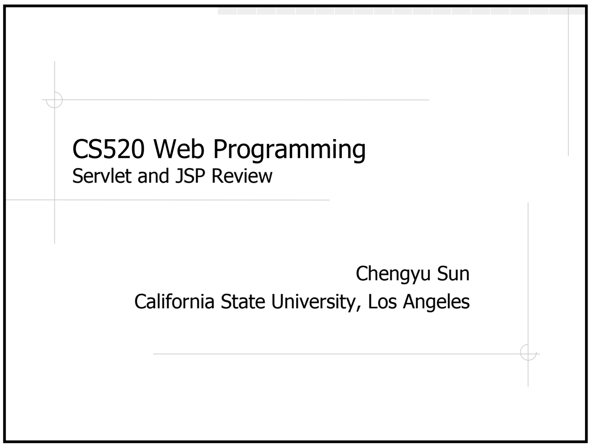
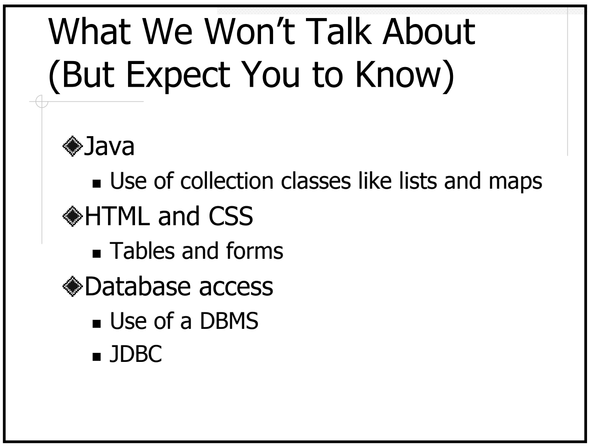


CS520 Web Programming

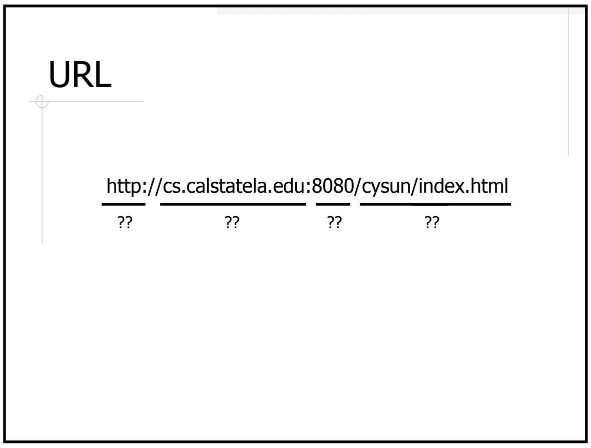
Servlet and JSP Review

Chengyu Sun
California State University, Los Angeles



What We Won't Talk About (But Expect You to Know)

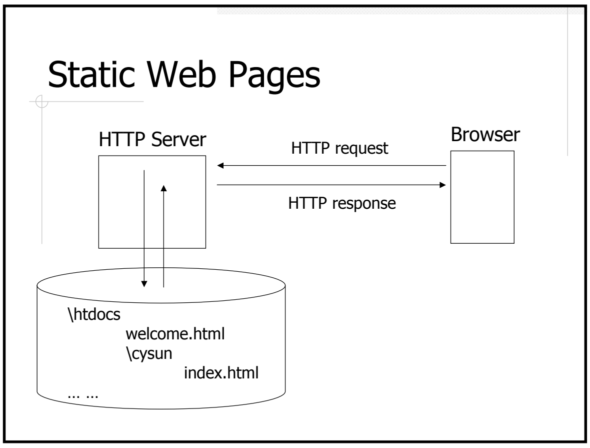
- Java
  - Use of collection classes like lists and maps
- HTML and CSS
  - Tables and forms
- Database access
  - Use of a DBMS
  - JDBC



URL

http://cs.calstatela.edu:8080/cysun/index.html

?? ?? ?? ??



Static Web Pages

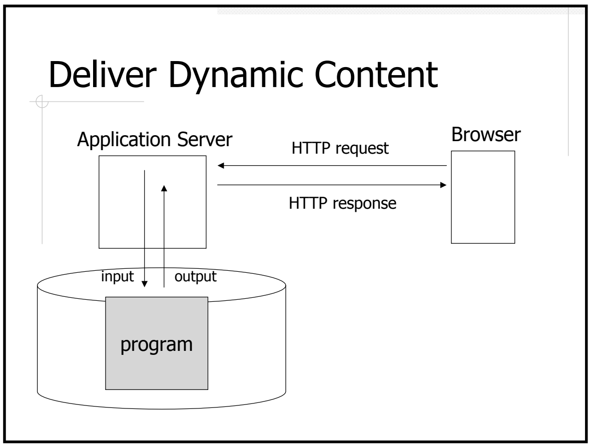
HTTP Server

Browser

HTTP request

HTTP response

\htdocs
welcome.html
\cysun
index.html
… …



Deliver Dynamic Content

Application Server

Browser

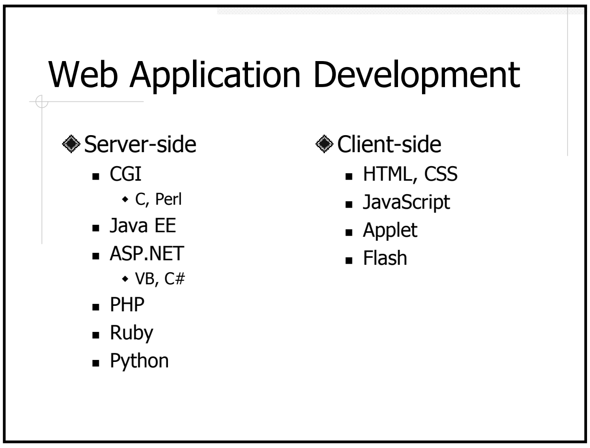
HTTP request

HTTP response

input

output

program



Web Application Development

- Server-side
  - CGI
    - C, Perl
  - Java EE
  - ASP.NET
    - VB, C#
  - PHP
  - Ruby
  - Python
- Client-side
  - HTML, CSS
  - JavaScript
  - Applet
  - Flash

Dynamic Web Project in Eclipse

- **`build`**: generated files
  - **`classes`**: compiled Java classes
- **`src`**: source code
- **`WebContent`**: other resources (HTML pages, images, JavaScript ...); root directory of the web application
  - **`WEB-INF`**: cannot be accessed remotely
    - **`lib`**: Library jar files
  - **`web.xml`**: web application deployment descriptor

More About web.xml

- `web.xml` in CSNS
- Java Servlet 2.4 Specification
  - SRV.13.4

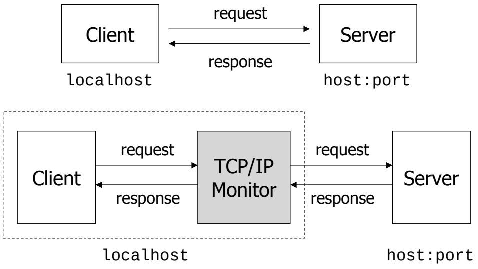
Servlet Hello World

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

public class HelloWorld extends HttpServlet {
  public void doGet( HttpServletRequest request,
                     HttpServletResponse response )
    throws ServletExceptoin, IOException
  {
    PrintWriter out = response.getWriter();
    out.println( “Hello World” );
  }
}
```

Program I/O

- Input: HTTP Request
- Output: HTTP Response

TCP/IP Monitor in Eclipse

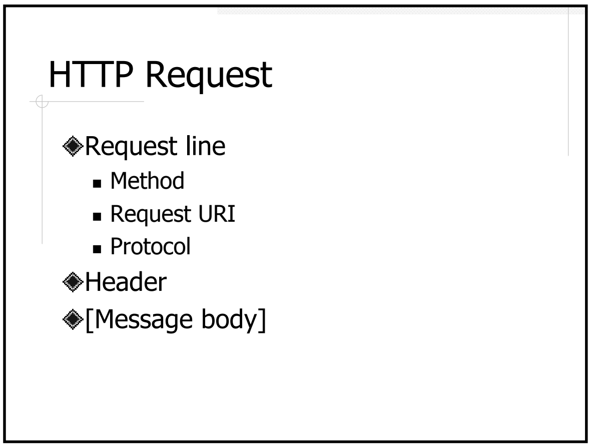


Local monitoring port??

HTTP Request Example

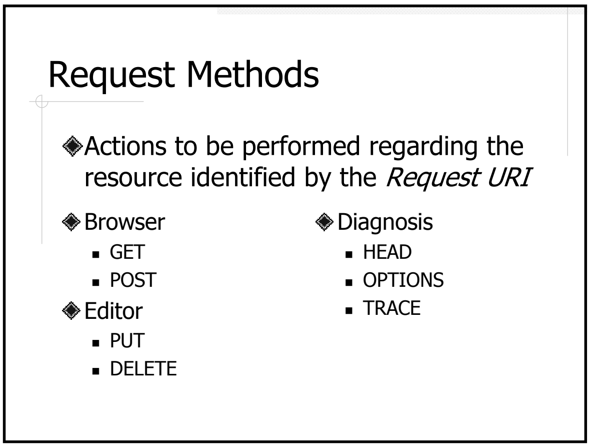
http://cs3.calstatela.edu:4040/whatever

```
GET /whatever HTTP/1.1
Host: cs.calstatela.edu:4040
User-Agent: Mozilla/5.0 (Windows; U; Windows NT 5.0; en-US; rv:1.7.3) ...
Accept: text/xml,application/xml,application/xhtml+xml,text/html;q=0.9,...
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 300
Connection: keep-alive
Cookie: nxt/gateway.dll/uid=4B4CF072; SITESERVER=ID=f1675...
```



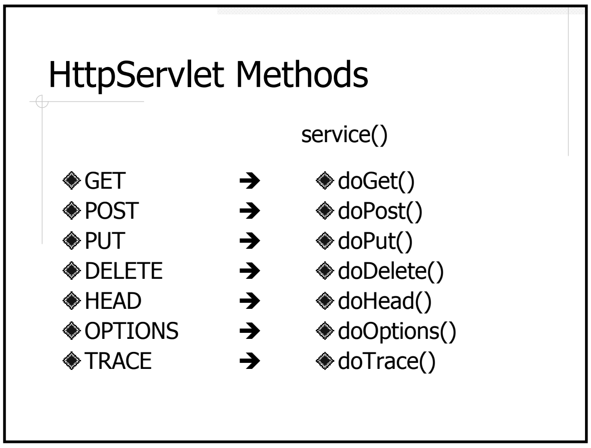
HTTP Request

- Request line
  - Method
  - Request URI
  - Protocol
- Header
- [Message body]



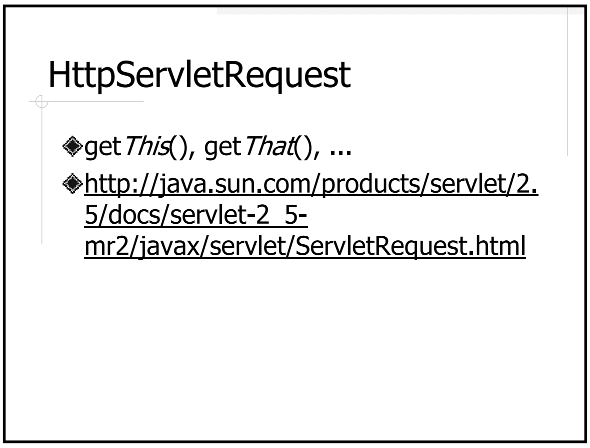
Request Methods

- Actions to be performed regarding the resource identified by the *Request URI*
- Browser
  - GET
  - POST
- Editor
  - PUT
  - DELETE
- Diagnosis
  - HEAD
  - OPTIONS
  - TRACE



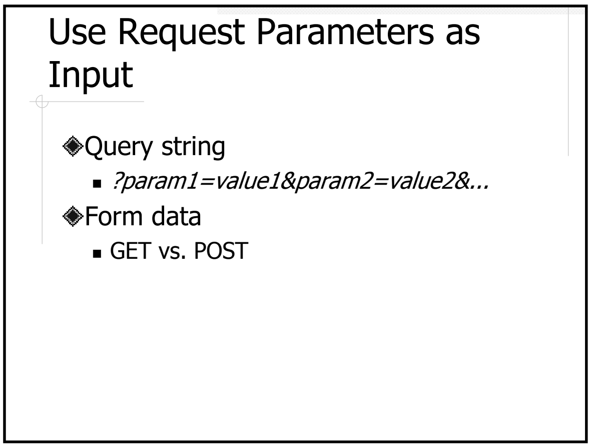
HttpServlet Methods

		service()
GET	→	doGet()
POST	→	doPost()
PUT	→	doPut()
DELETE	→	doDelete()
HEAD	→	doHead()
OPTIONS	→	doOptions()
TRACE	→	doTrace()



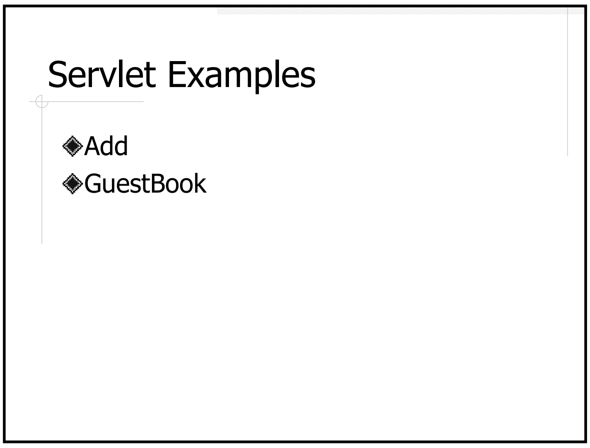
HttpServletRequest

- get*This*(), get*That*(), ...
- http://java.sun.com/products/servlet/2.5/docs/servlet-2_5-mr2/javax/servlet/ServletRequest.html



Use Request Parameters as Input

- Query string
  - *?param1=value1&param2=value2&...*
- Form data
  - GET vs. POST



Servlet Examples

- Add
- GuestBook

Use Request URI as Input

?param1=value1&param2=value2

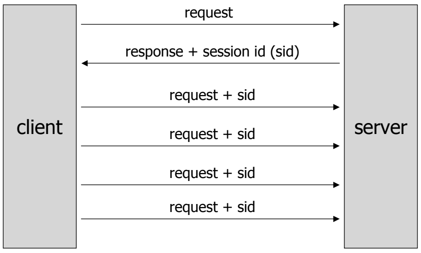
⇩

/param1/value1/param2/value2

Session Tracking

- ◈The Need
  - shopping cart, personalization, ...
- ◈The Difficulty
  - HTTP is a "stateless" protocol
  - Even persistent connections only last seconds
- ◈The Trick??

General Idea



Three Ways to Implement Session Tracking

- ◈URL Re-writing
- ◈Hidden form field
- ◈Cookies

Cookies

- ◈Issued by the server
  - HTTP Response: Set-Cookie
- ◈Part of the next client request
  - HTTP Request: Cookie

Cookie Attributes

- ◈Name, Value
- ◈Host/Domain, Path
- ◈Require secure connection
- ◈Max age
- ◈Comment (Version 1)

Servlet Cookie API

- Cookie
  - get*This*(), set*That*() ...
  - setMaxAge(int)
    - 1000??, -1??, 0??
- HttpServletResponse
  - addCookie(Cookie)
- HttpServletRequest
  - Cookie[] getCookies()

Servlet Session Tracking API

- HttpServletRequest
  - HttpSession getSession()
- HttpSession
  - setAttribute(String, Object)
  - getAttribute(String)
  - setMaxInactiveInterval(int)
    - Tomcat default: 30 seconds
  - invalidate()

Example: Improved GuestBook

- A use only need to specify a name when he or she leaves the first message

Scopes and Data Sharing

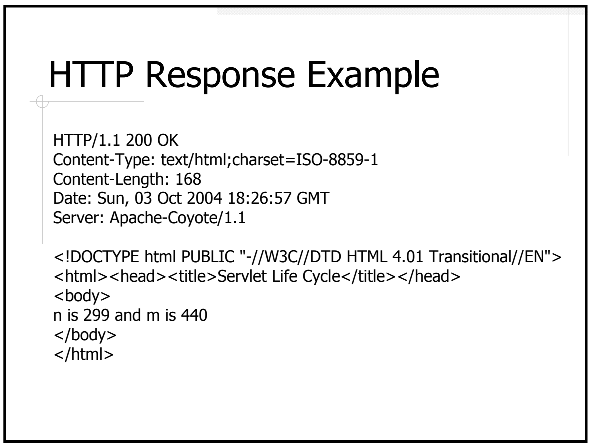
- page scope – data is valid within current page
  - include
- request scope – data is valid throughout the processing of the request
  - forward
- session scope – data is valid throughout the session
  - redirect, multiple separate requests
- application scope – data is valid throughout the life cycle of the web application

Access Scoped Variables in Servlet

- Application scope
  - `getServletContext()`
- Session scope
  - `request.getSession()`
- Request scope
  - `request`
- Page scope (in JSP scriptlet)
  - `pageContext`

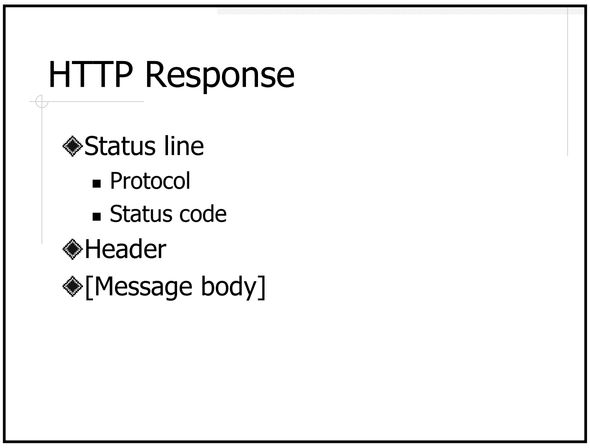
Scoped Variable Example

- A separate AddComment servlet for GuestBook



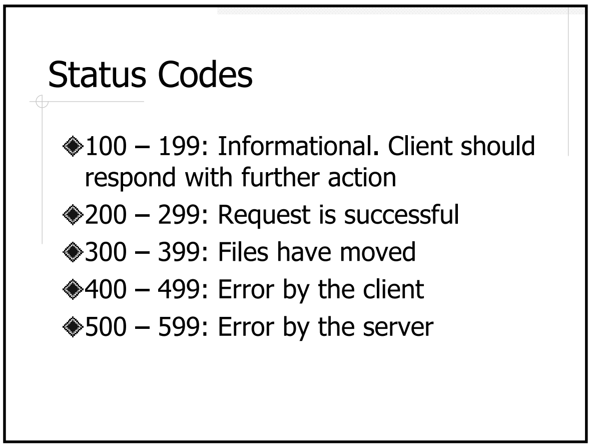
HTTP Response Example

```
HTTP/1.1 200 OK
Content-Type: text/html;charset=ISO-8859-1
Content-Length: 168
Date: Sun, 03 Oct 2004 18:26:57 GMT
Server: Apache-Coyote/1.1

<!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN">
<html><head><title>Servlet Life Cycle</title></head>
<body>
n is 299 and m is 440
</body>
</html>
```



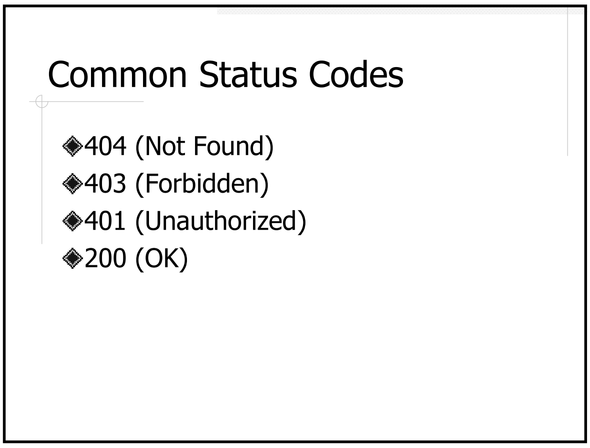
HTTP Response

- Status line
  - Protocol
  - Status code
- Header
- [Message body]



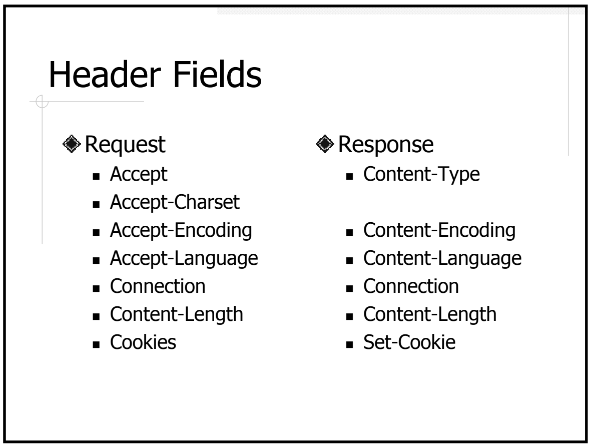
Status Codes

- 100 – 199: Informational. Client should respond with further action
- 200 – 299: Request is successful
- 300 – 399: Files have moved
- 400 – 499: Error by the client
- 500 – 599: Error by the server



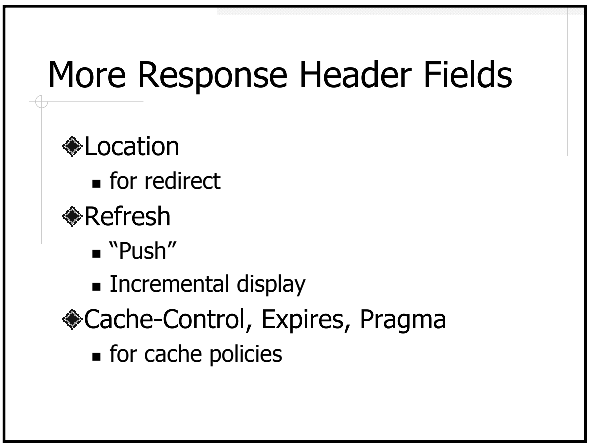
Common Status Codes

- 404 (Not Found)
- 403 (Forbidden)
- 401 (Unauthorized)
- 200 (OK)



Header Fields

- Request
  - Accept
  - Accept-Charset
  - Accept-Encoding
  - Accept-Language
  - Connection
  - Content-Length
  - Cookies
- Response
  - Content-Type
  - Content-Encoding
  - Content-Language
  - Connection
  - Content-Length
  - Set-Cookie



More Response Header Fields

- Location
  - for redirect
- Refresh
  - “Push”
  - Incremental display
- Cache-Control, Expires, Pragma
  - for cache policies

Example: File Download

- Download file using a servlet
  - Indicate file name
  - Indicate whether file should be displayed or saved

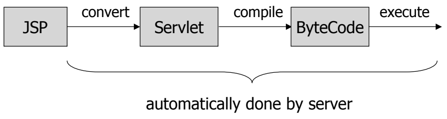
Java Server Page (JSP)

- Why?
  - It’s tedious to generate HTML using println()
  - Separate presentation from processing
- How?
  - *Java code* embedded in *HTML documents*

HelloJSP.jsp

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.0
Transitional//EN">
<HTML>
<HEAD><TITLE>JSP Hello World</TITLE></HEAD>
<BODY>Hello World on <%= new java.util.Date() %>.
</BODY>
</HTML>
```

How Does JSP Work?



- Look under $CATALINA_HOME/work/Catalina/localhost/*context_name*

Some Simple Observations about the JSP/Servlets

- In package org.apache.jsp
- _jspService() handles everything
- HTML text → out.write(...)
- A number of pre-defined variables
  - request, response, out
  - config, pageContext
  - page, session, application

JSP Components

- HTML template text
- Code elements of Java
  - Directives
  - Scripting elements
  - Beans
  - Expression language
  - Custom tag libraries

Directives

- Affect the overall structure of the JSP/servlet
- **<%@** *type attr=“value” …* **%>**
- Three type of directives
  - page
  - include
  - taglib

Directive Examples

<%@ **page import**=“java.util.*, java.util.zip.*” %>

<%@ **page contentType**=“text/html” %>

<%@ **page pageEncoding**=“Shift_JIS” %>

<%@ **page session**=“false” %>

<%@ **taglib** prefix="c" uri="http://java.sun.com/jsp/jstl/core" %>

<%@ **include** file=“path_to_file” %>

Comments

- **<%--** Hidden Comments **--%>**
- **<!--** Output (HTML) Comments **-->**

Scripting Elements

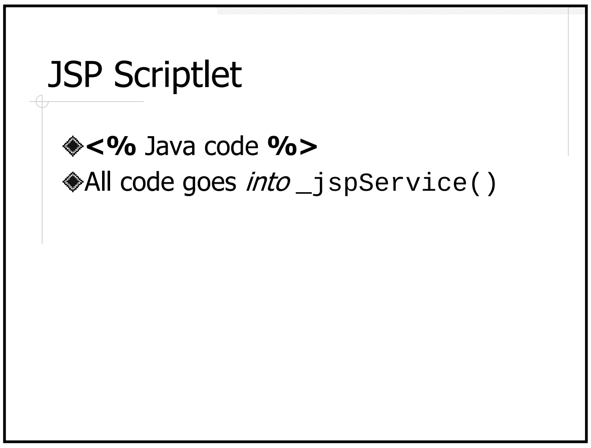
- JSP Expression
- JSP Scriptlet
- JSP Declarations

Scripting Elements Example

- RequestCounter servlet
- RequestCounter in JSP with scripting elements

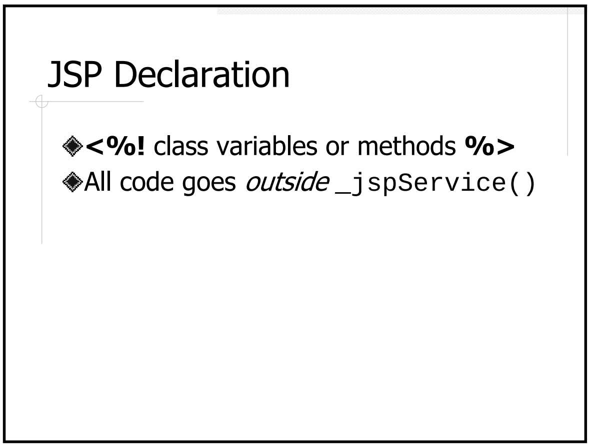
JSP Expression

- **<%=** Java expression **%>**
  - What’s an expression??
- Converted to `out.print(…)` in `_jspService()`



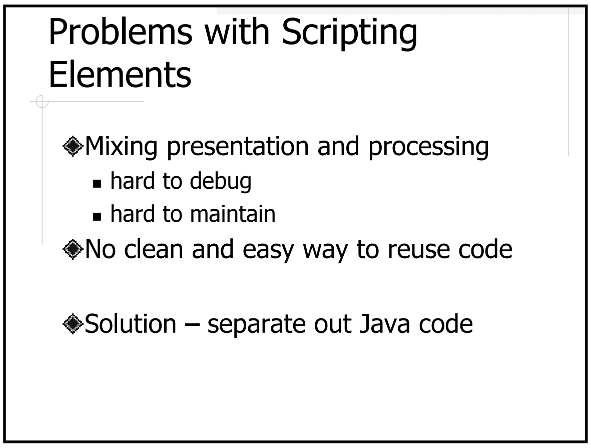
JSP Scriptlet

- **<%** Java code **%>**
- All code goes *into* `_jspService()`



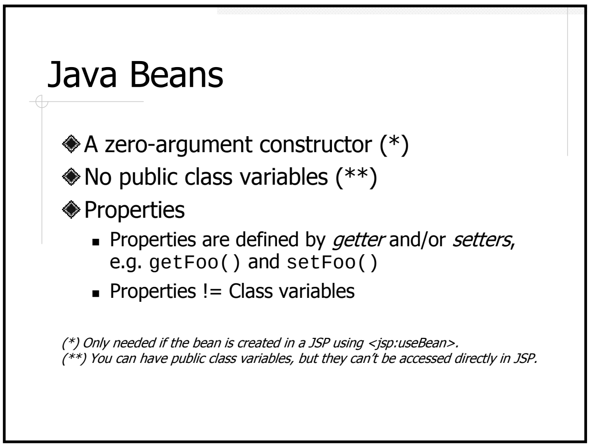
JSP Declaration

- **<%!** class variables or methods **%>**
- All code goes *outside* `_jspService()`



Problems with Scripting Elements

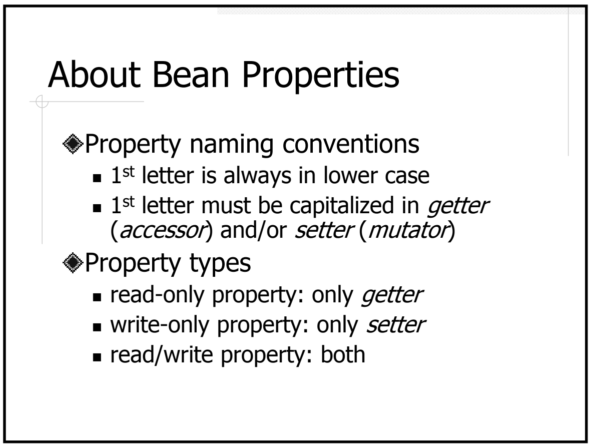
- Mixing presentation and processing
  - hard to debug
  - hard to maintain
- No clean and easy way to reuse code
- Solution – separate out Java code



Java Beans

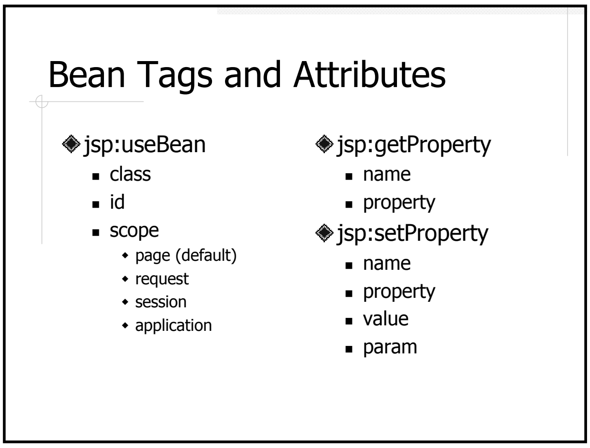
- A zero-argument constructor (*)
- No public class variables (**)
- Properties
  - Properties are defined by *getter* and/or *setters*, e.g. `getFoo()` and `setFoo()`
  - Properties != Class variables

(*) Only needed if the bean is created in a JSP using <jsp:useBean>.
(**) You can have public class variables, but they can't be accessed directly in JSP.



About Bean Properties

- Property naming conventions
  - 1st letter is always in lower case
  - 1st letter must be capitalized in *getter* (*accessor*) and/or *setter* (*mutator*)
- Property types
  - read-only property: only *getter*
  - write-only property: only *setter*
  - read/write property: both



Bean Tags and Attributes

- jsp:useBean
  - class
  - id
  - scope
    - page (default)
    - request
    - session
    - application
- jsp:getProperty
  - name
  - property
- jsp:setProperty
  - name
  - property
  - value
  - param

Simple Bean Example

- RequestCounter using a Counter bean

Expression Language

- Expression Language (EL)
  - A JSP 2.0 standard feature
  - A more concise way to write JSP expressions
    - vs. <%= expression %>
  - Java’s answer to scripting languages
    - e.g. associative array
- EL Syntax

${ *expression* **}**

Expression

- Literals
- Operators
- Variables
- Functions
  - see Custom Tag Libraries

EL Literals

- `true`, `false`
- `23`, `0x10`, …
- `7.5`, `1.1e13`, …
- `“double-quoted”`, `‘single-quoted’`
- `null`

- No char type

EL Operators

- Arithmetic
  - +, -, *, /, %
  - div, mod
- Logical
  - &&, ||, !
  - and, or, not
- Relational
  - ==, !=, <, >, <=, >=
  - eq, ne, lt, gt, le, ge
- Conditional
  - ? :
- empty
  - check whether a value is null or empty
- Other
  - [], ., ()

EL Evaluation and Auto Type Conversion

${2+4/2}	
${2+3/2}	
${“2”+3/2}	
${“2”+3 div 2}	
${“a” + 3 div 2}	
${null == ‘test’}	
${null eq ‘null’}	

${empty “”}	
${empty param.a}	
${empty null}	
${empty “null”}	
${“abc” lt ‘b’}	
${“cs320” > “cs203”}	

EL Variables

- You cannot declare new variables using EL (after all, it’s called *"expression"* language).
- However, you can access beans, implicit objects, and previously defined scoped variables.

Implicit Objects

- pageContext
  - servletContext
  - session
  - request
  - response
- param, paramValues
- header,headerValues
- cookie
- initParam

- pageScope
- requestScope
- sessionScope
- applicationScope

Simple EL Example

- RequestCounter that shows visitor’s IP address

Limitations of EL

- Only expressions, no statements, especially *no control-flow statements*

⇩

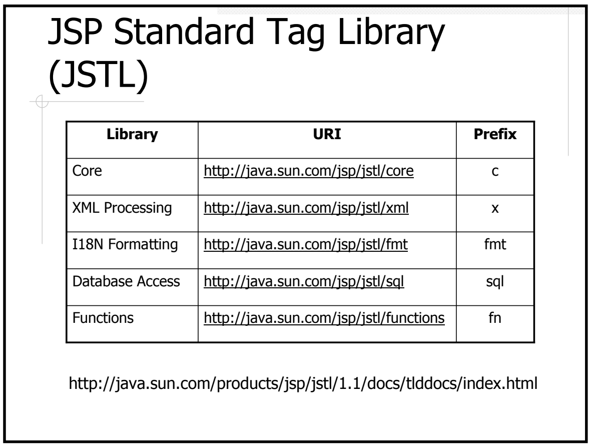
JSTL

JSTL Example

```
<%@ page contentType="text/html" %>
<%@ taglib prefix="c" uri="http://java.sun.com/jsp/jstl/core" %>

<html><head><title>JSTL Hello</title></head>
<body>

<c:out value="Hello World in JSTL." />

</body>
</html>
```

taglib Directive

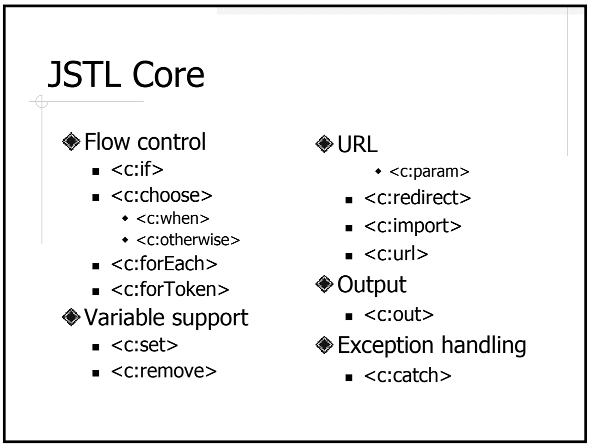
- URI
  - A unique identifier for the tag library
  - NOT a real URL
- Prefix
  - A short name for the tag library
  - Could be an arbitrary name



JSP Standard Tag Library (JSTL)

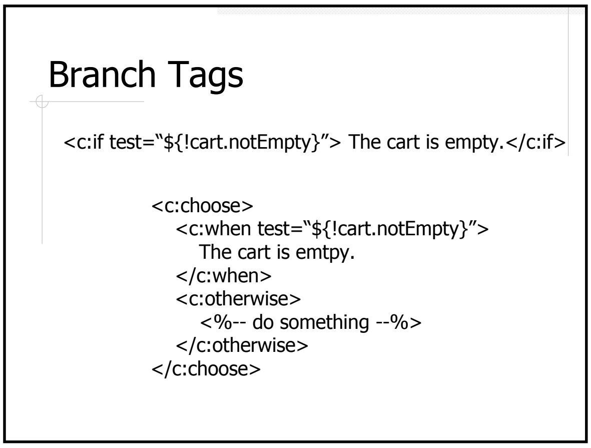
Library	URI	Prefix
Core	http://java.sun.com/jsp/jstl/core	c
XML Processing	http://java.sun.com/jsp/jstl/xml	x
I18N Formatting	http://java.sun.com/jsp/jstl/fmt	fmt
Database Access	http://java.sun.com/jsp/jstl/sql	sql
Functions	http://java.sun.com/jsp/jstl/functions	fn

http://java.sun.com/products/jsp/jstl/1.1/docs/tlddocs/index.html



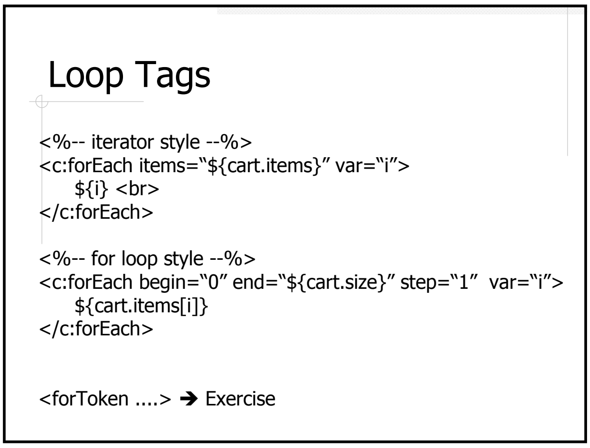
JSTL Core

- ◈Flow control
  - <c:if>
  - <c:choose>
    - <c:when>
    - <c:otherwise>
  - <c:forEach>
  - <c:forToken>
- ◈Variable support
  - <c:set>
  - <c:remove>
- ◈URL
    - <c:param>
  - <c:redirect>
  - <c:import>
  - <c:url>
- ◈Output
  - <c:out>
- ◈Exception handling
  - <c:catch>



Branch Tags

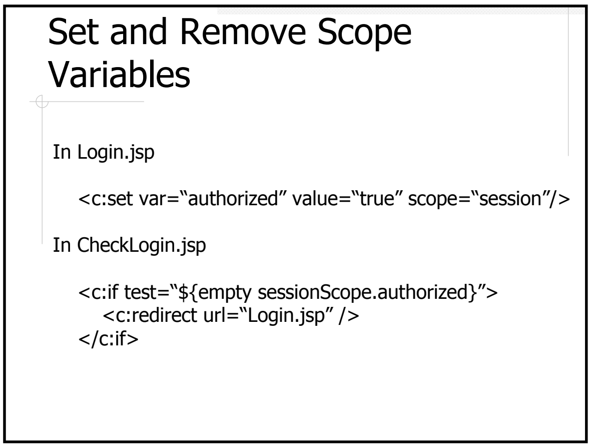
```
<c:if test=“${!cart.notEmpty}”> The cart is empty.</c:if>


           <c:choose>
              <c:when test=“${!cart.notEmpty}”>
                 The cart is emtpy.
              </c:when>
              <c:otherwise>
                 <%-- do something --%>
              </c:otherwise>
           </c:choose>
```



Loop Tags

```
<%-- iterator style --%>
<c:forEach items=“${cart.items}” var=“i”>
    ${i} <br>
</c:forEach>

<%-- for loop style --%>
<c:forEach begin=“0” end=“${cart.size}” step=“1”  var=“i”>
    ${cart.items[i]}
</c:forEach>
```

<forToken ....> ➔ Exercise



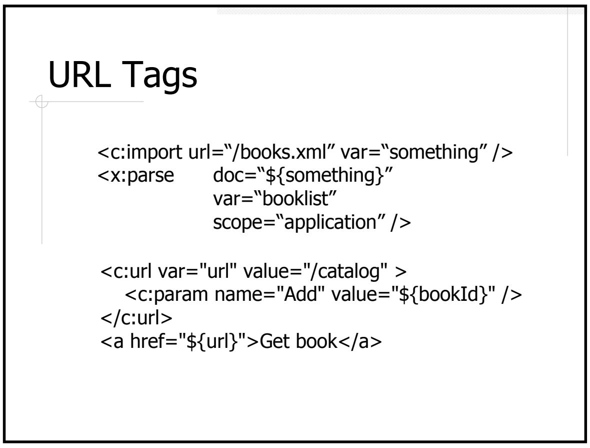
Set and Remove Scope Variables

In Login.jsp

```
<c:set var=“authorized” value=“true” scope=“session”/>
```

In CheckLogin.jsp

```
<c:if test=“${empty sessionScope.authorized}”>
   <c:redirect url=“Login.jsp” />
</c:if>
```



URL Tags

```
<c:import url=“/books.xml” var=“something” />
<x:parse      doc=“${something}”
              var=“booklist”
              scope=“application” />

<c:url var="url" value="/catalog" >
   <c:param name="Add" value="${bookId}" />
</c:url>
<a href="${url}">Get book</a>
```

Output

```
<c:out value=“100” />          ⇨    ${100}
<c:out value=“${price}” />          ${price}
```

◈You want to use <c:out> if

- *escapeXML*=true
- *value* is a Java.io.Reader object

Character Conversion

◈When *escapeXML*=true

<	&lt;
>	&gt;
&	&amp;
‘	&#039;
“	&#034;

Exception Handling

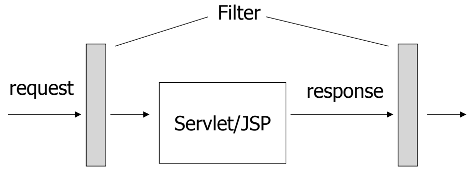
◈<c:catch>

Bean + EL + JSTL Example

◈GuestBook.jsp

Filter

◈Intercept, examine, and/or modify request and response



Filter Example

◈CheckParamFilter

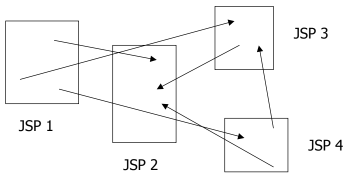
- Check whether a request comes with certain parameters

Putting It All Together - Java Web Application

- Components
  - Servlets
  - Filters
  - JSPs
  - Classes
  - Static documents (HTML, images, sounds etc.)
  - Meta information
- *Everything in the same context is considered part of <u>one</u> application*

Model 1 Architecture

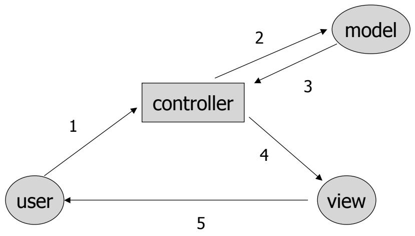
- JSPs + Java beans
  - JSPs for presentation
  - beans for business logic



Model 2 Architecture

- Also know as Model-View-Controler (MVC) architecture
  - JSPs + beans + servlet
  - Beans for business logic – Model
  - JSPs for presentations – View
  - servlet for web logic – Controller
    - HTTP related processing, e.g. request, response, sessions etc.
    - *Request dispatching*

MVC Control Flow ...



... MVC Control Flow

1. Process request
2. Populate beans
3. Store results in request, session, or servlet context
4. Forward request to JSP page
5. Extract bean data from beans and display

GuestBook (MVC Version)

- Model
  - GuestBook
- Controller
  - Display
  - Add comment
- View
  - Display
  - Add comment

Need for Web Application Frameworks

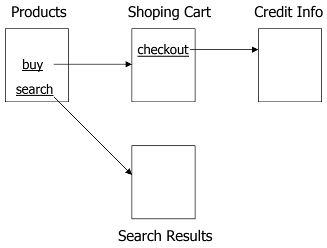
- ◈Simplifying creation of controllers
- ◈Front controller
- ◈Input validation
- ◈Error and exception handling
- ◈Transaction support
- ◈Integration of common libraries
- ◈...

Some Java Web Application Frameworks

- ◈Struts
  - http://struts.apache.org/
- ◈Spring
  - http://www.springframework.org/
  - More than a MVC framework
- ◈WebWork, Tapestry, JSF, GWT, ...

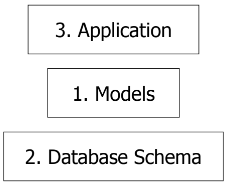
Web App Development – Where Do We Start?

- ◈Control flow driven approach

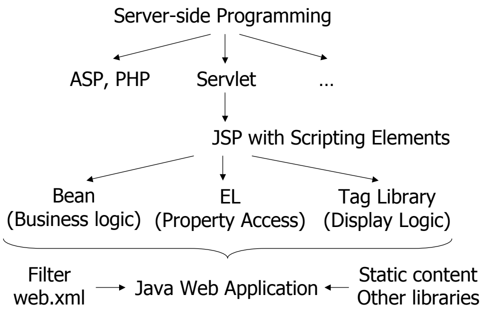


Web App Development – Where Do We Start?

- ◈Data driven approach



Summary


Server-side Programming
ASP, PHP
Servlet
...
JSP with Scripting Elements
Bean
(Business logic)
EL
(Property Access)
Tag Library
(Display Logic)
Filter
web.xml
Java Web Application
Static content
Other libraries