Introduction to JavaServer Pages (JSP) – Part 1

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Introduction to JavaServer Pages (JSP)

- **JavaServer Pages (JSP)** is an extension of servlet technology.
- Like servlets, JSPs simplify the delivery of dynamic web content. They allow web programmers to create dynamic content by reusing predefined components and by interacting with components using server-side scripting.
- JSPs can reuse JavaBeans and create custom tag libraries that encapsulate complex, dynamic functionality.
- JSP classes and interfaces can be found in packages `javax.servlet.jsp` and `javax.servlet.jsp.tagext`. 
Introduction to JSP (cont.)

• There are four key components to JSPs

1. **Directives:** messages to the JSP container (server component executing the JSP) that enable the programmer to specify page settings, include content from other resources and specify custom tag libraries to use in a JSP.

2. **Actions:** encapsulate functionality based on the information sent to the server as part of a specific client request. They can also create Java objects for use in JSP scriplets.

3. **Scripting elements:** enable the programmer to insert Java code that interacts with components in a JSP to perform request processing.

4. **Tag libraries:** are part of the tag extension mechanism that enables programmers to create custom tags. Typically, most useful for web page designers with little knowledge of Java.
Introduction to JSP (cont.)

• In some ways, JSPs look like standard HTML or XML documents.

• JSPs normally include HTML or XML markup. Such markup is known as fixed-template data or fixed-template text.

• Fixed-template data/text often helps a programmer decide whether to use a servlet or a JSP. Recall that JSPs are most often used when most of the content sent to the client is fixed-template data and little or none of the content is generated dynamically with Java code. Servlets are more commonly used when only a small amount of the content returned to the client is fixed-template data.
Introduction to JSP (cont.)

• When a JSP-enabled server receives the first request for a JSP, the JSP container translates the JSP into a Java servlet that handles the current request as well as all future requests to the JSP.

• Literal text in the JSP becomes string literals in the servlet that represents the translated JSP.

• Any errors that occur in compiling the new servlet result in translation-time errors.

• The JSP container places the Java statements that implement the JSP’s response in method _jspService at translation time.

• If the new servlet compiles properly, the JSP container invokes method _jspService to process the request.

• The JSP may respond directly or may invoke other web application components to assist in processing the request. Any errors that occur during request processing are known as request-time errors.
Introduction to JSP (cont.)

• Overall, the request-response mechanism and the JSP lifecycle are the same as those of a servlet.

• JSPs can override methods jspInit and jspDestroy (similar to servlet methods init and destroy), which the JSP container invokes when initializing and terminating a JSP.

• A JSP programmer defines these methods using JSP declarations which are part of the scripting mechanism.
The First JSP Example

• Our first look at a JSP is with a simple clock JSP which displays the current date and time inserted into a web page using a JSP expression.

• To execute this clock.jsp from your own system, as with the servlet examples we’ve been running – copy the clock.jsp file into the webapps subdirectory you created for your servlet examples.

  – My Tomcat webapps subdirectory is named CNT4714 and I created a subdirectory named JSP in this directory to hold all the JSP examples. From the index page I created – the JSPs can be executed directly, otherwise…type http://localhost:8080/CNT4714/jsp/clock.jsp to execute this JSP.
<?xml version = "1.0"?><!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN" "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd"><!-- A clock.jsp -->
<html xmlns = "http://www.w3.org/1999/xhtml">
    <head>
        <meta http-equiv = "refresh" content = "60" />
        <title>An Initial JSP Example</title>
        <style type = "text/css">
            .big { font-family: helvetica, arial, sans-serif;
                font-weight: bold;
                font-size: 2em; }
        </style>
    </head>
    <body>
        <p class = "big">A Clock JSP</p>
        <table style = "border: 6px outset;">
            <tr>
                <td style = "background-color: black;"
                    class = "big" style = "color: cyan;">
                    <p class = "big" style = "color: cyan;">
                        <!-- JSP expression to insert date/time -->
                        <%= new java.util.Date() %>
                    </p>
                </td>
            </tr>
        </table>
    </body>
</html>

JSP expressions are delimited by <%= ... %>. Creates a new instance of class Date (package java.util). When the client requests this JSP, this expression inserts the String representation of the date and time in the response to the client.

XHTML meta-element sets a refresh interval of 60 seconds
A Clock JSP

Thu Oct 24 17:11:48 EDT 2013
Implicit Objects

- Implicit objects provide access to many servlet capabilities in the context of a JSP.

- Implicit objects have four scopes:
  1. **Application**: the JSP container owns objects with application scope. Any JSP can manipulate such objects.
  2. **Page**: objects with page scope can only be manipulated in the page that defines them. Each page has its own instances of the page-scope implicit objects.
  3. **Request**: these objects go out of scope when request processing completes with a response to the client.
  4. **Session**: these objects exist for the client’s entire browsing session.
# Implicit Objects

<table>
<thead>
<tr>
<th>Implicit Object</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Application Scope</strong></td>
<td></td>
</tr>
<tr>
<td>application</td>
<td>This <code>javax.servlet.ServletContext</code> object represents the container in which the JSP executes.</td>
</tr>
<tr>
<td><strong>Page Scope</strong></td>
<td></td>
</tr>
<tr>
<td>config</td>
<td>This <code>javax.servlet.ServletConfig</code> object represents the JSP configuration options. As with servlets, configuration options can be specified in a Web application descriptor.</td>
</tr>
<tr>
<td>exception</td>
<td>This <code>java.lang.Throwable</code> object represents the exception that is passed to the JSP error page. This object is available only in a JSP error page.</td>
</tr>
<tr>
<td>out</td>
<td>This <code>javax.servlet.jsp.JspWriter</code> object writes text as part of the response to a request. This object is used implicitly with JSP expressions and actions that insert string content in a response.</td>
</tr>
<tr>
<td>page</td>
<td>This <code>java.lang.Object</code> object represents the <code>this</code> reference for the current JSP instance.</td>
</tr>
<tr>
<td>pageContext</td>
<td>This <code>javax.servlet.jsp.PageContext</code> object hides the implementation details of the Underlying servlet and JSP container and provides JSP programmers with Access to the implicit objects listed in this table.</td>
</tr>
</tbody>
</table>
## Implicit Objects

<table>
<thead>
<tr>
<th>Implicit Object</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>response</strong></td>
<td>This object represents the response to the client. The object normally is an instance of a class that implements <code>HttpServletResponse</code> (package <code>javax.servlet.http</code>). If a protocol other than HTTP is used, this object is an instance of a class that implements <code>javax.servlet.ServletResponse</code>.</td>
</tr>
<tr>
<td><strong>Request Scope</strong></td>
<td></td>
</tr>
<tr>
<td><strong>request</strong></td>
<td>This object represents the client request. The object normally is an instance of a class that implements <code>HttpServletRequest</code> (package <code>javax.servlet.http</code>). If a protocol other than HTTP is used, this object is an instance of a subclass of <code>javax.servlet.ServletRequest</code>.</td>
</tr>
<tr>
<td><strong>Session Scope</strong></td>
<td></td>
</tr>
<tr>
<td><strong>session</strong></td>
<td>This <code>javax.servlet.http.HttpSession</code> object represents the client session information if such a session has been created. This object is available only in pages that participate in a session.</td>
</tr>
</tbody>
</table>
Scripting

- JSPs often present dynamically generated content as part of an HTML document that is sent to the client in response to a request.

- In some cases, the content is static, but is output only if certain conditions are met during a request (e.g., providing values in a form that submits a request).

- JSP programmers can insert Java code and logic in a JSP using scripting.
Scripting Components

- JSP scripting components include scriplets, comments, expressions, declarations, and escape sequences.

- Scriplets are blocks of code delimited by `<% and `%>. They contain Java statements that the container places in method `_jspService` at translation time.

- Comments come in three flavors in JSPs: JSP comments, XHTML comments, and scripting language comments.
  - JSP comments are delimited by `<%-- and --%>`. Can be placed throughout the JSP except inside scriplets.
  - XHTML comments are delimited by `<!-- and -->`. Can be placed anywhere in the JSP except inside scriplets.
  - Scripting language comments are Java comments (Java is currently the only JSP scripting language which is allowed). Scriplets can use either `//` or `/` and `*/ as in normal Java.
Scripting Components (cont.)

- JSP comments and scripting language comments are ignored and do not appear in the response to a client. When clients view the source code of a JSP response, they will see only the HTML comments in the source code.
  - The different comment styles are useful for separating comments that the user should be able to see from those that document logic processed on the server-side.

- **Expressions** are delimited by `<%=` and `%>` and contain a Java expression that is evaluated when a client requests the JSP containing the expression. The container converts the result of a JSP expression to a `String` object, then outputs the `String` as part of the response to the client.
• **Declarations** are delimited by `<%!` and `%>`.
  Declarations enable the JSP programmer to define variables and methods for use in a JSP. Variables become instance variables of the servlet class that represents the translated JSP. Similarly, methods become members of the class that represents the translated JSP. Declaration of variables and methods in a JSP use Java syntax such as:

  ```java
  <%! int increment = 0; %>
  ```

• **Escape sequences** are necessary to include special characters or character sequences that the JSP container normally uses to delimit JSP code.
  
  – Example: literal: `<%`, escape sequence is: `<\%`
<!DOCTYPE html>

<!-- welcome.jsp -->
<!-- JSP that processes a "get" request containing data. -->
<html lang="en">

<!-- head section of document -->
<head>
    <title>A JSP that processes "get" requests with data</title>
</head>

<!-- body section of document -->
<body>

    <% // begin scriptlet
        String name = request.getParameter("firstName");
        if ( name != null ) {
            %>
    <!-- end scriptlet to insert fixed template data -->
    </body>
</html>

HTML comments shown in blue.
Scriptlets shown in green.
Hello <%= name %>, <br />
Welcome to JavaServer Pages Technology!
</h1>

<% // continue scriptlet

} // end if
else {

%> <%- end scriptlet to insert fixed template data --%>

<form action = "welcome.jsp" method = "get">
<p>Type your first name and press Submit</p>
<p><input type = "text" name = "firstName" />
<input type = "submit" value = "Submit" />
</p>
</form>

<% // continue scriptlet

} // end else
%> <%- end scriptlet --%>
</body>

</html> <!-- end HTML document -->
Editors like Notepad++ will delineate your scriplets and allow for easy differentiation of the various scripting elements that make up more complex JSP files.
Type your first name and press Submit

Mark
Submit

Hello Mark,
Welcome to JavaServer Pages Technology!
How A JSP Is Processed

• Much like a servlet, a JSP must first be processed by a web server before it can be displayed in a web browser. The web server must support JSPs and the JSP page must be stored in a file with a .jsp extension. The web server translates the JSP into a Java servlet, compiles the servlet, and executes it. The result of the execution is sent to the browser for display.
More On JSP Scripting Constructs

- There are three main types of JSP constructs: scripting constructs, directives, and actions.

- **Scripting elements** allow you to specify Java code that will become part of the resultant servlet.

- **Directives** enable you to control the overall structure of the resultant servlet.

- **Actions** enable you to control the behavior of the JSP engine.

- We’ll look in more detail at all of these, starting with the scripting constructs.
Scripting Constructs

- There are three main types of JSP scripting constructs that can be used to insert Java code into a resultant servlet: expressions, scriptlets and declarations. Recall that there are also comments and escape sequences.

- A JSP expression is used to insert a Java expression directly into the output. It has the following form:

  `<%= java expression %>`

- The expression is evaluated, converted into a string, and set to the output stream of the servlet.
Scripting Constructs

• A JSP scriptlet enables you to insert a Java statement into the servlet’s jspService method which is invoked by the service method. A JSP scriptlet has the following form:

  \(<%\) java statement \(%>\)

• A JSP declaration is for declaring methods or fields into the servlet. It has the following form:

  \(<%!\) java declaration \(%>\)

• HTML comments have the form:

  \(<!-\)-- HTML comment -->

• If you don’t want the comment to appear in the resultant HTML file, use a JSP comment which has the form:

  \(<%--\)-- JSP comment -->
<!-- ComputeLoan.html -->

<html>
  <head>
    <title>ComputeLoan</title>
  </head>
  <body bgcolor=white background=images/background.jpg lang=EN-US link=blue vlink=blue style='tab-interval:.5in'>
    <font size = 5><b>Compute Loan Payment</b></font>
    <form method="get" action="/CNT4714/jsp/ComputeLoan.jsp">
      Loan Amount  
      <input type="text" name="loanAmount">
      
      Annual Interest Rate  
      <input type="text" name="annualInterestRate">
      
      Number of Years  
      <input type="text" name="numberOfYears" size="3">
      
      <input type="submit" name="Submit" value="Compute Loan Payment">
      <input type="reset" value="Reset">
    </form>
  </body>
</html>
<! -- ComputeLoan.jsp -->

<title>ComputeLoan</title>

<body bgcolor=white background=images/background.jpg lang=EN-US link=blue vlink=blue
style='tab-interval:.5in'>

<% double loanAmount = Double.parseDouble(request.getParameter("loanAmount"));
    double annualInterestRate = Double.parseDouble(request.getParameter("annualInterestRate"));
    double numberOfYears = Integer.parseInt(request.getParameter("numberOfYears"));
    double monthlyInterestRate = annualInterestRate / 1200;
    double monthlyPayment = loanAmount * monthlyInterestRate / 
                                      (1 - 1 / Math.pow(1 + monthlyInterestRate, numberOfYears * 12));
    double totalPayment = monthlyPayment * numberOfYears * 12;
%>

<b><font size = 7> Loan Details </font><br><br>
Loan Amount: <i><%= loanAmount %></i> <br><br>
Annual Interest Rate: <i><%= annualInterestRate %></i> <br><br>
Number of Years: <i><%= numberOfYears %></i> <br><br>
Monthly Payment: <i><%= "\$" + monthlyPayment %></i> <br><br>
Total Payment: <i><%= "\$" + totalPayment %></i>

</b>

</body>

<html>
Compute Loan Payment

Loan Amount 475000

Annual Interest Rate 6

Number of Years 15

Compute Loan Payment  Reset
Loan Details

Loan Amount: 475000.0

Annual Interest Rate: 6.0

Number of Years: 15.0

Monthly Payment: $4008.319933230196
package code;

public class Loan {

    private double annualInterestRate;
    private int numOfYears;
    private double loanAmount;
    private java.util.Date loanDate;

    /** Default constructor */
    public Loan() {
        this(7.5, 30, 100000);
    }

    /** Construct a loan with specified annual interest rate, 
     * number of years and loan amount */
    public Loan(double annualInterestRate, int numOfYears,
                double loanAmount) {
        this.annualInterestRate = annualInterestRate;
        this.numOfYears = numOfYears;
        this.loanAmount = loanAmount;
        loanDate = new java.util.Date();
    }

    /** Return annualInterestRate */
    public double getAnnualInterestRate() {
        return annualInterestRate;
    }

    /** Set a new annualInterestRate */
    public void setAnnualInterestRate(double annualInterestRate) {
        this.annualInterestRate = annualInterestRate;
    }

    /** Return numOfYears */
    public int getNumOfYears() {
    }
}
```java
/** Return numOfYears */
public int getNumOfYears() {
    return numOfYears;
}

/** Set a new numOfYears */
public void setNumOfYears(int numOfYears) {
    this.numOfYears = numOfYears;
}

/** Return loanAmount */
public double getLoanAmount() {
    return loanAmount;
}

/** Set a new loanAmount */
public void setLoanAmount(double loanAmount) {
    this.loanAmount = loanAmount;
}

/** Find monthly payment */
public double monthlyPayment() {
    double monthlyInterestRate = annualInterestRate / 1200;
    return loanAmount * monthlyInterestRate / (1 -
        Math.pow(1 / (1 + monthlyInterestRate), numOfYears * 12));
}

/** Find total payment */
public double totalPayment() {
    return monthlyPayment() * numOfYears * 12;
}

/** Return loan date */
public java.util.Date getLoanDate() {
    return loanDate;
}
```
JSP directive to include a Java class.

```jsp
double loanAmount = Double.parseDouble(request.getParameter("loanAmount"));
double annualInterestRate = Double.parseDouble(request.getParameter("annualInterestRate"));
int numberOfYears = Integer.parseInt(request.getParameter("numberOfYears"));

Loan loan = new Loan(annualInterestRate, numberOfYears, loanAmount);
```

<b>Loan Details</b>

Loan Amount:
```jsp
<%= loanAmount %>
```

Annual Interest Rate:
```jsp
<%= annualInterestRate %>
```

Number of Years:
```jsp
<%= numberOfYears %>
```

Monthly Payment:
```jsp
<%= "$" + loan.monthlyPayment() %>
```

Total Payment:
```jsp
<%= "$" + loan.totalPayment() %>
```
Scripting Example Using Directives

Compute Loan Payment

Loan Amount 575000

Annual Interest Rate 6

Number of Years 15

Compute Loan Payment  Reset
Scripting Example Using Directives

Loan Details

Loan Amount: 575000.0
Annual Interest Rate: 6.0
Number of Years: 15
Monthly Payment: $4852.176761278675
JSP Standard Actions

- JSP standard actions provide programmers with access to several of the most common tasks performed in a JSP, such as including content from other resources, forwarding requests to other resources and interacting with JavaBean software components.

- JSP containers process actions at request time.

- Actions are delimited by `<jsp: action>` and `<jsp: action>`, where `action` is the standard action name.
  - In cases where nothing appears between the starting and ending tags, the XML empty element syntax `<jsp: action />` can be used.
## JSP Standard Actions

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;jsp: include&gt;</code></td>
<td>Dynamically includes another resource in a JSP. As the JSP executes, the referenced resource is included and processed.</td>
</tr>
<tr>
<td><code>&lt;jsp: forward&gt;</code></td>
<td>Forwards request processing to another JSP, servlet or static page. This action terminates the current JSP’s execution.</td>
</tr>
<tr>
<td><code>&lt;jsp: plugin&gt;</code></td>
<td>Allows a plug-in component to be added to a page in the form of a browser-specific object or embed HTML element. In the case of a Java applet, this action enables the browser to download and install the Java Pug-in, if it is not already installed on the client computer.</td>
</tr>
<tr>
<td><code>&lt;jsp: param&gt;</code></td>
<td>Used with the include, forward and plug-in actions to specify additional name-value pairs of information for use by these actions.</td>
</tr>
</tbody>
</table>
## JSP Standard Actions

<table>
<thead>
<tr>
<th>JavaBean Manipulation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;jsp: useBean&gt;</td>
<td>Specifies that the JSP uses a JavaBean instance (i.e., an object of the class that declares the JavaBean). This action specifies the scope of the object and assigns it an ID (i.e., a variable name) that scripting components can use to manipulate the bean.</td>
</tr>
<tr>
<td><a href="">jsp:setProperty</a></td>
<td>Sets a property in the specified JavaBean instance. A special feature of this action is automatic matching of request parameters to bean properties of the same name.</td>
</tr>
<tr>
<td><a href="">jsp:getProperty</a></td>
<td>Gets a property in the specified JavaBean instance and converts the result to a string for output in the response.</td>
</tr>
</tbody>
</table>
<jsp: include> Action

- JSPs support two include mechanisms – the <jsp: include> action and the include directive.

- Action <jsp: include> enables dynamic content to be included in a JSP at request time. If the included resource changes between requests, the next request to the JSP containing the <jsp: include> action includes the resource’s new content.

- The include directive copies the content into the JSP once, at JSP translation time. If the included resource changes, the new content will not be reflected in the JSP that uses the include directive, unless the JSP is recompiled, which would normally occur only if a new version of the JSP were installed.
A JSP Using the `<jsp: include>` Action

```
<!DOCTYPE html>

<!-- include.jsp -->

<html lang="en">
    <head>
        <title>Using jsp:include</title>
        <style type = "text/css">
            body {
                font-family: tahoma, helvetica, arial, sans-serif;
            }
            table, tr, td {
                font-size: 1.1em;
                border: 3px groove;
                padding: 5px;
                background-color: #dddddd;
            }
        </style>
    </head>
</html>
```
Banner.html

<!-- banner.html -->
<!-- banner to include in another document -->
<div style = "width: 800px">
  <p>
    CNT 4714 - Enterprise Computing
    <br />
    Fall 2013 Semester - University of Central Florida
  </p>
  <p>
    <a href = "mailto:markl@cs.ucf.edu">markl@cs.ucf.edu</a>
  </p>
</div>
Table of Contents (toc.html)

```html
<!-- toc.html -->
<!-- contents to include in another document -->
<p><a href = "http://www.cs.ucf.edu/courses/cnt4714/fall2013">CNT 4714 Course Webpage</a></p>
<p>Send questions or comments about this site to <a href = "mailto:markl@cs.ucf.edu">markl@cs.ucf.edu</a></p>
</p>
```

<!-- clock2.jsp -->
<!-- date and time to include in another document via redirection -->
<table>
<tr>
<td style = "background-color: black;">
<p class = "big" style = "color: cyan; font-size: 3em; font-weight: bold;">
<!-- script to determine client local and -->
<!-- format date accordingly -->
<% // get client locale
java.util.Locale locale = request.getLocale();

// get DateFormat for client's Locale
java.text.DateFormat dateFormat =
    java.text.DateFormat.getDateTimeInstance(
        java.text.DateFormat.LONG,
        java.text.DateFormat.LONG, locale );
%>  <!-- end script --%>
%-- output date --%>
<%= dateFormat.format( new java.util.Date() ) %>
</p>
</td>
</tr>
</table>
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Fall 2013 Semester - University of Central Florida

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October 24, 2013 5:28:10 PM EDT
<jsp: forward> Action

- JSP action `<jsp: forward>` enables a JSP to forward request processing to a different resource, such as an error page.

- Request processing by the original JSP terminates as soon as the JSP forwards the request.

- In the next example, this action is illustrated by forwarding a welcome request to another welcome page. JSP forward1.jsp forwards the request to JSP forward2.jsp. The forwarding action requests a date and time at which the original request was received that is forwarded.
Initial Forward JSP (forward1.jsp)

```html
<!DOCTYPE html>
<!-- forward1.jsp -->
<html lang="en">
<head>
    <title>Forward request to another JSP</title>
</head>
<body>
    <% // begin scriptlet
        String name = request.getParameter( "firstName" );
        if ( name != null )
        {
            %> <jsp:forward page = "forward2.jsp">
                <jsp:param name = "date" value = "<%= new java.util.Date() %>">
            </jsp:forward>
    <% // continue scriptlet
    } // end if
```
Initial Forward JSP (forward1.jsp) (cont.)

```html
else
{
  %> <%%-- end scriptlet to insert fixed template data --%%>

      <form action = "forward1.jsp" method = "get">
          <p>Type your first name and press Submit</p>
          <p><input type = "text" name = "firstName" /></p>
      </form>

  <% // continue scriptlet

  } // end else

%> <%%-- end scriptlet --%%>
</body>
</html>  <! -- end HTML document -->
Forward2 JSP (forward2.jsp)

```html
<!DOCTYPE html>
<!-- forward2.jsp -->
<html lang="en">
<head>
  <title>Processing a forwarded request</title>
  <style type="text/css">
    .big {
      font-family: tahoma, helvetica, arial, sans-serif;
      font-weight: bold;
      font-size: 2em;
    }
  </style>
</head>
<body>
  <p class="big">
    Hello <%= request.getParameter( "firstName" ) %>, <br />
    Your redirection request was received <br />
    and forwarded at
  </p>
</body>
</html>
```
</p>
	<table style = "border: 6px outset;">
		<tr>
			<td style = "background-color: black;">
				<p class = "big" style = "color: cyan;">%
					request.getParameter("date") %
				</p>
			</td>
		</tr>
	</table>
</body>
</html>
Type your first name and press Submit

Mark

Submit

Original request is invoked by forward1.jsp
Hello Mark,
Your redirection request was received and forwarded at

Thu Oct 24 17:29:42 EDT 2013

Forward2.jsp receives forwarded request for service with firstName passed as a parameter