Annotations and Input Validation in Java

SHIP Validator

Dag Hovland. Based on joint work with Khalid A. Mughal and Federico Mancini.

July 17, 2009

Information as Properties

- Java is Object-Oriented — everything is an object
- Information available in no-arg methods: *properties*
- Input is represented as properties of an object

Goals

- A framework that should be easy to add onto existing projects
- It should be easy to use and create tests
- Tests should be reusable and composable
- Composition of tests should be easy and powerful
- No code inside methods in the class representing input
- No references to code by string names

Annotations

- From Java 5.0
- Standardizing comments
- A kind of interface
- On classes, methods, fields, variables

Scenario: International Money Transfer

IBAN

BIC BICCODE

Account

Clearing-code AB1232342

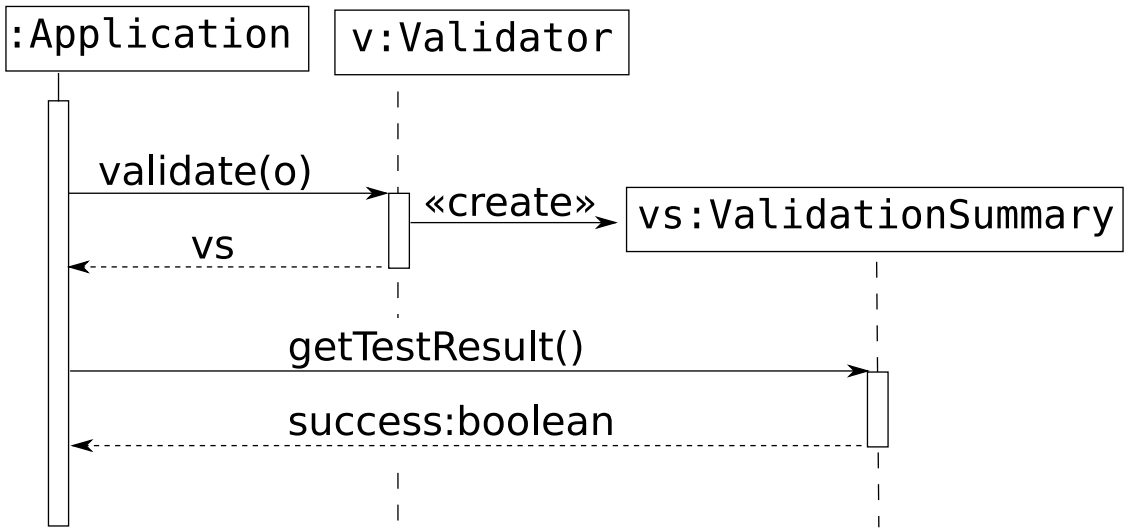
Amount € 10000 . 10 c

Pay international bill

Configuration by Proximity

```
@ValidateBIC
public String getBIC() { return BIC; }

@IntRange(min=0,max=10000)
public Integer getAmountEuro() { return amountEuro; }

@IntRange(min=0,max=99)
public Integer getAmountCents() { return amountCents; }
```

Using the Framework



The Validation Process

```
@Validation
public @interface IntRange {
  int min();
  int max();
  public static class Tester
  implements IPropertyTester<IntRange, Integer> {
    public boolean runTest(IntRange r, Integer v) {
      return(v >= r.min() && v <= r.max());
    }
  }
}
```

Interface for Property-Tests

```
public interface IPropertyTester <A extends Annotation,I>
{
  public boolean runTest(A an, I o)
  throws ValidationException;
}
```

Input Validation as Dynamic Typing

- `validate(o)` similar to down-casting in Java
- Why cannot Java's type hierarchy be used?
- `String` and `Integer` are `final`

`@Required` and `@NotRequired`

- But how should tests handle `null` values?
- They should, by default, lead to a crash
- However, `null` is also used to signal special cases
- `@Required` specifies that a property should not be `null` — almost standard
- `@NotRequired` causes no other tests to be run, if the value is `null`

Cross-Tests over Multiple Properties

- *Property-Tests* test a single property
- *Cross-Tests* test several properties at once

Scenario: International Money Transfer

IBAN	
BIC	BICCODE
Account	
Clearing-code	AB1232342
Amount	€ 10000 . 10 c

Pay international bill

Using Cross-Tests

```
@ExactlyOneNull
@NotRequired
public String getIBAN() { return IBAN; }

@ExactlyOneNull
@AllOrNoneNull
@NotRequired
public String getAccount() { return account; }

@AllOrNoneNull
@NotRequired
public String getClearingcode() { return clearingcode; }
```

Declaring a Cross-Test

```
@CrossValidation
public @interface AllOrNoneNull {
  public static class Tester
  implements ICrossTester<AllOrNoneNull,String>{
    public boolean runTest(AllOrNoneNull c,
                           ArrayList<String> v)
    throws ValidationException {
      ...
    }
  }
}
```

```
public interface ICrossTester <A extends Annotation, V> {
  public boolean runTest(A a, ArrayList<V> v)
  throws ValidationException;
}
```

Basic and Composed Tests

- *Basic Tests* contain an inner class implementing a test
- *Composed Tests* are annotated with property-annotations

Property-Tests

```
@ValidateBIC
public String getBIC() { return BIC; }
```

Example of Composed Property-Test

```
@Validation
@BoolTest(BoolType.AND)
@PatMatch("\\w8|\\w11")
@AdditionalTest
@interface ValidateBIC{}
```

Boolean Composition of Tests

- Annotation `@BoolTest`
- `public enum BoolType{OR, AND, ALLFALSE}`

Types of Tests

	Basic Tests	Composed Tests
Property-Tests	`@IntRange`	`@ValidateBIC`
Cross-Tests	`@AllOrNoneNull`	`@AmountCheck`

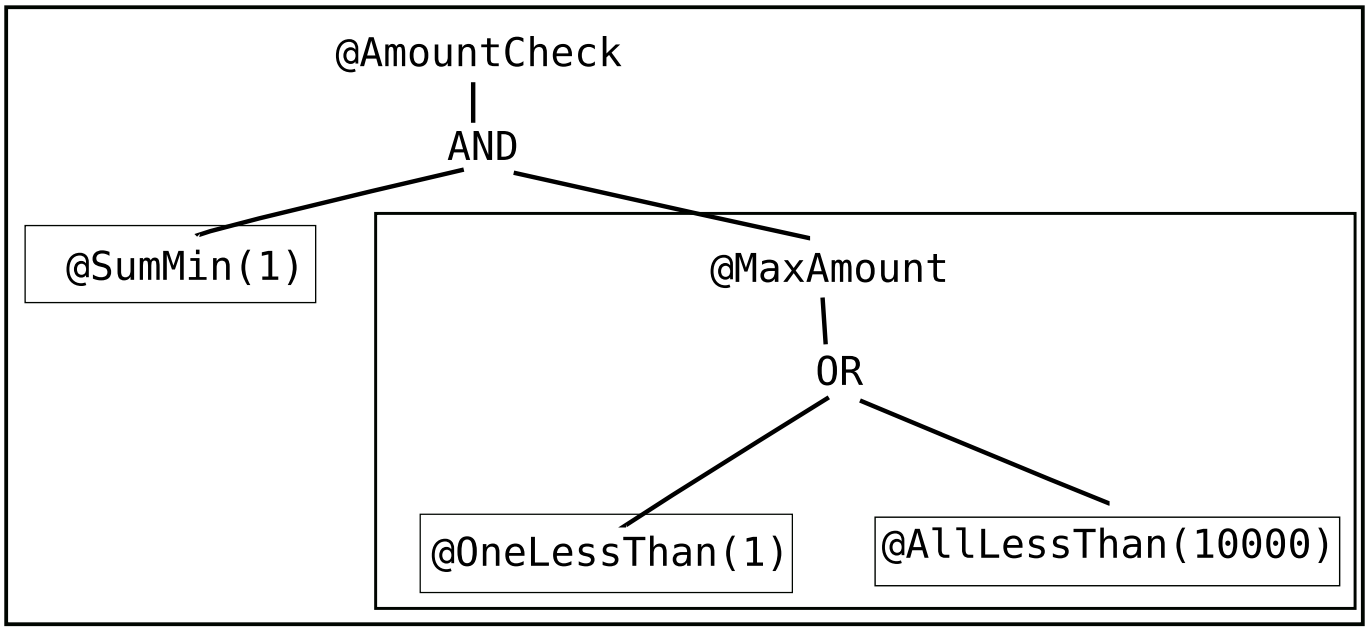
Composed Cross-Tests

```
@IntRange(min=0,max=10000)
@AmountCheck
public Integer getAmountEuro() { return amountEuro; }

@IntRange(min=0,max=99)
@AmountCheck
public Integer getAmountCents() { return amountCents; }
```

Declaring Composed Cross-Tests

```
// MaxAmount declaration
@CrossValidation
@BoolTest(BoolType.OR)
@OneLessThan(1)
@AllLessThan(10000)
public @interface MaxAmount {}

//AmountCheck declaration
@CrossValidation
@BoolTest(BoolType.AND)
@SumMin(1)
@MaxAmount
public @interface AmountCheck {}
```

@AmountCheck



Custom Error Message

```
@Validation
@BoolTest(BoolType.AND)
@PatMatch("\\w8|\\w11")
@AdditionalTest
@ValErr(message="Invalid BIC")
public @interface ValidateBIC{}
```

```
The value "BICCODE" returned by method "getBIC" has not
passed the following property-test:
+Test:  @ValidateBIC()
 (Error Message:  Invalid BIC) because:
 |-+Test:  @PatMatch(value=\w8|\w11)
================================================
The following cross-tests have failed:
+Test:  @AmountCheck() because:
 |-+Test:  @MaxAmount() because:
  |-+Test:  @OneLessThan(value=1)
  |-+Test:  @AllLessThan(value=10000)
+Test:  @AllOrNoneNull()
+Test:  @ExactlyOneNull() because:
 |-+Test:  @ExactlyNNull(value=1)
================================================
```

- Heimdall
- Struts 2
- Java Specification Request (JSR) 303: Bean Validation
- Hibernate
- Hookom and Holmgren

`http://shipvalidator.sourceforge.net`