Invoking Java Code with JSP Scripting Elements

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Taught by the author of Core Servlets and JSP, More Servlets and JSP, and this tutorial. Available at public venues, or customized versions can be held on-site at your organization. Contact hall@coreservlets.com for details.
### Agenda

- Static vs. dynamic text
- Dynamic code and good JSP design
- JSP expressions
- Servlets vs. JSP pages for similar tasks
- JSP scriptlets
- JSP declarations
- Predefined variables
- Comparison of expressions, scriptlets, and declarations
- XML syntax for JSP pages
**Uses of JSP Constructs**

- Scripting elements calling servlet code directly
- Scripting elements calling servlet code indirectly (by means of utility classes)
- Beans
- Servlet/JSP combo (MVC)
- MVC with JSP expression language
- Custom tags
- MVC with beans, custom tags, and a framework like JSF 2.0

**Design Strategy: Limit Java Code in JSP Pages**

- **You have two options**
  - Put 25 lines of Java code directly in the JSP page
  - Put those 25 lines in a separate Java class and put 1 line in the JSP page that invokes it
- **Why is the second option much better?**
  - **Development.** You write the separate class in a Java environment (editor or IDE), not an HTML environment
  - **Debugging.** If you have syntax errors, you see them immediately at compile time. Simple print statements can be seen.
  - **Testing.** You can write a test routine with a loop that does 10,000 tests and reapply it after each change.
  - **Reuse.** You can use the same class from multiple pages.
### Basic Syntax

**• HTML Text**
- `<H1>Blah</H1>`
- Passed through to client. Really turned into servlet code that looks like
  - `out.print("<H1>Blah</H1>");`

**• HTML Comments**
- `<!-- Comment -->`
- Same as other HTML: passed through to client

**• JSP Comments**
- `<%-- Comment --%>`
- Not sent to client

**• Escaping <**
- To get `<%` in output, use `<\%`

### Types of Scripting Elements

**• Expressions**
- Format: `<%= expression %>`
- Evaluated and inserted into the servlet’s output. I.e., results in something like `out.print(expression)`

**• Scriptlets**
- Format: `<% code %>`
- Inserted verbatim into the servlet’s `_jspService` method (called by `service`)

**• Declarations**
- Format: `<%! code %>`
- Inserted verbatim into the body of the servlet class, outside of any existing methods

**• XML syntax**
- See slides at end of the lecture for an XML-compatible way of representing JSP pages and scripting elements
JSP Expressions: `<%= value %>`

**Format**
- `<%= Java Expression %>`

**Result**
- Expression evaluated, converted to String, and placed into HTML page at the place it occurred in JSP page
- That is, expression placed in `_jspService` inside `out.print`

**Examples**
- Current time: `<%= new java.util.Date() %>`
- Your hostname: `<%= request.getRemoteHost() %>`

**XML-compatible syntax**
- `<jsp:expression>Java Expression</jsp:expression>`
- You cannot mix versions within a single page. You must use XML for entire page if you use `jsp:expression`.
  - See slides at end of this lecture
JSP/Servlet Correspondence

• Original JSP

```jsp
<H1>A Random Number</H1>
<%= Math.random() %>
```

• Representative resulting servlet code

```java
public void _jspService(HttpServletRequest request,
                          HttpServletResponse response)
    throws ServletException, IOException {
    response.setContentType("text/html");
    HttpSession session = request.getSession();
    JspWriter out = response.getWriter();
    out.println("<H1>A Random Number</H1>");
    out.println(Math.random());
    ...
}
```

JSP Expressions: Example

```html
...<BODY>
<H2>JSP Expressions</H2>
<UL>
    <LI>Current time: <%= new java.util.Date() %>
    <LI>Server: <%= application.getServerInfo() %>
    <LI>Session ID: <%= session.getId() %>
    <LI>The <CODE>testParam</CODE> form parameter:
        <%= request.getParameter("testParam") %>
</UL>
</BODY></HTML>
```
**Predefined Variables**

- **request**
  - The HttpServletRequest (1st argument to service/doGet)
- **response**
  - The HttpServletResponse (2nd arg to service/doGet)
- **out**
  - The Writer (a buffered version of type JspWriter) used to send output to the client
- **session**
  - The HttpSession associated with the request (unless disabled with the session attribute of the page directive)
- **application**
  - The ServletContext (for sharing data) as obtained via getServletContext().

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**Comparing Servlets to JSP: Reading Three Params (Servlet)**

```java
@WebServlet("/three-params")
public class ThreeParams extends HttpServlet {
    public void doGet(HttpServletRequest request,
                        HttpServletResponse response)
        throws ServletException, IOException {
        ...
        out.println(docType +
                     "<HTML>
                     " +
                     "<HEAD><TITLE>" + title + "</TITLE></HEAD>
                     " +
                     "<BODY BGCOLOR="#FDF5E6">" +
                     "<H1 ALIGN="CENTER">" + title + "</H1>" +
                     "<UL>" +
                     "<LI><B>param1</B>: " +
                     request.getParameter("param1") + "
                     <LI><B>param2</B>: " +
                     request.getParameter("param2") + "
                     <LI><B>param3</B>: " +
                     request.getParameter("param3") + "
                     </UL>" +
                    "</BODY></HTML>"; }
```
Reading Three Params (Servlet):
Result

Comparing Servlets to JSP:
Reading Three Params (JSP)

```html
<!DOCTYPE ...>
<html>
<head>
<title>Reading Three Request Parameters</title>
<link rel="stylesheet" href="JSP-Styles.css" type="text/css">
</head>
<body>
<h1>Reading Three Request Parameters</h1>
<ul>
<li><b>param1</b>: <%= request.getParameter("param1") %></li>
<li><b>param2</b>: <%= request.getParameter("param2") %></li>
<li><b>param3</b>: <%= request.getParameter("param3") %></li>
</ul>
</body>
</html>
```
Reading Three Request Parameters

• param1: foo
• param2: bar
• param3: baz
JSP Scriptlets

• **Format**
  – `<% Java Code %>`

• **Result**
  – Code is inserted verbatim into servlet’s `_jspService`

• **Example**
  – `<% String queryData = request.getQueryString(); %>`
    Attached GET data: `<%= queryData %>`
  – `<% response.setContentType("text/plain"); %>`

• **XML-compatible syntax**
  – `<jsp:scriptlet>Java Code</jsp:scriptlet>`

JSP/Servlet Correspondence

• **Original JSP**
  `<H2>foo</H2>`
  `<%= bar() %>`
  `<% baz(); %>`

• **Representative resulting servlet code**
```java
public void _jspService(HttpServletRequest request,
                          HttpServletResponse response)
    throws ServletException, IOException {
    response.setContentType("text/html");
    HttpSession session = request.getSession();
    JspWriter out = response.getWriter();
    out.println("<H2>foo</H2>");
    out.println(bar());
    baz();
    ...
}
```
JSP Scriptlets: Example

• Suppose you want to let end users customize the background color of a page
  – What is wrong with the following code?

```html
<BODY BGCOLOR="<%= request.getParameter("bgColor") %>">
```

```html
<!DOCTYPE …>
<html>
<head>
  <title>Color Testing</title>
</head>
<body>
  <% String bgColor = request.getParameter("bgColor");
      if ((bgColor == null) || (bgColor.trim().equals(""))){
        bgColor = "WHITE";
      }
  %>
  <body BGCOLOR="<%= bgColor %>">
  <H2 ALIGN="CENTER">Testing a Background of "<%= bgColor %>".</H2>
</body></html>
```
Using Scriptlets to Make Parts of the JSP File Conditional

- **Point**
  - Scriplets are inserted into servlet exactly as written
  - Need not be complete Java expressions
  - Complete expressions are usually clearer and easier to maintain, however

- **Example**
  - `<% if (Math.random() < 0.5) { %>`
    - Have a `<B>nice</B>` day!
  - `<% } else { %>`
    - Have a `<B>lousy</B>` day!
  - `<% } %>`

- **Representative result**
  - if (Math.random() < 0.5) {
    - out.println("Have a `<B>nice</B>` day!");
  } else {
    - out.println("Have a `<B>lousy</B>` day!");
  }
JSP Declarations: `<%! Code %>`

**JSP Declarations**

- **Format**
  - `<%! Java Code %>`

- **Result**
  - Code is inserted verbatim into servlet’s class definition, outside of any existing methods

- **Examples**
  - `<%! private int someField = 5; %>`
  - `<%! private void someMethod(...) {...} %>`

- **Design consideration**
  - Fields are clearly useful. For methods, it is usually better to define the method in a separate Java class.

- **XML-compatible syntax**
  - `<jsp:declaration>Java Code</jsp:declaration>`
JSP/Servlet Correspondence

• Original JSP

```jsp
<H1>Some Heading</H1>
<%
    private String randomHeading() {
        return("<H2>" + Math.random() + "</H2>" ordered);
    }
<%>
<%= randomHeading() %>
```

• Better alternative:
  – Make randomHeading a static method in a separate class

---

JSP/Servlet Correspondence

• Possible resulting servlet code

```java
public class xxxx implements JspPage {

    private String randomHeading() {
        return("<H2>" + Math.random() + "</H2>" ordered);
    }

    public void _jspService(HttpServletRequest request, HttpServletResponse response)
    throws ServletException, IOException {
        response.setContentType("text/html");
        HttpSession session = request.getSession();
        JspWriter out = response.getWriter();
        out.println("<H1>Some Heading</H1>" ordered);
        out.println(randomHeading());
        ...
    }
}```
JSP Declarations: Example

<!DOCTYPE ...>
<HTML>
<HEAD>
<TITLE>JSP Declarations</TITLE>
<LINK REL=STYLESHEET
    HREF="JSP-Styles.css"
    TYPE="text/css">
</HEAD>
<BODY>
<H1>JSP Declarations</H1>
<%! private int accessCount = 0; %>
<H2>Accesses to page since server reboot:
<%= ++accessCount %></H2>
</BODY></HTML>

JSP Declarations: Result

JSP Declarations
Accesses to page since server reboot: 10
JSP Declarations: the jspInit and jspDestroy Methods

- JSP pages, like regular servlets, sometimes want to use init and destroy
- Problem: the servlet that gets built from the JSP page might already use init and destroy
  - Overriding them would cause problems.
  - Thus, it is illegal to use JSP declarations to declare init or destroy.
- Solution: use jspInit and jspDestroy.
  - The auto-generated servlet is guaranteed to call these methods from init and destroy, but the standard versions of jspInit and jspDestroy are empty (placeholders for you to override).

JSP Declarations and Predefined Variables

- Problem
  - The predefined variables (request, response, out, session, etc.) are local to the _jspService method. Thus, they are not available to methods defined by JSP declarations or to methods in helper classes. What can you do about this?
- Solution: pass them as arguments. E.g.
  ```java
  public class SomeClass {
      public static void someMethod(HttpSession s) {
          doSomethingWith(s);
      }
  }
  ...% somePackage.SomeClass.someMethod(session); %
  ```
- Notes
  - Same issue if you use methods in JSP declarations
  - But separate classes preferred over JSP declarations
  - println of JSPWriter throws IOException
  - Use “throws IOException” for methods that use println
Comparing JSP Scripting Elements

Using Expressions, Scriptlets and Declarations

• **Task 1**
  – Output a bulleted list of five random ints from 1 to 10.
    • Since the structure of this page is fixed and we use a separate helper class for the randomInt method, JSP expressions are all that is needed.

• **Task 2**
  – Generate a list of between 1 and 10 entries (selected at random), each of which is a number between 1 and 10.
    • Because the number of entries in the list is dynamic, a JSP scriptlet is needed.

• **Task 3**
  – Generate a random number on the first request, then show the same number to all users until the server is restarted.
    • Instance variables (fields) are the natural way to accomplish this persistence. Use JSP declarations for this.
**Helper Class: RanUtilities**

```java
package coreservlets; // Always use packages!!

/** Simple utility to generate random integers. */
public class RanUtilities {

/** A random int from 1 to range (inclusive). */

    public static int randomInt(int range) {
        return(1 + ((int)(Math.random() * range)));
    }

    public static void main(String[] args) {
        int range = 10;
        try {
            range = Integer.parseInt(args[0]);
        } catch(Exception e) { // Array index or number format
            // Do nothing: range already has default value.
        }
        for(int i=0; i<100; i++) {
            System.out.println(randomInt(range));
        }
    }
}
```

**Task 1: JSP Expressions (Code)**

```html
<!DOCTYPE ...>
<html>
<head>
<title>Random Numbers</title>
<link rel=stylesheet href="JSP-Styles.css" type="text/css">
</head>
<body>
<h1>Random Numbers</h1>
<ul>
    <li><%= coreservlets.RanUtilities.randomInt(10) %></li>
    <li><%= coreservlets.RanUtilities.randomInt(10) %></li>
    <li><%= coreservlets.RanUtilities.randomInt(10) %></li>
    <li><%= coreservlets.RanUtilities.randomInt(10) %></li>
    <li><%= coreservlets.RanUtilities.randomInt(10) %></li>
</ul>
</body>
</html>
```
Task 1: JSP Expressions (Result)

Random Numbers

- 1
- 3
- 10
- 9
- 6

Task 2: JSP Scriptlets (Code: Version 1)

```html
<!DOCTYPE ...>
<html>
<head>
<title>Random List (Version 1)</title>
<link rel=stylesheet href="JSP-Styles.css" type="text/css">
</head>
<body>
<h1>Random List (Version 1)</h1>
<ul>
<% int numEntries = coreservlets.RanUtilities.randomInt(10); for(int i=0; i<numEntries; i++) {
   out.println("<li>" +
            coreservlets.RanUtilities.randomInt(10));
}%>
</ul>
</body></html>
```

Again, you can import the package with `<%@ page import="coreservlets.*" %>`, then omit the package name in the calls to the static method.
Task 2: JSP Scriptlets
(Result: Version 1)

Random List (Version 1)

8
5
6
9
5
3
7
9
1

Task 2: JSP Scriptlets
(Code: Version 2)

<!DOCTYPE ...>
<html>
<head>
<title>Random List (Version 2)</title>
<link rel="stylesheet" href="JSP-Styles.css" type="text/css">
</head>
<body>
<h1>Random List (Version 2)</h1>
<ul>
<% int numEntries = coreservlets.RanUtilities.randomInt(10); for(int i=0; i<numEntries; i++) { %>
<li><%= coreservlets.RanUtilities.randomInt(10) %></li>
<% } %>
</ul>
</body></html>
Task 2: JSP Scriptlets (Result: Version 2)

Random List (Version 2)

- 3
- 2
- 4
- 4
- 8

Task 3: JSP Declarations (Code)

```html
<!DOCTYPE ...>
<html>
<head>
<title>Semi-Random Number</title>
<link rel=stylesheet href="JSP-Styles.css" type="text/css">
</head>
<body>
<%!
private int randomNum =
coreervlets.RanUtilities.randomInt(10);
%>
<h1>Semi-Random Number:<br>%= randomNum %></h1>
</body>
</html>
```
Task 3: JSP Declarations (Result)

Semi-Random Number: 2

JSP Pages with XML Syntax
Why Two Versions?

- **Classic syntax is not XML-compatible**
  - `<%= ... %>`, `<% ... %>`, `<%! ... %>` are illegal in XML
  - HTML 4 is not XML compatible either
  - So, you cannot use XML editors like XML Spy

- **You might use JSP in XML environments**
  - To build xhtml pages
  - To build regular XML documents
  - You can use classic syntax to build XML documents, but it is sometimes easier if you are working in XML to start with
    - For Web services
    - For Ajax applications

- **So, there is a second syntax**
  - Following XML rules

---

XML Syntax for Generating XHTML Files (somefile.jspx)

```xml
<?xml version="1.0" encoding="UTF-8" ?>
<html xmlns:jsp="http://java.sun.com/JSP/Page">
  <jsp:output
    omit-xml-declaration="true"
    doctype-root-element="html"
    doctype-public="-//W3C//DTD XHTML 1.0 Transitional//EN"
    doctype-system="http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd" />
  <jsp:directive.page contentType="text/html"/>
  <head><title>Some Title</title></head>
  <body bgcolor="#fdf5e6">
    Body
  </body></html>
```

The `jsp` namespace is required if you use `jsp:blah` commands. You can use other namespaces for other custom tag libraries.

Needed because of Internet Explorer bug where xhtml pages that have the XML declaration at the top run in quirks mode.

Builds DOCTYPE line.

For JSP pages in XML syntax, default content type is `text/html`.

Normal xhtml content, plus JSP commands that use `jsp:blah` syntax, plus JSP custom tag libraries.
XML Syntax for Generating Regular XML Files (somefile.jspx)

```xml
<?xml version="1.0" encoding="UTF-8" ?>
<your-root-element xmlns:jsp="http://java.sun.com/JSP/Page">
  <your-tag1>foo</your-tag1>
  <your-tag2>bar</your-tag2>
</your-root-element>
```

**Uses**
- When you are sending to client that expects real XML
  - Ajax
  - Web services
  - Custom clients
- Note
  - You can omit the xmlns declaration if you are not using any JSP tags. But then you could just use .xml extension.

XML Syntax for Generating HTML 4 Files (somefile.jspx)

**Many extra steps required**
- Enclose the entire page in jsp:root
- Enclose the HTML in CDATA sections
  - Between `<![CDATA[` and `]]>`
  - Because HTML 4 does not obey XML rules
- Usually not worth the bother
Sample HTML 4 Page: Classic Syntax (sample.jsp)

```html
<!DOCTYPE HTML PUBLIC "-//W3C//DTD ...">
<html>
  <head>
    <title>Sample (Classic Syntax)</title>
  </head>
  <body bgcolor="#DF5E66">
    <center>
      <h1>Sample (Classic Syntax)</h1>
      <h2>Num1: <%= Math.random()*10 %></h2>
      <h2>Num2: <%= double num2 = Math.random()*100; %></h2>
      <h2>Num3: <%= private double num3 = Math.random()*1000; %></h2>
    </center>
  </body>
</html>
```

Sample XHTML Page: XML Syntax (sample.jspx)

```xml
<?xml version="1.0" encoding="UTF-8"?>
<html xmlns:jsp="http://java.sun.com/JSP/Page">
  <jsp:output
    omit-xml-declaration="true"
    doctype-root-element="html"
    doctype-public="-//W3C//DTD ..."
    doctype-system="http://www.w3.org...dtd" />
  <jsp:directive.page contentType="text/html"/>
  <head>
    <title>Sample (XML Syntax)</title>
  </head>
  <body bgcolor="#DF5E66">
    <div align="center">
      <h1>Sample (XML Syntax)</h1>
      <h2>Num1: <jsp:expression>Math.random()*10</jsp:expression></h2>
      <jsp:scriptlet>
        double num2 = Math.random()*100;
      </jsp:scriptlet>
      <h2>Num2: <jsp:expression>num2</jsp:expression></h2>
      <jsp:declaration>
        private double num3 = Math.random()*1000;
      </jsp:declaration>
      <h2>Num3: <jsp:expression>num3</jsp:expression></h2>
    </div>
  </body>
</html>
```
XML Document Generated with XML Syntax

```xml
<?xml version="1.0" encoding="UTF-8" ?>
<some-root-element
   xmlns:jsp="http://java.sun.com/JSP/Page">
   <some-element-1>Text</some-element-1>
   <some-element-2>
      Number:
      <jsp:expression>Math.random()*10</jsp:expression>*10
   </some-element-2>
</some-root-element>
```
Summary

- **JSP Expressions**
  - Format: `<%= expression %>`
  - Wrapped in `out.print` and inserted into `_jspService`
- **JSP Scriptlets**
  - Format: `<% code %>`
  - Inserted verbatim into the servlet’s `_jspService` method
- **JSP Declarations**
  - Format: `<%! code %>`
  - Inserted verbatim into the body of the servlet class
- **Predefined variables**
  - `request`, `response`, `out`, `session`, `application`
- **Limit the Java code that is directly in page**
  - Use helper classes, beans, servlet/JSP combo (MVC), JSP expression language, custom tags
- **XML Syntax**
  - There is alternative JSP syntax that is sometimes useful when generating XML-compliant documents, probably for Ajax apps.
    - But is more trouble than it is worth for most HTML applications