OOP with Java

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OOP with Java

- 通知
  - Project 5: 5 月 26 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)

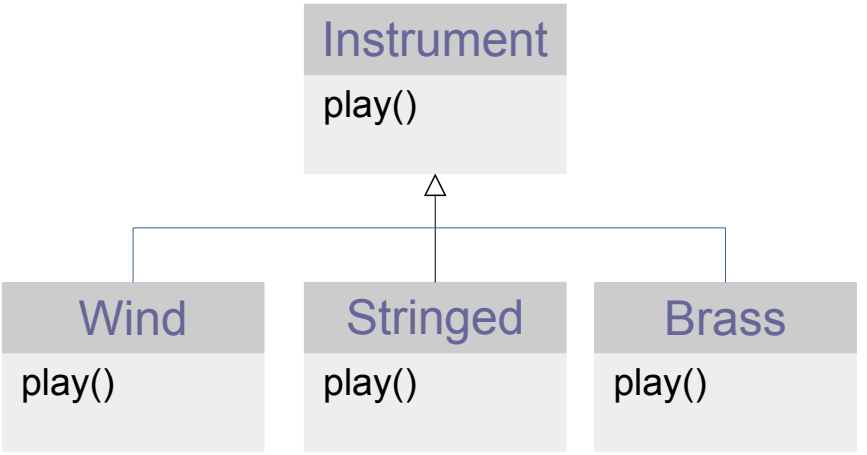
- 复习
  - 静态绑定
    - 函数的调用在编译后便确定，也称为 early binding
    - 优点：快速，易于 debug，缺点：接口繁琐
  - 动态绑定
    - 函数的调用在运行时才能确定 也称 late binding
    - 优点：接口简洁 缺点：函数调用需要额外开销
  - Java 中的所有方法都采用动态绑定，除了
    - final
    - Static
  - 数据成员不动态绑定

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

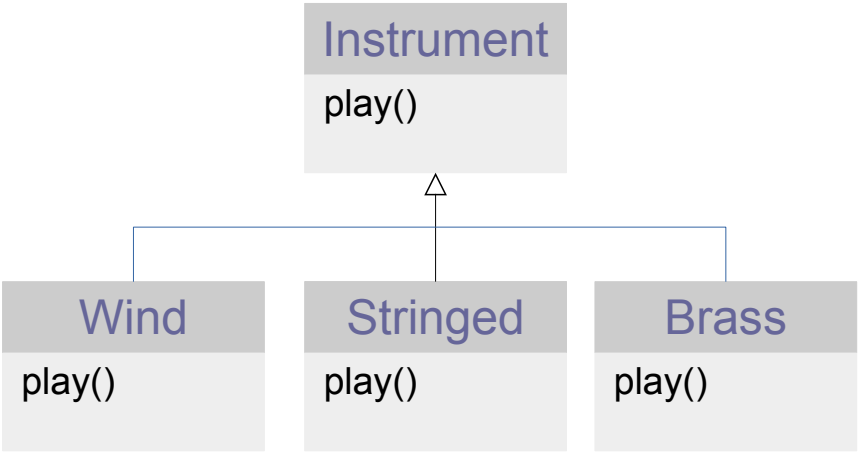
- 父类的方法
  - Instrument: play()
- 子类重写父类的方法
  - Wind: play()
  - Stringed: play()
  - Brass: play()
- 可扩展性
  - 用户程序仅知父类方法
  - 子类修改不会影响用户程序




```
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

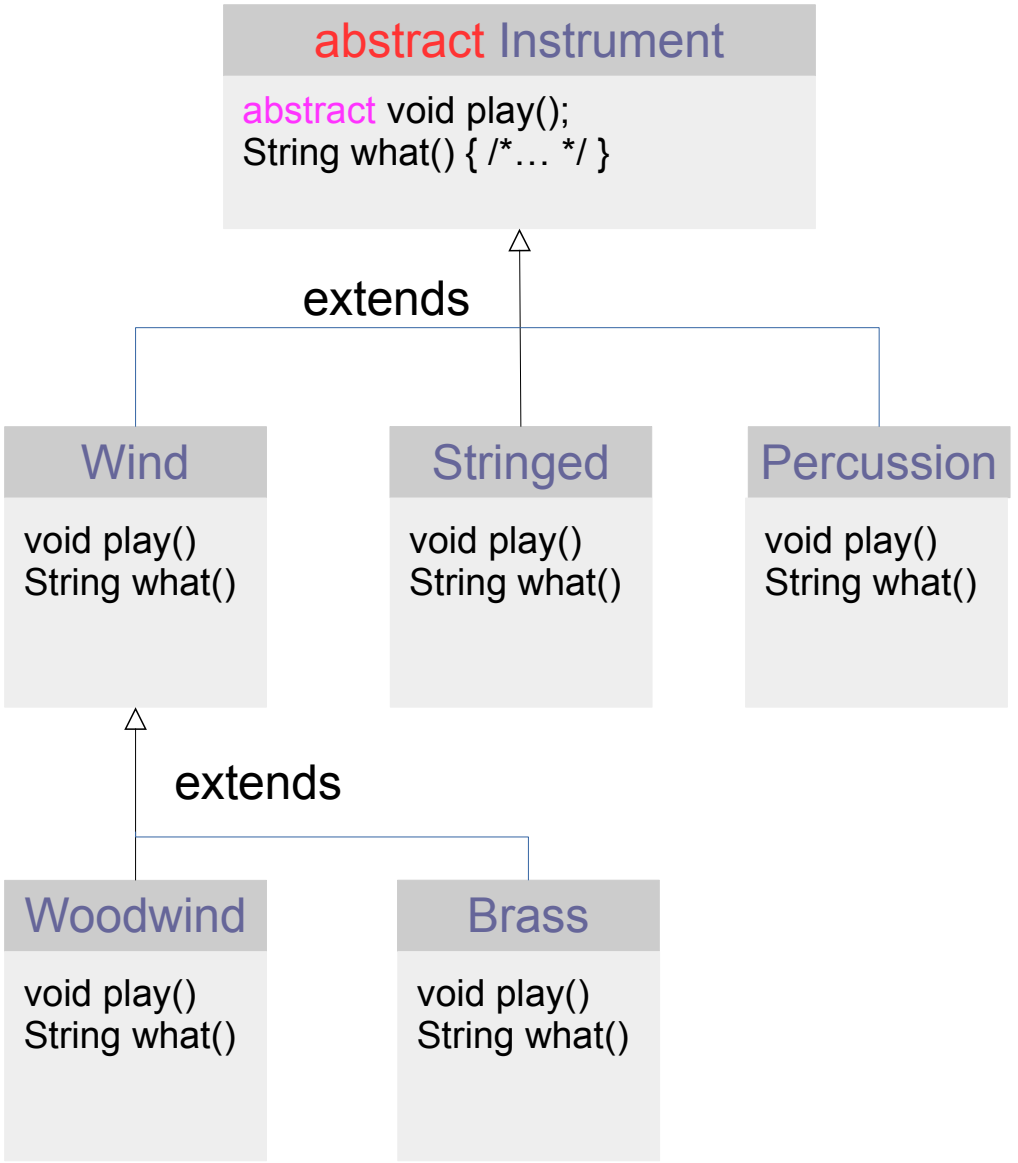
抽象类

- 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 Instrument
abstract void play();
String what() { /*… */ }
extends
Wind
void play()
String what()
Stringed
void play()
String what()
Percussion
void play()
String what()
extends
Woodwind
void play()
String what()
Brass
void play()
String what()

```
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

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

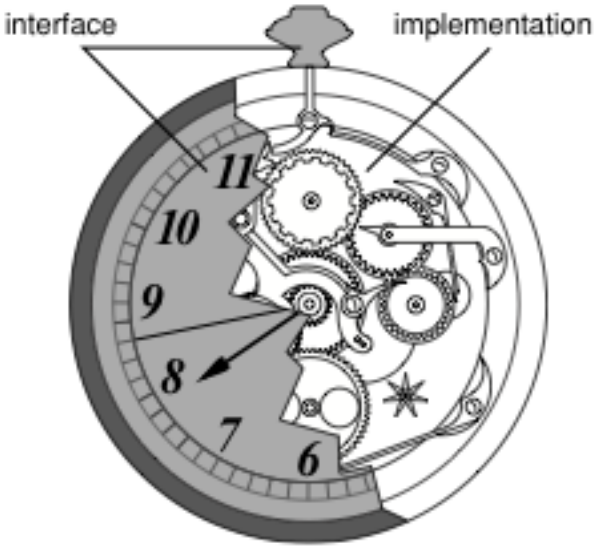
- 继承
  - 重用 (class reusing)
    - 子类重用父类的方法 / 数据
  - upcasting 和多态
    - 父类出现之处可用子类代替
    - 能够调用正确的子类方法 (动态绑定)
- 接口
  - 没有代码重用，仅仅保留 upcasting 和多态

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();
}
```

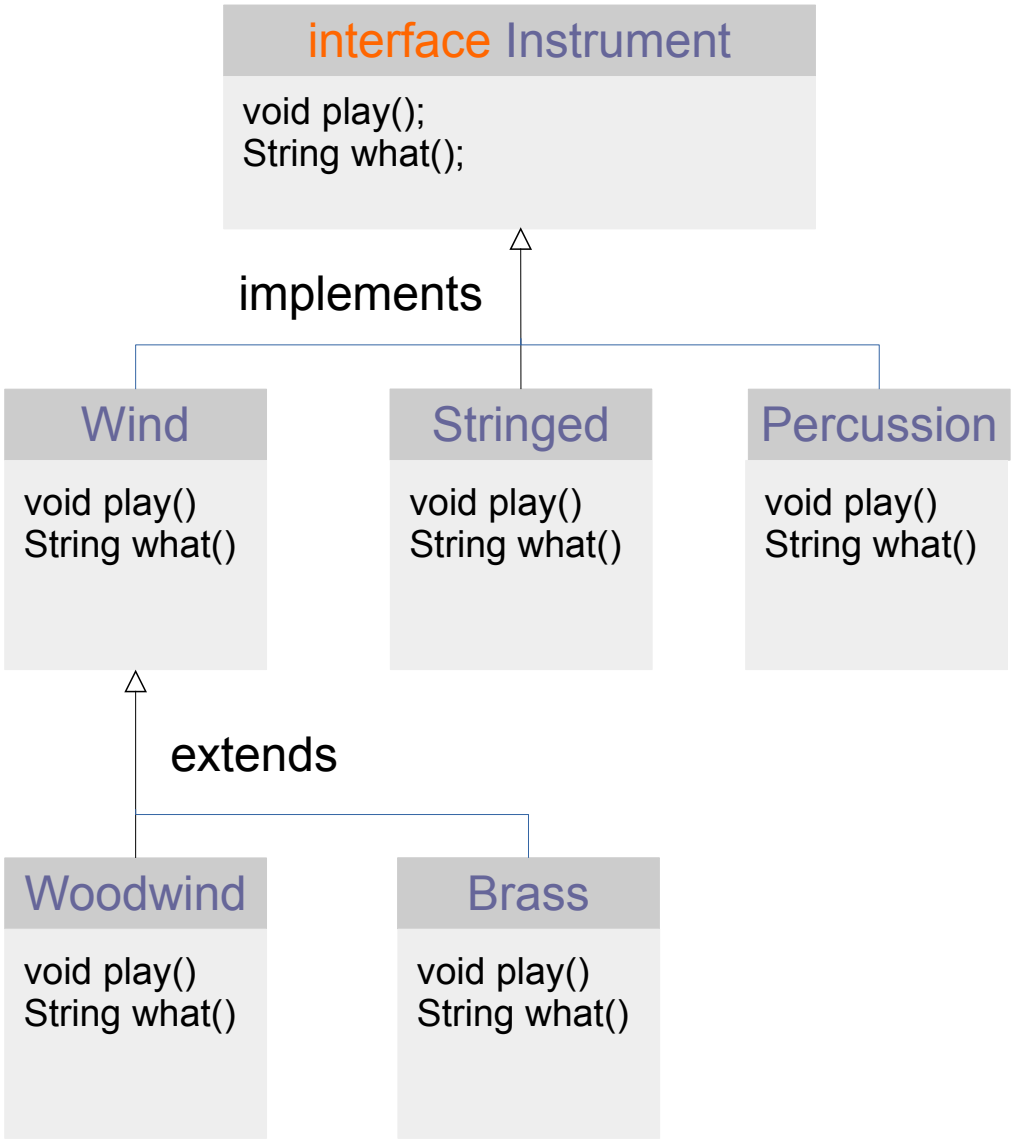
```
class Stringed extends Instrument {
    public void play(int note) {
        System.out.println(“Stringed.play()” + n);
    }
   public String what() {return “Stringed”;}
}
```

```
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”;}
}
```

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

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


interface Instrument
void play();
String what();
implements
Wind
void play()
String what()
Stringed
void play()
String what()
Percussion
void play()
String what()
extends
Woodwind
void play()
String what()
Brass
void play()
String what()

```
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”;}
}
```

- 普通类，抽象类，接口

```
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”;}
}
```

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;
}
```

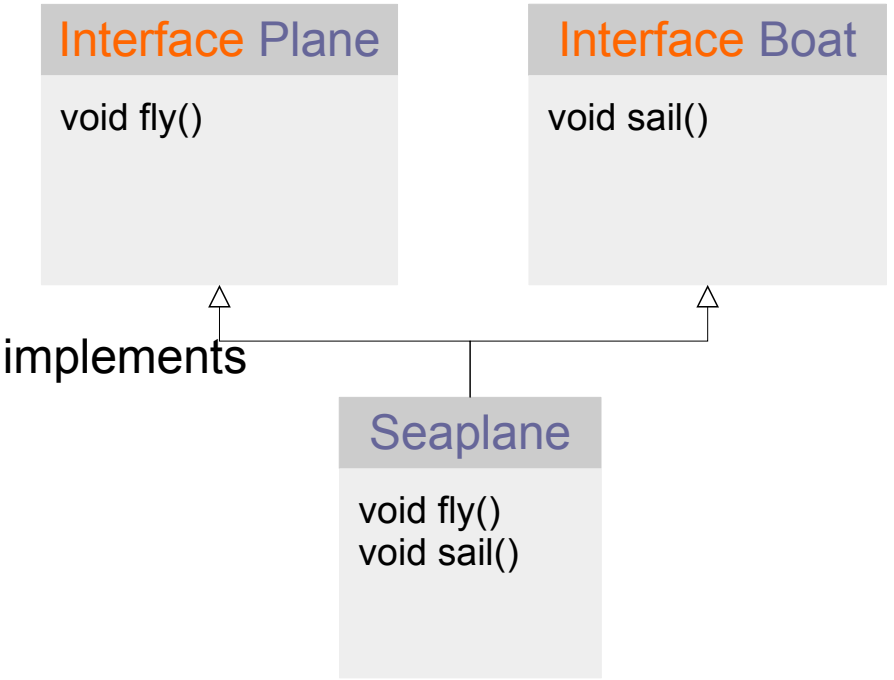
```
class Week {
    public static final int MONDAY = 1;
    public static final int TUESDAY = 2;
    public static final int WEDNESDAY = 3;
    public static final int THURSDAY = 4;
    public static final int FRIDAY = 5;
    public static final int SATURDAY = 6;
    public static final int SUNDAY =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

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

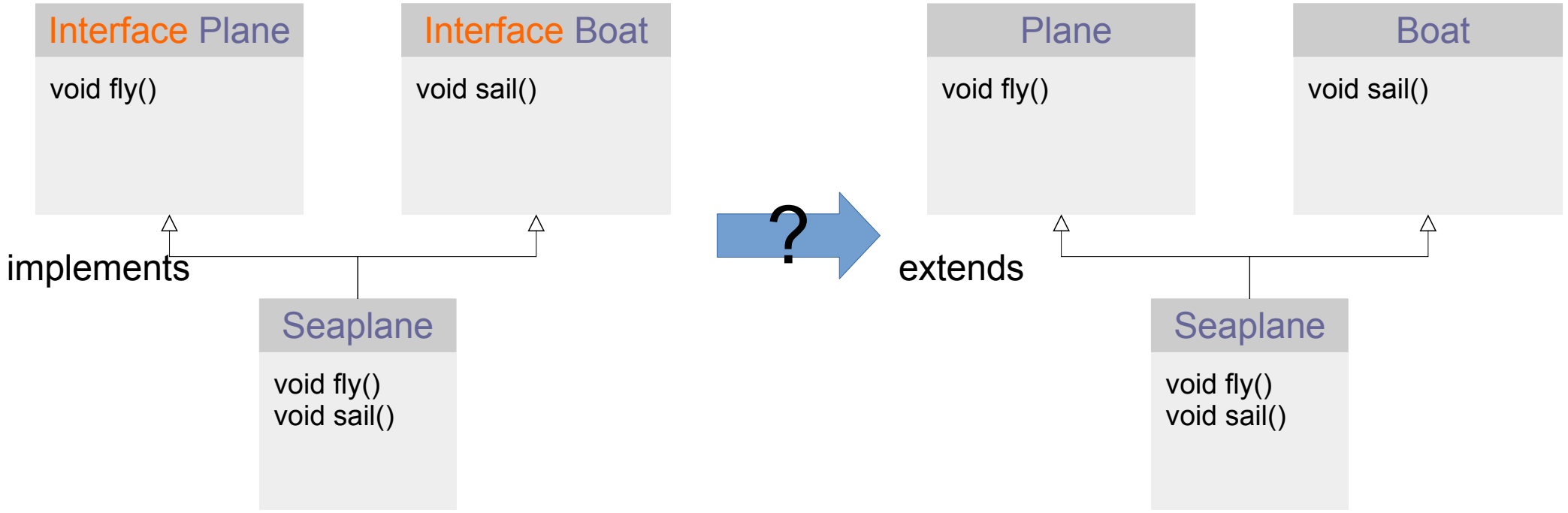
- 一个类实现多接口

```
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

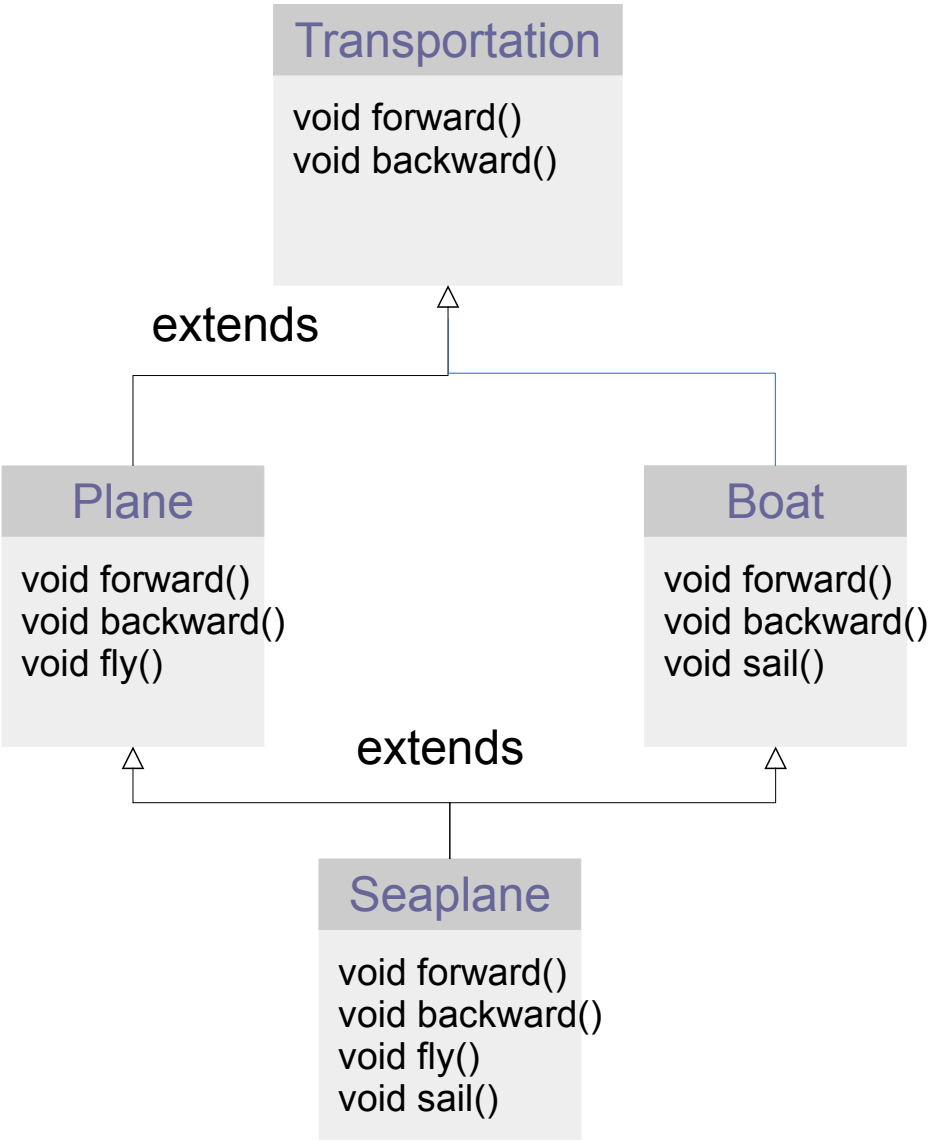
- 问题：
  - 如果将接口替换成普通类会如何？



接口

- 多继承问题
  - Diamond problem

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



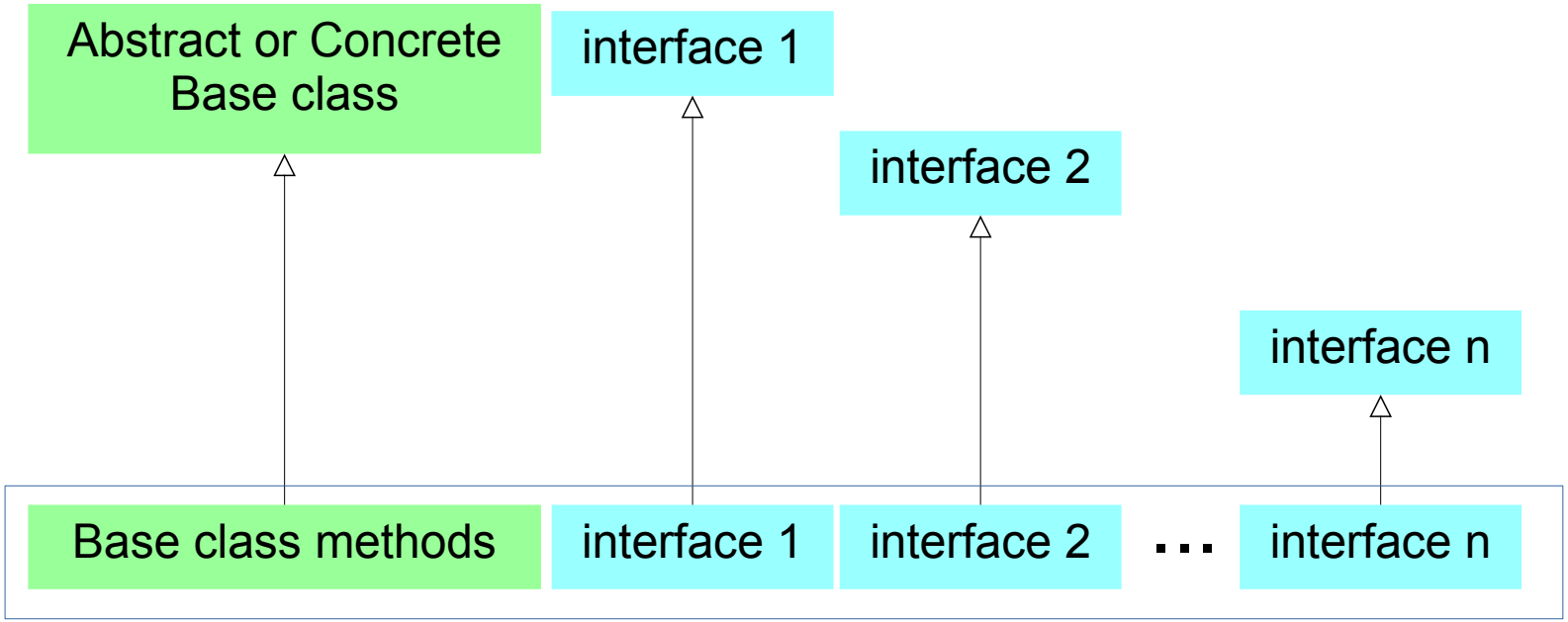
接口

- 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


Abstract or Concrete Base class
interface 1
interface 2
interface n
Base class methods
interface 1
interface 2
...
interface n
Methods of the derived class

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

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

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

```
class ActionCharacter {
    public void fight() { }
}
```

```
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
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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(){}
}
```

?

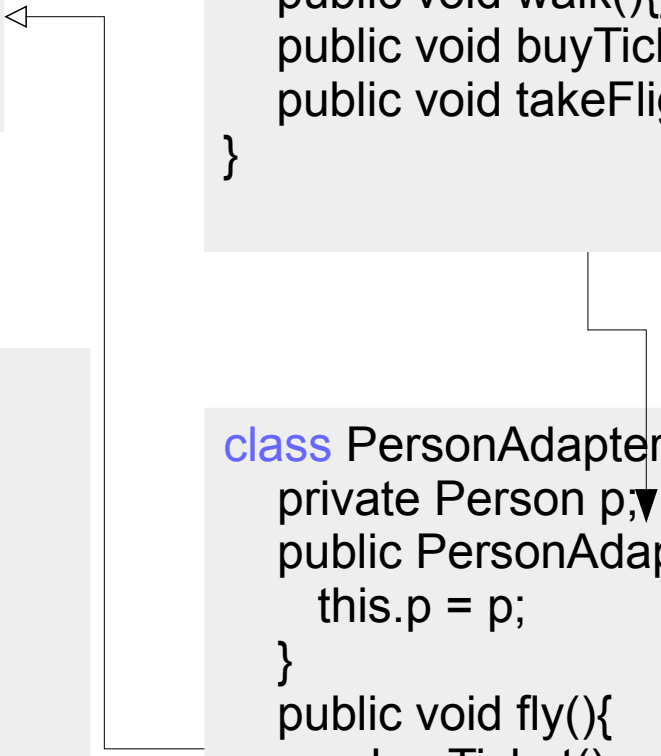
```
class Adventure {
    public static void travel(CanFly c) {
        c.fly();
    }
    public static void main(String []args){
        Bird b = new Bird();
        Insect ins = new Insect();
        travel(b); travel(ins);
    }
}
```

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

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

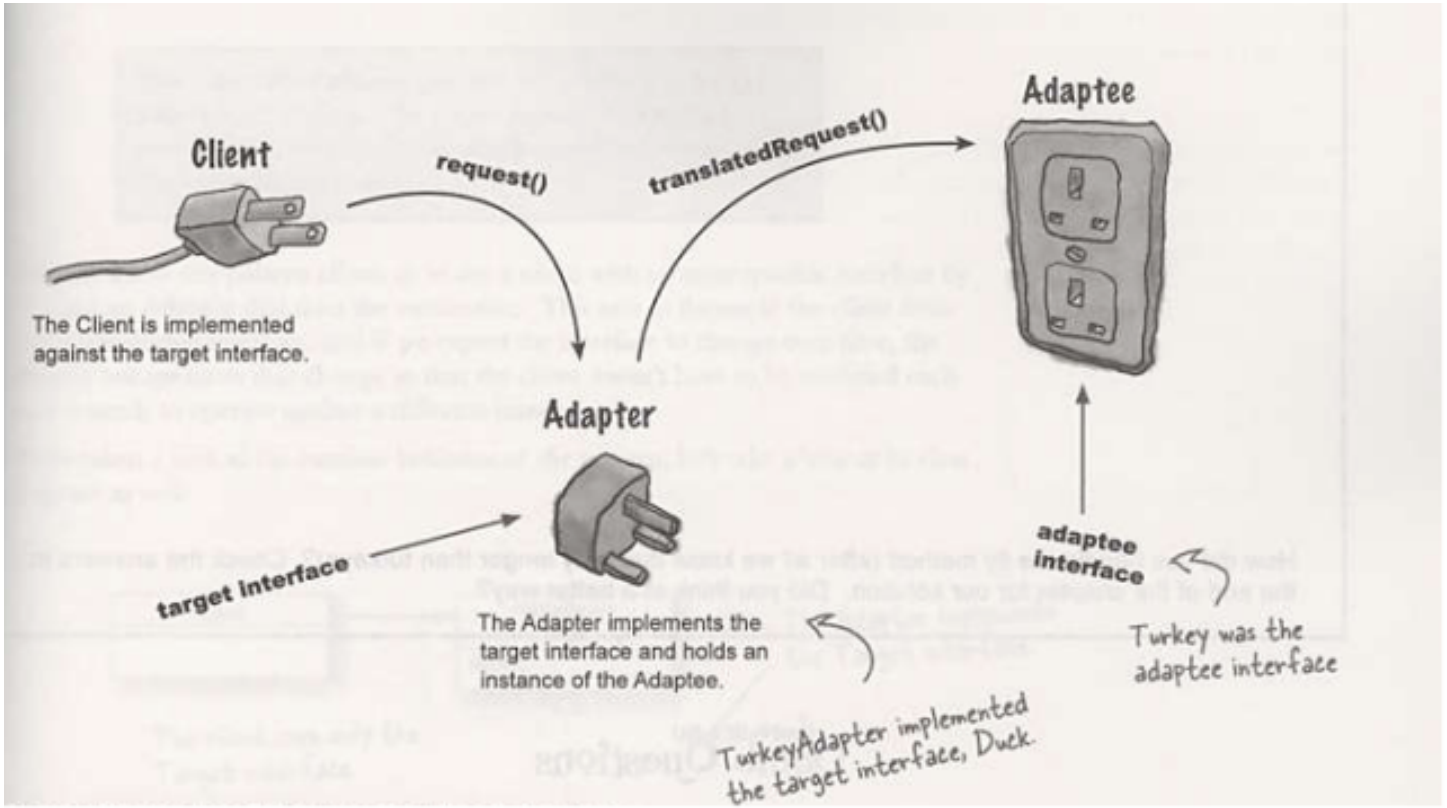
```
class Adventure {
    public static void travel(CanFly c) {
        c.fly();
    }
    public static void main(String []args){
        Bird b = new Bird();
        Insect ins = new Insect();
        travel(b); travel(ins);

        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
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  - 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(“Imp1.method1”);
    }
    public void method2() {
       System.out.println(“Imp1.method2”);
    }
}
```

```
class Impl2 implements Service {
    public void method1() {
       System.out.println(“Imp2.method1”);
    }
    public void method2() {
       System.out.println(“Imp2.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(“Imp1.method1”);
    }
    public void method2() {
       System.out.println(“Imp1.method2”);
    }
}
```

```
class Impl2 implements Service {
    public void method1() {
       System.out.println(“Imp2.method1”);
    }
    public void method2() {
       System.out.println(“Imp2.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, inplements 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

- 9 lines rangeCheck
- Fair use
- API or Implementation