OOP with Java

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OOP with Java

- 通知
  - Project 5: 5 月 9 日晚 9 点

- 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

```
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”;}
}
```

```
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);
    }
}
```

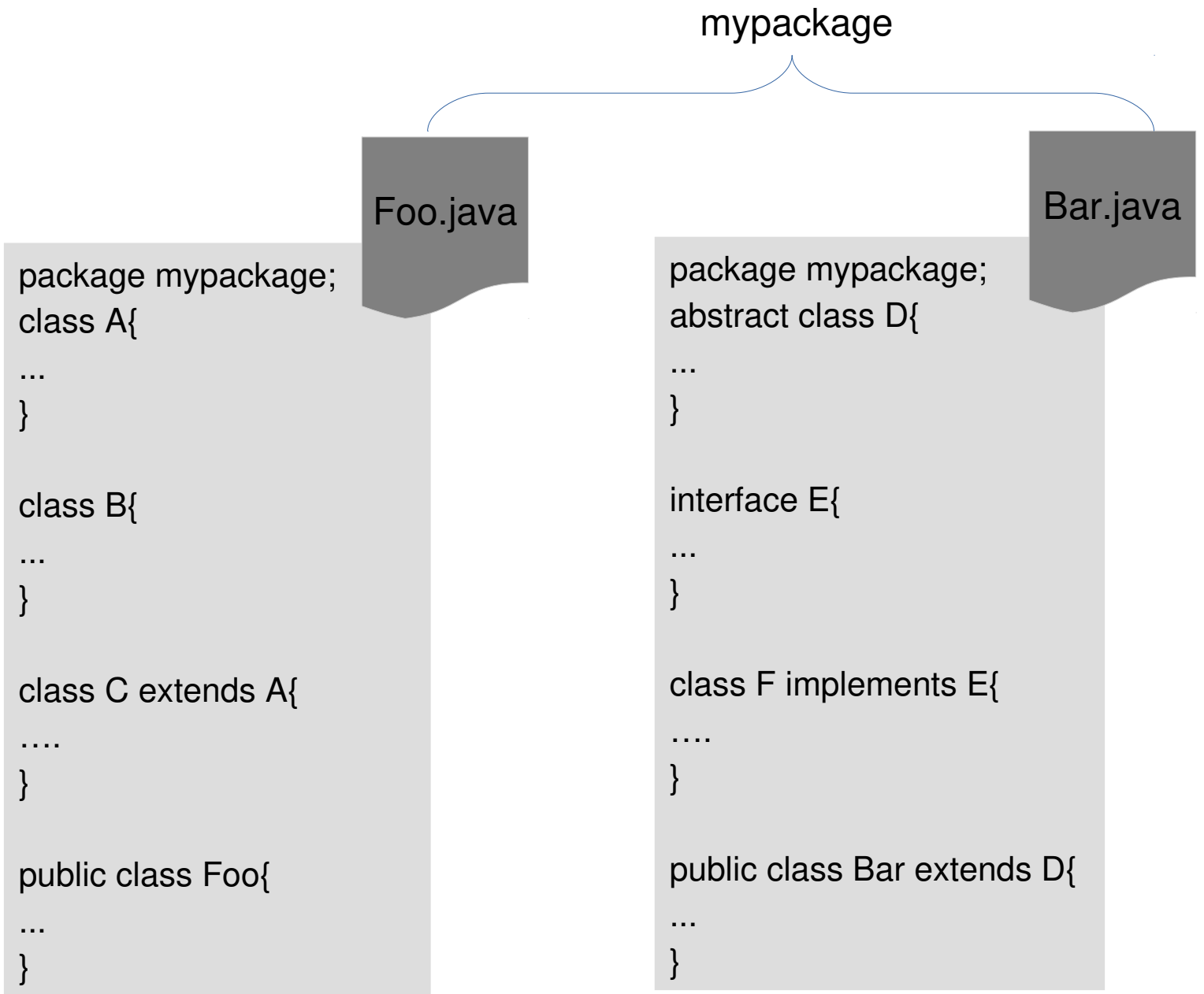
实现多个接口可以 upcast 到不同的类

OOP with Java

- 内部类
  - 普通内部类
  - 匿名内部类
- 嵌套类
- 内部类的作用

内部类

- 类的定义


mypackage
Foo.java
package mypackage;
class A{
...
}
class B{
...
}
class C extends A{
….
}
public class Foo{
...
}
Bar.java
package mypackage;
abstract class D{
...
}
interface E{
...
}
class F implements E{
….
}
public class Bar extends D{
...
}

内部类

- 内部类 (Inner class)
  - 定义在一个类的内部
  - 与组合不同

Inner class

```
class Outer{
    …
    class Inner{
        ...
    }
    ...
}
```

Composition

```
class Outer{
    …
    Inner in = new Inner();
    ...
}
class Inner{
    ….
}
```

```
public class Parcel{
    class Contents{
        private int i = 11;
        public int value() {return i;}
    }
    class Destination{
        private String label;
        Destination(String r) {label = r;}
        String readLabel() { return label;}
    }

    public void ship(String dest){
        Contents c = new Contents();
        Destination d = new Destination(dest);
        System.out.println(d.readLabel());
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        p.ship("Tasmania");
    }
}
```

- 内部类的作用
  - 帮助隐藏实现细节
  - 代码组织
  - ...

```
public class Parcel{
    class Contents{
        private int i = 11;
        public int value() {return i;}
    }
    class Destination{
        private String label;
        Destination(String r) {label = r;}
        String readLabel() { return label;}
    }
    public Destination to(String s){
        return new Destination(s);
    }
    public Contents contents(){
        return new Contents();
    }
    public void ship(String dest){
        Contents c = new Contents();
        Destination d = new Destination(dest);
        System.out.println(d.readLabel());
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Parcel.Destination d = p.to(“Tasmania”);
        Parcel.Contents c = p.contents();
    }
}
```

- 返回内部类的引用
- OutClassName.InnerClassName

内部类

- 内部类与外部类的关系
  - 内部类的对象隐含了一个引用，指向包含它的外部类对象
  - 内部类对象能够访问该外部对象的所有成员 / 方法
    - public, private, protected

```
public class Sequence
    private Object[] items;
    private int next = 0;
    public Sequence (int size) {items = new Object[size];}
    public void add(Object x){
        if (next < items.length)
            items[next++] = x;
    }
    private class SequenceSelector implements Selector{
        private int i = 0;
        public boolean end() {return i == items.length;}
        public Object current () {return items[i];}
        public void next() { if(i < items.length) i++; }
    }
    public Selector selector(){
        return new SequenceSelector(s);
    }
    public static void main(String []args){
        Sequence seq = new Sequence(10);
        for (int i = 0; i < 10; ++i)
            seq.add(Integer.toString(i));
        Selector s = seq.selector();
        while(!s.end()) {
            System.out.println(s.current() + " ");
            s.next();
        }
    }
}
```

```
interface Selector{
    boolean end();
    Object current();
    void next();
}
```

1. Sequence 类包含内部类 SequenceSelector
2. 内部类实现接口 Selector
3. 内部类能访问 Sequence 的 private 成员
4. 内部类为 private
5. 内部类的对象隐藏包含一个外部类对象的引用
   - 多数情况下由编译器自动完成

6. 复习 : upcasting: Object / selector()
7. 复习： 还有哪些地方出现通过隐藏引用？

内部类

- 内部类和外部类的关系
  - 内部类的对象隐含了一个引用，指向包含它的外部类对象
  - 如何在内部类中访问外部类对象的引用？
    - OuterClassName.this
  - 如何创建内部类的对象
    - 在外部类的方法中： 直接创建
    - 其他地方 : OuterClassObject.new

内部类

- 如何在内部类中访问外部类对象的引用？
  - OuterClassName.this

```
public class Outer{
    void f() { System.out.println("Outer.f()");}
    class Inner{
        public Outer g() {return Ourter.this;}
    }
    public Inner inner() { return new Inner(); }

    public static void main(String []args){
        Outer o = new Outer();
        Outer.Inner i = o.inner();
        i.g().f();
    }
}
```

内部类

- 如何创建内部类的对象
  - 在外部类的方法中：直接创建

```
public class Outer{
    void f() { System.out.println("Outer.f()");}
    class Inner{
        public Outer g() {return Ourter.this;}
    }
    public Inner inner() { return new Inner(); }

    public static void main(String []args){
        Outer o = new Outer();
        Outer.Inner i = o.inner();
        i.g().f();
    }
}
```

内部类

- 如何创建内部类的对象
  - 其他地方：OuterClassObject.new
    - 内部类的对象隐含了一个引用，指向包含它的外部类对象
    - 创建内部类对象前，需要有包含它的外部类对象

```
public class Outer{
    class Inner{  }

    public static void main(String []args){
        Outer o = new Outer();
        Outer.Inner i = o.new Inner();
    }
}
```

```
public class Parcel{
    class Contents{
        private int i = 11;
        public int value() {return i;}
    }
    class Destination{
        private String label;
        Destination(String r) {label = r;}
        String readLabel() { return label;}
    }
    public Destination to(String s){
        return new Destination(s);
    }
    public Contents contents(){
        return new Contents();
    }
    public void ship(String dest){
        Contents c = new Contents();
        Destination d = new Destination(dest);
        System.out.println(d.readLabel());
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Parcel.Destination d = p.to("T");
        Parcel.Contents c = p.contents();
    }
}
```

```
public class Parcel{
    class Contents{
        private int i = 11;
        public int value() {return i;}
    }
    class Destination{
        private String label;
        Destination(String r) {label = r;}
        String readLabel() { return label;}
    }
    public void ship(String dest){
        Contents c = new Contents();
        Destination d = new Destination(dest);
        System.out.println(d.readLabel());
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Parcel.Destination d = p.new Destination("T");
        Parcel.Contents c = p.new Contents();
    }
}
```

内部类

- 内部类通常实现某个接口 / 继承某个类
  - 帮助隐藏实现细节

```
public class Parcel{
    private class PContents implements Contents{
        private int i = 11;
        public int value() {return i;}
    }
    private class PDestination implements Destination{
        private String label;
        Destination(String r) {label = r;}
        String readLabel() { return label;}
    }
    public Destination to(String s){
        return new PDestination(s);
    }
    public Contents contents(){
        return new PContents();
    }
    public void ship(String dest){
        Contents c = new Contents();
        Destination d = new Destination(dest);
        System.out.println(d.readLabel());
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Destination d = p.to("T");
        Contents c = p.contents();
    }
}
```

```
public interface Destination{
    String readLabel();
}

public interface Contents{
    int value();
}
```

1. private 的内部类可以完全隐藏内部类
2. 外界仅知道接口，并不知道内部类的存在
3. 此时，内部类中增添新的方法没有意义.

```
// Destination d = p.new PDestination("T");
// Contents c = p.new PContents();
// compile error:
//    - private inner class can not be accessed
```

内部类

- 其他类型的内部类
  - 定义在方法中的内部类
  - 定义在任意作用域中的内部类

内部类

- 定义在方法中的内部类
  - 也称为 local inner class
  - 在方法之外，该类不可见

```
public class Parcel{
    public Destination to(String s) {
        private class PDestination implements Destination {
            private String label;
            private Destination(String r) {label = r;}
            public String readLabel() { return label;}
        }
        return new PDestination(s);
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Destination d = p.to("T");
    }
}
```

```
public interface Destination{
    String readLabel();
}
```

内部类

- 定义在任意作用域中的内部类
  - 在该作用域之外不可见

```
public class Parcel{
    public Destination to(String s) {
        if (s != null) {
            private class PDestination implements Destination {
                private String label;
                private Destination(String r) {label = r;}
                public String readLabel() { return label;}
            }
            return new PDestination(s);
        }
        return null;
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Destination d = p.to("T");
    }
}
```

```
public interface Destination{
    String readLabel();
}
```

内部类

- 总结
  - 定义在类的内部
  - 隐含指向一个指向外部类对象的引用
  - 作用：帮助隐藏细节

匿名类

- 匿名内部类 (匿名类)
  - 没有名字的内部类
  - 必须继承某个类，或实现某个接口

```
public class Parcel{

    public Contents contents(){
        return new Contents() {
            // anonymous inner class definition
            private int i = 11;
            public int value() {return i;}
        };
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Contents c = p.contents();
    }
}
```

```
public interface Contents{
    int value();
}
```

“ 创建一个实现 Contents 的匿名类”

语法解释

1. “;” 为 return 语句的分号
2. 在 return 语句中定义匿名类
   - 实现 Contents 接口
   - 花括号内部
3. 创建一个改匿名类的对象
   - new Content () { }

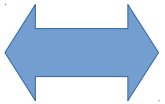
匿名类

- 匿名类

```
public class Parcel{

    public Contents contents(){
        return new Contents() {
            // anonymous inner class definition
            private int i = 11;
            public int value() {return i;}
        };
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Contents c = p.contents();
    }
}
```



```
public class Parcel{
     class PContents implements Contents{
        private int i = 11;
        public int value() {return i;}
    }

    public Contents contents(){
        return new PContents() ;
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Contents c = p.contents();
    }
}
```

匿名类

- 匿名类
  - 没有名字
  - 没有构造函数
  - 同时定义和创建
  - 必须继承另一个类或者实现一个接口

匿名类

- 匿名类**必须**继承另一个类 / 实现一个接口
  - 父类构造函数带有参数？

```
public class Parcel{

    public Wrapping wrapping(int x){
        return new Wrapping(x) {
            public int value() {
                return super.value() * 47;
            }
        };
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Wrapping w = p.wrapping(10);
    }
}
```

```
public class Wrapping{
    private int i;
    public Wrapping(int i) { i=x; }
    public int value() { return i; }
}
```

匿名类

- 匿名类
  - 使用外部变量对匿名类数据成员初始化
    - 外部变量需要 final

```
public class Parcel{

    public Contents contents(final int v){
        return new Contents() {
            private int i = v;
            public int value() {return i;}
        };
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Contents c = p.contents(13);
    }
}
```

```
public interface Contents{
    int value();
}
```

匿名类

- 匿名类没有构造函数
  - Instance initialization

```
public class Parcel{

    public Contents contents(){
        return new Contents() {
            private int i;
            { // instance initialization
                System.out.println("Instance Initialization");
                i = 11;
            }
            public int value() {return i;}
        };
    }
    public static void main(String []args){
        Parcel p = new Parcel();
        Contents c = p.contents(13);
    }
}
```

```
public interface Contents{
    int value();
}
```

匿名类

- 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);
    }
}
```

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

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

```
class Impl1 implements Service {
    public void method1() {
        System.out.println("Imp1.method1");
    }
    public void method2() {
        System.out.println("Imp1.method2");
    }
    public static ServiceFactory factory =
        new ServiceFactory() {
            public getService() {
                return new Impl1();
            }
        };
}
```

```
class Impl2 implements Service {
    public void method1() {
        System.out.println("Imp2.method1");
    }
    public void method2() {
        System.out.println("Imp2.method2");
    }
    public static ServiceFactory factory =
        new ServiceFactory() {
            public 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);
    }
}
```

匿名类

- 总结
  - 没有名字
  - 没有构造函数
  - 同时定义和创建
  - 必须继承另一个类或者实现一个接口

嵌套类

- 内部类
  - 内部类的对象隐含了一个引用，指向包含它的外部类对象
- 静态的内部类
  - 不需要外部类的对象即可创建
  - 也称为嵌套类 (nested class)

嵌套类

- 嵌套类
  - 不包含指向外部类对象的引用
  - 无法访问外部类的非静态成员

```
public class Parcel{
    private static class PContents implements Contents{
        private int i = 11;
        public int value() {return i;}
    }
    private static class PDestination implements Destination{
        private String label;
        Destination(String r) {label = r;}
        String readLabel() { return label;}
    }
    public Destination to(String s){
        return new PDestination(s);
    }
    public Contents contents(){
        return new PContents();
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Destination d = p.to("T");
        Contents c = p.contents();

        Destination d1 = new Destination("T");
        Contents c1 = new Contents();
    }
}
```

```
public interface Destination{
    String readLabel();
}

public interface Contents{
    int value();
}
```

嵌套类

- 接口中的内部类
  - 接口：
    - 通常只有方法的说明，不含实现
    - 所有成员默认为 public static
  - 嵌套类
    - 静态的
    - 可以放入接口中
  - 接口中的内部类
    - 让接口重拾 " 重用 " 的功能

嵌套类

```
public interface ClassInInterface {
    void f();
    class Test implements ClassInInterface{
        public void f() {
            System.out.println(“hello”);
        }
        public static void main(String []args){
            new Test.f();
        }
    }
}
```

嵌套类

- 总结
  - 静态的内部类
  - 不包含指向外部类对象的引用
  - 可以包含在接口中

内部类的作用

- 内部类的用途
  - 内部类通常继承一个类或者实现一个接口

```
public class Parcel{
    private class PContents implements Contents{
        private int i = 11;
        public int value() {return i;}
    }
    private class PDestination implements Destination{
        private String label;
        Destination(String r) {label = r;}
        String readLabel() { return label;}
    }
    public Destination to(String s){
        return new PDestination(s);
    }
    public Contents contents(){
        return new PContents();
    }
    public void ship(String dest){
        Contents c = new Contents();
        Destination d = new Destination(dest);
        System.out.println(d.readLabel());
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Destination d = p.to("T");
        Contents c = p.contents();
    }
}
```

```
public interface Destination{
    String readLabel();
}

public interface Contents{
    int value();
}
```

问题：

为何不让原始类上直接实现该接口？

回答：

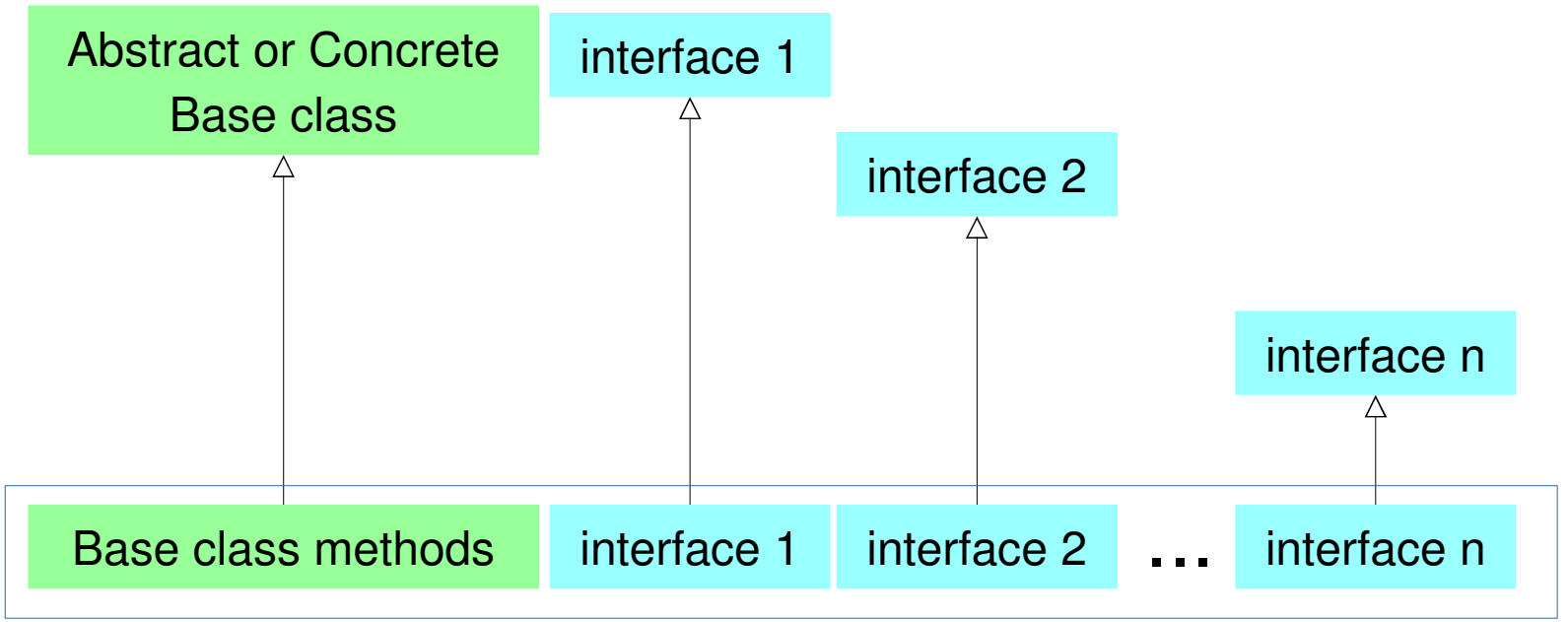
1. 如果可以，那么就做！
2. 有时不行
   - 外部类已经确定，无法修改
   - 内部类可以灵活的继承 / 实现其他接口

内部类的作用

- 为什么引入内部类
  - 多继承
  - 闭包和回调函数
    - 闭包 (closure)
      - 带有自由变量的函数 + 被绑定的自由变量
    - 回调函数 (callbacks)
      - 函数指针

内部类的作用

- 多继承
  - 复习
    - 父类只能有一个普通类 / 抽象类



嵌套类

```
public interface ClassInInterface {
    void f();
    class Test implements ClassInInterface{
        public void f() {
            System.out.println(“hello”);
        }
        public static void main(String []args){
            new Test.f();
        }
    }
}
```

内部类的作用

- 多继承
  - 可以通过多个内部类继承多个类 / 抽象类 / 接口

```
public interface A { }
public interface B { }
class X implements A, B {}

class Y implements A{
    B makeB() {
        return new B(){};
    }
}
```

```
interface A { }
interface B { }
class X implements A, B {}

class Y implements A{
    B makeB() {
        return new B(){};
    }
}

public class Test{
    static void takeA(A a) {}
    static void takeB(B b) {}
    public static void main(String []args){
        X x = new X();
        Y y = new Y();
        takeA(x); takeB(x);
        takeA(y); takeB(b.makeB());
    }
}
```

```
class A { }
abstract class B { }
// class X implements A, B {}
// won't compile

class Y extends A{
    B makeB() {
        return new B(){};
    }
}

public class Test{
    static void takeA(A a) {}
    static void takeB(B b) {}
    public static void main(String []args){
        Y y = new Y();
        takeA(y); takeB(b.makeB());
    }
}
```

内部类的作用

- 在类中使用内部类
  - 同一个内部类可以有多个实例，每个示例有不同的状态
  - 对同一接口，可以有不同的内部类实现
  - 创建内部类对象可以按需创建
  - 不必遵从 is-a 关系

内部类的作用

- 应用： 事件驱动系统 (event-driven system)
  - 控制一组事件
  - 每个事件有准备时间，当准备妥当，状态转为 ready
  - 每个事件有方法 action()，表示事件的内容

```
public abstract class Event {
    private long eventTime;
    protected final long delayTime;
    public Event(long dt) {
        delayTime = dt;
        start();
    }
    public void start(){
        eventTime = System.nanoTime() + delayTime;
    }
    public boolean ready(){
        return System.nanoTime() >= eventTime
    }
    public abstract void action();
}
```

```
public  class Controller {
    private List<Event> eventList = new ArrayList<Event>();
    public void addEvent(Event c) { eventList.add(c); }
    public void run() {
        while (eventList.size()>0)
            for (Event e: eventList) {
                if (e.ready()){
                    System.out.println(e);
                    e.action();
                    eventList.remove(e);
                }
            }
    }
}
```

```
public class GreenhouseControls extends Controller {
    private boolean light = false;
    public LightOn extends Event {
        public LightOn(long dt) { super(dt); }
        public void action() { light = true;}
        public toString() {System.out.println(“Light on”);}
    }

    public LightOff extends Event {
        public LightOff(long dt) { super(dt); }
        public void action() { light = false;}
        public toString() {System.out.println(“Light off”);}
    }

    private boolean water = false
    public WaterOn extends Event {
        public LightOn(long dt) { super(dt); }
        public void action() { water = true;}
        public toString() {System.out.println(“Water on”);}
    }
    public WaterOff extends Event {
        public LightOff(long dt) { super(dt); }
        public void action() { water = false;}
        public toString() {System.out.println(“Water off”);}
    }
}
```

```
public class Greenhouses {
    public static void main(String[] args){
        GreenhouseControls gc = new GreenhouseControls();
        gc.add(gc.new LightOn(200));
        gc.add(gc.new WaterOn(400));
        gc.add(gc.new WaterOff(600));
        gc.add(gc.new LightOff(800));
        gc.run();
    }
}
```

内部类的作用

- 总结
  - 可以通过多个内部类继承多个类 / 抽象类 / 接口