

# OOP with Java

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# OOP with Java

- 通知
  - Project 4: 4 月 19 日晚 9 点

- 复习
  - Protected
    - 可以被子类 / 同一包中的类访问，不能被其他类访问
    - 弱化的 private
    - 同时赋予 package access

```
class MyType {  
    public int i;  
    public double d;  
    public char c;  
    protected void set(double x) { d = x;}  
    protected void set(int y) {i = y;}  
    public double get() { return d; }  
}
```

```
public class MySubType extends MyType{  
    public void set(double x){ i = (int)x; }  
    public void set(char z) {c = z; }  
    public static void main(String [ ]args){  
        MySubType ms = new MySubType();  
        ms.set(1.0);  
        System.out.println(ms.get());  
        System.out.println(ms.i);  
        System.out.println(ms.d);  
    }  
}
```

- 复习
  - Upcasting
    - 继承
    - 子类具有父类的所有方法和数据
    - Sub-class is **a type of** base class
  - 类型转换：父类的引用可以指向子类对象

```
class Instrument {  
    public void play() {}  
    static void tune(Instrument i) {  
        // ...  
        i.play();  
    }  
}  
  
public class Wind extends Instrument {  
    public static void main(String[] args) {  
        Wind flute = new Wind();  
        Instrument.tune(flute);  
    }  
}
```

- 复习
  - final 关键字
  - final 数据
    - static final int j = 1;
    - final int[ ] a = new int [10];
    - Blank final, 构造函数中初始化
  - final 参数
  - final 方法：不能重写
  - final 类：不能继承
  - immutable

# Quiz

```
public class Test{  
    public static void main(String []args){  
        Integer i = new Integer(10);  
        Integer j = i;  
        i += 10;  
        System.out.println(i);  
        System.out.println(j);  
    }  
}
```

# Quiz

```
class MyType {  
    int i;  
    double d;  
    char c;  
    public void set(double d){  
        d = d;  
    }  
    public double get(){  
        return d;  
    }  
    public static void main(String []args){  
        MyType m = new MyType();  
        m.set(11.0)  
        System.out.println(m.get());  
    }  
}
```

# Quiz

```
class Base {  
    public void show() {  
        System.out.println("In Base");  
    }  
}  
  
class Derived extends Base {  
    public void show() {  
        System.out.println("In Derived");  
    }  
}  
  
public class Main {  
    public static void main(String[] args) {  
        Base b = new Derived();  
        b.show();  
    }  
}
```



# Quiz

```
class Base {  
    public Base() {  
        System.out.println("In Base");  
    }  
}  
  
class Derived extends Base {  
    public Derived() {  
        System.out.println("In Derived");  
    }  
}  
  
public class Main {  
    public static void main(String[] args) {  
        Base b = new Derived();  
    }  
}
```

# Quiz

```
class Base {  
    private void show() {  
        System.out.println("In base");  
    }  
}  
  
class Derived extends Base {  
    public void Derived() {  
        System.out.println("In Derived");  
    }  
}  
  
public class Main {  
    public static void main(String[] args) {  
        Derived d = new Derived();  
        d.show();  
    }  
}
```

# 多态

- Upcasting 与多态
- 动态绑定
- Downcasting

# Upcasting

- 类型
  - 基本类型 (byte, short, char, int, long, float, double)
  - 类 (class, array)
- 类型检查
  - 基本类型的转换关系
  - **class A** 的引用只能指向 **class A** 的对象

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

# Upcasting

- 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

```
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
```

# Upcasting

- Upcasting 的优点
  - 简化接口

```
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(Wind i) {  
        i.play();  
    }  
    public static void tune(Stringed i) {  
        i.play();  
    }  
    public static void tune(Brass 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);  
    }  
}
```

Without upcasting

```
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);  
    }  
}
```

## With upcasting

1. 接口变简洁

2. play() 方法能正确的调用对应的重写 (override) 后的子类方法

## 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)



# 多态



by Sinipull for codecall.net

```
class Super {  
    public void f() {  
        System.out.println("In Super");  
    }  
}
```

```
public class Base1 extends Super {  
    public void f() {  
        System.out.println("In Base1");  
    }  
}
```

```
public class Base2 extends Super {  
    public void f() {  
        System.out.println("In Base2");  
    }  
}
```

```
public class Tester {  
    public static void main(String []args){  
        Super s = new Base1();  
        s.f();  
        s = new Base2();  
        s.f();  
    }  
}
```

# upcasting

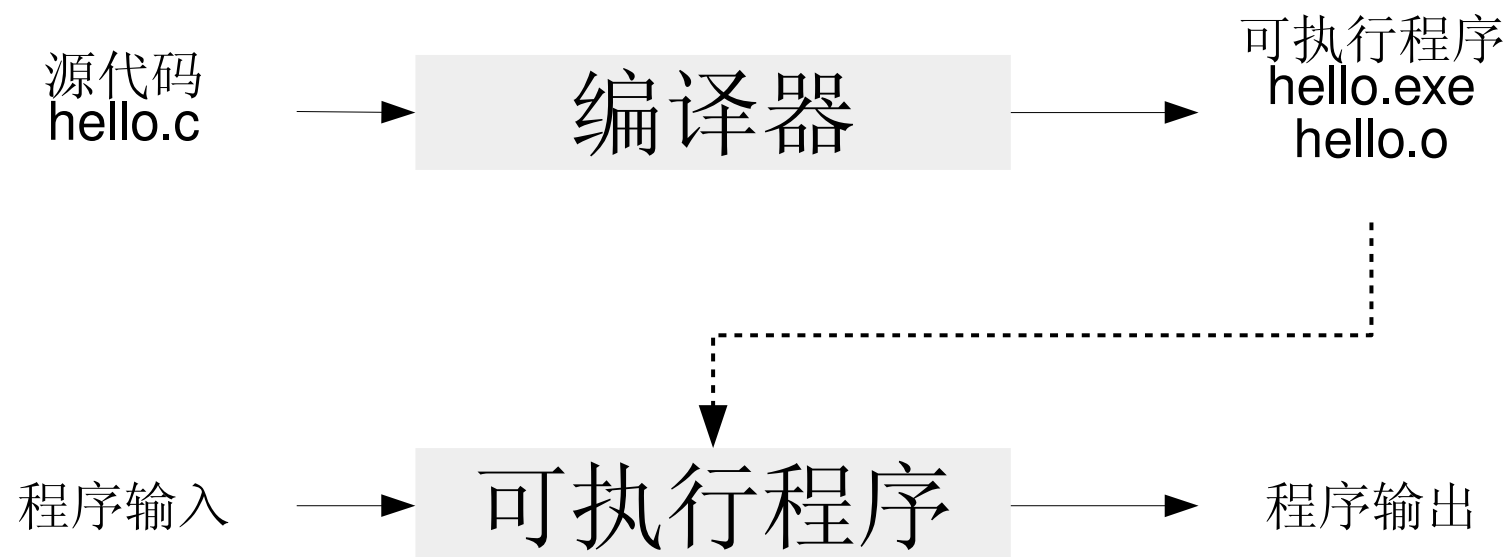
- 问题

```
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);  
    }  
}
```

tune() 方法是如何知道调用哪一个子类的 play()?  
多态是如何实现的？

# 动态绑定

- C 语言
  - 编译



- C 语言
  - 可执行文件

**静态绑定 (static binding) :**  
函数的位置在编译时确定

```
#include <stdio.h>

void hello(){
    ...
}

int main(){
    ...
    hello();
}
```

源代码  
hello.c

编译

函数 hello() 的机器码

hello()

函数 main() 的机器码

...  
hello();  
...

可执行程序  
hello.exe  
hello.o

编译后, main() 函数能够确定的知道 hello() 函数的位置

```
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);  
    }  
}
```

编译

```
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 Instrument 的机器码  
...  
play(note)  
...
```

```
class Wind 的机器码  
...  
play(note)  
...
```

随机给定 tune() 函数的参数？  
编译器无法确定 play() 函数的位置！

```
class Stringed 的机器码  
...  
play(note)  
...
```

```
class Brass 的机器码  
...  
play(note)  
...
```

```
class Music 的机器码  
tune(Instrument i) {  
    i.play()  
}  
main() {  
    ...  
    tune(flute)  
    tune(violin)  
    tune(frenchHorn)  
    ...  
}
```

动态绑定 (dynamic binding) :  
函数的位置在运行时才能确定

```
public class Shape {
    public void draw() { }
    public void erase() { }
}
```

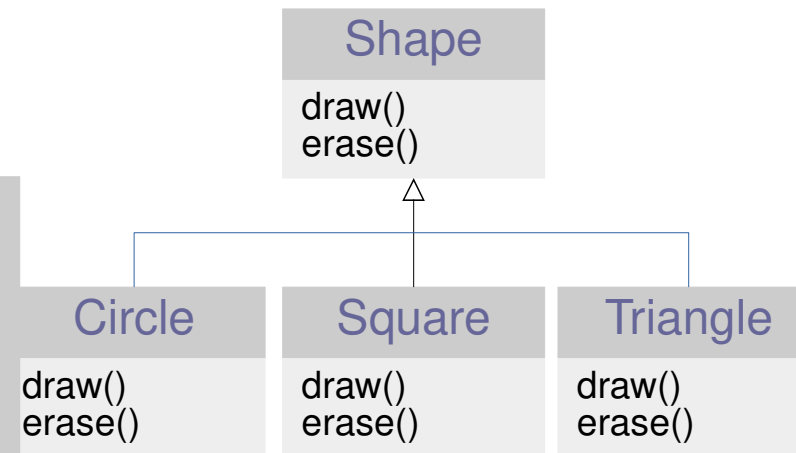
```
public class Circle extends Shape {
    public void draw() {System.out.println("circle draw");}
    public void erase() { System.out.println("circle erase");}
}
```

```
public class Square extends Shape {
    public void draw() {System.out.println("square draw");}
    public void erase() { System.out.println("square erase");}
}
```

```
public class Triangle extends Shape {
    public void draw() {System.out.println("triangle draw");}
    public void erase() { System.out.println("triangle erase");}
}
```

```
public class RandomShapeGenerator {
    public Shape next() {
        double r = Math.random();
        if (r < 0.3)
            return new Circle();
        else if (r >= 0.6)
            return new Tirangle();
        else
            return new Square();
    }
}
```

upcasting



```
public class Shapes {
    Private RandomShapeGenerator gen = new
    RandomShapeGenerator();
    public static void main(String []args) {
        Shape[]s = new Shape[9];
        for (int i = 0; i < s.length; ++i)
            s[i] = gen.next();
        for (Shape shp:s)
            s.draw();
    }
}
```

Dynamic Binding

# 动态绑定

- 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，给 **debug** 带来困难

# 动态绑定

- 多态 ( 动态绑定 ) 带来的扩展性

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

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

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

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

```
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);  
    }  
}
```

无需改变！

1. 增加新的接口，并不影响原有的只依赖于旧接口的代码
2. 原因：tune 的实现只与父类的相关



# 动态绑定

- 动态绑定
  - Java 中的所有方法都采用动态绑定，除了
    - final
    - static
  - 原因？
  - 数据成员 (field) 不使用动态绑定

# 动态绑定

```
public class Super {  
    public int field = 0;  
    public int getField() {return field;}  
}
```

```
public class Sub extends Super {  
    public int field = 1;  
    public int getField() {return field;}  
    public int getSuperField() {return super.field;}  
}
```

```
public class FieldAccess {  
    public static void main(String []args){  
        Super sup = new Sub();  
        System.out.println(sup.field);  
        System.out.println(sup.getField());  
  
        Sub sub = new Sub();  
        System.out.println(sub.field);  
        System.out.println(sub.getField());  
        System.out.println(sub.getSuperField());  
    }  
}
```

# 动态绑定

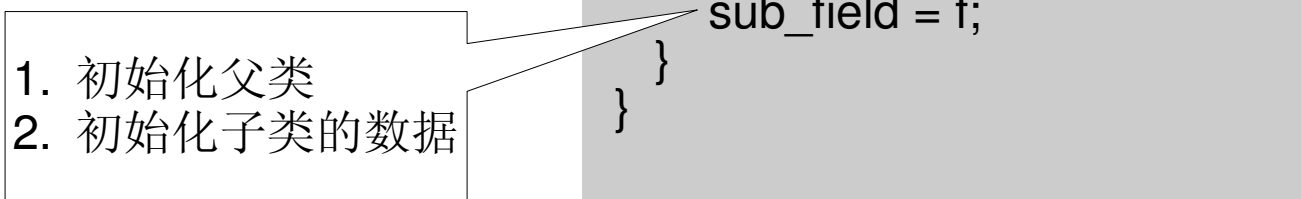
- 构造函数
  - 初始化顺序
    - 分配内存空间，默认初始化 ( 设置为 0 )
    - 初始化父类 ( 递归 ! )
    - 静态成员初始化 ( 首次创建该类对象 )
    - 数据成员初始化 ( 按照定义顺序 )
    - 调用构造函数

# 动态绑定

- 构造函数初始化顺序

```
public class Super {  
    int sup_field = 1;  
    public Super(){  
        ...  
    }  
}
```

```
public class Sub extends Super {  
    public int sub_field = 1;  
    public Sub(int f) {  
        sub_field = f;  
    }  
}
```

- 
1. 初始化父类
  2. 初始化子类的数据

```

class Meal {
    Meal() { print("Meal()"); }
}

class Bread {
    Bread() { print("Bread()"); }
}

class Cheese {
    Cheese() { print("Cheese()"); }
}

class Lettuce {
    Lettuce() { print("Lettuce()"); }
}

class Lunch extends Meal {
    Lunch() { print("Lunch()"); }
}

class PortableLunch extends Lunch {
    PortableLunch() { print("PortableLunch()"); }
}

public class Sandwich extends PortableLunch {
    private Bread b = new Bread();
    private Cheese c = new Cheese();
    private Lettuce l = new Lettuce();
    public Sandwich() { print("Sandwich()"); }
    public static void main(String[] args) {
        new Sandwich();
    }
}

```

Output:

```

Meal()
Lunch()
PortableLunch()
Bread()
Cheese()
Lettuce()
Sandwich()

```

# 动态绑定

- 构造函数中使用重写函数 → **BUG!**

```
public class Super {  
    public Super() {  
        System.out.println("Before Super draw");  
        draw();  
        System.out.println("After Super draw");  
    }  
    public void draw() {  
        System.out.println("draw");  
    }  
}
```

```
public class Sub extends Super {  
    public int field = 1;  
    public Sub(int f) {  
        field = f;  
        System.out.println("Sub" + field);  
    }  
    public void draw() {  
        System.out.println("draw" + field);  
    }  
}
```

```
public class Test {  
    public static void main(String []args){  
        Sub sub = new Sub(5);  
    }  
}
```

1. 子类的方法：在子类对象创建之后才有意义
2. 构造函数中，避免使用将被重写的函数

# 动态绑定

- 函数重写
  - 相同的函数：函数名与参数列表相同
  - 协变的返回值
    - 被重写的函数返回值可以是原函数的子类

```
class Grain {  
    public toString() { return "Grain"; }  
}  
class Wheat extends Grain {  
    public toString() { return "Wheat"; }  
}  
class Mill {  
    Grain process() { return new Grain(); }  
}  
class WheatMill {  
    Wheat process() { return new Wheat(); }  
}
```

```
public class CovariantReturn {  
    public static void main(String []args){  
        Mill m = new Mill();  
        Grain g = m.process();  
        System.out.println(g);  
  
        m = new WheatMill();  
        g = m.process();  
        System.out.println(g);  
    }  
}
```

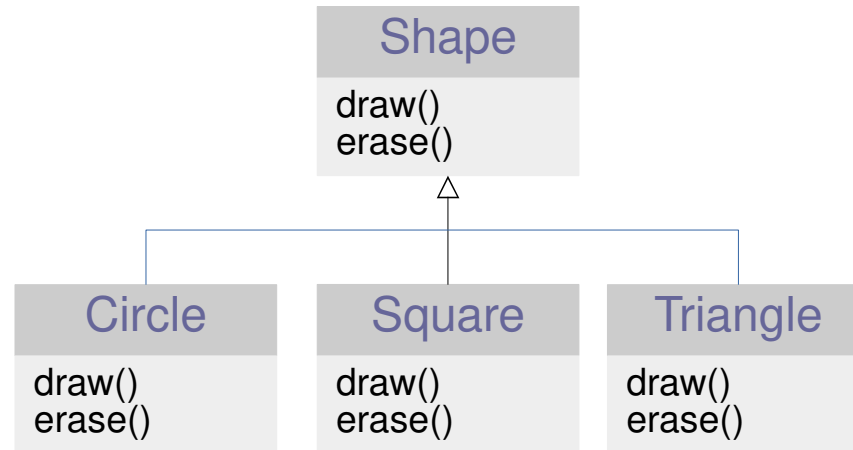
# 动态绑定

- 总结
  - 静态绑定：函数在编译时确定
  - 动态绑定：函数在运行时才能确定
  - 除了 **final**, **static** 外所有函数都为动态绑定
  - 在构造函数中减少使用可能会被重写的函数



# Downcasting

- Is-a 关系
  - 父类与子类的接口完全相同



# Downcasting

- Is-like-a 关系

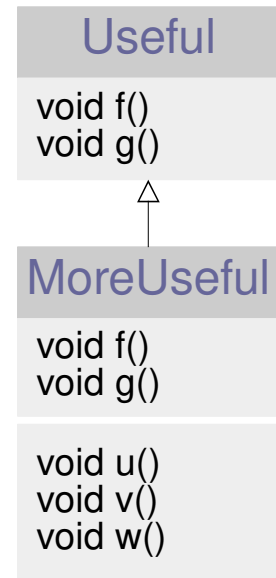
- 子类添加了新的方法

- Upcasting:

- 父类引用指向子类的对象
    - 安全的

- Downcasting

- 子类引用指向父类的对象
    - 不安全
    - 但当一个父类引用指向子类时，可以将该引用强制转换为子类引用



# Downcasting

```
public class Downcasting {  
    public static void main(String []args){  
        Useful x = new Useful();  
        Useful y = new MoreUseful();  
        x.f();  
        y.f()  
        // y.u(); compile error, u() not in Useful  
        ((MoreUseful)x).u; // run time error  
        ((MoreUseful)y).u; // downcasting  
    }  
}
```

