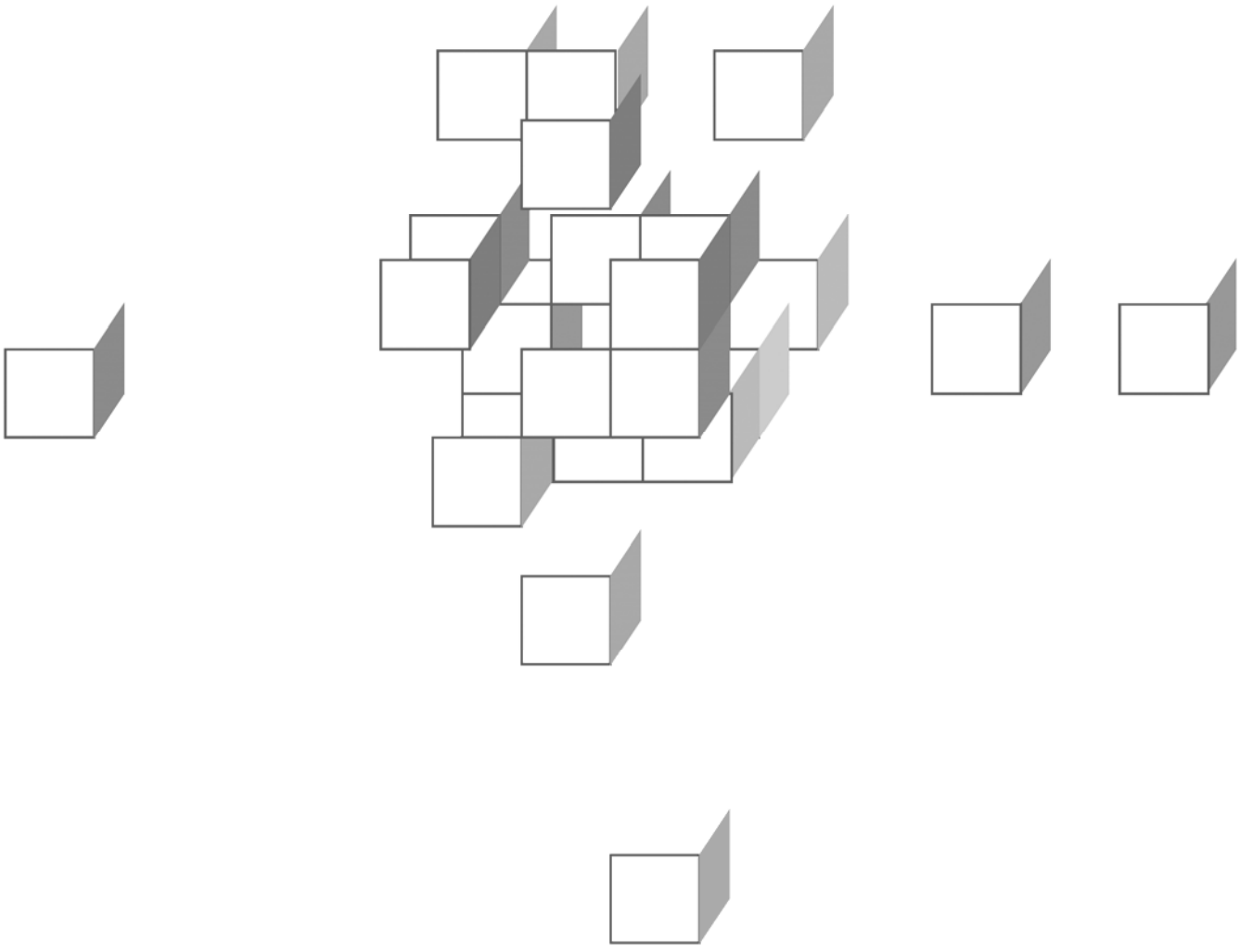
Chapter 6

Error Handling and Validation



OBJECTIVES

After completing "Error Handling and Validation," you will be able to:

- **Handle error conditions during request processing using Spring-MVC exception-handling techniques:**
  - Dedicated exception classes, annotated to translate instances automatically into HTTP responses
  - Declared exception-handling methods
- **Validate request content using Java-EE Bean Validation.**
- **Report validation errors clearly using custom exception handlers.**

Error Handling for REST Services

- **Thus far we've taken a fairly relaxed approach to error conditions in our exercises in REST services.**
  - Some services are defensive in detecting bad input or a failure to achieve the requested result, and do their own error messaging, for example in plain text.
  - Some are letting internal errors translate automatically to HTTP 500 responses – which is to say, they're not doing much at all!
- **We'll start to practice more robust error handling, and return more informative responses. Some good codes to keep in mind:**
  - HTTP 404 when an object is not found – just as we would get a 404 from the container if a URL were not found
  - HTTP 400 for bad inputs – a "bad request" response with some clarifying error message in the body
  - HTTP 409 for a conflict, such as when a caller tries to create a new object with an ID that already exists

Strategies

- **We could build error-handling into a service in a few ways.**
- **We might implement each method to do its own checking and handling.**
  - But this would be **clumsy**, hard to **maintain**, and even gets in the way of using **@ResponseStatus** to define a static response code.
  - Will every method now need to declare **ResponseEntity<>** for some type **T** as its return type, so that we can have dynamic control over the response code?
- **We could define helper methods to centralize production of error responses.**
  - This might address the re-use problem, but still leaves us with awkward choices in the method signature.
- **We could use Java exception handling: write methods as we currently do, and throw exceptions to express failure cases.**
  - But, who catches those exceptions?
  - How are they then translated to HTTP? We may be facing an unacceptable **loss of control** over the response.

HandlerExceptionResolver

- **Happily, DispatcherServlet offers more hooks than we've seen so far, and one of those is for exception handling.**
- **You can declare one or more exception handlers in the context configuration, and any exceptions that fall through to the servlet will be handed over to them.**
  - The interface to implement is **org.springframework.web.servlet. HandlerExceptionResolver**:

```
public interface HandlerExceptionResolver
{
  public ModelAndView resolveException
    (HttpServletRequest request,
      HttpServletResponse response,
      Object handler, Exception ex);
}
```

  - Any and all beans of this type will be discovered and wired to the servlet.
  - The handler becomes essentially a fallback controller: note the similarity of the handling method to controller **handleRequest**.
- **Exception handlers are called for errors occurring during controller execution; note that this excludes data binding, validation, and view resolution.**

@ExceptionHandler

- **You can also identify one or more methods on your controller as @ExceptionHandlers for that controller.**

```
@ExceptionHandler
public String handleError (Exception ex) { ... }
```

- **You can be specific about the type of exception you want to handle, just by stating a specific Exception subclass as the type of one of your parameters.**
  - Or you can use the **value** element of the annotation itself to identify the exception class your method is meant to handle.
- **The method signature is similarly flexible to that of a @RequestMapping method.**
  - **Parameter types** include **exceptions**, HTTP **request**, **response**, and **session** objects, Spring web request object, or stream objects.
  - **Return types** can be the usual means of identifying model and/or view, including **String**, **ModelAndView**, etc.
  - You can annotate for RESTful responses, too, with **@ResponseStatus**, **@ResponseBody**, etc.
- **The top-level configuration option described earlier is more global, while this approach is controller-scoped.**

@ControllerAdvice for Global Error Handling

- **Some sorts of error handling will naturally apply to more than one Spring-MVC controller.**
- **You can define your own HandlerExceptionResolver, as shown earlier in the chapter.**
- **A more modern approach is to annotate a class as providing @ControllerAdvice.**
  - Such a class can define its own **@InitBinder**, **@ModelAttribute**, and **@ExceptionHandler** methods – only the last of which is really interesting to a REST web service.
  - Any such methods will be applied to request handling by many controllers, as if defined within those controller classes.
- **You can apply controller advice to ...**
  - All controllers in the context – which is the default

```
@ControllerAdvice
```

  - Controllers of certain classes (or subtypes of them):

```
@ControllerAdvice
  (assignableTypes={A.class,B.class})
```

  - Controllers that bear a specific annotation:

```
@ControllerAdvice(annotations=MyQualifier.class)
```

  - Controllers found under a given base package:

```
@ControllerAdvice(basePackage="com.me.controllers")
```

Dedicated Exception Classes

- You can also annotate an exception type, in order to fix an HTTP response code to it for purposes of Spring MVC.

```
@ResponseStatus
(
  value=HttpStatus.BAD_REQUEST,
  reason="Missing information in request."
)
public static class BadInputException { ... }
```

- If an exception of such a type is caught as part of request processing, Spring MVC's **ResponseStatusExceptionResolver** will translate this to a stock error response with the given code.
- This is a nice tool for exception classes that you define yourself, but it's of limited use, because you will usually have to contend with exceptions that you can't annotate.
  - You could define your own library of REST-specific exceptions.
  - Then you'd spend a lot of code in your request-handling methods translating a caught exception – null-pointer, illegal-argument, etc. – into one of your own.
- The **@ExceptionHandler** method is a more powerful and general-purpose tool.

Common CRUD Error Responses

DEMO

- **Let's look at a new version of the DB.java service.**
  - Recall that the very first version of this service had a nice, natural mapping of returned values to response bodies as plain text.
  - Then, in order to handle error cases, we converted most methods over to using **ResponseEntity<String>** instead. This allowed us to control the response code, headers, and body dynamically; but it complicated the method signatures and implementations.
  - In **Basic_Step3** is a version that goes back to the simpler style, and lets dedicated exception classes do most of the work when errors are encountered.
  - We'll review this version, and try it out; and then find that we can refine it a little further, leading to answer code in **Basic_Step4**.
- **See src/cc/rest/DB.java, and note first the new exception types:**

```
public class DB
{
  @ResponseStatus(HttpStatus.NOT_FOUND)
  public static class NotFound
    extends RuntimeException {}

  @ResponseStatus(HttpStatus.CONFLICT)
  public static class Conflict
    extends RuntimeException {}
  ...
```

Common CRUD Error Responses

DEMO

– Then, in each request-handling method, we're back to returning the success-case value or message; and when there's trouble we just throw the appropriate exception type:

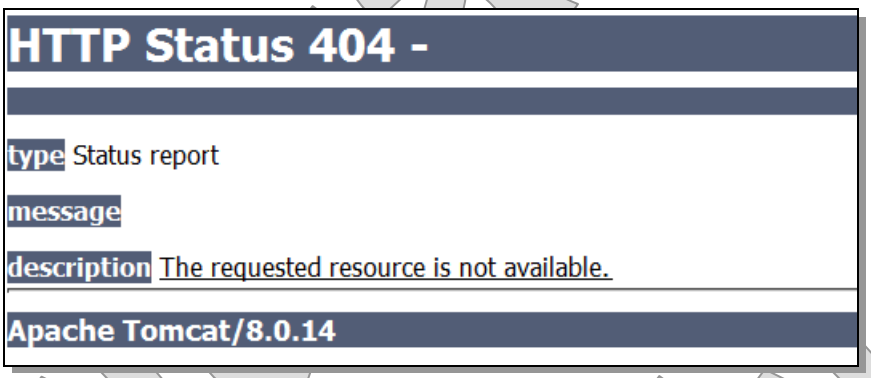
```
@RequestMapping
  (value="/{key}",method=RequestMethod.GET)
public String get
  (@PathVariable("key") String key)
{
  System.out.println ("GET key=" + key);
  if (!values.containsKey (key))
    throw new NotFound ();

  return values.get (key).toString ();
}
...
@RequestMapping
  (value="/{key}",method=RequestMethod.POST)
@ResponseStatus(HttpStatus.CREATED)
public String post
(
  @PathVariable("key") String key,
  @RequestBody String value
)
{
  System.out.println
    ("POST key=" + key + "&value=" + value);
  if (values.containsKey (key))
    throw new Conflict ();

  values.put (key, Integer.parseInt (value));
  return value;
}
...
```

Common CRUD Error Responses

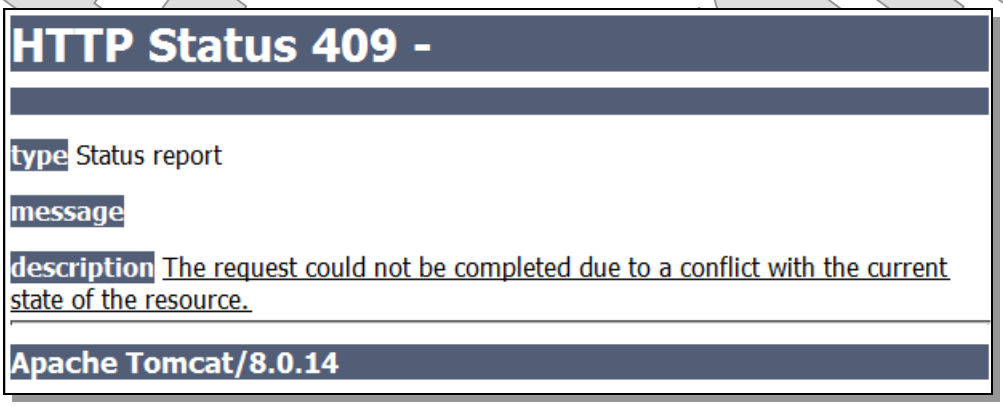
DEMO

1. Deploy this version of the service, and test as follows.
   - You'll see the HTML error pages, as below, in the **HTML** view of the HTTPPad tool.

```
GET /Basic/Number/A HTTP/1.1

HTTP/1.1 200 OK
Content-Type: text/plain;charset=ISO-8859-1

1

GET /Basic/Number/Z HTTP/1.1
```




```
POST /Basic/Number/A HTTP/1.1
Content-Type: text/plain

10
```



Common CRUD Error Responses

DEMO

- **So, it's perhaps a step in the right direction, but this version leaves some things to be desired.**
  - We might want to stick to plain text as our response type, given that this is what the rest of the service uses.
  - We can't express an error message – just the code.

2. Create a new nested class **CodedException** that will encapsulate a desired HTTP response code and a string message:

```
public static class CodedException
  extends RuntimeException
{
  public HttpStatus responseCode;
  public String message;

  public CodedException
    (HttpStatus responseCode, String message)
  {
    this.responseCode = responseCode;
    this.message = message;
  }
}
```

Common CRUD Error Responses

DEMO

3. Now, we can keep the dedicated types, and just re-wire them as extensions of the new class. Adjust **NotFound** to take a key, and to pass the 404 error code and a synthesized error message along to the superclass constructor. You can also drop the **@ResponseStatus** annotation now:

```
@ResponseStatus(HttpStatus.NOT_FOUND)
public static class NotFound
  extends CodedException
{
  public NotFound (String key)
  {
    super (HttpStatus.NOT_FOUND,
      "No such key: " + key);
  }
}
```

4. Do the same for the **Conflict** class:

```
@ResponseStatus(HttpStatus.CONFLICT)
public static class Conflict
  extends CodedException
{
  public Conflict (String key)
  {
    super (HttpStatus.CONFLICT,
      "A value is already defined for key: " +
        key);
  }
}
```

Common CRUD Error Responses

DEMO

5. Now we'll need to adjust the calls to all of these constructors, because each now requires an argument where it didn't, before ...
   - In **get**, **put**, and **delete**:

```
if (!values.containsKey (key))
  throw new NotFound (key);
```

   - In **post**:

```
if (values.containsKey (key))
  throw new Conflict (key);
```

6. So far, we'd just get the same responses if we were to test again, because Spring MVC won't know what to do with the extra information in our **CodedException** type. This is a job for an exception handler!

```
@ExceptionHandler
public ResponseEntity<String> handle
  (CodedException ex)
{
  HttpHeaders headers = new HttpHeaders ();
  headers.add
    ("Content-Type", MediaType.TEXT_PLAIN_VALUE);

  return new ResponseEntity<>
    (ex.message, headers, ex.responseCode);
}
```

   - Spring MVC will call this method whenever it catches a **CodedException**, and it will treat the behaviors of this method just as it would do with a normal request-handling method.
   - So now we can manage code, content type, and body.

Common CRUD Error Responses

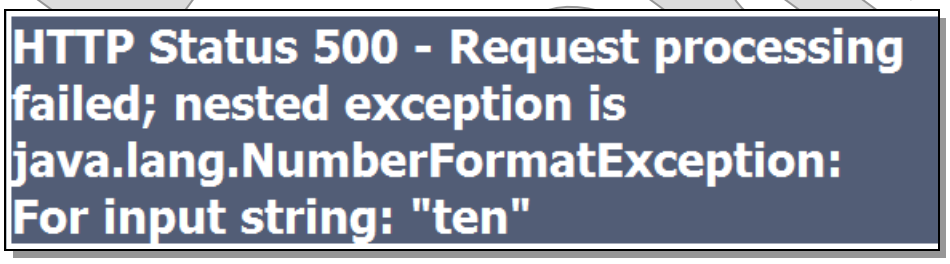
DEMO

7. Build and test the updated service, and see the difference in the error responses:

```
GET /Basic/Number/Z HTTP/1.1

HTTP/1.1 404 Not Found
Content-Type: text/plain

No such key: Z

POST /Basic/Number/A HTTP/1.1
Content-Type: text/plain

10

HTTP/1.1 409 Conflict
Content-Type: text/plain

A value is already defined for key: A
```

8. Try one more request, and see how your service handles it:

```
PUT /Basic/Number/A HTTP/1.1
Content-Type: text/plain

ten
```



Common CRUD Error Responses

DEMO

9. We can do better than that ... right? Add a second exception handler to the service:

```
@ExceptionHandler
public ResponseEntity<String> handle
  (NumberFormatException ex)
{
  HttpHeaders headers = new HttpHeaders ();
  headers.add
    ("Content-Type", MediaType.TEXT_PLAIN_VALUE);

  return new ResponseEntity<>
    ("Expecting a numeric value.",
      headers, HttpStatus.BAD_REQUEST);
}
```

10. Test to see that you can handle this built-in exception about as easily as you do your own, defined exception classes:

```
PUT /Basic/Number/A HTTP/1.1
Content-Type: text/plain

ten

HTTP/1.1 400 Bad Request
Content-Type: text/plain

Expecting a numeric value.
```

Error Handling in the Billing Service

LAB 6A

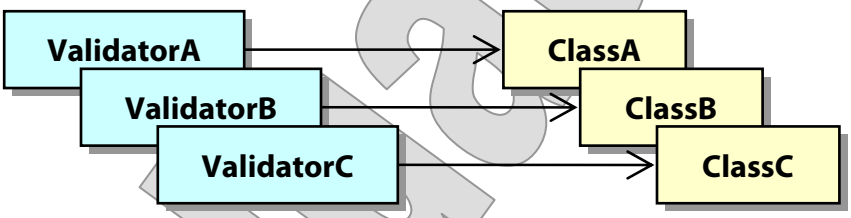
Suggested time: 30-45 minutes

In this lab you will add error handling to the Billing service, mostly by way of generic handling in **WebService<T>**. Then you'll define and handle a specific exception type for the **InvoiceWebService.**

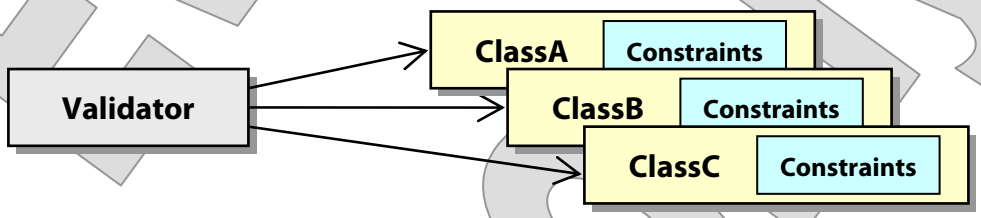
Detailed instructions are found at the end of the chapter.

Validation in Spring MVC

- Spring offers strong support for two means of validating inputs to an application, each based on a different theory of how and where constraints should be defined.
- Early in the evolution of object-oriented design, the idea that a class should be able to validate itself was discredited.
- For a long time Spring has espoused the idea that a separate validator class is defined and dedicated to a given target class.



  - This gave rise to the **Validator** interface and to **ValidationUtils**.
- An interesting middle-ground approach has gained popularity more recently, in which, yes, a separate validator is responsible for the process, but is itself completely generic, and is informed by metadata expressed on the target class:



  - This was proven in concept by the **Hibernate Validator** and is now a Java-EE standard known as **Bean Validation**.
- Spring supports both approaches, but for RESTful services, where inputs will mostly be in the form of HTTP entities, the Bean Validation approach makes the most sense.

Java-EE Bean Validation

- A new validation standard enters the Java EE platform as of edition 6: this is known as **Bean Validation**, or sometimes by its original JSR number, 303.
- By this standard, any JavaBean can carry source-code annotations that declare validation constraints on its properties.
- These annotations can then be observed and enforced by a validation tool – at any time, in any tier of the application.
- So the advantage is that we can define validation constraints once, instead of having to write them out in different languages for different parts of a large application.
- In these exercises we're using the Hibernate Validator, version 5.1, which implements the Bean Validation 1.1 standard.

Validation Annotations

EXAMPLE

- The **BeanValidation** project holds a simple Java SE application that validates values on two different JavaBeans.
- One of these is familiar – see **src/cc/math/Ellipsoid.java**:

```
@DecimalMin
(
  value="0",
  inclusive=false,
  message="Semi-axis A must be a positive number"
)
private double a = 1;
```

- The other, in **src/cc/web/PersonalInfo.java**, sets various constraints on its properties: rejecting **null** values and enforcing a regular expression, setting a value range, etc:

```
@NotNull
@Pattern
(
  regexp="([A-Za-z\\'\\-]+)( [A-Za-z\\'\\-]+)+",
  message="Must include at least ..."
)
private String name;

@Min
(
  value=18,
  message="Age must be at least 18"
)
@Max
(
  value=120,
  message="Age must be no greater than 120"
)
private int age;
```

Validation Annotations

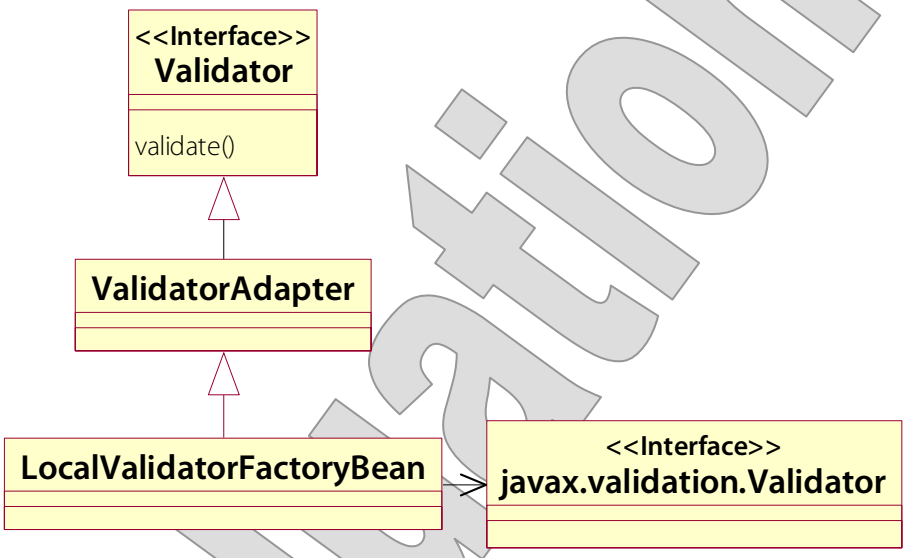
EXAMPLE

- **An application class creates a few instances of each type and applies the Bean Validator to them; we won't dig into this code as it's not directly relevant to JSF practice, since the JSF implementation will carry out this process for us.**
- **Build and test with run from the command line.**
  - Or, in Eclipse, just find **cc.validation.ValidateEverything**, and Run as Java Application.

```
Ellipsoid "sphere":
  Validation succeeded.

Ellipsoid "twoD":
  Semi-axis B must be a positive number.

Ellipsoid "senseless":
  Semi-axis C must be a positive number.

Good PersonalInfo:
  Validation succeeded.

Bad PersonalInfo:
  Must include at least first and last name.
  Please keep reference to 40 characters or less.
  Invalid e-mail address.
  Invalid SSN.
  Age must be at least 18.
```

Configuration in Spring

- **Spring adopts Bean Validation as an option by providing an adapter: the LocalValidatorFactoryBean.**



  - An object of this type will satisfy calling code that expects an **org.springframework.validation.Validator**, and it turns around and delegates actual validation to a Java-EE Bean Validator.
- **This class is both ApplicationContextAware and an InitializingBean – so it's much easier to configure than to create programmatically.**
- **Then inject it into your controller, and you are ready to use it.**
  - Call the validator manually.
  - Or configure it via an **@InitBinder**, calling **setValidator** on the data binder you are given.
  - A Bean Validation implementation – a/k/a a Bean Validator – must be found on the class path.

Automatic Support with @Valid

- **An even easier way to use Bean Validation is to get implicit support via `<mvc:annotation-driven>` configuration.**
  - You can set a **global validator** explicitly on this element – and this can be any Spring validator.
  - But if you don't, you will get the **Bean Validation adapter**.
- **Then, for an entity parameter annotated with @Valid, the Bean Validator will be invoked.**
  - It will then apply whatever constraints are defined on the class to the object at hand.
  - It will report violations to an **Errors** object, which is ultimately a map with "field names" or identifiers for content parts as keys and lists of error messages as values.
  - This will be found via a **MethodArgumentNotValidException** (package **org.springframework.web.bind**) that is thrown by the framework after the binding-and-validation process completes – meaning, before the method that declared the **@Valid** constraint is invoked.
  - Note that **@Valid** is not a Spring annotation, but a Bean Validation one; find it in the package **javax.validation**.

Validating Ellipsoids

EXAMPLE

- In **Ellipsoid_Step4**, we've adopted the Bean-Validation constraints shown earlier for the **Ellipsoid** class.
- We are **<mvc:annotation-driven>**, and required JARs are in the compile-time and server class paths.
- So all that remains is to require that the **ellipsoid** parameter be **@Valid**.
  - This will work both for command objects (as it was originally meant to in Spring MVC) and for request entities – although the means of error reporting are very different.
  - We have just annotated the **getEllipsoid** method, at the bottom of the source file:

```
@RequestMapping(value="/Analyze",
  consumes=MediaType.APPLICATION_JSON_VALUE,
  produces=MediaType.APPLICATION_JSON_VALUE)
@ResponseBody
public Ellipsoid getEllipsoid
  (@RequestBody @Valid Ellipsoid ellipsoid)
{
  return ellipsoid;
}
```

  - With just this, we would get an HTTP 400, Bad Request, if any of the input values were zero or negative.

Validating Ellipsoids

EXAMPLE

- But we can do a bit better by declaring an exception-handling method:

```
@ExceptionHandler
public ResponseEntity<String> handleError
  (MethodArgumentNotValidException ex)
{
  return new ResponseEntity<String>
    ("All semi-axis lengths must be " +
        "positive numbers.",
      HttpStatus.BAD_REQUEST);
}
```

- This will at least give a meaningful message as the body of the HTTP 406 response.

- **Deploy this application and test using HTTPPad – you can see this final test request at the bottom of HTTP/TestScript.txt:**

```
GET /Ellipsoid/REST/Analyze HTTP/1.1
Content-Type: application/json

{ "a": -1.0, "b": 3.0, "c": 3.0 }
```

- The parsed **Ellipsoid** will fail the validation constraint on **a**, throwing a **MethodArgumentNotValidException**.
- Our **handleError** method will then send the response:

```
HTTP/1.1 400 Bad Request
Content-Type: application/json

All semi-axis lengths must be positive numbers.
```

Bean Validation for a Generic Service

DEMO

- We'll add Bean Validation as a standard feature to our **WebService<T>**, and apply a few constraints to Billing domain classes to see validation in play.
- Then we'll re-factor a prepared exception handler to a new **@ControllerAdvice** class, which will be re-usable in other projects.
  - Do your work in **Billing_Step3**.
  - The completed demo is found in **Billing_Step4**.
- In **src/cc/rest/WebService.java**, we already have an exception handler for the **MethodArgumentNotValidException**, and so we're ready to report Bean Validation exceptions as plain-text HTTP 400 responses:

```
@ExceptionHandler
public ResponseEntity<String> onInvalidEntity
  (MethodArgumentNotValidException ex)
{
  String message = String.format
    ("Validation of the request entity failed, "
      + "with the following messages:%n");
  for (FieldError error :
      ex.getBindingResult ().getFieldErrors ())
    message += String.format
      ("  %s: %s%n", error.getField (),
        error.getDefaultMessage ());

  return new ResponseEntity<String>
    (message, HttpStatus.BAD_REQUEST);
}
```

Bean Validation for a Generic Service

DEMO

1. Deploy the service, and test with the following request, as found at the bottom of **HTTP/CustomerCRUD.txt**:

```
POST /Billing/REST/Customer/Create HTTP/1.1
Content-Type: application/json

{"firstName":"Millicent","lastName":"Mobry","addres
s1":"993 Moodicus Parkway","address2":"",
"city":"Mursky","state":"MT","zip":"78311",
"email":"not an e-mail address"}

HTTP/1.1 201 Created
Content-Type: application/json;charset=UTF-8

{"firstName":"Millicent","lastName":"Mobry","addres
s1":"993 Moodicus
Parkway","address2":"","city":"Mursky","state":"MT"
,"name":"Millicent Mobry","id":6,"email":"not an e-
mail address","zip":"78311"}
```

   – So the customer's e-mail address would be in our database in this obviously useless form.

2. Open **src/cc/billing/Customer.java** and un-comment a prepared constraint on the **eMail** field:

```
  /*
  @Pattern
  (
    regexp="\\w+([\\.-]?\\w+)*@\\w+([\\.-]?\\w+)*
      \\.(\\w{2}|(com|net|org|edu|int|mil|gov|arpa|
        biz|aero|name|coop|info|pro|museum))",
    message="Invalid e-mail address"
  )
  */
  private String eMail;
```

Bean Validation for a Generic Service

DEMO

3. In **src/cc/rest/WebService.java**, add the **@Valid** annotation to the parameter to each of the **add** methods, and to the **update** method:

```
public T add (@RequestBody @Valid T newObject)
...
public void add (@RequestParam int ID,
  @RequestBody @Valid T newObject)
    throws CRUDService.ConflictException
...
public void update
  (@RequestBody @Valid T modifiedObject)
    throws CRUDService.NotFoundException
```

4. Deploy and test, with the same request:

```
HTTP/1.1 400 Bad Request
Content-Type: text/plain;charset=ISO-8859-1

Validation of the request entity failed,
with the following messages:
  eMail: Invalid e-mail address
```

   - So the Bean Validator was engaged by Spring MVC, because it saw the **@Valid** annotation on the parameter.
   - When it found the e-mail value for this instance violated the **@Pattern** constraint, it threw its own exception.
   - This was caught, an error message packed into an **Errors** object, and this was wrapped in a **MethodArgumentNotValidException** – which the prepared handler method caught and translated to a plain-text HTTP 400.

Bean Validation for a Generic Service

DEMO

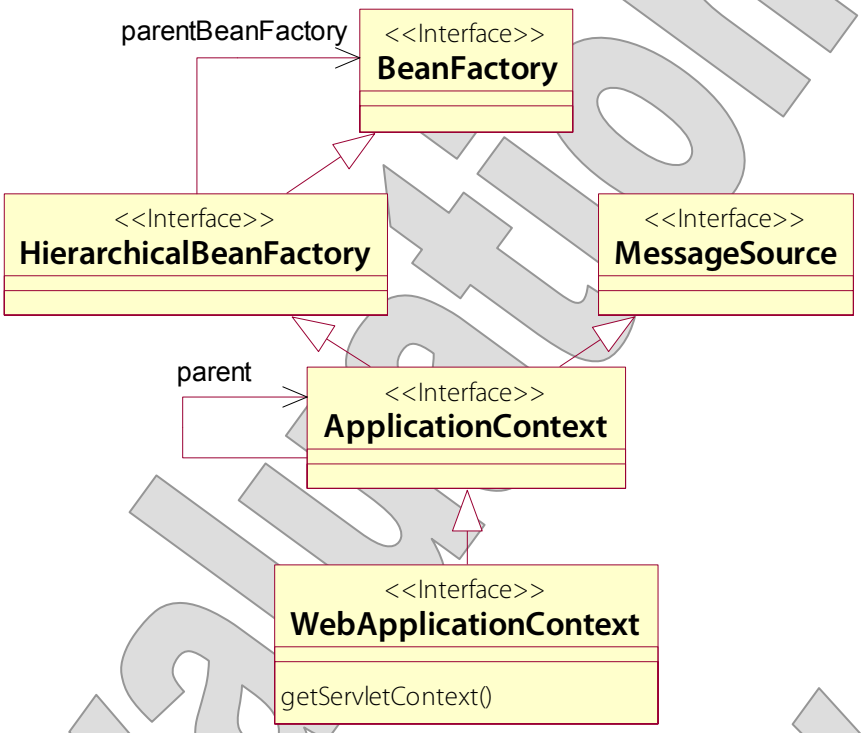
5. Create a new class **cc.rest.BeanValidationExceptionHandler**.
6. Cut the **onInvalidEntity** method from **WebService**, and paste it as the only content of the new class.
7. Annotate the class as **@ControllerAdvice**, so that the method will still be available to all controllers. So the full new source file is:

```
@ControllerAdvice
public class BeanValidationExceptionHandler
{
  @ExceptionHandler
  public ResponseEntity<String> onInvalidEntity
    (MethodArgumentNotValidException ex)
  {
    String message = String.format
      ("Validation of the request entity failed, "
        + "with the following messages:%n");
    for (FieldError error :
        ex.getBindingResult ().getFieldErrors ())
      message += String.format
        ("  %s: %s%n", error.getField (),
          error.getDefaultMessage ());

    return new ResponseEntity<String>
      (message, HttpStatus.BAD_REQUEST);
  }
}
```

8. Test again and see that the error handling is consistent.
   - And now the new class could be dropped into any other project that uses Bean Validation, and would work "out of the box."
   - The answer code also includes a constraint annotation in **Invoice.java**, asserting that invoice amounts can't be negative.

Configuring Message Sources for Localization

- Recall that any **ApplicationContext** is also a **MessageSource**.



- The web application context created by the **DispatcherServlet** can be configured with a default message source – just define a bean "messageSource":

```
<bean
  id="messageSource"
  class="org.springframework.context
    .support.ResourceBundleMessageSource"
>
  <property name="basename" value="messages" />
</bean>
```

- You can manually load and use as many other bundles as you like, but this one becomes the default for the application context, and will serve for localizable error-code lookups.

Resolving Error Codes

- The **Errors** interface offers overloads of various error-reporting methods.
- Here are the ways to report a field-level error on **Errors**:

```
public void rejectValue (String field, String code);
public void rejectValue (String field, String code,
  String defaultMessage);
public void rejectValue (String field, String code,
  Object[] args, String defaultMessage);
```

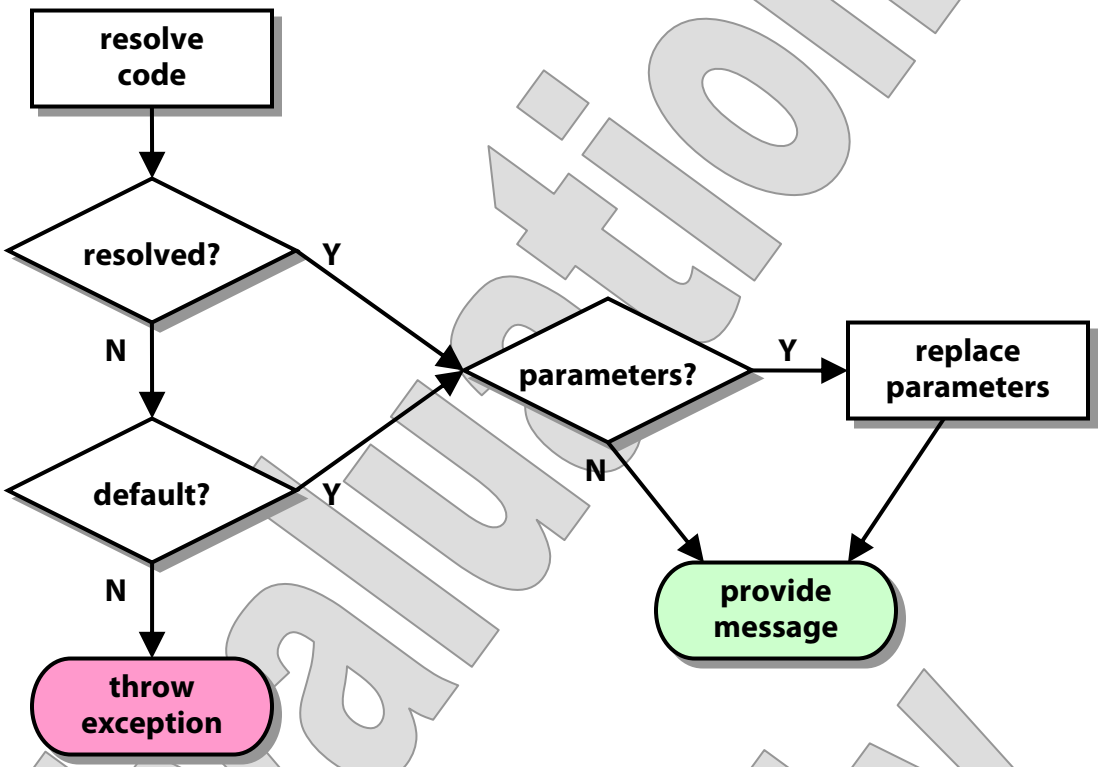
  - The first option is "flying without a net," in the sense that no default message is given by the application code. When the JSP tries to show the error message, if the code is not resolved by the applicable **MessageSource**, an exception will be thrown.
  - The second option supplies a default to be used in this case.
  - The third option also allows the code to provide arguments for replaceable parameters in the message, encoded as follows:

```
myMessage=Field {0} is wrong because {1}.
```

- When an object fails to pass a Bean Validation constraint, the **message** element of the constraint annotation will become the default message in the **Error** that gets reported.

Heuristic for Resolving Message Codes

- In order to resolve error objects to localized error messages, follow a heuristic like this:



  - The default message is used if the code can't be resolved.
  - If there is no default, an exception will be thrown.
  - Parameters will be replaced by provided arguments in either the resolved message or the default message.
- This is how `<form:errors>` tries to show error messages when building web pages with input forms in them, and similar code appears in producing the **message** property of various validation exception classes.
- We'll stick to the default message in most of our lab work.

Validating Orders

LAB 6B

Suggested time: 30 minutes

In this lab you will configure a bit of validation and error reporting for the Tracking service. You'll disallow non-positive quantities for line items in the order. Then you'll enforce this constraint for both of the methods that supply new data: **order** and **addToOrder**.

Detailed instructions are found at the end of the chapter.

SUMMARY

- **Spring's readiness to catch exceptions as thrown from your request-handling methods, and route them to your declared exception handlers, helps to keep those primary methods clean, and focused on service logic.**
- **You can configure exception handlers**
  - Per exception by annotating exception classes, where possible
  - Per controller with **@ExceptionHandler** methods
  - For multiple controllers via **@ControllerAdvice**
- **The Spring framework has traveled a long road in its quest for the perfect validation architecture.**
- **Ultimately, it found the answer in a Java EE standard, Bean Validation (which in turn came out of the Hibernate community).**
- **Spring MVC puts Bean Validation to work in a very simple way.**
- **The default error handling for REST services leaves something to be desired, especially compared to the relatively rich system enjoyed by web-application developers.**
- **But developing a custom exception handler is not hard, and so with a bit of extra effort you can get whatever depth and format of error reporting makes sense for your service.**

Error Handling in the Billing Service

LAB 6A

In this lab you will add error handling to the Billing service, mostly by way of generic handling in **WebService<T>**. Then you'll define and handle a specific exception type for the **InvoiceWebService.**

Lab project: **Billing_Step2**

Answer project(s): **Billing_Step3**

Files: * to be created
src/cc/service/CRUDService.java
src/cc/rest/WebService.java
src/cc/billing/rest/InvoiceWebService.java

Instructions:

1. Deploy the starter version of the service, and test, with an eye to a few error conditions – retrieving non-existent objects and adding objects with conflicting IDs:

```
GET /Billing/REST/Invoice/0 HTTP/1.1

See the usual Tomcat banner with the message:
HTTP Status 500 - Request processing failed; nested exception is
cc.service.CRUDService$NotFoundException: No Invoice found with ID 0.

GET /Billing/REST/Invoice/Number0 HTTP/1.1

Same as above, but the exception this time is a
cc.billing.InvoiceService$NotFoundByNumberException

PUT /Billing/REST/Invoice/Add?ID=1 HTTP/1.1
Content-Type: application/json

{"id":1,"amount":5000.0,"customer":{"EMail":"albertrawlins34@whee.net",
"ID":1,"ZIP":"67002","address1":"3306 North Shore
Drive","address2":"","city":"Algonquin","firstName":"Albert","lastName"
:"Rawlins","state":"SD"},"date":"2010-10-02T00:00:00-
04:00","number":7890551}

cc.service.CRUDService$ConflictException
```

So we can see that we have a ways to go here. In fact, the **CRUDService<T>** is already throwing some of its own dedicated exceptions, for things such as no-such-record and conflicting-key. But the **WebService<T>** isn't catching any of them – they are currently un-checked exceptions, so we get away with that – and then Spring MVC translates these to an HTTP 500, across the board.

Error Handling in the Billing Service LAB 6A

2. In **WebService.java**, define a static nested class **Error**. This will be the basis for a JSON-serialized error object to be used in HTTP responses. Your implementation will be iminimal, but loosely based on the JSON API standard for error objects.
3. Give it a field **status**, of type **int**, and a string **title**.
4. Build a constructor that initializes each of the two fields from given values.
5. Add accessor methods **getStatus** and **getTitle**.
6. Now give it a public, static method **produceResponse** that returns a **ResponseStatus<Error>** and takes an **HttpStatus** called **httpStatus** and an **Exception** called **ex** as parameters.
7. Implement this method to build a response with JSON as the media type and the given **httpStatus** as its response code. For the body, build an instance of **Error** and populate **status** with the results of a call to **httpStatus.value** and **title** with the results of a call to **ex.getMessage**.
8. Add an exception handler for the **CRUDService.NotFound** exception. Just have it return the results of a call to **Error.produceResponse**, passing the given exception object and the code **HttpStatus.NOT_FOUND**.
9. Test the first request again, and see a better response (especially via the **JSON** view in HTTPPad):

```
GET /Billing/REST/Invoice/0 HTTP/1.1

HTTP/1.1 404 Not Found
Content-Type: application/json

{
  "title": "No Invoice found with ID 0.",
  "status": 404
}
```

10. Test the second request, and see that this, too, has been improved.

```
GET /Billing/REST/Invoice/Number0 HTTP/1.1

HTTP/1.1 404 Not Found
Content-Type: application/json

{
  "title": "No invoice with number 0",
  "status": 404
}
```

Error Handling in the Billing Service LAB 6A

Now, how did that second one work? You just invoked a method defined in **InvoiceWebService**, and it was handled by a method defined in **WebService<T>**. There are a couple of inheritance relationships that matter, here. Of course the service object is an **InvoiceWebService**, and this inherits your exception-handling method along with all the other methods. So that's not so surprising. Then, notice that **getByNumber** throws **InvoiceService.NotFoundByNumberException** – which extends **CRUDService.NotFoundException**, and that means that your exception handler picks it up too, automatically. The exception's message is used as the response body, and so you get a nice polymorphic reaction from your code.

11. Do the same for the **CRUDService.ConflictException**. Test the third request and see that you've got that under control as well:

```
PUT /Billing/REST/Invoice/Add?ID=1 HTTP/1.1
Content-Type: application/json

{"id":1,"amount":5000.0,"customer":{"EMail":"albertrawlins34@whee.net",
"ID":1,"ZIP":"67002","address1":"3306 North Shore
Drive","address2":"","city":"Algonquin","firstName":"Albert","lastName"
:"Rawlins","state":"SD"},"date":"2010-10-02T00:00:00-
04:00","number":7890551}

HTTP/1.1 409 Conflict
Content-Type: application/json

{
  "title": "There is already a Invoice with ID 1.",
  "status": 409
}
```

Note that, in the answer code in **Billing_Step3**, these two exception types have also been converted from **RuntimeExceptions** to ordinary, checked **Exceptions**. This is, arguably, the more appropriate style for such conditions (and the **AlreadyPaidException** you'll develop later in the lab is a natural checked exception, too). We had them as un-checked exceptions in the early going so as to simplify work in the earlier lab where you built the web services themselves, but now all of the service methods are signed, as appropriate, to say that they may throw this or that checked exception.

The answer code also includes a third exception handler, for exceptions thrown during Java-EE Bean Validation; we'll work with this as a starting point for a later demonstration.

Error Handling in the Billing Service LAB 6A

Optional Steps

In this section of the lab, you'll define a custom exception tied to a business rule, which is that paid invoices can't be adjusted after the fact. You'll create an exception handler just for this new type, which will write a more detailed JSON error representation in the HTTP response.

12. Create a new class **AlreadyPaidException**, as a static nested class inside of **InvoiceWebService**. Give it an **invoice** field, of type **Invoice**, and a constructor that allows it to be created with reference to an **Invoice**. Provide a **getInvoice** method.
13. Define methods **getSummary** and **getDetail**, both returning strings. The summary message can be a literal string, such as "Can't adjust an invoice that's been paid." The detail should be more informative and dynamic, including for example the invoice number and the date of payment.
14. Override **getMessage** to return a concatenation of the summary and detail messages.
15. Create a second, static, nested class, **DetailedError**, which extends your existing **Error** class and adds a **detail** field. Define a constructor that takes response code, summary, and detail messages, and a **getDetail** method.
16. Add an **@ExceptionHandler** method for the **AlreadyPaidException** that does something like what **Error.produceResponse** does, but creates a **DetailedError** object for the message body, and always returns an HTTP 400.
17. Add a check in the **adjust** method, after getting the **invoice** but before doing anything with it: if its **paidDate** property is not **null**, then throw a new **AlreadyPaidException** that refers to the **invoice**.
18. Test with the following sequence of requests. You want to see responses similar to the following:

```
PUT /Billing/REST/Invoice/Number456/Pay?paymentType=CHECK HTTP/1.1

HTTP/1.1 204 No Content

PUT /Billing/REST/Invoice/Number456/Adjust?amount=100 HTTP/1.1

HTTP/1.1 400 Bad Request
Content-Type: application/json

{
  "detail": "Invoice 456 was paid on <date>.",
  "title": "Can't adjust an invoice that's been paid.",
  "status": 400
}
```

Validating Orders

LAB 6B

In this lab you will configure a bit of validation and error reporting for the Tracking service. You'll disallow non-positive quantities for line items in the order. Then you'll enforce this constraint for both of the methods that supply new data: **order** and **addToOrder**.

Lab project: **Tracking_Step5**

Answer project(s): **Tracking_Step6**

Files: * to be created
src/org/biz/xml/Line.java
src/org/biz/xml/Order.java
src/org/biz/TrackingService.java

Instructions:

1. Open **Line.java** and find the **quantity** field.
2. Add a constraint to this field, as shown below:

```
@XmlElement(required = true)
@Min(value=1, message="Quantity must be positive.")
protected BigInteger quantity;
```

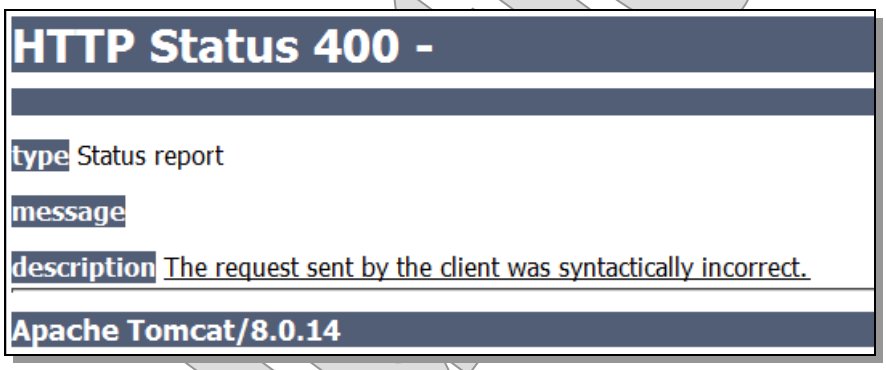
3. Now open **TrackingService.java**, and annotate the method parameter on **addToOrder** as being **@Valid**.

Validating Orders LAB 6B

4. Deploy the application and test with HTTPPad, as follows. You can find template requests in **HTTP/TestScript.txt**, and just tweak the **quantity** value to be negative:

```
PUT /Tracking/REST/AddToOrder/4 HTTP/1.1
Content-Type: application/json

{"quantity":-100,"item":{"partNumber":6,"name":"India Assam"}}
```

   You see that the validation constraint was tripped – but the error response leaves something to be desired:



5. Copy the **BeanValidationExceptionHandler.java** source file from **Billing_Step4** and put it in place in the Tracking project. Best to paste this into the existing package **org.biz**: it's more generic than that, but if you place it in for example the **cc.rest** package where it lives in the Billing example, you'll need to update your **Tracking-servlet.xml** because the **<context:component-scan>** element has a base package of "org.biz", which will cause it to miss the new component in **cc.rest**.

6. Test again:

```
HTTP/1.1 400 Bad Request
Content-Type: text/plain;charset=ISO-8859-1

Validation of the request entity failed, with the following messages:
  quantity: Quantity must be positive.
```

Validating Orders LAB 6B

7. Now make the **order** parameter on the **order** method **@Valid** as well.
8. Test this with a request such as the following. Again, use a good request in the test script as a template, and then make sure that both of the **quantity** values are negative:

```
POST /Tracking/REST/Create HTTP/1.1
Content-Type: application/json

{"id":5,"customerID":7890,"status":"RECEIVED","contents":{"line":
[{"quantity":-200,"item":{"partNumber":1,"name":"Yunnan"}},
{"quantity":-100,"item":{"partNumber":6,"name":"India Assam"}}]}}

HTTP/1.1 201 Created
Content-Type: text/plain;charset=ISO-8859-1

Order created.
```

   Strangely, this request seems to succeed. You can further confirm this by GETting the details on the order with ID 5. Why didn't the validation constraints kick in on the **Line** sub-objects?

   This is just something to know about Bean Validation: though a **Validator** is capable of recursion through object graphs, that recursion is not automatic, In many reflection-driven processes, such as Java Serialization, JAXB marshalling, or the Java Persistence API, you get recursion automatically and can "opt out" with keywords (**transient**) or annotations (**@XmlTransient**).

   With Bean Validation, you must "opt in" by declaring that an object-reference field is **@Valid** itself. Then the validator will be happy to recurse to sub-objects and will enforce their classes' constraints as well.

9. Open **Order.java** and make the **contents** field **@Valid**.
10. Then find the inner class **Contents** and make sure that the **line** field on this class is **@Valid** too. (The validator is smart enough to iterate the **List<Line>** and validate each element in it; no need to update the source code for **List.java**!)
11. Deploy and test again – aha! now you should see that validation kicked in, and that your souped-up exception handler is paying off:

```
HTTP/1.1 400 Bad Request
Content-Type: text/plain;charset=ISO-8859-1

Validation of the request entity failed, with the following messages:
  contents.line[1].quantity: Quantity must be positive.
  contents.line[0].quantity: Quantity must be positive.
```