

OOP with Java

Yuanbin Wu
cs@ecnu

OOP with Java

- 通知
 - Project 5: 5月14日晚9点

- 复习

- Upcasting

- 同一基类的不同子类可以被视为同一类型(基类)
 - 放宽类型一致性
 - 简化接口

```
class A{ ... }  
class B{ ... }  
A a = new A();  
B b = new B();
```

```
// A a = new B(); compile error
```

```
class A{ ... }  
class B extends A{ ... }  
A a = new A();  
B b = new B();
```

```
A a = new B(); // upcasting
```

- 复习
 - 多态

```
class Instrument {  
    public void play(int note) {  
        System.out.println("Instrument.play()" + n);  
    }  
}
```

```
public class Wind extends Instrument {  
    public void play(int note) {  
        System.out.println("Wind.play()" + n);  
    }  
}
```

```
public class Stringed extends Instrument {  
    public void play(int note) {  
        System.out.println("Stringed.play()" + n);  
    }  
}
```

```
public class Brass extends Instrument {  
    public void play(int note) {  
        System.out.println("Brass.play()" + n);  
    }  
}
```

```
public class Music {  
    public static void tune(Instrument i) {  
        i.play();  
    }  
    public static void main(String []args){  
        Wind flute = new Wind();  
        Stringed violin = new Stringed();  
        Brass frenchHorn = new Brass();  
  
        tune(flute);  
        tune(violin);  
        tune(frenchHorn);  
    }  
}
```

多态(Polymorphism)

参数Instrument i 可以代表不同的子类, 并能正确调用它们的方法(即, 有多种表现形态)

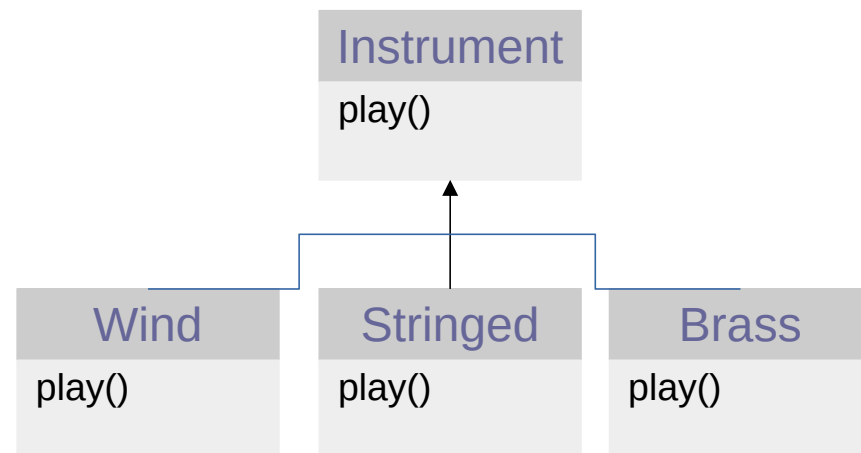
- 复习
 - 静态绑定
 - 函数的调用在编译后便确定, 也称为early binding
 - 优点: 快速, 易于debug, 缺点: 接口繁琐
 - 动态绑定
 - 函数的调用在运行时才能确定 也称late binding
 - 优点: 接口简洁 缺点: 函数调用需要额外开销
 - Java中的所有方法都采用动态绑定, 除了
 - final
 - static
 - 数据成员不动态绑定

OOP with Java

- 抽象类
- 接口
 - 定义
 - 实现多个接口
 - 扩展接口
 - 接口适配器
 - 应用: 工厂模式

抽象类

- 父类的方法
 - Instrument: play()
- 子类重写父类的方法
 - Wind: play()
 - Stringed: play()
 - Brass: play()
- 可扩展性
 - 用户程序仅知父类方法
 - 子类修改不会影响用户程序

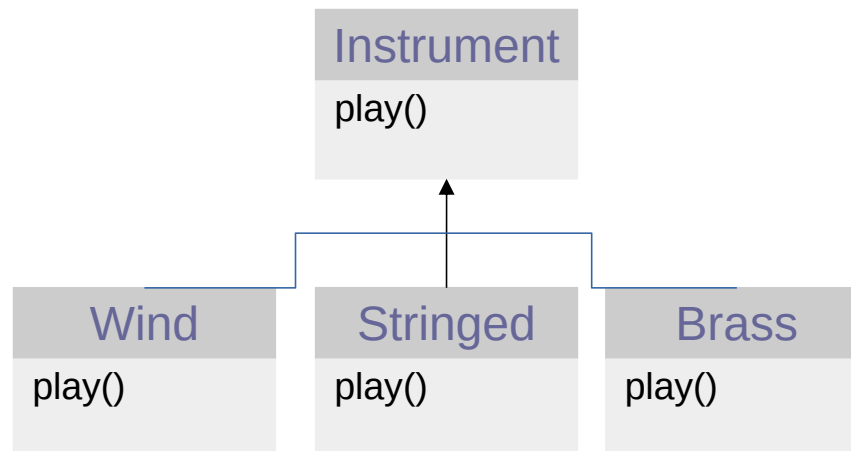


```
public class Music {
    public static void tune(Instrument i) {
        i.play();
    }
    public static void main(String []args){
        Wind flute = new Wind();
        Stringed violin = new Stringed();
        Brass frenchHorn = new Brass();

        tune(flute);
        tune(violin);
        tune(frenchHorn);
    }
}
```

抽象类

- 如果所有子类都将重写该方法
 - Instrument: play() 是否还必要?
- 是否有机制:
 - 在父类中不指定该方法的具体实现
 - 禁止调用父类的该方法



抽象类

- 抽象方法(**abstract method**)
 - 仅提供方法的名称, 参数和返回值
 - 没有具体实现
 - 使用 **abstract** 关键字

```
class Instrument {  
    public void play(int note) {  
        System.out.println("Instrument.play()" + n);  
    }  
}
```

普通方法

```
abstract class Instrument {  
    public abstract void play(int note) ;  
}
```

抽象方法

抽象类

- 抽象类(**abstract class**)
 - 包含抽象方法的类称为抽象类

抽象类

- 抽象类

```
abstract class Instrument {  
    public abstract void play(int note) ;  
}
```

```
public class Wind extends Instrument {  
    public void play(int note) {  
        System.out.println("Wind.play()" + n);  
    }  
}
```

```
public class Stringed extends Instrument {  
    public void play(int note) {  
        System.out.println("Stringed.play()" + n);  
    }  
}
```

```
public class Brass extends Instrument {  
    public void play(int note) {  
        System.out.println("Brass.play()" + n);  
    }  
}
```

抽象类

- 是否能直接创建抽象类的对象?
 - 否
 - 抽象类是不完整的类
 - 其中的抽象方法需要在子类补充完整(重写)后才有意义

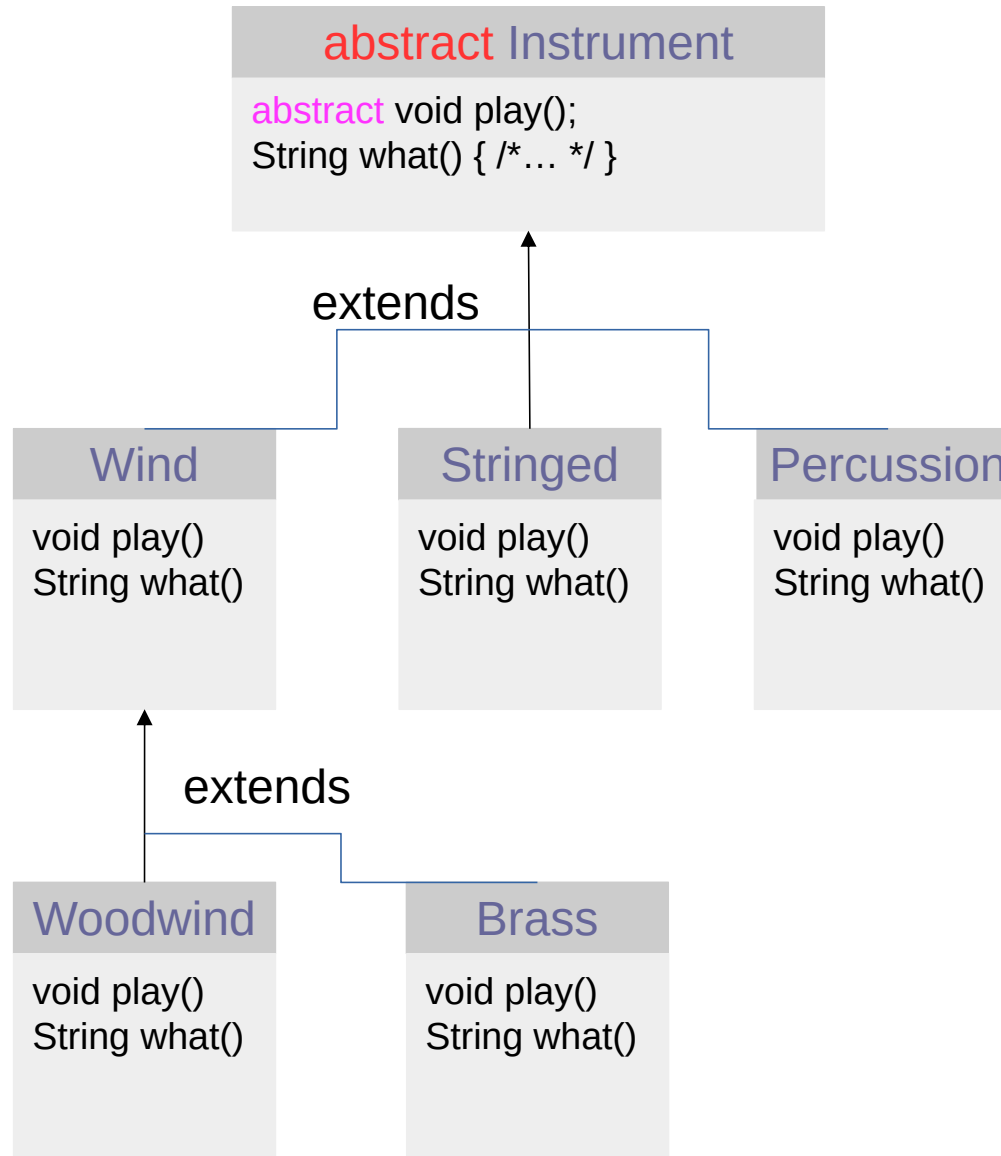
抽象类

- 无法直接创建该类的对象

```
abstract class Instrument {  
    public abstract void play(int note) ;  
}  
class Test {  
    public static void main(String []args){  
        // Instrument in = new Instrument();  
        // compile error: can not create instances of an abstract class  
    }  
}
```

super关键字？

抽象类



```
abstract class Instrument {  
    public abstract void play(int note) ;  
    public String what() {return "Instrument";}  
}
```

```
class Stringed extends Instrument {  
    public void play(int note) {  
        System.out.println("Stringed.play()" + n);  
    }  
    public String what() {return "Stringed";}  
}
```

```
class Percussion extends Instrument {  
    public void play(int note) {  
        System.out.println("Percussion.play()" + n);  
    }  
    public String what() {return "Percussion";}  
}
```

```
abstract class Wind extends Instrument {  
    public abstract void play(int note) ;  
    public String what() {return "Wind";}  
}
```

- 若子类没有重写父类中的抽象方法, 子类仍为抽象类

```
public class Music {  
    public static void tune(Instrument i) {  
        i.play();  
    }  
    public static void main(String []args){  
        Wind flute = new Wind();  
        Stringed violin = new Stringed();  
        Brass frenchHorn = new Brass();  
  
        tune(flute);  
        tune(violin);  
        tune(frenchHorn);  
    }  
}
```

```
class Woodwind extends Wind {  
    public void play(int note) {  
        System.out.println("Woodwind.play()" + n);  
    }  
    public String what() {return "Woodwind";}  
}
```

```
class Brass extends Wind {  
    public void play(int note) {  
        System.out.println("Brass.play()" + n);  
    }  
    public String what() {return "Brass";}  
}
```

抽象类

- 总结

- 抽象类包含抽象方法, 只有方法名, 参数, 返回值, 没有方法的实现
- 抽象类不能**直接**实例化
- 若子类没有重写父类中的抽象方法, 子类仍为抽象类

- 复习

- 抽象类

- 抽象类包含抽象方法, 只有方法名, 参数, 返回值, 没有方法的实现
 - 抽象类不能实例化
 - 若子类没有重写父类中的抽象方法, 子类仍为抽象类

```
abstract class Instrument {  
    public abstract void play(int note) ;  
}
```

```
public class Wind extends Instrument {  
    public void play(int note) {  
        System.out.println("Wind.play()" + n);  
    }  
}
```

```
public class Stringed extends Instrument {  
    public void play(int note) {  
        System.out.println("Stringed.play()" + n);  
    }  
}
```

接口

- 接口
 - 定义
 - 实现多个接口
 - 扩展接口
 - 接口适配器
 - 应用: 工厂模式

接口

- 抽象类
 - 抽象方法
 - 普通方法

```
abstract class Instrument {  
    public abstract void play(int note) ;  
    public String what() {return "Instrument";}   
}
```

接口

- 接口(Interface)

- “所有方法都是抽象方法”
- 只有方法的名称, 参数和返回值
- 没有方法的实现

```
abstract class Instrument {  
    public abstract void play(int note);  
    public abstract String what();  
}
```

≈

```
interface Instrument {  
    void play(int note) ;  
    String what();  
}
```

接口

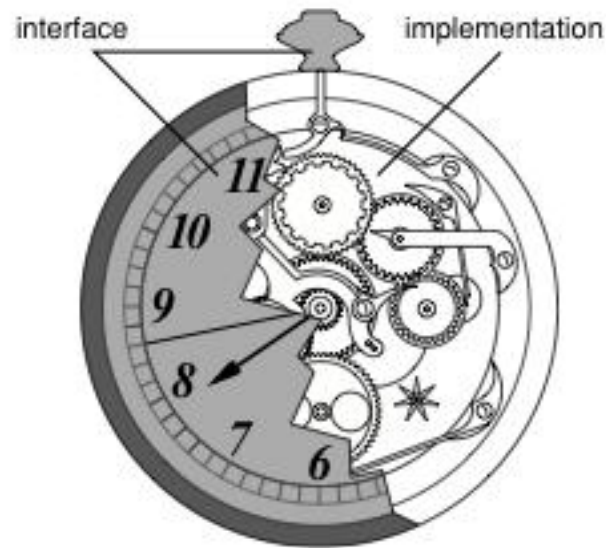
- 继承
 - 重用(class reusing)
 - 子类重用父类的方法/数据
 - upcasting和多态
 - 父类出现之处可用子类代替
 - 能够调用正确的子类方法(动态绑定)
- 接口
 - 没有代码重用, 仅仅保留upcasting和多态

接口

- 接口
 - 所有实现该接口的类都具有接口提供的方法
 - 任何使用该接口类型的方法, 都可以使用他的任何一种实现
 - 某种协议(protocol)

接口

- 接口的实现
 - 接口: 方法长什么样?
 - 实现: 方法具体怎样工作?



接口

- 接口的实现

```
abstract class Instrument {  
    public abstract void play(int note);  
    public abstract String what();  
}
```

```
class Stringed extends Instrument {  
    public void play(int note) {  
        System.out.println("Stringed.play()" + n);  
    }  
    public String what() {return "Stringed";}  
}
```

继承:

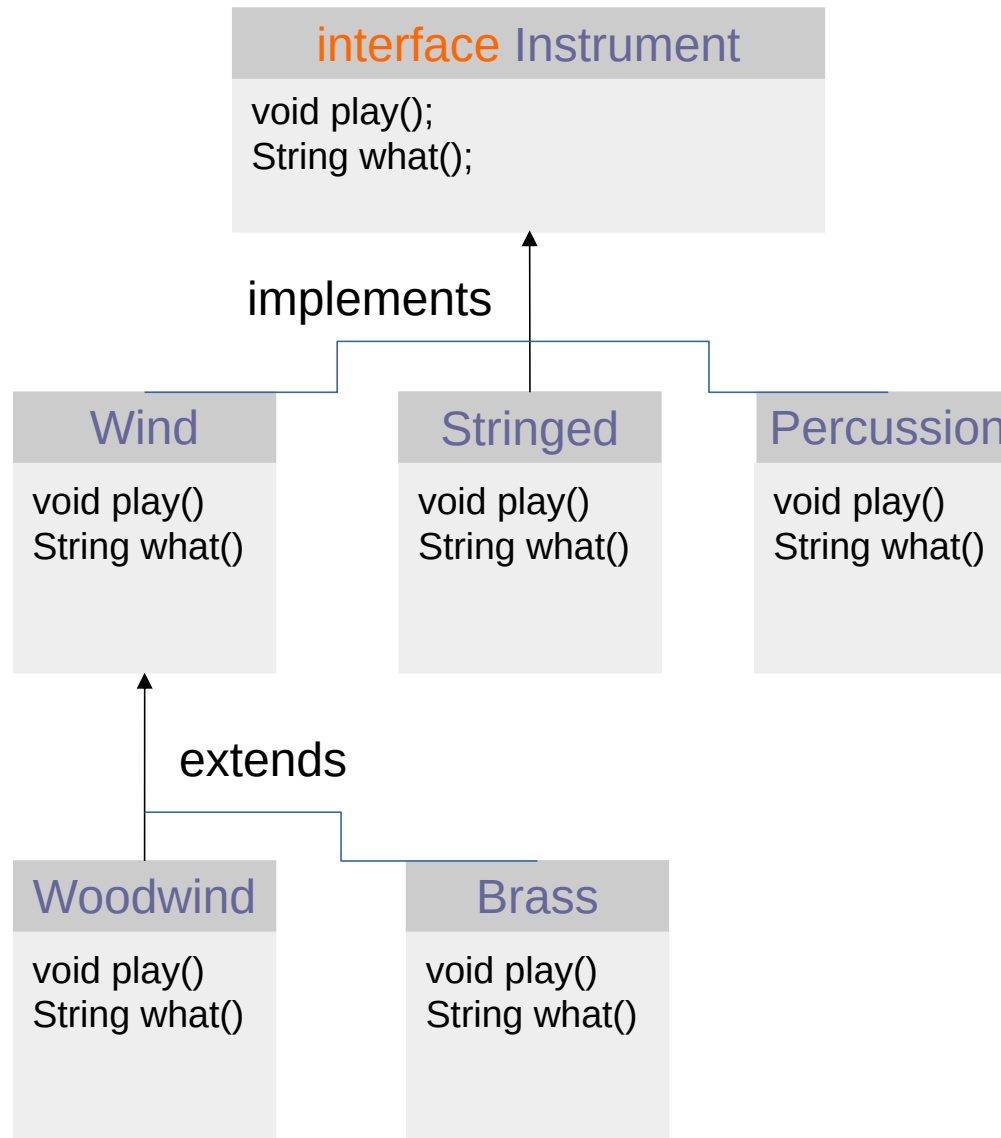
1. extends关键字
2. 父类,子类关系
3. class, extends

```
interface Instrument {  
    void play(int note) ;  
    String what();  
}
```

```
class Stringed implements Instrument {  
    public void play(int note) {  
        System.out.println("Stringed.play()" + n);  
    }  
    public String what() {return "Stringed";}  
}
```

接口:

1. implements关键字
2. 接口, 实现关系
3. interface, implements



```
interface class Instrument {  
    void play(int note) ;  
    String what();  
}
```

```
class Stringed implements Instrument {  
    public void play(int note) {  
        System.out.println("Stringed.play()" + n);  
    }  
    public String what() {return "Stringed";}  
}
```

```
class Percussion implements Instrument {  
    public void play(int note) {  
        System.out.println("Percussion.play()" + n);  
    }  
    public String what() {return "Percussion";}  
}
```

```
class Wind implements Instrument {  
    public void play(int note) {  
        System.out.println("Wind.play()" + n);  
    }  
    public String what() {return "Wind";}  
}
```

```
public class Music {  
    public static void tune(Instrument i) {  
        i.play();  
    }  
    public static void main(String []args){  
        Wind flute = new Wind();  
        Stringed violin = new Stringed();  
        Brass frenchHorn = new Brass();  
        tune(flute);  
        tune(violin);  
        tune(frenchHorn);  
    }  
}
```

```
class Woodwind extends Wind {  
    public void play(int note) {  
        System.out.println("Woodwind.play()" + n);  
    }  
    public String what() {return "Woodwind";}  
}
```

```
class Brass extends Wind {  
    public void play(int note) {  
        System.out.println("Brass.play()" + n);  
    }  
    public String what() {return "Brass";}  
}
```

- 普通类, 抽象类, 接口

接口

- 接口
 - 所有方法默认为public

```
interface Instrument {  
    void play(int note) ;  
    String what();  
}
```

```
interface Instrument {  
    public void play(int note) ;  
    public String what();  
}
```

接口

- 接口
 - 所有数据默认为final static
 - 定义常量

```
interface Week {  
    int MONDAY = 1;  
    int TUESDAY = 2;  
    int WEDNESDAY = 3;  
    int THURSDAY = 4;  
    int FRIDAY = 5;  
    int SATURDAY = 6;  
    int SUNDAY = 7;  
}
```

```
class Week {  
    public static final int MONDAY = 1;  
    public static final int TUESDAY = 2;  
    public static final int WEDNESDAY = 3;  
    public static final int THURSDAY = 4;  
    public static final int FRIDAY = 5;  
    public static final int SATURDAY = 6;  
    public static final int SUNDAY = 7;  
}
```

- 复习

- 抽象类

- 抽象类包含抽象方法, 只有方法名, 参数, 返回值, 没有方法的实现
 - 抽象类不能实例化
 - 若子类没有重写父类中的抽象方法, 子类仍为抽象类

```
abstract class Instrument {  
    public abstract void play(int note) ;  
}
```

```
public class Wind extends Instrument {  
    public void play(int note) {  
        System.out.println("Wind.play()" + n);  
    }  
}
```

```
public class Stringed extends Instrument {  
    public void play(int note) {  
        System.out.println("Stringed.play()" + n);  
    }  
}
```

- 复习： 接口
 - “所有方法都是抽象方法”
 - 只有方法的名称, 参数和返回值
 - 没有方法的实现

```
abstract class Instrument {  
    public abstract void play(int note);  
    public abstract String what();  
}
```

```
class Stringed extends Instrument {  
    public void play(int note) {  
        System.out.println("Stringed.play()" + n);  
    }  
    public String what() {return "Stringed";}  
}
```

继承:

1. extends关键字
2. 父类, 子类关系
3. class, extends

```
interface Instrument {  
    void play(int note) ;  
    String what();  
}
```

```
class Stringed implements Instrument {  
    public void play(int note) {  
        System.out.println("Stringed.play()" + n);  
    }  
    public String what() {return "Stringed";}  
}
```

接口:

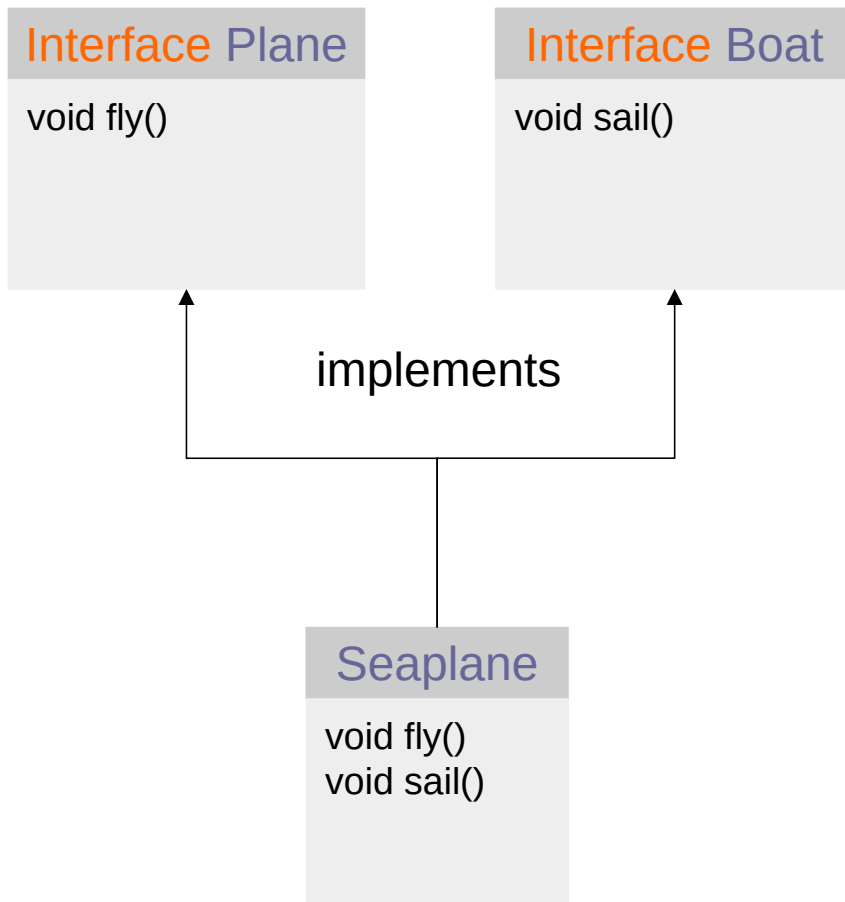
1. implements关键字
2. 接口, 实现关系
3. interface, implements

接口

- 接口
 - 定义
 - 实现多个接口
 - 扩展接口
 - 接口适配器
 - 应用: 工厂模式

接口

- 一个类实现多个接口



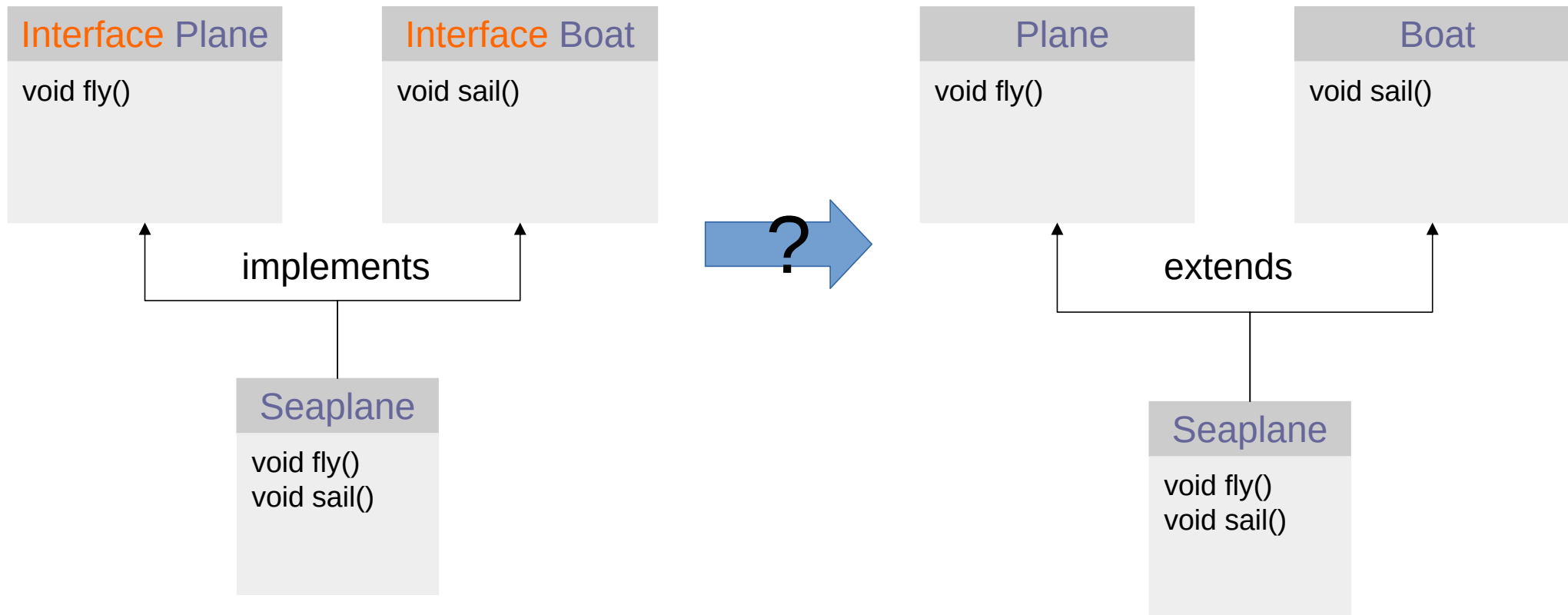
接口

- 一个类实现多接口

```
interface Plane {  
    void fly();  
}  
interface Boat {  
    void sail();  
}  
  
class Seaplane implements Plane, Boat {  
    public void fly(){  
        System.out.println("Fly!");  
    }  
    public void sail(){  
        System.out.println("Sail!");  
    }  
}
```

接口

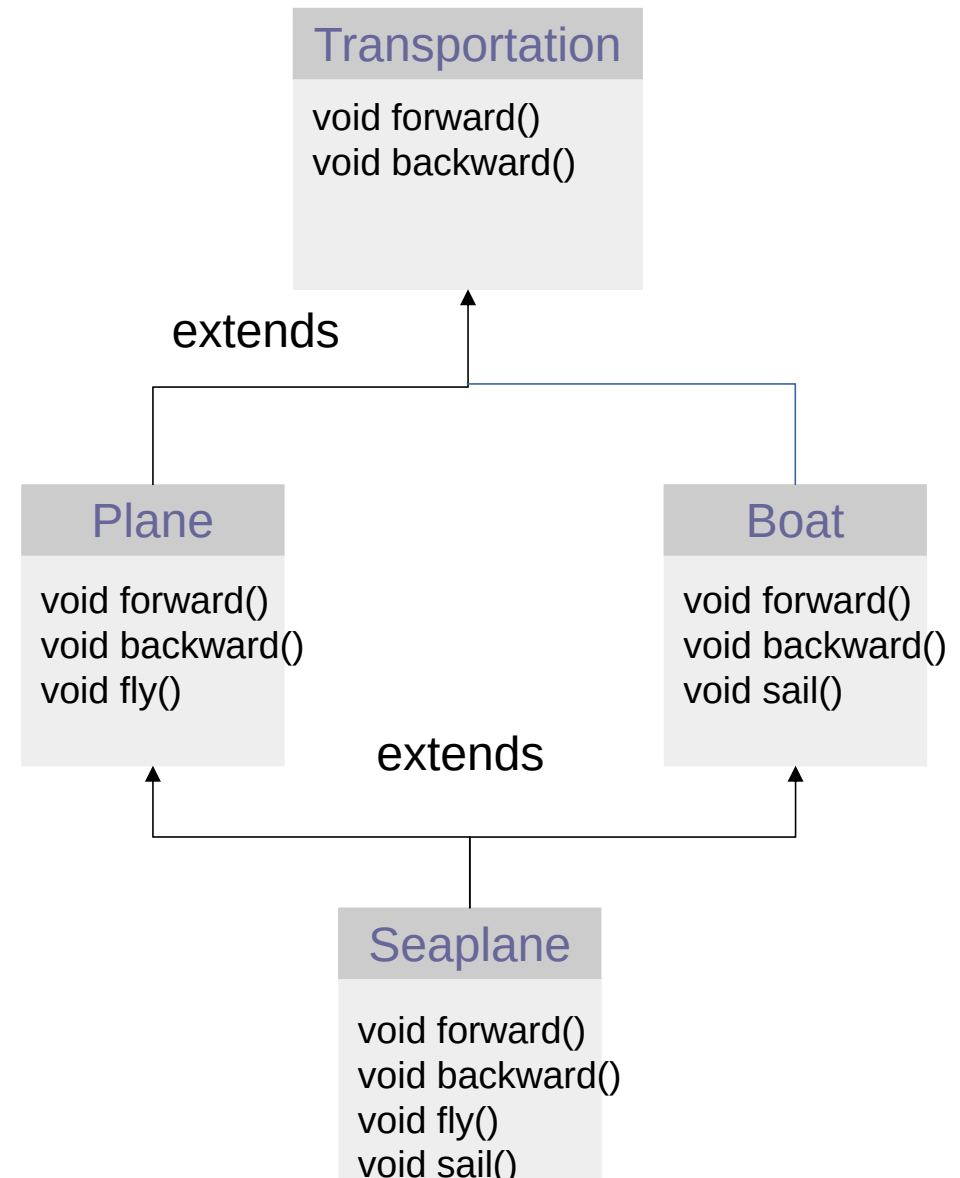
- 问题:
 - 如果将接口替换成普通类会如何?



接口

- 多继承问题
 - Diamond problem

```
Seaplane s = new Seaplane();  
// s.forward() which one?
```

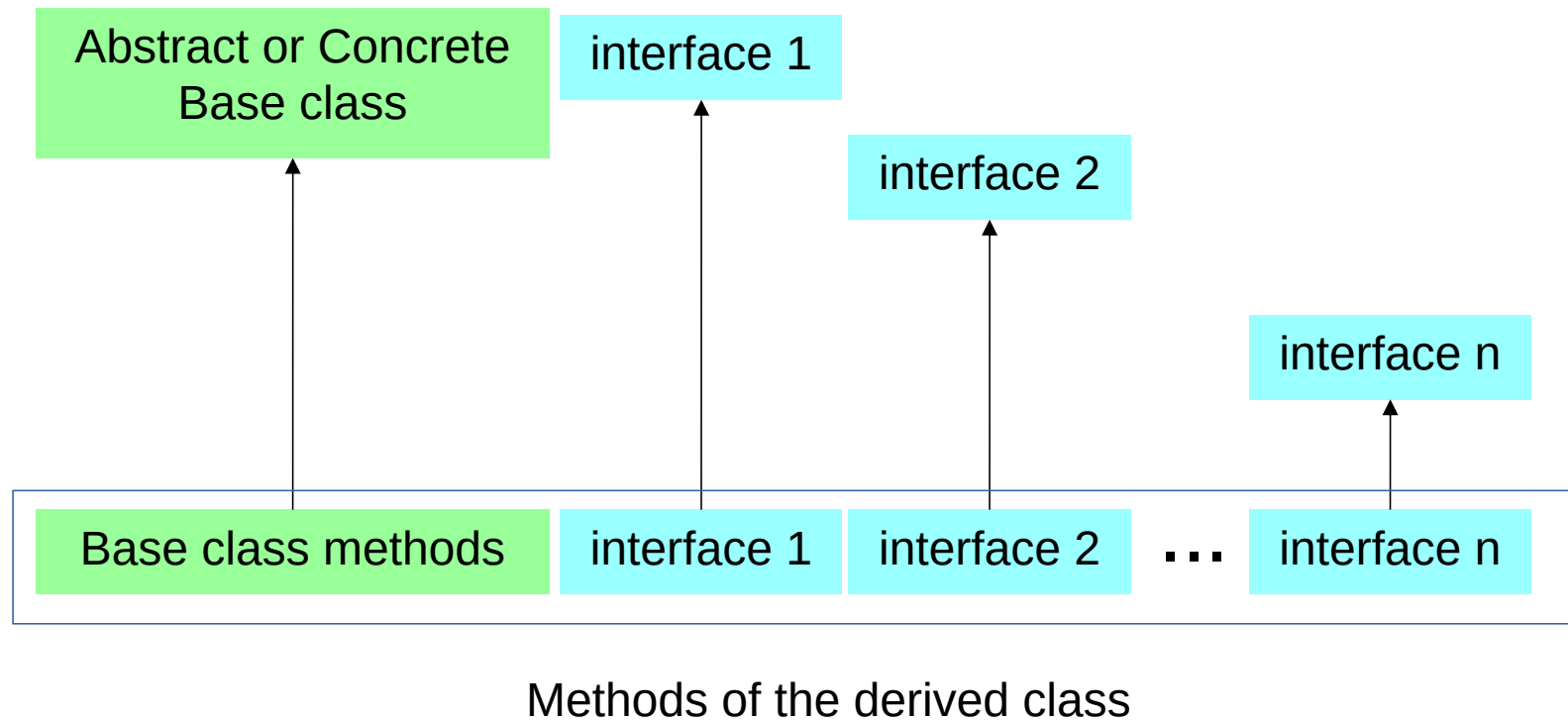


接口

- 多继承问题
 - 父类只能有一个普通类/抽象类

```
class A {  
    ...  
}  
class B {  
    ...  
}  
  
/* error  
class C extends A, B {  
    ...  
}  
*/
```

接口



```
interface CanFight {  
    void fight();  
}
```

```
interface CanSwim {  
    void swim();  
}
```

```
interface CanFly {  
    void fly();  
}
```

```
class ActionCharacter {  
    public void fight() {  
        System.out.println("fighting");  
    }  
}
```

```
class Hero extends ActionCharacter  
    implements CanFight, CanSwim, CanFly{  
    public void fly() { }  
    public void swim() { }  
}
```

```
public class Adventure {  
    public static void t(CanFight x) { x.fight();}  
    public static void u(CanSwim x) { x.swim();}  
    public static void v(CanFly x) { x.fly();}  
    public static void w(ActionCharacter x) { x.fight();}  
    public static void main(String []args) {  
        Hero h = new Hero();  
        t(h); u(h); v(h); w(h);  
    }  
}
```

1. 实现多个接口可以upcast 到不同的类型
- fight() ?
2. abstract class or interface?

接口

- 实现多个接口
 - 名字冲突

```
interface I1 {  
    void f();  
}
```

```
interface I2 {  
    void f();  
}
```

```
interface I3 {  
    void f(int i);  
}
```

```
interface I4 {  
    int f();  
}
```

```
class C1 implements I1, I2 {  
    public void f() {}  
}
```

```
class C2 implements I1, I3 {  
    public void f() {}  
    public void f(int i) {}  
}
```

```
/* compile error: return type incompatible  
class C2 implements I1, I4 {  
    public void f() {}  
}  
*/
```

接口

- 接口
 - 定义
 - 实现多个接口
 - 扩展接口
 - 接口适配器
 - 应用: 工厂模式

接口

- 扩展接口

```
interface A {  
    ...  
}  
interface B extends A {  
    ...  
}  
  
interface D {  
    ...  
}  
interface D extends A, C {  
    ...  
}
```

```
interface Monster {  
    void menace();  
}
```

```
interface DangerousMonster extends Monster{  
    void destroy();  
}
```

```
class DragonZilla implements DangerousMonster{  
    public void menace() {}  
    public void destroy() {}  
}
```



```
interface Lethal {  
    void kill();  
}
```

```
interface Vampire extends DangerousMonster, Lethal{  
    void drinkblood();  
}
```

```
class VeryBadVampire implements Vampire{  
    public void menace() {}  
    public void destroy() {}  
    public void kill() {}  
    public void drinkblood() {}  
}
```



```
public class HorrorShow {  
    public static void u(Monster x) { x.menace();}  
    public static void v(DangerousMonster x) {  
        x.menace();  
        x.destroy();  
    }  
    public static void w(Lethal x) { x.kill();}  
    public static void main(String []args) {  
        DangerousMonster m = DangerousZilla();  
        u(m); v(m);  
        Vampire a = VeryBadVampire();  
        u(a); v(a); w(a);  
    }  
}
```

接口

- 接口
 - 定义
 - 实现多个接口
 - 扩展接口
 - 接口适配器
 - 应用: 工厂模式

接口

- 接口适配器(Adapter)
 - 方法f, 参数类型为Interface1
 - 假设类A已存在, 它没有实现Interface1接口
 - 希望方法f()能处理类A的对象
 - 复用方法f()的代码

```
interface CanFly {  
    void fly();  
}
```

```
class Bird implements CanFly{  
    public void fly() { }  
}
```

```
class Insect implements CanFly{  
    public void fly() { }  
}
```

```
class Person {  
    public void walk(){  
    public void buyTicket(){  
    public void takeFlight(){  
}
```

..

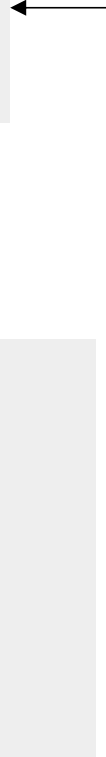
```
class Adventure {  
    public static void travel(CanFly c) {  
        c.fly();  
    }  
    public static void main(String []args){  
        Bird b = new Bird();  
        Insect ins = new Insect();  
        travel(b); travel(ins);  
    }  
}
```

```
interface CanFly {  
    void fly();  
}
```

```
class Person {  
    public void walk(){}  
    public void buyTicket(){}  
    public void takeFlight(){}  
}
```

```
class Adventure {  
    public static void travel(CanFly c) {  
        c.fly();  
    }  
    public static void main(String []args){  
        Bird b = new Bird();  
        Insect ins = new Insect();  
        travel(b); travel(ins);  
  
        Person p = new Person();  
        PersonAdapter pd = new PersonAdapter(p);  
        travel(pd);  
    }  
}
```

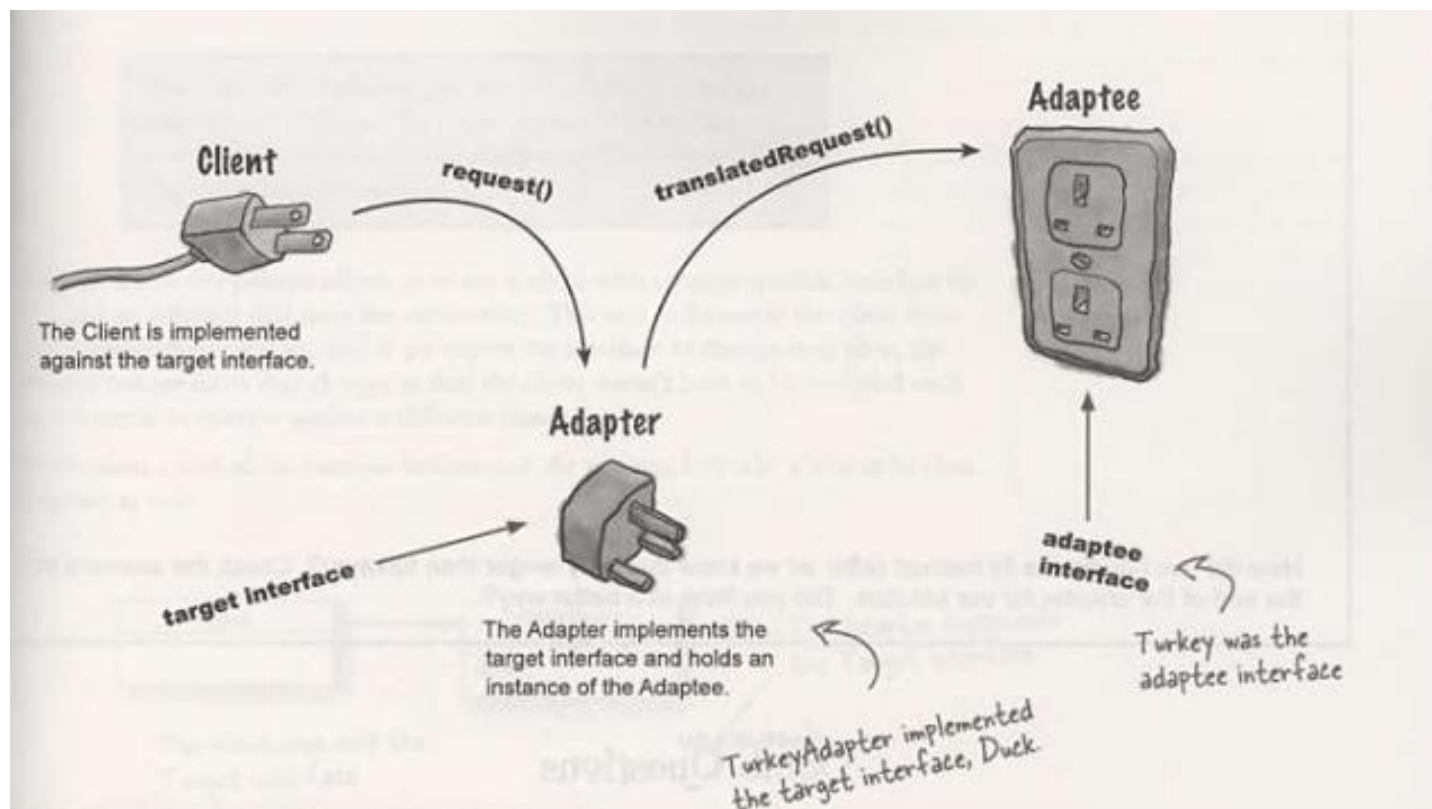
```
class PersonAdapter implements CanFly{  
    private Person p;  
    public PersonAdapter(Person p){  
        this.p = p;  
    }  
    public void fly(){  
        p.buyTicket();  
        p.takeFlight();  
    }  
}
```



接口

- 接口适配器

- 通过增加一个接口的实现, 使得现有类能够被“适配”到该接口



接口

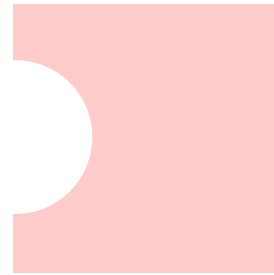
- 接口适配器



Existing class
(Person)



Adapter
(PersonAdapter)



Existing interface
(CanFly)

接口

- 接口
 - 定义
 - 实现多个接口
 - 扩展接口
 - 接口适配器
 - 应用: 工厂模式

接口

- 应用: 工厂模式
 - 更灵活的构造对象方式

```
interface Service {  
    void method1();  
    void method2();  
}
```

```
class Impl1 implements Service {  
    public void method1() {  
        System.out.println("Impl1.method1");  
    }  
    public void method2() {  
        System.out.println("Impl1.method2");  
    }  
}
```

```
class Impl2 implements Service {  
    public void method1() {  
        System.out.println("Impl2.method1");  
    }  
    public void method2() {  
        System.out.println("Impl2.method2");  
    }  
}
```

```
public class TestService {  
    public static void consume(Service s) {  
        s.method1();  
        s.method2();  
    }  
    public static void main(String []args){  
        Service s1 = new Impl1();  
        Service s2 = new Impl2();  
        consume(s1);  
        consume(s2);  
    }  
}
```

当构造对象/初始化比较繁琐时，
可以增加一层包装

```
interface Service {  
    void method1();  
    void method2();  
}
```

```
class Impl1 implements Service {  
    public void method1() {  
        System.out.println("Impl1.method1");  
    }  
    public void method2() {  
        System.out.println("Impl1.method2");  
    }  
}
```

```
class Impl2 implements Service {  
    public void method1() {  
        System.out.println("Impl2.method1");  
    }  
    public void method2() {  
        System.out.println("Impl2.method2");  
    }  
}
```

```
interface ServiceFactory {  
    Service getService();  
}
```

```
class Impl1Factory implements ServiceFactory {  
    public Service getService() {  
        return new Impl1();  
    }  
}
```

```
class Impl2Factory implements ServiceFactory {  
    public Service getService() {  
        return new Impl2();  
    }  
}
```

```
public class TestService {  
    public static void consume(ServiceFactory sf) {  
        Service s = sf.getService();  
        s.method1(); s.method2();  
    }  
    public static void main(String []args){  
        ServiceFactory sf1 = new Impl1Factory();  
        ServiceFactory sf2 = new Impl2Factory();  
        consume(sf1);  
        consume(sf2);  
    }  
}
```

总结

- 抽象类
 - 抽象方法: 只给出方法的名字, 参数, 返回值, 没有具体实现
 - 抽象类: 包含抽象方法的类
 - **abstract** 关键字
- 接口
 - “所有的方法都是抽象方法”
 - **interface, implements** 关键字
 - 接口的扩展: **extends**
 - 实现多个接口
 - 接口适配器

- Google v.s. Oracle on Java

- API or Implementation
- Fair use
- 9 lines rangeCheck
- <https://www.huxiu.com/article/419798.html>