# A Testing Framework (Part 2/2)

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### Last time...

We implemented two classes: Money, MoneyBag, and MoneyTest

We had a falling test, which is

@Test public void mixedSimpleAdd() {
 // [12 CHF] + [7 USD] == {[12 CHF][7 USD]}
 Money[] bag = { f12CHF, f7USD };
 MoneyBag expected = new MoneyBag(bag);
 assertEquals(expected, f12CHF.add(f7USD));
}



### **Outline for today**

## 1.Double dispatch - how to add different types of objects

2. Exercise: Catchipun



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#### 1.Double dispatch - how to add different types of objects

2. Exercise: Catchipun



### Adding MoneyBags

We would like to freely add together arbitrary Monies and MoneyBags, and be sure that *equals behave as equals*:

@Test public void mixedSimpleAdd() {
 // [12 CHF] + [7 USD] == {[12 CHF][7 USD]}
 Money[] bag = { f12CHF, f7USD };
 MoneyBag expected = new MoneyBag(bag);
 assertEquals(expected, f12CHF.add(f7USD));
}

That implies that Money and MoneyBag should implement a common interface ...



### Adding MoneyBags

f12CHF.add(f7USD) "=> return a money bag"

```
new MoneyBag().add(f12CHF) "=> return a money bag"
```

f12CHF.add(f12CHF) "=> return a money"

f12CHF.add(new MoneyBag()) "=> return a money bag"

•••



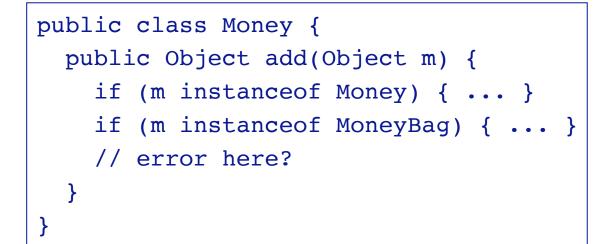
### A possible solution

```
public class Money {
  public Object add(Object m) {
    if (m instanceof Money) { ... }
    if (m instanceof MoneyBag) { ... }
    // error here?
  }
}
```

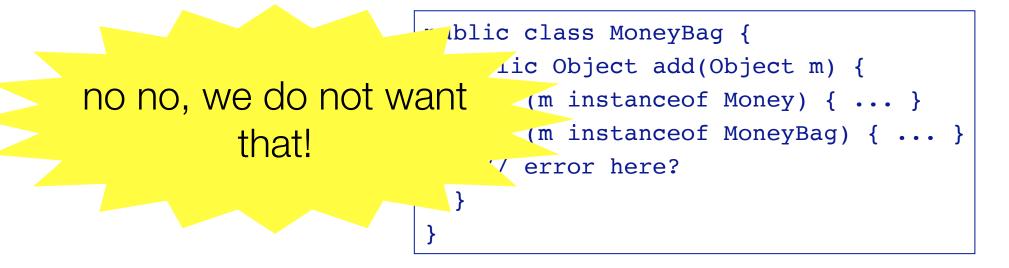
```
public class MoneyBag {
  public Object add(Object m) {
    if (m instanceof Money) { ... }
    if (m instanceof MoneyBag) { ... }
    // error here?
  }
}
```



### A possible solution



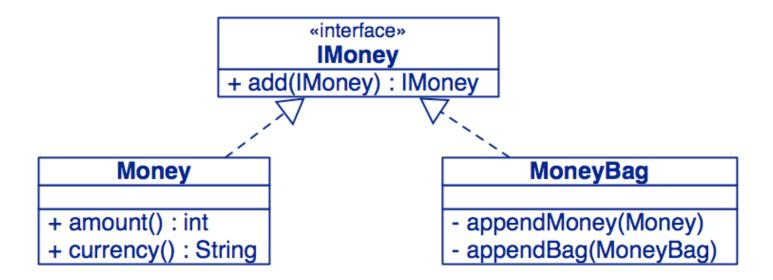






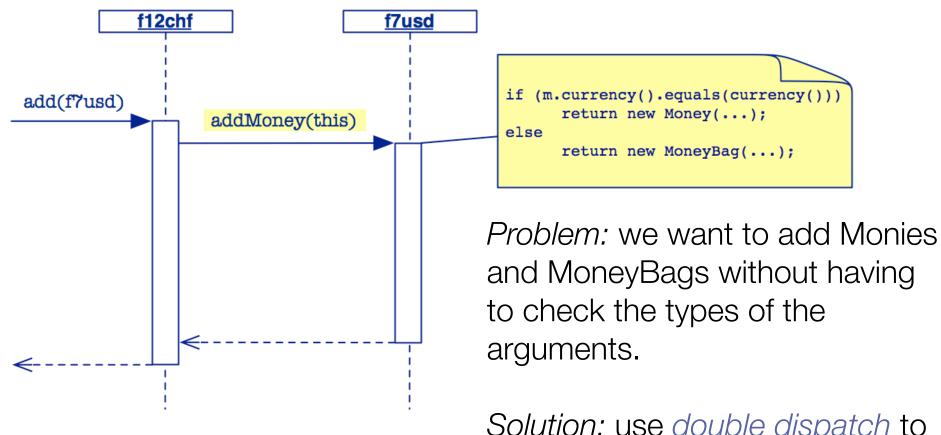
### The IMoney interface (I)

Monies know how to be added to other Monies



[NOTE: The diagram is incomplete, we will complete it later on]

### Double Dispatch (I)



*Solution:* use *double dispatch* to expose more of your own interface.

### Double Dispatch (II)

How do we implement add() without breaking encapsulation?

```
class Money implements IMoney { ...
  public IMoney add(IMoney m) {
    return m.addMoney(this); // add me as a Money
  } ...
}
class MoneyBag implements IMoney { ...
  public IMoney add(IMoney m) {
    return m.addMoneyBag(this); // add as a MoneyBag
  } ...
}
```

"The idea behind double dispatch is to use an additional call to discover the kind of argument we are dealing with..."

### Double Dispatch (III)

The rest is then straightforward ...

```
class Money implements IMoney { ...
public IMoney addMoney(Money m) {
    if (m.currency().equals(currency())) {
        return new Money(amount()+m.amount(),currency());
    } else {
        return new MoneyBag(this, m);
    }
    public IMoney addMoneyBag(MoneyBag s) {
        return s.addMoney(this);
    } ...
```

and MoneyBag takes care of the rest.

### Double Dispatch (IV)

#### Pros

No violation of encapsulation (no downcasting)

Smaller methods; easier to debug

Easy to add a new type

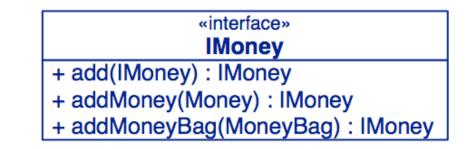
#### Cons

No centralized control

May lead to an explosion of helper methods

### The IMoney interface (II)

So, the common interface has to be:



```
public interface IMoney {
   public IMoney add(IMoney aMoney);
   IMoney addMoney(Money aMoney);
   IMoney addMoneyBag(MoneyBag aMoneyBag);
}
```

NB: addMoney() and addMoneyBag() are only needed within the Money package.

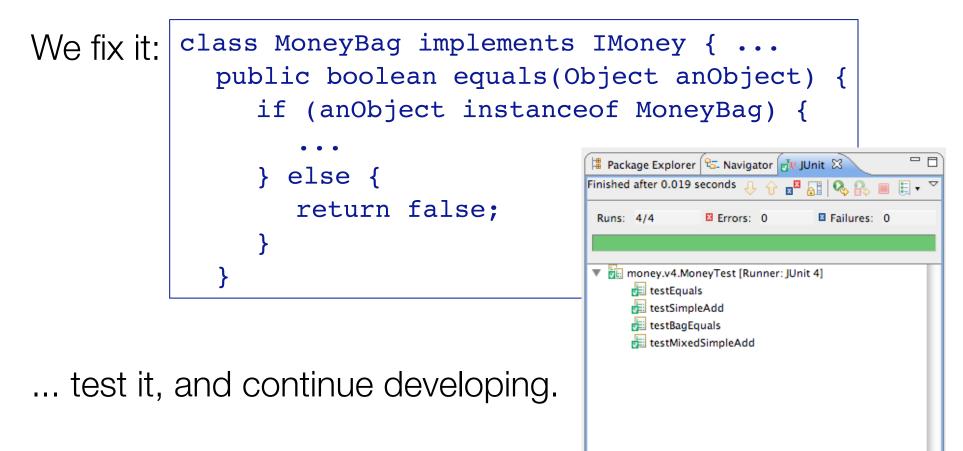
### A Failed test

This time we are not so lucky ...

nished at	fter 0.022 seconds			
Runs: 4	/4	Errors: 0	Failures: 1	
-	ney.v3.MoneyTest [Runner: JU	Init 4]		
	testEquals	///// 4]		
	testSimpleAdd			
	testBagEquals			
	testMixedSimpleAdd			
				-
Failure	e Trace			
💡 java.la	ang.AssertionError: expected:	<money.v3.moneybag(< td=""><td>@2af081&gt; but was:<money.v3.moneybag@13a53d></money.v3.moneybag@13a53d></td><td></td></money.v3.moneybag(<>	@2af081> but was: <money.v3.moneybag@13a53d></money.v3.moneybag@13a53d>	
at or	g.junit.Assert.fail(Assert.java:7	71)		
at or	g.junit.Assert.failNotEquals(As	ssert.java:451)		
at or	g.junit.Assert.assertEquals(As	sert.java:99)		
at or	g.junit.Assert.assertEquals(As	sert.java:116)		
at mo	oney.v3.MoneyTest.testMixedS	SimpleAdd(MoneyTest.j	ava:49)	
at su	n.reflect.NativeMethodAccess	orImpl.invoke0(Native I	Method)	
at su	n.reflect.NativeMethodAccess	orImpl.invoke(NativeMe	thodAccessorImpl.java:39)	
at su	n.reflect.DelegatingMethodAc	cessorImpl.invoke(Dele	gatingMethodAccessorImpl.java:25)	
at or	g.junit.internal.runners.TestM	ethodRunner.executeM	ethodBody(TestMethodRunner.java:99)	
at or	g.junit.internal.runners.TestM	ethodRunner.runUnpro	otected(TestMethodRunner.java:81)	
at or	g.junit.internal.runners.Before	AndAfterRunner.runPr	otected(BeforeAndAfterRunner.java:34)	
at or	g.junit.internal.runners.TestM	ethodRunner.runMetho	d(TestMethodRunner.java:75)	
at or	g.junit.internal.runners.TestM	ethodRunner.run(Test	/ethodRunner.java:45)	
	g.junit.internal.runners.TestCl	lassMethodsRunner.inv	okeTestMethod(TestClassMethodsRunner.java:66)	
at or	g.junit.internal.runners.TestCl	lassMethodsRunner.ru	n(TestClassMethodsRunner.java:35)	
at or	g.junit.internal.runners.TestCl	lassRunner\$1.runUnpr	otected(TestClassRunner.java:42)	
at or	g.junit.internal.runners.Before	AndAfterRunner.runPr	otected(BeforeAndAfterRunner.java:34)	
at or	g.junit.internal.runners.TestCl	lassRunner.run(TestCla	ssRunner.java:52)	

### The fix ...

It seems we forgot to implement MoneyBag.equals()!





### **Outline for today**

#### 1.Double dispatch - how to add different types of objects

2.Exercise: Catchipun



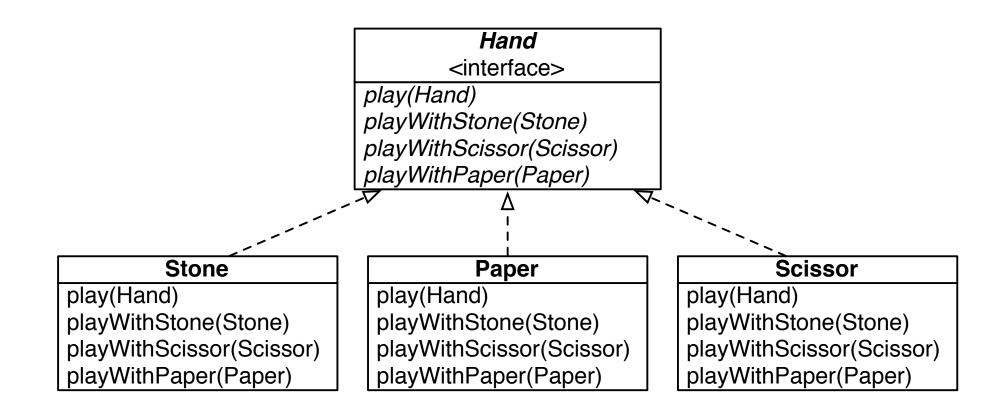
### Cachipun

Though it looks simple, designing this small game is a fantastic example of the double dispatch design pattern

This pattern is particularly important since it is the base of many other design patterns



### Design



#### interface Hand {

}

- // 1 win, 0 draw, -1 loose
- int play (Hand v);
- int playWithStone (Stone stone);
- int playWithPaper (Paper paper);
- int playWithScissor (Scissor scissor);

```
class Stone implements Hand {
 public int play(Hand v) {
    return v.playWithStone (this);
  }
  public int playWithStone (Stone v) {
    return 0;
  }
  public int playWithScissor (Scissor v) {
    return -1;
  }
  public int playWithPaper (Paper v) {
    return 1;
```

```
class Paper implements Hand {
  public int play(Hand v) {
    return v.playWithPaper (this);
  }
  public int playWithStone (Stone v) {
    return -1;
  }
  public int playWithScissor (Scissor v) {
    return 1;
  }
  public int playWithPaper (Paper v) {
    return 0;
```

```
class Scissor implements Hand {
  public int play(Hand v) {
    return v.playWithScissor (this);
  }
  public int playWithStone (Stone v) {
    return 1;
  }
  public int playWithScissor (Scissor v) {
    return 0;
  }
  public int playWithPaper (Paper v) {
    return -1;
  }
```



### Benefit of using double dispatch

Methods are shorts

Methods do not contains "if" and "instanceof"

This means that code is *easier to test*, thanks to double dispatch

Ideally, **instanceof** has to be used only in the **equals** method

The cost of adding a new type (e.g., spoke or [) is very low



### What you should know

How does the double dispatch pattern work?

- When should one apply this pattern?
- What are the benefits when using it?



### Can you answer these questions?

Can you give an example where the double dispatch is successfully employed?

Can the double dispatch be used to always get rid of the if statements?



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