# Web Programming with Java Servlets

© Leonidas Fegaras
University of Texas at Arlington



## Database Connectivity with JDBC

- The JDBC API makes it possible to access databases and other data sources from Java

```
import java.sql.*;
...
Class.forName("com.mysql.jdbc.Driver").newInstance();
String jdbc = "jdbc:mysql://localhost:3306/db?user=smith&password=xxx";
Connection con = DriverManager.getConnection(jdbc);
Statement stmt = con.createStatement();
ResultSet rs = stmt.executeQuery("select * from employee");
while (rs.next())
    System.out.println(rs.getString("fname")+" "+rs.getString("lname"));
rs.close();
stmt.close();
con.close();
```

- For updates/inserts/deletes, use

```
stmt.executeUpdate("update ...");
con.commit();
```



## Working with ResultSet

- **ResultSet**: a table of data representing a database result set
  - generated by executing a statement that queries the database
- It maintains a cursor pointing to its current row of data
  - Initially the cursor is positioned before the first row
  - The next method moves the cursor to the next row
- Provides getter methods for retrieving column values from the current row

```
getString, getInt, getBoolean, getLong, ...
```

- Also provides setter methods for updating column values

```
updateString, updateInt, ...
```

- Values can be retrieved/updated using either
  - the index number of the column (starting from 1)

```
rs.getString(2)          rs.updateString(2,"Smith")
```

  - or the name of the column

```
rs.getString("name")     rs.updateString("name","Smith")
```



## Updates

- To delete the current row from the ResultSet and from database

```
rs.deleteRow();
```

- To update a column value in the current row

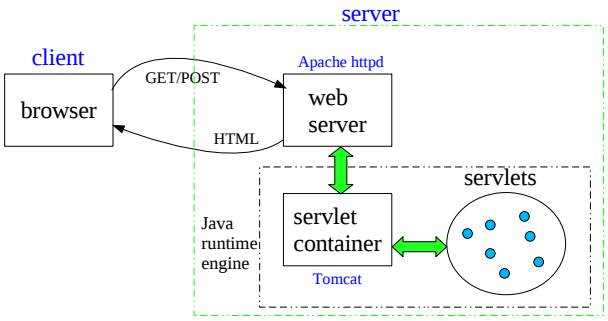
```
rs.updateString("name", "Smith");
rs.updateInt("salary",100000);
rs.updateRow();
```

- To insert column values into the insert row

```
rs.moveToInsertRow();
rs.updateString("name", "Smith");
rs.updateInt("salary",100000);
rs.insertRow();
```

## Java Servlets

- A **servlet** is a small Java program that runs within a Web server
- Servlets receive and respond to requests from Web clients
- Need a **servlet container** (web container) to run servlets






## History

- 1997: Sun released the Java Web Server and Java Servlet Developers Kit
- 1999: Sun introduced JavaServer Pages (JSPs)
- 2003: Java 2 Enterprise Edition (J2EE)
- 2000: NetBeans
  - open source IDE (Integrated Development Environment)
  - Java EE (Enterprise Edition)
  - Enterprise Java Beans (EJB), servlets, JSP pages, JAX-WS web services
- Servlet engines (web containers): hosts for servlets and JSPs
  - Jakarta Tomcat by Apache
  - GlassFish
  - Sun's Java System Application Server
  - BEA WebLogic
  - RedHat JBoss
  - IBM's WebSphere



## Installing and Learning about NetBeans

- Works on most platforms (Linux, Mac OS, Solaris, MS Windows)
- Install JDK 6 (Java SE Development Kit 6) from:
  http://java.sun.com/j2se/downloads.html
- Install NetBeans IDE 6.0 from:
  http://www.netbeans.org/
  - Select to install both Tomcat and GlassFish
- To learn more about NetBeans:
  - The Help Contents in NetBeans Visual Designer (very useful)
  - Documentation about NetBeans Web applications:
    http://www.netbeans.org/kb/trails/web.html
  - Java Studio Creator Reference
    http://developers.sun.com/jscreator/reference/techart/2/index.jsp
  - The Java EE 5 Tutorial (similar to NetBeans)
    http://java.sun.com/javaee/5/docs/tutorial/doc/index.html
  - The Java API
    http://java.sun.com/javase/6/docs/api/



## The Servlet Interface

- To implement this interface, you can write
  - a generic servlet that extends javax.servlet.GenericServlet or
  - an HTTP servlet that extends javax.servlet.http.HttpServlet
- It defines methods to initialize/remove a servlet and to service requests
- Servlet life-cycle:
  - The servlet is constructed, then initialized with the init() method
  - Calls from clients to the service method are handled
  - The servlet is taken out of service, then destroyed with the destroy() method, then garbage collected and finalized
- Other methods:
  getServletConfig()
  getServletInfo()

## GenericServlet

- Defines a generic, protocol-independent servlet
- Example:

```
import javax.servlet.*;

class MyServlet extends GenericServlet {
   public void service ( HttpServletRequest request,
                         HttpServletResponse response )
                   throws ServletException, IOException {
      response.setContentType("text/html");
      PrintWriter out = response.getWriter();
      out.println("<html>...</html>");
   }
```

- There are also default methods to initialize (init) and finalize (destroy) a servlet that can be overridden
- To write an HTTP servlet for use on the Web, implement the HttpServlet interface instead



## HttpServlet

- The HttpServlet interface extends the GenericServlet interface to handle GET/POST requests
- Example:

```
import javax.servlet.*;
import javax.servlet.http.*;

class Hello extends HttpServlet {
   public void doGet ( HttpServletRequest request,
                       HttpServletResponse response )
                 throws IOException, ServletException {
      response.setContentType("text/html");
      PrintWriter out = response.getWriter();
      out.println("<html>... </html>");
   }
```

- doPost is similar



## Cookies

- To read the cookies associated with the servlet request:

```
Cookie[] cookies = request.getCookies();
```

- Cookie methods:

```
cookie.getName()
cookie.getValue()
```

- To create a new cookie:

```
cookie = new Cookie("myCookie","some-value");
cookie.setPath(request.getContextPath( ));
cookie.setMaxAge(-1);
response.addCookie(cookie);
```



## HttpSession

- Use getParameter() to access GET/POST parameters:

```
String value = request.getParameter("parameter-name");
```

- To get all parameter names:

```
Enumeration parameters = request.getParameterNames();
```

- Method getSession() returns the current session associated with this request, or if the request does not have a session, creates one

```
HttpSession session = request.getSession();
```

- HttpSession methods:
  - To get the session ID:

    ```
    String session_id = session.getId();
    ```

  - To get the names of all session attributes:

    ```
    Enumeration attributes = session.getAttributeNames();
    ```

  - Given the name of a session attribute, get its value:

    ```
    Object value = session.getAttribute("name");
    ```

  - Change the value of a session attribute

    ```
    session.setAttribute("name",value);
    ```

## ServletContext

- Contains the objects common to all sessions
  - particular to the web application
  - its a location to share global information (eg, a database of sale items)
- To extract:

```
ServletContext context = getServletContext();
```

- Methods:

```
Enumeration attributes = context.getAttributeNames();
Object value = context.getAttribute("name");
context.setAttribute("name",value);
```



## The Directory Structure

- The directory for the application MyApplication has structure:
  - MyApplication/: contains all static HTML and JSP files
  - MyApplication/WEB-INF/web.xml: the deployment descriptor
  - MyApplication/WEB-INF/classes/: contains the Java classes
  - MyApplication/WEB-INF/lib/: contains the JAR files
- The easiest way to deploy the application is to convert it to a WAR file using JAR. Inside directory MyApplication do:

```
jar cvf MyApplication.war .
```

- **WAR**: Web Application Archive file
- Then, you can deploy the file MyApplication.war using the Tomcat manager

```
http://localhost:8080/manager/html
```

- If you use the NetBeans Visual Studio
  - it will create a default deployment descriptor
  - it will deploy your application automatically



## The Deployment Descriptor

- It's the file web.xml in the WEB-INF directory

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<web-app ...>
   <display-name>Hello, World Application</display-name>
   <description> ...  </description>
   <servlet>
      <servlet-name>HelloServlet</servlet-name>
      <servlet-class>mypackage.Hello</servlet-class>
   </servlet>
   <servlet-mapping>
      <servlet-name>HelloServlet</servlet-name>
      <url-pattern>/hello</url-pattern>
   </servlet-mapping>
</web-app>
```

- After you deploy with Tomcat, to run it on browser use:

```
http://localhost:8080/hello/
```



## Web Components

- **Java Server pages** (JSP) are text documents that execute as servlets but allow a more natural approach to creating web content
  - They contain two types of text:
    - static data, which can be expressed as HTML or XML, and
    - JSP elements, which determine how the page constructs dynamic content
  - JavaServer Pages **Standard Tag Library** (JSTL) encapsulates core functionality common to many JSP applications
    - iterator and conditional tags
    - tags for manipulating XML documents
    - tags for accessing databases
- **JavaServer Faces** (JSF) technology provides a user interface component framework for web applications. Components:
  - a GUI component framework
  - a flexible model for rendering components in HTML
- JSF pages are translated to JSP pages (lazily)
  - Need library descriptor files in WEB-INF to deploy JSP pages
  - Tomcat's Jasper

## JSP Example

```
<%@ taglib uri="http://java.sun.com/jstl/core" prefix="c" %>
<jsp:useBean id="date" class="java.util.Date" />
<html>
  <head><title>JSP Example</title></head>
  <body>
      <h2>Today's Date</h2>
      <c:out value="${date}" />
   </body>
</html>
```



## Java Beans

- **Java Beans** are Java classes that have properties (variables) and have get and set methods for accessing the properties

```
package org.myserver;
class MyResult {
  String result;
  public String getResult () { return result; }
  public void setResult ( String s ) { result = s; }
}
```

- There are 4 Java Bean categories (**scopes**) used by JSP:
  - application (global objects)
  - session (session objects)
  - request (objects passing from servlet to servlet through requestDispatch)
  - page (local to the current page)



## JSP Syntax

- JSP expressions ${...} retrieve the value of object properties
  - for deferred evaluation use: #{...}
- Variables are properties in a scope bean (the default scope is *page*)
- The custom tag c:set sets a variable:

```
<c:set var="y" value="${x+1}" />
<c:set var="user" value="${x.user}" scope="session"/>
```

- There are custom tags to do
  - iterations over a collection
    `<c:forEach var="x" items="..."> ... </c:forEach>`
  - conditions: `<c:if test="..."> ... </c:if>`
  - XML and SQL stuff
    `<sql:query var="x" sql="select * from PUBLIC.books where id = ?"/>`
- To create/update/use a Java Bean object:

```
<jsp:useBean id="MyResult" class="org.myserver" scope="application"/>
<jsp:setProperty name="MyResult" property="result" value="${...}"/>
${MyResult.result}
```



## GET/POST Parameters and Cookies

- Use the param object associated with the Map.Entry bean

```
<html>
<head><title>Posted Data</title></head>
<body>
  <h1>Posted Data</h1>
  <c:forEach var="x" items="${param}">
     <p><c:out value="${x.key}" />: <c:out value="${x.value}" /><p/>
  </c:forEach>
</body>
</html>
```

- For cookies, use the cookie object

```
<c:forEach var="c" items="${cookie}">
   <p><c:out value="${c.key}"/>: <c:out value="${c.value}" /></p>
</c:forEach>
```

## Database Connectivity

- Custom tags for SQL:

```
<sql:transaction>
  <sql:update>
      insert into person values('John Smith','smith@domain.com')
  </sql:update>
  <sql:query var="result">
      select * from person
  </sql:query>
</sql:transaction>

<c:forEach var="row" items="${result.rows}">
   <c:forEach var="col" items="${row}">
      <c:out value="${col.key}"/>: <c:out value="${col.value}"/>
   </c:forEach>
 </c:forEach>
```



## Scriplets and JavaScript

- You can embed Java code fragments (called **scriplets**) into the JSP pages
  - Syntax: <% java-code %>
  - Not recommended because the application programming should be detached from web page content
  - Use custom tags instead
- You can include JavaScript code to be executed at client side

```
<c:import url="/WEB-INF/javascript/client.js" />
<form name="myForm" onSubmit="popup()">
```

- NetBeans provides a library of Ajax JavaScript templates



## User-defined Custom Tags

- You can create your own custom tag, **ct**, in the namespace mytags, by providing a Java bean, the **tag handler** CtTag
- Structure of a custom tag:

```
<mytags:ct name= "x">some content</mytags:ct>
```

- Code in mypackage.tag:

```
import javax.servlet.jsp.tagext.*;
public class CtTag extends BodyTagSupport {
  String name;
  public int doStartTag () throws JspException { }
  public int doStartTag () throws JspException {
    JspWriter out = pageContext.getOut( );
    String content = getBodyContent().getString().trim();
    out.println(content);
```

- To import mytags:

```
<%@taglib uri="mypackage.tags" prefix="mytags" %>
```



## JavaServer Faces

- Based on a special tag library
- Pages are created using **User Interface Components**
  - they represent common user interface components, such as buttons, output fields, input fields, etc
  - they are organized in a tree-like structure
  - they are separated from **renderer**s (which map to HTML)
    - Renderers can be redefined (in render kit)
- The event and listener model lets developers register listeners on components to handle events
  - **Action event**: An action event is fired when a user does something, such as pressing a button or clicking a hyperlink
  - **Value-change event**: A value-change event is fired when a user changes a component's value, such as by clicking a checkbox or entering a value in a text field
- You can define a listener to an event as a **backing bean** method
- You can have multiple registered listeners (observers) to an event

## Navigation Model

- Must define page navigation separately
  - Navigation is a set of rules for choosing the next page to be displayed after a button or hyperlink is clicked
  - Instead of a URL, use a tag name
  - Tag names are mapped to URLs in page navigation configuration file

```
<navigation-rule>
  <from-view-id>/greeting.jsp</from-view-id>
  <navigation-case>
    <from-outcome>success</from-outcome>
    <to-view-id>/response.jsp</to-view-id>
  </navigation-case>
</navigation-rule>
```

  - They can be returned from event listeners

```
public String button1_action() {
    return "success";
}
```

- NetBeans provides a GUI to draw navigation graphs



## Backing Beans

- These are the back-end objects that provide the User Interface functionality
  - They can validate a component's data
  - They can handle an event fired by a component
  - They can perform processing to determine the next page to which the application must navigate
- Types:
  - **User Interface Backing Beans**: page and page fragment beans
    - contains everything necessary to manage the server-side logic for a web page
      - component properties and events
  - **Data backing beans**:
    - **Application beans** are created at the application level and available to all users, sessions, and requests
    - **Session beans** are created and are available at the user session level
    - **Request beans** are created for each request and are only available during the request. They are useful for passing information between two pages



## Data Providers and RowSets

- **Data providers** provide a simple interface to various data sources
- The **RowSet** interface provides JDBC code that reads and updates data from a data provider (eg, a database table)
  - Extends the standard JDBC ResultSet Interface
  - ... but can be used as a JavaBeans component
    - supports JavaBeans events, allowing other components in an application to be notified when an event occurs on a RowSet, such as a change in its value
- Can have parameter placeholders:

```
rs.setCommand("select fname, lname from CUSTOMER" +
              "where credit > ? and region = ?  ");
```

- Which can be instantiated and executed later:

```
rs.setInt(1, 5000);
rs.setString(2, "West");
rs.execute();
```



## CachedRowSet

- A **CachedRowSet** object is a container that caches database rows in memory
  - It is scrollable, updatable, and serializable
  - It extends the RowSet Interface
  - Updating a CachedRowSet object is similar to updating a ResultSet object, but must also call the method acceptChanges() to have updates written to the data source
- When you drag and drop a database table to a web page, you create a data provider along with the CachedRowSet for the table

  eg, if you drop the table CUSTOMER, you add the methods

  customerRowSet (a CachedRowSet in session bean)

  customerDataProvider (a DataProvider in page bean)

  (plus some JDBC code in the session _init() method to connect to the DB)

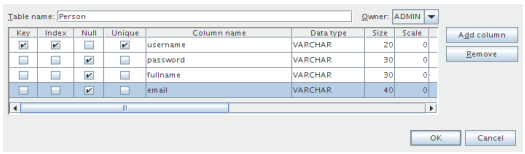
## A Simple Application

- Create a new project, called MyProject:
  - Open the NetBeans Visual Designer and click on “New Project”
  - On Choose Project, select Categories: “Web”, Projects: “Web Application”, push “Next”
  - On Name and Location, put Project Name: “MyProject”, Server: “Tomcat 6.0”, push “Next”
  - On Frameworks: check “Visual Web JavaServer”, push “Finish”
- On the Projects window, expand MyProject and “Web Pages”
  - Double-click to rename Page1.jsp to Main.jsp
- Create a new Database Customer:
  - On the Tools menu, select “Java DB Database”/“Create Database ...”
  - Put Database Name: customer, and pick a User Name and Password
  - On the Services window, expand Databases, right click on the jdbc:derby driver for customer and select “Connect ...”
  - Left-click on the customer driver to expand it
  - Right-click on Tables and select “Create Table ...”

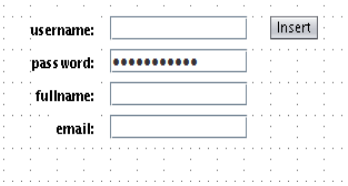


## The Main Page

- ... then create the table Person:




- From the Palette, drag and drop into the Main Design window Label, Text Field, Password, and Button components as follows:






## The Main Page (cont.)

- Click on the Insert button and, in the Properties menu (right bottom), change its id to insertButton
- Go to the Main JavaBean by clicking on Java on the Main window and add the following properties inside the class Main:

```
String newUsername;
String newPassword;
String newFullname;
String newEmail;
```

- Right click and select “Refactor”/“Encapsulate Fields ...”
  - Click on boxes to create getters and setters for the four new properties
  - Push Refactor
- Go back to the Main.jsp Design
- Right-click on the Text Field (the rectangle) next to “username:” and “Select Bind to Data ...”, then “Bind to Object”, then select newUsername
- Do the similar thing for the other Text Field rectangles



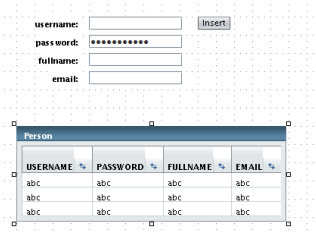
## Inserting New Data

- Drag and drop the PERSON table from the Servers menu to the Main Design window (don't drop it on a component)
  - Notice that there is now a personDataProvider in the Navigator menu
- Double-click on the Insert button to add code

```
public String insertButton_action() {
  try {
        SessionBean1 session = getSessionBean1();
        CachedRowSet rs = session.getPersonRowSet();
        rs.moveToInsertRow();
        rs.updateString(1,newUsername);  rs.updateString(2,newPassword);
        rs.updateString(3,newFullname);  rs.updateString(4,newEmail);
        rs.insertRow();
        rs.acceptChanges();
        newUsername = ""; newPassword = ""; newFullname = ""; newEmail = "";
    } catch (Exception ex) {
        throw new FacesException(ex);
    }
    return "main";
}
```

## Displaying Data in a Table

- Go back to the Main Design window and drag and drop a Table from the Palette into the Design window
- Drag and drop the PERSON table from the Services window onto the header of the new Table component in the Design Window
  - On the popup menu, select "Use personRowSet", press OK
  - Right-click on the Table header and change the title to Person






## Testing

- Right-click on the Design window and choose "Page Navigation"
  - Push on the plus sign in Main.jsp to see its buttons
  - Drag and drop the insertButton link into Main.jsp forming a loop
  - Select the loop line, right click, choose Rename..., and rename case1 to main


  - Recall that the insertButton_action() returns "main", which loops back
- Go back to the Main Design window and save the project
- Push "Run Main Project" to build, install, and run your program
  - It will run using Tomcat on a web browser at the URL:
    http://localhost:8080/MyProject/
- Insert few data and remember one username/password combination to use it for log-in



## The Login Page

- Click on "New File" and Select "JavaServer Faces" and "Visual Web JSF Design", click Next, put File Name: Login, push Finish
- On the Login Design window, drag and drop the following


- Click on the login button and change its id to loginButton in the Properties window
- Go to the Login class by clicking on Java and add the properties

```
String loginUsername;
String loginPassword;
```

  - Use the refactor as before to add getter/setter methods
- Go back to the design and bind the username/password to these new properties (as before using "Bind to an Object")



## Login using the Database

- Drag and drop the PERSON table from the Services window into the Login design window
  - Choose Create SessionBean1 with personRowSet1
- On the Navigator menu, right-click on personRowset1 in SessionBean1 and choose "Edit SQL Statement"
- Use the SQL editor to add query criteria (parameters) and construct the SQL query

```
SELECT ALL ADMIN.PERSON.USERNAME
FROM ADMIN.PERSON
WHERE ADMIN.PERSON.USERNAME = ?
      AND ADMIN.PERSON.PASSWORD = ?
```

- Right-click on Login.jsp in the Projects window and select "Set as Start Page"

## The Login Action

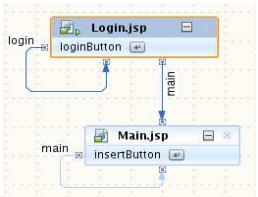
- Double-click on login button to edit the action:

```
public String loginButton_action() {
    try {
        SessionBean1 session = getSessionBean1();
        CachedRowSet rs = session.getPersonRowSet1();
        rs.setObject(1,loginUsername);
        rs.setObject(2,loginPassword);
        rs.execute();
        loginUsername = "";  loginPassword = "";
        if (rs.first())
            return "main";
    } catch (Exception ex) {
        throw new FacesException(ex);
    }
    return "login";
}
```



## Navigation

- Right-click on the Login design page and select Page Navigation
  - Draw the following navigation (based on the loginButton action)




- Save and run the project again
- Login using one of the Person accounts
- *Question*: if we add a logout button in Main, what would be its action?