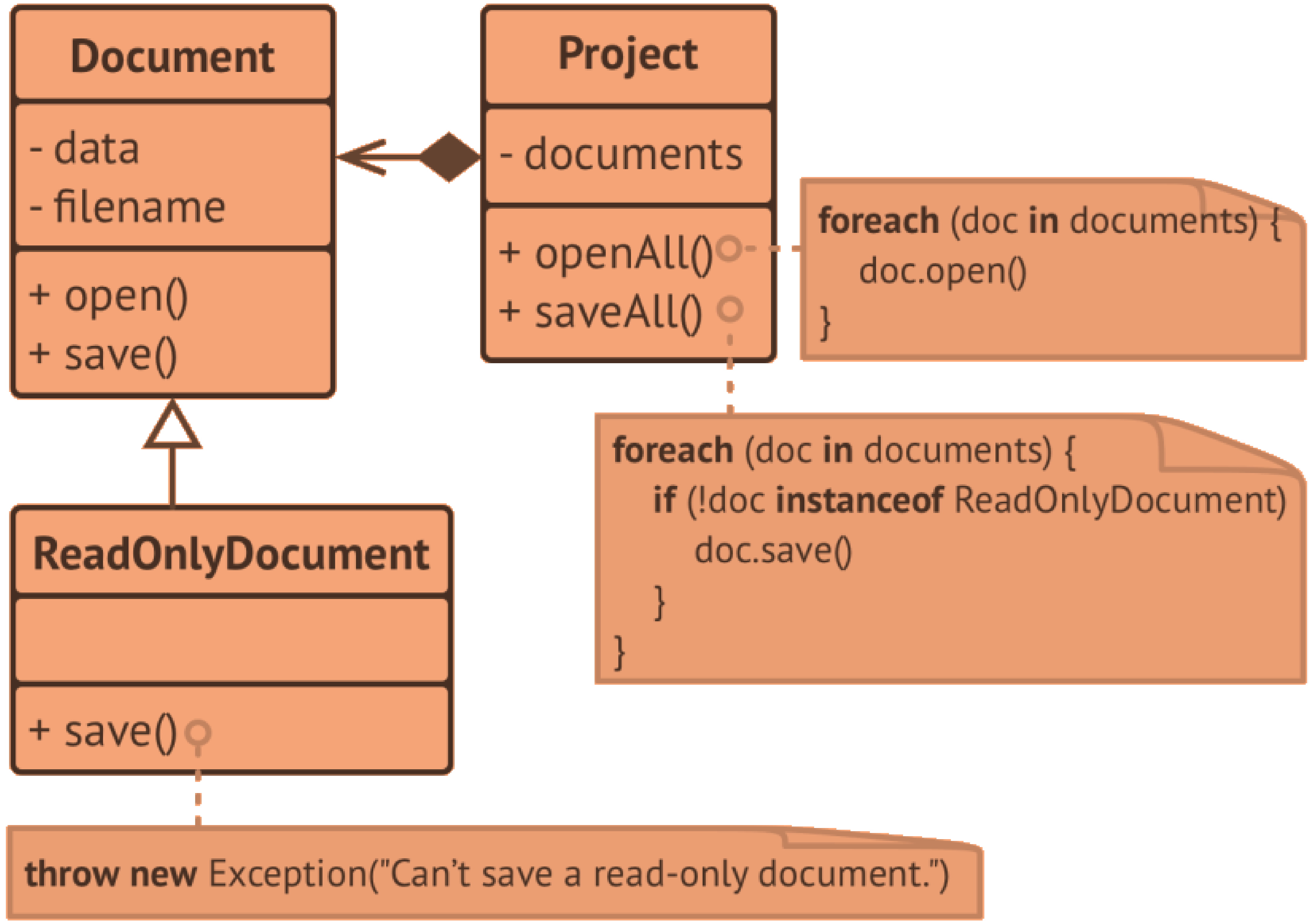
LSP Example: Banking System Solution



```java
public class BankingAppWithdrawalService {
    private WithdrawableAccount withdrawableAccount;

    public BankingAppWithdrawalService(WithdrawableAccount withdrawableAccount) {
        this.withdrawableAccount = withdrawableAccount;
    }

    public void withdraw(BigDecimal amount) {
        withdrawableAccount.withdraw(amount);
    }
}
```



LSP Example: Saving Documents



Document

- data
- filename

+ open()
+ save()

Project

- documents

+ openAll()
+ saveAll()

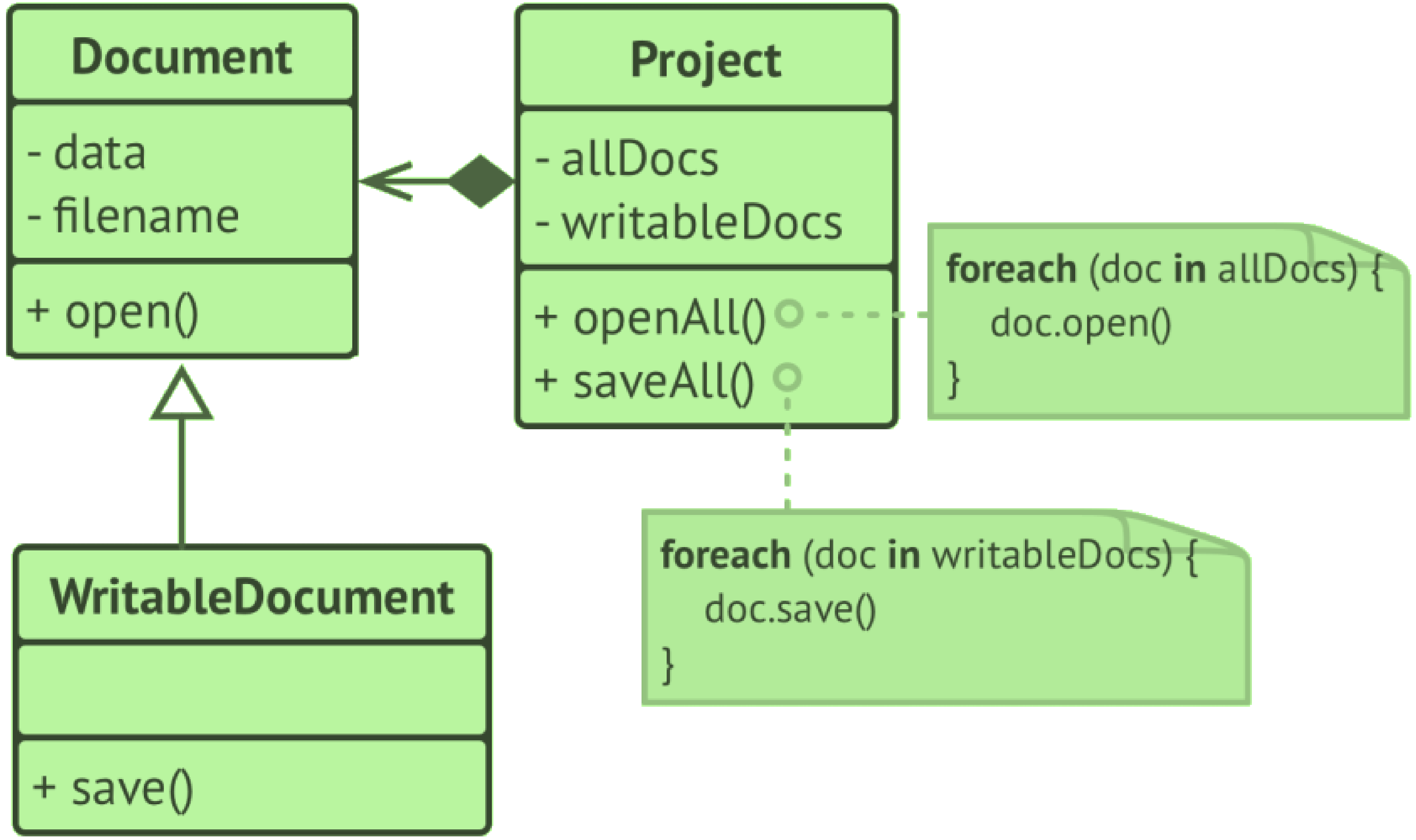
```
foreach (doc in documents) {
    doc.open()
}
```

```
foreach (doc in documents) {
    if (!doc instanceof ReadOnlyDocument)
        doc.save()
    }
}
```

ReadOnlyDocument

+ save()

```
throw new Exception("Can't save a read-only document.")
```



Document

- data
- filename

+ open()

Project

- allDocs
- writableDocs

+ openAll()
+ saveAll()

```
foreach (doc in allDocs) {
    doc.open()
}
```

```
foreach (doc in writableDocs) {
    doc.save()
}
```

WritableDocument

+ save()

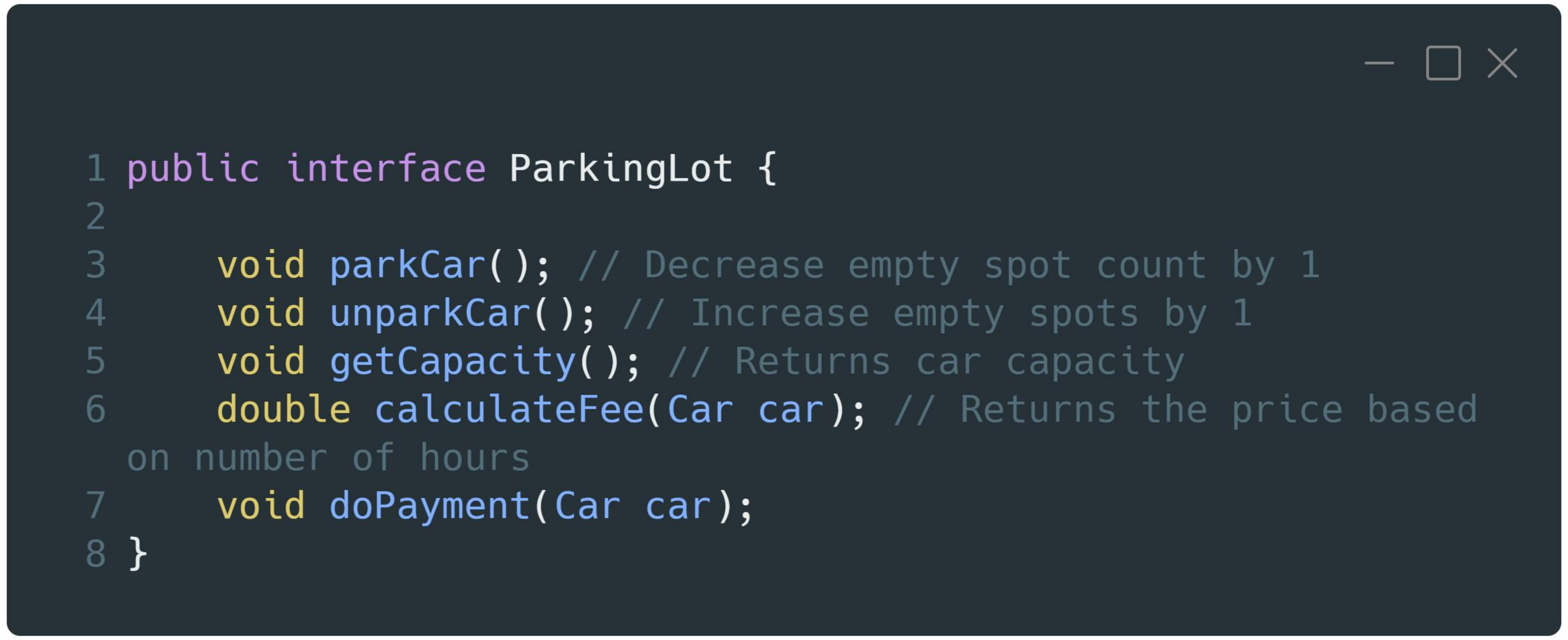
Interface Segregation Principle

- **Many client-specific interfaces are better than one general-purpose interface.**
- **Reduce the side effects of using larger interfaces by breaking application interfaces into smaller ones.**
- **Similar to SRP:**
  - Each class or interface serves a single purpose.
- **It take more time and effort in the design phase .**
- **It increase the code complexity.**
- **It leads to flexible code.**
- **Examples:**
  - logging interface for writing and reading logs – DB vs Console
  - Reportable interface: generateExcel() and generatedPdf().
  - Large Employee class:
    - EmployeeTimeLogController, EmployeeTimeOffController, EmployeeSalaryController
- **How to make sure your code follows the ISP?**

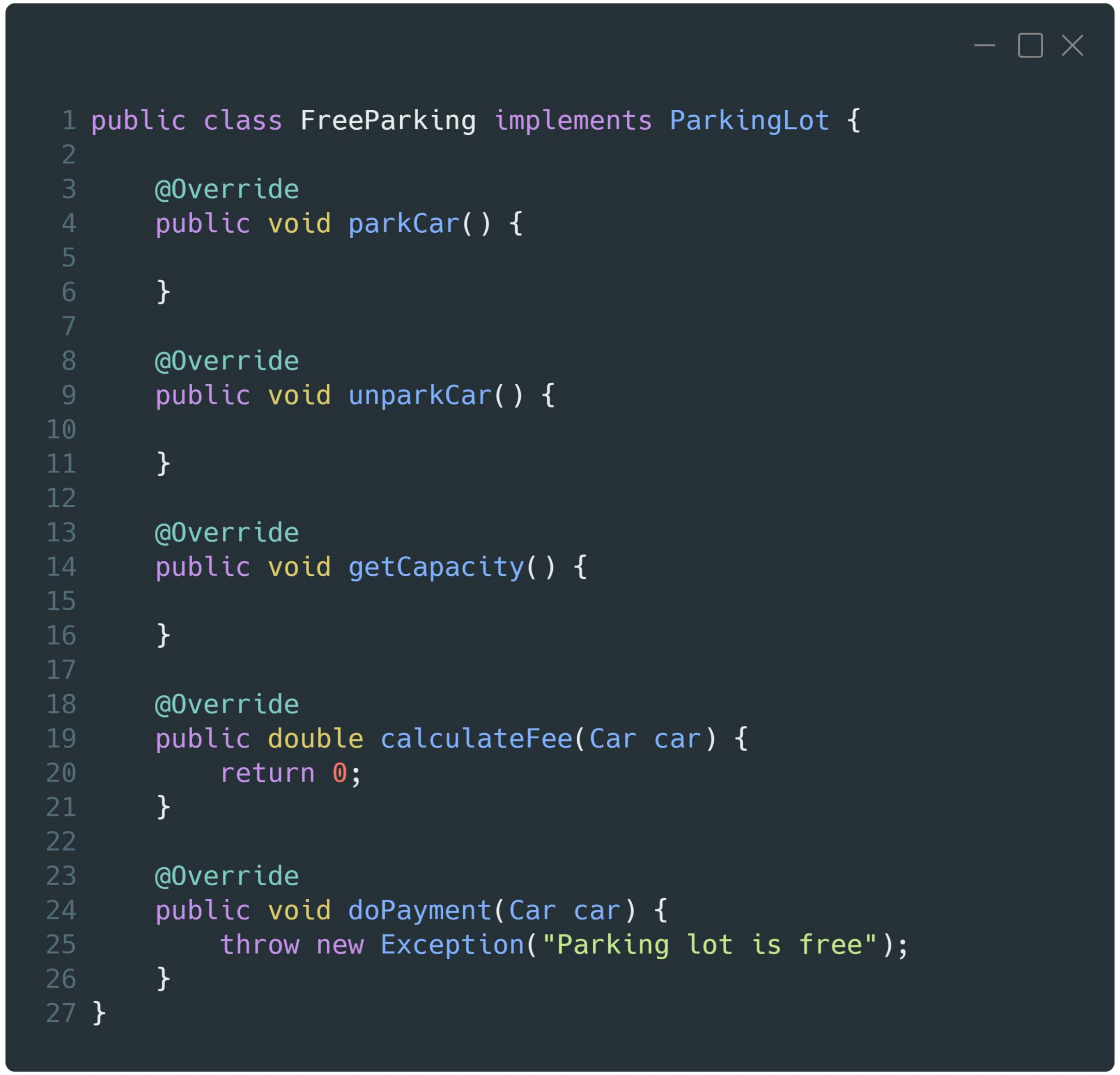
> **“Clients should not be forced to implement unnecessary methods which they will not use”**

INTERFACE SEGREGATION PRINCIPLE
You Want Me To Plug This In, Where?

ISP Example: ParkingLot App Problem

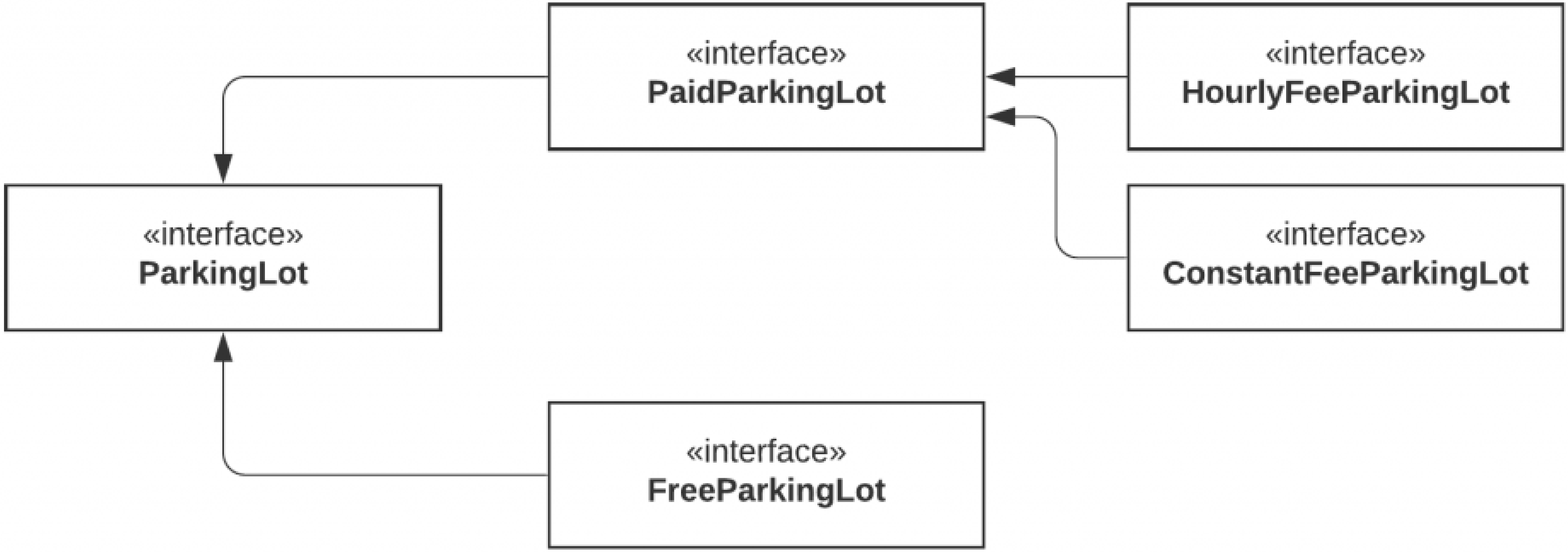


```java
public interface ParkingLot {

    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);
}
```



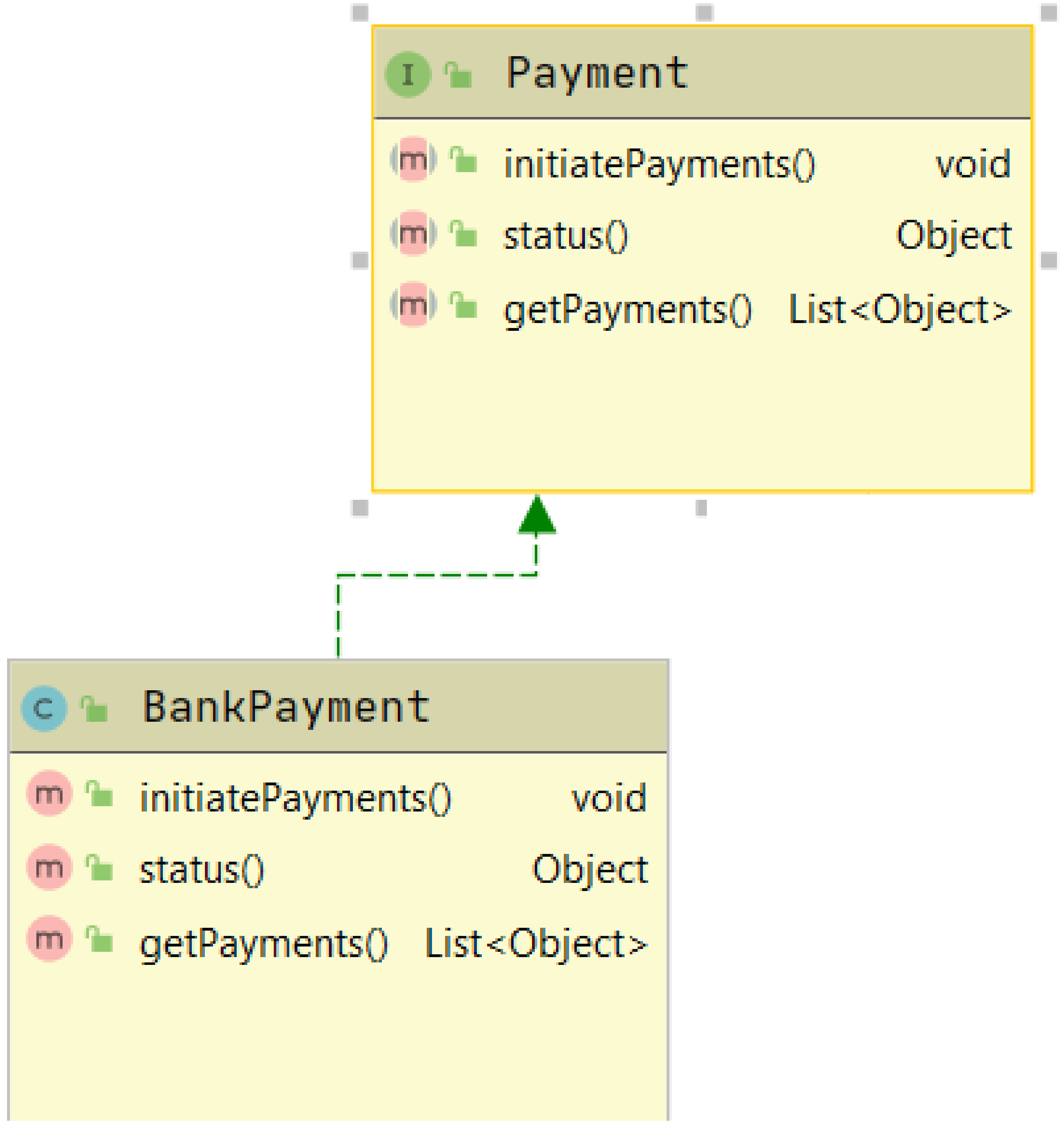
```java
public class FreeParking implements ParkingLot {

    @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");
    }
}
```

ISP Example: ParkingLot App Solution



ISP Example: Payment App

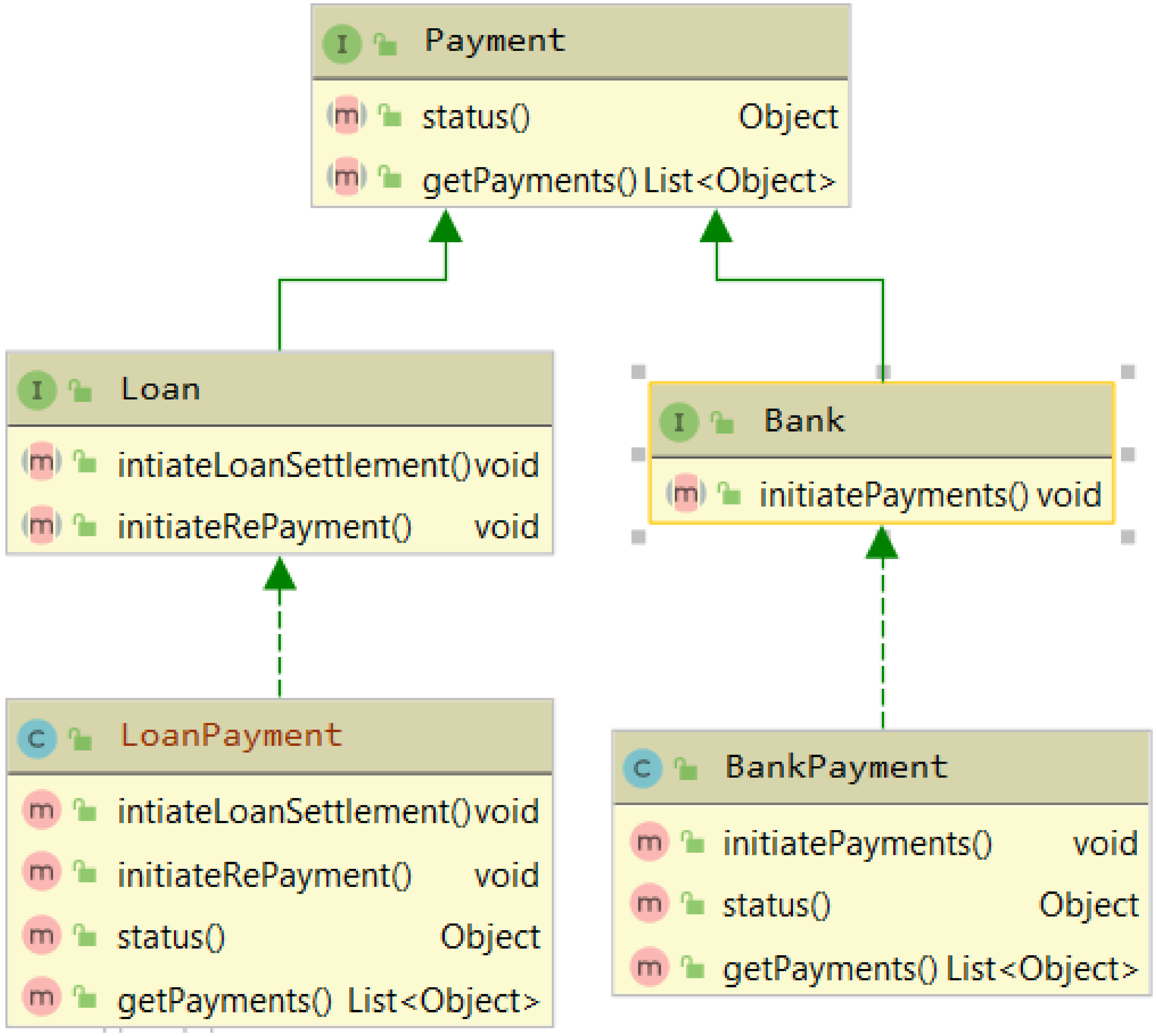
ISP Violation



Payment
initiatePayments() void
status() Object
getPayments() List<Object>

BankPayment
initiatePayments() void
status() Object
getPayments() List<Object>

ISP Compliance



Payment
status() Object
getPayments() List<Object>

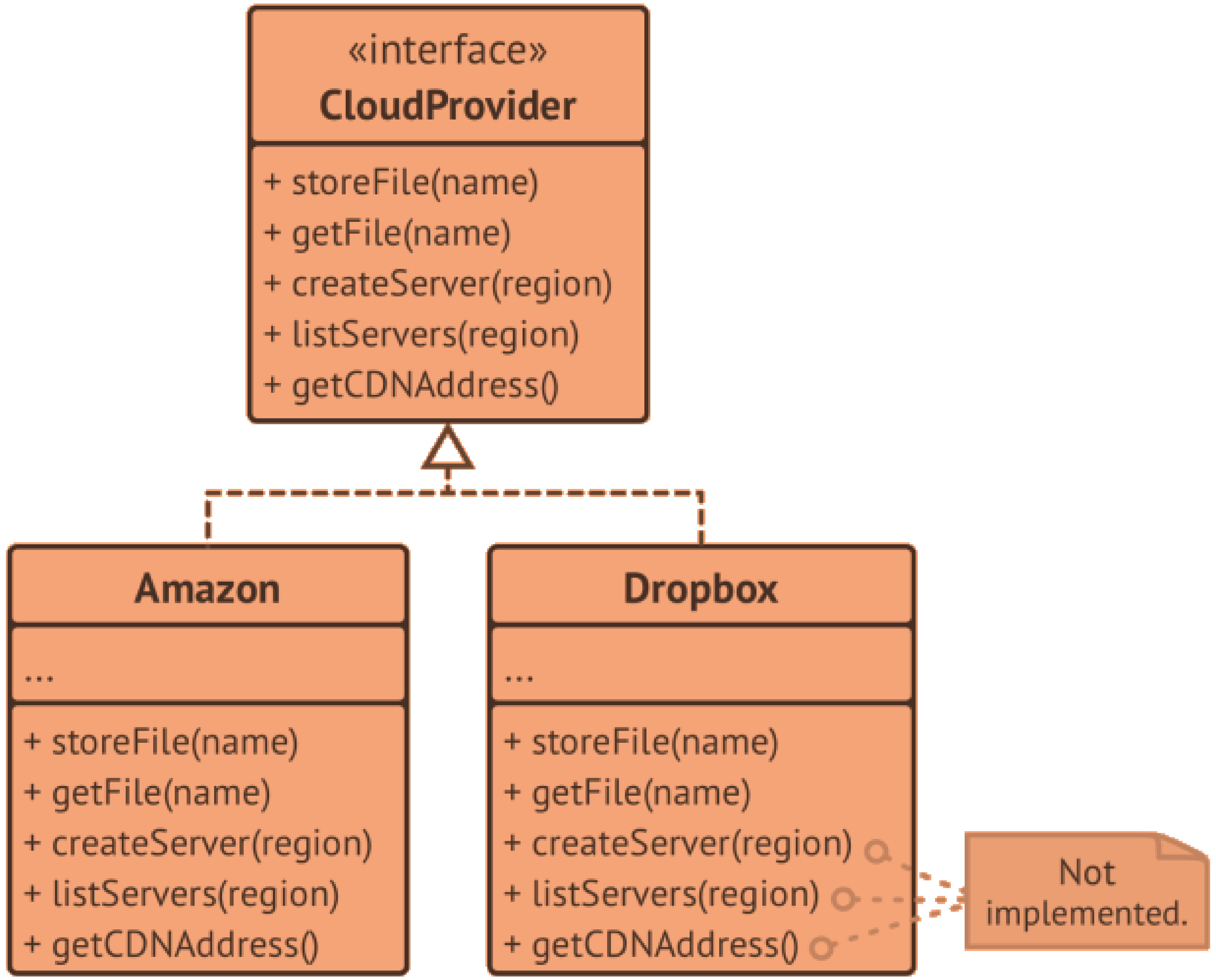
Loan
intiateLoanSettlement() void
initiateRePayment() void

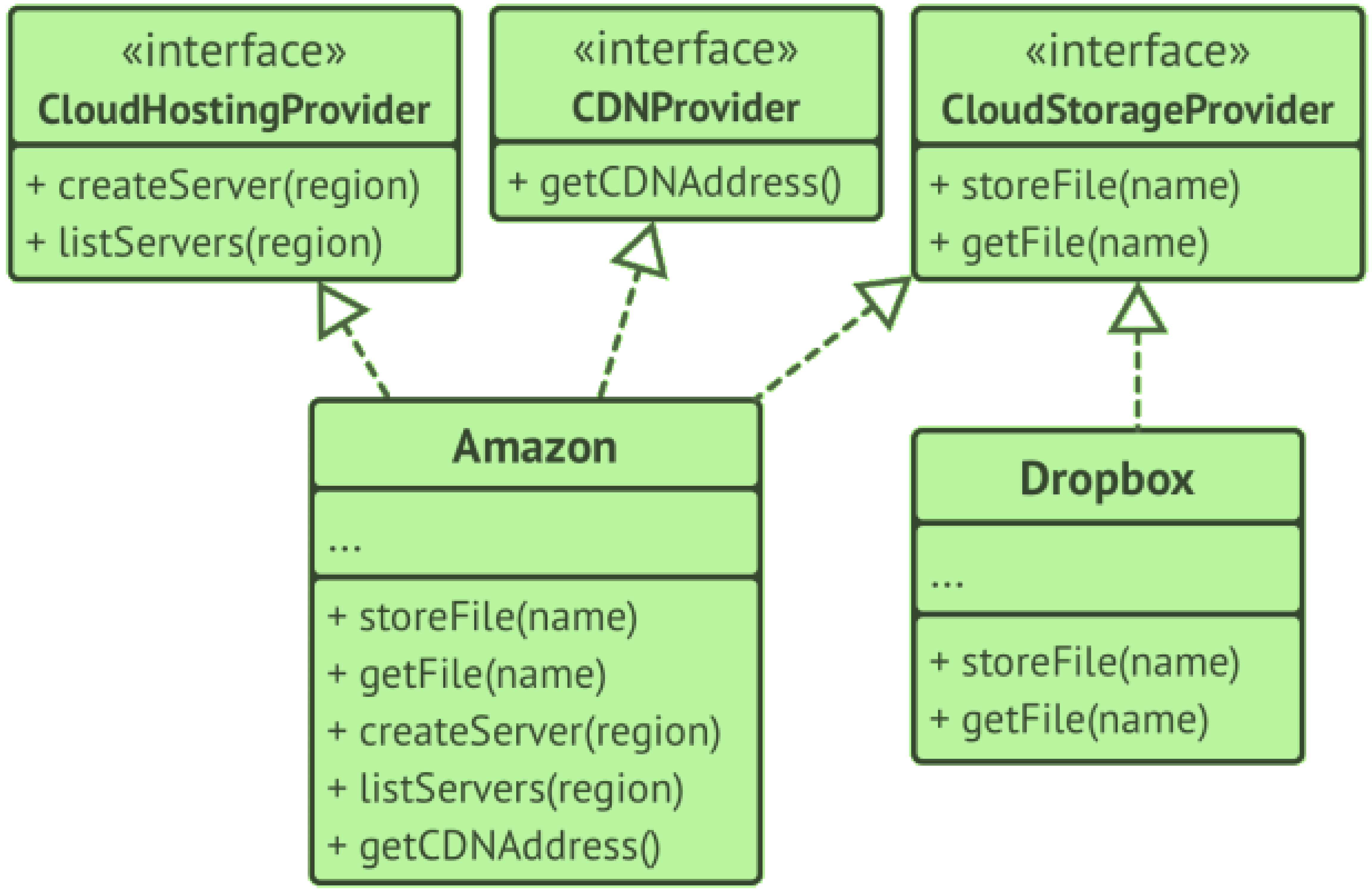
Bank
initiatePayments() void

LoanPayment
intiateLoanSettlement() void
initiateRePayment() void
status() Object
getPayments() List<Object>

BankPayment
initiatePayments() void
status() Object
getPayments() List<Object>

ISP Example: Cloud Provider





Any Question

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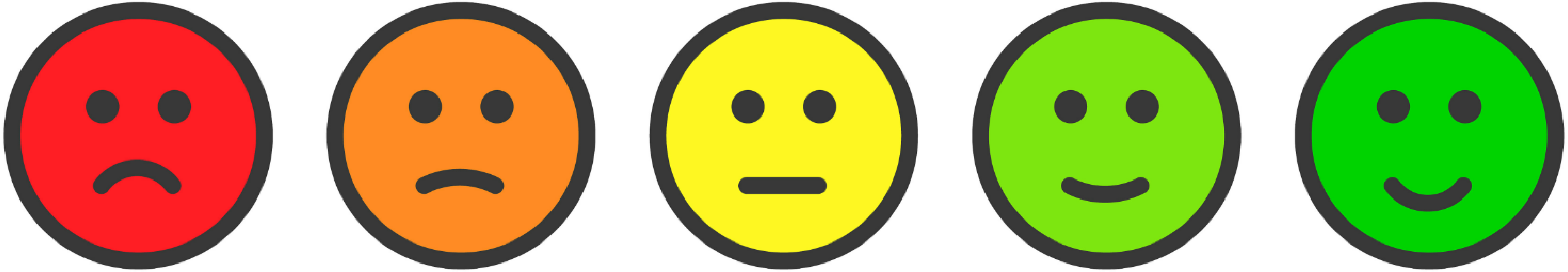
How do you feel about the course?



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