Internet Technologies
10 – Integrating JSP and Servlets

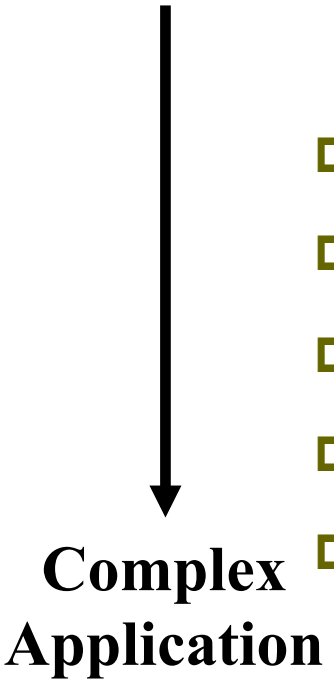
F. Ricci

2010/2011

Content

- Understanding the benefits of MVC
- Using `RequestDispatcher` to implement MVC
- Forwarding requests from servlets to JSP pages
- Handling relative URLs
- Including pages from servlets
- Forwarding pages in JSP
- Expression language
- Accessing scoped variables
- Accessing Bean properties
- Accessing collections

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 Struts or JSF

Why Combine Servlets & JSP?

- **Typical picture**: use JSP to make it easier to develop and maintain the HTML content
  - For simple dynamic code, call servlet code from scripting elements
  - For slightly more complex applications, use custom classes called from scripting elements
  - For moderately complex applications, use beans and custom tags
- But, that's not enough
  - For complex processing, starting with JSP is awkward
  - Despite the ease of separating the real code into separate classes, beans, and custom tags, the assumption behind JSP is that a *single* page gives a *single* basic look.

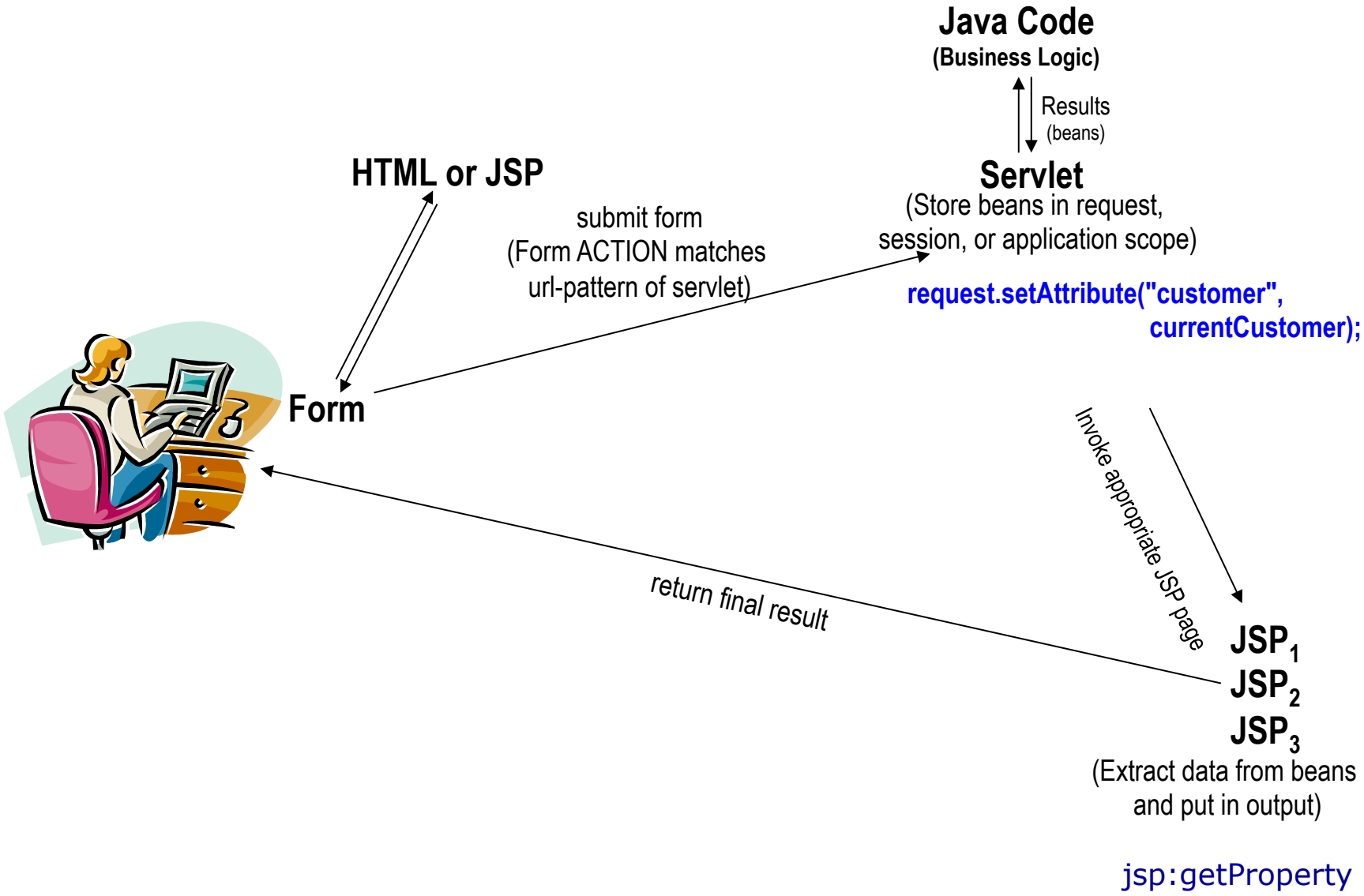
Possibilities for Handling a Single Request

- **Servlet only**. Works well when:
  - Output is a binary type. E.g.: an image
  - There is *no* output. E.g.: you are doing forwarding or redirection as in Search Engine example (lecture 7)
  - Format/layout of page is highly variable
- **JSP only**. Works well when:
  - Output is mostly character data. E.g.: HTML
  - Format/layout mostly fixed
- **Combination (MVC architecture)**. Needed when:
  - A single request will result in multiple substantially different-looking results
  - You have a large development team with different team members doing the Web development and the business logic
  - You have a relatively fixed layout, but perform complicated data processing.

Model-View-Controller

- An approach where you break the response into three pieces
  - **The controller:** the part that handles the request, decides what logic to invoke, and decides what JSP page should apply
  - **The model:** the classes that represent the data being displayed
  - **The view:** the JSP pages that represent the output that the client sees
- Examples
  - **MVC** using `RequestDispatcher` – works very well for most simple and moderately complex applications
  - Struts (*future course*)
  - JavaServer Faces JSF (*future course*)

MVC Flow of Control



Implementing MVC with RequestDispatcher

1. **Define beans** to represent the data
2. Use a **servlet to handle requests**
   - Servlet reads request parameters, checks for missing and malformed data, calls business logic, etc.
3. **Populate the beans**
   - The servlet invokes business logic (application-specific code) or data-access code to obtain the results. Results are placed in the beans that were defined in step 1
4. **Store the bean** in the request, session, or servlet context
   - The servlet calls `setAttribute` on the `request`, `session`, or `ServletContext` objects to store a reference to the beans that represent the results of the request.

Implementing MVC with RequestDispatcher

5. **Forward** the request to a **JSP page**
   - The servlet determines which JSP page is appropriate to the situation and uses the forward method of `RequestDispatcher` (from the `ServletRequest`) to transfer control to that page
6. **Extract the data from the beans**
   - The JSP page accesses beans with `jsp:useBean` and a scope matching the location of step 4. The page then uses `jsp:getProperty` to output the bean properties.
   - The JSP page **does not create or modify the bean**; it merely extracts and displays data that the servlet created.

Request Forwarding Example

```
public void doGet(HttpServletRequest request,
                  HttpServletResponse response)
  throws ServletException, IOException {
  ... // Do business logic and get data
  String operation = request.getParameter("operation");
  if (operation == null) {
    operation = "unknown";
  }
  String address;
  if (operation.equals("order")) {
    address = "/WEB-INF/Order.jsp";
  } else if (operation.equals("cancel")) {
    address = "/WEB-INF/Cancel.jsp";
  } else {
    address = "/WEB-INF/UnknownOperation.jsp";
  }
  RequestDispatcher dispatcher =
    request.getRequestDispatcher(address);
  dispatcher.forward(request, response);
}
```

RequestDispatcher

- First get the appropriate `RequestDispatcher`: `request.getRequestDispatcher(address);`
- Then the `RequestDispatcher` can
  - `forward(ServletRequest request, ServletResponse response)` - forwards a request to another resource on the *same* server
  - That resource can be a Servlet, JSP page or a simple HTML page
  - `include(ServletRequest request, ServletResponse response)` - works like a server-side include (SSI) and includes the response from the given resource (Servlet, JSP page, HTML page) within the caller response.

jsp:useBean in MVC vs.in Standalone JSP Pages

- **The JSP page should not create the objects**
  - The servlet, not the JSP page, should create all the data objects
  - To guarantee that the JSP page will not create objects, you should use

    <jsp:useBean ... type="package.Class" />

    instead of

    <jsp:useBean ... class="package.Class" />

- **The JSP page should not modify the objects**
  - So, you should use **jsp:getProperty** but not **jsp:setProperty**.

Scope Alternatives

- request
  - <jsp:useBean id="..." type="..." scope="request" />
- session
  - <jsp:useBean id="..." type="..." scope="session" />
- application
  - <jsp:useBean id="..." type="..." scope="application" />
- page
  - <jsp:useBean id="..." type="..." scope="page" />
    or just
    <jsp:useBean id="..." type="..." />
  - This scope is not used in MVC (Model 2) architecture (Why?)

Request-Based Data Sharing

- Servlet

```
ValueObject value = new ValueObject(...);
request.setAttribute("key", value);
RequestDispatcher dispatcher =
  request.getRequestDispatcher
                              ("/WEB-INF/SomePage.jsp");
dispatcher.forward(request, response);
```

- JSP

```
<jsp:useBean id="key" type="somePackage.ValueObject"
             scope="request" />
<jsp:getProperty name="key" property="someProperty" />
```

Name chosen by the servlet.

Name of accessor method, minus the word "get", with next letter changed to lower case.

Session-Based Data Sharing

- Servlet

```
ValueObject value = new ValueObject(...);
HttpSession session = request.getSession();
session.setAttribute("key", value);
RequestDispatcher dispatcher =
  request.getRequestDispatcher
                    ("/WEB-INF/SomePage.jsp");
dispatcher.forward(request, response);
```

- JSP

```
<jsp:useBean id="key" type="somePackage.ValueObject"
             scope="session" />
<jsp:getProperty name="key" property="someProperty" />
```

Session-Based Data Sharing: Variation

- **Redirect** to page instead of **forwarding** to it
  - Use `response.sendRedirect` instead of `RequestDispatcher.forward`
- Distinctions: with `sendRedirect`:
  - With **redirect** user sees JSP URL (user sees only servlet URL with `RequestDispatcher.forward`)
  - **Two round trips** to client (only one with forward)
- Advantage of sendRedirect
  - User can visit JSP page separately
    - User can bookmark JSP page
- Disadvantages of `sendRedirect`
  - Two round trips to server is more expensive
  - Since user can visit JSP page without going through servlet first, bean data might not be available
    - So, JSP page needs code to detect this situation.

ServletContext-Based Data Sharing

- Servlet

Who is "this"?

```
synchronized(this) {
  ValueObject value = new ValueObject(...);
  getServletContext().setAttribute("key", value);
  RequestDispatcher dispatcher =
    request.getRequestDispatcher
                        ("/WEB-INF/SomePage.jsp");
  dispatcher.forward(request, response);
}
```

- JSP

```
<jsp:useBean id="key" type="somePackage.ValueObject"
             scope="application" />
<jsp:getProperty name="key"
  property="someProperty" />
```

Relative URLs in JSP Pages

- Issue:
  - Forwarding with a request dispatcher is transparent to the client: ***Original* URL is the only URL browser knows about**
- Why does this matter?
  - What will browser do with tags like the following?

```
<img src="foo.gif" …>
<link rel="stylesheet"
      href="my-styles.css"
      type="text/css">
<a href="bar.jsp">…</a>
```

  - **Browser treats** addresses as relative to *servlet URL*

Applying MVC: Bank Account Balances

- **Bean**
  - BankCustomer
- **Servlet** that populates bean and forwards to appropriate JSP page
  - Reads customer ID, calls data-access code to populate BankCustomer
  - Uses current balance to decide on appropriate result page
- **JSP** pages to display results
  - Negative balance: warning page
  - Regular balance: standard page
  - High balance: page with advertisements added
  - Unknown customer ID: error page

Bank Account Balances: Servlet Code

```
public class ShowBalance extends HttpServlet {
  public void doGet(HttpServletRequest request,
                    HttpServletResponse response)
      throws ServletException, IOException {
    BankCustomer customer =
      BankCustomer.getCustomer(request.getParameter("id"));

    String address;
    if (customer == null) {
      address =
        "/WEB-INF/bank-account/UnknownCustomer.jsp";
    } else if (customer.getBalance() < 0) {
      address =
        "/WEB-INF/bank-account/NegativeBalance.jsp";
      request.setAttribute("badCustomer", customer);
    }
    …
    RequestDispatcher dispatcher =
      request.getRequestDispatcher(address);
    dispatcher.forward(request, response);
```

The bean contains a small data base of customers in a static variable

BankCustomer.java

ShowBalance.java

call1 *call2* *call3*

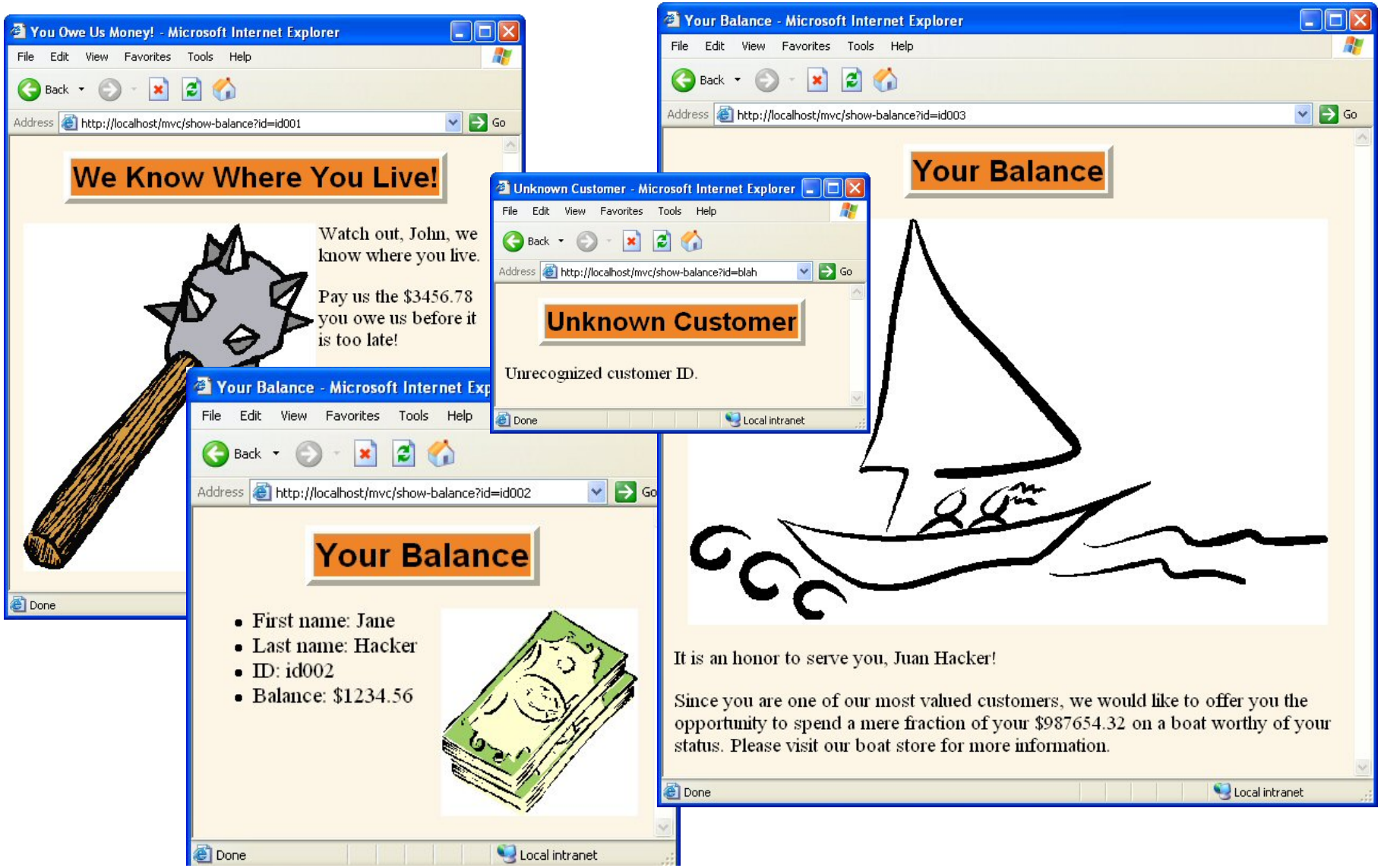
JSP Code (Negative Balance)

```
…
<BODY>
<TABLE BORDER=5 ALIGN="CENTER">
  <TR><TH CLASS="TITLE">
      We Know Where You Live!</TABLE>
<P>
<IMG SRC="bank-support/Club.gif" ALIGN="LEFT">
<jsp:useBean id="badCustomer"
             type="coreservlets.BankCustomer"
             scope="request" />
Watch out,
<jsp:getProperty name="badCustomer"
                 property="firstName" />,
we know where you live.
<P>
Pay us the $<jsp:getProperty name="badCustomer"
                             property="balanceNoSign" />
you owe us before it is too late!
</BODY></HTML>
```

JSP 2.0 Code (Negative Balance)

```
…
<BODY>
<TABLE BORDER=5 ALIGN="CENTER">
  <TR><TH CLASS="TITLE">
      We Know Where You Live!</TABLE>
<P>
<IMG SRC="/bank-support/Club.gif" ALIGN="LEFT">
Watch out, ${badCustomer.firstName},
we know where you live.
<P>
Pay us the $${badCustomer.balanceNoSign}
you owe us before it is too late!
</BODY></HTML>
```

Bank Account Balances: Results



Forwarding from JSP Pages

```
<% String destination;
   if (Math.random() > 0.5) {
     destination = "/examples/page1.jsp";
   } else {
     destination = "/examples/page2.jsp";
   }
%>
<jsp:forward page="<%= destination %>" />
```

- Legal, but bad idea
  - **Business and control logic belongs in servlets**
  - Keep JSP focused on presentation.

Including Pages Instead of Forwarding

- With the `forward` method of RequestDispatcher:
  - **New page generates all of the output**
  - Original page *cannot* generate any output
- With the `include` method of RequestDispatcher:
  - Output can be generated by **multiple pages**
  - Original page *can* generate output **before** and **after** the included page
  - Original servlet does not see the output of the included page
  - Applications
    - Portal-like applications (see first example)
    - Including alternative content types for output (see second example)

Using RequestDispatcher.include: portals

```
response.setContentType("text/html");
String firstTable, secondTable, thirdTable;
if (someCondition) {
  firstTable = "/WEB-INF/Sports-Scores.jsp";
  secondTable = "/WEB-INF/Stock-Prices.jsp";
  thirdTable = "/WEB-INF/Weather.jsp";
} else if (...) { ... }
RequestDispatcher dispatcher =
  request.getRequestDispatcher("/WEB-INF/Header.jsp");
dispatcher.include(request, response);
dispatcher =
  request.getRequestDispatcher(firstTable);
dispatcher.include(request, response);
dispatcher =
  request.getRequestDispatcher(secondTable);
dispatcher.include(request, response);
dispatcher =
  request.getRequestDispatcher(thirdTable);
dispatcher.include(request, response);
dispatcher =
  request.getRequestDispatcher("/WEB-INF/Footer.jsp");
dispatcher.include(request, response);
```

RequestDispatcher.include: Setting Content-Type of Output

```
public void doGet(...) ... {
    ...
    if ("xml".equals(format)) {
      response.setContentType("text/xml");
      outputPage = "/WEB-INF/results/cities-xml.jsp";
    } else if ("json".equals(format)) {
      response.setContentType("text/javascript");
      outputPage = "/WEB-INF/results/cities-json.jsp";
    } else {
      response.setContentType("text/plain");
      outputPage = "/WEB-INF/results/cities-string.jsp";
    }
    RequestDispatcher dispatcher =
      request.getRequestDispatcher(outputPage);
    dispatcher.include(request, response);
  }
```

Expression Language

- When using MVC in JSP 2.x-compliant server change:

```
<jsp:useBean id="someName"
             type="somePackage.someClass"
             scope="request, session, or
  application"/>
<jsp:getProperty name="someName"
                 property="someProperty"/>
```

- To:

```
${someName.someProperty}
```

Advantages of the Expression Language

- **Concise access to stored objects**
  - To output a **"scoped variable"** (object stored with `setAttribute` in the PageContext, HttpServletRequest, HttpSession, or ServletContext) named `saleItem`, you use `${saleItem}`
- **Shorthand notation for bean properties**
  - To output the `companyName` **property** (i.e., result of the `getCompanyName` method) **of a scoped variable** named company, you use `${company.companyName}`
  - To access the `firstName` property of the president property of a scoped variable named `company`, you use `${company.president.firstName}`.

Advantages of the Expression Language

- **Simple access to collection elements**
  - To access an element of an array, List, or Map, you use `${variable[indexOrKey]}`
  - Provided that the index or key is in a form that is legal for Java variable names, the dot notation for beans is interchangeable with the bracket notation
- **Succinct access to request parameters, cookies, and other request data**
  - To access the standard types of request data, you can use one of several predefined implicit objects
- **A small but useful set of simple operators**
  - To manipulate objects within EL expressions, you can use any of several arithmetic, relational, logical, or empty-testing operators.

Advantages of the Expression Language

- **Conditional output**
  - To choose among output options, you do not have to resort to Java scripting elements. Instead, you can use ${test ? option1 : option2}
- **Automatic type conversion**
  - The expression language removes the need for most typecasts and for much of the code that parses strings as numbers
- **Empty values instead of error messages**
  - In most cases, missing values or NullPointerExceptions result in empty strings, not thrown exceptions.

Accessing Scoped Variables

- **${varName}**
  - Searches the PageContext, the HttpServletRequest, the HttpSession, and the ServletContext, *in that order*, and output the object with that attribute name - PageContext does not apply with MVC
- Equivalent (alternative) forms

1. `${name}`
2. `<%= pageContext.findAttribute("name") %>`
3. `<jsp:useBean id="name" type="somePackage.SomeClass" scope="..."> <%= name %>`

Example: Accessing Scoped Variables

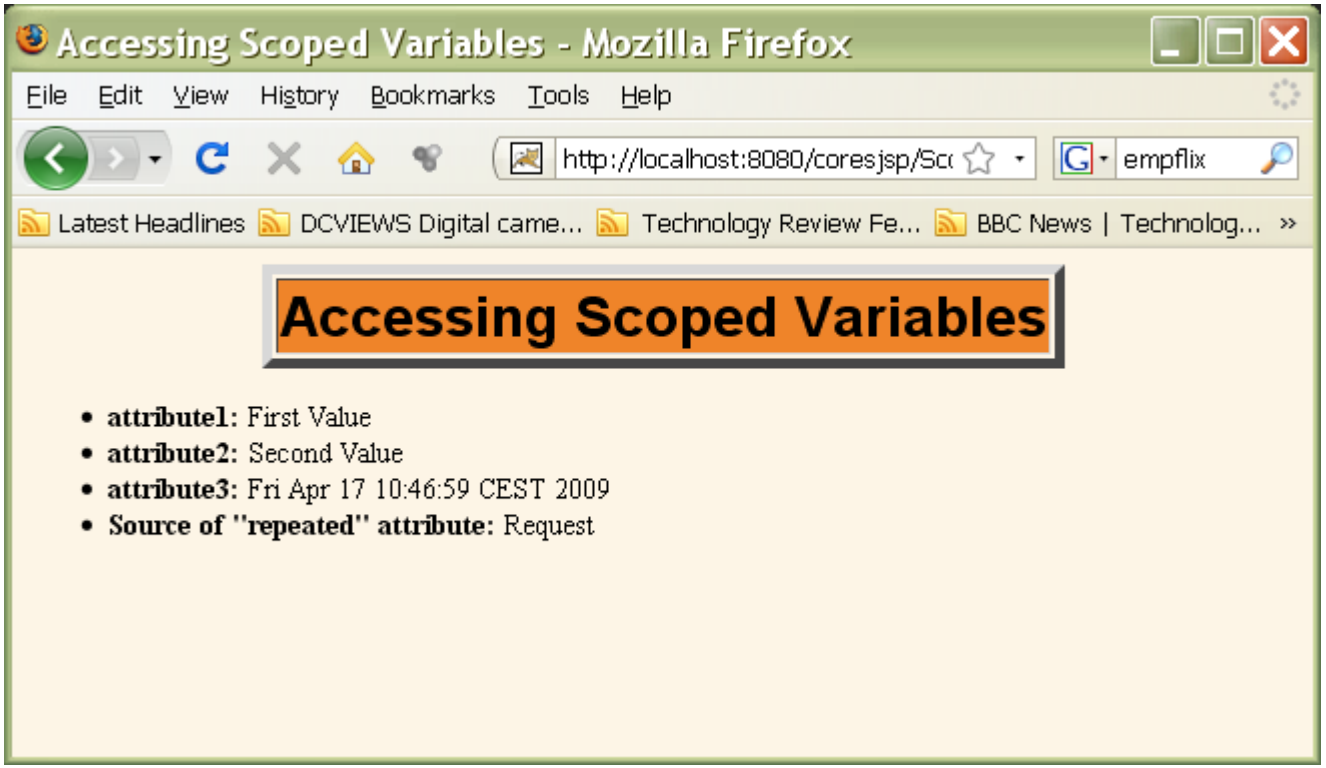
```
public class ScopedVars extends HttpServlet {
  public void doGet(HttpServletRequest request,
                    HttpServletResponse response)
      throws ServletException, IOException {
    request.setAttribute("attribute1", "First Value");
    HttpSession session = request.getSession();
    session.setAttribute("attribute2", "Second Value");
    ServletContext application = getServletContext();
    application.setAttribute("attribute3",
                             new java.util.Date());
    request.setAttribute("repeated", "Request");
    session.setAttribute("repeated", "Session");
    application.setAttribute("repeated",
   "ServletContext");
    RequestDispatcher dispatcher =
      request.getRequestDispatcher
                      ("scoped-vars.jsp");
    dispatcher.forward(request, response);
  }
}
```

Example: Accessing Scoped Variables (cont.)

The called JSP

```
<!DOCTYPE …>
…
<TABLE BORDER=5 ALIGN="CENTER">
  <TR><TH CLASS="TITLE">
  Accessing Scoped Variables
</TABLE>
<P>
<UL>
  <LI><B>attribute1:</B> ${attribute1}
  <LI><B>attribute2:</B> ${attribute2}
  <LI><B>attribute3:</B> ${attribute3}
  <LI><B>Source of "repeated" attribute:</B>
      ${repeated}
</UL>
</BODY></HTML>
```

Example: Accessing Scoped Variables (Result)



call

Accessing Bean Properties

- `${varName.propertyName}`
  - Means to find scoped variable of given name and output the specified bean property

- **Equivalent forms:**

1. `${customer.firstName}`
2.
```
<%@ page import="coreservlets.NameBean" %>
<% NameBean person =
     (NameBean)pageContext.findAttribute
("customer");
%>
<%= person.getFirstName() %>
```

Accessing Bean Properties

- **Equivalent forms:**
  - `${customer.firstName}`
  -
```
<jsp:useBean id="customer"
             type="coreservlets.NameBean"
             scope="request, session, or
                    application" />
<jsp:getProperty name="customer"
                 property="firstName" />
```
- This is better than script on previous slide
  - But, **requires you to know the scope**
  - **And fails for subproperties:**
  - No non-Java equivalent to:

```
${customer.address.zipCode}
```

Example: Accessing Bean Properties

```
public class BeanProperties extends HttpServlet {
  public void doGet(HttpServletRequest request,
                    HttpServletResponse response)
      throws ServletException, IOException {
    Name name = new Name("Marty", "Hall");
    Company company =
      new Company("coreservlets.com",
                  "Java EE Training and Consulting");
    Employee employee =
      new Employee(name, company);
    request.setAttribute("employee", employee);
    RequestDispatcher dispatcher =
      request.getRequestDispatcher
        ("/WEB-INF/results/bean-properties.jsp");
    dispatcher.forward(request, response);
  }
}
```

Example: Accessing Bean Properties

```
public class Employee {
  private Name name;
  private Company company;

  public Employee(Name name, Company company) {
    setName(name);
    setCompany(company);
  }

  public Name getName() { return(name); }

  public void setName(Name name) {
    this.name = name;
  }

  public CompanyBean getCompany() { return(company); }

  public void setCompany(Company company) {
    this.company = company;
  }
}
```

Example: Accessing Bean Properties

```
public class Name {
  private String firstName;
  private String lastName;

  public Name(String firstName, String lastName) {
    setFirstName(firstName);
    setLastName(lastName);
  }

  public String getFirstName() {
    return (firstName);
  }
  public void setFirstName(String firstName) {
    this.firstName = firstName;
  }
  public String getLastName() {
    return (lastName);
  }
  public void setLastName(String lastName) {
    this.lastName = lastName;
  }
}
```

Example: Accessing Bean Properties (Cont.)

```
public class Company {
  private String companyName;
  private String business;

  public Company(String companyName, String business) {
    setCompanyName(companyName);
    setBusiness(business);
  }

  public String getCompanyName() { return(companyName); }

  public void setCompanyName(String companyName) {
    this.companyName = companyName;
  }

  public String getBusiness() { return(business); }

  public void setBusiness(String business) {
    this.business = business;
  }
}
```

Example: Accessing Bean Properties (Cont.)

```
<!DOCTYPE …>
…
<UL>
  <LI><B>First Name:</B>
      ${employee.name.firstName}
  <LI><B>Last Name:</B>
      ${employee.name.lastName}
  <LI><B>Company Name:</B>
      ${employee.company.companyName}
  <LI><B>Company Business:</B>
      ${employee.company.business}
</UL>
</BODY></HTML>
```

Example: Accessing Bean Properties (Result)

call

Equivalence of Dot and Array Notations

- Equivalent forms
  - `${name.property}`
  - `${name["property"]}`
- Reasons for using array notation
  - To access arrays, lists, and other collections
    - See upcoming slides
  - To calculate the property name at request time.
    - `{name1[name2]}` (no quotes around name2)
  - To use names that are illegal as Java variable names
    - `{foo["bar-baz"]}`
    - `{foo["bar.baz"]}`

Accessing Collections

- `${attributeName[entryName]}`
- Works for
  - Array. Equivalent to
    - `theArray[index]`
  - List. Equivalent to
    - `theList.get(index)`
  - Map. Equivalent to
    - `theMap.get(keyName)`
- Equivalent forms (for HashMap)
  - `${stateCapitals["maryland"]}`
  - `${stateCapitals.maryland}`
  - But the following is illegal since 2 is not a legal var name: `${listVar.2}`

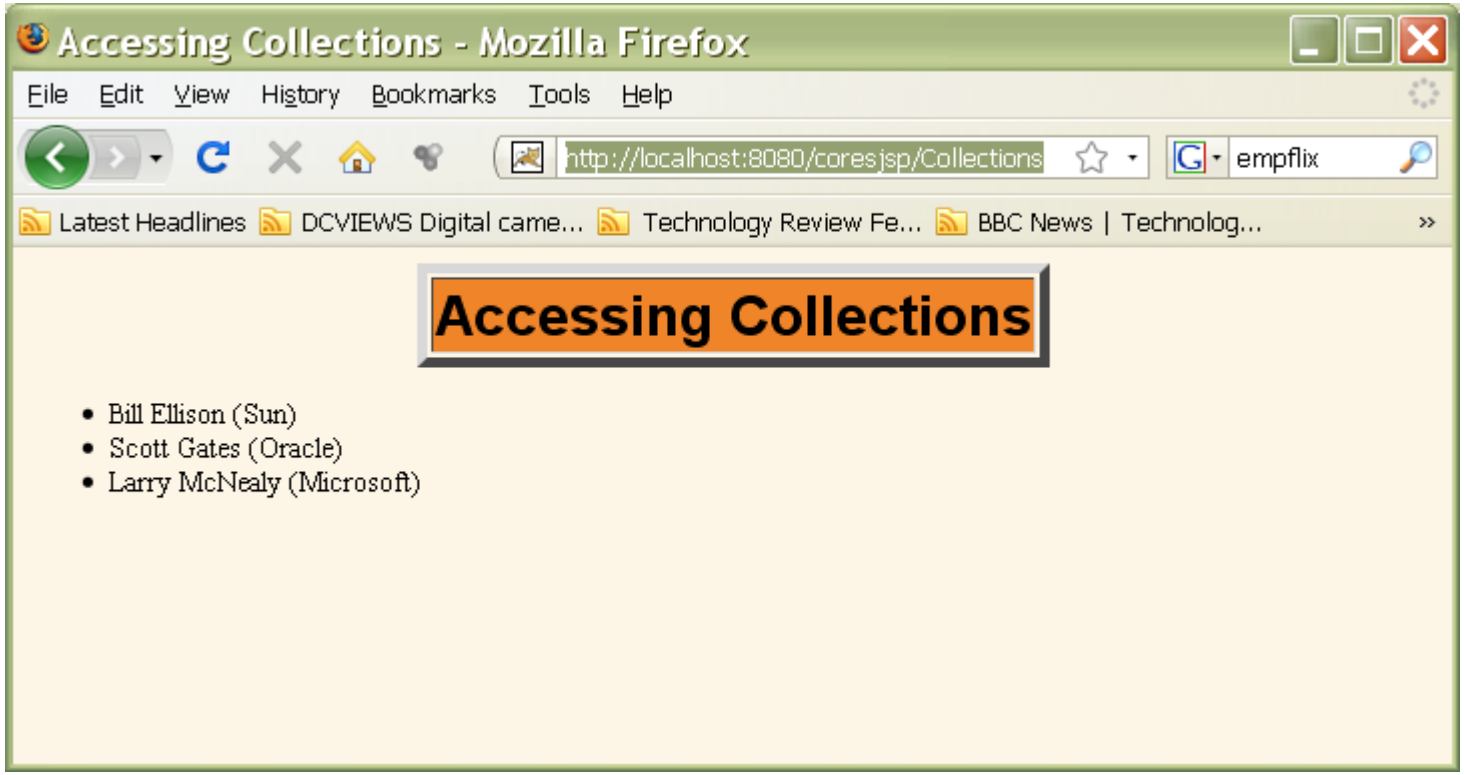
Example: Accessing Collections

```
public class Collections extends HttpServlet {
  public void doGet(HttpServletRequest request,
                    HttpServletResponse response)
      throws ServletException, IOException {
    String[] firstNames = { "Bill", "Scott", "Larry" };
    ArrayList lastNames = new ArrayList();
    lastNames.add("Ellison");
    lastNames.add("Gates");
    lastNames.add("McNealy");
    HashMap companyNames = new HashMap();
    companyNames.put("Ellison", "Sun");
    companyNames.put("Gates", "Oracle");
    companyNames.put("McNealy", "Microsoft");
    request.setAttribute("first", firstNames);
    request.setAttribute("last", lastNames);
    request.setAttribute("company", companyNames);
    RequestDispatcher dispatcher =
      request.getRequestDispatcher
                        ("collections.jsp");
    dispatcher.forward(request, response);
  }
}
```

Example: Accessing Collections (Continued)

```
<!DOCTYPE …>
…
<BODY>
<TABLE BORDER=5 ALIGN="CENTER">
  <TR><TH CLASS="TITLE">
  Accessing Collections
</TABLE>
<P>
<UL>
  <LI>${first[0]} ${last[0]} (${company["Ellison"]})
  <LI>${first[1]} ${last[1]} (${company["Gates"]})
  <LI>${first[2]} ${last[2]} (${company["McNealy"]})
</UL>
</BODY></HTML>
```

Example: Accessing Collections (Result)



call

Referencing Implicit Objects (I)

- `pageContext`: The PageContext object
  - E.g. `${pageContext.session.id}`
- Using the `pageContext object` you can obtain:
  - `Request: pageContext.request`
  - `Response: pageContext.response`
  - `Session: pageContext.session`
  - `Out: pageContext.out`
  - `ServletContext: pageContext.out`
- `param` and `paramValues`: Request params
  - E.g. `${param.custID}`

The value(s) of custID parameter

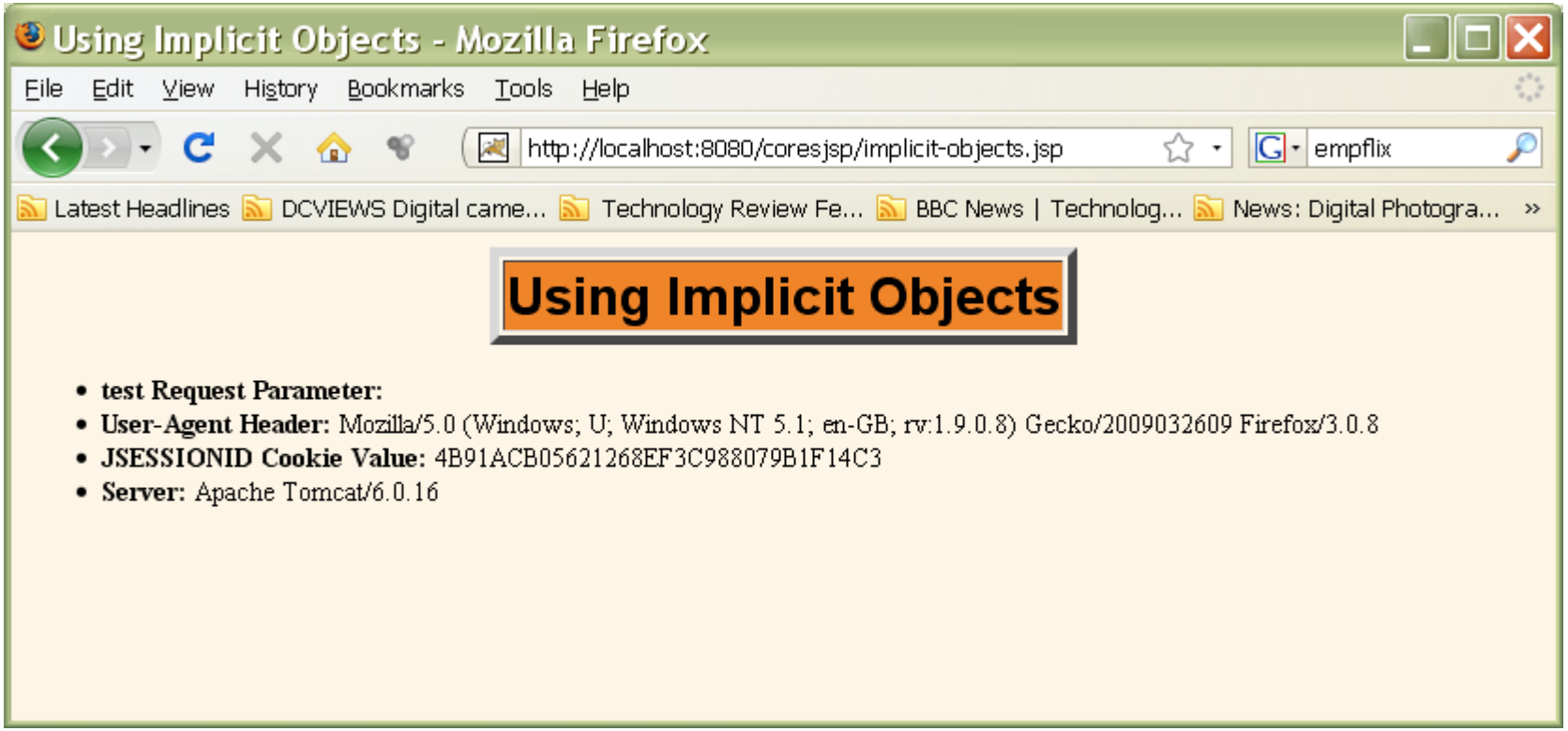
Referencing Implicit Objects (II)

- `header` and `headerValues`: Request headers
  - E.g. `${header.Accept}` or `${header["Accept"]}`
  - `${header["Accept-Encoding"]}`
- `cookie`: Cookie object (not cookie value)
  - E.g. `${cookie.userCookie.value}` or `${cookie["userCookie"].value}`
- `pageScope`, `requestScope`, `sessionScope`, `applicationScope`
  - Instead of searching scopes
  - `${requestScope.name}` look only in the `HttpServletRequest` object.

Example: Implicit Objects

```
<!DOCTYPE …>
…
<P>
<UL>
  <LI><B>test Request Parameter:</B>
      ${param.test}
  <LI><B>User-Agent Header:</B>
      ${header["User-Agent"]}
  <LI><B>JSESSIONID Cookie Value:</B>
      ${cookie.JSESSIONID.value}
  <LI><B>Server:</B>
      ${pageContext.servletContext.serverInfo}
</UL>
</BODY></HTML>
```

Example: Implicit Objects (Result)



call